REQUEST FOR PERMISSION TO REPRODUCE MATERIAL

Washington State University Library System

FORMAT IN WHICH MATERIAL IS TO BE REPRODUCED

Permission is requested for posting the material described below in digital form on the Cedar Mesa Project Research Community web site https://research.wsulibs.wsu.edu:8443/dspace/handle/2376/735 Posting will make the requested material publicly accessible as part of the Washington State University Library Research Exchange digital repository of research-related documents. See background information about the Research Exchange at https://research.wsulibs.wsu.edu:8443 - WSU Research Exchange The Washington State University Library reserves the right to mask or delete topographic maps or text passages that provide detailed information on the location of specific archaeological sites, in conformance with policies of the U.S. Bureau of Land Management under the Archaeological Resources Protection Act.

MATERIAL FOR WHICH PERMISSION IS REQUESTED

Haase, William R., IV

By signing and submitting this permission form, you (the author) grant to Washington State University Library the non-exclusive right to digitally reproduce and transmit your submission worldwide in electronic medium via the Research Exchange web site, as described above. You also agree to hold harmless Washington State University from any claims to damage resulting from the digital reproduction and/or electronic distribution of your submission.

PERMISSION GRANTED BY:

Name and title WILLIAM R. HAASE

Telephone/email (860) 464-1242 haase55@comcast.net

Institution

Signature

Date 02/11/07

PLEASE RETURN SIGNED FORM TO:
Dr. Mary Collins, Director
Museum of Anthropology
Washington State University
Pullman, WA 99164-4910
PUEBLO II AND PUEBLO III SETTLEMENT PATTERNS ON
CEDAR MESA, SOUTHEASTERN UTAH

By
William Rudolph Haase, IV

A thesis submitted in partial fulfillment of
the requirements for the degree of
MASTER OF ARTS

WASHINGTON STATE UNIVERSITY
Department of Anthropology

1983
To the Faculty of Washington State University:

The members of the Committee appointed to examine the Thesis of WILLIAM RUDOLPH HAASE, IV find it satisfactory and recommend that it be accepted.

__________________________
Chairman
ACKNOWLEDGMENTS

As is the case with any undertaking of this scope, literally dozens of people have contributed in some way to its successful completion. I cannot mention every individual, but I sincerely wish to thank them all.

I thank the members of my thesis committee, Drs. William D. Lipe, John Bodley, Timothy Kohler and R.G. Matson for both their constructive comments and patience as I pursued a variety of ideas about settlement patterns. Tim Kohler and R.G. Matson are to be especially thanked for assistance with statistical methods and warnings about the limits of such techniques.

I also thank Dr. Bruce Frazier of the Soils and Agronomy Department at Washington State University for allowing me to use the department's Bausch and Lomb Zoom Transfer Scope, thus enabling me to make resource maps of the Cedar Mesa study area. Susan Matson did an excellent job redrafting figures I botched the first time around. When time came to prepare the final draft of this thesis, Thirza Kennedy and Cathy Watts provided much needed assistance with the Dolores Archaeological Program word processing facilities.

Final thanks go to Laurie Whiting, whose patience and understanding saw me through three years at Washington State University. Her editing has made this thesis a readable document.
PUEBLO II AND PUEBLO III SETTLEMENT PATTERNS ON
CEDAR MESA, SOUTHEASTERN UTAH

ABSTRACT

by William Rudolph Haase, M.A.
Washington State University, 1983

Chairman: William D. Lipe

This thesis identifies several environmental and cultural factors that affected prehistoric Pueblo settlement on portions of Cedar Mesa, southeastern Utah. The settlements were established by farmers of the Mesa Verde and Kayenta branch of the Anasazi cultural tradition during the late Pueblo II and Pueblo III periods (A.D. 1050 to 1270).

Data were gathered from three drainage basins on Cedar Mesa. Forty-five randomly located 400 m square quadrats were surveyed, providing a 7 percent sampling rate. The settlement pattern analysis was accomplished by: 1) a review of literature regarding Southwestern settlement patterns; 2) formulation of hypotheses that could be tested against the archaeological data; and 3) objective evaluation of hypotheses using statistics.

Two site types capable of statistical evaluation were recognized: dispersed habitations and seasonally utilized field stations. Most of the field stations are found within the pinyon-juniper plant community above 1950 m elevation in the highest portions of the study area. Small numbers of field stations also are found in the lower elevation desert shrub community, and in the canyon and escarpment zones. Only the pinyon-juniper zone has large quantities of arable land and enough precipitation to support successful agriculture. Within this zone, field stations are located either
upon divides having deep soil or along drainages that provide floodwaters after thundershowers. Field stations have two directional aspects: mesic northern exposures and drier but sunny southern exposures.

Habitations are also primarily within the pinyon-juniper plant community, but show less variability in environmental associations than do field stations. These sites have predominantly southern exposures and with few exceptions, are found upon watershed divides. Proximity to drinking water is not important until after A.D. 1150, when habitations tend to be located closer to springs.

Methods used to assess cultural factors affecting settlement pattern were less rigorous than those used in the environmental analysis; nevertheless, patterns could be inferred. The first Pueblo farmers on Cedar Mesa settled atop earlier Basketmaker III sites, but later settlers generally did not. For all phases, facility types at field stations increase with increasing distance from contemporary habitations. Finally, habitations tend to cluster into semi-nucleated "homestead groups" at the highest elevations of the study area.

It is believed that most farming occurred within sight of habitations, and that field stations are an attempt to diversify farming locations into a number of different environmental settings to avoid catastrophic effects on the agricultural system. Drought, frost, or other problems would have a lesser chance of wiping out an entire crop if several fields in different locations were used.
TABLE OF CONTENTS

ACKNOWLEDGMENTS

ABSTRACT

LIST OF TABLES

LIST OF ILLUSTRATIONS

Chapter
I. INTRODUCTION ........................................... 1

   The Cedar Mesa Project .................................. 2
   Scope of thesis data ....................................... 3
   Goals and purpose ......................................... 6

II. ENVIRONMENTAL PERSPECTIVE ............................. 11

   Geology and physiography .................................. 11
   Climate ..................................................... 14
   Plant communities and vegetation ......................... 17

      Desert shrub community ................................ 20
      Pinyon-juniper woodland community .................... 23
      Escarpment community ................................... 25
      Canyon community ....................................... 26

   Summary ................................................... 27

III. CHRONOLOGY OF PUEBLO REMAINS ON CEDAR MESA ............ 29

   The Pueblo occupation sequence .......................... 31

IV. CLASSIFICATION OF PUEBLO ARCHAEOLOGICAL SITES ........... 38

   Pueblo site types found on Cedar Mesa .................... 38

      Habitations ............................................. 39
      Field stations .......................................... 43
      Limited use sites ....................................... 45
      Community integrative structures ...................... 45

   Multidimensional scaling of habitations and field stations .. 47
TABLE OF CONTENTS (continued)

V. ENVIRONMENTAL FACTOR IN SETTLEMENT LOCATION ........... 51

Variables used in settlement pattern analysis .......... 51
Methods of settlement pattern analysis .......... 55

Random points and clustering effects .......... 59
Strength of associations between variables .......... 60

Plant community as a factor in site location .......... 62
Biotic association as a factor in site location .......... 64
Landform as a factor in site location .......... 67
Aspect or exposure as a factor in site location .......... 71
Elevation as a factor in site location .......... 75
Distance to nearest probable water source .......... 78
Distance to nearest drainage .......... 82
Watershed divide as a factor in site location .......... 86

Distance to nearest watershed divide .......... 87
Rank of nearest watershed divide .......... 90

Summary of environmental factors of site location .......... 92

Preferred locations for field stations .......... 98
Preferred locations for habitations .......... 99

VI. CULTURAL FACTORS IN SETTLEMENT LOCATION .......... 101

Shifting settlement location over time .......... 102
Investment in facilities at field stations .......... 105
Pueblo homestead groups .......... 113
Settlement systems on Cedar Mesa .......... 115

VII. SUMMARY .......... 123

REFERENCES CITED .......... 132
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Plant communities and biotic associations present within the Cedar Mesa study area</td>
<td>21</td>
</tr>
<tr>
<td>2.</td>
<td>Pueblo components listed by occupational phase</td>
<td>37</td>
</tr>
<tr>
<td>3.</td>
<td>Site facilities present at Pueblo components within the study area</td>
<td>40</td>
</tr>
<tr>
<td>4.</td>
<td>Binomial confidence intervals of site distribution among plant communities</td>
<td>63</td>
</tr>
<tr>
<td>5.</td>
<td>Binomial confidence intervals of site distribution among biotic associations</td>
<td>66</td>
</tr>
<tr>
<td>6.</td>
<td>Binomial confidence intervals of site distribution upon landforms</td>
<td>70</td>
</tr>
<tr>
<td>7.</td>
<td>Aspect or directional orientation of sites</td>
<td>73</td>
</tr>
<tr>
<td>8.</td>
<td>Rank of nearest watershed divide</td>
<td>91</td>
</tr>
<tr>
<td>9.</td>
<td>Summary of environmental factors of settlement location for habitations and field stations</td>
<td>93</td>
</tr>
<tr>
<td>10.</td>
<td>Statistical summary of environmental variables</td>
<td>97</td>
</tr>
<tr>
<td>11.</td>
<td>Pueblo components having spatial overlap with Basketmaker III remains</td>
<td>103</td>
</tr>
<tr>
<td>12.</td>
<td>Pueblo &quot;homestead groups&quot;</td>
<td>114</td>
</tr>
</tbody>
</table>
# LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Map of the Cedar Mesa region</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>East-west profile of study area</td>
<td>19</td>
</tr>
<tr>
<td>3.</td>
<td>Chronology of archaeological remains on Cedar Mesa and the Red Rock Plateau</td>
<td>30</td>
</tr>
<tr>
<td>4.</td>
<td>Frequency histogram of tree-ring cutting dates from the Cedar Mesa region, A.D. 1030 to 1270</td>
<td>34</td>
</tr>
<tr>
<td>5.</td>
<td>Scatter diagram derived from multidimensional scaling showing placement of 78 pueblo components</td>
<td>49</td>
</tr>
<tr>
<td>6.</td>
<td>Example of a Tukey box-and-whisker plot</td>
<td>58</td>
</tr>
<tr>
<td>7.</td>
<td>Rose diagrams showing proportions of random points and prehistoric sites oriented in cardinal</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>and subcardinal directions</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Elevations of random points and archaeological sites</td>
<td>77</td>
</tr>
<tr>
<td>9.</td>
<td>Distance to nearest probable water source</td>
<td>80</td>
</tr>
<tr>
<td>10.</td>
<td>Distance to nearest drainage</td>
<td>85</td>
</tr>
<tr>
<td>11.</td>
<td>Distance to nearest watershed divide</td>
<td>89</td>
</tr>
<tr>
<td>12.</td>
<td>Placement of sites by phase along an east-west axis through the Cedar Mesa study area</td>
<td>106</td>
</tr>
<tr>
<td>13.</td>
<td>Distance between contemporary habitations and field stations</td>
<td>110</td>
</tr>
<tr>
<td>14.</td>
<td>Settlement types within the study area and elevational ranges in which they occur</td>
<td>117</td>
</tr>
<tr>
<td>15.</td>
<td>Inter-site relationships between settlements occupied by related households on Cedar Mesa</td>
<td>119</td>
</tr>
<tr>
<td>16.</td>
<td>Inter-site relationships between settlements forming a Pueblo settlement-subsistence system</td>
<td>120</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

In the American Southwest, a number of factors, including length of growing season, distribution of precipitation, and access to important resources imposed limits on prehistoric settlement. In particularly marginal regions where resources were scarce or widely scattered, the survival of a community depended upon the locational strategies of its inhabitants. One of these marginal regions was Cedar Mesa, located in the southeastern portion of Utah immediately north of the San Juan River. For nearly a millennium, farmers and horticulturalists established dispersed settlements consisting of widely scattered homesteads on mesa tops and within canyons of the region.

Virtually all prehistoric occupation on Cedar Mesa can be assigned to the Anasazi tradition, confined to the period between A.D. 200 and A.D. 1270. Within this time frame, substantial changes in population and settlement pattern occurred. Using units of the Pecos Classification (Kidder 1927), Matson and Lipe (1978) developed the following cultural sequence for the area: Basketmaker II sites are abundant, both in rock shelters in canyons and on mesa tops near canyon rims. Basketmaker III sites occur on mesa tops and to some extent in canyons, but are rare relative to sites of other periods. Except for the extreme eastern portions of the plateau, Cedar Mesa was unoccupied by permanent settlers during the Pueblo I and early Pueblo II periods. By late Pueblo II and early Pueblo III, a strong occupation is again evident on the mesa tops. By mid-Pueblo III the canyons are again reoccupied, and during late Pueblo III the area, along with the rest of the region north of the San Juan River, is abandoned by the Anasazi. Today, the Anasazi are considered ancestors of Pueblo Indians living in Arizona and New Mexico.
During all periods on Cedar Mesa, habitation sites tend to be small by southwestern standards, and there are many small limited activity sites detached from habitations. This is true even for the "classic" Pueblo period (ca. A.D. 1100 to 1300), when the Anasazi congregated into large permanent communities in some other places in the Four Corners area (cf. Wormington 1947; Martin and Plog 1973). Most sites have only thin deposits of cultural debris, and appear to be single component, at least in terms of the general periodization given above (Lipe and Matson 1974:16). Significant exceptions occur in some of the habitation sites; most sites in the Cedar Mesa region, however, appear to have been occupied only briefly.

The Cedar Mesa Project

Data for this thesis were obtained through systematic surface survey and excavations conducted by William Lipe and R.G. Matson between 1971 and 1976. The project was originally stimulated by discussions at the 1971 meeting of the Southwestern Anthropological Research Group (Gumerman 1971). The group's effort and research focused on the question, "Why did prehistoric populations locate sites where they did?" (Plog and Hill 1971:11). When applying this question to the Cedar Mesa region, Lipe and Matson established the following goals: 1) reconstruct adaptive strategies of prehistoric cultures in the area; 2) identify the environmental limits of these adaptations; and 3) account for both change and stability in the cultural strategies.

At the outset of the Cedar Mesa Project, the decision was made to standardize sampling, surface survey, artifact collection and record keeping. The result is that sites from a number of different temporal periods and spatial locations have been accurately dated through pottery seriation (Matson and Lipe 1977) and compared with one another. Standardization has
also allowed application of a battery of quantitative and statistical techniques to the data for testing of hypotheses.

The sampling design used by Matson and Lipe (1975) called for stratification of Cedar Mesa into naturally defined clusters consisting of drainage basins separated from one another by watershed divides. Five clusters were selected through random means, representing the northern and southern portions of the mesa. Within each watershed unit, a number of 400 meter square survey quadrats were randomly chosen. The quadrats covered approximately 7 percent of the surface area of each watershed unit. An intensive survey of each 400 meter square quadrat was then conducted, and all surface artifacts were then collected from archaeological sites found within the sampling units. Checklists of botanical and physiographic characteristics were also filled out for each of the sites and random quadrats examined. In all, 76 quadrats were intensively surveyed within the 5 watershed units, yielding detailed survey records on 268 prehistoric sites dating from Basketmaker II through Pueblo III.

Intensive surveys indicated that site densities ranged from less than 12 per square kilometer in some of the lower elevation areas, to upwards of 60 per square kilometer in some locations near watershed divides. For Lipe and Matson (1974:17), a "site" was a "conveniently mappable concentration of artifacts and/or features, ordinarily separated from other such concentrations by areas in which features and artifacts were absent or occurred in extremely low densities."

Scope of Thesis Data

Information used for this analysis is actually a subset of data from the Cedar Mesa Project, because 1) analysis is limited to late Pueblo II and
Pueblo III remains, and 2) only 3 of the 5 watershed units mentioned above are examined. By narrowing investigation to just the late Pueblo periods, individual factors affecting the settlement pattern can be examined in greater depth than would be the case if the entire thousand-year record were explored. Furthermore, the period to be examined can itself be divided into four phases of Puebloan occupation spanning 200 years.

Three watershed units -- Hardscrabble, Bullet and North Road -- were chosen for analysis because they form a contiguous east-west transect across the heart of Cedar Mesa. The three units combined form a single transect or study area 31 km long and 2 to 6 km wide (Figure 1). The canyons of Bullet and North Road provide names for two portions of the study area, while the third portion -- Hardscrabble -- was named after a large sagebrush park located southeast of the point where Polly's Canyon entrenches into the mesa. Two other watershed units, Upper Grand Gulch and West John's Canyon, were also examined as part of the Cedar Mesa Project during the 1970's. Because they do not form part of the east-west transect, the information they yielded is not used in this thesis.

Forty-five of the 76 randomly chosen survey quadrats fell within the Bullet, Hardscrabble and North Road watershed units. Superimposition of these quadrats on a vegetation/landform map assembled for this thesis indicates that all of the natural plant communities and biotic associations were included in the quadrat sample. Seventy-eight Pueblo components within these quadrats are examined as part of this study.

As indicated above, archaeological sites were defined in the field only as conveniently mappable concentrations of prehistoric remains. This was done so site definition would be based only on observable spatial patterning of artifacts and features. As work on this thesis progressed, I found that
STUDY AREA OUTLINED
1 HARDSCRABBLE
2 BULLET
3 NORTH ROAD

SURVEY QUADRATS

Figure 1. Map of the Cedar Mesa Region
a number of sites had spatially overlapping but temporally distinct components. As part of my analysis, I constructed maps of multi-component sites and plotted locations of ceramics from different temporal periods on them. This separated 19 of the sites into two or more distinct components and facilitated interpretation of the data. Thousands of additional sites exist on Cedar Mesa, but these are located outside random quadrats, cannot be identified with a particular period, or are from the earlier Basketmaker II or III periods. These were not analysed as part of this thesis.

A three-part alphanumerical designation was assigned each site during survey. Sites from Hardscrabble are given the prefix HS, those from Bullet are B, and those from the North Road unit of the east-west transect are NR. The second part of the designation is a number indicating which survey quadrat the site was found in. Because some quadrats contain several sites, the third part of the alphanumerical designation indicates individual sites within each quadrat in the order they were discovered by field survey crews. Thus, B 1-1 refers to site one in quadrat one of the Bullet watershed unit. Multiple-component sites complicate the system. When sites were divided into two or more components, each was assigned a letter from the alphabet. If the above site had been divided into two components, the designations would be B 1-1A and B 1-1B. These separate designations are essential because each component is treated individually in the study.

**Goals and Purpose**

This thesis will focus on patterns of settlement during the late Pueblo II and Pueblo III periods (ca. A.D. 1060 to 1270), when Cedar Mesa was occupied by Anasazi farmers. Ceramics indicate that both the Mesa Verde and Kayenta branches of the Anasazi are represented, though Mesa Verde dominates
all but one phase. Communities consisting of small, dispersed sites, as is
caracteristic of Cedar Mesa offer a number of advantages in the southwestern
environment. The dispersed settlements may be distributed to provide good
access to noncontiguous patches of arable land, to availability of drinking
water, or to the spotty distribution of other resources. As a consequence,
settlement patterns on Cedar Mesa are expected to reflect resource access
priorities set by the Puebloan cultural system.

This paper is intended to be a case study of adaptation in what was to
agriculturalists at least, a marginal environment. The goals of this study
are: 1) to identify the set of environmental and cultural factors that
affected settlement location, and 2) because human behavior is variable, to
establish the range within which these factors affect Pueblo settlement
location.

Settlement pattern studies deal with how and why sites are distributed
over a landscape. Settlement patterns have been a focus of archaeological
study since the late 1940's, when Gordon Willey first examined regional
patterning of settlements in the Viru Valley of Peru. Willey (1956:1)
defined "settlement pattern" as:

... the way in which man disposed himself over the landscape on which
he lived. It refers to dwellings, to their arrangement, and to the
nature and disposition of other buildings pertaining to community life.
These settlements reflect the natural environment, the level of
technology on which the builders operated, and the various institutions
of social interaction and control which the culture maintained.

Within this broad definition of settlement pattern are two levels of
emphasis: Man-land and man-man relationships. Man-land relationships stress
the availability, abundance, spacing and seasonality of plant, animal and
mineral resources in determining locations of settlements (Roper 1979:120).
Man-man relationships stress interactions among contemporaneous settlements
affecting locational patterning. Man-land and man-man relationships are not polar opposites; each needs to be recognized and addressed when interpreting the archaeological record. Both will be examined as they impinge on the distribution of sites across the landscape of Cedar Mesa.

The analysis and interpretation of settlement patterns will be facilitated by statistical evaluation of the data. The approach taken here is essentially a three step process outlined by Steele and Torrey (1980:4). It consists of: 1) a review of facts, theories and proposals; 2) formulation of logical hypotheses subject to testing by experimental methods; and 3) objective evaluation of hypotheses based on the experimental results. In Chapter IV, analytical techniques are used to evaluate an intuitive classification of site type and function. In Chapters V and VI, patterns of settlement will be evaluated using binomial confidence intervals, Tukey box-and-whisker plots, and non-parametric statistics such as chi-square tests, the Wilcoxon's rank-sum test, and the Kruskal and Wallis multi-sample test. Procedures of each test will be described at appropriate places in the following chapters. The fundamental goal of each, however, is objective evaluation of hypotheses concerning Puebloan settlement patterns.

Not explicit in the scientific method is the process one uses to develop appropriate hypotheses or interpret patterns found as a result of analytical techniques. For this thesis, the research of other archaeologists, an evaluation of the general environmental constraints on rainfall farming, and analogy with living cultural groups, will be used as a source for both hypotheses and interpretations of the prehistoric record. Because ethnographic analogy as it is used here is the most subjective of the three, it will be discussed in some detail.
For too many years, Southwestern archaeology has been guided by a largely implicit model based on analogy with ethnographically known Pueblo Indians. As a result, prehistoric Puebloans were expected to be villagers, living in substantial and permanent communities. In actuality, this situation was rare in the northern Southwest prior to regional abandonment about A.D. 1300 (Lipe 1970:121). As Jennings (1963:12-13) writes:

One forgets the huge centers are rare and scattered, found only in very favorable locations ... most settlements are fairly small; they consist of one or two dwellings and a cluster of storage rooms, which can be most descriptively called little ranches or rancherias.

Settlement and community patterns in "marginal" areas such as Cedar Mesa differ from the ethnographic pattern and also from patterns observed prehistorically in such places as Chaco Canyon or the Yellowjacket district of southwestern Colorado, where large pueblos abound.

Recognition of these differences necessitated development of a settlement model for Cedar Mesa that is somewhat independent of analogies based on other Pueblo groups. As Lipe and Matson (1974:101) write, "Continuities of cultural style do not necessarily imply continuities of organization or adaptation." After a number of conversations with R.G. Matson, it was decided the historic Navajo settlement pattern would provide the best analog to distributions of prehistoric Puebloan sites on Cedar Mesa. The Navajo population is dispersed, and tends to be confined to homesteads containing only one or a few dwellings occupied by a nuclear family or a small extended family (Jett and Spencer 1981:7). Although herders, the traditional Navajo subsisted largely on corn, beans and squash, and like the prehistoric residents of Cedar Mesa, tended to place fields in dispersed locations where natural factors such as growing season length and precipitation would be maximized. Further supporting this analogy is the fact that the Navajo
occupy, or recently occupied, the same areas as the Anasazi. Ancient Pueblo masonry storage structures are occasionally reutilized by the Navajo while they till fields that must have been used prehistorically by the Pueblo (Jett and Spencer 1981:191). On Cedar Mesa, remnants of a few sweat lodges and brush corrals have been found, often in proximity to Anasazi ruins.

Of course, there are differences between the Navajo and the Anasazi. One of the most obvious is that the Navajo are pastoralists, herding domestic sheep brought to the New World by the Spanish after A.D. 1500. To a degree, this affects Navajo settlement patterns, creating seasonal shifts in settlement not found in the archaeological record of the Anasazi. Also, there are no direct historical connections between the prehistoric remains of Puebloans and Navajo on Cedar Mesa. The latter group did not enter the Southwest until after the region north of the San Juan River was abandoned by the Anasazi (Jett 1978:352). There are other differences, but these examples serve to underline the limits of the analogy to anything more than general inferences about settlement patterns. In sum, the Navajo are used to construct interpretative or general analogies, based not on historical continuities, but on formal similarities between the two cultures (Charlton 1981:133).
CHAPTER II
ENIRONMENTAL PERSPECTIVE

As stated in the introduction, the goal of this thesis is to establish a model of settlement location that assumes strong effects for the distributions and quantities of resources essential for maintenance of late Pueblo II and Pueblo III lifeways. The purpose of this chapter is to 1) provide an environmental background for establishment of hypotheses designed to test man-land factors of settlement location, and 2) establish the range or extent of natural features and vegetation within the study area, against which the hypotheses can be tested.

Geology and Physiography

Cedar Mesa is a region north of the San Juan River consisting of uplifted tablelands covered with low-lying sandstone "haystacks" and buttes. The surface is trenching by deep canyons that reveal their presence only when the rims are reached (Gregory 1938). Cedar Mesa is bounded by the San Juan River to the south, the valleys of Comb Wash and Lime Creek to the east and southeast, by the Elk Ridge highlands to the north, and by the deeply entrenched canyon of Grand Gulch to the west. Within the study area, surface drainage enters the San Juan River via the Comb Wash and Grand Gulch watersheds (Lipe and Matson 1971:126).

The surface of Cedar Mesa slopes upwards from both the west and east to form a broad flat north-south trending axis at the highest elevations. This axis marks the spine of the Monument Upwarp, a geologic structure extending from Canyonlands National Park in the north to Kayenta, Arizona in the south. The central axis, which is also the major drainage divide, slopes gradually
from about 2100 m at the north end of Cedar Mesa to about 1950 m at the southern end of the plateau overlooking the San Juan River. The study transect, comprised of the Hardscrabble, Bullet and North Road watershed units, is perpendicular to this axis, containing topographical relief of about 350 m. The lowest elevations, about 1700 m, are found at the extreme east and west portions of the transect, while the highest elevations, just over 2040 m, occur where the study area crosses the central axis of Cedar Mesa.

The plateau has been sculptured almost entirely out of Cedar Mesa Sandstone, a crossbedded, largely eolian formation of the Permian Age. This formation ranges in thickness from about 120 m on the south face of the mesa, to over 300 m in canyons at the foot of Elk Ridge. Overlying the Cedar Mesa Sandstone along the central axis of the mesa is a narrow belt of soft red shales and siltstones. These deposits, known as "Organ Rock Shale," also date to the Permian Age, and comprise the red to brown slope forming unit that overlies Cedar Mesa Sandstone across the entire Monument Upwarp (Baars 1972:87). Distribution of these shales is limited to a north-south trending band only about 20 km long and 1 to 2 km wide; consequently, most exposed bedrock on the plateau is Cedar Mesa Sandstone.

The drainage patterns on Cedar Mesa are predominately dendritic, resembling the spreading branches of an oak or chestnut tree. The numerous canyons of Cedar Mesa wind back and forth in a series of closely spaced meanders, and upon full entrenchment achieve depths of 150 to 300 m. Within canyons, sandstone walls begin with vertical drops of 10 to 15 m and continue downwards as a series of undercut ledges 3 to 15 m high (Gregory 1938:11). Cedar Mesa Sandstone is a good aquifer and there are generally year-round springs in the canyons, usually both at the point where entrenchment first
begins and in the canyon bottoms after full entrenchment (Lipe and Matson 1971:127).

Valleys filled with alluvial, colluvial and eolian sediments comprise the general topographic makeup of the mesa tops. Shallow parts of these valleys appear to form upland catchment basins for canyons, and frequently terminate where canyon entrenchment begins. Surficial deposits in mesa top valleys are currently somewhat dissected by arroyos, and the washes at their centers flow only after intense summer thundershowers.

For later tests of settlement location, the hundreds of drainages within the study area are ranked according to size and complexity. For example, all first order streams are incipient, short in length, and confined to mesa tops near watershed divides. Second order drainages are formed by the confluence of two first order streams, while third order drainages begin where two second order streams meet. Generally, streams of the first three ranks are located on the mesa tops. Fourth and fifth order streams entrench deeply into the Monument Upwarp, forming Bullet and North Road Canyons. Virtually all permanent water sources on Cedar Mesa are found along fourth and fifth order drainages, although even these are isolated springs and seeps flowing only short distances. Like lesser order drainages, water flows in these only after intense summer storms or during the spring when snow melts.

The polar opposite of a drainage is its watershed divide. Divides are boundaries of rainfall catchment areas for streams. On Cedar Mesa, divides are generally elevated topographical features covered with a mantle of fine sandy loam that was probably deposited by wind during the Pleistocene (Arrhenius and Bonatti 1965). In divide areas this unconsolidated loess reaches depths of up to 2 m, but thins rapidly near drainages and especially near canyon rims where large areas of bedrock are exposed. Loess in divide
areas is frequently dissected where unprotected by vegetation, forming short first order drainages. A few divides on Cedar Mesa are composed of long linear bands of exposed bedrock and colluvium, consisting primarily of the Organ Rock Formation, but even along these divides deep soil can be found in the immediate proximity. Over the centuries, much of the loess appears to have been washed into broad, shallow mesa top valleys creating colluvial and alluvial fills, some of which have depths of several meters.

Climate

According to Koppen's classification of world climates based on annual and monthly means of temperature and precipitation, Cedar Mesa has a cold, middle latitude, semiarid climate. Trewartha (1954:268) observes that, "In general, steppe or semiarid type of dry climate is a transitional belt surrounding the real desert and separating it from the humid climate beyond." Cedar Mesa is in such a transitional zone, and separates the xeric desert-shrub communities of Monument and Lime Creek Valleys to the south from the ponderosa pine covered Elk Ridge highlands to the north.

The importance of climate is due largely to its limiting effects on Pueblo agriculture. At higher elevations, farming is limited by short growing seasons, while at lower elevations, benefits of a lengthened growing season are offset by decreasing amounts of precipitation (Lowe 1967:7).

According to a limited 15-year record at Natural Bridges National Monument, which is located about 10 km north of the study area at 1950 m elevation, mean annual precipitation is 290 mm (11.5 in). The main source of precipitation are late winter and late summer storms, with 30 to 40 percent resulting from thundershowers during the latter half of the May-September
growing season. The first half of the growing season, from May to mid-July, is characterized by drought conditions and little rainfall.

These conditions mean that for the first half of the growing season, natural vegetation and domestic crops have to rely primarily on stored ground water from snow melt. According to R.G. Matson (personal communication):

Two factors are important for storing water from winter snow melt, those of storage capacity and exposure. The first is relatively straight-forward in that only deep soils have the capacity to store water. Most soils on Cedar Mesa are sandy loams, so storage capacity is controlled by soil depth, either to bedrock or to an impervious caliche horizon . . . Exposure or aspect is also important in moisture storage. North and northeast exposures hold snow longer because of less thermal input by a winter sun that rises in the southeast and sets in the southwest.

By combining the two aspects of rainfall and soil moisture storage, it is believed that some of the most suitable farmland for agriculturalists using dry-farming techniques would be deep unconsolidated soils on gentle north or northeastern facing slopes facing away from the winter sun.

The average frost free season at Natural Bridges is 145 days in length, varying from 163 days in 1976 to 122 days in 1967. Lipe and Matson (1971:128) report that estimates of growing season length on Cedar Mesa decrease with increasing elevation, ranging from 144 days at a point overlooking the San Juan River (1950 m) to about 129 days at the base of Elk Ridge (2100 m).

In addition to elevation, local topography is a micro-factor controlling length of the growing season. As Billings (1954) points out for the Great Basin, temperature inversions account for the lower limits of pinyon-juniper forest. Large parks of the more cold tolerant sagebrush grow at slightly lower elevations in the region studied by Billings. This phenomenon is apparently widespread, and may occur on Cedar Mesa as well, with the location of sagebrush in many of the shallow mesa top valleys being a partial response
to a slightly shorter growing season. Indeed, the sagebrush parks in the pinyon-juniper zone are colder during summer evenings than surrounding forest covered uplands. If this is the case, it would be expected that Pueblo farmers would avoid planting in low lying areas of potential cold air drainage.

For the Four Corners area in general, elevations for successful dry farming have been estimated as lying between 1950 and 2320 m by Kane (1977), or to have a maximum of 2255 m by Nickens (1977). Elevations within the Cedar Mesa study area are situated either below or just slightly above Kane's suggested lower limits for agriculture. These relatively low altitudes suggest the number of frost free days on Cedar Mesa may not have been as great a constraint on agriculture as the amount of annual precipitation, which decreases with lowering of elevation. Hack (1942:8) reports that for the Hopi farmers of northeastern Arizona, about 300 mm (12 in) of rainfall is necessary for successful cultivation of maize. Current yearly precipitation averages on Cedar Mesa are slightly below this, indicating the region is marginal for maize agriculture based on dry farming techniques.

In actuality, it appears that agricultural strategies on Cedar Mesa were a mix of dry farming and runoff farming. The latter method would have been dependent upon small watersheds (and in many cases, just a small slope above the field). While runoff farming would also be directly affected by drought, the impacts could be mitigated in that water for the crops did not have to fall directly on the fields. This could allow farming in areas slightly lower in precipitation than the limits suggested by Hack.

Although climatic fluctuations have occurred in the past (cf. Euler et al. 1979), overall trends of increasing precipitation with increasing elevation must have remained the same. If, as suggested, growing season
length was not the limiting factor, Puebloans relying on dry farming or even runoff farming would be expected to have most settlements at the upper elevations of the study area along the central axis of the mesa. These ideas will be tested in Chapter V. If today's climate is similar to that of the prehistoric period, it would appear that conditions for agriculture on Cedar Mesa would have been marginal at best; it is likely that even small fluctuations in amounts of precipitation would have resulted in either a bust or boom for the Anasazi farmers. In considering the relationship between man and the environment, Trewartha (1954:283) writes:

Because of the greater precipitation than in the deserts, the steppes are somewhat better fitted for human settlement, but this, together with the unreliable nature of the rainfall, also makes them regions of greater economic catastrophe. A succession of humid years may tempt settlers to push the agricultural frontier towards the desert, but here also drought years are sure to follow, with consequent crop failure and ensuing disaster.

**Plant Communities and Vegetation**

The climatic and edaphic factors discussed above interact with one another to create the vegetational mosaic of Cedar Mesa. This section will examine the mosaic, which is composed of plant communities and biotic associations found within the study area. It is essential that patterns and distributions of vegetation be understood before patterns of human settlement can be addressed in an analytical framework.

Frequently on Cedar Mesa, several plant species are found growing in association with one another, forming a grouping that contrasts with other distinctive clusters of plant species. Lowe (1967:7) calls these biotic associations, with each containing a specific species composition. A number of biotic associations repeatedly found adjacent to one another form plant
Plant communities. Plant communities are generally greater in areal extent than the area occupied by a single biotic association.

At first glance, plant species on Cedar Mesa appear distributed across the landscape in irregular patches which are more or less isolated from one another in a random fashion. Examination of a detailed vegetation/landform map of the study area prepared for this thesis, however, shows two regional trends:

1) Climatically determined vegetational patterning forms a continuum dependent upon elevation. Plant communities and biotic associations vary along a moisture-temperature gradient, with the species found at higher elevations being those that require greater precipitation than those found at lower altitudes.

2) Edaphically determined vegetational patterning consists of complex mosaics of abruptly changing biotic associations. These associations are generally found growing adjacent to one another, and are confined to the same relative elevation along a moisture-temperature gradient. Factors such as soil depth, soil type and exposure determine the distribution of particular plant species.

On Cedar Mesa, the moisture-temperature gradient appears to be the principal determinant of plant community boundaries. Exceptions are plant communities found within deeply entrenched canyons. Here, biotic associations follow canyon meanders, responding to moisture found along stream bottoms or stored in alluvium after spring runoff. Also, the moisture-temperature gradient is not completely related to elevation, as prevailing southwesterly winds tend to evaporate soil moisture in western portions of the study area. This results in xeric species being found at higher elevations on the west slopes of Cedar Mesa than is the case on the east slopes of the plateau.

The vegetation/landform map, the details of which are summarized in Figure 2, was constructed using color aerial infrared photographs (scale 1:31,680) taken by the U.S. Department of the Interior Bureau of Land
Figure 2. East-west profile of the study area
Management in the summer of 1975. The set of photographs allowed monocular transfer of vegetational details to a topographic base map. The base map (scale 1:13,000) was made from a set of photographic enlargements of preliminary 7 1/2-inch scale U.S. Geological Survey maps of Cedar Mesa. A scale of this size facilitated the inventory of landforms and biotic resources within the study area.

A Bausch and Lomb Zoom Transfer Scope was used to reconcile disparity in photo and map scales. With this device it was possible to optically superimpose aerial photographs and the base map into the same field of view while compensating for differences in scale. Images were then drawn directly onto the base map. When assembled, the map was over 2.5 m long and 70 cm wide. Although it was not possible to check for ground truth, the map is considered very reliable because plant checklists were available for each survey quadrat and for all archaeological sites discovered within the study area.

When completed, the base map showed placement of four plant communities and a number of biotic associations. These are listed on Table 1 and their distributions portrayed in cross-section on Figure 2. In the figure, biotic associations are listed along the left margin, while plant communities are summarized at the bottom of the page according to elevation within the study area. Although exposed bedrock is not truly a biotic association, it is treated as one in ensuing analyses because it forms an integral part of each of the four plant communities.

Desertshrub Community

Desertshrub communities on Cedar Mesa are found in western portions of the study area between 1700 and 1860 m elevation, and contain biotic
Table 1.—Plant communities and biotic associations present within the Cedar Mesa study area.

<table>
<thead>
<tr>
<th>Plant Community</th>
<th>Biotic Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desert shrub</td>
<td>Blackbrush</td>
</tr>
<tr>
<td></td>
<td>Mixed blackbrush and sagebrush</td>
</tr>
<tr>
<td></td>
<td>Sagebrush</td>
</tr>
<tr>
<td></td>
<td>Sparse savannah-like stands of pinyon-juniper</td>
</tr>
<tr>
<td></td>
<td>Small groves of dense pinyon-juniper</td>
</tr>
<tr>
<td></td>
<td>Small expanses of exposed bedrock</td>
</tr>
<tr>
<td>Pinyon-Juniper</td>
<td>Sage parks confined to mesa top drainages</td>
</tr>
<tr>
<td></td>
<td>Sparse pinyon-juniper on shallow rocky soils</td>
</tr>
<tr>
<td></td>
<td>Dense pinyon-juniper forest on deep eolian soils</td>
</tr>
<tr>
<td>Escarpment</td>
<td>Cliffside or brushy talus slope associations</td>
</tr>
<tr>
<td></td>
<td>Sparse pinyon-juniper on rocky slopes</td>
</tr>
<tr>
<td></td>
<td>Small groves of dense pinyon-juniper</td>
</tr>
<tr>
<td></td>
<td>Long narrow breaks of exposed bedrock</td>
</tr>
<tr>
<td>Canyon</td>
<td>Cliffside or brushy talus slope associations</td>
</tr>
<tr>
<td></td>
<td>Sparse pinyon-juniper on rocky slopes</td>
</tr>
<tr>
<td></td>
<td>Small groves of dense pinyon-juniper</td>
</tr>
<tr>
<td></td>
<td>Sagebrush covered canyon bottom alluvium</td>
</tr>
<tr>
<td></td>
<td>Stream bottom riparian associations</td>
</tr>
<tr>
<td></td>
<td>Large expanses of exposed bedrock</td>
</tr>
</tbody>
</table>
associations of blackbrush, mixed blackbrush and sagebrush, sagebrush, savannah-like stands of pinyon-juniper, and small groves of dense pinyon-juniper forest. Effective moisture is lower here than elsewhere on Cedar Mesa, and where it averages about 150 mm annually, large stands of blackbrush are found (West 1978:41). Although a number of springs and seeps are found in canyons, no water sources are present on mesa top portions of the desertshrub community.

Below 1770 m elevation, the landscape is dominated by blackbrush (Coleogyne ramosissima), Indian rice grass (Oryzopsis hymenoides), Mormon tea (Ephedra sp.), rabbitbrush (Chrysothamnus sp.), four-wing salt bush (Atriplex canescens), yucca (Yucca sp.), snakeweed (Gutierrezia sp.), and various cacti (Oputina and Echinocactus). Additionally, sparse and scattered pinyon pine (Pinus edulis) and juniper (Juniperus osteosperma) grow where soils are shallow or rocky outcrops are present.

Between 1770 and 1830 m in elevation, an interfingering of blackbrush and sagebrush (Artemisia tridentata) occurs. Sage is usually confined to sandy hummocks where there is slightly greater moisture retention, or to north facing slopes where there is protection from the drying southwesterly winds of the region. Above 1830 m, there is little blackbrush and the dominant vegetation is sagebrush which grows in large open parks of several square kilometers. Small stands of dense pinyon-juniper forest may occur at these elevations, but in general, the forest is not found below 1860 m in the western portions of the study area. At about 1860 m elevation an interfingering of sagebrush parks and pinyon-juniper forest occurs, denoting a major ecotone between the desertshrub and pinyon-juniper plant communities.
In eastern portions of the study area below 1750 m elevation, only the uppermost portions of the desertshrub community are observed. No blackbrush is present, and sagebrush, which again grows in large open parks, rapidly gives way to dense pinyon-juniper above 1750 m. In eastern portions of Cedar Mesa, mesic biotic associations are found growing at lower elevations than is the case in western areas of the plateau. Dry westerly or southwesterly winds are the attributed cause of this phenomenon (R.G. Matson, personal communication).

Due to sparse rainfall, dry farming within the desertshrub plant community appears impractical. Evidence suggests that if utilized prehistorically, the desertshrub community was a source of gathered rather than domesticated foods. Perhaps most useful to the Pueblo was the abundance of cactus and Indian rice grass, both of which were used historically by Southwestern tribes during times of famine (Whiting 1939). In sum, the overall utility of the desertshrub community was probably restricted because probability of crop failure was too great to foster permanent settlement of agriculturalists.

Pinyon-Juniper Woodland Community

The most common plant community on Cedar Mesa is pinyon-juniper woodland. It is found above 1860 m elevation in western portions of the study area, and above 1750 m in eastern portions of the transect. This zone is confined primarily to the mesa tops. There are two principal biotic associations within this community: woodland and sagebrush parks.

The woodland consists of pinyon and juniper, with neither species growing much above 10 m. Juniper favors lower elevations, while pinyon are found in progressively greater proportions at higher elevations within the community
(West 1978:33). Understory includes buffaloberry (*Shepherdia rotundifolia*), snakeweed, yucca, scattered sagebrush and a variety of cacti. Overall, however, understory is sparse and frequently there is no ground cover other than cryptogamic soil lichens (West 1978:37).

The second biotic association consists of long, narrow sagebrush parks with an understory of snakeweed and occasional grasses, although the latter appear to be recent Asian imports. The parks are confined primarily to mesa top valleys filled with alluvial, colluvial and eolian sediments. There appears to be some recent minor encroachment by forest into sagebrush parks, but both are considered climax vegetation associations closely correlated to soil type (Ed Scherrick, Area Manager, BLM San Juan Resource Area: personal communication). Soils in the woodland association are moderately deep and well drained, while soils in areas occupied by sagebrush are usually deep, well drained sandy loams. It appears that edaphic characteristics, rather than wildfires, are the major factors affecting distribution of sagebrush along mesa top drainages.

The pinyon-juniper community is very important ethnographically. The Navajo still visit Cedar Mesa to harvest pinyon and juniper for building material, fuel and bedding, and to harvest pinyon nuts when they are in season. This plant community appears important prehistorically as well, both for reasons just cited, and because the woodland correlates in general with the location of the deeper soils receiving enough precipitation to make them arable. DeBloois et al. (1975) reports that higher archaeological site densities are found in pinyon-juniper forests than in other Southwestern plant communities.
Escarpmnt Community

Remnants of the Organ Rock shales, an easily eroded formation found above Cedar Mesa Sandstone, form the principal substrata underlying the escarpment community. This plant community is most striking just east of the north-south axis of Cedar Mesa, where it is found on steep and eroded ridge-like escarpments or talus slopes. The interface between the Organ Rock and Cedar Mesa formation is not generally distinct, and consist of a number of alternating facies. The soft red shales form escarpments that surround a number of small, low-lying mesas that have cap rocks of Cedar Mesa Sandstone. These abrupt escarpments contrast sharply with the generally horizontal relief of the mesa tops, and vary from 15 to 75 m in relief. The little soil that exists is residual in origin and is interspersed among large boulders scattered along the talus slopes. Seeps are fairly common along larger escarpments, and are found just below the sandstone caprock near tops of the talus slopes.

Although dominated by pinyon-juniper, the escarpment community contains a considerable number of shrubby species. Most common are mountain mahogany (Cercocarpus sp.), bitterbrush (Purshia tridentata), Gambel oak (Quercus gambelii), buffaloberry (Shepherdia rotundifolia), cliffrose (Cowania stansburiana), yucca, Mormon tea, and a variety of cacti.

A limiting factor to settlement within this plant community is the paucity of arable land. However, the escarpment community is not large, and any settlements within it would be no more than a few hundred meters from the deep arable soils covering the relatively flat mesa tops. Furthermore, this region contains seeps and a number of plant species utilized for the manufacture of clothing, mats, ropes, sandals and digging sticks (Elmore 1976).
Canyon Community

Meandering through both the desertshrub and pinyon-juniper communities, deeply entrenched canyons support the final natural plant community found on Cedar Mesa. This community contains several distinct biotic associations. The first is really a non-association consisting of large expanses of exposed bedrock immediately adjacent to canyon rims. Vegetation is sparse, because soil only occurs in shallow patches. A second association consists of steep talus slopes that rest upon successive sandstone ledges lining canyon walls. Vegetation is similar to that found within escarpment communities.

The final biotic associations of this plant community are found on floors of some of the larger entrenched canyons. Deposits of alluvial sediments covered with sagebrush are common, although arroyo cutting since the 1880's has exposed considerable amounts of bedrock along wash bottoms. Where there are alluvial remnants, large deciduous trees, predominately box elder (Acer glabrum) and cottonwood (Populus fremontii) are found. Also present are juniper, pinyon, yucca, and a variety of cacti and grasses. Thick patches of Gambel oak often grow on alluvial remnants, either at the base of steep talus slopes or perched precariously at the edges of deep arroyos.

Within arroyo bottoms or adjacent to seeps and springs are a number of riparian species not found elsewhere on Cedar Mesa. These include dense thickets of willow (Salix sp.), and tamarisk (Tamarix pentandra), although the latter is a recent import from the middle east. Also present are rushes (Juncus sp.), reeds (Phragmites communis), reedgrass (Calamagrostis scopulorum), horsetail (Equisetum laevigatum), and cattails (Typha angustifolia).

The canyon community, with its abundance of water and wide variety of vegetation, was very important to the prehistoric occupants of Cedar Mesa.
Prior to arroyo cutting, alluvial terraces in the wider or deeper canyons would have made excellent fields for domestic crops. It is expected that a number of farming settlements would be located in canyons, nestled in cliffside alcoves overlooking the fields. In broad, shallow sandstone walled canyons such as upper Bullet, there are considerable amounts of eolian and even some colluvial sediments, upon which are found extensions of the dense pinyon-juniper woodland. Because of arable soils and a particularly high floral diversity, the shallow canyons are expected to contain considerable numbers of Puebloan farming sites.

Summary

This chapter has discussed the environment of Cedar Mesa with a primary emphasis on its utility to prehistoric Pueblo farmers dependent upon rainfall. A number of factors have been identified that would appear to facilitate successful settlement and crop growth. These are summarized below; they provide a basic framework from which hypotheses can be generated for testing later in the thesis. Acceptance or rejection of hypotheses generated from these particular factors will in turn lead to development of further assumptions and tests of Puebloan settlement location.

The factors of settlement that have been identified include:

1) Settlement will concentrate on divides because of moderately deep soil deposits. Deep soil is necessary for root growth and ground water storage.

2) Some farming will occur on north or northeast facing slopes that hold snow longer, thus minimizing evaporation by solar radiation and prevailing southwesterly winds.

3) Due to shortening of growing seasons caused by cold air drainage, areas subject to this will be avoided.
4) Settlements will be concentrated in higher elevations of the study area because of greater precipitation levels.

5) Settlements will be sparse in the desertshrub community because of low precipitation.

6) Most settlements will be concentrated in the pinyon-juniper zone because this community has arable soils, relatively high precipitation, and abundant supplies of fuel and building materials.
CHAPTER III
CHRONOLOGY OF PUEBLO REMAINS ONcedar mesa

An understanding of the Pueblo cultural sequence is important because groups of archaeological sites from several phases within the late Pueblo II and Pueblo III periods will be contrasted with one another to identify changes in settlement patterns over time.

The Cedar Mesa chronology can be correlated with the Pecos classification, which includes the hypothetical Basketmaker I (now Late Archaic), as well as Basketmaker II and III, and Pueblo I, II, III, IV and V (Kidder 1927). As seen in Figure 3, not all these phases are found on Cedar Mesa. The Pecos classification is a developmental scheme based on architectural and artifactual trends found across wide areas of the northern Southwest. It was established prior to recognition of considerable local variation and change. These shortcomings have long since been addressed and archaeologists have developed localized chronological schemes for numerous regions (cf. Hayes 1964; Rohn 1977). The developmental implications of the Pecos classification have for the most part been dropped because, for example, while sites from a region may date to Pueblo III, the architecture may be indicative of trends abandoned elsewhere by Pueblo II. Despite these problems, the Pecos scheme is still an important tool for making preliminary dating assignments, and for tying together a number of regional chronologies spread over wide areas of the Southwest.

Along with the Cedar Mesa phase series, Figure 3 illustrates the overall Pecos scheme and Lipe's (1970) chronology for the Red Rock Plateau. The latter is located between 15 and 35 km west of the Cedar Mesa study area. Although A.D. 1100 is generally used in the Pecos scheme as a boundary
Figure 3. Chronology of archaeological remains on Cedar Mesa and the Red Rock Plateau
between Pueblo II and Pueblo III, this varies regionally. In the Glen Canyon area for instance, the boundary between the periods is A.D. 1150.

For both Cedar Mesa and the Red Rock Plateau, boundary dates for phases are estimated on the basis of occurrence and frequency of pottery types dated elsewhere by association with dated tree-ring specimens. This is a relative dating technique that by itself does not yield precise chronometric dates. Consequently, several of the beginning and ending dates for phases in the Cedar Mesa sequence are represented by zig-zag or wavy lines in Figure 3. On the basis of seriated pottery assemblages (Matson and Lipe 1977), four occupations dating between A.D. 1060 and A.D. 1270 were recognized (Matson and Lipe 1978:8). The phases are named after prominent topographic features visible from Cedar Mesa.

**The Pueblo Occupation Sequence**

The initial period of Pueblo colonization and growth on Cedar Mesa began with the Windgate phase in the waning stages of the Pueblo II period about A.D. 1060, approximately 400 years after the region had been abandoned by the Basketmaker III peoples. Like later Pueblo occupations, this phase is characterized by dispersed rancherias scattered across the landscape (Jennings 1963). Mancos Black-on-white dominates decorated pottery types, although small amounts of Cortez and Mesa Verde Black-on-white are present as well (Matson and Lipe 1977:25). The Mesa Verde Black-on-white ceramics include both the McElmo and Mesa Verde varieties recognized by Rohn (1977). The dominance of these ceramic types suggest an eastern or Mesa Verde origin for the occupants of Cedar Mesa during the Windgate phase.

The Clay Hills phase comes next in the Pueblo sequence on Cedar Mesa. The decorated pottery assemblage is dominated by Sosi and Dogoszhi
Black-on-white from the Kayenta ceramic tradition. Elsewhere in the Kayenta region, these types reach their peak frequency between A.D. 1100 and 1140.

When discussing the Clay Hills phase, Matson and Lipe (1977:55) write:

Ceramic traditions could be related to cultural groups moving onto and away from Cedar Mesa. [The Clay Hills phase could] be the traces of an immigration from the Kayenta area, perhaps during a time when the mesa had been abandoned by the Mesa Verde peoples. If the ceramic traditions do not signify the movement of actual populations or ethnic groups, then the [Clay Hills phase] might indicate a time when Kayenta-style ceramics were popular along the western border of the Mesa Verde tradition. This could have come about due to the importation of spouses from the Kayenta area, through extensive trade, or perhaps by other mechanisms that would not require the movement of groups . . .

The Clay Hills occupation of Cedar Mesa appears to have been part of a general movement of Kayenta peoples or traits into southern Utah during the early 1100's. Farther west on the Red Rock Plateau, Lipe (1970) recognizes this movement as part of the Klethla phase of the Kayenta Anasazi tradition. He believes that substantial numbers of early Klethla phase sites were also established on the Kaiparowits Plateau and Cummings Mesa, and on the eastern fringes of the Aquarius Plateau near Boulder, Utah.

About A.D. 1150, Kayenta populations in southern Utah declined sharply. The Red Rock Plateau seems to have been abandoned at this time, as was most of the northern and western part of the Glen Canyon area. This abandonment correlates with a general southward retreat of the northern boundary of the Kayenta Branch, the disappearance of the Virgin Branch of the Anasazi, and the eclipse of most Fremont settlements in eastern and central Utah (Lipe 1970:114).

A sudden population decline or perhaps an abandonment may have occurred at this time on Cedar Mesa. Such actions would be supported by regional trends. Ceramic evidence hints at abandonment. Matson and Lipe (1977:45) argue that ceramic assemblages from the Clay Hills phase show good overlap
with the most recent part of the earlier Windgate phase, but little evidence of overlap with the early part of the succeeding Woodenshoe phase, which dates after A.D. 1150. "In fact," Matson and Lipe (1977:45) write, "there appears to be good evidence of separation between what should be the most similar halves of the [Woodenshoe and Clay Hills] phases."

The occupational hiatus, if it occurred, was of short duration. Sometime after A.D. 1165 farmers again moved onto Cedar Mesa, represented by assemblages of Woodenshoe phase ceramics. The ceramic assemblage of this phase is dominated by Mesa Verde Black-on-white sherds, suggesting movement onto Cedar Mesa was again from the east.

The Red House phase represents the final Pueblan occupation of Cedar Mesa. Because assemblages from sites of this phase are strongly dominated by organic paint Mesa Verde Black-on-white sherds, Matson and Lipe (1977) believe that the complex post-dates A.D. 1200. Less than .005 percent of sherds found at Red House phase sites are of Kayenta origin. This occupation appears to have continued until about A.D. 1270, by which time most of the northern Southwest had been abandoned by the Anasazi. Both the Woodenshoe and Red House phases may represent a single ca. 100-year-long occupation by the same cultural group, with ceramic changes between the two phases occurring when certain ceramic types became popular and others fell into disfavor.

To a degree, the four phases can also be recognized in Figure 4, which illustrates frequencies of tree-ring cutting dates between A.D. 1030 and 1270. Shown are 182 dates from the Cedar Mesa Project, 5 dates from Grand Gulch reported by Bannister et al. (1969), and 16 dates from nearby Natural Bridges National Monument reported by Hobler and Hobler (1978). Excluded are unreliable "vv" dates and a large group of dates from Moon House, a cliff
Figure 4. Frequency histogram of tree-ring cutting dates from the Cedar Mesa region, A.D. 1030 to 1270
dwelling occupied primarily between A.D. 1250 and 1270. These dates are excluded because the thorough collection techniques used here tends to distort the Figure 4 frequency histogram. While all other sites in the sample provided between 1 and 20 dates, Moon House provided over 150, most of which could be confined to a time frame between A.D. 1225 and 1270.

Virtually all cutting dates come from well preserved roof or wall beams found in dry rock shelters. Due to exposure, few beams remain in mesa top sites. This created some problems because dating arguments are based largely on seriated pottery collected from mesa top sites, and to a lesser degree from tree-ring specimens collected from cliff dwellings. It was observed, however, that tree-ring dates supported, rather than disputed the pottery seriation.

Figure 4 also shows where the various Pueblo occupations tend to be located. To some degree, all four phases are represented by mesa top sites; otherwise they would not have been recognized from the pottery seriation. Three of the phases, at least, also appear to be represented by canyon tree-ring data. These are the Clay Hills phase (ca. A.D. 1100 to 1150), the Woodenshoe phase (ca. A.D. 1165 to approximately 1200) and the Red House phase (ca. A.D. 1200 to 1270). Only the Windgate phase is not clearly expressed in canyon tree-ring data. This suggests the earliest Pueblan occupants of Cedar Mesa were selecting for mesa top locations only, while later occupants settled both on mesa tops and in the canyons.

Figure 4 shows very clearly the break between the Clay Hills phase and the Woodenshoe phase occurring about A.D. 1150. A few dates are recognized in the 15-year interval prior to A.D. 1165, but these could have come from later structures, whose builders had used wood from trees that had died during the interim. The few dates between A.D. 1150 and 1165 could also
represent remnants of a greatly reduced population that survived on Cedar Mesa between the Clay Hills and Woodenshoe phases. Coupled with the lack of overlapping ceramic assemblages between the two phases, however, the sharp decline in dates supports arguments for a short occupational hiatus on Cedar Mesa between A.D. 1150 and 1165.

Just as the absence of dates may indicate an abandonment, an increasing number of tree-ring dates from A.D. 1165 through 1240 lends support to the argument that the Woodenshoe and Red House phases actually represent the development of a single cultural group that occupied Cedar Mesa until its final abandonment about A.D. 1270.

The efforts of Matson and Lipe (1977) succeeded in placing most Pueblo components from survey quadrats into one of the four chronological phases. These components, along with the assigned phase of occupation, are listed in Table 2. It should be noted that several of the smaller components could not be assigned to a single phase. Some were termed "Windgate/Clay Hills," while others obviously of a later date were termed "Woodenshoe/Red House." A set of 6 components could not be placed in any phase because only corrugated ceramics from the Pueblo II or Pueblo III periods were present. These are termed "Unknown Pueblo" on Table 2.
Table 2.--Pueblo components listed by occupational phase.

<table>
<thead>
<tr>
<th>Windgate Phase</th>
<th>Clay Hills Phase</th>
<th>Woodenshoe Phase</th>
<th>Red House Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>B3-1A</td>
<td>B1-4</td>
<td>B6-3A</td>
<td>B1-1</td>
</tr>
<tr>
<td>B3-1B</td>
<td>B1-7</td>
<td>B14-2</td>
<td>B1-2</td>
</tr>
<tr>
<td>B3-7</td>
<td>B4-4</td>
<td>B17-1</td>
<td>B3-10A</td>
</tr>
<tr>
<td>B6-3B</td>
<td>B5-2</td>
<td>B18-3</td>
<td>B7-5</td>
</tr>
<tr>
<td>B6-4</td>
<td>B8-2</td>
<td>NR4-5</td>
<td>B12-4</td>
</tr>
<tr>
<td>B7-2</td>
<td>B10-7</td>
<td>HS8-3</td>
<td>B15-1</td>
</tr>
<tr>
<td>B7-4</td>
<td>B11-4</td>
<td>HS13-1</td>
<td>B15-6</td>
</tr>
<tr>
<td>B7-6</td>
<td>B11-8</td>
<td>HS14-2A</td>
<td>B15-7</td>
</tr>
<tr>
<td>B12-1A</td>
<td>NR4-6</td>
<td></td>
<td>B16-1B</td>
</tr>
<tr>
<td>B12-1B</td>
<td>NR9-1</td>
<td></td>
<td>B19-1A</td>
</tr>
<tr>
<td>B12-1C</td>
<td>NR9-3</td>
<td></td>
<td>B19-1B</td>
</tr>
<tr>
<td>B12-1D</td>
<td>NR10-2</td>
<td></td>
<td>B19-1C</td>
</tr>
<tr>
<td>B12-1E</td>
<td></td>
<td></td>
<td>B19-1D</td>
</tr>
<tr>
<td>B12-8</td>
<td></td>
<td></td>
<td>B19-2</td>
</tr>
<tr>
<td>B13-2</td>
<td></td>
<td></td>
<td>B21-10</td>
</tr>
<tr>
<td>B13-3</td>
<td></td>
<td></td>
<td>B22-2</td>
</tr>
<tr>
<td>B16-1A</td>
<td></td>
<td></td>
<td>B22-3</td>
</tr>
<tr>
<td>B17-2</td>
<td></td>
<td></td>
<td>NR11-12</td>
</tr>
<tr>
<td>NR4-1</td>
<td></td>
<td></td>
<td>HS3-1</td>
</tr>
<tr>
<td>NR4-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR5-9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR8-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR11-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR11-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR11-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS14-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS14-2B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS14-2C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Windgate/Clay Hills Phase</th>
<th>Woodenshoe/Red House Phase</th>
<th>Unknown Pueblo Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>B4-3</td>
<td>B8-4</td>
<td>B1-6</td>
</tr>
<tr>
<td>B7-1</td>
<td>B21-12</td>
<td>B3-4</td>
</tr>
<tr>
<td>NR2-1</td>
<td></td>
<td>B9-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B12-7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NR9-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NR11-8</td>
</tr>
</tbody>
</table>
CHAPTER IV

CLASSIFICATION OF PUEBLO ARCHAEOLOGICAL SITES

When Pueblo farmers occupied Cedar Mesa they established hundreds of settlements, each of which served a particular function or set of functions within the settlement system. An understanding of these settlement types and function is essential for successful analysis of settlement patterns. The purpose of this chapter is to: 1) categorize prehistoric Pueblo sites on Cedar Mesa on the basis of functional characteristics; and 2) identify the types of sites found within survey quadrats that are amenable to settlement pattern analysis.

Pueblo site types found on Cedar Mesa

Differences in site function have long been recognized by archaeologists, but there is no universally accepted system of site classification. Schemes that have been established are based upon the characteristics individual archaeologists want to emphasize, the attributes most conveniently observed or described, or the goals of the particular study (Jett and Spencer 1981:29). The classification established here is admittedly the result of all these factors.

During late Pueblo II and Pueblo III, four types of sites appear to have been used by the Anasazi living on Cedar Mesa. These include: 1) habitations; 2) seasonally occupied field stations; 3) limited use sites; and 4) community integrative structures. Each will be described, but it should be noted that only the first two were recognized within the randomly distributed survey quadrats. The latter two site types exist within the study area, but because they were located outside survey quadrats, there is
no accurate basis for evaluating numbers, occupational phases, or the environmental strata in which they are found. As a result, questions of spatial arrangement of these two site types will not be evaluated in the next chapter.

The two categories of sites that will be examined for settlement patterns -- habitations and field stations -- were established intuitively after visual inspection of Table 3. This table shows the presence or absence of particular attributes, including surface and pitstructures, slab-lined hearths, unlined ash hearths, burned jacal, middens or structured trash, slab-lined storage cists, and grinding or milling stones such as manos or metates. These eight attributes were chosen because all could be recognized from surface survey. The presence of each was noted on site forms by field survey crews. This information was tabulated for each site by R.G. Matson on "Revised Feature and Surface Architecture" forms. At the time, Matson also made preliminary assignments of site function.

Habitations

It is assumed that habitations on Cedar Mesa were occupied by a household equivalent to or slightly larger than a nuclear family. A household of this type has been described as a group of individuals sharing an economic workload and occupying jointly one house or cluster of spaces that are well demarcated spatially, and into which outsiders do not freely intrude (Rohn 1971:31).

As defined by the intuitive classification, habitations have either slab-lined or masonry surface structures, pitstructures, or evidence of structured trash disposal. Although no Pueblo II or Pueblo III pitstructures from this sample were fully excavated as part of the Cedar Mesa Project, it
Table 3.--Site facilities present at Pueblo components within the study area. Components listed in order of the first dimension generated by multidimensional scaling techniques.

<table>
<thead>
<tr>
<th>Site</th>
<th>RB</th>
<th>GS</th>
<th>AH</th>
<th>JA</th>
<th>LH</th>
<th>MI</th>
<th>SC</th>
<th>PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) NR4-5</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2) NR4-2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>3) NR4-6</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>4) B18-3</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>5) B3-1A</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>6) B12-1E</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>7) B22-2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>8) NR10-2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>9) B1-1</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>10) B14-2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>11) B15-7</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>12) B19-1B</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>13) B17-1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>14) B3-7</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>15) B3-10A</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>16) B19-1C</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>17) B10-7</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>18) B8-2</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>19) B16-1A</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>20) NR11-3</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>21) B6-4</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>22) B12-1D</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>23) B22-3</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>24) B6-3A</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>25) B12-1B</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>26) B12-1C</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>27) B11-8</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>28) B17-2</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>29) B19-1D</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>30) B12-1A</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>31) B4-4</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>32) B5-4</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>33) HS14-2A</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>34) HS14-2C</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>35) HS8-3</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>36) NR11-12</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>37) B21-10</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>38) NR4-1</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>39) HS3-1</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>40) NR11-1</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

RB = masonry roomblock  
GS = grinding stones (manos or metates)  
AH = unlined ash hearth  
JA = burned jical  
LH = slab lined hearth  
MI = structured trash midden  
SC = slab lined storage cist  
PS = pitstructure
<table>
<thead>
<tr>
<th>Site</th>
<th>RB</th>
<th>GS</th>
<th>AH</th>
<th>JA</th>
<th>LH</th>
<th>MI</th>
<th>SC</th>
<th>PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>65) NR9-1</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>66) NR9-3</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>67) B1-4</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>68) B8-4</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>69) B12-8</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>70) B16-1B</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>71) B1-2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>72) B1-6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>73) B4-3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>74) B11-4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>75) B12-7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>76) B13-2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>77) B19-2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>78) NR11-8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
is assumed most are kivas. This assumption is based on the presence of kivas that remain in cliff dwellings, and the discovery of mesa top kivas in salvage excavations associated with the construction of Utah Highway-95, located about 10 km northeast of the study area (Wilson 1974). While evidence of structured trash disposal is present at a number of sites, a midden by itself does not define a habitation. However, middens in association with surface or pitstructures suggests the occurrence of relatively long-term residential activities, and lends support to a site's classification as a habitation.

Of the 32 habitation sites found within survey quadrats (numbers 1 to 32 on Table 3), only 30 percent contained all the above features. Another 30 percent had surface rooms and middens but lacked pitstructures, while 10 percent had both surface rooms and pitstructures but lacked evidence of a midden. Finally, 30 percent of habitations had evidence only of surface structures, lacking evidence of both pitstructures and structured trash disposal. This does not mean that pitstructures or middens were never present at this last group of habitations; it is always possible that erosion has removed or obscured these features from detection. In sum, definition of habitations was at times arbitrary. However, an objective test discussed later in this chapter attempts to resolve some of these interpretive problems.

Although the following attributes are characteristic of habitations, they are also found at sites identified as field stations, so were not used as criteria for classification of site type. Manos or metates are present at 75 percent of habitations; burned jacal was present at 72 percent of these sites; external slab-lined storage cists were found at 41 percent; and external hearths were present were present at all but one of the habitations,
usually south of the room block. That external hearths are common is not unusual. In describing excavation of a small habitation on Mesa Verde, Lister (1966:29) writes:

Several fire pits are located in the open adjacent to cleared rooms and it is not unlikely that others may exist outside the excavated areas. Thus it seems certain that the majority of culinary activities took place around fire pits outside the houses.

Occurring at habitations were a variety of residential-type activities such as food preparation as evidenced by milling stones and hearths, integration of household members as evidenced by kivas, and food storage as evidenced by slab-lined cists and masonry surface rooms. It is also believed that habitation sites could have served agricultural functions, because fields could be located in close proximity to settlements. This last assumption is the subject of an in-depth examination in the next chapter.

Field Stations

The second type of Pueblo site found in survey quadrats is the seasonally occupied field station. Modifying Binford's (1980) definition of "station" to fit the Anasazi of Cedar Mesa, field stations are the temporary centers for task groups engaging in the maintenance of agricultural fields (or other activities) located away from habitations. A field station is where a task group eats and otherwise maintains itself away from the residential base. The function of field stations are inferred from analogy with the historic Hopi and Laguna Puebloans, and with the Navajo, each of whom follows a multiple-field strategy. Fish and Fish (1978:57) write:

One of the means by which Southwestern groups have sought to ensure sufficient year-to-year returns, despite vagaries of rainfall and other agricultural uncertainties has been environmental diversification of subsistence activities . . .
It is a common pattern for one household to maintain fields in several parts of the community territory in the expectation that at least some of them will yield successful harvests. If this is the main level at which diversification occurs, it might be expected that only simple, very temporary occupied shelters would be associated with the scattered fields.

The initial tendency was to term these remains "field houses," but this implies the presence of some type of architecture and residential activities. By definition, none of the 46 components in this class (numbers 33 to 78 on Table 3), have any evidence of surface masonry, pitstructures or structured trash disposal. However, 61 percent of field stations had either manos or matates present, while 63 percent had evidence of hearths. These attributes suggest that both processing and preparation of food occurred at the majority of field stations.

While the "typical" field station contained only a hearth and a few grinding tools, 7 percent of the sites had evidence of burned jacal, while 17 percent contained slab-lined storage cists. Slab-lined storage cists associated with seasonal use sites are reported elsewhere in the Southwest. Ellis (1978:64) describes several Pueblo III Gallina sites in northern New Mexico as having . . .

. . . storage pits and what one must classify as stone-walled storage rooms too small to have been habitations . . . suggesting that considerable quantities [of crops] were accumulated before foods were carried back to home bases.

Three field stations within the study area had a considerable investment in facilities, including burned jacal and the remains of hearths, slab-lined storage cists, and milling stones. With few exceptions, these sites are all located at considerable distances from contemporary habitations, suggesting the possibility of some residential activities in addition to field maintenance activities. The burned jacal suggests there may have been
non-masonry surface structures present at the time of occupation; if so, however, this was atypical of field stations on Cedar Mesa.

**Limited Use Sites**

Limited use sites are areas where specific resources such as water, clay for ceramic manufacture, lithic raw materials, or subsistence resources were obtained. Physical remains include small isolated masonry storage granaries, pictograph panels or lithic scatters. These were sometimes present within survey quadrats, but were unrecognized as Pueblo II or Pueblo III either because no pottery was present and age of site was misidentified, or because no artifacts were found and they were ignored entirely. Because these sites were single purpose in nature, they were likely visited by the Pueblo for only a few minutes or hours at a time.

It is expected that a few of the sites classified as field stations are in actuality limited use sites serving non-agricultural functions. Although they cannot be recognized from material attributes listed on Table 3, it is expected these sites will appear as anomalies during the settlement pattern analysis, and will be located in areas where the probability of successful farming is negligible. If, however, the limited use sites occur in areas suitable for agriculture, there will be no easy way to distinguish them from field stations.

**Community Integrative Structures**

A second site type that is found on Cedar Mesa but not recognized within survey quadrats are community integrative structures. To Flannery (1976:6), a community is the "maximum subsistence-settlement unit" which includes all
people integrated at one or more intervals in the functioning of a subsistence-settlement system. According to Rohn (1971:40), "A community consists of persons who because of the proximity of their dwellings or because of various economic, social and religious activities associate with one another on virtually a day-to-day basis."

A community integrative structure then, is a common meeting ground for residents interacting with one another within the same community. Lipe (1970) sees evidence for these on the nearby Red Rock Plateau, where a dispersed settlement pattern also exists. He believes "There is some evidence for the occasional formation of larger groups of people and mechanisms for integrating several ... residential units" (Lipe 1970:117). This situation occurs elsewhere in the Southwest. Gumerman (1975:112) writes:

The solution in the Hopi Buttes [Arizona] area to an expanding, but scattered population was to construct a single special purpose site ... to act as a socio-religious hub in a large network of small communities.

According to Windes (1978:65), isolated stone circles found from Mesa Verde in the north to regions south of Chaco Canyon, New Mexico, "... fulfill an integrative role for towns, similar to that currently ascribed to great kivas."

This author knows of only two structures on Cedar Mesa where these functions can be inferred; others, however, may exist. Where found, such structures are situated atop isolated promontories having wide fields of view. Although a number of habitations may be located within sight of community integrative structures, none appear to be immediately adjacent to the integrative sites. One of the integrative structures, consisting of several large rooms and open plazas is located north of the study area on a
small butte overlooking two sagebrush parks known as Shieks and Coyote Flats. The second known structure of this type is again atop an isolated butte, and consists of a thick-walled circular structure about 1 m in height and 12 m in diameter. It does not appear to have been roofed, and is very similar to Windes' (1978) description of stone circles. Both sites identified as community integrative structures are located above 1950 m elevation in portions of the plateau having the greatest densities of habitations and field stations. The presence of large, upright sandstone boulders at the rims of both buttes where these sites are situated suggests that at least one of the functions was defense, with the aggregation of residents from nearby habitations during times of strife.

Multidimensional Scaling of Habitations and Field Stations

The initial dichotomy of habitations and field stations -- the two types of sites readily recognized within survey quadrats -- was established in an intuitive fashion. A metric multidimensional scaling technique (Matson and True 1974; Torgerson 1958) was used to determine whether the intuitive classification could be replicated through objective means.

Multidimensional scaling is a set of computer generated mathematical techniques enabling a researcher to uncover "hidden structure" within the data base, which in this case consists of eight chosen attributes from 78 Pueblo components found within the survey quadrats. This technique evaluates proximity among the components, based on the presence or absence of certain attributes each contains. As previously noted, attributes considered here are surface structures, pitstructures, slab-lined hearths, unlined ash hearths, burned jacal, slab-lined storage cists, milling stones, and evidence of structured trash disposal.
Through use of Jaccard's distance or compliment, a number of "proximities" were generated (R.G. Matson: personal communication). A "proximity" is a number which indicates how similar or how different two components are, based on the combination of attributes each contains. The chief output of multidimensional scaling is a series of two dimensional spatial representations called scatter diagrams, one of which is illustrated in Figure 5. It consists of a configuration of points, as on a map. This configuration visually plots the "hidden structure" of the data not readily apparent from casual observation. The farther apart two components are from one another on the scatter diagram, the greater the dissimilarity between them (Kruskal and Wish 1978:7). Conversely, a number of sites located at exactly the same point on the scatter diagram suggest functional similarity.

Although results of the test indicated the presence of six separate dimensions reflecting the "hidden structure" of the data, the first two dimensions appeared to explain most of the relationship between the components. The number of each data point on Figure 5 corresponds with one or more individual components listed in Table 3. The derived groupings tend to be consistent with intuitive evaluations of the data. This was not wholly unexpected, however, as both classifications of settlement type were based on the same set of attributes.

As seen from Figure 5, habitations are very tightly clustered along the negative ends of both the X and Y axis of the matrix. Field stations are widely scattered, depending on the presence or absence of particular attributes. Considering both habitations and field stations, negative values on the first dimension indicate the presence of both surface rooms and burned jacal, while sites where these features are absent are placed on the positive end of the X axis. The second dimension places components with pitstructures
Figure 5. Scatter diagram derived from multidimensional scaling showing placement of 73 Pueblo components.
at the negative end of the axis and those without these features at the positive end. Of interest is the group of sites at the lower right-hand corner of the matrix. These were Pueblo sherd and lithic scatters, and contained none of the attributes listed above.

As was noted in the intuitive classification, several components inferred as field stations had considerable investment in facilities, including burned jacal and slab-lined storage cists. In the scatter plot, these components appear to take a half-way position between true field stations and true habitations, supporting the assertion that some residential functions may have occurred at these units. In conclusion, it appears that the intuitive classification held up quite well and was to a large degree successfully replicated by multidimensional scaling techniques. The exceptions are intensively utilized field stations. The reason why these few components resemble habitations will be dealt with in Chapter VI.
CHAPTER V
ENVIRONMENTAL FACTORS IN SETTLEMENT LOCATION

Archaeological sites are not distributed randomly across the landscape of Cedar Mesa. Instead, they appear to be located near elements (e.g., arable land, fuel supply, etc.) that facilitated survival. Conversely, elements not essential to the cultural system should appear no closer to sites, nor in greater abundance adjacent to sites, than would be expected for a randomly generated series of points having no archaeological significance.

The goals of this chapter are to: 1) further define the environmental variables thought to influence Puebloan settlement patterns; 2) compare locations of archaeological sites to a number of non-archaeological points scattered at random in order to isolate the environmental correlates of settlement location; and 3) objectively rank the influence of the several environmental variables as they affect settlement patterns. Although statistical techniques are used to quantify data necessary to achieve the last two goals, interpretations of settlement patterns are intuitive, based on prior research, ethnographic analogy, and known environmental constraints on rainfall farming.

Variables used in Settlement Pattern Analysis

Recent analyses of settlement pattern (cf. Gumerman 1971; Euler and Gumerman 1978; Binford 1980; Grady 1980) emphasize relationships between the set of resource locations where raw materials could be obtained, and the loci which were chosen for settlement. A common thread to these studies is the principle of least effort, in which locational decisions are assumed to be made so as to minimize both the effort and effects of distance in resource
procurement (Zipf 1949). This principle is clearly expressed in a set of assumptions that have guided Southwestern settlement pattern studies for over a decade. Plog and Hill (1971:12) list these as:

1) Sites were located with respect to critical on-site resources.

2) Sites were located so as to minimize the effort expended in acquiring required quantities of critical resources.

3) Sites were located so as to minimize the cost of resource information flow between sites occupied by interacting populations.

It should be noted, however, that these assumptions have been questioned by Sullivan and Schiffer (1978). They argue that what is minimized in Zipf's principle of least cost is not work expenditure at any given moment or location, but the average rate of work expenditure over time (Sullivan and Schiffer 1978:171). In other words, a site or even a portion of a settlement system may not represent least cost behavior, and instead may exhibit large outlays of material and energy. This is done, however, in anticipation of minimizing the effort necessary to maintain the overall system of settlement.

Another problem is that the three principles listed above are termed "core hypotheses" by Plog and Hill (1971:12), suggesting they are subject to confirmation or rejection. Instead, they were used as basic assumptions to help identify specific determinants of settlement location. They are used this way here, leading to hypotheses that certain relationships will exist between site locations and environmental variables; these assumptions, however, are not themselves subject to hypothesis testing.

As implied in Plog and Hill's first two assumptions, it is essential that "critical resources" be obtained. Critical resources are features of the environment assumed to be necessary to prevent social collapse. Sullivan and Schiffer (1978:172) have criticized this concept, stating that there are
"an enormous set of sufficient conditions that can precipitate system collapse other than inavailability of critical resources." Furthermore, they believe "... the concept of critical resources is really a definition that has no factual content and can be verified or empirically identified only with great difficulty" (Sullivan and Schiffer 1978:172). It is possible, however, to empirically test the proposition that some resources in general (critical or otherwise) are conditions affecting settlement location.

The following is the list of environmental variables against which locations of the 78 Pueblo components were evaluated. They were chosen because other studies in archaeology, ethnography, or botany suggested they were likely to be relevant to prehistoric Pueblo adaptation. All are believed to contain enough diversity or breadth to offer both advantages and disadvantages to Pueblo farmers occupying Cedar Mesa. The variables can be grouped from two different perspectives. The first examines the location of particular sites or components, relative to environmental factors found either on-site or within the immediate proximity of the sites. The five on-site variables examined include:

1) type of plant community sites are located within.
2) type of biotic association sites are located within.
3) type of landform sites are located on.
4) site aspect or exposure.
5) elevation of sites.

The second perspective examines the distance from sites or components to particular environmental features not generally considered on-site variables. The three variables in this group include:
1) distance to nearest probable water source.
2) distance to nearest water course or drainage.
3) distance and rank of nearest watershed divide.

While some of the variables have straightforward interpretations (e.g., distance to nearest water source), others are "proxy measures" having little meaning by themselves. For example, it may be demonstrated that settlements may congregate in one plant community rather than another. Yet the motivation for this may not be the plant community per se, but instead may be related to particular environmental features within the community. Although four plant communities were identified from vegetation visible from aerial photographs, soil tests noted that deep arable soils are present in the pinyon-juniper community but are generally absent in the desertshrub community. In this case, pinyon-juniper may be an indicator of arable land while desertshrub is not. Plant community type is also a proxy measure for amounts of precipitation, with desertshrub receiving somewhat less than the pinyon-juniper zone. The Pueblo may have selected settlement locations based on soil depth or rainfall, but it is doubtful if they would have embraced the somewhat arbitrarily defined proxy measures utilized in this thesis. These examples illustrate the possibility of arriving at relevant factors of settlement location indirectly through knowledge of other aspects of the environment. Also illustrated are some of the problems inherent in dealing with highly correlated variables one at a time.

It must be remembered that significant correlation does not necessarily imply causality, and variables acting as good predictors of site location may not themselves be causative. This is almost always the case when proxy measures of site location are used. A way to resolve problems of causality and intercorrelation is to be aware of the possible effects each variable may
have had on the prehistoric farmers of Cedar Mesa. If one variable is suspected to be primarily a proxy measure for another factor, this will be made explicit. If significant correlations occur between such proxy measures and settlement locations, they will be interpreted with caution unless it is clear what factors of settlement the proxy measures relate to.

Methods of Settlement Pattern Analysis

Sets of hypotheses were generated to test each of the eight variables listed above. Null hypotheses are exemplified by distributions of points having no archaeological significance scattered at random across the landscape. Hodder and Orton (1976:30) remark, "This theoretical random process can be used as a norm against which a particular pattern may be examined and measured." Since distributions of archaeological sites are considered to be the result of cultural patterns, measurement of degrees of departure between random points and archaeological sites may indicate why and to what degree specific locations are favored over others (Grady 1980:154).

To limit redundancy, only alternative hypotheses are explicitly stated in this chapter. It is necessary, however, that one be aware of null hypotheses and their implications. Rejection of a null hypothesis at a given confidence interval (say, a .05 alpha level), indicates that for a particular variable there is a significant difference between distributions of archaeological sites and random points. Failure to reject the null hypothesis suggests that the variable or by implication, the environmental factor for which it is a proxy, did not play a significant role in determining settlement location.

Several of the variables examined are nominal in scale. To test hypotheses of no difference between locations of sites and locations of
random points for three of the nominal-level variables, binomial confidence
intervals are placed around each cell frequency, based on tables in Conover
test:

If the observed frequency of [archaeological sites] falls within the
[95% confidence] interval, we can state that it is possible that chance
alone was responsible for any difference between the observed site
frequency and that which would be expected under the null hypothesis. If
the observed frequency falls outside this confidence interval, the
outcome can be regarded as quite unlikely to have happened on the basis
of chance alone.

A final nominal-level variable examined is site aspect or exposure. Both
sites and random points are placed in octants depending on their cardinal or
subcardinal exposure. For prehistoric sites, this information was obtained
from field survey notes. In cases where information was ambiguous, the
landform/vegetation map of the study area was consulted. Aspect of random
points was obtained from this 1:13,000 scale map as well. A chi-square
goodness-of-fit test is used to compare exposures of prehistoric sites with
random points.

The last set of variables are evaluated through use of the Wilcoxon's
rank-sum ($W_n$) test. This is a non-parametric statistic that compares two
ratio level or numerical populations from lowest to highest rank-order. The
test is sensitive to unequal locations of individual scores within the two
populations. However, the $W_n$ is not a exactly a rank-sum value because
samples are too large to use tables provided in appendices of statistics
texts. Instead, $W_n$ is a unit normal deviate approximation. Bradley
(1968:106) explains the rationale of the Wilcoxon's rank-sum test:
Suppose that an experimenter has randomly and independently drawn \( n \) observations from an \( X \)-population and \( m \) observations from a \( Y \)-population, and wishes to test the null hypothesis that the two populations are identical against the alternative that they are nonidentical, and [also] wishes the test to be especially likely to reject the null hypothesis when the populations have unequal locations.

If the experimenters null hypothesis is true, the "\( X \)-sample" and the "\( Y \)-sample" are merely arbitrary labels for subsets . . . \( n \) and \( m \) . . . all of which were, in effect, drawn from a common population. We may reject the null hypothesis of identical populations if the value of \( W_n \) for the . . . data falls in a preselected rejection region [say, the .05 alpha level]. If the two populations differ in location . . . the larger we would expect \( W_n \) to be.

Metric variables which are evaluated through use of the Wilcoxon's rank-sum test are also portrayed graphically using the Tukey box-and-whisker plot (Hartwig and Dearing 1979:23). Figure 6 illustrates how the box-and-whisker plot works.

The vertical line forming the left side of the box illustrated in Figure 6 is located at the lower quartile (or hinge) of the distribution, while the vertical line at the right side of the box is located at the upper quartile (or hinge). Within the box is a vertical line representing the midpoint or median value of the distribution. The box itself encompasses the midspread and contains the middle 50 percent of values forming the distribution. Another 25 percent of the values lie to the right of the box, while the final 25 percent lie to the left of the box. The dots at ends of the two solid horizontal lines, called "whiskers," mark individual values farthest from, but still within one midspread equivalent distance from either the upper or lower hinge. Cases beyond one midspread equivalent distance from the hinges are considered outliers or residuals, and are marked individually by dots. In a normal distribution, all but about 5 percent of the values will be within the box or the whiskers. Distributions where more than 5 percent of
Figure 6. Example of a Tukey box-and-whisker plot.
the cases are individually located may not be normal, and the outliers or residual cases are easily identified (Hartwig and Dearing 1979:23).

Random points and clustering effects

Random points were chosen by establishing a grid of 48,300 units on the vegetation/landform map of the study area. A larger number of grid units would have made it nearly impossible to differentiate and accurately locate random points on the 1:13,000 scale map. As it was, each of the grid units appeared as a large dot on the map. The 78 random points used in this analysis were selected from a table of random numbers (Blalock 1979); using this method, all portions of the study area had equal chance of being selected for use in the randomly generated model.

This study compares 1) a simple random sample of "dummy sites" consisting of the centers of grid units, and 2) a 2-stage cluster sample of actual archaeological sites, ranging in numbers from zero to seven, within 400 m square randomly chosen quadrats, 45 of which are found within three randomly chosen watershed units (Matson and Lipe 1975). The accuracy of the cluster sample must be judged with an understanding that physical space is being sampled as well as the sites themselves (Asch 1975:172). Each quadrat in the study area can be considered a sample of space, within which, various sites may be regarded as individual elements or attributes of the quadrat. This is opposed to the "dummy sites," in which the point itself is the subject of analysis. Because of these differences, the comparability of the two samples can be questioned.

The problem with cluster samples is that virtually all hypothesis testing assumes a simple random sample of elements (in this case, prehistoric sites). When using cluster samples, however, elements in spatial proximity, that is,
sites within the same quadrat, tend to be more similar to each other than would be the same number of elements chosen through a simple random sampling technique (Asch 1975:179-180). To the extent that this is true, the power of the cluster sample to fully represent the variability in the population of archaeological sites is lessened. In statistical terms, the effective sample size is smaller than the apparent sample size. The end result of this effect is that null hypotheses successfully rejected at a nominal significance level of .05 on the basis of cluster-sampled elements, may have in fact been rejected with a much higher probability of Type I error (Blalock 1979:571).

These problems bring to mind what R.G. Matson (personal communication) has called the "Alfred Law," which states: "No matter how large the initial sample size is, by the time all the relevant variables have been controlled for, the final sample is too small to do anything statistically significant with."

**Strength of associations between variables**

Up to this point the primary concern has been whether or not a significant relationship exists between settlement location and particular environmental variables. The final goal of this chapter is to objectively rank the influence of each variable as it affects the settlement pattern. This will be accomplished by measuring the strength of relationship or association between the variables. The measure used, Goodman and Kruskal's Tau Beta ($T_b$), is a proportionate reduction in error (PRE) measure. PRE measures simply state the proportions by which one can reduce errors in prediction through knowledge of the independent variable (IV) (Blalock 1979:308). In general form:

\[
T_b = \frac{\text{no. of errors not knowing IV minus no. of errors knowing IV}}{\text{no. of errors not knowing IV}}
\]
This formula evaluates the relationship between the independent variable (for our purposes, environmental features) and a dependent variable (settlement location). A value of 1.00 indicates a perfect association, while a value of 0.00 indicates statistical independence. The higher the value, the greater the strength of association (Blalock 1979:307). This measure of strength necessitates use of contingency tables, such as those used in chi-square analysis.

Goodman and Kruskal's $T_b$ has been determined for all of the environmental variables. The $T_b$ for nominal level variables were easy to determine because contingency tables had already been established in order to determine significance of associations. Rank-order variables (e.g., distance to resource measures) were collapsed into contingency tables as well, and as a result, became ordinal level with cells representing particular cases of ranked distributions. This was necessary to establish comparability between all of the environmental variables being evaluated in this chapter. With hindsight, it appears that more appropriate PRE measures could have been used to determine strengths of association for rank-sum variables without collapsing them to ordinal level scale. The results, however, are the same regardless of whether they were collapsed or not.

The advantage of Goodman and Kruskal's $T_b$ is that it can be used in a row by column, rather than a 2 by 2 contingency table, thus allowing use of ordinal data. Furthermore, it has simple intuitive interpretations. Also, when a number of scores are compared with one another, as at the end of this chapter, the relative effects of each variable on the pattern of settlement can be evaluated.
Plant Community as a Factor in Site Location

In outlining a research design for the Southwestern Anthropological Research Group (SARG), Plog and Hill (1971:27) asked: "Do sites appear in plant communities in proportion to the area of those communities or is there a departure from this proportion?" The first test of environmental factors will answer this question for Puebloan settlements on Cedar Mesa. The four environmental strata under consideration -- the desertshrub, pinyon-juniper, canyon, and escarpment communities -- have been described in Chapter II.

Based on background research, it was predicted in the Chapter II summary that most settlements will be concentrated in the pinyon-juniper community because of arable soils, relatively high levels of precipitation, and abundant supplies of fuel and building material. It should be noted that "plant community" is a proxy measure, and that causality is likely related to these three factors.

The distribution of archaeological sites within these communities can be reduced to a testable hypothesis:

- A significantly greater number of sites than expected will be found in the pinyon-juniper community because of abundance of arable land, fuel, building supplies, and higher levels of precipitation.

As written, this is an alternative hypothesis. The related null hypothesis is identical, except that a random distribution of prehistoric sites between plant communities is assumed.

Binomial confidence intervals on Table 4 indicate that when proportions of sites within each plant community are considered individually, significant differences between numbers of archaeological sites and random points occur within several of the environmental zones. An asterisk (*) indicates differences between sites and random points significant at the .05 alpha level.
Table 4.--Binomial confidence intervals of site distribution among plant communities.

**Field Stations (n = 46)**

<table>
<thead>
<tr>
<th>Plant Community</th>
<th>Sites</th>
<th>95% C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desertshrub</td>
<td>.11 *</td>
<td>.05 -.24</td>
<td>.26</td>
</tr>
<tr>
<td>Pinyon-Juniper</td>
<td>.87 *</td>
<td>.73 -.96</td>
<td>.45</td>
</tr>
<tr>
<td>Canyon</td>
<td>.02 *</td>
<td>.00 -.12</td>
<td>.20</td>
</tr>
<tr>
<td>Escarpment</td>
<td>.00</td>
<td>.00 -.08</td>
<td>.08</td>
</tr>
</tbody>
</table>

**Habitations (n = 32)**

<table>
<thead>
<tr>
<th>Plant Community</th>
<th>Sites</th>
<th>95% C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desertshrub</td>
<td>.00 *</td>
<td>.00 -.11</td>
<td>.26</td>
</tr>
<tr>
<td>Pinyon-Juniper</td>
<td>.81 *</td>
<td>.64 -.92</td>
<td>.45</td>
</tr>
<tr>
<td>Canyon</td>
<td>.13</td>
<td>.04 -.30</td>
<td>.20</td>
</tr>
<tr>
<td>Escarpment</td>
<td>.06</td>
<td>.01 -.21</td>
<td>.08</td>
</tr>
</tbody>
</table>

* = difference significant at the .05 alpha level
The disparity between random points and field stations was significant at the .05 alpha level for three of the plant communities. Nearly twice the expected proportion of sites were located within the pinyon-juniper zone, while field stations were significantly underrepresented in the desertshrub and canyon plant communities. For habitations, significant differences exist between proportions of sites and random points within the desertshrub and pinyon-juniper communities. Habitations are completely absent in desertshrub, while the sites outnumber random points by a 3:2 ratio in the pinyon-juniper zone. In sum, the vast preponderance of habitations and field stations (84 %) are found within the pinyon-juniper community, which itself covers only 51 percent of the study area.

Habitations within the canyon and escarpment communities did not significantly differ from the null hypothesis. This does not mean the Anasazi were locating their settlements at random within these two zones, however, because factors other than plant community prove to be just as important in determining settlement location. As a proxy measure, plant community type holds up quite well. The alternative hypothesis was accepted, and it appears that knowledge of plant community is a good predictor of settlement location.

Biotic Association as a Factor in Site Location

Each of the four plant communities on Cedar Mesa is composed of a number of distinctive groupings of plant species called biotic associations. The biotic associations to be assessed for the presence of prehistoric sites are listed on Table 1.

It was demonstrated above that the pinyon-juniper zone contained the greatest proportions of archaeological sites found within the study area.
This community consists primarily of the dense pinyon-juniper biotic association. Similar to plant community type, biotic associations are proxy measures of features in the environment valued by the Anasazi. It can be logically argued that the greatest numbers of sites will be located in the dense pinyon-juniper association because of the abundance of resources facilitating survival. Hypotheses include:

- A significantly greater number of sites than expected will be found in the dense pinyon-juniper biotic association because of abundance of arable land, fuel, and building materials.

- Sites will occur in less than expected numbers in biotic associations lacking essential features such as arable land, fuel, and building materials.

Results of the binomial confidence interval approach are mixed, and there is only partial acceptance of the hypotheses. However, Table 5 indicates that significant departures from the random model at the .05 level exist for several of the biotic associations. Significant differences between random points and field stations are evident in the bare rock, sagebrush, and dense pinyon-juniper associations. While the first two associations contained 41 percent of the random points, only 5 field stations -- 11 percent of the total -- were found in these areas. These 5 field stations were all found within sagebrush associations. Another 32 percent of random points were located within dense pinyon-juniper, but 85 percent of field stations found within the study area are located in this biotic association.

Habitations are similarly clustered in the dense pinyon-juniper woodland, with 88 percent of Anasazi sites versus 32 percent of random points located here -- nearly a 3:1 ratio. However, only 6 percent of habitations are located within blackbrush, sagebrush, cliffside and bare rock associations,
Table 5.--Binomial confidence intervals of site distribution among biotic associations.

### Field Stations (n = 46)

<table>
<thead>
<tr>
<th>Biotic Association</th>
<th>Sites</th>
<th>95 % C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbrush</td>
<td>.00</td>
<td>.00 - .08</td>
<td>.06</td>
</tr>
<tr>
<td>Mixed sagebrush/blackbrush</td>
<td>.00</td>
<td>.00 - .08</td>
<td>.03</td>
</tr>
<tr>
<td>Sagebrush</td>
<td>.11 *</td>
<td>.05 - .24</td>
<td>.27</td>
</tr>
<tr>
<td>Sparse pinyon-juniper</td>
<td>.04</td>
<td>.00 - .14</td>
<td>.10</td>
</tr>
<tr>
<td>Dense pinyon-juniper</td>
<td>.85 *</td>
<td>.71 - .93</td>
<td>.32</td>
</tr>
<tr>
<td>Bare rock</td>
<td>.00 *</td>
<td>.00 - .08</td>
<td>.14</td>
</tr>
<tr>
<td>Cliffside</td>
<td>.00</td>
<td>.00 - .08</td>
<td>.08</td>
</tr>
</tbody>
</table>

### Habitations (n = 32)

<table>
<thead>
<tr>
<th>Biotic Association</th>
<th>Sites</th>
<th>95 % C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbrush</td>
<td>.00</td>
<td>.00 - .11</td>
<td>.06</td>
</tr>
<tr>
<td>Mixed blackbrush/sagebrush</td>
<td>.00</td>
<td>.00 - .11</td>
<td>.03</td>
</tr>
<tr>
<td>Sagebrush</td>
<td>.00 *</td>
<td>.00 - .11</td>
<td>.27</td>
</tr>
<tr>
<td>Sparse pinyon-juniper</td>
<td>.06</td>
<td>.01 - .21</td>
<td>.10</td>
</tr>
<tr>
<td>Dense pinyon-juniper</td>
<td>.88 *</td>
<td>.72 - .96</td>
<td>.32</td>
</tr>
<tr>
<td>Bare rock</td>
<td>.03</td>
<td>.00 - .16</td>
<td>.14</td>
</tr>
<tr>
<td>Cliffside</td>
<td>.03</td>
<td>.00 - .16</td>
<td>.08</td>
</tr>
</tbody>
</table>

* = difference significant at the .05 alpha level
while 55 percent of the random points were distributed among these four associations.

A major difference between the two site types is that only field stations are found within sagebrush biotic associations, although even here, they occur in numbers less than expected from the random model. No habitations are found in the shallow sagebrush covered mesa top valleys above 1860 m elevation, nor in the large open parks located below this elevation. As indicated in the summary of Chapter II, the shallow mesa top valleys appear to be cold air drainages, with cool air puddling in areas where sagebrush grows. This factor, along with the paucity of fuel wood, is one possible explanation for lack of habitations in these areas. It is important to note, however, that many sites, including both habitations and field stations, are located immediately adjacent to the sagebrush parks at the edge of woodland associations.

Another noticeable difference between the two site types is that only 4 percent of field stations are located in areas of shallow soils -- the blackbrush, mixed blackbrush and sagebrush, sparse pinyon-juniper, cliffside and bare rock associations. This is in contrast to the 12 percent of habitations located in these shallow soil areas. Although this is probably not a significant difference, it is interesting to note that field stations -- presumably farmsteads occupied during the summer months -- are virtually confined to areas with deep arable soils.

**Landform as a Factor in Site Location**

Landforms or terrain features are another important aspect in analysis of Pueblo settlement patterns. On Cedar Mesa, landform type is determined by the structural characteristics of underlying bedrock, by erosion, and by
unconsolidated mesa top sediments deposited by wind or water. Landforms within the study area include:

- Drainage bottoms
- Rocky breaks or escarpments
- Watershed divides
- Shallow mesa top valleys
- Sandstone cliffs
- Canyon bottom alluvial terraces

A short definition of each is necessary. "Drainage bottoms" are simply the channels of stream courses; all are linear and very narrow in plan. Sometimes they contain remnants of alluvial terraces. "Rocky breaks" are escarpments or talus slopes containing sandstone boulders and patches of colluvium. "Watershed divides" are self explanatory, but frequently have deep eolian soils when found within the pinyon-juniper community and the uppermost elevations of the desertshrub community. "Shallow mesa top valleys" are found only in the pinyon-juniper community above 1860 m elevation. These landforms may be a kilometer or two wide, but only 20 or 30 m deep. A good indicator of these shallow valleys is the presence of sagebrush parks. The last two landforms are found only within canyons. "Sandstone cliffs" are very steep and nearly devoid of vegetation. "Canyon bottom alluvial terraces" are found only in entrenched canyons. While most such terraces have been removed by arroyo cutting over the past century, they were formerly much greater in extent, covering large areas of canyon bottoms.

Each of these variables can be considered proxy measures for arable land. Landforms considered most suitable for farming include watershed divides and canyon bottom alluvial terraces. It is also believed that floodwater farming could have occurred along drainage bottoms and within the shallow mesa top valleys. The disadvantage of these landforms is that each is found at slightly lower elevations than the surrounding terrain, and as a consequence
are cold air drainages. Least suitable for farming are rocky breaks and sandstone cliffs. The following hypothesis relates to Puebloan settlement upon the landforms found within the study area:

- Due to Puebloan agricultural needs, sites will occur in greater proportions than expected on landforms having arable qualities, and will be underrepresented on landforms lacking these properties.

This hypothesis is only partially supported by binomial confidence intervals illustrated in Table 6. Departures from random points are most apparent for field stations. While 42 percent of random points are located on watershed divides and shallow mesa top valleys -- landforms having arable qualities -- 79 percent of field stations occupy these landforms. Rocky breaks and cliffsides -- landforms unsuited for farming -- contain 30 percent of random points but only 4 percent of the field stations, a difference significant at the .05 level. These factors support the assumption that for the most part, field stations were agricultural in function.

When evaluating habitations and corresponding random points, 69 percent of the former and 42 percent of the latter were located on watershed divides. The difference between the two is significant, suggesting the presence of divides were important criteria in locating residential sites. Other criteria may have included avoidance of drainage bottoms and shallow mesa top valleys -- distributions of sites on these landforms have discrepancies from the random model significant at the .05 level.

Although no habitations were located in drainage bottoms, the Anasazi apparently did not avoid locating field stations along these terrain features. The reasons for this are not clear, but differences in site facilities may have played a role in locational decisions. Habitations frequently had pit structures, and these could not easily have been built in areas such as drainage bottoms where soil is relatively shallow and rocky
Table 6.--Binomial confidence intervals of site distribution upon landforms.

**Field Stations (n = 46)**

<table>
<thead>
<tr>
<th>Landform</th>
<th>Sites</th>
<th>95% C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage bottom</td>
<td>.15</td>
<td>.07 - .29</td>
<td>.15</td>
</tr>
<tr>
<td>Rocky breaks</td>
<td>.04 *</td>
<td>.00 - .14</td>
<td>.15</td>
</tr>
<tr>
<td>Watershed divide</td>
<td>.70 *</td>
<td>.54 - .83</td>
<td>.42</td>
</tr>
<tr>
<td>Shallow mesa top valley</td>
<td>.09</td>
<td>.03 - .22</td>
<td>.12</td>
</tr>
<tr>
<td>Sandstone cliff</td>
<td>.00 *</td>
<td>.00 - .08</td>
<td>.15</td>
</tr>
<tr>
<td>Canyon bottom alluvium</td>
<td>.02</td>
<td>.00 - .12</td>
<td>.01</td>
</tr>
</tbody>
</table>

**Habitations (n = 32)**

<table>
<thead>
<tr>
<th>Landform</th>
<th>Sites</th>
<th>95% C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage bottom</td>
<td>.00 *</td>
<td>.00 - .11</td>
<td>.15</td>
</tr>
<tr>
<td>Rocky breaks</td>
<td>.19</td>
<td>.08 - .37</td>
<td>.15</td>
</tr>
<tr>
<td>Watershed divide</td>
<td>.69 *</td>
<td>.50 - .84</td>
<td>.42</td>
</tr>
<tr>
<td>Shallow mesa top valley</td>
<td>.00 *</td>
<td>.00 - .11</td>
<td>.12</td>
</tr>
<tr>
<td>Sandstone cliff</td>
<td>.06</td>
<td>.01 - .21</td>
<td>.15</td>
</tr>
<tr>
<td>Canyon bottom alluvium</td>
<td>.06</td>
<td>.01 - .21</td>
<td>.01</td>
</tr>
</tbody>
</table>

* = difference significant at the .05 confidence level
outcrops common. Also, there is the danger of flooding in these areas. However, the same floodwaters that would make habitations very uncomfortable would bring nutrients, soil and moisture to fields located within or alongside drainages.

Aspect or Exposure as a Factor in Site Location

This section examines the aspect, or directional angle at which prehistoric sites were oriented. Both sites and random points were considered oriented in either cardinal (N, E, S, W) or subcardinal (NE, SE, SW, NW) octants having 45 degree exposures.

None of the previous hypotheses lend insight into this locational factor, but perusal of the literature is enlightening. When discussing the sun's influence on the form of modern Hopi habitations, Fewkes (1906:88) speculated as part of his "heliotrophic hypothesis" that:

The arrangement and orientation of houses in Hopi pueblos are largely due to an attempt to secure sunny exposures for entrances and terraces and consequent protection from cold and wind . . . this form . . . has evolved from a preexisting condition in which the sedentary people of the Southwest were more scattered, the habitations partaking more of the nature of isolated rancherias . . . "

Hence, it appears that southern exposures were sought when establishing habitations, while northern exposures were avoided.

Exposures of field stations are also mentioned in the literature. When discussing results of the Wetherill Mesa survey, Erdman et al. (1969:58) write:

The distribution of farming terraces was studied to determine whether the use of those slopes and mesa rims that harbor more favorable moisture regimes was intentional. The pattern indicates that the more mesic canyon and mesa slopes were selected for agriculture purposes. Of the terrace systems . . . about 75 percent . . . surveyed have a northeastern exposure and about 25 percent of the sites have a southern exposure.

The suspected reason for this phenomenon was:
Table 6.--Binomial confidence intervals of site distribution upon landforms.

<table>
<thead>
<tr>
<th>Landform</th>
<th>Sites</th>
<th>95% C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage bottom</td>
<td>.15</td>
<td>.07 - .29</td>
<td>.15</td>
</tr>
<tr>
<td>Rocky breaks</td>
<td>.04 *</td>
<td>.00 - .14</td>
<td>.15</td>
</tr>
<tr>
<td>Watershed divide</td>
<td>.70 *</td>
<td>.54 - .83</td>
<td>.42</td>
</tr>
<tr>
<td>Shallow mesa top valley</td>
<td>.09</td>
<td>.03 - .22</td>
<td>.12</td>
</tr>
<tr>
<td>Sandstone cliff</td>
<td>.00 *</td>
<td>.00 - .08</td>
<td>.15</td>
</tr>
<tr>
<td>Canyon bottom alluvium</td>
<td>.02</td>
<td>.00 - .12</td>
<td>.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Landform</th>
<th>Sites</th>
<th>95% C.I.</th>
<th>Random Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage bottom</td>
<td>.00 *</td>
<td>.00 - .11</td>
<td>.15</td>
</tr>
<tr>
<td>Rocky breaks</td>
<td>.19</td>
<td>.08 - .37</td>
<td>.15</td>
</tr>
<tr>
<td>Watershed divide</td>
<td>.69 *</td>
<td>.50 - .84</td>
<td>.42</td>
</tr>
<tr>
<td>Shallow mesa top valley</td>
<td>.00 *</td>
<td>.00 - .11</td>
<td>.12</td>
</tr>
<tr>
<td>Sandstone cliff</td>
<td>.06</td>
<td>.01 - .21</td>
<td>.15</td>
</tr>
<tr>
<td>Canyon bottom alluvium</td>
<td>.06</td>
<td>.01 - .21</td>
<td>.01</td>
</tr>
</tbody>
</table>

* = difference significant at the .05 confidence level
outcrops common. Also, there is the danger of flooding in these areas. However, the same floodwaters that would make habitations very uncomfortable would bring nutrients, soil and moisture to fields located within or alongside drainages.

Aspect or Exposure as a Factor in Site Location

This section examines the aspect, or directional angle at which prehistoric sites were oriented. Both sites and random points were considered oriented in either cardinal (N, E, S, W) or subcardinal (NE, SE, SW, NW) octants having 45 degree exposures.

None of the previous hypotheses lend insight into this locational factor, but perusal of the literature is enlightening. When discussing the sun's influence on the form of modern Hopi habitations, Fewkes (1906:88) speculated as part of his "helictrophic hypothesis" that:

The arrangement and orientation of houses in Hopi pueblos are largely due to an attempt to secure sunny exposures for entrances and terraces and consequent protection from cold and wind . . . this form . . . has evolved from a preexisting condition in which the sedentary people of the Southwest were more scattered, the habitations partaking more of the nature of isolated rancherias . . ."

Hence, it appears that southern exposures were sought when establishing habitations, while northern exposures were avoided.

Exposures of field stations are also mentioned in the literature. When discussing results of the Wetherill Mesa survey, Erdman et al. (1969:58) write:

The distribution of farming terraces was studied to determine whether the use of those slopes and mesa rims that harbor more favorable moisture regimes was intentional. The pattern indicates that the more mesic canyon and mesa slopes were selected for agriculture purposes. Of the terrace systems . . . about 75 percent . . . surveyed have a northeastern exposure and about 25 percent of the sites have a southern exposure.

The suspected reason for this phenomenon was:
... that while the southwest slope receives more solar radiation at noon, the actual maximum radiation occurs in late morning at the northeast exposure ... We believe that the southern exposure receives more solar radiation on a yearly basis, but the northeast slope probably receives more during the growing season (Erdman et al. 1969:48).

From these quotes come the hypotheses used to test the aspect of prehistoric Pueblo sites on Cedar Mesa:

- Due to year-round heliotrophic needs, habitations will have predominately southern exposures.

- Field stations, due to limited summer occupation and the need to maximize crop success, will be oriented in either of two major directions -- north and south.

Results are evaluated by chi-square goodness-of-fit tests (Table 7) and by Rose diagrams (Figure 7).

When comparing habitations with random points, the chi-square value was significant at the .005 level. It is obvious from the chi-square table that considerably greater numbers of habitations have southern exposures than would be expected, given the distribution of random points. When the same test was used to evaluate orientation of field stations, however, the discrepancy was significant only at the .25 level, indicating that no real difference exists between aspect of random points and field stations. Of course, differences may have been masked, because octants were collapsed in order to achieve adequate cell sizes for the chi-square test.

Rose diagrams illustrate site aspect more clearly. As is seen, 50 percent of habitations have southern exposures, and when southeast and southwest oriented sites are combined with this group, the figure becomes 70 percent. This lends credence to Fewkes' (1906) speculation that isolated prehistoric habitations were oriented towards sunny exposures.

While the chi-square test for field stations failed to reject the null hypothesis, the Rose diagram for this set of sites indicates most were
Table 7. -- Aspect or directional orientation of sites versus random points. Chi-square goodness-of-fit test.

<table>
<thead>
<tr>
<th>Field Stations</th>
<th>Site Aspect</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/NE</td>
<td>E/SE</td>
<td>S/SW</td>
<td>W/NW</td>
</tr>
<tr>
<td>Field Stations</td>
<td>17</td>
<td>10</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Random Points</td>
<td>13</td>
<td>6</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>16</td>
<td>27</td>
<td>19</td>
</tr>
</tbody>
</table>

\[
x^2 = 4.91 \\
p \text{ of } H_0 = .10 \\
T_b = .03
\]

<table>
<thead>
<tr>
<th>Habitations</th>
<th>Site Aspect</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N/NE</td>
<td>E/SE</td>
<td>S/SW</td>
<td>W/NW</td>
</tr>
<tr>
<td>Habitations</td>
<td>4</td>
<td>8</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Random Points</td>
<td>9</td>
<td>4</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>12</td>
<td>28</td>
<td>11</td>
</tr>
</tbody>
</table>

\[
x^2 = 18.61 \\
p \text{ of } H_0 = <.005 \\
T_b = .16
\]
Figure 7. Rose diagrams showing proportions of random points and prehistoric sites oriented in cardinal and subcardinal directions.
oriented either in the northern or southern octants. Although proportions are different from the Wetherill Mesa study, the dichotomy is quite similar to what Erdman et al. (1969) has described. A major difference though, is that on Cedar Mesa, fields were not defined by stone check dams or terraces. Instead, field stations are assumed to be located either within or at the borders of fields, similar to modern-day Navajo field shelters.

Erdman et al. (1969) suggest the reason for northern exposures is to grow crops in more mesic conditions, but this may not be the complete explanation for the duality of field locations. Increased soil moisture was certainly a positive locational factor, but at the same time, fields with northern exposures may have been susceptible to late spring or early autumn frosts. The duality of location then, may represent a risk-minimizing strategy designed to counter the cumulative effects of both drought and frosts on Anasazi harvests.

**Elevation as a Factor in Site Location**

The importance of elevation as an environmental variable is due largely to the limiting effects of this factor upon Pueblo agricultural practices. The reasons for this, along with estimated elevational ranges of Pueblo settlement have been discussed in Chapter II. It should be noted that elevation is also a proxy measure for precipitation, with greater amounts of precipitation found at higher elevations of the study area.

Previous tests have shown that habitations are concentrated almost exclusively within the pinyon-juniper zone. Although most field stations are also located within this zone, a few are found in the lower elevation desertshrub community. This suggests there may be some differences in elevational constraints between the two site types, with field stations
located in a wider range of elevations than habitations. Given these considerations, the following hypotheses are in order:

- Habitations and field stations will be non-randomly distributed, with a majority located above 1950 m in elevation.

- Field stations will exhibit a broader distribution of elevational range, but will generally cluster in the same elevations as habitations.

The elevation 1950 m was chosen for the first hypothesis because this is Kane's (1977) postulated lower limit for successful dry farming in the Four Corners area.

Test results support the first hypothesis. Using the Wilcoxon's rank-sum test, differences between random points and habitations were significant at the .00005 level ($W_n = 4.06$). Equally significant differences exist between field stations and random points ($W_n = 4.60$). Box-and-whisker plots in Figure 8 illustrate the considerable differences between prehistoric sites and random points. While only 24 percent of random points are located above 1950 m elevation, 66 percent of habitations and 61 percent of field stations are found above this point.

The second hypothesis, which has been separated into two components, is also tenable. The first component -- clustering of field stations within the same elevation as habitations -- is supported by negative results of the Wilcoxon's rank-sum test, which indicated no significant difference between the two site types ($W_n = .0711$). Additionally, the median elevation of habitations and field stations, above which 50 percent of sites are located, are within 3 m of one another (1975 m vs. 1978 m).

Another component of the second hypothesis states that field stations will have a broader distribution of elevations than habitations. All differences in distributional ranges shown in Figure 8 occur below the median
Figure 8. Elevation of random points and archaeological sites
elevation of the two site categories. While 25 percent of habitations are located below 1915 m -- the lower hinge for this site category -- 33 percent of field stations are located below this point. More striking are proportions of sites located below the lower hinge of the field station box-and-whisker plot. While 25 percent of field stations are located below 1865 m, only 6 percent of habitations are present below this elevation. Significantly, these two "residual" habitations are located in the eastern North Road section of the study area. As was noted in Chapter II, mesic biotic associations grow at lower elevations here than in the western Hardscrabble portion of the study area. While any sites found below 1860 m in the Hardscrabble section would be in the desertshrub community, the two habitations in the North Road section are at least 75 m higher in elevation than the pinyon-juniper/desertshrub ecotone. Hence, these two outlying sites are not really different from the main body of habitations when factors such as plant community or biotic association are considered.

Distance to Nearest Probable Water Source

While water is of course an essential factor in human settlement, in semi-arid environments the scarcity of this resource poses special problems. On Cedar Mesa, water sources ranked to degree of reliability occur as: 1) springs or seeps located at canyon heads where entrenchment first begins; 2) springs or seeps located along fully entrenched canyon bottoms; 3) seeps located along upper portions of steep mesa top escarpments; and 4) mesa top potholes capable of holding water after summer thundershowers.

During the 1970's, locations of the many flowing seeps and springs within canyons were plotted on aerial photographs of the study area. A number of seeps were noted along mesa top escarpments, but investigation of this
landform was not systematic, hence the number of known sources in this area underrepresent actual water availability. Mesa top potholes were not noted during survey. What remains then, is an accurate picture of water availability only within the canyon community. Today, this is the only zone that contains reliable amounts of water in any quantity during dry seasons. In the past, this was the most likely zone used by Anasazi when procuring this important resource. Although constrained by availability of data, the following hypothesis can be tested:

- If location of water sources exerted a marked effect upon site location, then Pueblo sites will be closer to water sources than will random points.

Results of Wilcoxon's rank-sum tests, based on interval level data summarized in Figure 9, indicate that acceptance of the above hypothesis was mixed, and was dependent upon a site's function or temporal period.

For random points versus field stations, the Wilcoxon's rank-sum test indicated a discrepancy significant at the .13 level \( W_n = 1.20 \). Surprisingly, field stations were farther from water sources than were random points. The median distance to water for random points is 700 m, while for field stations it is 875 m. There is only a 50 m difference between the two groups at the lower quartile or hinge, but again, random points are closer to water than are field stations. The greatest difference is apparent at 1 km -- the upper hinge of the random point distribution. While 25 percent of random points were at greater distances than this to water, 37 percent of field stations were found beyond 1 km from any known water source.

The relationship between random points and habitations is more complex. When comparing Windgate and Clay Hills phase habitations to random points, the Wilcoxon's rank-sum test indicated no difference between the two groups \( W_n = .044 \). Box-and-whisker plots for habitations and random points
Figure 9. Distance to nearest probable water source
have the same lower hinge, median, and upper hinge -- 400 m, 700 m, and 900 m respectively.

The only real distributional differences occur between random points and habitations from the combined Woodenshoe and Red House phases. During this period of time sites are found much closer to water sources than are random points, with differences between the two groups significant at the .025 level ($W_n = 2.007$). While 50 percent of random points are farther than 700 m from water, only 8 percent of the Woodenshoe/Red House habitation sites are found beyond this distance. Although 50 percent of habitations from the post-A.D. 1150 period are located within 400 m of water, only 31 percent of the random points were as close. The only "residual" habitation site from this period (B 1-1), may not be as far from water as indicated. The site is close to a large mesa top escarpment, and as noted in the introduction to this section, this zone was not systematically examined for potential water sources.

In summary, Pueblo field stations of all periods appear to avoid water sources, suggesting that other environmental factors were of greater importance in determining site location. The Anasazi of the combined Clay Hills/Windgate phase also showed a tendency to value other factors above proximity to water when choosing locations for their habitations. Only combined Woodenshoe/Red House phase habitations are located significantly closer to water sources than are random points. When establishing habitations in the latter part of the A.D. 1100's and the 1200's, the Anasazi placed great priority on water sources. This is perhaps indicative of a gradual drying trend occurring across the Four Corners area at this time. Such a trend has been documented by tree-ring indices and other lines of evidence (Euler et al. 1979).
The latter part of the 1100's saw increased construction of cliff dwellings within the canyons of Cedar Mesa (Matson and Lipe 1978). It may be that the Red House phase was more canyon-use oriented than were the earlier phases. A drawback to this particular test is that it was not possible to draw distinctions between water sources and the presence of other resources within canyons that also may have influenced the settlement pattern during the final phase of Puebloan occupation within the region.

**Distance to Nearest Drainage**

The objective of this section is to examine relationships between locations of sites and the locations of water courses. Rather than just note the presence or absence of sites along drainages, however, the question is asked: How close or how far are archaeological sites from stream beds?

Although the majority of habitations and field stations are located on watershed divides, analysis of landform data suggested the Anasazi were not adverse to locating some field stations within the general proximity of drainages. Reasons for this latter choice of field station location are perhaps found in an analogy with the modern Navajo. Hill (1938:20) describes the primary requirements for farming locations selected by the Navajo:

> The prime essential was the possibility of getting water on the land. This was accomplished by . . . locating where . . . the natural flood would inundate the land. Hence, fields were distributed along courses of perennial or intermittent streams, on the gentler slopes below escarpments, on the flood plains of ephemeral streams, and on alluvial fans at the mouths of streams.

This statement suggests that while sites or fields may not have been located within drainages, they could have been within the general proximity of such landforms.
A few comments about methods used to operationalize this test are necessary. The 1:13,000 scale vegetation/landform map was used to measure distances from sites and random points to water courses. However, not all drainages appeared on the map. Short, ephemeral streams were apparent only from contour lines and not from blue stream markings printed on the topographical maps. To correct this, I drew additional drainages on the map. Criteria used to locate additional drainages were both simple and consistent: when three or more adjacent contour lines interlocked to form a set of "v's" pointing towards higher elevations, this was considered evidence of a drainage channel. Most first order and many second order streams were delimited in this fashion.

The hypotheses utilized to test choices of Pueblo settlement location relative to distance of nearest water course are:

- Habitations are located at greater distances from drainages than are field stations or random points because of the desire to avoid flooding and cold air drainage.

- Distributions of field stations will resemble distributions of random points because some sites of this type are located near drainages and some are found on deep soil divides.

A comment on the second hypothesis is needed. While it is assumed that distributions of field stations will resemble the random model, this does not mean that field stations were randomly distributed with regard to nearest drainage. What it does suggest is that this is an inappropriate test for field stations. Because of the dual nature of field station location, a "middle ground" will be displayed on the box-and-whisker plot, which is incapable of illustrating two groups of sites located at extreme ends of the distance spectrum. The test that follows is a more appropriate illustration of field station location within the settlement pattern.
When comparing distances of habitations and random points to the nearest drainage, the Wilcoxon's rank-sum test indicated differences significant at the .008 level ($W_n = 2.43$). This discrepancy is illustrated by box-and-whisker plots in Figure 10. As anticipated, differences were not significant between locations of field stations and random points (.75 alpha level, $W_n = 0.65$).

While 25 percent of field stations and and 35 percent of random points are within 30 m of a drainage, no habitations are closer to water courses than this. Only 30 percent of habitations are within 50 m of a water course, although this is the median distance of field stations to these topographic features. Opposite trends occur at the far end of the box-and-whisker plots: beyond the median distance for habitations, located 100 m from the nearest drainage, lie only 33 percent of field stations. In sum, the data support the first alternative hypothesis presented above.

The second hypothesis is also supported, because distributions of field stations do indeed resemble the distributions of random points. Median values of both are 50 m from the nearest drainage. Furthermore, there is no significant difference between random points and field stations when using the Wilcoxon's rank-sum test to compare distributions of the two data sets.

Drainage rank was mentioned briefly at the introduction of this section. When conducting chi-square goodness-of-fit tests of drainage rank, no significant differences were observed when comparing habitations and field stations with one another or with random points. In all cases, the nearest drainage for both types of archaeological sites and for random points was a small first order mesa top stream.
Figure 10. Distance to nearest drainage
Watershed Divide as a Factor in Site Location

The polar opposite of a drainage is its watershed divide. Divides are boundaries of rainfall catchment areas for streams. On Cedar Mesa, major divides are generally elevated topographic features covered with eolian soils and dense pinyon-juniper. Even in the more xeric desertshrub community, divides have higher amounts of pinyon-juniper and sagebrush than do non-divide areas.

Like other variables examined in this chapter, watershed divide is a proxy measure. Divides are important because this is where concentrations of deep, eolian deposited loess are found. There is headward removal of loess starting at canyon rims, escarpment rims, and along mesa top drainages. Because watershed divides are generally the points farthest from these three topographic features, erosion is limited. Divides are also more level than areas adjacent to canyons and escarpments; there is less energy available for erosion. In sum, it is thought that watershed divides would be the preferred locations for habitations, and to a degree, for field stations as well (although the latter are at times positioned near drainages for possible exploitation of sediment-bearing floodwaters).

Position and location of watershed divides were determined in the same fashion as stream drainages. When three or more contour lines formed sets of interlocking "v's" -- always in the opposite direction from "v's" forming drainages -- a line denoting the divide was drawn on the base map of the study area. In general, a first order ranked stream was bounded by a pair of first order divides, second order streams were bounded by second order divides, and so on. Exceptions exist, however, especially at the outer boundaries of the study area. These divides are classified as fourth or
fifth order because they ultimately separate entrenched fourth or fifth order drainages central to the study area from one another.

Two factors of settlement location are examined in this section: 1) distance to nearest watershed divide, and 2) rank of nearest watershed divide. Each will be discussed individually below.

Distance to nearest watershed divide

Earlier in this chapter, it was noted that roughly 70 percent of all sites were located on or very near watershed divides. The apparent reasons include the presence of arable soils, and for habitations, avoidance of floodwaters and cold air drainage. Based on these insights, the following hypothesis concerning Puebloan settlement can be made:

- Both habitations and field stations, due to residential and agricultural needs, are located closer to watershed divides than are random points.

This hypothesis is supported by results of the Wilcoxon's rank-sum test. Field stations are much closer to watershed divides than are random points, with differences significant at the .0004 level ($W_n = -3.40$). Habitations are also closer to divides than are random points, with the discrepancy significant at the .005 level ($W_n = -2.61$). Box-and-whisker distributions showing distance to nearest watershed divide are shown in Figure 11.

For both field stations and habitations, the black dot denoting the end of the distribution is located at the zero point on the box-and-whisker scale. The vertical line denoting the lower quartile of the two groups also falls on the zero point of the scale. This evidence shows how skewed distributions of sites are towards divides. In fact, 41 percent of field stations and 37 percent of habitations are located directly atop watershed divides, while 67 percent and 72 percent respectively, are located within 30
m of these terrain features. Only 15 percent of random points are located directly atop divides, and only 36 percent of the points are within 30 m of these features.

Only two "residual" sites are present in distributions shown in Figure 11. A habitation (B 22-2), is located along the south fork of Bullet Canyon about 30 m from the wash and is adjacent to steep sandstone canyon walls. It is one of two habitations located in the canyon plant community, and arable canyon bottom alluvial soils are found in the immediate vicinity of the site. The second outlier is a field station (B 19-2) that is located within a shallow mesa top valley that drains into one of the forks of Bullet Canyon. This site is one of the most ephemeral in the study area, containing only 49 artifacts.

At first glance, the fact that a majority of field stations are located upon watershed divides would appear to contradict earlier statements suggesting field stations were at times close to drainages. What was postulated, however, was a duality in field station location: some of these sites appear to be located within drainages while others appear to have taken advantage of divide areas having relatively deep arable soils. Of course, if the drainages are small and first order in rank, they could also be located relatively close to their watershed divides. If this were the case, several of the field stations in the sample could be located close to both drainages and divides.

The present day Navajo follow field strategies very similar to this. Russell (1978b:20) writes:
Figure 11. Distance to nearest watershed divide
Three agricultural field types exist among the seventeen [Navajo] fields examined [on Black Mesa, Arizona]. Nine are dry fields, six are floodwater fields, and two are irrigated from water stored behind a spreader dam. Dry fields receive their moisture from precipitation that falls directly on the field. Floodwater fields in contrast, are located in a position such that during the summer where rainfall occurs, floodwaters, from a normally small catchment area, move into the fields.

The Anasazi on Cedar Mesa followed a similar strategy, pursuing the first two "Navajo" approaches to field location described by Russell. This duality would minimize the calamity of a drought killing crops solely dependent upon rainfall, or an excessive downpour washing away floodwater fields. If either of these things happened, there would still be crops in the other location.

**Rank of nearest watershed divide**

A final factor in site location is the rank of the nearest watershed divide. There are hundreds of divides within the study area, but most are neither long nor wide, and separate only first order drainages from one another. Few are third order or greater. The approach used here is exploratory; therefore, no hypotheses have been generated. However, median rank values and chi-square goodness-of-fit tests (Table 8) are used to evaluate differences in divide rank between prehistoric sites and random points.

Results indicate that median divide rank for both field stations and random points is first order, while median divide rank for habitations is second order. When conducting chi-square tests of nearest divide rank, an evaluation of random points versus field stations elicited no significant difference. However, a similar test between random points and habitations indicated differences between the two groups were significant at the .05 level.
Table 8. -- Rank of nearest watershed divide -- sites versus random points.
Chi-square goodness-of-fit test.

<table>
<thead>
<tr>
<th>Field Stations</th>
<th>Divide Rank</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3+</td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td>24</td>
<td>14</td>
<td>8</td>
<td>46</td>
</tr>
<tr>
<td>Stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random</td>
<td>25</td>
<td>14</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>Points</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>49</td>
<td>28</td>
<td>15</td>
<td>92</td>
</tr>
</tbody>
</table>

\[ x^2 = 0.18 \quad \text{df} = 2 \]
\[ p\text{ of } H_0 = .75 \quad T_b = .001 \]

<table>
<thead>
<tr>
<th>Habitations</th>
<th>Divide Rank</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3+</td>
<td></td>
</tr>
<tr>
<td>Habitations</td>
<td>12</td>
<td>10</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>Random</td>
<td>17</td>
<td>10</td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>Points</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>20</td>
<td>15</td>
<td>64</td>
</tr>
</tbody>
</table>

\[ x^2 = 6.47 \quad \text{df} = 2 \]
\[ p\text{ of } H_0 = .05 \quad T_b = .04 \]
A final way to evaluate relationships between sites and watershed divides is to examine proportions of each group having nearest divides ranked second order or greater. For habitations, 62 percent of the closest divides were second order or higher. This figure was only 47 percent for field stations and 46 percent for random points. This suggests that for habitations, there may have been conscious selection for divides having greater ranks than would be expected, given the random model. It is unlikely the Anasazi were aware of divide rank, but because they are likely to have deeper soils, denser pinyon-juniper forest, and commanding views, second order or higher watershed divides were the preferred locations for year-round settlement. Conversely, field stations, although located mostly atop divides, appeared to have been positioned without regard for watershed divide rank. Instead, this group of sites fits almost exactly the distribution expected from randomly positioned points having no archaeological significance.

Summary of Environmental Factors of Site Location

It has been demonstrated that Pueblo settlements were not distributed randomly across the landscape of Cedar Mesa. When comparing locations of field stations and habitations to positions of randomly generated points, certain elements within the environment appear to have been consistently exploited or avoided by the Anasazi. The results of the settlement pattern analysis are summarized on two sets of tables.

Table 9 lists each of the environmental variables examined, and shows differences, if they exist, between distributions of random points and archaeological sites. Where differences between random points and sites are significant at the .05 alpha level or greater, this is indicated by directional arrows. Arrows pointing to the right indicate that proportions
Table 9.--Summary of environmental factors of settlement location for habitations and field stations.

\(<\) = Site occurrence significantly less than expected from distributions of random points.

\(\textgreater\) = Site occurrence significantly greater than expected from distributions of random points.

\(<\rightarrow\) = No significant discrepancy between distributions of sites and random points.
### Table 9.-(continued)

Relationship of site location to on-site environmental resources

<table>
<thead>
<tr>
<th>Plant Community</th>
<th>Field Stations</th>
<th>Habitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desertshrub</td>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Pinyon-Juniper</td>
<td>&gt;</td>
<td>&gt;</td>
</tr>
<tr>
<td>Escarpment</td>
<td>&lt;-&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Canyon</td>
<td>&lt;</td>
<td>&lt;-&lt;</td>
</tr>
</tbody>
</table>

#### Biotic Association

<table>
<thead>
<tr>
<th>Biotic Association</th>
<th>Field Stations</th>
<th>Habitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackbrush</td>
<td>&lt;-&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Mixed blackbrush/sagebrush</td>
<td>&lt;-&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Sagebrush</td>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Sparse pinyon-juniper</td>
<td>&lt;-&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Dense pinyon-juniper</td>
<td>&gt;</td>
<td>&gt;</td>
</tr>
<tr>
<td>Cliffside</td>
<td>&lt;-&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Bare rock</td>
<td>&lt;</td>
<td>&lt;-&lt;</td>
</tr>
</tbody>
</table>

#### Landform

<table>
<thead>
<tr>
<th>Landform</th>
<th>Field Stations</th>
<th>Habitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage bottom</td>
<td>&lt;-&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Rocky breaks</td>
<td>&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Watershed divide</td>
<td>&gt;</td>
<td>&gt;</td>
</tr>
<tr>
<td>Shallow mesa top valley</td>
<td>&lt;-&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Sandstone cliff</td>
<td>&lt;</td>
<td>&lt;-&lt;</td>
</tr>
<tr>
<td>Canyon bottom alluvium</td>
<td>&lt;-&lt;</td>
<td>&lt;-&lt;</td>
</tr>
</tbody>
</table>

#### Elevation

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Field Stations</th>
<th>Habitations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;</td>
<td>&gt;</td>
</tr>
</tbody>
</table>

#### Site Aspect

<table>
<thead>
<tr>
<th>Site Aspect</th>
<th>Field Stations</th>
<th>Habitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>S/N</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>
Table 9.--(continued)
Variables examining distance from sites to environmental features

<table>
<thead>
<tr>
<th>Field Stations</th>
<th>Habitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to nearest probable water source</td>
<td>&lt;-&gt;</td>
</tr>
<tr>
<td>Distance to nearest drainage or water course</td>
<td>&lt;-&gt;</td>
</tr>
<tr>
<td>Distance to nearest watershed divide</td>
<td>&lt;</td>
</tr>
<tr>
<td>Rank of nearest watershed divide</td>
<td>&lt;-&gt;</td>
</tr>
</tbody>
</table>

Notes
1. Only Woodenshoe/Red House phase habitations less than expected.
of on-site environmental variables, or distances to off-site environmental features, are significantly greater than expected, given distributions of random points. Arrows to the left indicate proportions of on-site variables or distances to off-site variables were significantly less than expected.

Table 10 summarizes the statistics used in this chapter. Listed first are strengths of association for each of the environmental variables, ranked from strongest to weakest, for both habitations and field stations. These strengths of relationship were determined using Goodman and Kruskal's $T_b$. The value of $T_b$ determined the order in which particular environmental variables are listed in Table 10. Table 10 also shows the probability of obtaining null hypotheses ($P$ of $H_0$) for various environmental variables.

Statistical significance, however, should not be confused with strength of association. It should be noted that it is possible to have a strong association, yet a low level of significance between a particular set of variables, or conversely, a weak association and a high level of significance. Increasing size of the sample tends to increase the significance of a relationship, regardless of the strength of the association between the variables. Furthermore, the calculation for the PRE measure is not necessarily based on the same quantities as the probability measure. Thus, there is only a general similarity between the strength and significance of an association, and each needs to be inspected with care.
Table 10.--Statistical summary of environmental variables. Shown are strengths of relationships ranked from strongest to weakest, probabilities of obtaining null hypotheses, and tests used to determine significance of the associations.

<table>
<thead>
<tr>
<th>Field Stations</th>
<th>Tau beta</th>
<th>P of $H_0$</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotic association</td>
<td>.28</td>
<td>&lt;.005</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Plant community</td>
<td>.20</td>
<td>&lt;.005</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Elevation</td>
<td>.19</td>
<td>&lt;.005</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Landform</td>
<td>.13</td>
<td>&lt;.005</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Distance to nearest watershed divide</td>
<td>.07</td>
<td>&lt;.005</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Exposure or aspect</td>
<td>.03</td>
<td>.10</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Distance to nearest drainage</td>
<td>.03</td>
<td>.75</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Distance to nearest probable water source</td>
<td>.02</td>
<td>.13</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Rank of nearest watershed divide</td>
<td>.001</td>
<td>.75</td>
<td>$x^2$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitations</th>
<th>Tau beta</th>
<th>P of $H_0$</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotic association</td>
<td>.27</td>
<td>&lt;.005</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Elevation</td>
<td>.27</td>
<td>&lt;.005</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Exposure or aspect</td>
<td>.16</td>
<td>&lt;.005</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Plant community</td>
<td>.13</td>
<td>&lt;.005</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Distance to nearest drainage</td>
<td>.12</td>
<td>.008</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Distance to nearest watershed divide</td>
<td>.11</td>
<td>.005</td>
<td>Wilcoxon</td>
</tr>
<tr>
<td>Rank of nearest watershed divide</td>
<td>.04</td>
<td>.05</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Landform</td>
<td>.04</td>
<td>.25</td>
<td>$x^2$</td>
</tr>
<tr>
<td>Distance to nearest probable water source</td>
<td>.03</td>
<td>see text</td>
<td>Wilcoxon</td>
</tr>
</tbody>
</table>
Preferred locations for field stations

The majority of field stations are found within the pinyon-juniper plant community, and within this zone, they appear to favor the biotic association consisting of dense pinyon-juniper forest. As noted earlier, these are considered proxy measures for relatively deep arable soils. When choosing locations for field stations, the Pueblo appeared to avoid the desertshrub and canyon communities, and within these, the sagebrush and bare rock biotic associations. With the exception of alluvium in the canyon community and the shallow mesa top valleys characterized by dense stands of sagebrush, none of these areas are suitable for farming. When evaluating landforms, the Pueblo appear to have deliberately selected watershed divides over other terrain features, and appear to have avoided rocky breaks and sandstone cliffs. At times, field stations are found along drainage bottoms, but numbers do not differ from that expected from the random model. Field stations also have greater than expected elevations within the study area, with most located above 1950 m. There does appear, however, to be a greater elevational range for field stations than for habitations. Finally, field stations are distributed in two major directional aspects -- north and south.

These factors support the initial assumption that field stations are seasonally occupied agricultural sites. They seem to have been located in areas of the mesa having highest annual precipitation and in areas covered with deep eolian soils. Although a majority of field stations are located on watershed divides, a smaller number are found along drainages where runoff from thundershowers could inundate fields. For the most part though, even sites located atop divides were close to small, first rank drainages. Another apparent duality is the number of sites found both in the northern
and southern exposure categories. It has been suggested that fields with northern exposures were more mesic but more susceptible to late spring or early autumn frosts, while fields with southern exposures would be more susceptible to drought but less likely to freeze during the growing season.

In sum, a number of factors appeared important for the Pueblo when choosing locations of field stations. Rather than confining these sites to a small set of environmental features, the Pueblo appeared to emphasize diversity as a way to maximize survival of at least some crops throughout the growing season.

Preferred locations for habitations

Similar to field stations, the majority of habitations are found within the pinyon-juniper community, and within this zone are most common in the dense pinyon-juniper biotic association. The desertshrub community appears to have been avoided as a locus for habitations, along with sagebrush biotic associations. While habitations occur in greater proportions than expected atop watershed divides, a number of landforms were avoided, including drainage bottoms and shallow mesa top valleys.

Habitations have greater elevations than do random points, with most concentrated into the upper 25 percent of elevational range within the study area. As anticipated from the examination of landform data, habitations are significantly closer in distance than expected to divides, and they are considerably farther from stream bottoms or drainages than are random points. This was presumably done to avoid water seeping into residences and perhaps to avoid the effects of cold air flowing down drainages. Interestingly, springs and seeps do not appear to play a role in location of habitations until the Woodenshoe and Red House phases after A.D. 1150. Prior to this
time, habitations were no closer to water sources than were random points. Finally, habitations have only one major orientation -- most were located on slopes having southern exposures.

A number of environmental factors support the assumption that sites defined as habitations were year-round residences. One is the consistent southern exposure. This aspect maximizes solar absorption throughout the year, but particularly so during the short days of winter when the sun rises in the southeast and sets in the southwest. Another fact is that these sites are almost exclusively located in the dense pinyon-juniper forest. Although field stations are also concentrated into pinyon-juniper forests, sites of this type show greater locational diversity, and are found within the desert shrub zone and sagebrush parks in the pinyon-juniper zone. Proximity to pinyon-juniper would have been essential if demands for fuel and building material were to be easily satisfied.

Finally, it is believed that habitations played an important role in the Pueblo agricultural system. These sites are all confined to elevations where rainfall farming would be tenable, and the majority are surrounded by considerable amounts of arable land. It may be that the preponderance of farming took place within sight of these dispersed homesteads, and that field stations are merely an attempt to diversify farming locations into a number of different environmental settings in an attempt to avoid catastrophic effects on the agricultural system. Drought, frost, or other problems would have a lesser chance of wiping out an entire crop if several fields in different locations were used.
CHAPTER VI
CULTURAL FACTORS IN SETTLEMENT LOCATION

Although emphasis so far has been on environmental determinants of Pueblo settlement, distributions of prehistoric remains cannot be explained by these factors alone. The preferred settlement pattern often reflects a culture's social organization. Elements of social organization can be seen in the patterning of prehistoric sites on Cedar Mesa. However, because of the way Southwestern regional-level archaeological analyses have been conducted, most interpretations of the social aspects of settlement patterns have been speculative. Specifically, sample surveys, by the nature of their discontinuous coverage, are poorly suited for such reconstructions. Ecological data, on the other hand, are more easily understood and mapped. As a consequence, most settlement pattern analyses have stressed human interactions with the environment, rather than locational decisions based primarily on cultural needs and demands. The works of Longacre (1970) and Hill (1970) may come to mind as exceptions, but both dealt with nucleated Pueblo villages rather than dispersed communities such as those found on Cedar Mesa.

Of course, regional-level social organization and ideology is difficult to quantify. Methods of geographers, including gravity models and central place theory, require untenable assumptions such that geographic regions are featureless plains, or that the study area was fully surveyed, rather than just sampled (cf. Crumley 1979). Furthermore, there is no guarantee that our interpretations of prehistoric Anasazi sites accurately reflect the ideology of the inhabitants. For instance, great kivas and stone circles are
called "integrative structures," but it remains to be shown who gathered at these sites, and the reasons for such assemblies remain unknown.

In previous chapters, an analytic assessment of the data has proved insightful, providing an empirical basis for interpreting settlement patterns. Where feasible, this approach will be used here. Also important are general analogies between the prehistoric Pueblo and modern Navajo. These two approaches will be joined in an attempt to model cultural determinants of settlement patterns for the late Pueblo II and Pueblo III occupants of Cedar Mesa.

**Shifting Settlement Location over Time**

Nearly 400 years prior to resettlement of Cedar Mesa by Windgate phase farmers in late Pueblo II, the region was occupied by Basketmaker III farmers of the Anasazi tradition. When describing Basketmaker III settlement patterns, Matson and Lipe (1978:8) write:

Sites were typically located in deep soil areas and were concentrated in the higher and better watered areas of the mesa. . . . The settlement and subsistence patterns for late Pueblo II groups are essentially the same as those of Basketmaker III.

Matson and Lipe (1978:5) also noted that the settlement pattern "...is complicated by . . . Pueblo II/III sites . . . found in close association with Basketmaker III sites with surface remains mixed." The characteristics of this temporal overlap became more clear when I plotted ceramic distributions from the various periods on maps as preliminary research for this thesis.

As seen from Table 11, the majority (62 percent) of Basketmaker III components that spatially overlapped with later Pueblo assemblages did so with Windgate phase sites representing the first Puebloan occupation on Cedar
Table 11. -- Pueblo components having spatial overlap with Basketmaker III remains.

<table>
<thead>
<tr>
<th>PHASE</th>
<th>Windgate</th>
<th>Clay Hills</th>
<th>Woodenshoe</th>
<th>Red House</th>
</tr>
</thead>
<tbody>
<tr>
<td>HABITATIONS</td>
<td>B3-1A *</td>
<td>B4-4</td>
<td>B6-3A</td>
<td>B1-1</td>
</tr>
<tr>
<td></td>
<td>B3-7 *</td>
<td>B5-2</td>
<td>B14-2</td>
<td>B3-10A</td>
</tr>
<tr>
<td></td>
<td>B6-4 *</td>
<td>B8-2</td>
<td>B17-1</td>
<td>B15-7</td>
</tr>
<tr>
<td></td>
<td>B12-1 *</td>
<td>B10-7</td>
<td>B18-3</td>
<td>B19-1B *</td>
</tr>
<tr>
<td></td>
<td>B16-1A</td>
<td>B11-8</td>
<td>NR4-5 *</td>
<td>B19-1C</td>
</tr>
<tr>
<td></td>
<td>B17-2 *</td>
<td>NR4-6</td>
<td>B19-1D</td>
<td>B22-2 *</td>
</tr>
<tr>
<td></td>
<td>NR4-2 *</td>
<td>NR10-2 *</td>
<td>B22-3</td>
<td>B22-3</td>
</tr>
<tr>
<td></td>
<td>NR11-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIELD STATIONS</td>
<td>B3-1B</td>
<td>B1-4</td>
<td>HS8-3</td>
<td>B1-2</td>
</tr>
<tr>
<td></td>
<td>B6-3B</td>
<td>B1-7</td>
<td>HS13-1</td>
<td>B7-5</td>
</tr>
<tr>
<td></td>
<td>B7-1 *</td>
<td>B11-4</td>
<td>HS14-2A *</td>
<td>B12-4</td>
</tr>
<tr>
<td></td>
<td>B7-2 *</td>
<td>NR9-1 *</td>
<td>B15-1</td>
<td>B15-6</td>
</tr>
<tr>
<td></td>
<td>B7-4</td>
<td>NR9-3</td>
<td>B15-6</td>
<td>B15-6</td>
</tr>
<tr>
<td></td>
<td>B7-6</td>
<td></td>
<td>B16-1R</td>
<td>B19-1A</td>
</tr>
<tr>
<td></td>
<td>B12-8</td>
<td></td>
<td>B9-1A</td>
<td>B21-10</td>
</tr>
<tr>
<td></td>
<td>B13-2</td>
<td></td>
<td>B21-10</td>
<td>B11-12</td>
</tr>
<tr>
<td></td>
<td>B13-3 *</td>
<td></td>
<td>NR11-12</td>
<td>HS3-1</td>
</tr>
<tr>
<td></td>
<td>NR4-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NR5-8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NR8-3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NR11-1 *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NR11-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HS14-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HS14-2B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HS14-2C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Pueblo components spatially overlapping with earlier Basketmaker III components.
Mesa after a 400 year hiatus. Although later Pueblo settlements were also components, these are few in number and do not appear in any obvious concentrations.

The exact reasons for what appears to be intentional selection of Basketmaker III site locations by Windgate phase farmers will never be known, but reasonable speculations are possible. The ideas presented here are an outgrowth of conversations with W.D. Lipe and R.G. Matson.

When Windgate phase peoples first entered Cedar Mesa, they were pioneers settling a virgin landscape. The region may have been used for hunting or gathering, but within these farmers' lifetimes, no one had attempted to test its agricultural potential. During the 400 years Cedar Mesa remained unoccupied by permanent residents, Basketmaker clearings and fields must have become completely reforested. However, Basketmaker III sites, all with sherd scatters and many with pithouse depressions, were probably as evident to the Pueblo newcomers as they are to the archaeologist today.

Upon finding these remains, the Windgate farmers likely concluded that the Basketmakers had been farmers as well, following similar lifeways. Certainly the Basketmaker III sites were located in areas of deep arable soil and had sunny exposures -- necessary requirements for any farmer. The forest had returned, providing fuel wood. Perhaps the returning Anasazi liked what they saw in the immediate proximity of Basketmaker III sites. Because the region had yet to be thoroughly assessed for its agricultural potential, they simply settled atop these sites with the assumption that if the vicinity had been previously productive, it would once again maintain farming settlements.

Occupants of later Pueblo phases, however, did not intentionally select locations containing Basketmaker III components. This is illustrated by
the general lack of asterisks adjacent to Clay Hills, Woodenshoe and Red House phase habitations and field stations listed on Table 11. Later Pueblo occupations also did not appear to settle in exactly the same vicinity as Windgate phase Anasazi. Differences are illustrated in Figure 12, which shows placement of sites by period along a east/west axis running the length of the study area. While there is considerable overlap on Figure 12 between all periods, post-Windgate phase occupations are concentrated farther to the west, suggesting that factors other than proximity to Basketmaker III sites became important in determining settlement location. Using the Wilcoxon's rank-sum test to examine differences in east/west location of sites between periods, no significant differences were observed between Basketmaker III and Windgate phase sites ($W_n = 0.023$), while the discrepancy between the Windgate phase and later Pueblo phases is significant at the .015 level ($W_n = 2.233$).

Findings in the last chapter suggest that the placement of resources within the environment may have played a role in the westward shift of settlement locations over time. During the Windgate phase, it was likely that Cedar Mesa was thoroughly explored and through a series of trials and errors, the region's agricultural potential determined. With the exception of a few field stations, however, the westward trend ceased at the desertshrub/pinyon-juniper ecotone.

**Investment in Facilities at Field Stations**

In Chapter III, it was observed that although "typical" field stations contained a hearth and a few grinding tools, there was actually considerable variability in the number of facility types present at these sites. A
Figure 12. Placement of sites by phase along an east-west axis through the Cedar Mesa study area.
group of eight field stations had no facilities, being nothing more than sherd and lithic scatters, while another group of four sites had a number of facilities including hearths, slab-lined cists, burned jacal, and milling stones. As indicated in Table 3, most field stations fell somewhere between these two extremes.

This section illustrates how a general analogy with the Navajo can lead to creation of a hypothesis that attempts to explain patterns of site facilities found at Pueblo field stations. Review of the literature suggests that the Navajo have a specific strategy when placing facilities at temporary camps. Jett and Spencer (1981:38) write that "... lightly constructed shelters are most commonly for use near fields distant from the main camp" (emphasis added), implying that fields close to hogans do not have structures associated with them. In another article, Russell (1978a:38) states that storage pits at Navajo fields or field houses were visited during the winter to restock corn and squash supplies at the winter habitation. Although Russell did not mention distance from storage pits to habitations, a preliminary examination of Cedar Mesa settlement data indicated that field stations with slab-lined cists were located at greater distances from contemporary habitations than field stations lacking these features.

I believe these observations can be applied to many types of site facilities, and that increasing or decreasing distances from habitations might be related to diversity in site facility types found at field stations on Cedar Mesa. Formulated as a hypothesis:

- As distance between contemporary habitations and field stations increases, the diversity of site facility types at field stations will increase relative to distance from the habitations.

Diversity of facility types, rather than total number of facilities found at field stations, was chosen as the relevant dependent variable in order to use
the presence/absence data shown in Table 3. The term "contemporary" refers
to habitations and field stations falling within the same ceramic assemblage,
and assignable to one of the four Puebloan occupational phases found on Cedar
Mesa. Sites with mixed assemblages or those not assignable to a specific
phase were excluded from this analysis.

A problem with this analysis is the "design effect" inherent in the
discontinuous nature of the quadrat sample. While sites from one isolated
quadrat were compared with sites from other quadrats, the territory between
the sampling units remained unevaluated. Consequently, cistance measures
between contemporary sites have probably been overestimated, the result of
which could be an overestimate of the significance of the association between
the variables.

It was initially expected that a linear regression analysis could test
this hypothesis. This test, however, assumes the data to be normally
distributed. Unfortunately, normal distributions are for the most part
lacking in the archaeological record. The high number of residual or
outlying cases resulted in correlation coefficients of less than .35,
indicating a general failure to reject the null analog to the above
hypothesis.

As an alternative, R.G. Matson (personal communication) suggested use of
a Kruskal and Wallis multi-sample test sensitive to unequal locations of data
points (Bradley 1968:129). This is similar to the Wilcoxon's rank-sum test
in that the null hypothesis assumes no significant difference between
locations or values of elements comprising each of the sample groups. The
tests are different because the Wilcoxon's test compares populations falling
within two classes, while the Kruskal and Wallis test examines populations
falling into more than two groups.
Field stations used in this analysis were placed into one of four classes, depending on the diversity of facility types found at these sites. The four classes include: 1) sites with no facilities; 2) sites with one facility type; 3) sites with two facility types; and 4) sites with either 3 or 4 facility types. Due to the "Alfred Law," examination of sites by individual facility type (e.g., cists vs. hearths) split the data into categories too small to interpret statistically.

Results of the Kruskal and Wallis test indicate that differences in distance between habitations and field stations are significant at the .05 level for the four categories of field stations ($H = 9.914$, df. = 3). Box-and-whisker plots on Figure 13 graphically illustrate these trends.

The median distance between contemporary habitations and field stations having no site facilities is 250 m. With the exception of one site located 940 m from the nearest habitation, field stations lacking facilities are all found within 300 m of residential sites. Field stations with one facility (usually a hearth or a milling stone), are generally located farther from habitations, having a median distance of 690 m and a maximum distance of 3.06 km. Sixty-one percent of sites within this category are less than 1 km from the nearest contemporary habitation. Field stations with two facility types are located at even greater distances from habitations, having a median distance of 950 m and a maximum distance of 4.62 km. However, 52 percent of these sites are within 1 km of contemporary habitations.

The real break occurs with field stations containing either 3 or 4 facility types. For this group, median distance to the nearest contemporary habitation is 4.06 km, while maximum distance is 7.25 km. Only two sites in this category are located closer than 2.75 km to the nearest habitation. While 75 percent of field stations with 3 or 4 facility types are found at
Figure 13. Distance between contemporary habitations and field stations. Field stations separated by number of facility types.
distances greater than 2.75 km from habitations, 84 percent of field stations with 2 or less facility types are closer than this distance to contemporary residential bases.

In sum, the hypothesis that diversity of site facilities at field stations increases with distance from habitations, is supported by the data. But why did this occur? Plog and Hill's (1971:12) assumption that "sites were located so as to minimize the cost of resource information flow between sites . . ." offers some insight. It can be inferred that cost of "resource information flow" means a number of things, including time expended walking between sites. This is important, because the more time spent traveling between field stations and habitations, the less time could be spent tilling and protecting distant fields. The time element would be especially critical during harvest or planting when maximum labor at the fields was necessary.

While travel time may not have been a factor when tilling plots of land located only a few hundred meters from habitations, a daily trip could consume considerable amounts of time if fields were located several kilometers from the residential base. This distance factor may explain why nearly 60 percent of field stations are found within 1 km of contemporary habitations. Lack of facilities at a site may indicate that farmers maintaining the fields returned to habitations on a daily basis, while field stations with facilities limited to hearths and milling stones suggest food processing and preparation occurred, perhaps necessitated by occasional overnight stays at the fields.

At distances greater than 2.5 or 3 km from habitations, the Anasazi appear to have spent proportionately greater amounts of time at field stations. With few exceptions, field stations at these distances had
hearth, milling stones, slab-lined storage cists, and burned jacal. Remnants of burned jacal may suggest the presence of ephemeral field houses, while cists may indicate that harvested food was stored at these sites in anticipation of retrieval later in the year. Cists may have also stored seed for the next growing season. It is believed field stations at these distances were occupied for much of the growing season, serving similar functions as the residential base during that period of time. The Hopi village of Moenkopi is a historical example of this phenomenon. Although Moenkopi is now occupied year-round, it was for a long time settled just for the period between spring planting and fall harvest (Ellis 1978).

As noted on Figure 13, two sites with either 3 or 4 facility types do not fit the overall trend; they are within 300 m of the nearest contemporary habitation. This may be the result of either 1) weak chronological and spatial controls (i.e., the 'design effect'), or 2) the possibility that these "residuals" are in fact small residential sites. Contemporary sites are those occupied during a single phase which may have had a temporal duration of 50 years. Many sites could have been occupied and abandoned during that period of time. Because individual field stations cannot be associated with a particular habitation, the two residuals may not be located within 300 m of the parent site, and instead, may be associated with habitations located at greater distances perhaps not accounted for in the archaeological survey. The second problem suggests a fault with the site classification in Chapter IV. Ultimately, the decision to call a site a habitation was based on the presence of pitstructures, masonry surface rooms, or structured trash disposal. According to field notes, these sites lacked all three of these facilities.
Pueblo Homestead Groups

Previous discussion has created the impression that Pueblo habitations and field stations were widely scattered across the landscape of Cedar Mesa. While this is generally true, there are several clusters of contemporaneous sites located in very close spatial proximity to one another. The three obvious clusters and their constituent habitations and field stations are listed on Table 12. There are other site clusters on Cedar Mesa, but constraints of the discontinuous quadrat survey make it difficult to find such clusters.

Two clusters, composed of sites having the prefix B 12-1 and B 19-1 were actually considered single large sites when field mapping and collection was conducted in the 1970's. Because of close proximity and nearly identical ceramic assemblages, it was believed single large components were being investigated. However, when plotting distributions of ceramics on maps, I observed fairly large and distinct spatial gaps (ca. 40 to 80 m) between groups of cultural remains. Because these large clusters did not fit my definition of a habitation site (the space and facilities occupied by a single household), I separated them into spatially discrete components for analysis.

Interpretation of these site clusters is problematical, but a general analogy borrowed from the Navajo proves insightful. Jett (1978:355) writes that:

Among the Navajo, a "homestead group" is an extended family -- usually a nuclear family plus its married daughters families -- that occupies a clearly defined territory or territories. It comprises one or more closely related households voluntarily living close to each other and sharing certain basic resources. Members usually . . . cooperate or give reciprocal aid in economic production, distribution and consumption. Shared tasks may include hogan and corral construction; . . . plowing and harvest; care of children and sick members; and ceremony sponsorship.
Table 12.--Pueblo "homestead groups".

<table>
<thead>
<tr>
<th>Cluster I</th>
<th>Habitations</th>
<th>Field Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windgate Phase</td>
<td>B19-1B</td>
<td>B19-1A</td>
</tr>
<tr>
<td>(150 m radius)</td>
<td>B19-1C</td>
<td>B19-2</td>
</tr>
<tr>
<td>elev. 1980 m</td>
<td>B19-1D</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cluster II</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Windgate Phase</td>
<td>B3-1A</td>
<td>B3-1B</td>
</tr>
<tr>
<td>(200 m radius)</td>
<td>B3-7</td>
<td>B6-38</td>
</tr>
<tr>
<td>elev. 2040 m</td>
<td>B6-4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cluster III</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Red House Phase</td>
<td>B12-1A</td>
<td>B12-8</td>
</tr>
<tr>
<td>(150 m radius)</td>
<td>B12-1B</td>
<td></td>
</tr>
<tr>
<td>elev. 1990 m</td>
<td>B12-1C</td>
<td>B12-1D</td>
</tr>
<tr>
<td></td>
<td>B12-1E</td>
<td></td>
</tr>
</tbody>
</table>
When describing the settlement pattern of Navajo homestead groups or "outfits," Adams (1958:65) states that they:

... consist of closely related households living "within shouting distance" of each other ... The hogans constituting a single residence group are seldom more than a couple hundred yards apart, whereas they are always at least half a mile ... from those of neighboring groups.

Although human interrelationships such as those described by Jett cannot be gleaned from the archaeological record, interaction within Puebloan "homestead groups" on Cedar Mesa is suggested by close temporal affiliation of ceramics. The median radius encompassing these clusters is 150 m, while the maximum radius is 200 m. Both these factors fit criteria established for ethnographic homestead groups. Furthermore, site B 12-1 has a small isolated tower atop a nearby cliff. Fields of view from this tower would cover all habitations within this group, thus providing for a common defense.

As a final observation, the median elevation of "homestead groups" on Cedar Mesa is 1990 m, placing them within the upper 10 percent of elevational range within the study area. As was noted previously, this is also the approximate elevation of the two community integrative structures mentioned in Chapter IV. When examining factors such as amounts of arable land, precipitation and fuel supply, the "homestead groups" are located in the most preferred portions of Cedar Mesa.

**Settlement Systems on Cedar Mesa**

While the Pueblo communities on Cedar Mesa consisted for the most part of dispersed settlements, it is doubtful if lines delimiting the actual boundaries of these communities could be drawn on a map. One limitation is that the quadrat survey covered only about 7 percent of the study area, which itself covered only a few of the many drainages on Cedar Mesa. It is
possible though, to identify the types of sites comprising Pueblo communities, and to draw integrative links between them.

Habitations and field stations have been examined at depth, but discussion of other site types found within the settlement system has been limited to short descriptions in Chapter IV. When examining the overall settlement-subsistence system, however, it is unwise to ignore the limited use sites and community integrative structures. For example, one can imagine the folly if a survey of the Valley of Mexico ignored Teotihuacan simply because it was located outside survey quadrats or transects. Because additional types of Pueblo sites can be identified, it is appropriate to schematically illustrate dispersed communities as they might have appeared on Cedar Mesa. It must be noted that much of the following model is conjectural, and as such, is not subject to analytical confirmation or rejection.

Elevation may be the most important factor determining the structure and complexity of Puebloan settlement systems that existed on Cedar Mesa. As noted elsewhere, precipitation, arable land and fuel supply all increase with elevation, making the uppermost portions of the study area best suited for settlement. The Anasazi appeared aware of these factors, because complexity and density of settlements on Cedar Mesa increase with elevation. These settlement trends are illustrated in Figure 14. The only sites unevaluated are "residuals" not fitting general settlement patterns.

As seen from Figure 14, structural complexity of the settlement system is greatest within the upper 60 m of elevational range within the study area. Above 1980 m are found all of the Pueblo "homestead groups" and the community integrative structures defined in Chapter IV, as well as 50 percent of field stations and habitations. When proceeding to lower elevations, both the
SETTLEMENT TYPES WITHIN STUDY AREA AND ELEVATIONAL RANGE IN WHICH THEY OCCUR

*NOT OBSERVED IN SURVEY QUADRATS

Figure 14. Settlement types within the study area and elevational ranges in which they occur.
number of settlements and types of settlement decrease. With the exception of one "residual" field station (which in actuality may be a limited use site unrelated to agriculture), the lower 25 percent of elevation within the study area remained unsettled by the Pueblo. These trends suggest strong relationships between community organization and the environment. Although such trends were anticipated, it was not expected they would be so dramatic.

Settlement systems can also be illustrated by schematic plan diagrams providing "birds eye views" of intersite relationships. Two such plans are illustrated in Figures 15 and 16. It should be noted that distances between sites and even the number of sites shown on each figure are arbitrary. The purpose of the figures is to illustrate potential integrative links between site types found within the settlement system; they are not intended to show actual distributions of sites found in any of the survey quadrats.

Figure 15 illustrates potential intersite relationships between settlements occupied perhaps by a single lineage, that is, a group of households having a common ancestor. This figure portrays the idealized layout of the Pueblo "homestead group" discussed above. Each of the habitations has a number of satellite field stations, representing a multiple field strategy designed to minimize agricultural loss. The habitations share a number of limited use areas, which could vary from common clay sources to pot holes along canyon rims that contain water after thundershower. The households are presumed to share an integrative structure, whether it be an isolated cliff kiva or a similar structure located immediately adjacent to one of the masonry surface structures. The latter cluster would be interpreted by archaeologists as an unit-type pueblo. It would have been interesting to determine whether non-kiva habitations tended to cluster
Figure 15. Inter-site relationships between settlements occupied by related households
Figure 16. Inter-site relationships between settlements forming a Pueblo settlement-subistence system.
around habitations having kivas. Unfortunately, non-contiguous survey quadrats precluded this investigation.

Figure 16 illustrates the types of sites and integrative relationships perhaps typifying the entire Pueblo settlement system found on Cedar Mesa. The settlement system would consist of a community of persons who associate with one another on virtually a day-to-day basis (Rohn 1971:40). Like the last figure, the distance, spacing and numbers of sites are purely arbitrary. The settlement system shown on Figure 16 consists of three separate clusters of habitations. The individual residential units which comprise each of the clusters are tethered to an interhousehold integrative structure -- a kiva. The separate households comprising the community are also integrated at a higher level, represented in the archaeological record by community integrative structures resembling stone circles. The boundary of the settlement system or community is denoted by a hatched line, which is less of an archaeological trait than it is a concept within the minds of long deceased Puebloans. Although such a boundary is arbitrary, Flannery (1976:6) considers "all the villages in a single valley" to constitute this maximum subsistence-settlement unit.

While distances between individual habitations and integrative structures illustrated in Figure 16 are arbitrary, it is noted that the habitation cluster on the left is much more dispersed than the cluster on the far right of the diagram. This illustrates the actual diversity found within settlement patterns on Cedar Mesa. Although most sites are widely dispersed and resemble the pattern on the left side of the figure, some aggregation occurs as well, evidenced by the three "homestead groups" mentioned earlier in this chapter.
In conclusion, the empirical evidence on which the two figures are based is fairly strong. Although two site types crucial to the model are not recognized within survey quadrats, their presence has been documented nearby. The evidence for settlement systems on Cedar Mesa has been presented for critical review and examination -- these two models will hopefully generate ideas that perhaps someday can be objectively tested and evaluated.
CHAPTER VII
SUMMARY

This thesis examines a number of factors affecting locations of late Pueblo II and Pueblo III archaeological sites on Cedar Mesa, southeastern Utah. The area is considered marginal for agriculture relative to other areas in the northern Southwest, and a number of environmental factors including length of the growing season, distribution of precipitation, and access to important resources imposed limits on prehistoric settlement. Settlement patterns also appear to be influenced by the social organization of the Anasazi.

Data for this thesis were obtained through systematic surface collection and excavation conducted by William Lipe and R.G. Matson in the 1970's. The sampling design stratified Cedar Mesa into naturally defined drainage basins bounded from one another by watershed divides. Within each watershed unit, a number of 400 meter square quadrats were chosen randomly for intensive survey and surface artifact collection. The result was identification of 268 prehistoric sites dating from Basketmaker II through Pueblo III.

Information used in this thesis is actually a subset of Cedar Mesa Project data because analysis is limited to late Pueblo II and Pueblo III components (ca. A.D. 1060 to 1270). The 45 randomly chosen survey quadrats evaluated for presence of archaeological remains came from three watershed study units that formed a contiguous east/west oriented transect 31 km long by 2 to 6 km wide. After evaluation of field notes and construction of site maps showing distributions of ceramic assemblages, 78 spatially and for the most part temporally discrete Pueblo components were identified within the
survey quadrats. This includes 6 components that could not be assigned to a particular phase.

Prior to settlement pattern analysis, the natural environment of Cedar Mesa was evaluated for suitability of rainfall farming. This was accomplished by constructing a 1:13,000 scale vegetation/landform map of the study area. Four plant zones were defined, including the desert shrub community, the pinyon-juniper community, the escarpment community, and the canyon community. Each contains a number of biotic associations, extending from deep soil to bare rock and from thick pinyon-juniper forest to sparse and scattered shrubs.

Chronology of Pueblo remains is based on tree-ring cutting dates and seriation of pottery. The first Pueblo occupation of Cedar Mesa began with the windgate phase about A.D. 1060, when the region was occupied by Mesa Verde branch Anasazi migrating from the east. This was followed by the Clay Hills phase, an occupation by Kayenta branch Anasazi. These two occupations may have had some temporal overlap. About A.D. 1150, there may have been a brief abandonment of Cedar Mesa, but by A.D. 1165 or 1170, the region was again being colonized by Mesa Verde branch Anasazi. The Woodenshoe and Red House phases are observed between these dates and A.D. 1270, when large portions of the region north of the San Juan River were abandoned. It is believed the Woodenshoe and Red House phases may represent a single 100 year occupation by the same cultural group, with ceramic changes between the two periods representing a transition as certain types became popular and others fell into disfavor.

Four types of sites appear to have been utilized by the Pueblo on Cedar Mesa. These include 1) habitations, 2) seasonally occupied field stations, 3) limited use sites, and 4) community integrative structures. Only the
first two site types are recognized in survey quadrats. The latter two types exist within the study area, but there is no accurate basis for estimating numbers, periods of occupation, or the environmental strata in which they are located. Consequently, only habitations and field stations are evaluated in the settlement pattern analysis. Based on intuitive evaluation of field notes, 32 habitations and 46 field stations were defined in the study area. This intuitive classification was successfully replicated by an objective technique -- multidimensional scaling.

The eight environmental variables examined in this thesis emphasize the set of resource locations where raw materials could be obtained, and the loci which were chosen for settlement. A common thread to the analysis is the principle of "least effort," in which locational decisions are assumed to be made so as to minimize effects of distance in resource procurement. Sets of hypotheses were generated to test each of the variables. Null hypotheses were exemplified by distributions of 78 points having no archaeological significance scattered at random across the landscape. Since distributions of archaeological sites are considered to be the result of systematic forces, measurement of departures from randomly distributed points indicate why and to what degree specific locations are favored for settlement over others.

When examining the environmental variable of plant community, the disparity between random points and habitations was significant in both the pinyon-juniper and desert shrub zones. Eighty-one percent of habitations were found in the former (as opposed to 45 percent of all random points), while no habitations occurred in the latter, which contained 26 percent of all random points. Disparities between field stations and random points are significant in three plant communities. Eighty-seven percent of these sites are found within the pinyon-juniper zone, which was much greater than anticipated given
distributions of random points. Only two percent of field stations were found in canyon and escarpment zones, which contained 28 percent of the random points. Plant community is a proxy measure for a number of resources, including relatively deep arable soils, fuel wood and building material. It appears the Anasazi were selecting for these resources when concentrating their habitations and field stations in the pinyon-juniper community.

Each of the plant communities is composed of a number of biotic associations. When comparing distributions of archaeological sites with random points, habitations appear in greater than expected numbers only in the dense pinyon-juniper association, and in less than expected numbers in the sagebrush biotic association. Field stations also appear in greater than expected numbers in the dense pinyon-juniper biotic association, but in less than expected frequencies in the sagebrush and bare rock associations. By avoiding these latter associations, the Pueblo minimized the effort and distance required to farm and homestead Cedar Mesa.

Landforms and terrain features are another important aspect in selection of suitable settlement locations. Pueblo habitations occur in greater than expected numbers on watershed divides, and in numbers significantly less than expected along drainage bottoms and within shallow mesa top valleys. Drainage bottoms and valleys are susceptible to flooding and effects of cold air drainage. Field stations occur in greater than expected numbers along watershed divides, and less than anticipated numbers on exposed rocky breaks and sandstone cliffs. Watershed divides, for the most part, consist of fairly deep eolian soils, while the latter landforms are nearly devoid of
soil. It appears that field stations were placed in areas where farming would be most suitable.

When examining site aspect, it was observed that habitations were oriented primarily to the south, while field stations had either of two major exposures — north and south. Habitations were apparently oriented towards sunny exposures, while aspect of field stations appears to represent a dual field location strategy designed to minimize cumulative effects of either drought or frost on crops. Northern exposures may have been more mesic, but at the same time, were more susceptible to late spring or early fall frosts. Field stations with southern exposures probably had longer growing seasons, but were susceptible to drought when rainfall did not replenish moisture absorbed from snow melt during the spring.

The importance of elevation is due primarily to the limiting effects of this factor on Pueblo agriculture. A literature review indicated 1950 m elevation was the postulated lower elevation for successful dry farming in the Four Corners area. Sixty-six percent of habitations and 61 percent of field stations are found above this elevation. Field stations, however, have a broader elevational range than habitations, with 25 percent located below 1860 m. Only 6 percent of habitations are found below this elevation.

It was hypothesized that distance to nearest probable water source would exert an influence on settlement location, but for the most part data did not support this. Field stations were no closer to water than were random points. Habitations from the Windgate and Clay Hills phases also were no closer to water than were random points. The only sites significantly closer than expected to water sources were habitations from the Woodenshoe and Red House phases. When establishing habitations in the latter part of the A.D.
1100's and the 1200's, the Anasazi placed greater priority on water than they had in the past, perhaps responding to regional drought conditions.

When evaluating distance to nearest drainage, it was observed that habitations were significantly farther from these terrain features than were random points. While 25 percent of field stations and 35 percent of random points were within 30 m of a drainage, no habitations were closer to water courses than this point. Similar distributions of field stations and random points were anticipated because of the dichotomous locational nature of these sites. While most field stations are found along watershed divides, a significant minority were positioned to take advantage of runoff from thundershowers, and thus did not have to rely entirely on direct rainfall for field watering. Water courses were apparently avoided when constructing habitations because of cold air drainage, problems with flooding, and shallow soil.

The polar opposite of a drainage is its watershed divide. Divides are actually proxy measures for placement of arable soils. Forty-one percent of field stations and 37 percent of habitations are found directly upon divides, while 67 percent and 72 percent respectively, are located within 30 m of these terrain features. Only 15 percent of random points are directly atop divides, and only 36 percent of the points are within 30 m of such features. Although field locations along divides could not take advantage of flood waters, the deep loess soils were capable of storing considerable amounts of moisture from melting snows.

A final environmental factor in site location is rank of nearest watershed divide. Sixty-two percent of the closest divides to habitations were second order or greater. This figure was only 47 percent for field stations and 46 percent for random points. For habitations, at least, there
may have been a conscious selection for higher ranked divides. It is unlikely the Anasazi were aware of divide rank, but because they generally have deeper soils and dense pinyon-juniper forest, the higher ranked watershed divides were apparently the preferred locations for year-round settlement.

A number of non-environmental factors also appear to influence the Pueblo settlement pattern. One factor is the location of Basketmaker III archaeological sites. Sixty-two percent of the Windgate phase Pueblo components were found to spatially overlap with earlier Basketmaker III remains. Although later Pueblo components were at times mixed with Basketmaker III remains, these are few in number and do not appear in any obvious concentrations. Exact reasons for this apparently conscious selection for areas with Basketmaker remains by Windgate Puebloans are not known, but most of the Basketmaker sites are located in areas of deep soil having sunny exposures. Because the pioneer Windgate farmers had yet to thoroughly assess Cedar Mesa for its agricultural potential, they may have settled atop Basketmaker III sites with the assumption that if the vicinity had been productive previously, it would maintain farming settlements once again.

When examining types of facilities present at field stations, it was observed that as distance from habitations increased, the diversity of site facility types present at field stations increased as well. The key factor appears to be travel time between the parent habitation and the field station, because the more time spent travelling between sites meant less time could be spent tilling and protecting distant fields. Lack of facilities at a field station suggests farmers returned to habitations on a daily basis, while sites with facilities limited to hearths and milling stones suggest
food processing and preparation occurred, perhaps necessitated by occasional overnight stays at the fields. At distances greater than 2.5 or 3 km from habitations, the Anasazi appear to have spent considerably more time at field stations. With the exception of just a few sites, field stations greater than these distances have hearths, milling stones, slab-lined storage cists and evidence of burned jacal. Jacal remnants suggest the presence of ephemeral field houses, while cists may indicate that harvested food or seed was stored at these sites for retrieval later in the year.

Several clusters of archaeological sites dating to the same temporal phase were found in close proximity to one another. Interpretation is based on a general analogy borrowed from the historic Navajo. It is suggested that these prehistoric site clusters are "homestead groups," that is, closely related households voluntarily living close to one another and sharing certain basic resources and responsibilities.

Elevation appears to be the most crucial factor determining the structure and complexity of the settlement pattern. Precipitation, arable land and fuel supply all increase with elevation, making the uppermost portions of Cedar Mesa best suited for settlement. The Anasazi may have been aware of this, because both the density of sites and the numbers of different site types found within the settlement system increase with elevation. Above 1950 m elevation are found all of the Pueblo "homestead groups" and community integrative structures, as well as 50 percent of all habitations and field stations.

In conclusion, a number of environmental factors appeared important for the Pueblo when choosing settlement locations. Rather than confine field stations to just a small set of environmental features, they appeared to emphasize diversity as a way to maximize survival of at least some crops
throughout the growing season. Habitations also appear to have played a role in the Anasazi agricultural system. These sites are all confined to elevations where rainfall farming would be tenable, and for the most part are surrounded by considerable amounts of arable land. The preponderance of farming may have occurred within sight of these dispersed homesteads, while field stations may represent a multiple field strategy designed to avoid catastrophic loss of the entire agricultural harvest.
REFERENCES CITED

Adams, William Y.
1958 New data on Navajo social organization. Plateau 30:64-70.

Arrhenius, G. and E. Bonatti

Asch, David L.

Baars, Donald L.

Bannister, Bryant, Jeffery Dean and William Robinson
1969 Tree-ring dates from Utah, S-W: Southern Utah area. Laboratory of Tree-Ring Research, Tucson.

Billings, W.D.

Binford, Lewis R.

Blalock, Hubert M.

Bradley, James V.

Charlton, Thomas H.

Conover, W.J.

Crumley, Carole L.
DeBloois, Evan I, D.F. Green, and Henry G. Wylie

Ellis, Florence H.

Elmore, Francis H.

Erdman, J.A., C.L. Douglas and J.W. Marr

Euler, Robert C. and George J. Gumerman (editors)

Euler, R.C., G.J. Gumerman, T.V.N. Karlstrom, J.S. Dean and R.H. Hevly

Fish, Suzanne and Paul R. Fish

Fewkes, J. Walter

Flannery, Kent V.

Grady, James

Gregory, Herbert E.
Gumerman, George J. (editor)

Gumerman, George J.

Hach, John T.

Hartwig, Frederick and Brian Dearing

Hill, James N.

Hill, W.W.

Hobler, P.M. and A.E. Hobler

Hodder, Ian and Clive Orton

Hayes, Alden C.

Jennings, Jesse D.

Jett, Stephen C.

Jett, Stephen C. and V.E. Spencer
Kane, Allen E.
1977 The archaeology of the Shell-Mobil Wassen Field. Ms. on file, Dolores Archaeological Program, Dolores, Colorado.

Kidder, Alfred V.

Kohler, Timothy A.
1980 An archaeological survey of selected areas of the Fort Benning Military Reservation, Alabama and Georgia. Ms. in possession of the author.

Kruskal, Joseph B. and Myron Wish

Lipe, William D.

Lipe, William D. and R.G. Matson

Lipe, William D. and R.G. Matson
1974 Prehistoric cultural adaptation in the Cedar Mesa area, Southeastern Utah. Research proposal submitted to the National Science Foundation. Ms. in possession of the authors.

Lister, Robert H.

Longacre, William A.

Lowe, Charles H.

Martin, Paul S. and Fred Plog

Matson, R.G. and William D. Lipe
Matson, R.G. and William D. Lipe  
1977 Seriation of Pueblo ceramic assemblages from Cedar Mesa, Southeastern Utah. Ms. in possession of the authors.

Matson, R.G. and William D. Lipe  

Matson, R.G. and D.L. True  

Nickens, Paul R.  

Plog, Fred and James M. Hill  

Plog, Fred  

Rohn, Arthur H.  

Rohn, Arthur H.  

Roper, Donna C.  

Russell, Scott C.  

Russell, Scott C.  
1978b The Navajo oral history and ethnohistory of northeastern Black Mesa eastern coal lease area. Ms. in possession of the author.
Steele, Robert G.D. and James H. Torrie

Sullivan, Alan P. and Michael B. Schiffer

Torgerson, W.S.

Trewartha, Glenn T.

West, Gerald A.
1978 Recent palynology of the Cedar Mesa area, Utah. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

Whiting, Alfred E.

Willey, Gordon R.

Wilson, Curtis J.

Windes, Thomas C.

Wormington, H.M.

Zipf, G.K.
1949 Human behavior and the principle of least effort. Addison-Wesley, Cambridge.