# THE VEGETATION OF THE ZUNI MOUNTAIN REGION IN HISTORICAL PERSPECTIVE

## WITH SPECIAL REFERENCE TO EL MORRO NATIONAL MONUMENT

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# INTRODUCTION

This essay is an attempt to consider the current vegetation of the Zuni Mountain Region of New Mexico in historical perspective. Such a view is important in this era when government agencies and private individuals are charged with managing the land. Knowledge of the historical dimension facilitates wise management decisions. Ignorance or disregard of it can lead to unsound policies, such as the suppression of fire in Ponderosa Pine forests, which later require expensive corrective measures.

To gain historical perspective we must know what the vegetation is like now, and, from an independent source, what it was like at some time in the past, and what have been the land uses and environmental conditions in the interim. So, an independent reconstruction of pristine or prehistoric vegetation is a necessary step. Three kinds of evidence can be applied to the problem. They are historical records, soils, and pollen and archaeological data.

To my knowledge no pollen cores have been taken within the Zuni Mountains. Some pollen samples from archaeological sites on the periphery of the region do exist, but these and the associated plant remains cannot be taken as random samples of the pollen rain and vegetation of the area at the time they were laid down. A more exhaustive study of the pollen rain of the nearby Chuska Mountains has been performed (Wright et al. 1973) and will be referred to below.

The soils of the region have been studied intensively, by the Forest Service (Williams 1967), by the Soil Conservation Service, and by the Bureau of Indian Affairs. Because soils evolve slowly and their horizons reflect the kinds of plants and mineral material from which

they were formed, study of soils can reveal much about the vegetation which once grew on them.

Both soils and pollen have much to offer as lines of evidence, and should be used for a thorough attempt at reconstructing past vegetation. This attempt, unfortunately, is a first approximation and has no hope of being exhaustive. For it I have chosen to emphasize the historical route, hoping in the future to build on this foundation with palynological and pedological data, as well as more historical information. In order to make the historical record more meaningful I will first summarize what we have now.

## PRESENT VEGETATION

### The Region

The area under consideration is roughly that part of west-central New Mexico included within the polygon described by State Highways 53 and 32 and Interstate Highway 40. This is an artificially-defined area, but it has the asset of easily recognized boundaries, whereas more natural boundaries would be difficult to locate. The entirety of the Zuni Mountains is included. Places outside these boundaries are considered in order to incorporate more data.

### Methods

No quantitative measurements of the vegetation have been made to date. Quantification is always desirable, but to be reliable it must be of adequate scope. The region as defined is vast and numbers drawn from only a part of it would be so misleading as to be worse than no numbers at all. Two examples will suffice. Sampling around

Mt. Sedgwick (9256 feet) would lead one to believe that Limber Pines (Pinus flexilis) occur also on Oso Ridge, while a transect from Oso Ridge (8900 feet) through Sawyer to Lookout Mountain (9112 feet) might lead one to look for Common Junipers (Juniperus communis) with Douglasfirs (Pseudotsuga menziesii) and to look for Alligator Junipers (J. deppeana) with Ponderosa Pines (Pinus ponderosa) on Mt. Sedgwick. None of these inferences would be correct.

I have collected botanical specimens extensively in the Zuni Mountains, and have learned enough in the process to appreciate that there is still much to learn. But a general impression of the vegetation has taken shape. For present purposes a qualitative description, based on my impressions and on the few published sources, is best.

The Vegetation

Ponderosa Pine forest is the main forest type of the region. It occupies the highest points in the Zunis and spreads down the slopes to an elevation of about 7500 feet. It is also found in canyons and on the higher mesas southwest of the mountains proper. At present it is primarily a closed, even-aged forest of thickets, pole-timber, and some larger trees. There are some notable exceptions to this physiognomy, both naturally occuring and resulting from thinning operations in the Cibola National Forest and elsewhere. Where stands are not too dense there is often a carpet of grasses below the trees. The dominant species are Arizona Fescue (Festuca arizonica), Mountain Muhly (Muhlenbergia montana), and Muttongrass (Poa fendleriana) at higher elevations replaced by Blue Grama (Bouteloua gracilis) downslope. Ponderosa Pine is often accompanied by Gambel Oak (Quercus gambelii), which, depending upon conditions, may be anything from a shrub to a large tree. Thickets

of these oaks occur in some places, especially on south-facing slopes or on burns. Other shrubs are not common in forests proper. On certain sites where sandstone bedrock (usually Glorieta Sandstone) is not far below the surface large Alligator Junipers may grow among the pines. Within the pine zone are many grassy meadows, many of which are punctuated with clumps of Orange-flowered Currant (Ribes pinetorum) and other shrubs. Some, but by no means all, of these meadows are deeply gullied. Other valley floors are covered not with grass but with dense stands of Rubber Rabbitbrush (Chrysothamnus nauseosus) and/or Broom Snakeweed (Gutierrezia sarothrae).

On north-facing slopes of peaks, mesas, and canyons Douglasfirs grow, sometimes to the exclusion of Ponderosa Pines, more often with them. The pure Douglasfir forests are characteristically closed, with rather small trees, and with few shrubs on the shaded floor below. Rocky Mountain Maples (Acer glabrum) may grow in pockets of light, and shrubby thickets of Ribes, Serviceberry (Amelanchier), Gambel Oak, and Snowberry (Symphoricarpos utahensis) often choke the openings.

An associate of Douglasfir and Ponderosa Pine in mixed coniferous forests in the Mt. Sedgwick area is Limber or Southwestern White Pine (P. flexilis or P. strobiformis, depending upon taxonomic preference). This pine does not occur on Oso Ridge, Lookout Mountain, or other high points away from Mt. Sedgwick. Widespread, however, is the Quaking Aspen (Populus tremuloides), which occurs occasionally with the mixed conifers and occasionally in dense groves in grassy valleys or along streams.

Below and blending with the ponderosas at about 7500 feet is pinyon-juniper woodland. The dominant tree in the upper part of the zone is

Colorado Pinyon (P. edulis), replaced as dominant with decreasing elevation by the One-seed Juniper (J. monosperma). At about 6500 feet the pinyon drops out altogether as the juniper straggles into the arid grasslands. Utah Juniper (J. osteosperma) is said to occur in this woodland in the Gallup area. I cannot verify that assertion, but I have not studied the junipers in that corner of the region with any rigor.

East of the Continental Divide shrubs, except small oaks, are in most places absent from pinyon-juniper woodland. Tree Cholla (Opuntia imbricata) is locally abundant and a pseudo-chaparral of Mountain Mahogany (Cercocarpus montanus), Mockorange (Philadelphus microphyllus), and Fendlera rupicola joins the conifers on a few steep slopes. West of a line running from Iyanbito to Ramah Big Sagebrush (Artemisia tridentata) is very common. It grows in the woodland and on slopes and valleys below it. Grass cover in the woodland is sparse. Where it occurs Blue Grama is usually dominant.

Pinyon-juniper woodland occurs mainly on rocky substrates. Where soils are deep grasses or shrubs are more likely to be found. Blue Grama is the dominant at upper elevations with Galleta (Hilaria jamesii) becoming common at about 7000 feet. The rhizomatous Western Wheatgrass (Agropyron smithii) can be very common in swales, within both the forest and woodland zones. In sandy soils Indian Ricegrass (Oryzopsis hymenoides) and Needle-and-thread Grass (Stipa comata) are often common.

Almost all grasslands in this zone are occupied by snakeweed, sometimes to the exclusion of the grasses. Rubber rabbitbrush is barely less common, but is more likely on well-watered level sites. Where the soil is sandy, as at El Morro National Monument, Horsebrush (Tetradymia canescens) may dominate both of the former shrubs as well as the grasses.

No place in the region is really too low for junipers but below 7000 feet, because of topography, valley soils become increasingly abundant and trees are less likely to be seen. The shrubs Greasewood (Sarcobatus vermiculatus) and Four-wing Saltbush (Atriplex canescens) are often dominant in the plant communities on these soils. Some areas support Blue Grama, Galleta, and Alkali Sacaton (Sporobolus airoides).

Riparian ecosystems occupy a very small portion of the landscape. The largest cottonwood (Populus) grove in the region is above Black Rock Reservoir. There are good stands of these trees in Nutria Canyon, Cottonwood Canyon, Bluewater Canyon, and Cottonwood Gulch, but many of the lower elevation streams, including most of the Puerco, the Pescado, and the San José, lack them.

Some springs support dense stands of willows (Salix) (e.g. Pescado, Cottonwood Gulch) or sedges and rushes (e.g. Shuster), while the waters from others (e.g. Agua Fria, La Jara) sink quickly into gravelly channels and do not support even semi-aquatic vegetation. The historic pool at El Morro has been dammed and has a constant supply of water but does not support a wetland ecosystem. Natural lakes are present (in Glorieta Sandstone) but few and vary from dry to permanent with bulrushes, cattails, and other truly aquatic plants. In the lake in Section 27, T12N, R14W Bladderwort (Utricularia vulgaris) is common. The two largest reservoirs, Bluewater and Ramah, have no fringe of marsh vegetation, but rich marshes occur below their dams. The lakes on the Zuni Reservation, and various small ponds, support luxuriant stands of bulrush (Scirpus), Cattail (Typha), sedges (Carex), and rushes (Juncus), as well as aquatic grasses and forbs.

## PAST VEGETATION

I have used the indefinite term "past" because it does not encourage the false sense of precision of "pristine." "Prehistoric" does not apply to the entire temporal range of former vegetation which will be discussed. Precision is not attainable because the vegetation of a long stretch of former time is of interest. Even a hypothetically unadulterated vegetation would have changed in response to environemntal changes during that time.

Paleobotanists, working with fossil plants, tell us that our region's present vegetation is derived from the Arcto-Tertiary Geoflora. In other words, most of our species of plants, or their ancestors, came from the north, where they evolved in cool or cold environments. Under the influence of the glaciers of the Pleistocene the climate of New Mexico was colder and wetter than it is now. On the basis of pollen cores taken from four lakes in the Chuska Mountains Wright et al. (1973) hypothesized that from more than 34,000 to about 13,500 years ago, during the last glaciation, spruce and fir, now restricted to a few canyons in those mountains, covered the crest and extended further down the slopes. At times a small alpine zone may have existed on the crest. Ponderosa Pine occurred much lower than it does today, but they felt that pinyon-juniper woodland rather than pine forest covered the vast plains to the east of the Chuskas, plains which are today treeless.

Extrapolating from these hypotheses we may say that it would be surprising in the extreme if all the vegetation belts of the Zunis of the late Pleistocene were not also depressed altitudinally, relative to their present positions. Likewise, spruce-fir forest, which does not

occur in the Zunis today but does above 10,000 feet on Mt. Taylor, probably did occupy the highest elevations of the Zunis then. A palynological study of the sediments of the small natural lakes of the Zunis might shed some light on these speculations.

Drawing us closer to the present and sharpening the resolution of our view somewhat are indications from soils. Many of the soils of the Zuni Mountains are of great age (Williams 1967). Most of the upland soils have distinct horizons. Attaining this state would have required a very long time, considering the hardness of the parent material. Many of the alluvial soils have developed to a greater degree than is typical of alluvial soils and some of these lie over up to three buried profiles. These facts indicate deposition has been occurring over a long period, interrupted by erosion cycles. Williams (1967) felt that for at least a part of the time these soils were forming the climate must have been more humid than it now is. He also hypothesized drastic shifts in climatic conditions to account for the erosion cycles.

The characteristics of soils give indication of the kinds of plants under which they formed. Brown soils develop under grasses and shrubs and gray wooded soils under trees. Soils of these types are covered with such vegetation today (Williams 1967). But chestnut and reddish-chestnut soils, which form under grasses and shrubs, are covered with Ponderosa Pines, pinyons, junipers, and oaks in many parts of the Zunis. Although Williams (1967) does not say so, this appears to me to indicate that woodland and forest have expanded into areas once occupied by grassland or shrubland. Also, some of the alluvial soils now support coniferous trees. Alluvium is by definition material that is deposited by water, so the character of these places has changed since deposition.

We turn now from the indirect evidence of fossils, pollen, and soils to specific statements in historical documents. We ignore data from archaeological sites, even though they are tantalizing, because they are strongly biased towards plants cultivated by Man. Homo sapiens has probably influenced the vegetation, primarily through burning, as long as it has been in the New World. The date of arrival is progressively pushed back as more information is obtained, but one thing is certain--arrival greatly predated the end of the Pleistocene. Thus Man has been a factor in the vegetation throughout the current climatic regime. We shall learn more of the effect of aboriginal Americans on vegetation below.

Historical Records

The earliest historical records of our area are those resulting from the expedition of Coronado in 1540-42. Coming down out of the White Mountains of Arizona, where they had run out of food for men and horses and grass had been scarce, the advance party led by Coronado

> found fresh rivers and grass like that of Castile, and especially one sort like what we call Scaramoio, many nut and mulberry trees, but the leaves of the nut trees are different from those of Spain's. There was a considerable amount of flax near the banks of one river, which was called on this account El Rio del Lino. (Winship 1896:555)

The nut trees were probably Arizona Walnuts (Juglans major), while the mulberries were Morus microphylla. Interestingly, McDougall (1973) does not record the latter species as occurring in the country through which Coronado passed. Neither species occurs in our area.

Coronado entered the province of Cibola at Hawikuh, near present Ojo Caliente. He occupied the place and wrote in a letter to the Viceroy Mendoza on August 3, 1540:

> The climate of this country and the temperature of the air is almost like that of Mexico, because it is sometimes hot and sometimes it rains. I have not yet seen it rain, however, except once when there fell a little shower with wind, such as often falls in Spain. The snow and the cold are usually very great, according to what the natives of the country all say. This may very probably be so, both because of the nature of the country and the sort of houses they build and the skins and other things which these people have to protect them from the cold. There are no kinds of fruit or fruit trees. The country is all level, and is nowhere shut in by high mountains, although there are some hills and rough passages. There are not many birds, probably because of the cold, and because there are no mountains near. There are no trees fit for firewood here, because they can bring enough for their needs from a clump of very small cedars 4 leagues distant. Very good grass is found a quarter of a league away, where there is pasturage for our horses as well as mowing for hay, of which we had great need, because our horses were so weak and feeble when they arrived. (transl. in Winship 1896: 559)

Winship (1896:559) added in a note, "This accounts perfectly with the condition of the vegetation in Zuni valley at the present time."

Another chronicler of the expedition added, "The land where they plant is entirely sandy; the water is brackish; the country is very dry. They have some fowls, although not many. They do not know what sort of a thing fish is." (Relacion Postrera de Sivola, transl. in Winship 1896:569)

Along the route from Zuni to Acoma, which is followed from Zuni to the malpais by Highway 53, the army was snowed on every night (it was by then December). Castañeda, main chronicler of the expedition, wrote, "There are junipers and pines all over the country." (transl. in Winship 1896:494)

Later Spanish travellers did not maintain even the record of the Coronadans in describing the vegetation. Espejo, who crossed the region in 1583, said only, "In this province we found a great quantity of Castilian flax, which appears to grow in the fields without being

planted." (transl. in Bolton 1916:184) Thus flax rates a second mention, presumably because of real or imagined economic importance. Oñate, who passed through twice, in 1598 and 1604, could remark only that in some places rabbits and hares seemed more common than Indians (Bolton 1916: 268). This seems hardly surprising.

I have found no records from the Spanish period subsequent to Oñate's. The story does not resume until the Treaty of Guadalupe-Hidalgo transferred New Mexico to the United States in 1848 and a series of military expeditions and emigrant trains brought Anglo diarists to the area. From this point on, because the record is more extensive, each type of vegetation will be treated separately.

Montane Forest

As stated earlier, many of the Ponderosa Pine forests of today have nearly closed canopies and in some cases are dominated by thickets of small, spindly trees. There is much evidence, summarized by Cooper (1960), that this was not the case in Southwestern pine forests of 100 years ago and earlier. The picture that emerges is of towering red-barked ponderosas scattered in an open forest whose floor was a sea of bunch-grasses. Beale's (1858) description of the northern Arizona forests in 1857 is particularly exuberant:

> We came to a glorious forest of lofty pines, through which we have travelled ten miles. The country was beautifully undulating, and although we usually associate the idea of barrenness with the pine regions, it was not so in this instance; every foot being covered with the finest grasses, and beautiful broad grassy vales extending in every direction. The forest was perfectly open and unencumbered with brush wood, so that the travelling was excellent.

The statements on Zuni Mountain pine forests, taken cumulatively, support this view. In 1849 Simpson, travelling from El Morro to Ojo del

Gallo, ascended "a beautiful narrow valley, clothed with a rich black loamy soil, and interspersed with large pines." (Simpson 1964:140) I suspect his route was up Valle Largo. Later in the day, between Oso Ridge and Malpais Springs at the head of Zuni Canyon, he passed through two miles of "hilly pine barren country," showing by his comment that all forests were not luxuriant even then. Woodhouse, the naturalist on the Sitgreaves expedition of 1851, commented favorably upon the country, but said nothing of the pine forests (Woodhouse 1853), while the leader, the taciturn Captain Sitgreaves, had little to say at all about what was for him disagreeable country.

On the Whipple expedition of 1853, though, was a wealth of diarists and note-takers. Whipple (1941:129) remarked of his Camp 66, on November 16, 1853, "Our camp is in a grassy, park-like spot, without water, but in the midst of a forest of spruce and pines. The trees are tall, straight, and, almost without exception, appear to be perfectly sound." Bigelow, the botanist of the expedition, commented further that the western slope of the continental divide in the Zuni Mountains was "well timbered with Douglas's spruce, New Mexico yellow Pine, piñon, and balsam fir." (Bigelow 1856a:6)

Bigelow's statement requires interpretation. The New Mexico yellow pine is obviously Ponderosa Pine. "In all places it forms a beautiful timber tree," he wrote (Bigelow 1856b:18). Likewise the Douglas spruce is what we now call Douglasfir. This is undoubtedly the "spruce" to which Whipple referred. Neither a spruce (Picea) nor a true fir (Abies), it was often referred to by both names in the nineteenth and early twentieth centuries. In his "Description of Forest Trees," Bigelow (1856b:17) said that this species was quite abundant in the

Zunis. It is evident from his article on the balsam fir (Bigelow 1856b: 18) that he actually did not see this species in our area, for therein he ascribes it only to the Sandias, San Francisco Peaks, and Sierra Nevada. The eastern Balsam Fir (Abies balsamea) does not occur in the western United States, and it is probable that Bigelow saw only the White Fir (Abies concolor). At present in the Zuni Mountains spruces (preponderantly, perhaps exclusively Picea pungens) are found only in moist canyons above about 7900 feet. I have seen no true firs at all.

Möllhausen (1858) and Kennerly (1856), both naturalists on the 1853 expedition, frequently referred to "lofty pines." While this may have been simply a figure of speech I doubt it would occur to them were they to retrace their route today.

The loquacious Beale journeyed up the Wingate Valley in August, 1857. Of the Zuni Mountains, which he passed on his left, he said, "The foot-hills are covered with small cedars, and the higher mountains with large pine trees." (Beale 1858:35) On his return, via Zuni and El Morro, in February 1858, he said of Oso Ridge, "a thick forest of pine covers the mountain, which defines the limits of the valley." (Beale 1858:85) He travelled from El Morro to Agua Fria Spring "through a fine open forest of tall pine, with extensive open glades and meadows at short distances." (Beale 1858:86) In the valley of Agua Fria Creek he found that, "The soil is exceedingly rich, and the hills bounding it covered with pine, and among the trees, which are not thick or scrubby, the finest grass." (Beale 1858:86)

Returning to the area in March 1859, Beale built a wagon road over the continental divide between Agua Fria Spring and the valley in which El Morro lies. "The country here," he wrote in his journal, "even at this

forbidding season, is beautiful, and the forests of pine and abundant grass render it particularly favorable for settlement." (1860:36) Along a "sparkling fresh brook" grew some enormous pines and a species of juniper which sounds from his description to have been Rocky Mountain Juniper (J. scopulorum).

John Udell, an emigrant (nineteenth century accounts consistently referred to such persons as emigrants, not immigrants) travelling Beale's road in July 1859, camped at Agua Fria Spring: "Around this spring is an open forest of large, fine pine timber, plenty of grass and good soil." (Udell 1946:23)

Joseph Rockrock, botanist with the Wheeler Survey of 1873, crossed the Zunis from Ft. Wingate to Nutria:

> Gaining the summit a thousand feet above Fort Wingate, we were at an altitude of about 8000 feet above the sea, a fine, open, park-like region with a large growth of yellow pine (Pinus ponderosa) and fir covering the hillsides. A diversified herbaceous vegetation was out in the most brilliant colors, beautifying alike the woods and open grounds. . . . Good forage was abundant. (Rothrock 1875, quoted in Cooper 1960)

In his "General Report" on the flora, published in 1878, he said, "Pinus ponderosa, Pseudotsuga douglasii [= P. menziesii], and Abies concolor, with here and there a straggling oak-tree, make up the tree flora of the higher parts. . . ." (Rothrock 1878:21) In his journal for August 5, 1873, the day he crossed the mountains, he refers to Ponderosa Pine and "fir usually at elevations above 8000 feet." (Rothrock 1878: 60) One would indeed expect White Fir (Abies concolor) with Douglasfir at that level in the Zunis, but there is no evidence that it occurs there, or on nearby Mt. Taylor, today. Rothrock's statement is more persuasive than Bigelow's, but I remain unconvinced that he saw White

Fir. His specific mention of it is made in a general report, no doubt written some time later when memory was clouded by subsequent experiences; his journal entry is not specific.

A final statement on the montane zone is that of Lt. C. C. Morrison, quoted by Rothrock (1878:21) on the central valley of the Zuni Mountains:

> Following the axial line was a wide valley running nearly the entire length of the range, abounding in the most beautiful glades with bunch-grass 18 inches high, standing as thick as it could grow, here and there rooted out in the damper places by red and white clover.

Thus the picture of the Zuni Mountains which emerges is the same as that which Cooper (1960) reconstructed for northern Arizona, an open forest of tall Ponderosa Pines over a carpet of grasses, with frequent glades and interior valleys also grown to grasses. To see that ponderosa forest <u>can</u> look this way one need only go to the Defiance Plateau or the San Carlos Indian Reservation in Arizona, although these places, especially the former, receive some grazing pressure now.

The observations quoted above suggest that Douglasfir was more common, especially at lower altitudes, a century ago than it is now, although this assertion will probably never be as clearly demonstrable as that about the character of the pine forests. Of particular interest in this regard is a forest of Douglasfir snags, standing among pinyons and junipers, on north-facing slopes in upper Zuni Canyon.

Rothrock's statement about the straggling oaks, as well as Beale's description of dense pine forests on the south slope of Oso Ridge without any mention of the oaks which are common there now, suggest that Gambel Oak has greatly increased in abundance.

Woodland

Pinyon-juniper woodland received much less detailed attention from nineteenth century observers than pine forest, probably because it lacked marketable timber. Its main value to them was as a source of firewood for their expeditions. Nevertheless it merited short mentions by most of those writers.

The careful observer Simpson noted cedars (=junipers) on several occasions. Of the route from Zuni to Ojo del Pescado he said, "Scrub cedars have dotted the hills, and the artemisia the valleys"(Simpson 1964:124) He described the Sierra de Zuni as "richly covered with pine and cedar," (Simpson 1964:128) just as Beale was to do later (Beale 1858: 85). The "prairie" around El Morro caused Simpson to wax idyllically: it was "beautifully tasty on account of solitary and clustered trees, or sombrously dark on account of low mesas and oblong ridges covered with cedars." (Simpson 1964:129)

Woodhouse (1853:35) described the Zuni "Mountain" from the vicinity of present Grants to La Jara Spring, i.e. up Zuni Canyon, as covered with cedars and pinyons. These are also the dominant trees at present. Bigelow (1856:19) observed that from the Llano Estacado to Cajon Pass in California the pinyon was everywhere associated with junipers. In his day the taxonomy of the latter was yet to be worked out, and he was content to restrict his identifications to the generic level.

Möllhausen (1858) mentioned "dwarf cedars" as frequently as "lofty pines." Pines and cedars were found together on the north side of Inscription Rock, while the south side, beyond the water hole "was covered by dwarf cedars, reaching up to the summit of the plateau, and adding greatly to the picturesque effect of the scenery." (Möllhausen

1858:69) One wonders if he noticed the pinyons. The cedar-woods of the valleys west of El Morro "became fewer and fewer, and towards the point where we proposed to pass the night /Ojo del Pescado/, evidently vanished altogether, so that, by the advice of our guide, we tied bundles of dry wood to the waggons." (Möllhausen 1858:82) Whipple (1941:138) added to this, a day beyond Ojo del Pescado, "For the last two days no timber has made its appearance. Scrub cedars and piñons upon mesa slopes have furnished sufficient fuel."

Just beyond the gates of Zuni (just west of the junction of present Highways 53 and 32) Möllhausen (1858:85) found the country "just as rocky and rugged as before, and more or less overgrown with cedars." He and Kennerly went hunting on the mesas southeast of Zuni with an Indian guide. Cedars were again the dominant trees, and at some places "the wood became too thick for riding." (Möllhausen 1858:91)

Down the Rio Zuni from the pueblo the expedition camped on the night of November 27 "in a treeless valley, but the gently rising hills that surrounded it were covered with fresh and dry cedar-wood." (Möllhausen 1858:101) Whipple gave a similar account of the place.

Beale's chief interest in woodland was as a source of firewood for his camps, and he mentioned the presence of "cedars" on almost every day. August 21-24, 1857, as he travelled from Hay Camp east of present Grants to the Puerco west of the divide, he noted "cedar" or "cedar and pine" on the mountain to his left. No doubt "pine" here refers to pinyon, for he never used the latter word. On his return trip he noted the cedars and pines already mentioned by others between Zuni and Ojo del Pescado. The valley surrounding El Morro he found "rolling but not hilly, and dotted over with clumps of pines and groves of cedar." (Beale 1858)

A more scientific perspective comes from Rothrock, who, in describing the trees of the Zuni Mountains,noted (1878:21), "at lower levels the Piñon Pine and the Western form of our Eastern Juniper appears." From this statement, that of Woodhouse, and others quoted above, it is reasonable to assume that the configuration of pinyon-juniper woodland was much the same at the advent of Anglo exploration and settlement as today. Indeed, there are many stands of this woodland which are clearly several hundred years old. One old pinyon at Cottonwood Gulch, south of Thoreau, dates back to the mid-seventeenth century. Junipers could be older, but are not amenable to tree-ring dating.

But it is the extent, not so much the configuration, of woodland that may have changed in the relatively recent past. None of the accounts quoted above is exact enough to provide a dependable test of the expansion of pinyon-juniper woodland or simply juniper in the past century. Simpson's statement that scrub cedars dotted the hills implies that junipers were restricted to rocky ground. Möllhausen's statement that the south side of Inscription Rock "was covered by dwarf cedars, reaching up to the summit of the plateau. . . ." seems to confirm this, but he said nothing one way or the other about the gently sloping sandy country below the "plateau," now covered with pinyons and junipers. On the other hand, Möllhausen described the lowlands below the gates of Zuni as overgrown with cedars. The dense woodland which stands there now looks young enough to have sprung up since 1853. Perhaps I have not located the site he described.

We now turn to the question of the presence among the pinyons and junipers, and below them, of vast stands of shrubs. The nineteenth-centurt diarists and naturalists made few mentions of shrubs, but these

few are interesting and significant. Simpson, encamped on Whitewater Wash, noted of the day's journey from the north, "The sylva has been piñon, yellow pine, and cedar. Artemisia, as usual has been very common." (Simpson 1964:111) Artemisia is of course the genus of sagebrush, and Simpson was probably referring to Big Sagebrush, A. tridentata, which is common in that area now. After the march from Zuni to Ojo del Pescado he wrote, "The soil of the valley [Rio Pescado], which is of an argillo-arenaceous [character], is exceedingly fertile. Scrub cedars have dotted the hills, and the artemisia the valleys."(Simpson 1964:124) The presence of Artemisia in this rich valley is of great interest. Of the same spring Udell wrote, "...came to Fish Spring, a large spring of excellent water, good road, grass and sage, brush plenty, wood one-half mile off."(Udell 1946:24)

The only other mention of Artemisia is by Rothrock, who said of his trip from Ft. Wingate to Nutria and beyond, "The artemisia of the Western plains was frequently noticed with piñon pine and scrub cedar prevalent, interspersed with heavy pine timber at intervals, especially at higher altitudes, along the day's march."(Rothrock 1878:60)

Woodhouse (1853:35) made a curious observation: "Between the Inscription Rock and the Ojo Pescado the country is almost barren, there being little else but grease-weed, (Obione canescens) and occasionally a little grass." The plant referred to is definitely Four-wing Saltbush (now called Atriplex canescens), but I doubt that it was any more common then than now between El Morro and Ramah. Following Woodhouse's route today one would encounter dense stands of Big Sagebrush on the valley Floor at Ramah and Four-wing Saltbush and Greasewood near Ojo del Pescado. Woodhouse must have remembered locations imperfectly (he

probably wrote the overview here quoted from long after the fact), but he must have seen a "barren" valley dominated by shrubs somewhere in that area. The most plausible locations are those now dominated by shrubs.

Woodhouse found cacti and "grease-weed" abundant down the Rio Zuni from the pueblo. Beale, at "Navajo Spring" on September 1, 1857, and again at Rio de la Xara the next day, found greasewood the only woody plant present (Beale 1858:39-40). These places are west of our region, but the statement indicates he was aware of these plants. It is impossible to tell whether he meant the "grease-weed" of Woodhouse (Atriplex canescens) or Sarcobatus vermiculatus, the greasewood of today. It is perhaps not the most critical distinction. Both plants are most likely to be found where the soil is somewhat saline and fine-grained.

The statements of Simpson and Rothrock, taken together, leave little room for doubt that some kind of Artemisia, probably A. tridentata, occupied some woodland areas in the mid-nineteenth century. Simpson, Woodhouse, and Udell all mention the presence of brush on the valley floor near Pescado. Their assertion is not further corroborated by Beale, Whipple, or Möllhausen, but neither did these writers make any contradictory statements. Thus it appears that the presence of brush in the lowlands, at least in the valley of the Pescado, antedated the coming of the Anglos in about 1850.

Grass and Water

Grass and water were the two most important resources for the nineteenth-century traveler. Most writers mentioned each spring or creek, and its surrounding meadows, in some detail. Because of the relative wealth of detail I shall treat each water source separately.

(Laguna)

Laguna is outside our area, but is of interest because of the lake that once was there. Simpson, travelling downstream on September 19, 1849, observed:

> Within about a couple of miles, the San José expands into a small lake, which is the resort of large flocks of cranes. . . . Bunch and gramma grasses have been seen in patches along the way. The cactus has been quite common. (Simpson 1964:145)

He had found much of the valley planted to corn and melons. Woodhouse briefly mentioned, "quite a variety of waterfowl" at the lake. (Woodhouse 1853:34)

Waterfowl were on the mind of Möllhausen, too, who tried unsuccessfully to get a shot at some of "the immense flocks of water birds which, tempted by the spacious lake in the middle of the valley, covered every large or small pool." He noted snow geese, "long-legged strand-snipes," swans, and various kinds of ducks. It was mid-November 1853. (Möllhausen 1858:58-60) Beale did not mention Laguna until his second trip, when he noted on March 11, 1859, with uncharacteristic terseness, "came to Laguna, encamped near the lake; grass all grazed off; no wood but a few small cedars." (Beale 1860:35)

Beale's is the latest specific reference to the lake that I have found. I do not know when it dried up, although Beadle (1873:514) referred to dry lagunas there in 1873, in the third year of a drouth. Today, near where the lake must have been, the flood plain is dammed and a large marsh of bulrushes, cattails, and aquatic grasses results. Below the dam and elsewhere in alluvial soil Four-wing Saltbush is abundant, and Salt Cedar (Tamarix) lines the San Jose from here downstream for many miles.

(Hay Camp)

Hay Camp was so-named because hay was cut from its vegas for Ft. Defiance. Foreman (1941:128), in a note to his edition of Whipple's journal, speculated that it was near present McCarty's, but Whipple's description of the place and of his route to it indicate that it was near the west end of the narrow, lava-choked valley through which Interstate Highway 40 and the Santa Fe Railroad now run. It must have been then, as it is now, a very lush place. Whipple (1941:128) spoke of it as "covered with an abundance of grama." He may not have been speaking of Bouteloua. The term "grama" was used rather generally in the nineteenth century. As it was often written with, and seemingly contrasted to, the term "bunch grasses" it may simply refer to any mat-forming grass. Some authors may have used it more specifically.

In his 1857 journey up the San José Valley Beale camped near the present McCarty's on August 17. The diarist Stacey referred to this place incorrectly as Ojo del Gallo (Stacey 1929:82), continuing the error of Beale, who consistently referred to the San José as the Gallo. I have found no indication that Beale ever saw the real Ojo del Gallo.

The next night they camped at Hay Camp. The narrow valley is described thus by Beale (1858:33):

> The whole valley is so completely filled with the solid lava as to leave only here and there a narrow belt of meadow; but this is knee deep with the finest and greenest grass, and almost hidden by it, and winding its way through it is the clear, sparkling brook of the Gallo. The stream is quite narrow, in fact no where over six feet in width, but the water clear as crystal and very cool. It is quite deep, being in many places breast high.

Beale's men made a rude net of gunny sacks and took many fish, "principally mullet, with a few trout" from this stream. On the second day one haul of the net yielded "ninety-six fine fish." (Beale 1858:34)

In 1859 Beale camped again at "Ojo del Gallo" (McCarty's), on March 12. His hunters took four beavers along the San Jose in two days. On the fourteenth he and his servant killed 60 to 80 ducks--Canvasbacks, Redheads, Mallards, and "spring-tail" (probably Ruddy Ducks) (Beale 1860: 35). Engle, a man on this second expedition, also told of catching fish in the San José. He recorded the creek as about three feet deep and fifteen wide (Beale 1860:71).

John Beadle, who passed through in about 1872, referred to the lava-strewn valley as mostly marsh, "and thither the officers from Wingate often go to hunt ducks." (Beadle 1873:506) This was a trip of more than 50 miles.

The picture emerging from these accounts does not differ greatly from what one sees in the area today. Waterfowl still inhabit the marshes, although probably not as plentifully as Beale's bag indicates they once did. Canvasbacks I have never seen there, but the other species are common at some seasons.

(Bluewater (Agua Azul))

Beale camped at Bluewater on August 21, 1857. He called it "Agua Azue." Apparently it was a regular stopping place for wagon trains going from Albuquerque to Ft. Defiance. He said:

> I cannot imagine why this place should ever have been called "Blue Water." It is a long ditch-like hole, extending about half a mile, and probably twelve feet in width, by an average depth of two and a half. The water . . . is the deepest colored red brown I ever saw . . . . [but] sweet, palatable, and wholesome.
>
> The meadow embraces, in all, probably two thousand acres of uncommonly fine land, and is covered with a beautiful grass, of a kind I have not before met with in this country. It grows quite tall, and is very pleasant to the taste and seemingly nutritious; in color a blue green, and very much resembling the blue grass of Jamaica. (Beale 1858:34-35)

I venture to guess that the grass was Western Wheatgrass (Agropyron smithii), which could be expected on that kind of substrate, and is the bluest grass in our region.

Beadle stopped at Agua Azul in May of 1871 or 1872, probably the former. According to his testimony, "Running water was found only at the southwest corner of the valley, and there M. Provencher first began to cultivate the soil, when he established the ranche four years before." (Beadle 1873:507) The southwest corner of the valley would have been hard under the cliffs of Salitre Mesa, from which Bluewater Creek debouches through a narrow canyon. The water hole which Beale referred to must have been a pool in the creekbed.

Beadle reported that Provencher had raised bountiful crops of wheat and corn his first year, but that three years of drouth had followed and the creek had failed (Beadle 1873:507-508). Part of this valley has been cultivated ever since. It has also been grazed intensively (Tietjen 1969). The parts not now cultivated are covered with Four-wing Saltbush. The stream of course is now permanent and has been since the erection of the first dam in 1894 (Tietjen 1969), with the exception of several periods after dams washed out (Greever 1954:110).

(Ojo del Gallo)

Ojo del Gallo was just north of the present town of San Rafael. Simpson rejoined Col. Washington's column there after his diversion to El Morro in 1849. He recorded the place as "a fine spring" with "abundant pasture." (Simpson 1964:141) It was such a fine site, in fact, that the first Ft. Wingate was established there in the fall of 1862(James 1967). Nevertheless, none of the other travellers cited elsewhere in this paper visited it. The Camino del Obispo, the route to Zuni,

apparently cut across the malpais and missed the spring.

San Rafael was founded in the 1870's (Barela 1975:9-10), when settlers moved in from Cebolleta (Seboyeta). They turned the vegas below the spring into hay meadows. Tietjen (1969:62) said,"Nearby Ft. Wingate provided a ready market for whatever hay could be produced." However, San Rafael was almost certainly not in existence when Ft. Wingate was moved from Ojo del Gallo to Ojo del Oso in 1878. Perhaps the future settlers harvested hay in the days when old Ft. Wingate existed. There was a rich supply of water from the spring for the hay fields. Sugar cane was also raised (Tietjen 1969), and Joe Sanchez, whom Tietjen must have interviewed in the 1960's, remembered the settlers making syrup from it.

In October 1907 Vernon Bailey of the U. S. Biological Survey found marsh wrens common "in the tules around the spring at San Rafael." (Bailey 1928:545) The spring has since dried up. The acequia went dry in 1950 (Barela 1975:29), but the vegas may have disappeared long before. (Agua Fria Spring)

Apparently the early road from points east of the region to Zuni followed the present state Highway 53 along the western edge of the malpais until it reached Agua Fria Creek, then, instead of climbing what is sometimes called "Cinder Hill" to Bandera Crater, it continued up the creek to Agua Fria Spring. From there it found its way across Oso Ridge and into the valley north of El Morro. Nevertheless, neither Simpson nor Woodhouse visited Agua Fria, both skirting it to the north on the Zuni Canyon (Cañon del Gallo) route.

Whipple (1941:131) camped at the spring on November 17, 1853. "Agua Fria is a permanent spring," he wrote, "whose waters gush from a

broken bed of lava, flow about half a mile, and then hide themselves again among volcanic rocks." "Gush" was a strong word for A. W. Whipple; we may be sure that the flow of water was substantial. Möllhausen, too, said the water "gushed" as well as "rippled" out of the lava, but he said it disappeared into "the sandy soil." There is still a good flow of water, although it is not likely anyone would say it gushes from the pipe. The streambed consists of coarse sand and basaltic boulders. Engle, in Beall's company in 1859, made similar comments, and noted that a station of the Central Mail Company was at the spring (Beall 1860: 70). The most instructive comment, however, was that of Udell (1946: 23), for he mentioned that there was plenty of grass. Today there is some grama in the valley below Agua Fria Spring, but it is dominated by rabbitbrush.

(El Morro)

Greene (1978) has collected a number of references to the pool at El Morro. Before the National Park Service built a dam in 1926, the pool was much smaller than at present and fluctuated in size with the amount of precipitation. It was "surrounded by verdure" according to the nineteenth-century visitor Abbe Domenech (quoted in Greene 1978:8). Greene also quoted Woodhouse (1853:35) that "there is an abundance of grass, but few flowers." This quotation, however, was taken out of context. It actually refers to Ojo del Pescado. There may have been a small growth of semi-aquatic plants below the pool at one time, although the intermittent over-flow of the pool makes this unlikely. Domenech was the only person to assert that there was.

F. W. Hodge, visiting in 1889, found a small gully, across which he

easily stepped, below the pool (Greene 1978:11). By 1933 the arroyo had become enormous (Greene 1978:Illustration 4). It was filled in during the winter of 1933-34 by a crew under the direction of Evon Z. Vogt, Sr., Monument Custodian. At present the fill is covered with a thick growth of shrubs, predominantly Sand Sage (Artemisia filifolia). This species is not common in our area, and although the site is typical habitat for it, it is possible it was planted to stabilize the fill. In Southwestern Monuments Monthly Reports for September 1936 Custodian R.R. Budlong stated that piñon seeds had been planted in the "reclaimed area", where they had been planted before by the reclamation crew with no success. This area was presumably the arroyo fill.

The Box Canyon seems to most people today a secluded and even enchanted place. This emotion was not unknown to nineteenth-century visitors (Möllhausen 1858; Stacey 1929:86) but to some the place's appeal was utilitarian. Beale noted that the canyon could be closed with a wall 35 or 40 yards long. His capacity for exaggeration can be seen in his estimate of the canyon's containing "twenty to thirty acres of level land, and growing in it the finest pine timber." (Beale 1858:86) The floor of the canyon is actually a little over six acres in extent. Beale was undoubtedly accurate in his description of the pines, but his statement that "the ground is covered with fine grass" is of more interest. He did not camp at El Morro and there is no indication that he descended to the floor of the canyon. Stacey did ride into the canyon on horseback so his mention of "an abundance of fine grass" is more valuable. Udell gives the most thorough description of the canyon:

> There is a natural corral in it, with an entrance wide enough to admit five or six head of cattle, and sufficient room inside to herd several hundred head, surrounded by a perpendicular rock, about two hundred feet high;

> grass and trees growing within it. The bottom is on an even surface with the plains around it, the sloping part of the rock is covered with evergreen timber, towering to the height of the highest part of it, which makes it look quite picturesque. (Udell 1946:24)

The pines referred to by these chroniclers still stand. The grass is another matter. The floor of the canyon often produces an abundance of grass, but it is Cheatgrass (Bromus tectorum), an introduced annual which grows especially well in fairly moist, loose or disturbed soil. Four-wing Saltbush is also common. The combined presence of these two species implies past disturbance. Was Udell's account speculative, or a statement of what his train actually did? We do not know, but the vegetation implies that the canyon was used as a corral at some time. It was used occasionally in the 1930's as a camping spot, and a temporary road ran along its north side while the CWA crew was at the Monument (E.Z.Vogt, Jr., Southwestern Monuments Monthly Reports for July 1935). Today it is off-limits to the public.

A few other aspects of the vegetation at El Morro deserve mention. Fourwing Saltbush grows abundantly on both major ruins on the mesatop. Since the north ruin has never been excavated this growth must predate the Park Service period. I have found very old piñon litter in the middle of a juniper savannah south of the campground where no piñons now grow. While the source of this litter may have been other than living trees it is possible that piñons once extended somewhat farther into the flats than at present. This is definitely true for One-seed Junipers. On the lowest part of the Monument, between the highway and the entrance driveway, dead juniper "skeletons" greatly outnumber living plants, testifying perhaps to worsened moisture conditions in recent decades.

Although El Morro obtained its inscriptions and thus its fame because it was a dependable source of water on a well-tavelled route, it was not the only water nor was the road which passed it the only east-west route through the valley. If Simpson really diverted eight miles before reaching El Morro Colonel Washington's troops must have gone up Togeye Canyon and crossed the valley on its north side. Simpson (1964:140) deduced that the route taken by the troops was the main road of the day. This is sheer speculation, but it may be that Simpson's publicizing of the rock in his report led subsequently to its return to the preeminence it enjoyed in the early Spanish period.

Beale (1858:86) related that, according to a well-informed Mexican, there were four other "fine waters" in El Morro's valley. These were Ojo del Trinidad, the rivulet of Muertas, the rivulet of La Savoya, and Los Nutinas. The last is probably Rio Nutria, although it is in another valley. Savoya was the anglicized name given by the Mormon settlers to Cebolla Creek (Tietjen 1969:30). (However, they did not arrive until the 1870's, so this must be Beale's own anglicization.) Muertas was Muerto Spring and its creek. Ojo del Trinidad is not on current maps, but as it was described as a "large tank", it must have been one of the natural pools which gave the name La Tinaja to the Mexican settlement of San Lorenzo (Tietjen 1969:24).

Beale came through the valley again in March 1859. He explored the northern edge of the valley, and recorded his impressions in detail. The entirety of this segment of his journal is reproduced in Appendix A. I have not explored all of this area, but from what I have seen and with the help of topographic maps the places he mentions may be identified tentatively as follows:

| | |
|---|---|
| first or second dry ravine | Valle Largo creek, with ruins in section 30, T10N, R13W |
| large spring | vicinity of Tinaja |
| first stream | Water Canyon creek |
| dry creek with limestone | Lily Canyon creek |
| second stream | Muerto Canyon creek |
| stream with willows but no cottonwoods | possibly Pipkin Canyon creek |
| largest stream | Cebolla Creek |

The last identification is certain and those of Muerto and Water Canyons are less tentative than the others. The clarity of the water, near absence of snow on the slopes, and dryness of some of the ravines indicate that spring runoff had largely run its course by late March. Now, as probably then, all these streams flow intermittently. The lake he saw must be the seasonal one in Section 4, T10N, R15W.

Beale described patches of sandy soil in this valley, as did Simpson, but elsewhere he referred to abundant grass and good soil. At one place he said the valley was rapidly becoming green in grass, at another that this new green grass was four to six inches tall. This could not have been Blue Grama, which grows little in spring.

Mexican settlers from San Rafael moved into the valley in the 1860's and founded San Lorenzo (later La Tinaja). One of the principal stockmen of the area, Leopoldo Mazon, is said to have owned 12,000 sheep and 1200 cattle (Tietjen 1969:24). Mazon died in 1913 and his heirs were unable to keep his holdings intact (Barela 1975:26). During the 1930's bean farming was practiced in the valley, to within two miles of the Monument (Southwestern Monuments Monthly Reports, August 1938). These attempts were short-lived, and the valley is now devoted to grazing again.

I have not seen all of the valley, but if El Morro, the area

around Los Gigantes, the Cibolla and Pipkin valleys, and the mouth of Water Canyon are typical, loose sandy soils are predominant and shrubs are as important a component of the vegetation as grasses. In two open-country plots at El Morro coverage values for shrubs were 17.9 and 21.3 per cent and for grasses, 17.8 and 22.7 per cent (McCallum 1979). Williams (1967) did not map all of this area, but extrapolating from his map one concluded that sandy soils now cover a majority of the acreage visible from El Morro. As the valley narrrows westward loamy soils occupy the valley floor, but sands are still predominant on the southern slopes and in the canyons.

(Ojo del Pescado and Rio Pescado)

Ojo del Pescado was mentioned by more of the sources consulted than any other watering place. No matter how one crossed the divide or passed the El Morro valley one came finally by this spring. Many observers considered this the origin of the Rio Pescado, a reasonable assumption, but Cebolla Creek empties into the creek just below the springs.

Simpson (1964:123) referred to "a couple of noble springs, bubbling up, pure and cold, from the foot of some basaltic rocks." Downstream the waters of the rio "course directly by . . . , clear and bubbling." This impression was seconded by Whipple (1941:135) who wrote, "this spring bursts from a broken point of the lava bed, and at once becomes a pretty stream, glittering with great numbers of the finny tribe which gives name to it." The naturalist Kennerly (1856:9) added, "In many places in this creek there was much grass and moss and large masses of confervae floating on its surface." Möllhausen noted ducks and snipes along the stream, and Stacey shot seven Green-winged Teal in two days

of hunting there. He noted both "grass and water in abundance" in the "very pretty valley." (Stacey 1929:86) The water was "cold as ice and clear as crystal."

The above statements reflect conditions from August through November. On March 26, 1859 Beale wrote:

> we nooned at the beautiful spring of the Ojo Pescado; we crossed the Zuni river before coming to and after leaving this spring, a mile on either side of it; the river was full and running rapidly; it was about twenty-five feet in width and three in depth; it is sometimes quite dry where we crossed it, though water is always to be found in it below; . . . . (Beale 1860:39-40)

He had passed that way on February 18 of the previous year, when the spring was running, even if the river was not.

The testimony of the nineteenth-century observers was unanimous that Ojo del Pescado burst, clear and cold, from under a lava rock. It is not different in quality today, the water impounded around the spring being as clear as any I have seen. However, the stream below the spring does not now appear big enough to support the kinds of fishes (Gila) which Kennerly took there. The banks of the stream are grown up with willows (Salix). Some semiaquatic grasses, sedges, and horsetails grow in uncultivated areas. Not far below the spring the stream enters an arroyo. From here onward the valley floor is covered with Four-wing Saltbush and the slopes with sagebrush.

(Rio Zuni)

When Simpson visited Zuni on September 15, 1849, a dry year, the river at the pueblo was only six feet wide and a few inches deep in a bed 150 yards wide (Simpson 1964:114). When he crossed it just before entering the valley in which Highway 32 now meets Highway 53, he found the bed 30 feet wide and miry. These must have been the conditions when,

in the same month two years later, Sitgreaves (1853) called the Zuni "a mere rivulet." Yet Kennerly, but two years later, in 1853, was able to call it a "small stream of pure, clear water." These differences seem to result from point of view. Perhaps Sitgreaves was less inclined to be gracious toward this arid land. Kennerly took fishes from the Zuni at several locations. Also, Woodhouse, of the Sitgreaves expedition, collected sufficient variety of waterbirds to counteract somewhat his leader's disparaging remarks.

Whipple found springs flowing from the base of the gates of Zuni (Whipple 1941), and Möllhausen said that they camped there near a brook: "At the time of our arrival the hollows in the rocks only were filled with water, but these natural reservoirs abounded in fish." (Möllhausen 1858:86) In August 1857 Beale (1858:38) described the Zuni as dry at the pueblo, but the area was experiencing a drouth (despite the abundance of rain across the divide at Bluewater and beyond). In March 1859 he found the river about two miles upstream from the town "already beginning to lose a large portion of its waters in the loose soil of the valley." (Beale 1860:40)

Thus the Zuni, unlike the Pescado, seems to have been as intermittent and uninspiring in the 1850's as now, although the extensive marshes that currently line the river bed testify to a substantial subterranean flow. The impressive cottonwood bosque which occupies the flood plain above Blackrock Reservoir, the finest growth of these trees in western New Mexico between the San Juan and San Francisco Rivers, was not mentioned in any of the early accounts. It is possible that it sprang up in response to changed conditions resulting from the erection of the dam.

(Rio Puerco and Ojo del Oso)

The New Mexico part of the Rio Puerco attracted little notice in the mid-nineteenth century, primarily because most pre-railroad travelers took the southern route and did not meet the Puerco until well inside Arizona. Beale (1858:36) described it as "a deep gulley, in which we found water." This was east of present Gallup, in August; three days later he found no water in the Puerco west of Gallup. Beadle (1873) mentioned crossing the Puerco en route to Ft. Defiance but did not describe it. A well-known photograph of Gallup, taken about 1895, shows the arroyo of the Puerco already in existence, but the depth of it cannot be estimated. Photographs reproduced by Leopold (1951) show that near Churchrock sagebrush increased at the expense of Blue Grama from 1901 to 1946.

Ojo del Oso sent out "a cold, clear stream, sufficient to turn a mill wheel," according to Beadle (1873:512). I found no spring at all when exploring the wash where it is supposed to be, in August 1981.

## INTENSITY OF GRAZING AND LOGGING

Indians did not have grazing stock before the arrival of the Spaniards. At what point after 1540 they acquired them I do not know, but by the mid-nineteenth century the herds were large. Simpson (1964:86) wrote of a place near Canyon de Chelly:

> Innumerable signs of stock, principally sheep, have been seen along the route; and the road we have been traveling looks as if it might be one of the great thoroughfares of the nation.

Sitgreaves (1853), Whipple (1941), and Beale (1858) all commented on the difficulty of finding grass in the vicinity of Zuni. Near Nutria

Rothrock (1878) noted large herds of goats and sheep, belonging to both Zunis and Navajos.

These herds were probably small compared to those of the white men: Acoma Land and Cattle Company, with a maximum of 27,000 head of cattle; Zuni Mountain Land and Cattle Company, which ran 10,000 head between the continental divide and Bluewater; the 55 Bar Ranch, which ran 7000-8000 head between Prewitt and Pueblo Pintado; the Diamond Bar Ranch headquartered in Las Tusas Valley with 4000 head; the Box S Ranch, which ran 6000 head from near Nutria to the Arizona border (Tietjen 1969:77). To these must be added the 12,000 sheep and 1200 cattle of Leopoldo Mazon of La Tinaja and probably many other small holdings. In addition, "Beale's Road" was one of four major cattle trails from Texas to California after the Civil War (Morrissey 1950).

The 1880's saw the maximum glut of cattle on southwestern ranges. A large calf crop in 1891, followed by the failure of summer rains that year and the next, resulted in wholesale starvation. Many cattle companies went out of business. Herds were greatly reduced in size thereafter (Morrissey 1950), but probably exceeded carrying capacity of the depleted range for many decades more.

A false start at logging the Zuni Mountains was made in the 1890's by the Mitchell brothers. It wasn't until 1903, with the arrival of the American Lumber Company in Thoreau, that the work began in earnest. Eugene Lambson claimed that 100 carloads of logs were shipped out of the area every day for almost 20 years (Tietjen 1969:89). (Lambson was a great story-teller; his figures may have been a bit off.) A. B. McGaffey shipped 50-60,000 board feet a day from his operation headquartered at McGaffey (Tietjen 1969:91). These operations, or their descendants,

had closed by about 1930. In 1933 M. R. Prestridge and Carl Seligman began lumbering the south side of Oso Ridge (Myrick 1970). When they finished work in 1940 the Zuni Mountains had been almost completely logged over.

## WHAT HAS HAPPENED AND WHY

There is a legend in the Southwest that in earlier times the streams ran with clear water and abounded in fish and beaver, that the valleys grew to stirrup-high grass, and that in the forests park-like stands of large pines towered over grassy glades. Hastings (1959) has warned how biologists, untrained in historiography, fall prey to old accounts which seem to verify this rosy view of the good old days. It is wise to treat old accounts with caution, even healthy skepticism. Nevertheless, when many independent accounts tend to corroborate one another they deserve credit. Below I shall attempt to evaluate the truth of the legend in our area, with respect to each type of vegetation, and, drawing on recent research, offer explanations as to how changes that are thus demonstrated may have occurred.

### Pine Forest

It is known that the Zuni Mountains were intensively and extensively logged from 1903 to 1940. The evidence in the form of stumps is still present. That the pre-logging forest of our area was characterized by semi-open stands of tall trees seems adequately confirmed by the statements quoted above, especially when these are taken in concert with the evidence from Arizona (Cooper 1960) and what is known of unmanipulated Ponderosa Pine ecosystems.

Most pine forests of the Southwest do not now conform to the park-

like character expected of them. In the Zuni Mountains the second-growth timber has simply not reached the age to produce trees of large size. The situation is more complicated however. Many acres are covered by what foresters call "dog-hair stands," dense thickets of spindly, unhealthy, even-aged saplings. These stands are almost unanimously considered undesirable. Despite their stunted condition few of these saplings die, because competition is for water rather than sunlight (Cooper 1960). Thus none will reach mature stature and the stand stagnates. Their continued existence results in the build-up of litter and stems that may fuel a destructive conflagration. Balda (1975) has pointed out that they are not desirable for bird populations. Grazing is impossible because no grass grows under them. A person can walk through one of these stands only with great difficulty.

The establishment of dog-hair stands requires a virtual climatic accident (Cooper 1960: 133). If temperatures are above average in April and May a good seed crop will result in the fall of the second year following. Then, if rainfall is heavy the next July and August many of the seeds released the previous fall will germinate. The resulting seedlings, however, will not become established unless the following spring is wet. The rarity of wet springs in the Southwest thus makes establishment of a reproduction stand unlikely.

To become established pine seedlings also require a seedbed of mineral soil. It was once thought that overgrazing, which definitely occurred in many areas, significantly abetted the establishment of dense stands of reproduction by preparing a mineral seedbed and releasing the seedlings from competition with grasses. After reviewing the evidence, Cooper (1960:136) suggested, "In the rare year in which a wave of seedlings establishes itself, there may be so much moisture that no degree

of herbaceous competition is really inhibitory." Thus, he concluded, "reduction of grass competition and the preparation of a mineral seedbed by grazing animals probably helped to bring about the dense thickets, but do not seem to have been the controlling factor."

The controlling factor, it is generally agreed, was fire. Fires occurred at average intervals of 6 to 12 years at five sample sites in Arizona (Weaver 1951). These fires resulted from both lightning and intentional firing to drive game by Indians (Cooper 1960). Frequent fires, fueled by litter, down logs, and dried grass, destroyed most of the pine seedlings. The frequency of fires prevented a build-up of fuel, so these were relatively cool surface fires which did not kill older trees. They also prepared seedbeds because the area around a log would experience a hot fire. If subsequent moisture conditions were appropriate a stand of seedlings would spring up. The absence of fuel protected the seedlings for a few years. Subsequent fires would thin the resulting stands of saplings. The density of our present dog-hair stands results from the absence of the thinning effect of cool fires, which have been rare since the turn of the century. Overgrazing reduced the fuel for these fires, but the main cause of their rarity was the intentional suppression of all fires in the interest of silviculture. This model is summarized from Cooper (1960) and Weaver (1951, 1974).

It is now recognized that fire is an integral environmental influence in Ponderosa Pine ecosystems, but fuel has accumulated to the extent that fires often develop into conflagrations, such as the 1976 Frijoles Mesa fire in Bandelier National Monument. The corrective to this situation is selective thinning and controlled burning. The Cibola National Forest has an active policy of thinning followed by

burning of slash in the Zuni Mountains, and where it has been implemented the results are encouraging. The bountiful stands of Arizona Fescue, Mountain Muhly, and other bunchgrasses which resulted from the heavy rains of 1981 inspire in many places intimations of the forests of old.

On the steep north-facing slope of Oso Ridge many places are dominated by Gambel Oak and Ponderosa Pine. In a few spots dense stands of Douglasfir grow. On Mt. Sedgwick, no Canadian Zone, as such, exists. Pockets of boreal trees grow in ravines on the north slope, but the Transition Zone extends to the summit (Riffle 1971). One is tempted to ask if this is natural. In particular, one would expect a mixed coniferous forest of Ponderosa and Limber Pines, Douglasfir, and White Fir on the north slopes of Oso Ridge.

It has been suggested that subalpine spruce-fir forest occurred on the high ridges before logging, with mixed coniferous forest below. According to this hypothesis spruce-fir forest was logged out and has not regenerated because the Forest Service reseeded the entire range to Ponderosa Pine. Spruce was supposedly taken out first because, according to the oldtimers, it made the best mine timbers.

This is an intriguing hypothesis, probably partly true, as the situation on Oso Ridge implies. There seems little doubt that the Zunis were devastated by the loggers. But I doubt, on ecological grounds, that spruce-fir forest, which undoubtedly occupied the Zuni Mountains in the late Pleistocene, has occurred in our area in historic times. Spruce-fir stands do occur at the 9000-foot level in the Chuska Mountains. Special conditions make this possible. The Chuskas are oriented on a north-south axis and their west slope is fairly steep, thus heavy snow accumulations are likely to result from the westerly winter storms. In addition the subalpine species are found only in canyons which

descend the west slope, where cold air drainage is likely to enhance the production of a subalpine micro-climate. Even so, this subalpine assemblage is joined by Douglasfirs and White Firs, which characteristically grow below the subalpine zone. The Zunis trend northwest-southeast, are not steep, and like canyons like the ones which support temnant spruce-fir in the Chuskas. The moistest canyons in the Zunis, e.g. Little Water, Cottonwood, and Hausner Canyons, support Blue Spruce (Picea pungens) and Douglasfirs which are too large to have grown up since the logging days. Some of the spruces could be P. engelmannii, but the habitat is more appropriate to P. pungens and the physiognomy of the trees is that of southwestern Blue Spruce, as detailed by Jones and Bernard (1977). Additionally, Stanley Lewis of Ramah has told me that the oldtimers frequently referred to Douglasfir as spruce. This is understandable considering Bigelow's (1856) usage.

The absence of White Fir (if it is not absent it is certainly rare) is more problematical. Elimination by logging is a possibility, if the species was originally very limited in distribution. In the high-elevation ravines where it would have occurred the large Douglasfirs were eliminated very efficiently, to judge from the many huge stumps which remain, yet none of these places today lacks Douglasfir saplings. It seems more likely to me that White Fir occurred thousands of years ago but was eliminated by the same post-Pleistocene climatic changes which probably eliminated the subalpine forest. Limber Pine demonstrably once occurred in the Chuskas but now does not (Wright et al. 1973). If such a thing can happen there, while the more boreal Subalpine Fir persists, it is simple enough to imagine the local extinction of the White Fir as a result of climatic and stochastic events alone.

Limber Pine is common on the granitic Mt. Sedgwick highland, but absent (or very rare) on sedimentary Oso Ridge and Lookout Mountain, which are of equivalent height. Soil differences may explain these observations, but I know of no other conifer so limited and doubt the validity of such an explanation. More likely the species was "driven off the tops" of the latter two places by a dry climatic interval and has not recolonized them. Recolonization could have been inhibited by the prevailing southwesterly winds, opposite the direction needed for seed dispersal from Mt. Sedgwick. This hypothesis is flawed by the absence of an obvious refugium on Mt. Sedgwick. The distribution pattern remains, essentially, an unsolved riddle.

That mixed coniferous forest dominated by Ponderosa Pine and Douglasfir once occupied a greater acreage in the Zunis than it does now is a quite credible suggestion. Actually, the area presently occupied is extensive, but this may be obscured by the smallness of the Douglasfirs. In many places some now-large pines were left standing by loggers while virtually all the Douglasfirs were taken. Dense stands of Douglasfir reproduction occur in many such places, sometimes in plots where only ponderosa stumps are seen.

If fire suppression is continued at its present efficiency the Zuni Mountains may eventually have a greater acreage of mixed coniferous forest than they did before logging. In the Pacific Northwest the highly fire-resistant Ponderosa Pine is being replaced by the moderately fire-resistant Douglasfir and the fire-sensitive White Fir in the presence of effective fire suppression (Weaver 1974, Hall 1980). In that area apparently mixed conifers are the climatic climax and Ponderosa Pine is a fire climax; which of these is the "natural" climax is moot.

Woodland

Pinyon-juniper woodland is a vegetation type with a long history in our area. Palynological research (Wright et al. 1973) and woodrat "archaeology" push the history of this formation into the Pleistocene. Wright et al. (1973) speculated that such woodland once covered the entire San Juan basin.

At its upper boundary this woodland is seemingly limited by competition with Ponderosa Pine. It can be seen on dry, south-facing slopes above its usual elevation, as at Oso Ridge Lookout and on Cerro Colorado, where the north sides are occupied by Douglasfirs and the flats below by ponderosas. Perhaps the woodland species have an upper threshold of moisture above which they do not thrive, but this seems unlikely to be reached in the Ponderosa Pine zone.

Of greater interest in our area than the upper limit of the zone is the lower. As shown on pages 16-18, few conclusions about expansion of woodland in our area can be drawn from the historical accounts. Nevertheless, few people doubt that this has happened. Expansion has been documented for other areas (Cottam and Stewart 1940, Burkhardt and Tisdale 1976, other studies cited in Zarn 1977) and probably could be demonstrated here by investigation of stand structure. Wayne Fjeseth, of the U. S. Soil Conservation Service, told me that on one project his agency simply cleared stands of pinyons and junipers that had arisen since a series of aerial photographs was taken in 1935. The expansion had been significant. As mentioned above, the uniformy small stature and dearth of dead branches of the pinyons and junipers growing on valley soils near the gates of Zuni implies recent expansion. Linear expansion into surrounding shrublands or grasslands can be accompanied

by increasing density of existing woodland (Blackburn 1967, cited in Zarn 1977:38).

One place where at least a modest expansion appears to have taken place is El Morro National Monument. Large trees grow in the Box Canyon, on the mesatops, and on outcrops of lava. However, among the old trees on the east side of the Monument are many younger ones (this has not happened on the mesatops), and descending eastward from Inscription Rock is a gradient of progressively smaller One-seed Junipers. Although the size decrement could result from a gradient of diminishing soil moisture it may also represent an age-graded series. In the lowest sites the junipers are mostly less than 2 meters tall and most of them are dead (McCallum 1979:14). The interpretation that presents itself most favorably to me is that junipers have invaded the flats, but have retreated somewhat. An old photograph might illuminate this mystery.

Juniper and pinyon are thought to occur "naturally" on rocky slopes or in places with shallow soils. Apparently junipers lead the salients into deep soils. One-seed Junipers, our most common species, possess a suite of adaptations that make expansion easy (Johnsen 1962). I should interject here a point that I have not seen in print, though it seems obvious: this suite probably would not be so highly developed if opportunities for expansion had not been frequent in its evolutionary history, thus the current expansion is no unique event in the history of the species. Pinyons expand in the favorable micro-climates produced by the already-established junipers and eventually dominate the woodland, but because of the same moisture constraints do not descend as far into the hotter, drier lowlands as the junipers.

Expansion of the economically unattractive junipers into the eco-

nomically precious grasslands is part of the legend of the degraded Southwest. The legend holds that the once-vast herds of livestock reduced grass cover and juniper, released from root competition with the formerly abundant grasses, invaded the deep soils. The twin phenomena of over-grazing and invasion by junipers are widely accepted, but the causative link between the two is now generally thought to be less direct than the legend implies.

Burkhardt and Tisdale (1976) investigated the causes of Western Juniper (J. occidentalis) invasion of grasslands and shrublands in southwestern Idaho. They found that range conditions have little effect on juniper establishment, as shrubs and herbs produced micro-climates in which juniper seedlings throve. The controlling factor seemed to have been fire. Abundant charred stumps testified to a former history of frequent fires. Juniper had been confined to rocky slopes where herbage was not produced in sufficient abundance to support fires. Fire control by white settlers and the reduction of fuel as a result of heavy grazing removed the long-standing check on juniper invasion.

This model is supported by studies performed on other species further south, including in Arizona. Postfire examination of Blue Grama-pinyon-juniper rangeland in central New Mexico showed that some trees and cholla cactus were killed but grass had recovered after two years (Dwyer and Pieper 1967). Johnsen (1962) was less enthusiastic about the importance of fire as the sole inhibitor of One-seed Juniper invasion in northern Arizona: "Alone, competition or fire will not completely prevent juniper invasion, but together they could." (Johnsen 1962:205) He reasoned that competition would keep juniper seedlings small enough to be killed by periodic fires. "Thus, it would seem that these bottom

land areas were maintained as grassland by a combination of competition and grass fires and the areas were preclimax inclusions in the juniper woodlands before overgrazing by livestock reduced fuel and competition." (Johnsen 1962:205)

Johnsen's study has special value in that he studied the autecology of One-seed Juniper experimentally as well as in the field. Juniper seedlings grown with Blue Grama were considerably smaller after three years that those grown alone. Although the depth of the cans in which he grew the seedlings may have affected the results, the results as presented bolster his claim that competition plays a role in preventing invasion of junipers. This does not invalidate the somewhat contrary findings of Burkhardt and Tisdale (1976), who were working with bunchgrasses and a different species of juniper.

Johnsen felt that the junipers he studied were invading an area which, in a successional sense, was, in a manner of speaking, rightfully theirs. In so saying he inadvertantly gave the nod to fire as the controlling factor by implying that the lowland grasslands were a fire-regulated dysclimax, for how would the grasslands have developed, since shading inhibits the growth of Blue Grama, if fire had not incrementally pushed the junipers back to low-fuel sites? Although I think the competitive factor should not be ignored, fire seems to be the consensual choice as the protector of grasslands. This is true not only for Southwestern desert grasslands (Humphrey 1968), but also for the eastern parts of the tallgrass prairie (Vogl 1974) and the California valley grasslands (Stewart 1955). Thus the spread of junipers, and consequently of pinyons, can be seen as resulting from the virtual control of fire abetted by the reduction of fuel and of root competition from grazing.

A phenomenon which has accompanied the spread of pinyon-juniper woodland is the spread of Big Sagebrush. Overgrazing has been the main cause, at least in the view of grazing interests, who wish to see the shrublands "rehabilitated" to "natural" grassland. "Evidence from a variety of sources suggests, however, that the pre-grazing vegetation throughout the intermountain west was a mixture of grasses, forbs, and shrubs in which woody brush was usually conspicuous and ecologically dominant or co-dominant (Vale, 1973). Although shrub density increases with livestock use, ungrazed or lightly-grazed range supports much brush. Perennial forbs, not grasses, apparently decrease the most under heavy livestock grazing." (Vale 1974:275) Vale's research, it should be noted, was concentrated on the intermountain area.

It is thought that Big Sagebrush "naturally" occurs in sites also favorable to pinyon-juniper woodland. From here, like the junipers, it invades deeper soils. This has been demonstrated in a few places (e.g. Cottam and Stewart 1940). Reduction of competition from grasses and reduction of water tables by the gullying which frequently follows overgrazing are the facilitating factors (Cottam and Stewart 1940, various sources cited in Zarn 1977). Fire suppression should also contribute to the spread because Big Sagebrush is killed by fire. Sagebrush is sometimes successional to pinyon-juniper woodland (Zarn 1977).

There is ample evidence in the statements of Simpson (1964) and Rothrock (1876) that Big Sagebrush occurred in our area in the mid-nineteenth century. If Simpson's statement that the hills were dotted with junipers and the valleys with sagebrush is taken to mean that the present extensive valley-floor growth of sagebrush was already in place in 1849 one might assume that valley floors are the "natural" habitat of this plant in our region. That may be the case, but the Zunis and

Navajos had large flocks and herds when Simpson arrived (Simpson 1964: 86, also Rothrock 1878:60) and probably had had them for some time. Overgrazing by these animals could have initiated the spread of sagebrush centuries ago.

The axial valley of the Zuni Mountains, described by Lt. Morrison, now supports,in addition to good stands of grass, large expanses dominated by Rubber Rabbitbrush. This is a plant that does not normally occur in shallow soils. It favors moist alluvial soils, and resprouts vigorously after fire. It has probably always occurred in naturally disturbed areas, such as streambeds. Its recent spread is most dramatic in places that have been farmed. The valley from Agua Fria Spring to Highway 53, described by Udell (1946) and Engle (Beale 1860) as abounding in grass in 1859,is now a sea of rabbitbrush. A period of bean-farming, in the 1930's, intervened (W. Fjeseth, pers. comm.). At Cottonwood Gulch, in the Las Tusas Valley south of Thoreau, field planted to potatoes before 1930 and one cultivated in oats a single season about 40 years ago now abound in rabbitbrush. A corner of the oatfield lies in a flood plain and abuts three hayfields that have never been tilled. The change from rabbitbrush and Rosa woodsii to grasses at the fenceline is abrupt. I do not know what proportion of current rabbitbrush stands owe their existence to former cultivation. This plant seems to form natural dysclimaxes in disturbed deep soils, so heavy grazing probably has contributed substantially to its spread.

The most persistent and glorious part of the legend of the old Southwest is the stands of stirrup-high grass. It seems fanciful when one looks at the landscape today, but when one considers that the wet summer of 1981 produced many stands of knee-high Blue Grama, stirrups do

not seem very high for the shoots of Alkali Sacaton to reach. Remnant stands of this species show that it can be robust. Montane grasses also attain "mid-grass" stature where conditions are favorable.

While it seems likely that dense stands of grass were more common a century ago than today, it is important to remember that these stands were patchily distributed. Woodhouse (1853) referred to some areas as barren, and while many of his contemporaries noted good grass, there were also areas where grass was only "fair" or even "poor." In the mountains the good grass was concentrated around springs and in valleys. Some of these stands persist, while others have been replaced by rabbitbrush. The vegetation around springs, though closely-cropped in some places, is by and large not degraded.

It is in the lowland valleys that the grass is nearly gone. While fire may be required to keep brush out of grassland, if there is no grass left there is no way to have a grassland. The truly enormous herds maintained throughout our region in the late nineteenth and early twentieth centuries would, I suspect, have been a sufficient force to destroy the grasslands in the valleys of the Puerco, the Zuni, and the San José. The extensive grasslands between Zuni and Ojo Caliente show that fine stands of grass can grow near the elevation of those valleys. Alkali Sacaton is probably the species which dominated those stands. Now the valleys of the Puerco and Bread Springs Wash are dominated by Greasewood. The soils along Bread Springs Wash are not as alkaline as one would expect for a Greasewood stand, and it may be that the species is responding to very fine particle size (W. Fjeseth, pers. comm.). The saltbush stands of the Pescado and San José valleys have not been investigated.

If my identification of Beale's "blue" grass at Bluewater as Western Wheatgrass is correct, this species was capable of growing abundantly at most elevations in our region. Now the most abundant grass at middle and lower elevations is Blue Grama. It is more resistant to grazing than wheatgrass or the montane bunchgrasses and may have spread at their expense. Hanson (1924) found Blue Grama abundant in vast ungrazed grasslands in northeastern Arizona, so it is probably the natural grass in our pinyon-juniper woodlands and on slopes below them, but where it occurs in pine forest it probably replaced bunchgrasses because of grazing pressure (Cooper 1960). Western Wheatgrass, however, is becoming very common in some parts of our region.

Waterways and Springs

Most of the springs recorded in the nineteenth century still flow. Notable exceptions are Ojo del Oso and Ojo del Gallo. Both may owe their demise to the sinking of domestic and other wells in the vicinity.

Deep arroyos are a consistent feature in river valleys in our region. Lockett and Snow (1939) showed photographically changes in landscape along Beale's route between 1857 and 1930. They attributed the changes to overgrazing, probably a correct assessment. Especially illustrative are a photograph of a forty-foot vertical bank on the Puerco in Arizona, where Beale "found no difficulty in getting down without locking a wheel" (Lockett and Snow 1939:12), and a photograph of extensive gullying near South Chaves siding, a few miles east of Thoreau, where Beale mentioned only grama grass (Lockett and Snow 1939:8). McNitt pointed out in a note to his edition of Simpson's journal that Simpson made no reference to difficulty crossing the Puerco, although the banks were, in 1961, 40 feet high where he crossed (Simpson 1964:110). McNitt also noted that Black

Creek, which Simpson described as "a babbling streamlet of excellent water," now runs in a gully eight feet deep (Simpson 1964:108). Arroyos are also common in the mountains, where they seem to have formed from roads (Williams 1967).

Extensive arroyo-cutting, beginning toward the end of the nineteenth century, is documented for the entire Southwest (Leopold 1951, Hastings 1959). While overgrazing must have played a part it is important to remember that cycles of erosion and deposition are natural phenomena. The conclusion of Hastings for southeast Arizona seems the most prudent once: "A distinct possibility exists that secular trends in climate were operating, and operating in such a way as to load the gun in preparation for the pulling of the trigger by overgrazing." (Hastings 1959)

In conclusion it is safe to say that the vegetation and landscape of the Zuni Mountain region have changed considerably in the past 150 years, although opinions may differ as to where and how much. This is much-used, and frequently poorly-used country. But the situation is improving. Land management agencies are, for the most part, following policies designed to open the pine forests, reduce grazing to sustainable levels, and control erosion and stabilize watersheds. These policies may not produce a pristine wilderness, but they deserve the support of the public.

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# APPENDIX

## BEALE'S DESCRIPTION OF EL MORRO VALLEY

(from Beale 1860:36-39)

*March* 21.—Left camp and passing the back bone, on the road we had made, came to Inscription Rock; the road heavy with mud, caused by the frost coming out of the ground; having in my previous exploration described the road to Inscription Rock, shall make no further account of it than to say that grass and wood are abundant, and the spring at the rock unfailing and sufficient.

*March* 22.—Taking Doctors Floyd and Spiller, the Delaware and Little Axe, I started to explore the valley of Inscription Rock. Turning back on our road of yesterday, nearly to the head of the valley, I crossed to the opposite or northern side; following down the north side of the valley, came first to a dry ravine, which, however, has evidently at times much water in it, as the remains of a large Indian encampment proves; going on to the westward close under the mountain, and crossing a sandy piece of ground, for a mile or more, I found another of similar character, and having old Indian signs about it; beyond this, perhaps two miles, discovered a large spring in a grove of small oak; this spring was about forty feet in diameter, a perfect circumference; good solid ground around, even to the edge of the water, and issuing from it a rill of clear sweet water; the spring is seven feet in depth, a thicket of cotton-wood grows just below it and a long line of red willow, of small growth, marks the course of the rivulet which flows from it; Inscription Rock bears by compass SW. by W., distant about eight miles; between this point and the rock the grass is everywhere abundant and the soil good, but stony in parts; at the spring, where we are at present encamped, are several of great size, one of them of over four feet in diameter, and abundance of small oak; leaving our noon camp and crossing a low sandy ridge, we came into a rich sheltered valley; here, fringed with cotton-wood, we found a sparkling fresh flowing brook; it was of a size which in the eastern States would be called a fine trout stream, and was as lovely a spot as one would desire to see, flowing, as it did, over rocks, and making beautiful little cascades of clear bright water; some enormous pines grow in the bottom and much cedar, with a bark resembling white oak in every respect; the distance from the spring to this stream is about two miles NW. and its bearing from the Inscription NE.; remaining awhile at the stream, we pursued our way along the base of the mountain, and crossing the dry bed of what is evidently at times a large stream, we came at nightfall to another dry bed, where we encamped, defering until to-morrow a search up it for water; in the bed of this stream is found *limestone* in abundance, of a grey color and finest quality; in this stone we found innumerable fossils, some of which we took to camp with us; killed a catamount this evening.

*March* 23.—This morning we followed up the dry bed, and in a mile or two found abundant running water. In many places the solid limestone made cañons of twelve to twenty feet in height. Returning at ten, we raised camp and pursued our journey, still keeping the northern side of the valley and the base of the mountain, which is densely covered with pine of largest size, and the valley rapidly becoming green in grass. Leaving camp and pursuing the same course, at the foot of the mountains, about northwest, we came in a mile upon another fine stream, larger than the first. This was fringed, like the

other, with cotton-wood and oak, and in a grove of giant pines, on a little mound, we encamped for noon, Inscription Rock bearing about S. by E. The bottom lands, as well as the hill sides, are of the richest quality of soil. Following down the stream after nooning, we saw on the opposite bank the ruins of an ancient building, which we crossed to examine. We found it larger and more perfect than those on the summit of Inscription Rock. The wall remaining was about ten feet in height, built of stone, all of the same size, and regularly laid. Opposite, in strange contrast with its massive appearance, were some deserted huts, built of mud and twigs, the houses of the present inhabitants of this country. It was ancient and modern Greece. Leaving the stream and pursuing our course, and passing over a soil of incomparable richness, we came at sundown, after travelling about four miles, to another brisk running stream, on which we encamped in large pines at the foot of the mountain. This stream was fringed with small willow, but no cotton-wood on its banks. Inscription Rock bears about S.SE. I killed another catamount this evening.

*March* 24.—This morning, breakfast on wild cat being over, we started to explore the creek to its head. We found much rich copper ore on its banks. About a mile above our camp several rich and pretty pieces of malachite were found. Following up the mountain, we came to a grove of quaking aspen. Above this the stream flowed, almost to its head, over a broad flat rock, which seemed as though it might be the very backbone of the world. We found the stream had three forks. Two we explored to their heads. Both issued out from under the rocks near the summit of the mountain. The right hand fork is the largest, and bursts out of the mountain side a full grown brook, and goes on its way making cascades over the rocks, rushing and sparkling through crevices in fine style. In ascending these forks we found several spots where cat-tail was growing luxuriantly, and which gave unmistakable evidence of living water. The view from the summit was of the grandest description. We found the mountain covered to the summit with lofty pines, and but little snow, scarcely any upon it. Leaving this camp and travelling about five miles, still along the foot of the mountain and over the richest description of soil, we arrived at the largest stream we had yet seen. It would be impossible to do justice to the view from our present camp. Guided by the roar of the water, we followed up the stream a hundred or two yards above our camp, and there found it issuing from the mountain, roaring and boiling, and struggling among the rocks of the cañon. Looking up toward the mountain, up the bed of the stream, nothing could be wilder or more savage. The powerful stream pent up in the narrow, solid rocks, seemed in torture to get free, and was twisted and turned from its arrow-like career at every inch by the rocks which stubbornly opposed it. At times it broke with tremendous bounds in cascades, and at others formed deep whirls and pools of foam, always violent, restless and noisy; the steep sides of the mountain, even to the verge of the cañon, and where there was room within it uncovered with pine, and on all sides, huge rocks and broken trees, with occasional patches of snow. Turning from this scene of savage grandeur, just below and stretching for miles was a quiet, smiling, abundantly fertile valley, through the centre of which the fierce stream above flowed as peacefully as though its waters had never been vexed and tortured by the rocky walls of a cañon. On the opposite side, about five miles off, a high mesa of red and white

sandstone rose perpendicularly, its summit and its base covered with cedar. Altogether it was such a scene as, in all my wanderings, I have never looked upon before. This stream cuts directly across the valley we have been traversing, and enters a cañon on the opposite side. The whole valley through which it flows is as fertile as it is possible for land to become, and timber everywhere abundant. Its course is nearly north and south. Here, also, we found, in a hill on the side of which we encamped, and quite near to where the river comes out of the cañon, rich copper ore. From this point Inscription Rock bears about SE. by S., and distant some eighteen miles.

The climate of this region is most unexceptionable; the days warm, the air pure, the nights cool, without being too cold. The stream is of the size of the Pecos at San Miguel or Anton Chico. Above our camp, some three hundred yards within the cañon, is a natural bridge, over which part of the stream flows in spray, the main body of it passing beneath. It is of wonderful beauty. Above, as far as we explored the stream, it formed a succession of exquisite cascades all the way.

*March* 25.—To day I return to camp, my duties requiring my presence there; I shall cross to the opposite side of the valley, and return by it to Inscription Rock; my exploration has been every way most satisfactory, disclosing, as it has, a country rich in everything that makes the habitation of man prosperous and happy; to New Mexico it is of incalculable importance, and I trust to live to see my labors of the last few days rendered useful by the enterprise of our people, and some day to find flourishing settlements and prosperous communities where our footsteps have trodden, in what is now a wilderness, only known to the wretched Indians who now inhabit it; when I left camp this morning it was my intention to have returned home to the Inscription Rock, but the valley looked so beautiful to the northward that I determined to go to its head; following it up through the same beautiful scenery, we came to the head in about six miles, in a noble pine grove; looking beyond it seemed to droop by rapid descent into a similar country, which I felt every desire to explore, but the want of time prevented; at the head of the valley, about a half a mile, looking towards the north, I found another small spring up a cañon, and near it we stopped to noon and graze our animals on the fine green grass, here from four to six inches high; after nooning we crossed to the opposite side of the valley, and turned homeward under the high bluffs which bound its western extremity; the base and sides of these bluffs, and wherever a foothold is afforded, are covered with cedar and pine, and in places the rock is cut into the most fantastic shapes by the action of the water; travelling along the slopes, and sometimes in the valley bottom, we found the two first streams described to unite and form a large lake of about a mile in circumference; this found its outlet through a cañon, leading towards the Ojo Pescado and Zuñi rivers; where the last-discovered stream empties I cannot conjecture, but think it probable it finds its way underground after, leaving the valley, to the Rio Colorado Chiquito, or perhaps sinks altogether in the intervening sands; keeping our course towards camp, we reached it at nightfall, and immediately prepared for a start in the morning.