

<Introduction>

This volume reports the results of the Cedar Mesa project, a study of man-land relationships during the last 2000 years, on Cedar Mesa, in Southeastern Utah (Figure I-1,2). This area, about 800 sq. km in area as we defined it, had three separate Anasazi occupations, during Basketmaker II, Basketmaker III, and Pueblo II/III times and was finally abandoned for the last time by the Anasazi, shortly before AD 1300. We attempted to discover the prehistoric cultural adaptations to the environment via a three fold approach: 1) to reconstruct the cultural strategies by means of which prehistoric populations obtained necessary resources from the natural environment, 2) to identify for a given cultural adaptive strategy, the key environmental variables, and 3) to account for both change and stability. Our investigation was phrased in terms of an open systems model--the complex adaptive system--which we thought was best suited to explain both change and stability, in terms of the relationships and mechanisms that best fit the observed data.

Our field work was oriented toward regional survey and surface collection and mapping. The core of our field work was the collection of 76 quadrats each 400 meters on a side from 5 different drainages (Figure I-2). In addition, each of the five drainage canyons were completely inventoried and selected canyon sites were collected. It is these two closely related sources of data that serve as the basis of

Matson, Lipe, and Haase (Aug. 88) I-2  
this work. In addition references will be made to test  
excavations and an architectural and tree ring survey. These  
two subprojects are not fully reported here, and neither was  
central to the main core of the project, although various  
references will be made to information obtained from  
preliminary results of these subprojects.

The Cedar Mesa project was influenced by Lipe's previous  
work in the area, Matson's previous work with regional  
survey, and the development of the Southwestern  
Anthropological Research Group. Lipe had previously worked  
with the Glen Canyon project (Lipe 1960, Lipe <et al.>1960)  
and the Red Rock Plateau immediately west (Figure I-1) of  
Cedar Mesa had been the subject of his dissertation (Lipe  
1966, 1970). After his work in the Red Rock Plateau, Lipe had  
been attracted to the Cedar Mesa area by its abundance of  
Basketmaker II sites, and carried out two field seasons there  
in 1969 and 1970, funded by the National Geographical  
Society. This work focussed on the excavation of Basketmaker  
II sites, but included survey and the excavation of one  
Basketmaker III site (Lipe 1978). From this work Lipe had  
developed not only experience about the archaeology of the  
area but also ideas about developments in prehistory which  
were later formulated as formal hypotheses (Lipe and Matson  
1971). Matson's previous experience of the then new regional  
survey methods in Nevada (Thomas 1969) and in the Cerbat  
Mountains of Northwestern Arizona (Matson 1971, 1974) and the  
analysis of this kind of data were used in the development of  
a research design for Cedar Mesa (Lipe and Matson (1971). A

Matson, Lipe, and Haase (Aug. 88) I-3  
small pilot project carried out in 1971 by the Matson and  
Lipe helped to finalize many of the research design details,  
as well as familiarize Matson with the Cedar Mesa area.  
While Lipe and Matson were developing plans for the Cedar  
Mesa project, the Southwestern Anthropological Research Group  
was organized, incorporating a group of archaeologists  
working in the Southwest who had shared interests in regional  
patterns of adaptation and organization (Gumerman 1971,  
Euler and Gumerman 1978). The writings and discussions that  
developed at these meetings and that arose out of them had a  
major effect on the Cedar Mesa project, as did ideas  
expressed by Jack Major and John Wood (Wood 1971, Wood and  
Matson 1973).

In this setting the Cedar Mesa project was designed to  
investigate the questions outlined above. Major decisions  
included the reliance on surface survey and the determination  
to implement the survey using regional sampling methods. The  
data obtained were to be analyzed using probabilistic  
quantitative techniques, but only after going through a data  
reduction stage using multivariate quantitative techniques.  
From past experience it was decided to completely collect all  
artifacts from quadrats (in the end, four sites were  
exceptions). Although definite hypotheses were developed, we  
decided to also collect information on a large number of  
variables, both cultural and environmental, to allow us to  
explore ideas that developed out of our original ideas, or  
from other aspects of our work.

Some of the following sections dealing with research

Matson, Lipe, and Haase (Aug. 88) I-4 design and hypotheses may appear to be dated, not concerned with certain current issues. This is partly the result of the time that has passed since this project was initiated in 1971 and the manner in which it was carried out. The Cedar Mesa Project was designed with a set of ideas and orientations and largely carried out in that context, in the field in the early to middle 1970's and during analysis in the late 1970's and up to 1982. To pretend at this date that the situation was otherwise seems to us to be foolish. While our plans were not set in stone, they were generally adhered to, and reference to more recent developments are made as they were brought into the analysis, not in an attempt to recast our work in an inappropriate more modern framework.

<The Area>

Cedar Mesa, as we have defined it, is an area of about 800 sq. km. (300 sq. miles), located just north of the San Juan River in western San Juan County, Utah (Figures I-1,2). This area is centrally located on the Grand Gulch Plateau. As defined, Cedar Mesa has natural physiographic boundaries on most sides, and contrasts with much of the surrounding country in geology, elevation, vegetation and climate. The region is over 99 percent public land, which is administered by the U.S. Bureau of Land Management. State Highway U-261 runs approximately north-south down the center of the mesa, starting from 7 km (4 miles) east of Mexican Hat 11 km (7 miles) to the south of the mesa and ending at U-95 which runs across the mesa's north edge (Figures I-1,2). Highway U-95

Matson, Lipe, and Haase (Aug. 88) I-5 provides access to the town of Blanding on the northeast. Blanding, the largest settlement in San Juan County (population ca. 2500), and the nearest trading center to Cedar Mesa, is about 45 miles (70km) from the center of the mesa by road. The resource area office of the U.S. Bureau of Land Management, which administers the area, is in Monticello, about 65 miles (100km) by road from the center of the mesa. On the mesa itself, a network of dirt roads makes most of the mesatop and a few of the canyon areas accessible by vehicle. Few locations on the mesa are more than two miles from established dirt roads or tracks.

Broadly speaking, the Grand Gulch Plateau is bounded by the San Juan Valley on the south, by the valleys of Comb Wash and Lime Creeks on the east and southeast, by the Elk Ridge highlands and White Canyon on the north and northwest, and by the Red House Cliffs on the west. Except for the northwest corner, which drains into White canyon and hence into the Colorado, the drainage from Grand Gulch Plateau is into the San Juan, largely via the Grand Gulch and Comb Wash watersheds. The southern end of the Plateau drains directly into the San Juan through a number of shorter washes. On the southeast, south and southwest, the Plateau terminates in a ragged, precipitous, and prominent escarpment that faces the barren San Juan River lowlands. On the north, there are the escarpments of the still higher mesas of Elk ridge and its surroundings.

The divide between the Comb Wash and Grand Gulch drainage basins runs approximately north-south down the Plateau, and

Matson, Lipe, and Haase (Aug. 88) I-6 is continued to the southern end of the mesa by the Johns Canyon-Lime Creek divide. This divide, which forms the highest part of the mesa, slopes gradually from about 2100 or 2150 masl (6900 or 7000 ft) at the mesa's north end to about 1950m (6400ft) at the south end. It is followed fairly closely by U-261 and is the spine of the Monument Upwarp, a geological structure extending from Kayenta, Arizona north to Canyonlands National Park. Cedar Mesa, as we have defined it, is largely the central area around this divide.

From this divide, the top of Cedar Mesa gradually slopes to the east and west; the 1707m (5600ft) contour fairly well delimits the edge of the mesa top. Because most of the streams draining the highland have deeply entrenched themselves in their lower courses in canyons of up to 300m (1000 ft) depth, most edges of Cedar Mesa have a ragged or fringed appearance when viewed from above. Cedar Mesa is well defined physiographically to the south by the steep escarpment facing the San Juan lowlands, in the southwest by the edge of the escarpments of the canyons draining the divide are and in In the southeast, by the edges of the valleys surrounding Lime Creek and the lower portions of Comb Wash. In the north, the steeply rising slopes of Elk Ridge elimits both the Grand Gulch Plateau and Cedar Mesa. The situation to the northwest and northeast are not so obvious (Figure I-2). We elected to use Grand Gulch as our western edge. Since the upper reaches of Grand Gulch slant toward the northeast this results in a narrowing of the mesa toward the north. On the east, we chose to use Fish Creek as the

Matson, Lipe, and Haase (Aug. 88) I-7  
limit of Cedar Mesa, and Fish Creek slants toward the  
northwest, reinforcing the narrowing of the mesa to the  
north, as we defined it. Others have referred to portions of  
the Grand Gulch Plateau to the west of Grand Gulch and to the  
East of Fish Creek as Cedar Mesa, but in this work we  
generally restrict ourselves to the sampling universe, which  
was limited by Grand Gulch and Fish Creek. While the  
elevation to the north is also somewhat arbitrary, the choice  
of what elevation to use makes little difference<sup>ce</sup> as the land  
slopes up rapidly. We chose to use 2073m (6800 ft)(Figure  
I-2). In both the southwest and southeast, the dividing line  
between the mesa-top and the surrounding drainages was not  
always that clear. For this reason we used the 1707m (5600ft)  
contour as the mesa boundary.

The five sampled drainages, chosen by methods described in  
the next chapter, were Upper Grand Gulch, Bullet, North Road,  
Hardscrabble and West Johns. Upper Grand Gulch is located at  
the northwestern edge of the mesa, and Hardscrabble, Bullet  
and North Road, are spread from west to east across the  
middle of the mesa, while West Johns is located in the  
southwest portion(Figure I-2).

Cedar Mesa has been sculptured almost entirely out of  
Cedar Mesa sandstone, a crossbedded formation of Permian age  
(Thaden <et al.> 1964). In a few of the deeper canyons, the  
underlying Permian Halgaito and Rico formations are exposed.  
Over the Cedar Mesa Sandstone along the central axis of the  
mesa is a narrow belt of soft red shales and siltstones.  
These deposits, know as "Organ Rock Shale", also date to the

Matson, Lipe, and Haase (Aug. 88) I-8 Permian Age, and comprise the red to brown slope forming unit that overlies Cedar Mesa Sandstone across the entire Mounument Upwarp (Baars 1972:87). Distribution of these shales is limited to the central divide of the mesa, thus most exposed bedrock is Cedar Mesa Sandstone.

The Cedar Mesa Sandstone is horizontal and undeformed over most of the mesa, but dips gradually to the east along its eastern edge, as part of the Comb monocline, and more gradually towards the west.

Annual rainfall has been estimated to range from about 150mm (10inches) on the southern tip of the mesa to between 300 and 330 mm(12 and 13 inches) on the northern edge. The main sources of precipitation are winter snow storms and the late summer monsoon rains; 30 to 40 percent of the annual precipitation comes during the May-September growing season (U.S. Bureau of Land Management 1967;1967-68). As we will discuss in more detail later, the length of the spring drought, the timing of arrival of the summer monsoon, and the regularity of it, are as important as the gross averages reviewed here. Reliable data, however, on the timing and regularity of the monsoon are not easy to find. The monsoon does arrive later at Cedar Mesa than in areas to the south and is less regular than areas of simila<sup>r</sup> elevation to the south and southeast. Details on recent precipitation and temperature records are presented later in this chapter in the section on climate.

The Cedar Mesa sandstone is a good aquifer, and there generally are good springs in the canyons, both at the point

Matson, Lipe, and Haase (Aug. 88) I-9  
near the middle reaches of the drainage where the stream  
first begins to entrench, and in the canyon bottoms after  
full entrenchment. Potholes on the mesa top, particularly in  
the south, and in the canyons also hold water for up to  
several weeks after storms. Because of the abundant  
canyon-head springs, water is fairly easy to obtain on the  
mesa top, even in the dry seasons in early summer and late  
fall.

A mantle of fine sandy loam of probable aeolian  
derivation covers most of the mesa top, reaching depths of  
more than three meters (10 ft) on some of the relatively  
level divide areas, but thinning rapidly near the canyon  
rims. This soil is probably equivalent to the Mesa Verde  
Loess (Arrhenius and Bonatti 1965). In many places the soil  
has a limy zone at 300 to 450 mm(12 to 18 inches) below the  
surface, and in other places, shows a well developed caliche  
horizon. The caliche deposits appear to be less well  
developed towards the southern end of the mesa and in thin  
soils sometimes appears to be almost at the surface.

Many of the watercourses on the mesa have upper reaches  
that consist of broad, shallow valleys with substantial soil  
fills, apparently alluvial, colluvial and aeolian. Most of  
these watercourses undergo a marked steepening of gradient as  
they entrench themselves into the Cedar Mesa sandstone near  
the edge of the mesa; these sections are usually barren of  
alluvial soils, although they may have deposits of colluvium  
resting in steep slopes against the canyon sides. After full  
entrenchment, the stream gradients again flatten out, and the

Matson, Lipe, and Haase (Aug. 88) I-10 fully-entrenched canyons sometimes have substantial deposits of alluvium on their floors. At the edges, these alluvial fills generally merge with sloping deposits of colluvium, and with rock taluses. The present cycle of arroyo cutting (Agenbroad 1975) is rapidly removing the thick but generally narrow alluvial fills from the entrenched canyons. Arroyos have also begun in most of the shallow upper valleys on the mesa top, but have made less headway in removing the soil bodies there.

The growing season has been estimated at about 129 days at 2120m (6950 ft) elevation on the north end of the mesa to about 144 days at 1900m (6240ft) elevation near the south end (U.S. Bureau of Land Management 1967-68). North of the mesa, the land rises rapidly to over 2400m(8000ft) on Elk Ridge. Hack (1942) estimates that Hopi maize crops require a growing season of about 130 days; if these figures are applicable to the prehistoric period, it would appear that the highest parts of Cedar mesa are about at the margin for aboriginal maize cultivation. We present more detailed climatic information later in this chapter.

Since the mid-1960's there has been a single farm on the mesa, near its center, at an elevation of about 2000m (6600ft). Using dry farming techniques, the farmer has been able raise pinto beans and winter wheat. On occasion, as in 1970, he has planted small crops of maize and melons. This farm demonstrates that market-oriented dry farming is possible today on the mesa's deeper soils. Experiments by Victor Fisher, during the Cedar Mesa project, demonstrated

Matson, Lipe, and Haase (Aug. 88) I-11  
the feasibility of raising Hopi corn. The most successful  
plot was along the mesa spine, but only corn was successfully  
grown, as beans were never raised to maturity. Sheet floods  
also occasionally sweep down the shallow upper parts of the  
major drainages; ideally, floodwater farming should also be  
possible here. Fisher also tried two experimental flood  
water plots, but with only limited success on one and failure  
on the other. The results from these plots does not indicate  
that it would or would not be possible to successfully farm  
in this manner, but merely that we were unable to demonstrate  
its feasibility. A more thorough discussion of farming  
occurs later in this report.

#### <Vegetation>

The present day vegetation reflects the general trends  
described above; the higher and better watered areas have  
larger and more numerous trees and the lower areas have lower  
vegetation and more desert species. In addition to this  
general trend there are two other important factors, 1) of  
edaphic factors, usually of soil depth and 2) exposure with  
the northeast slopes having vegetation characteristic of  
higher elevations with neutral exposures, and southwest  
exposures having vegetation typical of lower elevations. Overall,  
however, the dominate vegetation is of  
pinyon-juniper woodland interspersed with sagebrush parks in  
the higher areas, and with blackbrush parks at lower  
elevations. In addition to these three plant communities,  
smaller communities are found along the rim rock--cliffside

Matson, Lipe, and Haase (Aug. 88) I-12 area and in the narrow alluvial canyon bottoms. Relying heavily on West (1978) we will describe these five communities in more detail.

<Pinyon-Juniper Woodland>

This community is well known as being associated with late Anasazi sites, and we will show that this is the case for Cedar Mesa as well. The elevation range in this area is from 1700m (5600ft) to 2380m(7800ft) and consists largely of Pinyon pine (<Pinus edulis>) and Utah juniper (<Juniperus osteosperma>). West (1978:33) reports that the Cedar Mesa pinyon-juniper conforms to Lowe's (1964:56) statement that this community ~~having~~ low diversity. An understory is often absent and such species that are found are also found in adjacent plant communities. West, Rea and Tausch (1975:43) report for pinyon-juniper woodlands in general: "No major plant species, other than the pines and junipers themselves, are endemic to the woodland." On Cedar Mesa shrub species associated with the woodland include Big Sagebrush (<Artemisia tridentata>), Silver Buffaloberry (<Shepherdia rotundifolia>), Mountain Mahogany (<Cercocarpus montanus> and <C. intricatus>) and Rabbitbrush(<Chrysothamnus> spp.). The ground is covered by cryptogams, i.e., lichens and algae. The soil lichens(<Collema coccophorum, Dermatocarpon hepaticum, Fulgensia fulgens, Lecidea decipiens>, and <Peccania kanasa>) give the soil a blackish color and hold the surface together (Loope and Gifford 1972, Cameron and Blank 1966).

West (1978:33-37) confirmed our impressions about

Matson, Lipe, and Haase (Aug. 88) I-13 differential amounts of pinyons and junipers at different elevations. He found that the pinyon-juniper ratio was 0.9 at 2036m(6680 ft) and only 0.4 at 1835m( 6020 ft). This trend agrees with studies at Grand Canyon, by Merkle(1952) and Bandelier National Monument, New Mexico (Yarnell 1965) and that found for pinyon-juniper in general by West, Rea and Tausch (1975:43). West (1978:33) also found wide differences in density of trees from the overall 363 trees/hectare mean to 128 in low elevation areas (Hardscrabble drainage 1900m(6240ft) and to 485 in higher elevation areas (Upper Grand Gulch drainage 2040m (6680ft). Our impression is that the size of the trees varies along with the density. In no area is the woodland too dense to interfere with easy walking.

In addition to the more common understory shrubs mentioned above, Cactus, both <Opuntia> and <Echinocactus> species, are found along with snakeweed (<Gutierrezia microcephala>), Mormon tea (<Ephreda> spp.), Yucca, both <Yucca baccata> and <Yucca angustissima> species, Cliff-Rose (<Cowania mexicana>), Gilia (<Gilia> spp.), Bitterbrush (<Purshia tridentata>), Buckwheat (<Eriogonum> spp.), and Rattle-Weed (<Astragalus> spp.). In the review of pinyon-juniper associations by West, Rea and Trusch (1975:44-45) the Cedar Mesa appears to be most similar to the woodland at No Man's Mesa, in Kane County Utah. A closer look at this comparison(Mason <et. al.> 1967) does show a number of differences. Still this does appear to be the closest reported in the literature, certainly of the 20

Matson, Lipe, and Haase (Aug. 88) I-14 communities reviewed by West, Rea and Trusch. In view of numerous references made elsewhere in this volume to Mesa Verde, it is noteworthy that the Mesa Verde pinyon-juniper woodland, as presented in the review by West, Rea and Trusch, is not identical with Cedar Mesa pinyon-juniper. This agrees with our intuitive impression that there are significant differences.

<Sagebrush Parkland>

The second most important plant community on Cedar Mesa is the Sagebrush Parkland. On the north half of the mesa this community occurs as islands within the pinyon-juniper woodland on the mesa top. There is considerable evidence that the distribution of sagebrush parklands within the pinyon-juniper is related to edaphic factors, with the sagebrush parklands found on deep soils and the trees on shallow soils. This relationship is more complicated than the above generalization suggests; the pinyon-juniper trees are found on shallow soils and the sagebrush is not, but both are sometimes found on deep soils. At the higher elevations on the mesa sagebrush parks are usually found in the broad upper valleys, in areas of deep soil. Billings (1954), however, has pointed out that in the Great Basin sagebrush is more cold tolerant than pinyon-juniper and is found at both higher elevations and, where cold air drainage occurs, at lower elevations. One observation of the sagebrush parks in the upper valleys is that they are notably cooler than the surrounding ridges at night. Thus the distribution of sagebrush parks in the upper elevations of the mesa may

Matson, Lipe, and Haase (Aug. 88) I-15 reflect both cold air drainage and edaphic factors. As is reported in the section on distribution of plant communities below, sagebush parkland is also found in certain lower elevations.

West (1978:39) reports Sagebrush Parklands from 1800-2150 m (5880-7000ft) in elevation. In addition to big sage (<Artemisia tridentata>) various grasses are common, such as species of <Oryzopsis>, <Poa>, <Hilaria> and <Agropyron>. While small pinyons and junipers are sometimes found at the fringes of the parklands, it is unusual to find an isolated large tree away from the fringes. Examination of at least some of the small trees on the fringes shows that many of them are decades, if not centuries, old, indicating the sagebrush park is not being rapidly invaded today. West also reports some information which suggests fires may aid in establishing and maintaining the sagebrush parklands. From our observations of lightning strikes, the pinyon-juniper community does not normally sustain widespread fires. Thus fires in the sagebrush parks would stop at the edge of the woodland, they would kill isolated trees in the parks.

The sagebrush community in many places has been railed or disked, but enough exists undisturbed to give us an idea of the original diversity of plants and it is far higher than in the pinyon-juniper. West (1978:40) lists the following:

Cactus	<Opuntia> spp. and <Echinocactus> spp.
Four-wing Saltbush	<Atriplex canescens>
Russian Thistle	<Salsola kali> (not native)
Aster	<Aster> spp.

	Matson, Lipe, and Haase (Aug. 88) I-16
Golden Aster	<Chrysopsis foliosa>
Rabbitbrush	<Chroothamnus> spp.
Daisy	<Erigeron> spp.
Snakeweed	<Gutierrezia microcephala>
Sunflower	<Helianthus>spp.
Actinea	<Hymenoxys acaulis>
Tansy Mustard	<Descurainia Pinnata>
Bladderpod	<Lesquerella rectipes>
Mormon Tea	<Ephedra> spp.
Rattle-Weed	<Astragalus> spp.
Narrow Leaf Yucca	<Yucca angustissima>
Banana Yucca	<Yucca baccata>
Flax	<Linum> spp.
Primrose	<Oenothera> spp.
Globe Mallow	<Sphaeralcea parvifolia>
Gilia	<Gilia>spp.
Buckwheat	<Eriogonum> spp.
Indian Paint Brush	<Castilleja> spp.
Penstemon	<Penstemon> spp.
Service Berry	<Amelanchier utahensis>
Blackbrush	<Coleogyne ramosissima>

<Blackbrush>

At the lower elevations, primarily on the western slope of the mesa, stands of blackbrush (<Coleogyne ramosissima>) occur. Blackbrush is common in elevations below Cedar Mesa, such as in Comb Wash and in the San Juan valley. West reports the elevation range of this community as from 1450m (4800ft) to 1700m (5600ft) Haase (1983:22) found the

Matson, Lipe, and Haase (Aug. 88) I-17  
blackbrush to extend into slightly higher elevations (1770m  
(5800ft) and to interfinger with sagebrush up to  
1830m(6000ft). In any event blackbrush is found at the lower  
elevations with significantly lower amounts of  
precipitation; West (1978:41) reports only 150-200mm (6 to 8  
inches). At the end of the vegetation section on blackbrush  
distribution in more detail, along with other plant  
communities.

Plants found in Blackbrush areas sometimes include large  
numbers of grasses (<Agropyron>, <Stipa>, and <Oryzopsis>),  
as well as sage (<Artemisia> spp.). Additional plants often  
include large amounts of Ephedra (<Ephedra >sp.), and lesser  
quantities of Gilia, Globe Mallow, Sand Verbena and Goosefoot  
(<Chenopodium> spp.). Daisies, snakeweed and additional  
species of grasses are also found in the low lying community.

#### <Rimrock-Cliffside>

While the first three plant communities do cover almost  
all of the mesa top, a unique group of plants are found on  
rocky escarpments, both along the edge of canyons and the  
edges of mesas. This group of plants might be thought to be  
a separate subset of pinyon-juniper, since it is dominated by  
these two tree species, but a wide variety of other shrubby  
plants are also found, which occur only rarely on the mesa  
top. Mountain mahogany, Gambel oak (<Quercus gambelli>),  
single leaf ash (<Fraxinus anomala>), Serviceberry,  
buffaloberry and bitterbrush all occur here, as well as  
squawbush(<Rhus trilobata>) and cliffrose.

A common denominator in this community is the lack of

Matson, Lipe, and Haase (Aug. 88) I-18  
aeolian soils. Such soil as exists is colluvial and scanty  
in nature. The ground cover is some of the most extensive in  
the mesa with snakeweed, rock solidago, groundsel and aster  
common. If sagebrush occurs it is usually black sage  
(*Artemisia biglovia*). Because of the steepness of the  
slope, exposure is often extreme with the result that  
protected northeast facing slopes often have plants that are  
normally found in much higher elevations. In the extreme  
case, Ponderosa pine (*Pinus ponderosa*) and Douglas fir  
(*Pseudotsuga menziesii*) are found along some of the higher  
canyon walls.

#### <Canyon Bottom>

This plant community is associated with the alluvial  
terraces in the major canyon bottoms. The different  
terraces in Agenbroad's sequence (Agenbroad 1975) are  
associated with different vegetations as well. The oldest  
terrace, designated T2, has sagebrush, pinyon and juniper  
present, as well as archaeological sites. The next terrace,  
T1, lacks the pinyon and juniper, but has abundant quantities  
of very large sagebrush, some over 2 meters tall. The most  
recent terrace, T0, tends to have willow (*Salix* spp.),  
tamarisk (*Tamarix gallica*) and rabbitbrush.

The most obvious plants endemic to the canyon bottoms are  
large cottonwoods (*Populus* spp.). These are found both in  
groves and as individuals in many of the canyons. West  
(1978:45) reports box elder (*Acer negundo*), canes  
(*Phragmites communis*) and rushes (*Juncus* spp.), as well

Matson, Lipe, and Haase (Aug. 88) I-19 as mustards, such as peppergrass (<*Lepidium montanum*>), prince's plume (<*Stanleya pinnata*>) and tansy mustard (<*Descurainia pinnata*>). In addition to various cactus and grasses, Gambel oak is often abundant in the canyons. It is only in the canyons that plants that are adapted to moist environments are found.

#### <Other Communities>

In addition to the plants found on Cedar Mesa, it should be mentioned that to the immediate north of the mesa, on Elk Ridge, several other communities are found. These include an oak brush-ponderosa pine and douglas fir community, beginning at 2400m (7800ft) and extending to about 2600m (8500ft). Oak brush is most abundant in the lower elevations of this zone. Within this community sagebrush parklands also occur. While these environments were not immediately available to Cedar Mesa inhabitants, the trip to Elk Ridge could be made on foot in less than a day from many points on the mesa.

#### <Distribution>

Both West (1978) and Haase(1983) have looked at the distribution of the vegetation along transects on Cedar Mesa. Haase's transect was based on mapping from aerial photographs using a zoom transfer scope and checking with plant lists from the quadrat survey and gives the percent coverage of the previously described communities. Figure I-3 illustrates Haase's west to east transect, from Hardscrabble, to Bullet, to North Road drainage, across the middle of the mesa. This figure clearly illustrates the effect of

Matson, Lipe, and Haase (Aug. 88) I-20 elevation upon plant community and the differential effects on this zonation of southwest and northeast exposures. In addition the location of the Organ Rock shales just to the east of the divide is also obvious. The small mesas on top of Cedar Mesa are usually composed of this formation, which supports the mesa-top cliff side community. It is somewhat surprising to see the sagebrush community concentrated at relatively low elevations at either end of the transect. Whatever the edaphic factors are, it appears that sagebrush out-competes both the blackbrush and pinyon-juniper communities at about 1850m (6050ft) on western exposures and 1750-1800m (5750-5900ft) on northeastern exposures. Haase(1983:22) reports that sagebrush in these elevations is usually confined to sandy hummocks or to north facing slopes, both of which have more effective moisture. This transect suggests that there may really be two different sagebrush communities--the sage parks in pinyon-juniper woodlands at higher elevations, and more extensive communities on the flanks of the mesa.

West made two transects, both north-south and east-west to discover the relationship between present day pollen rain and environment. The pollen ratio of pine to juniper increases with altitude, as does the tree ratio. The general progression, outlined earlier, of lower and dryer in the south, to higher and wetter in the north, appears to hold up, with the only exception being the presence of sagebrush parks (1978:61). The major determinants of vegetation on Cedar Mesa do appear to be first, elevation(effective moisture and

Matson, Lipe, and Haase (Aug. 88) I-21  
temperature regime) second, edaphic, mainly soil depth, and  
third, exposure (effective moisture and temperature regime).

<Wildlife>

Wildlife is scarce on Cedar Mesa today. The northern part of the area is today part of the wintering ground for part of the Elk Ridge deer herd (<Odocoileus hemionus>), which spends the warmer part of the year at higher elevations. A few deer frequent the canyons and canyon heads throughout the year. Generally speaking, though, deer are rare on the mesa top today.

Bighorn sheep (<Ovis canadensis>) were undoubtedly once common in canyon and rim areas and today have moved back into some of the deeper canyons near the San Juan river. Today they are essentially absent from Cedar Mesa as we defined it.

Cottontails (<Sylvilagus> spp. probably <S. nuttalli>) and Jackrabbits (<Lepus californicus>) do occur. While the abundance of rabbits varies from year to year we have never seen them as abundant as they sometimes occur in other areas, except on our farming plots. Coyotes (<Canis latrans>) are present as are bobcats (<Lynx rufus>). Mountain lions (<Felis concolor>) have occasionally been seen in the area. Other animals occasionally encountered are badgers (<Taxidea taxus>), mice, Kangaroo rats, (probably <Dipodomys ordi>), woodrats (<Neotoma> spp.), snakes, lizards, amphibians, and numerous birds, including hawks, owls, and Golden eagle (<Aquila chrysaetos>).

The degree to which the present environmental characteristics of Cedar Mesa resemble those of the

Matson, Lipe, and Haase (Aug. 88) I-22 archaeological past will be discussed in some detail later in the final chapter of this volume. At this point we will point out that West's (1978) pollen investigations do not indicate any major changes, nor do the types of wood preserved in cliff-dwellings and excavated as charcoal, suggest any obvious differences. Thus it appears very unlikely that gross changes in vegetation and, therefore, climate have taken place. The principal recent impact of man on the land has been the result of cattle grazing, initiated in the late 19th century. Although the area is not now being seriously overgrazed, it has been in the past, and this has probably led to some changes in the flora. The presence of cattle may also be responsible for the small number of ungulates present today. Also striking, at present, is the lack of an understory of grasses and small shrubs in the pinyon-juniper forests. While one might think that this is the result of past overgrazing, nearby areas that have never been grazed, such as Windgate Mesa, which is inaccessible to cattle, also show the lack of understory. Lack of recent change in the pinyon-juniper community is supported by West's (1978) pollen analysis; a study by Kleiner (1968) on grasslands of Canyonlands National Park, north of Cedar Mesa, also indicates that the changes which occur with grazing are not major.

The effects of grazing on the sagebrush parks, though, have been considerable. Native grasses were undoubtedly reduced, and many sagebrush parks have been reseeded to exotic grasses by the Bureau of Land Management. This

Matson, Lipe, and Haase (Aug. 88) I-23 treatment, generally accomplished by dragging down the mature sagebrush by chains or rails and sometimes by a light disking of the soil, has definitely had an impact on vegetation. Soil characteristics and archaeological sites appear less affected.

Because the soil beneath the pinyon-juniper cover and even in untreated sage areas is quite bare, one has the impression that soil erosion is proceeding at a rapid pace. Yet, archaeological sites dating from 700 to 1800 years ago are densely distributed over the land surface, including many on slopes. The presence at the surface of numerous features such as hearths suggests that the average lowering of the land surface since archaeological times has been on the order of no more than 10 to 15 cm. The cryptograms do hold the soil together. The alluvial soils, both in the shallow valleys of the mesa-top and in the canyon bottoms, however, are another story.

Almost all soil bodies in the mesa-top have narrow arroyos that have cut down to bedrock. The arroyos on the mesa top appear to be recent and are generally narrow so they have not cut out more than a few percent of the valley bottom soils. Lateral erosion does not appear to be progressing at a rapid rate, and may essentially have stopped. In the canyons, however, that had alluvial bodies, arroyos are generally deeper and wider than on the mesa-top, and widening of the arroyos appears to be continuing. It appears that more alluvium has been cut out in the canyons than remains. Given the narrowness of most canyons, again, the area and volumes

Matson, Lipe, and Haase (Aug. 88) I-24  
of alluvium involved are not great.

L. Agenbroad, as part of the Cedar Mesa Project, has done a study of quaternary alluvium in Cedar Mesa canyons, and has published a preliminary synthesis (Agenbroad 1975). He finds three terraces, the oldest is the T2 terrace, which is probably equivalent to the Tsegi formation of Tsegi Canyon. This is the highest terrace and has both Pueblo and Basketmaker III sites located on it, and in some cases, Basketmaker III partially embedded in them. The next lower terrace, the T1, resulted from aggradation after the T2 terrace had been degraded. No archaeological sites are found on this terrace so we assume it was deposited after the Anasazi occupation and is, therefore, probably equivalent to the Naha formation in Tsegi Canyon. The final terrace, T0, is probably the result of the degradation of T2 that took place in the late nineteenth century. The degradation of the Tsegi has been credited with forcing the abandonment of the Tsegi canyon area in late Pueblo III times. Whether the Cedar Mesa T2 degradation occurred then or slightly later can not be determined at this time. It does appear clear, though, that the the T1 terrace is post Anasazi.

The cutting out of the T1 undoubtedly began in the late nineteenth century, as Agenbroad(1975:65) reports radiocarbon dates of 230+-90 and 100+-200 B.P. from within this unit. It is this erosion episode which has created the mesa-top arroyos. While the arroyos may have had significant environmental effects, mainly by lowering water tables, which may have had significant effects on prehistoric agriculture,

Matson, Lipe, and Haase (Aug. 88) I-25 by eliminating farming on the canyon alluvium and mesa-top valley bottoms, they do not seem to have destroyed many sites. Neither human activity or erosion appears to have made large inroads in the site inventory. The single farm, plus other surface modification such as roads and oil and gas exploration scars, probably cover less than one or two percent of the mesa. Vandalism and simple wear and tear by visitors to cliff dwelling sites have done far more damage to archaeological sites on Cedar Mesa than has land modification.

<Climatic Information>

Environmental data for Cedar Mesa have been collected by the U.S. Bureau of Land Management for some years. Data was originally collected in connection with a study precipitated by the filing of numerous homestead claims in the area in the late 1960's (U.S. Bureau of Land Management 1964,1967, 1967-68). These claims were all rejected on the grounds that the area was environmentally too marginal for a homestead sized farm to be successful, given the existing economic conditions. There have been several temporary rain gauges on the mesa itself, and the U.S. National Park Service has recorded climatic data at the nearby Natural Bridges National Monument. It is this record that is the most extensive and detailed and reported on in detail below. The Bureau of Land Management has also sponsored research projects on the effects of juniper-pinyon removal and grass reseeding on soil permeability, soil moisture, runoff and erosion. The plot

Matson, Lipe, and Haase (Aug. 88) I-26 where these data are being gathered is located near the center of the mesa (Gifford 1969a, 1969b, 1970, 1973; Gifford and Tew 1970; Gifford, Williams and Coltharp 1970; Gifford, and Shaw 1973; Williams, Gifford and Coltharp 1970).

It is these sources that result in the summarized information reported earlier about an estimated annual precipitation of 250 mm (10 inches) on the southern tip to between 300 and 330 mm on the northern edge, and the estimate of 129 day growing season at the north end. More detailed information is available from the nearby Natural Bridges National Monument. This weather station is located at an elevation of 2080m (6500 ft) and 8 km (5 miles) from the northwest corner of our study area (Figure I-2). Located in a pinyon-juniper woodland, this record ought to be very similar to central Cedar Mesa at a similar elevation. Table I-1 gives the summary made available of this record. This table agrees nicely with the generalities reported by the Bureau of Land Management.

Some of the summary information from Natural Bridges (Table I-1) was used to produce the summary climatic diagram Figure I-4. Here the monsoon is clearly presented as well as the "drought" conditions existing in late spring. The record summarized here, though, is short only 15 years long.

Closer inspection of recent weather records from Natural Bridges leads to further details about the spring drought and the onset of the summer monsoon. Analyses of the daily records from 1975 to 1985 kindly made available by the Natural Bridges National Monument staff shows that the spring

Matson, Lipe, and Haase (Aug. 88) I-27  
drought is longer than the fall drought, and that the arrival  
of the monsoon, as defined here, varied from the middle of  
June to the latter part of July.

Inspection of the spring drought shows that it varies in  
length, and in beginning and ending dates, but that it always  
involves the month of May. The definition of drought used is  
simply the longest period between March 1 and the onset of  
the monsoon without a precipitation of 0.10 inches (2.5 mm)  
or more. The first and the last date of the drought period  
was then recorded and used for the following analyses. Note  
that this definition differentiates between two equally long  
periods, one of which has a relatively insignificant shower  
of 2.5 mm in the middle, and one which does not. Thus this  
definition is somewhat simplistic and definitely arbitrary.

Figure I-5 shows the spring droughts as defined, using  
"box-and-dot" plots. The box incloses the interquartile  
range, that is the first and third quartiles or "hinges" of  
the data, and the line dividing the box is that of the  
median. The dots are the actual data points. Spring  
droughts are seen to have a median of 50 days, a mean of 47.9  
and an interquartile range of 34 to 65 days. So this drought  
is a very substantial dry period with almost two months to be  
expected without significant rain. In all 11 years May was  
involved in the longest spring drought. In all but one case  
where the drought was 50 days or longer, June was involved.  
Droughts involving April were shorter, and given the lower  
temperatures occurring at that time, would not be so  
important to plants.

It is somewhat surprising to see how often rain is occurring in June. Droughts involving June, however, were not only longer than those not, but given the warmer weather present at that time, must have been more stressful for vegetation.

The fall drought, defined similarly as the spring drought, as the longest period without 2.5 mm (0.10 inches) of precipitation between Sept. 1 and Dec 1, is quite a bit shorter than that in the spring, as shown in Figure I-<sup>5</sup>6. The median drought period is 40 days, the mean is 42,, and the interquartile range is from 32 to 44, less than half of the 34 to 65 seen in the spring. Yet when the two samples were compared using an empirical two sample Monte Carlo test, 21 out of 100 trials upper quartiles as different as those observed were found, and 30 out of 100 trials means as low as seen in the fall were found. These figures indicate that with this sample sizes the differences in the droughts are not ~~significant~~ significant. If the same amount of difference hold<sup>s</sup> up over longer time periods, however, the differences would become statistically significant. Note, though, that the longest drought observed, 88 days, was in the fall.

The daily weather records can also be used to discover the arrival time of the monsoon in recent years. If we define the monsoon as the first rain after June 15 in which more than 2.5 mm (0.10 inches) of precipitation fell on one or on consecutive days, we find that the monsoon begins on dates ranging from June 1 to July 23 (Figure I-<sup>6</sup>7). The median date

Matson, Lipe, and Haase (Aug. 88) I-29 of arrival is July 1, and the interquartiles are June 2, and July 8th. The "mean" date is July 3. If we define the monsoon as running from the beginning as defined above until the end of September, the precipitation from 1975 to 1984 ranged from 34 mm (1.33 inches) to 160 mm (6.31 inches) (Figure I-7). Note that at least two of these years (1980 and 1978) did not produce enough rain--less than 50 mm (2 inches) for any rain-fall maize farmer, no matter how skillful, to produce a successful crop. Even the median amount of 106 mm (4.19 inches) and mean of 103 mm (4.04 inches) suggests marginal amounts of rain, particularly in that several years (1976, 1981) had a significant proportion of the precipitation of the rain in September, too late, if significant proportions had not fallen earlier. It is doubtful that a successful crop could be raised in a dry-farming situation with monsoons significantly less than 76 mm (3 inches).

A period of ten years to evaluate current monsoon precipitation, though is very short. The summary precipitation records from Natural Bridges in Table I-1 can be used to slightly extend the reliability of the mean estimates. Since these figures are averages for the months over the period, no disersions of the values are available. If we include all of June, a month which averaged 14 mm (.55 inches) of rain in that period, within the monsoon, as well as September, the resulting average should be slightly inflated, although not more than a quarter of an inch or so, if the precipitation patterns are similar to those of the

Matson, Lipe, and Haase (Aug. 88) I-30 last ten years. The mean over the 15 year period covered by the summary table is 110 mm (4.35 inches), very close to the previous 103 mm (4.04 inches) average, given the built in slight inflation. The summary table, then, supports the first analysis as being a relatively representative sample of current monsoon amounts, and by extension, other aspects of the monsoon pattern.

To summarize, this investigation verifies the presence of a strong spring drought, centred around the probable time of planting, and the current relatively early arrival of the monsoon, but a monsoon of uncertain strength, with recently a quarter of the summers having less than 64 mm (2.5 inches) of rain. The critical moisture issues in maize growing would be the timing of the monsoon and its arrival in sufficient strength. The other critical factor is that of growing season, or frost, is turned to next.

West (1978) summarizes the first nine years of the Natural Bridges record as indicating only two years having less than 138 day growing season. If we examine the daily information from Natural Bridges from 1975 to 1985, and define frost as a day with a minimum temperature less than 0 degrees C (32 degrees F). Figure I-~~8~~<sup>7</sup> results. The last frost ranges from April 2 to May 26, with an interquartile range of May 8-21 and a median of May 11, and a mean of May 12. May, then, is regularly the month of last frost, and also likely the month of planting.

The date of first frost ranges from Sept. 19 to Oct. 22 (Figure I-~~8~~<sup>7</sup>), with an interquartile range of Oct 1-16, and

Matson, Lipe, and Haase (Aug. 88) I-31 median and "means" of Oct. 8th and 9th. October is thus the usual time of the first frost. Note, that in this series June, July, August and the first half of September are frost free, notwithstanding a June while we were in the field, that definitely was not frost free.

The length of the frost free period (Figure I-~~2~~<sup>7</sup>) ranges from 134 to 174 days, with an interquartile range of 136 to 156 days, and a median and of mean of 148 and 149.3 days. West reports a minimum of 110 days in his series(1978). Given Hack's estimate(1942) of 130 day growing season being necessary for Hopi maize and Bradley's (1971) estimate of 115 to 130 days, these figures indicate that the growing season would allow for successful maize crops in most years. If this short record is representative of the current climate, water is the limiting weather variable for maize agriculture. If the past climate is similar to the present run, water was also the critical factor as well.

The measurement of frost free period is often sensitive to local physiographic situations, especially cold air drainage.

In this regard it should be noted that the Natural Bridges National Monument headquarters is not located in a draw which would be suspected to have cold air drainage, but instead, in an area more similar to Cedar Mesa drainage divides. Thus the length of the season may be less in many settings on Cedar Mesa than this record indicates.

The major features of Cedar Mesa climate can be seen in the climatic diagram Figure I-~~3~~<sup>8</sup>, drawn following Walter (1963). The calendar year begins with a cool humid period;

Matson, Lipe, and Haase (Aug. 88) I-32  
it is in this period that soil moisture is replenished. The  
spring drought is the most extensive ~~and~~ arid, as denoted by  
the dotted area. Note that according to Walter's measure the  
monsoon period is still slightly arid. The fall period after  
the monsoon is surprizingly humid, linking to the similar  
humid period that begins the calendar year. This diagram can  
be compared to similar ones fom Mesa Verde and Betakin, <sup>(Fig. I-9)</sup> which  
are both higher, with Mesa Verde being moister and cooler and  
Betakin being slightly dryer, with most of the decrease being  
in winter moisture (West et al. 1975:47). The Natural  
Bridges climatic diagram supports the notion that summertime  
moisture is today the limiting factor for agriculture on  
Cedar Mesa, with both the length of the growing season and  
winter moisture apparently being adequate.

To summarize the local weather information with respect to  
the potential for maize agriculture, the spring drought is  
important and occurs during the same time that planting must  
have occurred, which is also the period of the last frost.  
The monsoon today arrives relatively early, but the amount of  
precipitation is often insufficient. The growing season  
appears to be long enough today, with September usually being  
part of the growing season, and the months of June, July, and  
August always, in this short series. The relevance of the  
current weather information to the Anasazi occupation is, of  
course, subject to various caveats, but the current climate  
is an important baseline.

<Archaeological Work on Cedar Mesa>

Early archaeological work in the Cedar Mesa area was concentrated in the canyons, especially Grand Gulch. Charles McLoyd and C.C. Graham took large collections out of the dry caves of Grand Gulch in the early 1890's (McLoyd and Graham 1894; Nelson 1920b; McNitt 1956), to be followed by Richard Wetherill in 1893-94 and 1896-97 (Wetherill 1893-94, 1896-97 a and b, 1897 a and b, and correspondence with Hyde brothers; Nelson 1920b; McNitt 1956). Nels Nelson surveyed Grand Gulch rapidly but thoroughly in 1920 (Nelson 1920a) and Charles Bernheimer and Earl Morris spent some time in the area in 1929 (Morris 1929; Bernheimer 1929). With the exception of a letter by Wetherill (1897b) in the <Antiquarian> and two short papers by Pepper (1902, 1905), this early work was not published, but nonetheless had a substantial impact on Southwestern archaeology in that it formed the basis for the initial stratigraphic and chronological distinctions between the Basketmaker and Pueblo stages of culture (Brew 1946; Lipe 1966). More recently, Sharrock has attempted to study those parts of the McLoyd-Graham collections from southeastern Utah that are in the University Museum, Philadelphia, but has found them to be almost completely undocumented (Sharrock 1963). The McLoyd-Graham materials that are in the American Museum of Natural History are equally poorly documented, but the two Wetherill collections in the same museum have rather good provenience data, considering the time and circumstances of the fieldwork.

More recently, Michael Harner spent a few days surveying

Matson, Lipe, and Haase (Aug. 88) I-34  
parts of Grand Gulch and Cedar Mesa (Harner 1956) and T.

Matthews briefly surveyed a few locations on Cedar Mesa for the Glen Canyon Project (Weller 1959). Later in this same project, Robert Lister tested several sites in the area (Lister 1960) and Sharrock excavated a Basketmaker III site and a small Pueblo II-III site near the northern edge of the Mesa (Sharrock 1964). Just to the north of Cedar Mesa, at Natural Bridges National Monument, C. Steen (1937) described several sites, Lloyd Pierson (1957) did a brief survey in White Canyon, Phil Hobler in 1960 and 1961 did an extensive survey of part of the monument (1978) and A. Schroeder (1965) salvaged several small sites in the right-of-way of a new access road (Schroeder 1965). In 1969 and 1970, Lipe carried out a survey of about four square miles of the mesatop just east of Grand Gulch, and excavated five Basketmaker II and one Basketmaker III sites (Lipe 1978a, Lipe and Matson 1971a; Lipe and Matson 1971b). This work was supported by the National Geographical Society and the State University of New York Research Foundation. In 1971, Lipe and Matson carried out a pilot survey for the project reported here.

The Cedar Mesa Archaeological Project proper, consisted of three main field components, the survey, the testing program, and the canyon tree-ring and architectural survey, all carried out in 1972-74. The survey, in turn, consisted of three main parts, the quadrat and drainage canyon surveys, both fully reported here, and the drainage canyon mapping and collection program, which is also partly reported here, and which will be partly reported along with the tree-ring and

Matson, Lipe, and Haase (Aug. 88) I-35 architectural canyon survey.

The testing program consisted of small excavations at a number of sites, mainly to obtain material for dating and subsistence analysis, but also to define certain structures. Testing occurred at Upper Grand Gulch 4, both at a BM III site and a P II/III site, in North Road 11, in two BM III areas, one of suspected pithouse area, one in an area of slab lined features and at two BM II sites in West Johns 19. In addition, a BM III site in West Johns 19 was tested along with another at West Johns 2. Pueblo II/III components were also tested in quadrats North Road 4 and Bullet 3, at site 7 and site 10a. In addition to these testings of quadrat sites, a large column sample was removed from the Turkey Pen Rockshelter in Grand Gulch, a site with both Pueblo and BM II components. While some of the results of the testing program are referred to in this volume, and the pollen recovered has been reported by West (1978), this work remains to be described in detail.

The canyon tree-ring architectural survey, which was mainly carried out in the late summer and fall of 1974, consisted of mapping, collecting, and where suitable, beam coring and architectural rendering of canyon bottom Pueblo sites. Most of this subproject was carried out in the main part of Grand Gulch, the most densely occupied canyon in the Cedar Mesa area, between the junction of Kane Gulch with Upper Grand Gulch downstream ??km to the Split Level site, near the Junction with Todie Canyon. Two other areas, adjacent to Grand Gulch were also investigated, the Mouth of

Matson, Lipe, and Haase (Aug. 88) I-36  
Todie Canyon and Lower Bullet Canyon. Besides the Grand  
Gulch area, McLoyds Canyon, located in the southeast portion  
of Cedar Mesa and home to Moon House, probably the most well  
preserved large Cliff Dwelling on Cedar Mesa, was also  
investigated. While the important dating information from  
this subproject is reported in this volume, and some general  
conclusions have been reported (Powers 1985, Lipe 1978b) and  
will be referenced, full publication of this work awaits a  
future volume.

In 1976 Lipe carried out an inventory survey of areas  
proposed for inclusion into the Grand Gulch Primitive area  
(Lipe, Powers, and Matson 1977). Most of this area was to  
the west of Grand Gulch, but one area, Slickrock, to the  
south of Hardscrabble, to the west was also surveyed. While  
inventory in nature, the quadrat location techniques and  
forms were the same as used in the Cedar Mesa Project. In  
addition to quadrats, areas of canyons were also surveyed.  
The techniques used here, again, were essentially the same as  
those used during the canyon inventory parts of the Cedar  
Mesa Project. Because of the comparability of the methods  
used, and the overlap of personnel (Matson and Ahlstrom aided  
Lipe in the field, Powers and Matson in the analysis) this  
project is used to extend the range of the Cedar Mesa data.

In addition to this work, two projects have been carried  
out in conjunction with clean ups at the Turkey Pen site  
(AMNH 70) in Grand Gulch after major vandalism episode. One  
of these was carried out by the Museum of Northern Arizona  
(Keller, D.; R. V. Ahlstrom and D. Hartman 1974) and another

Matson, Lipe, and Haase (Aug. 88) I-37  
by the San Juan County Museum (Powers 1984). As it turns  
out, people involved with the Cedar Mesa Project carried out  
both these projects.

Besides these three related projects, many other smaller  
research projects were also carried out either as part of, or  
in conjunction with the Cedar Mesa Project. These were  
either separate field projects related in some way to the  
project, or "non-central" analyses of data. Two of these  
separate, but related filed projects were carried out by D.  
Brooks and C. Benson. D. Brooks (1974) investigated the  
settlement pattern and environment of a Pueblo III community  
at Horse Flats 33km (19 miles) northwest of the northwest  
corner of the Cedar Mesa sampling frame for his MA thesis.  
This community is at a higher elevation than is found on  
Cedar Mesa (circa 2390m--7500 ft) and contains numerous check  
dams. C. Benson carried out a block survey in the Owl Creek  
Drainage, within the Cedar Mesa sampling boundaries as part  
of her dissertation work on Pueblo settlement patterns (1984,  
1985). Both of these works will be referenced in later  
sections of this volume.

We have already mentioned aspects of L. Agenbroad's  
geological mapping and interpretation of alluvium (1975) and  
Jame West's dissertation (1978) on pollen analysis, involving  
both archaeological and other samples from Cedar Mesa. P.  
Salkin (1974,1975) also carried out research on the  
Malacology (molluscan fauna) from a deep alluvium exposure in  
Kane Gulch in reference to past environments. K. Aasen  
(1984) produced an MA thesis on coprolites from the Turkey

Matson, Lipe, and Haase (Aug. 88) I-38 Pen site. While this work on both macrofossils and pollen was done after the analysis was completed for this volume, her results are referred in support of certain of our conclusion<sup>S</sup> about the subsistence during the BM II period. P. Lepofsky (1986) did a supporting analysis on bulk samples of the same deposit.

Don Keller (1982) complete important analyses of lithic source identifications, as well as examining the differences in material used in the various occupations. Paul Sneed (1974) did important work on Basketmaker II and III interassemblage variability and lithic analysis for a dissertation that was never completed. Aspects of his work has been used as foundation work for this volume. D. Pokotylo (197?) also carried out an interesting analysis of lithic debitage from West Johns drainage.

K. Dohm analyzed aspects of the Cedar Mesa BM II settlement patterns for her MA thesis (1981) and has gone on from there to look a differences in features between BM II and BM III (1988). This latter has included the excavation West Johns 12- 6, a combination BM II and BM III site. E. Camilli has been concerned with aspects of settlement pattern, her MA thesis (1975) deals with settlementpatterns as seen in the Hardscrabble and North Road Drainages. Her PhD dissertation(1983) is more concerned with lithic analysis and settlement occupational history, using a wide variety of Cedar Mesa Project sites from BM II to Pueblo III.

The canyon cliff-dwelling episode has also been the subject of several reserach projects. C. Coupland (1981)

Matson, Lipe, and Haase (Aug. 88) I-39 places them in the context of general defensive structures and warfare. P. Powers (19--) has analyzed aspects of the general Cedar Mesa cliff-dwelling phenomena. Using another approach entirely B. Mills (1986) is incorporating Cedar Mesa ceramics and distribution within sites in her research on ceramic function and use.

The authors of the present volume, have, of course, also presented papers and other publications dealing with aspects of human adaptation on Cedar Mesa. We refer here only to publications and that unpublished material which has not been largely incorporated into this volume. There are numerous meeting papers, distributed manuscripts and so forth, that are superseded by this volume.

The previous publications include Lipe and Matson (1971a) (Research design and orientation); 1975 (Canyon sites and alluvium); Matson and Lipe 1975 (Sampling design) and 1978 (Preliminary synthesis). W. Haase completed research on his MA thesis (1983a) on Pueblo II/III settlement patterns in Hardscrabble, Bullet and North Road drainages that has been partially incorporated in this volume, and research on the relationship between site facilities present at limited activity sites and distance to habitation sites. Lipe has summarized aspects of the Cedar Mesa cliff-dwelling pattern in a paper delivered in 1978, and Matson attempted to develop the Hutchinson niche model for archaeology in a paper delivered in 1974.

After the first draft of this volume was completed Matson and Chisholm (1986; Chisholm and Matson n.d.) have looked at

Matson, Lipe, and Haase (Aug. 88) I-40  
the implications for BM II diet of stable carbon isotope  
analysis. In addition Matson, Lipe and Haase (1983)  
synthesized some of the findings reported here in detail.

Also in the early 1970's, the U-95 highway was relocated  
and paved. This highway (Figure I-2) includes a section that  
goes from Comb Ridge to Grand Flat at the north end of Cedar  
Mesa. Mitigation work was carried out for several years by  
crews from the University of Utah (Dalley 1973; Wilson 1974;  
Jennings 1978). Two Basketmaker III sites were excavated  
along with a number of Pueblo sites and one probable late  
Archaic-early Basketmaker site. We will make a number of  
comparative references to this work later in this volume.

Brief mention should be made of important work further  
afield. We have already referred to the work in the area  
immediately to the west by the Glen Canyon project in the Red  
Rock Plateau, analyzed by Lipe (1966,1970). To the Northeast  
at higher elevations extending down from Elk Ridge, D. Green  
and E. Deblois have carried out a number of projects (Green  
1971,1974; Deblois 1975, Green and Deblois 1976,1978 ).  
Their work at Milk Ranch Point, which has a concentration of  
Pueblo I sites will be referred to a number of times in later  
pages. Finally to the east work at Butler Wash, just east of  
Comb Ridge (Figure I-2), was carried out in the late 1970's  
by S. Nelson and P. Nickens at Denver University (Nelson  
1977).