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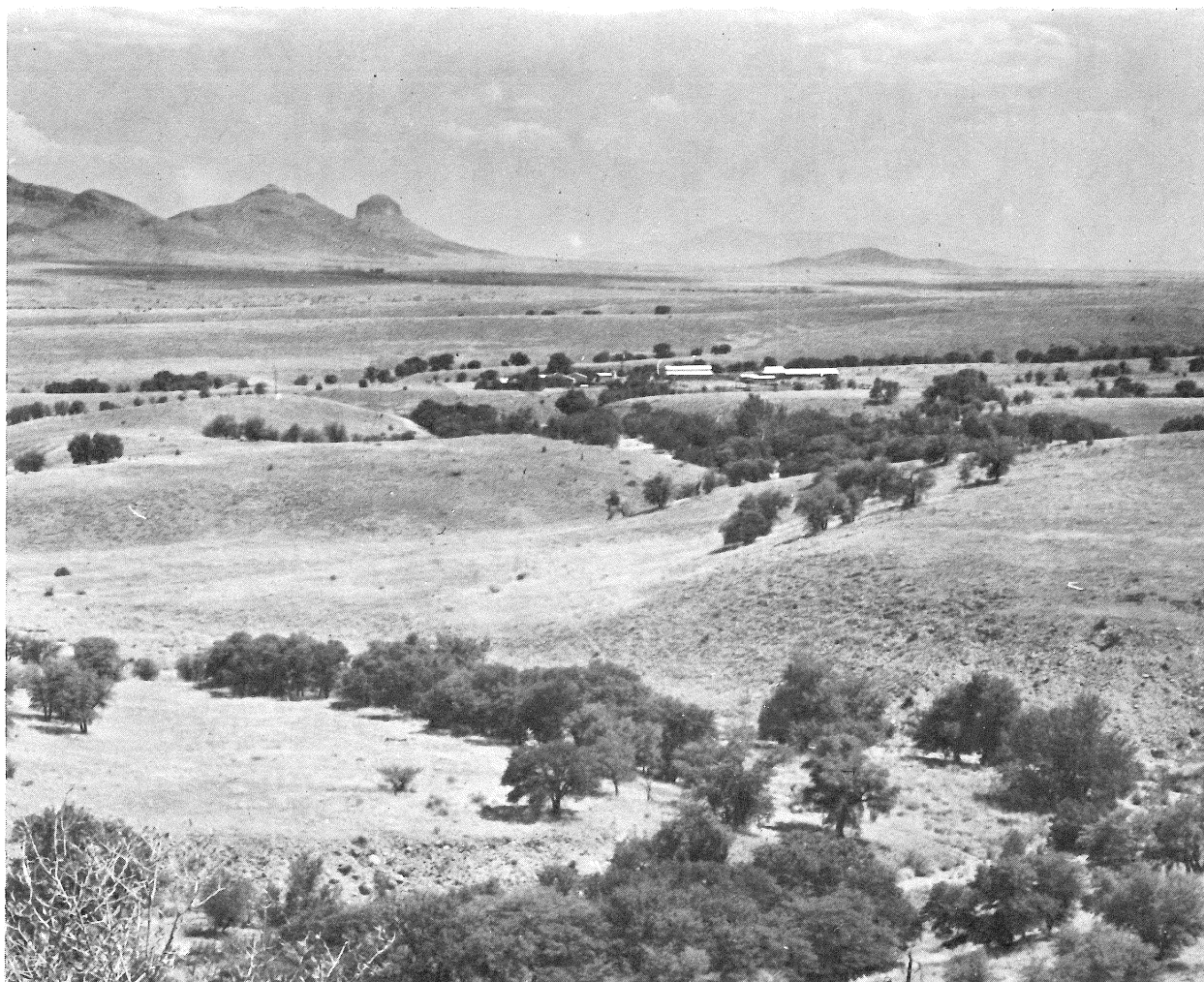
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LAND-USE HISTORY OF THE RESEARCH RANCH, ELGIN, ARIZONA

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PREFACE. — Seeking gold and plunder, they came out of Sinaloa north of the tropics. Exactly where they crossed the 31st parallel, and whether it was on the route leading into the headwaters of the San Pedro River of Arizona is unknown. More importantly, we can be sure that somewhere near the 31st parallel they found the rich grasslands and grassy woodlands of the Sonoran — Arizona Upland. Horses had not known this land for ten millennia. Entering with them, for the first time, were cattle.

Without knowing it, their route took them through country rich in vertebrate fossils. Late Cenozoic lake and alluvial beds along the San Pedro contain bones that imply ownership. For millions of years, southern Arizona, along with much of the West, belonged to ancient camels, horses, and elephants, first the mastodonts and then the mammoth. There were capybara and glyptodonts and later bison and even tapir. Eleven thousand years ago (some claim long before) the first people entered, leaving us a few stone artifacts, provocatively buried in black soils containing the last known bones of mammoth.

Did the explorers seek riches other than gold? Did they dream of ivory? They came much too late for living mammoths and in Arizona even the fossil tusks (unlike those found in the frozen ground of Siberia) are brittle and unsuitable for carving. In some dry tomb the precious ivory might have kept its resiliency, but no mammoth had the foresight to die in a dry cave and let us test this possibility.

So the land they crossed, which once harbored many large and fearsome beasts, was virtually empty when they arrived. Most remarkable of all, in the Arizona grassland there were no bison. From the fossil record of the San Pedro and elsewhere in southern Arizona, we know that bison had been here at one time, at least until 11,000 years ago. After that the record fades. When Coronado entered, it had been a long time since any large mammals had eaten the native grasses — the wispy bush muhly, coarse sacaton, wiry tobosa and, most important of all, the graceful gramas that store protein above ground long after the growing season.

What can we learn from this, and other records of the past? "History is bunk" Henry Ford said, showing that those who make history can also make fun of it. Prehistory, which casts a longer and fainter shadow, entirely escaped him. I hope Conrad Bahre's review of both subjects will guide visitors to Southern Arizona and to the Research Ranch to sense man's role in shaping the land. A geographer, Conrad appreciates the ways in which our knowledge of the past provides a dynamic view of both sides of the present. What would the land of Cochise be like without cattle, barbed wire, or the Forest Service? What might it be like with wildfire, with elephants and camels, or, once again controlled by Native Americans?

Ecologists having more faith in history than Henry Ford must learn what they can. For instance, what

about that famous drought and the record overstocking of the open range at the turn of the century? Old photos like those in Hastings and Turner's *The Changing Mile* show a grassless grassland. As Conrad Bahre reminds us, one of the first botanists at the new University of Arizona, Professor Toumey, complained about the lack of any good range grasses to collect and press for his herbarium.

On the close cropped range, erosion began. Down cutting ruined irrigation along the Santa Cruz. On the San Pedro, the Colorado squawfish and other large native fish went with the topsoil and the natural marshes or cienegas. Led by mesquite, unpalatable shrubs of many species spread across the land.

Few ecologists or range managers would fail to conclude that the land has been abused. The open range belonged to those who "got there fustest with the mostest." They did, and they ruined it, or so many believe.

Prehistory hints at something else. Geologists studying Arizona's floodplains long recognized that the gullies of the historic period were not the first or even the worst. Deep cuts formed and dropped the local water table at intervals long before livestock came and long after the mammoth and other megafauna left. As for starving herds of large animals, they can be seen in any African game park anytime after a series of wet years ending in a drought. Perhaps the only unusual aspect of the massive loss of animals on the upper San Pedro starting in the 1880's was the fact that it was domestic, not wild species that suffered. Perhaps no land was ruined after all.

I don't claim to know the answer. I do like natural springs, undammed streams and especially, those spongy wet marshes of uneroded flood plains, the cienegas. I mourn the dead ones when I see their fine black soil buried in the cut bank of an Arizona arroyo. However, I can't blame all the erosion and loss of cienegas on cattle. After all there must have been great droughts and some mighty trampling of the flood plains in the days of the mammoth and bison.

I do blame cattle for something else. I blame them for the weeds. In the Southwest a weed, I've learned, is anything that cattle won't eat. Any plant that grows in quantity in a heavily stocked pasture must be either bad tasting, bad smelling, full of hallucinogenic alkaloids, or heavily armed, like a cholla cactus. No matter what its other attributes, such a plant, native or alien, will not escape attention. It will be targeted in the extension agent's weed book, which used to be circulated free before printing costs grew excessive.

For what do we need the Research Ranch? Not simply for an enclosure. There are many already on public land in Arizona, many maintained and studied by the U.S. Forest Service. The Nature Conservancy excludes cattle from its fine streamside preserves. Fort Huachuca has been ungrazed for some time. The Research Ranch is

not needed simply as a playground for busy ecologists, although it is an excellent study site for those studying wildfire or niches of sparrows on primary productivity of the grasses themselves.

What is most exciting about the Research Ranch turns on an understanding of history. Cattle have lost not their dominion over the range; they have lost their historic momentum. The idea is spreading that we can do better than simply follow bovine values. Maybe grass is not always that good, and mesquite and groundsel not always that bad. If we consult the past for help in creating the future, other large animals, not cattle

alone, come to mind.

If Coronado's cattle pioneered a new dynasty when they entered the grasslands of the Southwest, the departure of one rancher's herd of cattle portended a new design when cattle were intentionally ushered out. That day, when the munching stopped on the Research Ranch was an historic moment. Suddenly, something else changed. There were no more weeds.

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LAND-USE HISTORY OF THE RESEARCH RANCH, ELGIN, ARIZONA

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INTRODUCTION. — The Research Ranch is a 7,830 acre area of short-grass prairie and oak woodland situated 6 miles south-southeast of Elgin, Arizona (see Maps 1 & 2¹ and Figures 1 & 2). It is located in rolling hills at an average elevation of 4,850 feet and receives an average annual rainfall of 17 inches (Bonham, 1972). Seventy-five percent of this rainfall occurs between July and August and from December through mid March. The Ranch was set aside in 1968 by the Appleton family for ecological research and has not been grazed by cattle or otherwise disturbed by livestock management techniques since late 1967.

Inasmuch as the Research Ranch has been established as a land laboratory on which to assess the impact of man's land-use patterns on the ecology of the region, a land-use history of the Ranch was deemed necessary in order to gain some perspective on the profound influence which man has had on the evolution of the wild landscape of the Ranch. The purpose of this investigation, therefore, is to elucidate some of the various human actions or land-use patterns involved in the evolution of the wild lands of the Ranch and its adjacent environs. Of necessity, this investigation does not confine itself to just the lands of the Research

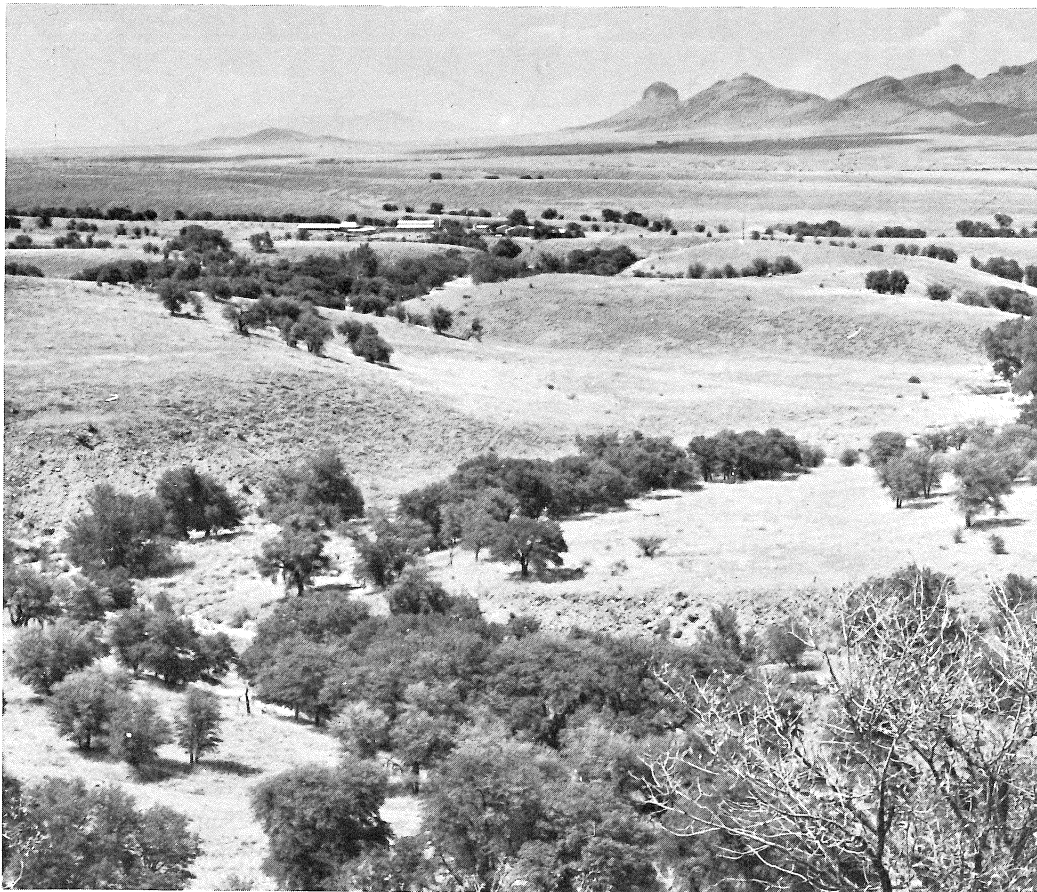
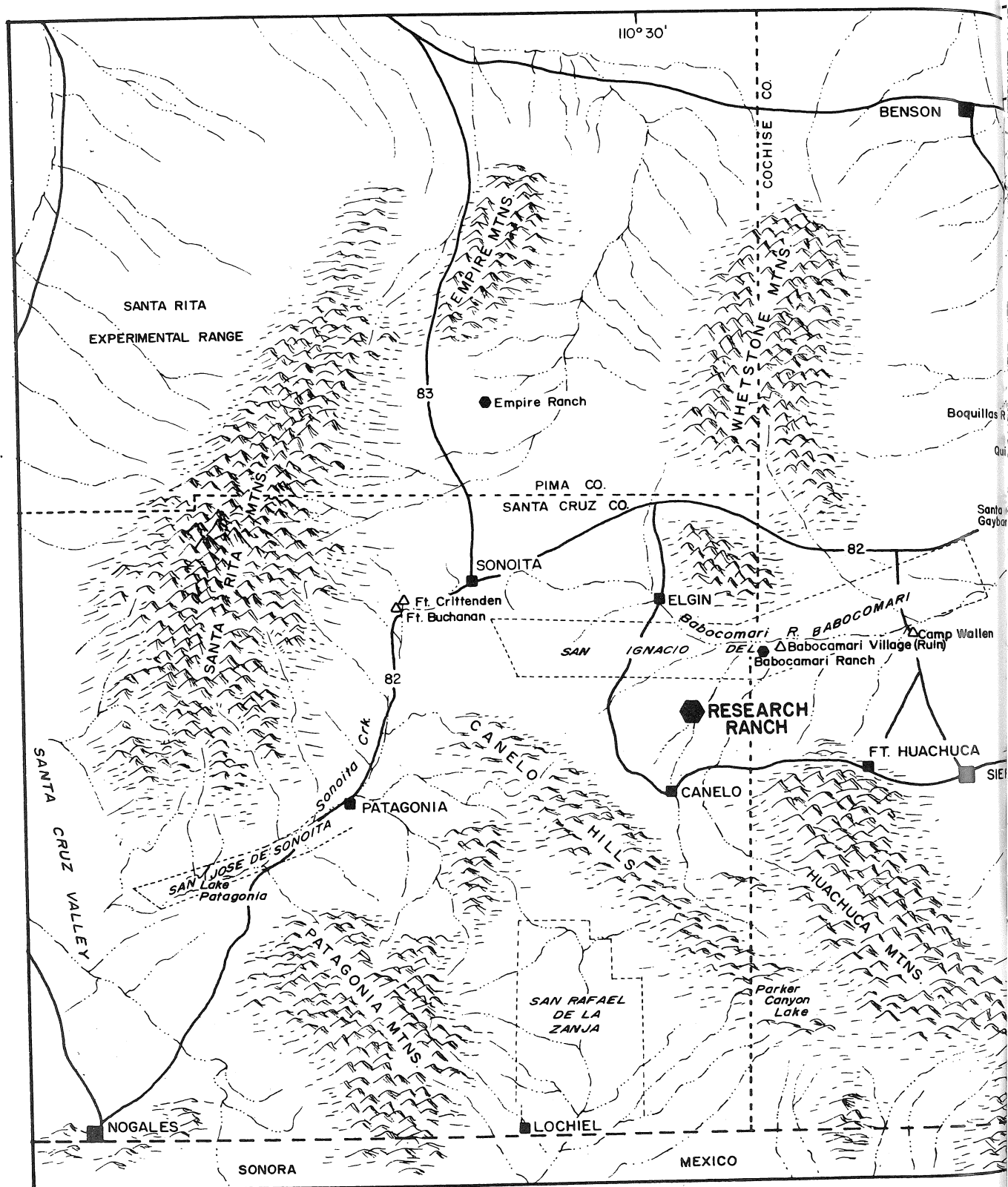
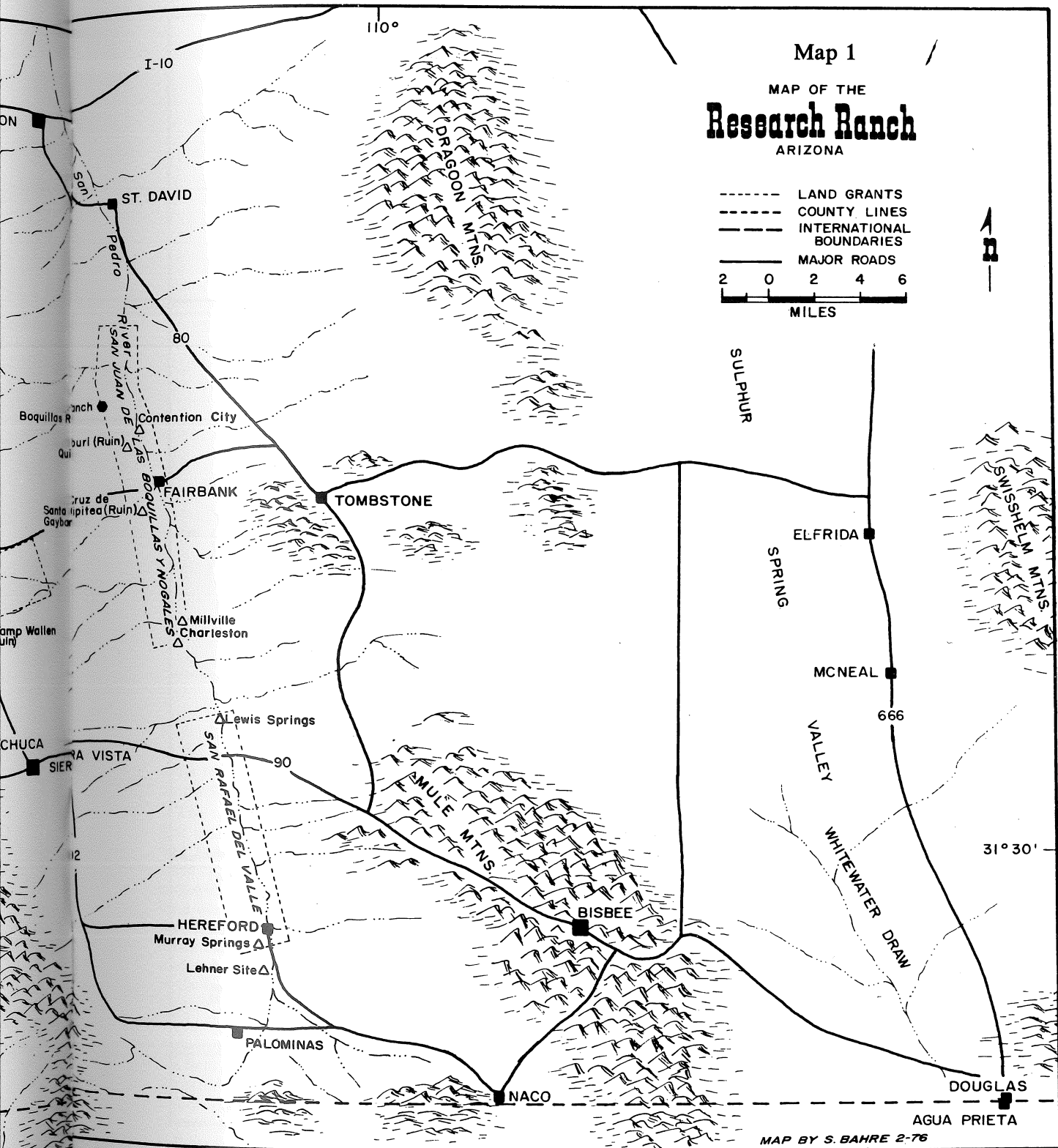
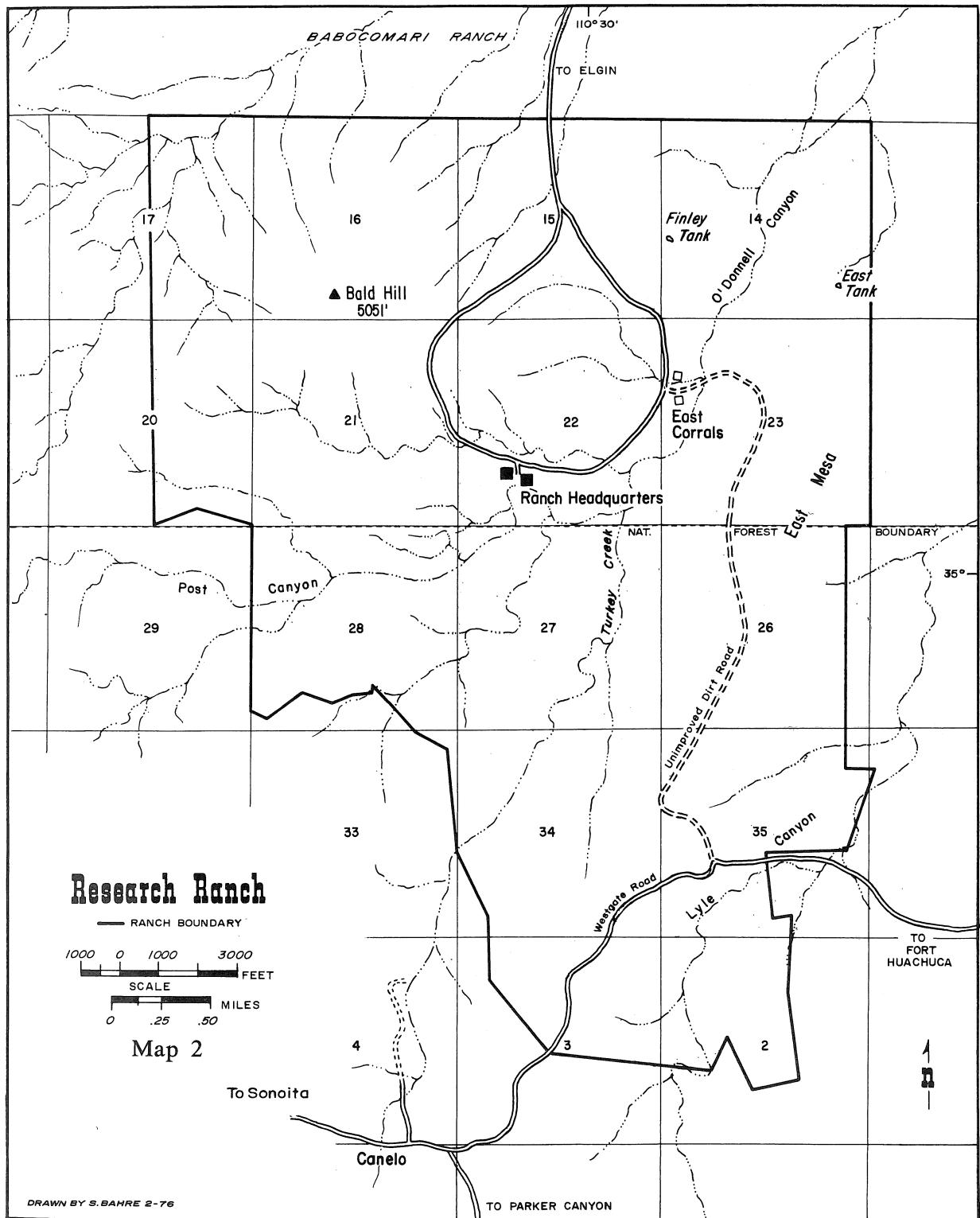


Figure 1. The Research Ranch — Looking north toward Ranch Headquarters.

¹Maps 1 & 2 include place names for Arizona mentioned in the investigation.







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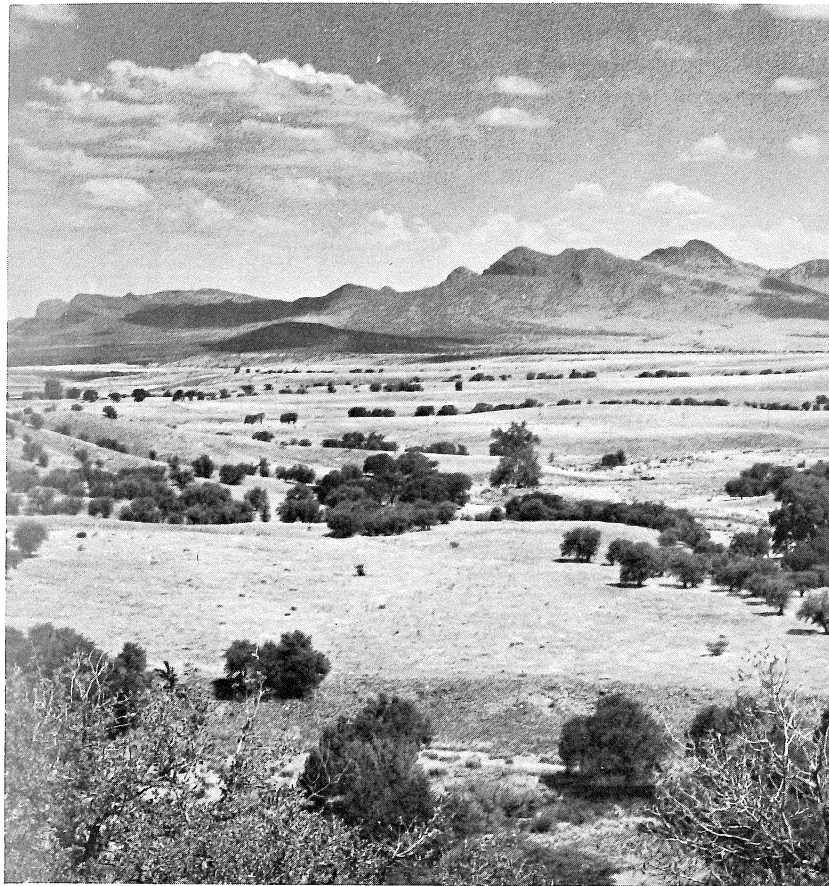


Figure 2. The Research Ranch — Looking northeast toward Babocomari Creek and the Mustang Mountains.

Ranch, but must include the land-use history of much of the upper San Pedro and Babocomari valleys in order to gain a more complete picture of what occurred on the wild lands of the Ranch.

The approach of this investigation is threefold. The first examines the sequence of occupancy in the upper San Pedro and Babocomari since the advent of man some 12,000 years ago and attempts to assess the ecological impact of each culture. The second identifies land-use activities which have affected the evolution of the landscape and examines these activities both historically and ecologically. Finally, the third looks at major changes that have occurred in the wild landscape in the last hundred years or so, and some of the ways to identify and account for these changes.

IMPACT OF PREHISTORIC PEOPLES. —

Although numerous archaeological sites are recorded in the field surveys of the Arizona State Museum and the Amerind Foundation for the upper San Pedro and Babocomari drainages, no sites are noted for the properties included in the Research Ranch. Several potsherds, projectile points, and other artifacts have

been found on the Ranch, however, and Mark Appleton (personal communication) knows the whereabouts of a few sites on the Ranch.

Fortunately, good archaeological data and contact ethnographies are available on the aboriginal inhabitants of the area, and from these data we can gain insights into the aboriginal impact on the wild landscape of the Ranch and its environs. Though man has been in the upper San Pedro Valley at least 12,000 years, we only have written records for the last 280 years of his occupancy. The last 280 years have probably been the most significant in terms of man's modification of the environment, but we cannot assume, as some scientists have, that the prehistoric impact of man on the wild landscape of the upper San Pedro watershed was insignificant, especially if aboriginal hunters were responsible for eliminating the Pleistocene megafauna which once roamed southern Arizona.

No firm chronology of the prehistoric cultures of the upper San Pedro watershed has yet been presented. There are two schools of thought on the prehistoric culture history of the region. The first is exemplified by

the chronology of Gordon R. Willey (1966: 188) presented below, and is the most generally accepted. The second comes from Charles Di Peso (1956:270, 559-68, and personal communication) (see Figure 3).

Figure 3. Comparison of the Chronologies of Willey and Di Peso for the Prehistoric Cultures of the San Pedro River Valley ^a

Willey's Chronology	Di Peso's Chronology
Dates:	Dates:
1690 A.D. Spanish Contact	1690 A.D. Spanish Contact
1400 Hohokam	1250-1300 Ootam Reassertion
1100 Classic Hohokam	900-1000 Hohokam Intrusion
900 Sedentary Hohokam	0-400 Formative Ootam
550 A.D. Colonial Hohokam	5000 B.C. Preceramic Ootam
100 B.C. Pioneer Hohokam	8000(?) Early Hunters and
2000 Cochise San Pedro	5000 B.C. Seed Gatherers
5000 Cochise Chiricahua	
7000 B.C. Cochise Sulphur Spring	
? (Lehner) Paleo-Indian	

^a For more complete review of Hohokam chronology see Bullard (1962: 88-95)

Even though his ideas on the prehistoric culture history of the Southwest are much disputed, I have chosen to follow Di Peso's chronology, since he is undoubtedly the authority on the archaeology of the upper San Pedro and his ideas on the culture history of the Southwest — especially with regards to the Hohokam — are being supported by his exhaustive research at Casas Grandes in northwest Chihuahua, Mexico (1974).

The first peoples to inhabit the Babocomari drainage were the so-called Big Game Hunters. These people appeared in the upper San Pedro basin near the end of the Pleistocene, some 12,000 years ago, when large Pleistocene mammals still survived (Miller, 1958). The Big Game Hunters are best known from their kill sites at Naco (Haury, Antevs, and Lance, 1953) and Lehner (Haury, *et al.*, 1959), where bifacially flaked, lanceolate projectile points and other artifacts of chipped stone related to the tool kit of hunters and skinners are found in conjunction with large Pleistocene animals such as mammoth, bison, tapir, dire wolf, horse, and sloth. Certainly, the entire livelihood of these Big Game Hunters did not center solely on the hunting of large mammals, and wild plant foods must have been significant in their diet (Woodbury, 1959: 83).

Though the glacio-pluvial climate of southeastern Arizona was wetter and cooler than it is today, pollen collected from postglacial alluvial beds at the Naco and Lehner early man sites show that 11,000 years ago the vegetation was similar to today's (Martin, 1963; and

Martin and Mehringer, 1965). In fact, all fossil samples from the Lehner site in the postglacial period represent either a grassland or a "Chihuahua Desert Scrub" type of environment. Moreover, fossils of mollusks found at the Lehner site supply additional evidence for minimal postpluvial changes in the climate and vegetation of the upper San Pedro. These mollusks are found in postglacial alluvial beds dating from about 11,200 years ago and are identical to the mollusks found at the Lehner site presently.

From what little evidence is available on the Big Game Hunters, it appears as though they foraged in the upper San Pedro Valley, moving with the game, and camping along now extinct streams and swamps (ciénegas) in small nuclear family groups. In most of the Southwest the eclipse of the Big Game Hunting tradition began about 8000 B.C. with the extinction of the megafauna; but in southern Arizona the tradition persisted until 5000 B.C. in the Sulphur Spring stage of Cochise culture.

The extinction of the Pleistocene megafauna is equated by some archaeologists and paleontologists with the arrival of the Altithermal, a period of extreme desiccation in the Southwest between 5500 and 2000 B.C. Paul Martin (1967, and 1975) feels that the extinction of the Pleistocene animals had little to do with the Altithermal, however, and that the Big Game Hunters were in the process of wiping out the large Pleistocene herbivores long before the onset of the Altithermal. Martin (1963) further concludes that pollen evidence suggests that the Altithermal was not hot and dry but rather relatively wet, at least in summer.

At any rate, the hunting of megafauna lasted quite late in the Sulphur Spring Valley of southeastern Arizona, and Big Game Hunting camps in the area are contemporaneous with the camps of seed gatherers.

It is difficult to assess the impact of the Big Game Hunters on the environment of the upper San Pedro from the archaeological data now available. Even if Big Game Hunters were not responsible for the extinction of several large herbivores in southeastern Arizona, they at least hastened their extinction. If prehistoric man was responsible for the extinction of the Pleistocene megafauna, his impact on the short-grass prairies of southeastern Arizona would have been substantial because the extinction of the megafauna resulted in the removal of most of the grazing diversity in the short-grass prairies. Paul Martin (1975) maintains that the present prairies could not have evolved without the variety of large animals once found in them.

In the Southwest the Big Game Hunting tradition was replaced by the bearers of the so-called Desert Tradition, which had its beginnings as early as 7000 B.C. in the Great Basin (Jennings and Norbeck, 1955; and Jennings, 1956). The Cochise culture of southern Arizona, which was studied in detail by Sayles and Antevs (1941), is now seen as a manifestation of the Desert Tradition. In the earliest stage of the Cochise sequence — the Sulphur Spring stage — the hunting of large megafauna still persisted (*Ibid.*). In Cochise

culture, however, life was primarily focused on the search for plant foods, and the Cochise peoples — like their predecessors the Big Game Hunters — moved in small nomadic groups, foraging for plants and hunting small game. Their lithic complex shows that they were primarily dependent on vegetal food.

The Sulphur Spring stage of Cochise culture was succeeded around 5000 B.C. by the Chiricahua stage of Cochise culture or, according to Di Peso, the Preceramic Ootam. Di Peso (1956: 479) refers to the Cochise inhabitants of Pimeria Alta as the Preceramic Ootam. Ootam is the name by which the modern Pimas address themselves, and Di Peso believes that these people have inhabited Pimeria Alta since 5000 B.C. and are the remote ancestors of the Pima and Papago. The Preceramic Ootam or Cochise peoples followed the nomadic subsistence patterns of their early Cochise predecessors, living in small bands and moving with the seasons and harvests. It appears that these wild-plant gatherers, like their predecessors, probably had a limited impact on the vegetal resources of the upper San Pedro unless they relied heavily on one or two plant or animal resources. A widely dispersed population using a large variety of wild food plants would probably not cause the extinction of any species, and, indeed, might disperse a weedy species more widely.

Around 2000 B.C. domesticated maize was found in association with the Chiricahua stage of Cochise culture in New Mexico. Squash and bottle gourds were probably also introduced at this time; but as with maize, they were not accepted by the Preceramic Ootam, who continued their traditional nomadic hunting and gathering subsistence patterns (Di Peso, 1956: 479). Domesticated maize is not found in Pimeria Alta until 600 A.D. (Di Peso, personal communication). As Di Peso (1956: 479) points out, however, the absence of domesticated maize in Pimeria Alta "may indicate that the Preceramic Ootam either did not utilize corn, or the evidence has disintegrated due to natural causes or because the people used corn cobs as fuel." The Preceramic Ootam persisted until 600 A.D., when the Formative Ootam period began (Di Peso, personal communication). In general, the Ootam seed gatherers of the upper San Pedro appear to have changed little throughout the period of Cochise culture in the Southwest.

The Formative Ootam period or the Pioneer stage of Hohokam began about 600 A.D. and was marked by several distinct changes: the growth of small clustered villages, the appearance of ceramics, and the cultivation of domesticated plants. Toward the end of the Formative period, agriculture appears to have been fairly well developed, with both maize and cotton important crops; but the food habits of the Formative Ootam, like those of their ancestors, continued to center around hunting and collecting wild plant foods (Di Peso, 1956: 481).

² There is still question whether "Río Nexpa" once referred to the San Pedro or to the western branch of the Río Bavispe (Di Peso, Rinaldo, and Fenner, Vol. 4, 1974: 96-103).

According to Di Peso (1956), about 900 A.D., if not earlier, a group of immigrants known archaeologically as the Hohokam, arrived from Mexico. They entered the Gila and Salt river valleys from the south with a material culture complex recognizably different from that of the Formative Ootam. Di Peso places the Hohokam at a much later date than do most archaeologists, and in contrast to prevailing archaeological opinion denies that the Hohokam were endemic Southwestern cultures developing *in situ* largely as a result of diffusion from Mexico. Di Peso feels that the Hohokam tradition represents an invasion of peoples from Mexico, possibly up the eastern corridors of the Sierra Madre Occidental through Casas Grandes, Mexico, and into southern Arizona.

The Hohokam dominated and settled among the Ootam and transformed their culture with intensive irrigation, more elaborate shell and stone carving, new pottery modes, copper bells, and the ball game. Di Peso (personal communication) contends that this Hohokam invasion was initiated by early Mexican trading guilds, similar to the Aztec *puchteca*, which entered Arizona to trade for *jojoba* (*Simmondsia chinensis*), peyote, and turquoise with the Ootam. The Hohokam introduced extensive maize and cotton farming as well as major river irrigation systems. The Ootam may have lived among the Hohokam in a tributary state. Around 1300, due to massive crop failures, Ootam rebellion, or other unknown causes, the major Hohokam sites were abandoned. Present-day Ootam (Papago) myths tell of how the Hohokam were driven from Pimeria Alta as a result both of crop losses and of taxing the Ootam to the point of rebellion (Di Peso, 1956: 482). These events would account for the abandonment of the Hohokam sites and the existence of the historic "lower" technological level of the Pima and Papago encountered by the Spaniards when they first entered the Gila and Salt river valleys.

The period from 1350 to 1692 in southeastern Arizona is not well understood archaeologically, but it is assumed that the Sobaipuri who inhabited the upper San Pedro and Babocomari rivers when Padre Eusebio Kino and Captain Juan Mateo Manje first visited the area in 1692 were either the modern relatives of the Ootam or possibly a mixture of Ootam and Western Pueblo (Di Peso, personal communication). Some 150 years before the *entrada* of Kino and Manje, the first Spanish *entradas* into Arizona occurred in 1539 and 1540 by Fray Marcos de Niza and Francisco Vázquez de Coronado. Both de Niza and Coronado left very poor accounts of the Indians living along the Río Nexpa, as the San Pedro River was then called.²

Most of what we know about the prehistoric inhabitants of the upper San Pedro and Babocomari drainages between 1000 and 1692 is due largely to the archaeological work of Charles Di Peso in the region. Di Peso has completed excavations at Babocomari Village (1951) on Babocomari Creek, near Babocomari Ranch headquarters; at Quiburi (1953) three miles north of Fairbank on the San Pedro River; and at Santa Cruz de

Gaybanipitea (1953) near the confluence of Babocomari Creek and the San Pedro River. Babocomari Village was called San Joaquín de Baosuca by Padre Eusebio Kino and Captain Juan Manje when they visited the village on November 6, 1697 (Manje, 1954; Di Peso, 1956: 2).

By utilizing early Spanish contact ethnographies and archaeological data, a picture of the subsistence patterns of the Sobaipuri and their impact on the wild landscape of the upper San Pedro watershed may be drawn. The inhabitants of Babocomari Village depended on wild plant gathering, hunting, and horticulture for their subsistence. The same subsistence patterns seem to have held for the prehistoric inhabitants of Quiburi and Santa Cruz de Gaybanipitea. At Babocomari Village, Di Peso (1951: 16) has identified the remains of domesticated maize (*Zea mays*), kidney beans (*Phaseolus vulgaris*), tepary bean (*Phaseolus acutifolius* var. *Latifolius*), pepo pumpkin (*Cucurbita pepo*), cotton (*Gossypium hopti*), peach pits (*Prunus persica*), and English walnuts (*Juglans regia*). Apparently both the peach tree and the English walnut preceded the Spaniards into the Babocomari drainage. Amaranth was also cultivated at Babocomari Village (Di Peso, personal communication).

In general, prehistoric agricultural sites in the area are found around springs and on stream benches or floodplains where simple ditch irrigation could be practiced or where the Indians could take advantage of the periodic flooding of the floodplains. According to Sauer and Brand (1930: 430) the important factor in localizing prehistoric settlements in southeastern Arizona is not local drinking water supply, which may or may not be present, but clay stretches, often indicated by sacaton (*Sporobolus* spp.) and cat's claw (*Acacia greggii*), which enjoy a high frequency of wetting. In general, the Indians irrigated the floodplains and stream benches or farmed on slopes in areas where runoff was concentrated. Dry farming was also practiced, described in Lyle Canyon in 1695 by Captain Juan Fernández de la Fuente, the head of a military company which passed west of the Huachucas through Lyle Canyon in 1695 in pursuit of hostile Apaches (Hidalgo del Parral, 1695).

The bones of several animals have been found in trash pits at Babocomari Village, Quiburi, and Santa Cruz de Gaybanipitea. At Santa Cruz de Gaybanipitea, Di Peso (1963: 236) found the bones of rabbits (*Sylvilagus* sp. and *Lepus* sp.), antelope (*Antilocapra americana*), and deer (*Odocoileus* spp.). Deer (*Odocoileus virginianus couesi* and *O. hemionus*) and antelope (*Antilocapra americana*) are quite abundant in all the sites. In the trash pits of Babocomari Village the bones of blacktail jackrabbits (*Lepus californicus*), muskrats (*Ondatra* sp.), rock squirrels (*Citellus variegatus*), cottontail rabbits (*Sylvilagus* sp.), ducks (*Anas* spp.), hawks (*Buteo* spp.), and eagles (*Aquila* sp.) are common (Di Peso, 1951: 12-14). According to contact ethnographies, the aborigines also ate cotton rats (*Sigmodon* spp.), pocket mice (*Perognathus* spp.),

pocket gophers (*Thomomys bottae*), and pack rats (*Neotoma* spp.). The most complete analysis of wild animal bones found in Ootam trash piles is included in Di Peso's *The Upper Pima of San Cayetano del Tumacacori* (1956). Di Peso has also found what he believes to be bison bones in cooking pits at Babocomari Village that could date from the contact period. These bones have been defined as "bison could be cow" bones, though a scientist at the Frick Laboratory identified them as the bones of a young female bison (Di Peso, 1956: 1). This find — if the bones are finally accepted as those of bison — would verify the existence of bison far west of the Pecos River during the contact period. Paul Johnson (personal communication) believes that bison definitely extended west of the Pecos, possibly as far west as the Colorado River, during historic times. There are no early records or accounts supporting the existence of bison west of the Pecos during the contact period, however. The Coronado expedition in 1540 did not describe bison until they arrived at the Pecos River. Buffalo did occur at Casas Grandes in northwestern Chihuahua Mexico, in the 1680's (Di Peso, personal communication, and Di Peso, Rinaldo, and Fenner, Vol. 8, 1974: 242-321). The San Pedro Valley is far west of Casas Grandes, however, and the existence of buffalo in Arizona as late as historic times is speculative. Johnson believes that bison will eventually be identified in 31 sites west of the Pecos (personal communication). Matters are also complicated by the fact that it is extremely difficult to tell the difference between *Bos* and *Bison* bones unless extremely good horn cores are found. For a fairly complete review of the wild animals eaten by the aborigines of southeastern Arizona one should examine the works of Castetter and Underhill (1935) and Russell (1908).

Fish bones are abundant in the trash pits at Quiburi (Di Peso, 1953: 236). The finding of large fishbones at Quiburi is significant because it points to a quite different stream regime for the San Pedro and Babocomari rivers in prehistoric and early historic times than today, since presently both streams flow only intermittently. The largest caudal vertebrae taken from a trash pit at Quiburi belonged to a Colorado squawfish (*Ptychocheilus lucius*) somewhat under five feet in length (Di Peso, 1953: 236; and Miller, 1961). Presently, the San Pedro River could not maintain a fish of this size. In fact, the stream bed is now usually dry at Quiburi. The only other large fish eaten by the Indians living along the San Pedro and Babocomari was the humpbacker sucker (*Xyrauchen texanus*) which, like the squawfish, is extinct in the region today.

It is strange that peccary (*Pecari tajacu*) bones have not been identified from early prehistoric archaeological sites in the area. Paul Johnson (personal communication) notes that no peccary remains have been identified from any prehistoric sites in Arizona. I have not had time to examine the archaeological record well enough to verify this, but I know that peccary bones have been found in rather late prehistoric levels

in Ramanote Cave in the Santa Cruz Valley (Di Peso, 1956: 476) and that the Pima and Papago presently eat peccary or *jabali*. The lack of peccary remains in early archaeological sites may represent a type of "pig avoidance" that was practiced among the prehistoric inhabitants of Pimería Alta. Padre Ignaz Pfefferkorn (1949: 103) points out in his description of Sonora in the 1760's that:

Swine are not raised in Sonora . . . and no Indian can be induced to do it (act as a swineherd), not because his pride stands in the way, but because of his inherent, implacable hatred for swine. The animal is so abhorrent to him that he would suffer the severest hunger rather than eat a piece of domestic pork.

In the same description, however, Pfefferkorn implies that the Indians ate peccary (*Ibid.*, 112-13). Another explanation for the absence of peccary bones in prehistoric sites is that the peccary, like the coati mundi (*Nasua narica*), may be a recent arrival in Arizona.

Only a few wild plant foods have been identified from archaeological sites in the region. This is understandable because of the perishability of most vegetal foodstuffs. For an excellent review of the wild plant foods of the historic Ootam see Castetter and Underhill (1935) and Russell (1908). Mescal pits are found in many of the sites along the Babocomari and the upper San Pedro, and mescal (*Agave* spp.) appears to have been an important food in the area. The mescal was baked and then eaten. The historic Apaches also relied heavily on mescal in their diet. *Yucca* pods (*Yucca* spp.) and Arizona walnuts (*Juglans major*) were similarly major foodstuffs at Babocomari Village (Di Peso, 1951: 16).

In general, the archaeological record of wild plant foods at Babocomari Village, Quiburi, and Santa Cruz de Gaybanipitea is skimpy; so, to gain some insights into the wild plant foods of the Sobaipuri and their ancestors, I have relied largely on the writings of early chroniclers (Pfefferkorn, 1949; and Nentuig, 1951), the ethnographic works of Castetter and Underhill (1935) and Russell (1908), and the archaeological records of wild plant foods identified for prehistoric Ootam sites in the Santa Cruz Valley (Di Peso, 1956). According to these data, the seeds of sacaton (*Sporobolus wrightii*), pepper grass (*Lepidium* spp.), pigweed (*Chenopodium* spp.), palo verde (*Cercidium* spp.), devil's claw (*Acacia gregii*), and a large number of tubers, bulbs, and cactus fruits were consumed. Di Peso (1956: 462) has also identified the seeds of panic grass (*Panicum fasciculatum*) and native pigweed (*Chenopodium fremontii*) in prehistoric remains at San Cayetano. Acorns must also have been eaten. The *bellota*, or the acorn of the Emory Oak (*Quercus emoryi*), is still an important food among the Apaches and the Sonorans. In fact, the Apaches still have permission to enter the Fort Huachuca Military Reservation to collect *bellotas*. Presently, Apaches come from as far away as the San Carlos and Fort Apache reservations to collect *bellotas*. Sonorans and Mexican-Americans make

flour out of *bellotas* for *atole* and cookies.

The Indians also cut juniper (*Juniperus* spp.) and mesquite (*Prosopis* spp.) for building materials, and beargrass (*Nolina* sp.) for thatch and for weaving *petates* or sleeping mats (Di Peso, 1956: 462). The cutting of trees and shrubs for fuel must have had a considerable impact on tree and shrub growth near sedentary villages. Indeed, Di Peso (personal communication) believes one of the major problems confronting the prehistoric "city" of Casas Grandes in its last days was the lack of nearby fuel.

Estimates of the aboriginal population of Pimería Alta during the period of initial Spanish contact are extremely disparate, and the size of the prehistoric population will probably never be known. Sauer (1935: 32) estimates that there were approximately 2500 Indians in the San Pedro Valley at the time of Spanish contact. Manje (1954) notes some 486 souls at Quiburi in 1697. Unfortunately, no census data were collected in 1539 and 1540 when de Niza and Coronado traveled along the San Pedro River.

By 1697 Old World diseases and the Apaches had greatly reduced the indigenous population of the San Pedro and Babocomari valleys; hence, contact estimates of the aboriginal population of the area are not a very good basis for estimating the prehistoric population. Diseases may have preceded the Spaniards into the area and wiped out large numbers of people. Malaria, which was prevalent until the turn of the present century in the Babocomari and San Pedro drainages, as well as small pox, may have taken a heavy toll on the indigenous population. Internal strife may also have decreased populations in the area. Pfefferkorn (1949: 264-5) notes that frequent wars and disease decimated the population of Sonora. Besides disease and internal strife, the Apaches seriously ravaged the population of the area. In 1529, Nuño de Guzman set up a slaving colony on the Fuerte River in Sinaloa, Mexico, and made raids deep into *tierra incognita* or present Sonora, Mexico, and Arizona (Hodge, 1937: 4; and Sauer and Brand, 1932: 41-51). Slaving operations into the upper San Pedro Valley, if indeed they did occur, would not only have resulted in fighting and loss of life, but also in the removal of population and possibly the introduction of disease. According to Di Peso (personal communication), it is difficult to obtain good population data on the San Pedro Valley during early historic times because the valley represented the western border of rebel peoples: first, the Mansos, Janos, Sumas, and Jocomes; and second, the Apaches. Even though the prehistoric population level of the area may never be correctly known, it was not until the late 19th century that the contact population was surpassed.

It appears that the Apaches arrived in the San Pedro Valley sometime after the Pueblo Revolt in 1680. Traditionally, the Jocomes and Sumas were the enemies of the Sobaipuri, but after 1700 these groups disappeared or were absorbed by the Apaches. During the 16th and 17th centuries, there had been contact

between the Sobaipuri and the Pueblo and Spanish settlements along the Río Grande. Velarde (Wyllis, 1931) states that in 1716 this trade was cut off by Indians (Apaches?) who had moved into the intervening area at an earlier date. By 1698 the pressure from Apaches was so great that the Sobaipuri abandoned Quiburi and moved to Los Reyes de Sonoidag on Sonoita Creek near present-day Patagonia (Bolton, Vol. I, 1948: 233). The Apaches were eventually to drive the Sobaipuri completely out of the upper San Pedro Valley and to hinder all but token white settlement in the area until the 1870's.

The prehistoric use of fire by the Ootam or other Indians of Pimeria Alta for driving game, clearing fields, greening pastures, etc. has not been clearly established either archaeologically or historically. Undoubtedly, camp fires must have escaped and burned uncontrollably, but man-made fires in the area seem to have added little to the natural incidence of burning. Pfefferkorn (1949: 198) notes the use of fire for clearing and the hunting of rodents in Sonora, but the burning of field stubble seems to have been learned from the Spaniards. There are no records of the aborigines intentionally burning the short-grass prairie in the Babocomari and San Pedro drainages, though the assumption of purposeful burning to "green" pastures seems warranted to some. Undoubtedly, there was a certain amount of "recreational" burning. The only Indians inhabiting the upper San Pedro and Babocomari valleys who made wide use of fire in hunting were the Apache. An account of a fire drive by Apaches was noted in 1796 by Don Antonio Cordero (Matson and Schroeder, 1957: 343-44).

The extent to which the prehistoric and early contact aboriginal population of the upper San Pedro and Babocomari drainages influenced the ecological balance of the region cannot be stated with any precision. Our knowledge of the prehistoric inhabitants of the area is incomplete. Prehistoric settlement seems to have been rather sparse, and even after the development of horticulture, amounted to little more than a few scattered villages near springs or along perennial streams. Many scholars minimize the impact of prehistoric peoples on the landscape of southeastern Arizona, but 10,000 years or more of prehistoric man living on the land could not have helped but bring about changes in the composition and structure of the wild vegetation. Hunting may have been indirectly significant in the evolution of the vegetation, especially if it resulted in the extinction of the Pleistocene megafauna. The introduction of agriculture, the clearing of land, the cutting of wood for fuel and construction, the building of irrigation ditches, the selective hunting of wildlife, the use of fire, and the selective gathering and spreading of wild plants undoubtedly resulted in changes in the vegetation cover. The nature and characteristics of these changes, however, are difficult to measure.

Cook (1949) has convincingly pointed out in his study of the Bajío of the Mesa Central of Mexico that

New World aborigines were quite capable of bringing about drastic changes in their environment and of destroying physical resources long before the arrival of the Europeans with their plows and livestock. Numerous studies dealing with the impact of aborigines on the land in the Americas have been completed, and there remains little doubt that prehistoric man played a large role in creating the modern vegetative landscape which we see in much of America. Surely, prehistoric man in the upper San Pedro Valley had the wherewithall to create major changes in the landscape.

THE SPANIARDS. — Probably the first European to contact the aboriginal inhabitants of the upper San Pedro River was the French friar, Fray Marcos de Niza, who, in search of the Seven Cities of Cibola, took possession of the San Pedro River Valley in the name of Spain in May, 1539 (Bandelier, 1890: 147). Carl Sauer (1932) believes Fray Marcos de Niza was a charlatan, however, and that the valley referred to by de Niza was not the San Pedro but the Sonora River Valley. Sauer further concludes that at most Fray Marcos only penetrated a very short distance into the modern state of Arizona before turning south.

Francisco Vasquez de Coronado was the next visitor to the San Pedro river valley. He entered the valley in 1540 on his way to the Seven Cities of Cibola; at that time the San Pedro River was known as the Río Nexpa. The chroniclers with Coronado were not much interested in the Indians of the San Pedro area, however, and consequently left us little information on the aboriginal inhabitants of the valley. Though the Coronado party had large numbers of livestock with them when they entered the San Pedro Valley, none of the livestock were given to the Indians nor did the Indians learn livestock tenure. After Coronado's expedition, there was no further Spanish penetration into southeastern Arizona until 1692 when Padre Eusebio Kino and Captain Juan Mateo Manje visited the Santa Cruz and San Pedro river valleys. Prior to the *entrada* of Kino and Manje, the Sobaipuri had trade relations with the Spanish colonists dwelling in the Río Grande Valley from about 1604 till the outbreak of the Pueblo Revolt in 1680 (Bolton, 1952: 428).

In late 1692 Padre Eusebio Kino visited the Sobaipuri village of Quiburi on the San Pedro River. The San Pedro River was then known as the Río de San José de Terrenate or Río de Quiburi (Bolton, Vol. 1, 1948: 123; and 1936: 269). Kino was to make at least five more visits to the villages of the San Pedro before his death in 1711. He was responsible for setting up *visitas* in the region and introducing Old World livestock and food crops. The Sobaipuri were under great pressure from their enemies living east of the San Pedro River — the Apaches, Jocomes, Sumas, Mansos, and Janos — and by 1698 the Apaches and their allies had managed to push the Sobaipuri out of the upper San Pedro River Valley when the last great Sobaipuri *ranchería* — Quiburi — was abandoned (Bolton, Vol. 1, 1948: 178-81). The Sobaipuri at Quiburi then moved to Los

Reyes de Sonoidag near present-day Patagonia.

From 1698 to 1705 the upper San Pedro River and its tributaries were in the hands of the Apaches and their allies — the Jocomes, Sumas, Janos, and Mansos. Around 1700 the latter were either assimilated or annihilated by the Apaches, because we hear no more about them in the literature. In 1705 with reassurances from the Spaniards, the Sobaipuri returned to resettle Quiburi. There was constant strife with the Apaches, however, and the Sobaipuri never received the missionaries or aid promised them by the Spaniards. After the death of Padre Kino in 1711, the Jesuits did little more in the San Pedro area before their ouster in 1767. Finally, in 1762, the Sobaipuri could no longer hold out against the Apaches, and the last of the Sobaipuri moved out of the San Pedro Valley for Santa Maria Soanca, San Xavier del Bac, and Tucson (Nentuig, 1951: 79). The depredations of the Apaches and other hostiles continued, and in an exaggerated statement in 1762, Padre Nentuig (*Ibid.*, 144) noted that only 24 of 174 settlements (mines, forts, farms, and towns) in Sonora were still inhabited. Finally, in 1767 the Jesuits were expelled from the New World by the King of Spain, and except for a few Spanish and Mexican inroads into the area, the Apaches largely controlled the San Pedro Valley from 1762 until the late 1870's.

With the Apache situation steadily worsening on the northern frontier, the Spaniards decided to move the presidio of Terrenate to the site of Quiburi in 1770 (?), and the new presidio at Quiburi became known as Santa Cruz de Terrenate (Brinckerhoff, 1967: 7; and Gerald, 1968: 16-20). The Spaniards fared no better against the Apaches than the Sobaipuri in attempting to hold the San Pedro Valley and the presidio had to be abandoned in 1775 (?), though reports of a Spanish military contingent at the fort until 1789 persist. By 1786 Visitador General José de Gálvez (Brinckerhoff, 1967: 10) succeeded in pacifying the marauding Apaches by bribing them with a fixed stipend, liquor, and meat. Bribing the Apaches led to a period of relative peace which lasted until Mexican Independence. Mining and ranching once again prospered in Sonora and Pimería Alta.

The Spaniards introduced new institutions and attitudes toward the land, which when blended with aboriginal cultural patterns, served as a basis for a whole new cultural landscape in Sonora and Pimería Alta. The introduction of European technology, systems of land tenure, Old World crops, and domesticated livestock was to lead to vast changes in the wild landscape of most of Sonora and Pimería Alta. The San Pedro Valley, however, was little affected by Spanish settlement during the 17th and 18th centuries because the valley was out of the mainstream of Spanish settlement.

275 years of Spanish rule in the San Pedro Valley seems not to have resulted in many changes in the landscape. The Spaniards brought about drastic changes in the subsistence patterns of the Sobaipuri,

but how these changes affected the landscape is not clear. The Sobaipuri began to experiment with making adobe bricks, metal tools, and raising domestic livestock (cows, pigs, sheep, and chickens). European seed crops made few inroads with the Sobaipuri, however, and the lack of most Old World seed crops as well as wild game bones in contact archaeological materials suggests that Spanish culture had an interesting imprint on the Sobaipuri (Di Peso, 1953: 269-76). The Sobaipuri apparently gave up many of their hunting practices in favor of raising livestock; and although they accepted domesticated livestock, they rejected most European crop plants, apparently preferring their own.

The early Spanish chroniclers left a very poor record of the wild vegetative cover of the upper San Pedro and Babocomari drainages. Captain Juan Fernández de la Fuente, who visited the Babocomari area in September 1695 with the notorious "Flying Company" (a company of mounted troops designed to cope with the raids perpetrated by Apaches and other hostiles in Sonora and Chihuahua), described the west-facing slopes of the Huachuca Mountains as an oak belt and noted that the Babocomari drainage, then referred to as Todos Santos, had large mesquite forests (Hidalgo del Parral, 1695; and Di Peso, personal communication).

The Spaniards undoubtedly hastened the decline of the Sobaipuri through the introduction of Old World diseases. The introduction of domestic livestock must have resulted in overgrazed areas and the establishment of weedy adventives, but the numbers of livestock or *ganado mayor* were too few to have had much impact on the whole region. Bolton's map of Pimería Alta in 1700 (1948) shows more than 100,000 head of cattle on the headwaters of the upper San Pedro and Bavispe rivers, but this figure seems much exaggerated. My suspicions are that there was very little livestock in the upper San Pedro and Babocomari drainages during the Spanish period. By 1762 the upper San Pedro was unpopulated except for a few nomadic Apaches. Excepting occasional Spanish and Mexican inroads before the Gadsden Purchase in 1854, the region was to remain largely a population void or *despoblado* until the late 1870's. Spanish, Mexican, and Anglo mining was insignificant in most of the upper San Pedro Valley and all of the Babocomari drainage until the late 1870's. Prior to 1878, the only placer mining noted on the Babocomari River occurred in 1777 (Bancroft, 1889: 400).

THE MEXICANS. — The truce between the Spaniards and Apaches initiated in the 1790's by José de Gálvez continued through the War of Mexican Independence. Nevertheless, with the end of the War and the overthrow of the Spaniards by the Mexicans in 1821, the bribery of the Apaches ceased and the Apaches started to raid in Pimería Alta and Sonora once again.

Even with the ensuing Apache troubles, however, three large stock-raising land grants were established on

the upper San Pedro and Babocomari drainages in the late 1820's and early 1830's. The largest land grant, the San Ignacio del Babocomari, was made to Ignacio and Dña Eulalia Elias, citizens of Rayón and Arispe, Sonora, Mexico, respectively, on December 25, 1832. The land grant was located along Babocomari Creek and included approximately 35,000 acres (Mattison, 1946: 313). E.B. Perrin bought the grant in 1877 and filed a claim for 128,000 acres in the United States Court of Private Land Claims when the legality of the grant was challenged at the turn of this century. Perrin was finally awarded 33,792 acres. The General Land Office Map of 1887 shows part of the present property of the Research Ranch as being claimed by the San Ignacio del Babocomari (*Ibid.*). The other two large grants in the area were the San Rafael del Valle, which was located on the San Pedro River between Hereford and Charleston, and the San Juan de las Boquillas y Nogales, astride the San Pedro River between Charleston and St. David (*Ibid.*). All of these grants were made for cattle-raising, and the largest grant, the San Ignacio del Babocomari, was reported to have grazed 40,000 cattle (Bartlett, Vol. I, 1854: 396-97). This figure seems absurdly high, however, considering the present carrying-capacity of the land. Nevertheless, the number of cattle in the San Pedro and San Bernardino valleys in the 1840's and 50's was quite high. All of the land grants in the San Pedro area seem to have been abandoned by 1846, if not before, though the Babocomari Ranch may have been inhabited until 1851 (Mattison, 1946: 313).

The movement of large-scale cattle raising into the upper San Pedro and Babocomari drainages during the Mexican period seems to have been the principal cultural impact bearing upon the ecology of the region during the Mexican period. The cattle were principally Andalusian types (longhorns or *criollos*), and the number of cattle and wild horses in the area must have been considerable. When Bartlett (Vol. I, 1854: 257) entered southern Arizona with the U.S.-Mexican Boundary Survey he described the San Bernardino Valley as desolate and covered with cattle trails. Furthermore, near present-day Agua Prieta, he had to use cattle dung for cooking fires because of the lack of firewood in the area (*Ibid.*, 258). Bartlett (*Ibid.*, 398) also noted a party of 30 to 40 Mexicans camped at the confluence of the Babocomari and the San Pedro rivers hunting wild cattle. Apparently, long after the grants were abandoned the Mexicans continued to come into the area to hunt cattle for tallow, hooves, hides, and meat (Wagoner, 1952:28). There are also other accounts which attest to the large number of cattle and horses along the San Pedro River between 1846-1854. Most of these accounts are by people traveling to the gold fields of California. Some of these descriptions are contained in *The Changing Mile* by Hastings and Turner (1965: 34).

Philip St. George Cooke, whose Mormon Battalion passed through the San Pedro Valley in 1846, noted

cattle throughout the area, and the entire battalion dined on beef all along the San Pedro (Bieber, 1938). In fact, at the juncture of the San Pedro and Babocomari they were attacked by a herd of wild cattle (*Ibid.*, 143).

With the abandonment of the large grants, no further human occupancy, other than transient, is recorded for the upper San Pedro river valley in what is presently Arizona until after the area was acquired by the United States in 1854. Though the Apaches had driven the Mexican ranchers out of the area, they apparently had little use for range cattle, preferring instead horses and mules for meat (Wagoner, 1952: 16). By 1860, however, wild cattle had largely disappeared from the area, presumably as a result of Apache depredations. Cattle raising during the early part of the Mexican period was probably extensive enough to weaken the native grass cover, especially in the bottom lands, and thus to create openings for the establishment of weeds. Heavy grazing in certain areas must have contributed to the withdrawal of minerals from the soil, the selective destruction of plant species, the physical destruction of top soil (trampling), the invasion and spreading of weeds, and micro-climatic changes. The extent of these changes is not recorded.

Bartlett (1854, Vol. I; 396-97) has an appropriate description of the Babocomari Valley and Ranch in 1851:

The valley of the Babocomari, is here from a quarter to half a mile in breadth, and covered with a luxuriant growth of grass. The stream which is about 20 feet wide, and in some places two feet deep, winds through this valley with willows and large cottonwood trees growing along its margins. Some of our men followed it about seven miles, to its junction with the San Pedro. This hacienda, as I afterwards learned, was one of the largest cattle establishments in the State of Sonora. The cattle roamed along the entire length of the valley; and at the time it was abandoned, there were not less than 40,000 head of them, besides a large number of horses and mules. The same cause which led to the abandonment of so many other ranchos, haciendas, and villages in the State, had been the ruin of this. The Apaches encroached upon them, drove off their animals and murdered the herdsmen; when the owners, to save the rest, drove them further into the interior, and left the place. Many of the cattle, however, remained and spread themselves over the hills and valleys near; from these numerous herds have sprung, which now range along the entire length of the San Pedro and its tributaries.

In Article V of the Gadsden Treaty (signed at Mexico City on December 30, 1853 and proclaimed June 30, 1854) the United States bought the land between the Gila River and the present international boundary from Mexico, thus ending Mexican ownership of the San Pedro and Babocomari drainages.

THE ANGLO-AMERICANS. — Even though the Gadsden Purchase was concluded in 1854, the initial period of Anglo settlement on the upper San Pedro and Babocomari did not begin until after the American Civil War. For the decade prior to the Gadsden Purchase, however, there exist a score of journals describing the upper San Pedro and Babocomari valleys. The picture painted by these journals of the valleys in the 1840's and '50's shows that grass was plentiful; the landscape was open; cattle abandoned by the grants were abundant; antelope were abundant; the streams were marshy, open, and largely unchanneled; malaria was rampant; and finally, fish and beaver were plentiful. Beaver were reported along the San Pedro by Pool (1935), Ohnesorgen (1929), and Boedecker (1930). Strangely, I have not encountered references to beaver in the San Pedro during the Spanish period. Fish were abundant in both the San Pedro and Babocomari and remained so until the 1880's (Tevis, 1954: 55; and Bieber, 1938: 42).

As has already been pointed out, until the conclusion of the American Civil War, the area remained unsettled, and Cooke (Bieber, 1938), Bartlett (1954), Emory (1857), and Bell (1854), all of whom passed through the upper San Pedro during the period between 1846 to 1860, attest that the valley was devoid of inhabitants. In 1857 Fort Buchanan was established on the headwaters of Sonoita Creek to control Apache raids into the Santa Cruz Valley (Serven, 1965: 27). The Fort, plagued by the malaria common along the Babocomari until the 1880's, was ineffective in halting Apache raids in the area and was abandoned at the outbreak of the Civil War in 1861. From 1861 till the establishment of Camp Wallen, the upper San Pedro and Babocomari were once again in control of the Apaches.

In 1866 Camp Wallen was established on Babocomari Creek near the old Babocomari Ranch headquarters (Brandes, 1960: 73). One year later, in 1867, Camp Crittenden was built near the site of old Fort Buchanan on Sonoita Creek. Camp Crittenden was established to protect settlers in the Babocomari, Sonoita, and Santa Cruz valleys. One of the first Anglo settlers on the Babocomari was Thomas Hughes, who started the Pennsylvania Ranch near Camp Crittenden in 1869. Also in 1869, Col. H. C. Hooker attempted to establish a herd of 4000 cattle on the upper Babocomari, but he, like Hughes and six or seven other families, was driven off by the Apaches. Malaria was very bad; indeed, ague bottles are frequently found in early Anglo sites along the Babocomari. The cattle left behind on the abandoned Mexican land grants were scattered and killed off by the 1860's, possibly by the Apaches (Wagoner, 1952: 27). Camp Wallen was abandoned in 1869 and Camp Crittenden in 1873. By 1873 a number of farmsteads were established along Sonoita and Babocomari creeks, and some lumbering was being carried out in the Santa Ritas (Serven, 1965: 40). However, these settlements, like earlier ones, were somewhat ephemeral because of the Apaches.

In 1877 Fort Huachuca was founded. According to Rogers (1965: 41), the first recorded land claim in the

upper San Pedro was declared by G.W. Belamy in 1875, who described the land as "160 acres with water and ditch situated one-half mile below old Camp Wallen on Babocomari Creek." At that time, and until 1900, land settlement in Arizona was done under the Territorial Land Laws of 1864 which protected squatters rights under "Possessory titles" to 160 acres of surveyed or 320 acres of unsurveyed land. Homestead or Desert Land entries under federal law were seldom used by settlers until a court decision near the close of the 19th century made eventual valification of land claims under territorial law dependent upon meeting requirements of federal land laws (Morrissey, 1950: 153). By 1877 two more land claims were recorded on the Babocomari, but like their predecessors they disappeared from subsequent records. In 1878 a sawmill was established in the Huachuca Mountains to supply firewood and construction materials to Fort Huachuca (Patch, 1956: 1-6). A few head of cattle and some 7000 sheep were reported on the Babocomari seven miles above old Camp Wallen in 1877 (Hinton, 1970: 235). Thus, at the close of 1877 at least four claims had been registered on the Babocomari, in addition to sheep and cattle being grazed in the area. Nearby was the newly established Fort Huachuca with a small garrison and a minor lumbering operation in the mountains.

In August, 1877, Ed Schieffelin, a prospector, located the Tombstone and Graveyard silver claims in the vicinity of present-day Tombstone, and the consequent mining boom was the impetus for a major influx of settlers into the upper San Pedro and Babocomari valleys in the 1880's. The rich silver mines in Tombstone not only gave rise to an overnight population boom in that city but to the "stamp mill towns" along the San Pedro — Charleston, Millville, Boston, Lewis Springs, Contenton City, and Fairbank. Also in 1877, a major copper strike was made at Bisbee. Along with the establishment of Fort Huachuca and the mining booms in Tombstone and Bisbee came another major incentive for the development of mining and the cattle industry in the upper San Pedro — the Southern Pacific Railroad. Indeed, the arrival of the railroad was a decisive factor in the settling of the San Pedro, arriving in Tucson in 1880 and El Paso in 1881. In 1882 a line connecting Benson, Arizona, with Guaymas, Mexico, by way of the San Pedro River, Babocomari Creek, and Nogales, Arizona, was completed (Greever, 1957: 162). This newly opened line, which had Elgin as a stop, was called the New Mexico-Arizona Railway and was operated by Southern Pacific until 1962, when the line was abandoned.

Between 1881 and 1885 the Phelps Dodge Corporation bought most of the mining claims at Bisbee and began large-scale copper production. The railroads brought settlers, facilitated the growth of the cattle industry by offering cheap transportation, and encouraged mining by supplying heretofore lacking cheap fuel and low-cost transportation. Smelting in the Bisbee area was done with wood cut from the Mule Mountains. Woodcutting for domestic fuel needs as well

as for smelting was also done in the Whetstone and Dragoon mountains, supplying Tombstone, Charleston, Contention City, and other river towns (McClintock, 1921: 239). Wood was much needed for the boilers and furnaces at the mill sites along the San Pedro. With the population of the upper San Pedro approaching 6000 in 1885, the need for domestic fuel must have been substantial. For the first time in the history of the upper San Pedro, beginning in the early 1880's, large quantities of firewood and timber were cut for domestic and mining needs. Sawmills were established in the Santa Rita, Huachuca, and Chiricahua mountains. According to the *Arizona Daily Star* (June 24, 1880), three sawmills were operating in the Huachuca Mountains in 1880 (Gird's — west side, established January, 1879; Hayes and Tanner's — east side, established June, 1879; and Turner's — Ramsey Canyon, established April, 1880). Thus, in 1880, there were sawmills cutting timbers for mining and construction purposes in Rucker Canyon in the Chiricahuas, Gardner Canyon in the Santa Ritas, and in Huachuca and Ramsey Canyons in the Huachucas. Until the arrival of the Southern Pacific in 1881, local wood supplies served as the only fuel for the mines. The major smelting operations in the area, however, developed after the arrival of the railroad and relied on coal brought in from New Mexico and Colorado.

Except for Bisbee, which continued to smelt ore with firewood until 1886, the demand for local supplies of firewood for smelting was probably small. The demand for wood for domestic fuel and construction, however, was great. Demand for wood for woodburning stoves lasted until the 1930's in the region. The domestic fuel supply needs were met by cutting firewood from the oak woodlands and pine forests of the upland regions of the upper San Pedro basin. Public lands were heavily cut over and not until 1905, with the creation of national forest preserves in Arizona, was the cutting of green wood on federal public domain stopped. Woodcutting must have been substantial in the upper San Pedro in the early 1880's since the federal government warned land claimants in the area in 1881-1882 that the cutting of wood on land claims other than to clear for cultivation was illegal until the land was patented (Rogers, 1965: 53). In the *Tombstone Daily Nugget* (September 15, 1881), it was noted that settlers were denuding the region by cutting wood to sell in Tombstone, Charleston, and Contention City.

In the 1880's the livestock population of the upper San Pedro and Babocomari was still relatively small. In 1881 Cochise County was established and separated from Pima County. With the danger of Indian depredations greatly reduced and the railroad well-established, the railroad began to advertise for settlers. Soon ranchers from overgrazed areas in Texas, New Mexico, and Sonora began to move their herds into the short-grass prairies of southeastern Arizona. By 1885 over 18,000 cattle were found on the upper San Pedro (Cochise County Tax Roll, 1885). Shortly thereafter, large investment capital poured into Arizona

cattle herds and cattle began to increase beyond expectations. This tremendous increase in the number of cattle took place, however, between 1885 and 1890, a period of almost continuous sub-normal rainfall.

By 1890 the whole upper San Pedro and Babocomari must have been a huge cattle ranch. *The Report of the Governor of Arizona to the Secretary of Interior* (1893) shows 113,974 cattle for Pima County and 83,792 cattle for Cochise County in 1890, and 121,377 cattle for Pima County and 95,850 cattle for Cochise County in 1891. After examining the Cochise County Tax Roles, Rodgers (1965: 65) estimates there were 36,000 head of cattle in the upper San Pedro in 1890, and this figure does not include the Babocomari. One University of Arizona botanist claimed that gross overgrazing combined with sub-normal rainfall had so depleted the ranges that it was difficult to find grass specimens suitable for study. He further stated that during the summer months cattle had to depend on oak and other shrubs for browse (Toumey, 1891). While 1890 was deficient in rainfall, 1891 and 1892 were almost devoid of summer rains. The cattle population continued to rise and finally in 1893 the combined effects of drought and overgrazing led to disaster — an estimated 50 to 75 percent of the cattle died (*Report of the Governor of Arizona to the Secretary of Interior*, 1896: 224-25). The coming of summer rains in 1893 saved the cattle industry from complete ruin, but overgrazing and overstocking were to continue, though at reduced levels, until the enactment of the Taylor Grazing Act of 1934.

Probably no single human activity in the entire history of the upper San Pedro has had such a devastating impact on the ecology of the region or has led to greater changes in the wild landscape in a short period than the livestock industry. An examination of the pictures in *Views of the Monuments and Characteristic Scenes Along the Boundary between the United States and Mexico West of the Río Grande 1892-1895* (International Boundary Commission, 1899) and the pictures in the George Roskrige Collection give one a deep appreciation of the combined effects of droughts and overstocking on the ranges of the upper San Pedro in the 1880's and '90's. In these pictures hundreds of square miles of rangelands are desolated and denuded of their cover. The grasses, even the sacaton in the river bottoms, are grazed to the ground; the hills are covered with cattle trails; and the oaks have browse lines. After the summer rains of 1893, the rangelands were covered with weeds, and for the first time the invasion and/or increase of woody xerophytic shrubs in the rangelands was noted (*Report of the Governor of Arizona to the Secretary of the Interior*, 1893: 23).

The continuous overstocking and overgrazing of the ranges, which began in the 1880's and lasted into the 1930's, has had an enormous impact upon the wild lands of upper San Pedro as well as upon the lands contained within the Research Ranch. Overgrazing has led to vast changes in the diversity and composition of the grass and shrub communities, the invasion of weedy

plants, and the compaction of the soils, and has upset the balance between infiltration and runoff in favor of the latter.

By 1900 the large ranches in the upper San Pedro were acquiring the smaller ranches. In general, settlement was dispersed. Ranches were established near water sources, and the rangelands were grazed in common. Mining collapsed in Tombstone in 1886, and the mill sites along the San Pedro River were abandoned shortly thereafter. In 1899 Santa Cruz County split off from Pima County. Whereas the population had reached 6000 for the upper San Pedro in 1885, by 1900 it had fallen to 1200. By 1900, if not before, the beaver dams were gone along the San Pedro River and the channel of the San Pedro began entrenching (Boedecker, 1930). Malaria also disappeared in the area at this time, as it did in most of the United States.

According to survey notes from the United States General Land Office, the Dragoons, the Mules, the north slopes of the Huachucas, and the southeast slopes of the Whetstones were reported to have been heavily cut over for fuel (U.S. Bureau of Land Management, *Field Notes* 1899-1916). It seems ridiculous that in fifteen years local demands for firewood could have been great enough to result in overcutting these ranges. It is my personal evaluation that the Field Notes of the surveyors for the U.S. General Land Office between 1899-1916 are neither very detailed nor reliable when it comes to descriptions of the wild vegetation, though two good studies on vegetation change in the upper San Pedro have relied on these notes (Woodward, 1969; and Stoiber, 1973). It is reasonable to believe, however, that the Mule Mountains, whose oak and pinon forests were cut for smelter and domestic fuel for a long period, were cut over.

In 1903 the San Ignacio del Babocomari Grant was awarded to Robert Perrin by the United States Court of Private Land Claims and squatters and homesteaders were moved off the Babocomari Ranch. Rangelands were still "open" and there were no fences along the Babocomari. In 1908 the Coronado National Forest was created. The creation of the national Forest prevented the cutting of green wood in much of the forested areas of the upper San Pedro and Babocomari and was the first major attempt by the government to stop ruthless exploitation of the land.

In 1909 the federal government passed the Enlarged Homestead Act which doubled the size of homesteads in arid lands to 320 acres. This increase was still far from realistic considering the carrying-capacity of the land in southeastern Arizona for cattle. The period from 1910 to 1920, however, saw the largest number of registered homesteads in the upper San Pedro subsequent to 1870. Lands within the boundaries of the Research Ranch were not homesteaded until 1916, however. Homesteaders may have claimed land on the Ranch previous to 1916, but their homesteads were never "proved up" or registered in the Santa Cruz County Recorder's Office. Actually, there were few homesteaders in the Elgin area before 1910, and

according to Carrie Fraizer, who homesteaded in Elgin in 1912, there were no fences in the upper Babocomari drainage except along the railroad right-of-way, "north of the railway were the Empire Ranch's cattle and south of the railway were the Rail X Ranch's cattle" (Tape in Museum of Pimería Alta, Nogales, Arizona).

In Carrie Fraizer's day, there were few ranching homesteads in the Elgin area, and most homesteaders were lucky just to have a milk cow and a few chickens. At that time, each homesteader had to plant a certain portion of his land in crops every year for three years in order to "prove up" his claim. Homesteaders in the Elgin area would raise from two to four acres of beans, milo maize, or corn. Pink beans did best, and there was usually a ready market for them. The land did not dry farm well, and those homesteaders without irrigation usually failed to "prove up" their homestead. Much of the land around Ranch headquarters and East Corrals was once farmed, as were areas in the bottom of Lyle Canyon north and south of Westgate Road, but crops never did well in Lyle Canyon and hence no homesteads were registered there. In 1916 the Stock Raising Homestead Act was passed, and a ranching homesteader could file a claim on grazing lands for up to 640 acres (*U.S. Statutes at Large*, Vol. 39: 659).

The patent or privately owned land of the Research Ranch was purchased by the Appleton family between 1959 and 1965. On June 15, 1959, Francis H. Appleton purchased the Clark Ranch (presently Ranch headquarters) from Newell E. Clark, Neppie Clark, and Evla Mae Lemmon, and then on November 1, 1965, Ariel Bryce Appleton received from Harold C. Tovrea the Swinging H. Ranch (presently East Corrals) (*Deeds of Real Estate* — Santa Cruz County Recorder's Office, Nogales, Arizona).

Tovrea and Clark had consolidated their ranches through the purchase of smaller holdings, many of which go back to the original homesteads. The following individuals were the original homesteaders of properties presently included within the Research Ranch:

1) Juan Telles established his homestead claim on September 26, 1919, for lots 1, 2, 3, and 4 in the S1/2 of N1/2 of Sec. 15, T21S, R18E.

2) William T. Roath established his homestead claim on February 19, 1925, for the S1/2 of Sec. 23, T21S, R18E.

3) Thadeous B. Titus consummated for H.E.S. No. 285 his metes and bounds claim embracing portions of Sec. 22 & 27, T21S, R18E, on April 13, 1923.

4) Rob R. McGregor established his homestead claim on June 20, 1935, for SE 1/4 of S1/2 of NW 1/4 and SW 1/4 of NE 1/4 of Sec. 23, T21S, R18E.

5) James L. Finley claimed his homestead on May 3, 1921, S1/2 of NW 1/4 & SW 1/4 of NE 1/4 & 1/2 of SW 1/4 and NW 1/4 of SE 1/4 and lots 2 & 3 in Sec. 14 in T21S, R18E, also received lot 4 Sec. 14 & NE 1/4 of SE 1/4 of Sec. 15, T21S, R18E.

6) Francis C. Fenderson homesteaded on May 19, 1916, the following land: E1/2 Sec. 22 in T21S, R18E.

7) Francis C. Fenderson homesteaded on July 8, 1921, the following land: Lots 6 & 7 of N 1/2 of SE 1/4 and NE 1/4 of Sec. 22, T21S, R18E. These claims can also be located on a plat map ("Plat for Township 21S, Range 18E, Santa Cruz County, Arizona, "United States Land Office of Patents Plat). Undoubtedly, a number of other homesteads were attempted on land that is presently Research Ranch property, and at earlier dates than those listed above, particularly in Lyle Canyon, but these claims were never "proved up."

By 1920 there were almost twice as many homesteads in the upper San Pedro as there were in 1910 (Rogers, 1965: 104). With the increased acreage allowance for homesteads after 1909 and the resultant influx of settlers, it was necessary to increase the size of landholdings to insure availability of more desirable grazing lands. The result was the abandonment of the smaller ranches in favor of the larger holdings. With the passage of the Taylor Grazing Act in 1934 all land in the upper San Pedro not in private hands became available for lease. The Taylor Grazing Act was designed to stop injury to public lands by preventing overgrazing and the consequent soil and watershed deterioration, as well as to stabilize the livestock industry dependent upon public range. In order to achieve these goals, grazing districts were established and grazing permits for the districts were issued. The leasees had to make improvements on the lands, such as drilling wells, maintaining fences, and practicing rotational grazing in order to keep their leases. Actually, the Forest Service, in their efforts to improve public grazing land, induced a whole set of changes in the wild landscape. They have initiated contour plowing, exotic grass introduction, brush conversion programs, predator poisoning, soil conservation projects, fire suppression, and a host of other activities designed to "protect" the watershed and improve the grazing industry.

Presently, the Research Ranch embraces 2,275 acres of national forest land, 2,350 acres of state land and 3,215 acres of private land. All of the land has been heavily disturbed by overgrazing. National forest lands on the Ranch are referred to as the "Chuney Allotment," and, in general, they are the least disturbed lands on the Ranch in terms of grazing. When the "Chuney Allotment" was analyzed by the Forest Service in 1956, however, (Permittee Plan, Range Condition, and Trend Survey — Chuney Allotment — Coronado National Forest, Sierra Vista, Arizona), the range was noted to be in generally poor to fair condition. According to the survey, most of Section 27 was rated as being in very poor range condition, while Sections 26, 34, and parts of Sections 2 and 3 were rated fair.

As this brief history demonstrates, the wild lands of the upper San Pedro and Babocomari have been heavily influenced by man and his activities. The Research Ranch has been exposed to at least 75 years of heavy livestock stocking and overgrazing as well as to a

land management mentality geared almost solely to improving livestock production or to structuring the wild landscape in ways most beneficial to the production of livestock. This attitude includes among other things, watershed improvement, game management, fencing, rotational grazing, fire suppression, brush conversion, reseeding, introduction of exotic forage plants, chaining of mesquite and oaks, contour plowing, the construction of check and spreader dams, predator and rodent control programs, controlled burning, weed removal, and a host of other activities, all of which affect the ecology of the region. As a consequence, the wild lands of the upper San Pedro and Babocomari drainages, especially within the national forest, are managed lands, manipulated for aesthetic as well as economic reasons. I am not criticizing these land management programs, but I am attempting to point out that they manifestly increase landscape changes. To a large extent the Forest Service serves as the innovation center from which land management and land-use programs in the upper San Pedro and Babocomari diffuse.

WOODCUTTING. — Except in a few areas, woodcutting seems to have had an insignificant impact on the wild vegetation of the upper San Pedro and Babocomari. Woodcutting by the aboriginal inhabitants of the region for construction and fuel seems to have little effect on the landscape, though shrubs and trees close to the villages may have been eliminated. Indeed, the availability of fuel for the aborigines who did not have beasts of burden must have been a significant factor in locating their villages.

The only significant amount of woodcutting to take place in the upper San Pedro during historic times began in the 1880's with the demands of mining and the booming population of Tombstone and Bisbee for construction wood and fuel. Wood was essential at that time for smelting and domestic fuel needs. Mexican labor was used to cut large amounts of firewood in the Mule Mountains for the smelters at Bisbee. Oak (*Quercus* spp.), juniper (*Juniperus* spp.) and manzanita (*Arctostaphylos* spp.) seem to have been the preferred woods for smelting and domestic fuels, and consequently were cut first. Juniper was also used for mine timbers because it resists rot well. As supplies of wood dwindled in the Mule Mountains, Mexican woodcutters headed for the Dragoons and Chiricahuas in search of wood.

According to some authors (Toles, 1964: 24-25; Douglas, 1923; and Langton, 1940: 86), the periodic floods which occurred in Bisbee after 1882 were due largely, if not entirely, to the denudation of the surrounding hills for firewood. Finally, after Bisbee's terrible flood of 1886, Copper Queen officials decided to seek a new source of fuel, and with the completion of the railroad to Bisbee shortly thereafter, coal was brought in from mines in Trinidad, Colorado, and Cardiff, New Mexico (Langton, 1940: 86). For all practical purposes, the importation of coal to Bisbee ended the cutting of wood for smelter fuel in southeastern Arizona.

In general, smelting with firewood in Arizona was restricted, and most of the major smelting operations developed after the arrival of the railroads and cheap coke. Prior to 1877 there was no significant mining in the upper San Pedro or Babocomari. Besides Bisbee the only other major smelting operation in the 1880's which relied heavily on firewood for smelting in southeastern Arizona was at the Longfellow mines in Clifton. Here, oak and mesquite were made into charcoal before being used as smelter fuel. According to *The Arizona Enterprise* (Vol. IV, No. 274, July 31, 1878: 304), the Longfellow mines were deliberating whether or not to employ Chinese laborers to do work neither Mexicans nor whites would do — namely, to make charcoal out of the oak and mesquite in mountain gorges and carry the charcoal out on their backs to points where it could be shipped to the mines. Firewood was also used to run the stamps and steam engines at the millsites on the San Pedro River. This wood was cut from mesquite forests along the river as well as from the oak woodlands in the Whetstones, Dragoons, and Huachucas.

The cutting of trees and shrubs for smelter fuel in such a vast area as the upper San Pedro Valley for five or six years could not have had much of an impact on regional forests, though woodcutting did denude the Mule Mountains. Woodcutting for domestic fuel needs probably had the greatest impact on the lower fringes of the oak woodlands and on the mesquite thickets along the rivers. Woodcutting was most extensive on public lands, and it was not until the establishment of national forest preserves in Arizona in 1905 that the cutting of green wood on forest lands was stopped. Agricultural clearing in the 1880's and '90's was minimal and usually occurred in riparian areas. Presently, however, the clearing of mesquite along the San Pedro River for fields, and grassland conversion is quite extensive. The chaining of oaks for grassland conversion has also occurred.

In the early 1900's thousands of juniper were cut for fence posts. Di Peso (personal communication) has heard that most of the junipers in Texas Canyon were cut out by "cedar choppers" for fence posts during the Depression.³ Stone Collie (personal communication), a fencepost cutter and homesteader in the Elgin area in 1910, had crews of Mexican woodcutters working for him in the Canelo Hills cutting juniper posts and firewood. The firewood was sent to Tombstone and Bisbee. Post Canyon, which passes through the Research Ranch, received its name from the thousands of juniper posts cut there. Collie claims that only dead juniper were cut because green juniper would rot; besides, it was against Forest Service regulations to cut live trees. Oaks are apparently useless for fence posts because they rot too fast. Mesquite and desert willow (*Chilopsis linearis*) make good fence posts, but these

³ Fred Gehlbach (personal communication) doubts this juniper-cutting hypothesis because he cannot find the juniper stumps to verify it. He suspects that juniper stumps would last at least fifty or more years in the arid climate of southeastern Arizona.

were apparently never very abundant in the Elgin area. With the advent of metal fence posts, the juniper fence post industry ceased, though juniper fence posts are still cut in the upper San Pedro in Mexico. According to Collie (*Ibid.*), a number of homesteaders in the Elgin area cut wood during the 1910's and '20's to sell, but most of the wood was deadwood collected on national forest lands.

Part of the contrast one notices along the international border between the United States and Mexico in the region is the greater paucity of trees and the almost total lack of deadfall and woody litter on the Mexican side. This is the result of the present dependence of Mexicans on firewood for heating and cooking. Even though the oaks are protected by governmental regulations in Sonora, Mexico, nearly every unprotected tree and woody shrub worthwhile for burning has been removed. Presently, Mexican nationals cross into Arizona to collect firewood in the Coronado National Forest. They obtain collecting permits and are allowed only to collect deadfall or cut dead wood. Mexicans used to cross the border and cut cotton wood (*Populus fremontii*), desert willow, and willow (*Salix* spp.) along the San Pedro and Babocomari for charcoal to make burnt adobe or bricks. In fact, during the 1880's and '90's, cottonwood and willow were removed from riparian areas in the region to make charcoal for kilning bricks. This may account for the paucity of cottonwoods and willows in the pictures of the San Pedro and its tributaries in the late 1880's and '90's.

Charcoal also was made in the Huachucas — Turkey Creek, Coal Pit Canyon, and Corn Canyon. The making of charcoal along the Babocomari was insignificant, however.

Mesquite is also cut for fence posts and is usually heat treated before being used. In Mexico mesquite posts are supposedly cut during the harvest moon because they will have less water and last longer in the ground. Whereas mesquite is usually considered a weed in Arizona, in Sonora, Mexico, it is considered beneficial because it is in great demand as firewood. Mexican-Americans apparently once used manzanita (referred to as squaw wood) for cooking and heating because it makes a hot fire, but it is doubtful if the collecting of manzanita had much effect on the *Arctostaphylos* population of the Babocomari drainage.

Woodcutting appears to have had little impact on the Research Ranch, though some juniper — especially in Post Canyon — were cut for fence posts. Oaks were undoubtedly cut on Ranch land in the past for domestic fuel, and some riparian areas may have been cleared for agriculture.

FIRE. — Though there is no historical evidence for continuous extensive fires in southeastern Arizona, both natural and man-caused fires have been a characteristic feature of the short-grass prairie (especially, before the introduction of livestock). There is substantial evidence of man's role in maintaining so called fire-climax prairies and savannas throughout the world, but it

appears as though fire may not be as ecologically important in maintaining the short-grass prairies of Arizona. Hastings and Turner (1965) have compiled a list of 22 early travel journals for southern Arizona, and these accounts provide no evidence for frequent fires in the whole region, let alone for the desert grasslands. Nevertheless, Humphrey (1958) believes that the desert grassland or short-grass prairie is a fire-caused sub-climax rather than a climatically induced climax. Whatever the role of fire and climate in the evolution of the short-grass prairie of Arizona, fires have occurred in the Arizona grasslands throughout history.

Lightning-caused fires have undoubtedly occurred since time immemorial, and man-made fires have surely occurred since the advent of man in the region; only the frequency and extensiveness of these fires are uncertain. Purposely set fires are rarely noted in the historical record, and of the historic Indians, only the Apaches used fire for hunting. There is no evidence that the Sobaipuri used fire for either hunting or clearing. Surely, escaping campfires and so-called "recreational burning" must have led to vast prairie fires during the aboriginal period in southeastern Arizona. The introduction of livestock resulted in the suppression of range fires, especially in the late 19th century, because the overgrazed prairies would have had a much diminished fire-carrying capacity.

Natural or lightning fires are frequent throughout the upper San Pedro and Babocomari, especially in the mountains and during the summer convective storms. Though the incidence of fires in the prairies of southeastern Arizona appears to have decreased since the introduction of domestic livestock, the coniferous forests, oak woodlands, and chaparral communities of the mountainous areas have had more serious and intensive fires because of the National Forest Service's policy of fire suppression, which has led to biomass buildup and to more intense and more devastating fires than ever before. Fire information has been recorded for the Coronado National Forest since 1908, but unfortunately these records have been sent to the Forest Service Record Center in St. Louis, and were not available to the author. A gleaning of Forest Service fire records should enable one to construct a highly detailed fire map of the Forest lands in the area.

There are many adherents to the thesis that fires were once abundant enough in the ranges of the Southwest to suppress the growth of weedy shrubs, and that as a consequence of fire suppression, mesquite and other weedy, shrubby xerophytes are invading the grasslands of the Southwest. It has been demonstrated repeatedly, however, that grass fires will not kill mature mesquite, only seedlings (Cable, 1967). Once the mesquite is past the seedling stage (1 or 2 years), it is safe from grass fire even if the top wood is killed, because the stem buds are usually deep enough underground to survive. Therefore, in order to hold a population of mesquite in check with fire, if not kill it back, an area would have to be burned at least every other year or every three years. Usually grass fires do

not get hot enough to affect the dormant seed buds on a mature mesquite or even injure the larger trees. In fact, some investigators believe a burn actually encourages mesquite fruiting. In any case fire's impact on mesquite and white thorn (*Acacia constricta*) increases and/or invasions in the Southwest is not completely understood; it is even doubtful that fire or the suppression of fire has anything to do with the increase of mesquite in Southwestern ranges today.

Ranchers have seldom burned range grasses to improve grazing, though areas of galleta (*Hilaria rigida*), tobosa (*Hilaria mutica*) and sacaton (*Sporobolus* spp.) have been burned frequently to "green" pastures. The burning of overgrazed ranges may be quite destructive since livestock will literally graze greening plants "into the ground" after a burn because of the palatability of such stimulated grass. Once these grasses mature they become dry and unpalatable. The ranchers then burn them so the cattle can eat the green shoots. One rancher also stated that oak thickets used to be burned in order to obtain more grass.

Fires occur on the Research Ranch, and since all cattle were removed the buildup of dead grass has resulted in greater fire potential. Four major fires have occurred on the Ranch since February, 1974. The first two fires (in February, 1974, at Westgate, and in April, 1974, at East Corrals) were man-caused and encompassed some 300 acres each. Drs. Jane and Carl Bock are currently studying these two burns in an effort to measure the impact of fire on the vegetation, birds, and mammals of the Ranch. According to their assistant, Rob McKnight (personal communication), no evidence has been found in the study so far to indicate that fire improves grass production, causes changes in species diversity, lessens seed drop, or results in much change at all in the grasslands of the Ranch.

The last two fires occurred in the summer of 1975. One was started by lightning on May 15 and burned 350 acres of sacaton near Finley Tank, while the other, which was apparently man-caused, started near the dam in O'Donnell Canyon on June 16 and burnt east towards Fort Huachuca, consuming 750 acres.

Numerous depositional strata of ash and charcoal can be seen on the Ranch in the exposed sides of the entrenched stream channel in O'Donnell Canyon. Also, many of the oaks show fire scars, and in some cases where the top wood of the oaks has been killed by fire, the oaks have stump sprouted. Even though written historical evidence for frequent, extensive fires in southeastern Arizona is lacking, fire, whether natural or man-caused, appears to have had a long impact on the short-grass prairie of the upper San Pedro and Babocomari. The Ranch has had frequent fires throughout its history and fire seems to have been a part of the evolution of the wild lands of the Ranch. One only has to walk around the Ranch to see evidence of past fires.

Presently, the Research Ranch's neighbors are concerned that the Ranch will be a fire hazard due to the dead grass buildup. Since the Ranch is surrounded

by rangelands having lower fire-carrying capacity than itself, one might suspect that the incidence of natural fire on the Ranch will be lower than it would have been in the past when dense grass covered the whole Babocomari drainage and grass fires must have burned thousands of acres.

Man appears to have changed the ecological role of fire in the short-grass prairie of southern Arizona by (1) introducing domestic livestock which have led to decreased grass cover and the reduced fire-carrying capacity of the prairies, and (2) purposeful fire prevention and exclusion. The chaparral and forested areas of the Babocomari, however, seem to have suffered from more devastating fires because of fire suppression and lumbering.

MINING. — Outside of the tremendous boost given settlement in the upper San Pedro Valley by the mining booms in Tombstone and Bisbee in the 1880's, mining has had no direct impact on the wild lands of the Elgin area. Nearly every mine in the upper San Pedro is post 1878. The Research Ranch has been relatively free of mining activity, although one mine shaft and two test holes are found south of Westgate Road in Lyle Canyon. According to local ranchers, there was a camp named Evan's Camp or Evansville near the mine in 1910 (?). Evansville apparently had a school in 1912, which was closed and moved to Canelo in 1913 (Buster Pyeatt, personal communication). The Anderson and Manila mines on the northwest slopes of the Huachucas were the only mines worked within a seven mile radius of the Ranch.

MEDICINAL PLANT COLLECTING. — A large number of plants have been collected traditionally in the upper San Pedro and Babocomari valleys for medicinal purposes, especially by the Mexican-American populace. I thought that the best information on medicinal plants might be gathered on the Mexican side of the upper San Pedro because *curanderos* or herbalists are still important in Mexico. Most Mexicans interviewed, however, were displaced *ejidatarios* who knew little about the endemic wild vegetation or local medicinal plants, or who were too embarrassed to admit that they used a *curandero* or practiced wild plant cures at home. In general, Mexicans interviewed said they were wealthy enough to get "modern" medicine. Nevertheless, a small collection of medicinal plants was made.

The tradition of using medicinal plants in the Southwest goes back to the aboriginal period, and the contemporary pharmacopoeia of medicinal plants exhibits a blending of aboriginally used endemics, cosmopolitans, and Old World adventives. For fine descriptions of the medicinal plants used in Sonora and Pimeria Alta in the 1760's see Pfefferkorn (1949: 60-78) and Nentuig (1951: 43-52).

Some medicinal plants which are still collected in the upper San Pedro by Mexican and Anglo-Americans are *chuchupate* (*Ligusticum porteri*), pasmo (*Baccharis pteronioides*), *yierba de vibora* or snakeweed (*Gutierrezia sarothrae*), Mormon tea (*Ephedra* spp.) and

toronjil morado (*Marrubium vulgare*). Pasma is especially sought after by both Mexican and American ranchers as a liniment for wire cuts on horses and cattle. Prickly pear pads (*Opuntia* spp.) are still used as poultices, and a number of other wild plants are used for their purgative powers.

The collecting of wild plants for medicinal purposes has had little or no impact on Ranch lands. Indeed, since the vast majority of medicinal plants are weedy adventives and grow in disturbed areas, their abundance is indicative of landscape degradation. In no part of the upper San Pedro has the collecting of medicinal plants led to the depletion of a plant species.

WILD PLANT COLLECTING FOR FOOD, CONSTRUCTION, AND INDUSTRY. — Wild plant collecting was particularly important to the prehistoric inhabitants of the upper San Pedro and Babocomari, as has already been pointed out in this investigation. For a review of the aboriginal use of wild plants for food, clothing, and construction in the region see Nentuig (1951), Pfefferkorn (1949), Di Peso (1951, 1953, and 1956), Castetter and Underhill (1935), and Russell (1908).

Many of the wild plants used for food by the aborigines are still gathered by the present inhabitants of the upper San Pedro. The Mexican-Americans in particular have remained close to the land, and wild plant collecting, especially for foodstuffs, is an important part of their cultural heritage. Indeed, the use of many indigenous plants in the diet of Mexican-Americans and Sonorans is based on aboriginal uses. *Quelites* (cooked amaranth greens), *verdolagas* (cooked greens of some members of the Purslane Family) and *bledo* (the seeds of amaranth) are still widely eaten by the Sonorans and Mexican-Americans. Both *verdolagas* and *quelites* are eaten as dinner greens, as are dandelions (*Taraxacum officinale*). *Bellotas*, the acorns of *Quercus emoryi*, are also much esteemed, especially by the Apaches. Mexican nationals have crossed the border for years to collect *bellotas* in the Canelo Hills. According to Buster Pyeatt (personal communication), until the 1940's Mexicans used to set up bellota camps in the Canelo Hills and collect *bellotas* to take back across the border to sell. Presently, the Apaches from the Fort Apache and San Carlos reservations have rights to collect *bellotas* on Fort Huachuca. Cactus fruit (*tunas*) are also eaten, as are the pads (*nopales*) of some platyopuntias. The *tunas* and *nopales* most commonly eaten in Sonora and Arizona, however, come from the *nopal*, a domesticated platyopuntia that is presently found throughout the world but which was most likely domesticated in Mexico. The berries of manzanita (*Arctostaphylos* spp.) and elderberry (*Sambucus* spp.) are collected to make jelly.

Mescal (*Agave* spp.) was cooked and eaten by the Apaches and by the Sobaipuri before them, and mescal cooking pits dating in the prehistoric period are found in the Babocomari drainage. The mescal agave was also

used during Prohibition in the Elgin area to make "moonshine," not to be confused with the true mescal made in Jalisco, Mexico. Even today, Mexicans occasionally come across the border to collect mescal hearts to take back to Mexico to use for food. The mescal heart is usually baked in an earthen pit, and the cooked, molasses colored, fibrous heart is eaten. Slices of cooked mescal heart can be bought in most large north Mexican markets. In some parts of Mexico, mescal has been eradicated by overcollecting.

Yucca (*Yucca* spp.), sotol (*Dasylirion* spp.), and lechuguilla (*Agave* spp.) have been a source of fiber in the region since prehistoric times. An industry based on making brooms and brushes out of beargrass (*Nolina* spp.) is located in Agua Prieta, Sonora, and Mexican nationals frequently come to Sonoita and Elgin to harvest the dry grass. The collecting of beargrass is usually done on private land, and large truck loads of the grass are cut and taken back to Mexico. The cutting of beargrass does not seem to injure the plant; besides, most ranchers consider the grass useless anyway. Wild grapes (*Vitis arizonica*) and walnuts (*Juglans major*) have also been collected for food. Some other wild plants collected for food or spice are mesquite beans, water cress, onions, and oregano.

Presently, outside of the collecting of beargrass to make brooms, there is no other industry based on collecting wild plants in the upper San Pedro. The collecting of bellotas and other plant foods is done generally for personal consumption. Walnut was supposedly cut out of riparian areas for construction and furniture wood in the 1880's but appears to be coming back today. The collecting of wild plant products in the Babocomari drainage appears to have had a minor impact on the ecology of the region, though admittedly certain species may have been removed from local areas by overcollecting.

WEEDS. — The use of the term weed represents a rather anomalous situation, because if a plant is defined as a weed it would have no use by most definitions. For simplicity's sake, however, and in order to point out the ability of man to spread plants that are neither crop plants or ornamentals,⁴ the term weed is used here to simplify the discussion of introduced plants and/or endemics which are of little or no economic use to man and which inhabit disturbed areas in the upper San Pedro and Babocomari drainages. The weedy composition of any area is not only influenced by varying types of physical phenomena but by the kind and intensity of human disturbance. In other words, the composition of weedy species in abandoned cropland is different from that in an overgrazed field. The plants which a farmer considers weeds might not be considered such by a rancher. In general, the subjective appraisal of what is or is not a weed is relative to a particular land-use pattern. For example, mesquite is

not considered a weed by the rural inhabitants of Sonora, Mexico, where it is in great demand for firewood, while it is the scourge of the ranching industry in much of the American Southwest. In the extreme, oaks may be considered weeds by the Forest Service and ranchers who would rather see highly palatable grasses in place of oaks on range lands. Finally, it should be pointed out that some of the best forage plants for cattle are introduced Mediterranean or African grass species.

A cursory review of the list prepared by Jane Bock of plant species occurring on the Ranch indicates more than 45 weedy species. Some of the "dominant" weeds on the terraces and upper slopes of the Ranch are threadleaf groundsel (*Senecio longilobus*), loco weed (*Astragalus* spp.), snakeweed (*Gutierrezia sarothrae*), pasmo (*Baccharis* sp.), burroweed (*Haplopappus tenuisectus*), desert broom (*Baccharis sarothroides*), and mustard (*Brassica* spp.). In riparian situations seep willow (*Baccharis glutinosa*), rabbit bush (*Chrysothamnus nauseosus*), and cocklebur (*Xanthium* sp.) are particularly abundant; while near the buildings and in the old corrals, one encounters Russian thistle (*Salsola kali*), cocklebur, sacred datura (*Datura meteloides*), prickly poppy (*Argemone platyceras*), and a number of different types of spurge. The check dams constructed throughout the Ranch are covered by Bermuda grass (*Cynodon dactylon*), and in the contour plowed areas on the northeast corner of the Ranch large reseeded areas of Lehmann's lovegrass (*Eragrostis lehmannii*) and Boer lovegrass (*Eragrostis chlorometas*) are found. The contour plowed area on East Mesa was plowed in 1940 (?), and the plowed area around Finley Tank in 1953 or '54 (?). A few of the introduced grasses found on the Ranch are stinkgrass (*Eragrostis megastachya*), feather fingergrass (*Chloris virgata*), Lehmann's lovegrass, Boer lovegrass, sanbur (*Cenchrus pauciflorus*), Bermuda grass, and Johnson grass (*Sorghum halepense*). Most of the shrubby weeds found on the slope lands of the Ranch, such as threadleaf groundsel, snakeweed, burroweed, locoweed, cocklebur, and Russian thistle are either poisonous or harmful to cattle, which accounts in large measure for their abundance in overgrazed areas. Apparently, cattle do benefit some endemic species such as curly mesquite (*Hilaria belangeri*), which can be an excellent livestock forage and which seems to do quite well in heavily grazed and trampled areas.

One of the first observations of weedy invaders in the grasslands of the upper San Pedro and Babocomari came after the drought of 1890-1893, when it was noted that the hills of southeastern Arizona were covered with weeds, especially pigweed, instead of the usual grass (*Report of the Governor of Arizona to the Secretary of Interior*, 1893: 23). Shortly thereafter, there was a noticeable increase and/or invasion of xerophytic shrubs and trees; in particular, mesquite (*Prosopis* sp.), white thorn (*Acacia constricta*), and *Acacia vernicosa* began to increase and invade. According to Rogers (1965: 118), ranchers noted a large increase in xerophytic brush and

⁴Some crop plants and ornamentals have escaped from cultivation, however, and taken on the characteristics of weeds.

shrub in the upper San Pedro between 1900 and 1930. In fact, it was no longer possible to hold cattle roundups in the area east of Fairbank because of the increased density of shrubs. While some areas of the upper San Pedro basin had increases and invasions of woody shrubs, many areas experienced little or no change. E.g., Susan Woodward (1969), after reviewing the U.S. General Land Office Survey Notes, suggests no major vegetation change in the Murray Springs area since 1900.

Contrary to generally accepted notions, it seems clear that prior to 1880 mesquite was not confined to river valleys and drainage courses but was also found in the uplands. Cattle and other domestic livestock are known to act as disseminators of weeds by scattering viable seeds in droppings or carrying seeds in their hair. Cattle in particular are known to spread mesquite in their droppings. And although there seems to be a positive correlation between overgrazing and mesquite increases and/or invasions in Arizona and the rest of the Southwest, mesquite has continued to increase in areas where livestock grazing has been eliminated — the Jornada in New Mexico (Branscomb, 1958) and the Santa Rita Experimental Range in Arizona (Cable, 1967). At this time, however, no hypothesis adequately explains the increase and invasion of mesquite throughout its range.

The Research Ranch is relatively mesquite-free except for a few mesquite in Section 23 along an old wagon road that once passed from the Babocomari Ranch south through Ranch property, and for some scattered mesquite in the Lyle Canyon area. According to Alex Gonzalez (personal communication), the mesquite invaded Lyle Canyon, especially near Westgate Trailer Park, after much of the area was planted in beans around 1926. Apparently, after the beans failed, the abandoned fields were taken over by mesquite. Though both white thorn and *Acacia vernicosa* are real problems on the Babocomari Ranch, they have not appeared on the Research Ranch.

The following species found on the Ranch are considered by Hastings and Turner (1965) to be invaders of the grasslands and oak woodlands of the upper San Pedro: mesquite, ocotillo (*Fouquieria splendens*), desert broom, rabbit bush, one-seed juniper (*Juniperus monosperma*), cottonwood, desert willow, threadleaf groundsel, burroweed, Russian thistle, and wait-a-minute (*Mimosa biuncifera*). Many of these species, however, do not have the habits of invaders on the Ranch, and cottonwood cannot be considered an invader because it is missing in the early photographs of the area. In the 1850's and '80's cottonwood was cut extensively to make charcoal for

brick kilns; furthermore, its growth in riparian areas was spotty.

Humphrey (1958) lists five reasons for the invasion of woody plants into the rangelands of southeastern Arizona: grazing by domestic livestock, competition or the lack of it, effects of rodents, changes in climate, and suppression of grassland fires. My feelings are that while any of the above factors may have affected the vegetation of the area, the introduction of livestock and the management of public lands for livestock production have been the two most important factors contributing to the increase and invasion of weeds in the grasslands of southeastern Arizona.

WILDLIFE. — The first large animals to feel the impact of man in the upper San Pedro and Babocomari were the Pleistocene megafauna exterminated by the Big Game Hunters around 5000 B.C. In the past 90 years the native fish fauna and the large vertebrates like the antelope, elk, bighorn sheep, beaver, grizzly bear, and wolf have been wiped out. Native antelope (*Antilocapra americana mexicana*)⁵ survived in the Babocomari and San Rafael valleys until the late 1920's, when they were finally shot out. In 1949 the Arizona Game and Fish Department reintroduced antelope (*Antilocapra americana americana*) to Fort Huachuca from northern Arizona. Over the years, however, the antelope, reintroduced on the Fort and in the rest of Game Unit 35,⁶ have fared poorly. According to a paper presented to the Arizona Game and Fish Department in 1975 by Glen Dickens, there are only 77 antelope remaining in the whole Game unit, of which 24 are on the Fort. Dickens also noted that the herd had no fawn survival in 1974. At the same time as the antelope were reintroduced in 1949, the Arizona Game and Fish Department stocked the Fort with Merriam's turkey and bison. Both the turkey and bison steadily increased in numbers on the Fort. In 1954, however, the bison were completely removed from the Fort and taken to House Rock and Raymond ranches in northern Arizona.

The grizzly bear (*Ursus horribilis*) once occurred in the Huachucas as well as in other high mountain ranges in southeastern Arizona. The last grizzly in the area appears to have been killed in Sonora in 1918, while the last grizzly which I have record of in the Huachucas was killed by John Waters, a market hunter, in 1892. There may have been Merriam's elk (*Cervus canadensis merriami*) in the Huachucas, but I have not discovered any concrete evidence of their existence there. Beaver (*Castor canadensis frondator*), which were once reportedly abundant along the Babocomari and San Pedro rivers, appear to have been killed off by 1880, if not before.

Whitetail (*Odocoileus virginianus couesi*) and black-tailed or mule deer (*Odocoileus hemionus eremica*) are plentiful in the area, and according to local ranchers, there are more deer today in the Babocomari drainage than when the area was first homesteaded in the 1910's. Black bear (*Euarctos americanus*) have been

⁵ Scientific names and distributions of mammals are taken from Cockrum (1960) and Hoffmeister and Goodpaster (1954).

⁶ Game Unit 35 includes the area between Highway 82 on the north and west and the U.S.-Mexico International Boundary on the south. Its eastern border runs along the Southern Pacific tracks between Fairbank and Palominas.

reported historically in the Huachucas and even today occasionally wander down into the Canelo Hills (Howard Boss, personal communication). Lions (*Felis concolor*) and wolves (*Canis lupus baileyi*) are still seen, though the latter are quite rare. Coati mundi (*Nasua narica*) appear to be recent invaders in the area, and Buster Pyeatt (personal communication) stated that the first coati seen in the region was shot in Sunnyside Canyon of the Huachucas in 1926. However, Fisher (1892) verifies the existence of coatis in the Huachucas in the early 1890's.

In 1972 an attempt was made to reintroduce the black-tailed prairie dog (*Cynomys ludovicianus arizonensis*) on the Research Ranch, though no record of black-tailed prairie dogs west of the Huachucas exists. Until they were victims of federal programs to eliminate them in the 1920's, black-tailed prairie dogs were abundant in the upper San Pedro and Sulphur Spring valleys. The attempt to reintroduce the prairie dogs on the Ranch failed, however, and attempts are presently underway to reintroduce the dogs in the San Rafael Valley.

Through the years, the federal government, in conjunction with local ranchers, has instituted a number of programs to kill livestock predators, skunks, rodents and other "range pests" in the Babocomari drainage. Some of these programs have been fairly effective. As a result, skunks are presently rare in the Elgin area. During the 1950's, the Forest Service recommended that the rat and pocket gopher infestations on the "Chuney Allotment," national forest lands on the Ranch, be wiped out by poisoned grain. Programs such as these must surely have affected rodent and predator populations in the region.

Changes in the native fish population of the Babocomari and San Pedro rivers appear to have occurred after these streams lost their perennial flow, though the introduction of exotic fish and chemical pollution from the stamp mills on the San Pedro must have also played a role in the decimation of the native fish fauna. As pointed out earlier in this investigation, the San Pedro River was once the habitat of the Colorado squawfish (*Ptychocheilus lucius*), and a squawfish measuring nearly five feet in length was identified from archaeological remains at Quiburi near Fairbank (Miller, 1961: 375). Humpback suckers (*Xyrauchen texanus*) also inhabited the Babocomari and San Pedro rivers and were marketed in Tombstone as "buffalo" in the 1880's (*Ibid.*). According to Miller (1961: 376), of eleven indigenous species of fish identified from the San Pedro River from 1846-1854 only three managed to survive until 1950. Some fish, like the Verde trout (*Gila robusta robusta*), survived until recently in the headwaters of the Babocomari and San Pedro. According to Pete Bidegain (personal communication), no Verde trout have been in the Babocomari since the Babocomari Ranch stocked smallmouth bass in the stream two or three years ago.

Fluctuations in the kinds and numbers of small mammals and insects often have marked effects on the

vegetation and/or accompany vegetal changes resulting from the grazing of domestic livestock. The ecological relationships between the flora and fauna of the upper San Pedro and Babocomari drainages have been little studied, however, and the role of extinct fauna in the evolution of the wild vegetative landscape may never be interpreted. Surely future work on the fauna of the area and its ecological interrelationships with man is warranted.

REPEAT PHOTOGRAPHY AND REMOTE SENSING. — Old photographs and repeat photography are especially helpful in recreating the vegetation and climate of the past. However, the time spent collecting old photographs of the Research Ranch and the Elgin area was not very productive, and few of the photographs encountered were taken prior to 1940. Dr. Raymond Turner has given the Ranch a set of photographs taken by Homer Leroy Shantz in 1933 showing a panoramic view of the Huachucas. Except for a quite noticeable decrease in *Senecio* sp. and an increase in grass since 1933, these particular pictures show little change in the vegetation of the Ranch between 1935 and 1975. Since the abundance of *Senecio longilobus* in the area correlates with overgrazing, as it does presently in much of Sonora, Mexico, such a change would be understandable in light of reduced grazing pressure in the area since 1933. Presently, the Ranch has decided to begin a photographic file of Ranch landscapes, and in conjunction with Dr. Turner, 38 photographic stations have been established on the Ranch. Pictures will be taken from these stations during the different seasons and after fires, so that changes in the different vegetation communities of the Ranch can be monitored in the future.

The Ranch already has a fine collection of color near-infrared vertical aerial photographs of Ranch property flown June 7, 1969, as well as a complete set of 1:10,000 black and white vertical aerial photographs of the Ranch flown on October 12, 1971. Ground truthing and an examination of the aerial photographs show noticeable headward cutting by some of the streams and their tributaries on the Ranch in the last four years, especially in the East Corrals area. The aerial photographs also show a number of abandoned Ranch roads which are difficult to perceive on the ground, but which show quite clearly on the air photos. Fence lines are also clearly defined on the color near-infrared air photos, as are old fields or pastures. Differences in land use or land management on state, private, and national forest lands on the Ranch might be compared by studying the color near-infrared aerial photographs of the Ranch. The furrows made by contour plowing in Sections 23, 14, and 15 of the Ranch, however, do not stand out as clearly on the Ranch as they do on the adjacent Babocomari Ranch property on the air photos, especially along the fence line in O'Donnell Wash. A comparison of Ranch aerial photographs with a set taken in 1938 also points out quite clearly mesquite invasion in the contour plowed areas on the northwest corner of the Ranch. Austin

Moss (personal communication) notes that the mesquites in that area are advancing along an old wagon road that once ran south across the Ranch and which is still discernible on the air photos.

Existing satellite imagery does not seem worthwhile for monitoring small spatial areas such as the Ranch, and of the satellite imagery available only LANDSAT (formerly called ERTS) covers the Ranch. There is no Skylab imagery available for the Ranch because eastern Santa Cruz County was missed on the Skylab flight lines. The small-scale of LANDSAT and its relatively low resolution make it relatively useless for large-scale monitoring of the Ranch.

NASA high altitude U-2 imagery of the Ranch is available, however, and a scale of 1:30,000 can be obtained from U-2 photos for work in the area. The U-2 imagery clearly shows the boundaries of the Ranch because they are enhanced by the "denser" grass cover of the Ranch when compared with the surrounding area. The U-2 imagery seen by the author was flown in August shortly after a rain storm, and standing surface water shows clearly old pasture or field patterns on the Ranch that would not have ordinarily showed up had the imagery been taken before it rained. Apparently, some of the old pastures were so trampled by cattle that surface water percolation has been slowed to a point where the pastures retain large amounts of standing water shortly after a downpour. Since wet soil gives off more near-infrared reflection than dry soil, the old trampled pastures stand out clearly in the photographs. If the large amounts of standing water in these areas are the result of trampling and compaction of the soils by cattle, the U-2 imagery would be quite valuable in assessing the impact of cattle on the Ranch. Certain species of trees can be identified on the U-2 imagery on the basis of different near-infrared returns. The U-2 imagery might serve as a good base for a large-scale resource inventory of the Ranch; in general, however, it offers few more perspectives of the Ranch than does the fine black and white and color near-infrared imagery already collected by the Ranch.

CLIMATIC CHANGE. — In contrast to Hastings (1963) and Hastings and Turner (1965), I do not find the concept of climatic change satisfactory for explaining the vast landscape changes that have occurred in the wild landscape of the upper San Pedro and Babocomari in the last 90 years. Hastings and Turner (1965) believe that climatic change is the one factor that can best explain most of the alterations which have occurred in the drainage and vegetation of southeastern Arizona since 1880. There is, however, no evidence that climatic changes of much magnitude have even occurred in the region since 1880, especially any of large enough magnitude to cause the great changes that have occurred in the landscape. The changes in the structure and composition of the vegetative communities of the upper San Pedro and Babocomari are a result mainly of drier conditions and micro climatic changes caused by man's activities, primarily the overgrazing of livestock. In

general, the supporters of the climatic change theory have concluded that southern Arizona is drying out; that the summer rainy season is later; that there are more big storms with high runoff and fewer small storms with moderate runoff; and finally, that winter rainfall has decreased while summer rainfall has remained the same.

Climatic information on the upper San Pedro and Babocomari prior to 1900 is scanty and unreliable. Because of the pooriness of climatic data before 1900, considerable note is taken from data derived from tree-ring analysis. Tree-ring data show below normal (?) precipitation from 1871 to 1905, above normal precipitation from 1905 to 1931, and below normal precipitation again from 1931 to 1940 (Fritts, 1965: 421-43). The changes in the drainage and vegetation in the upper San Pedro and Babocomari do not correlate with the wet or dry periods proposed by various authors. Nor is there a retreat of oak or other vegetative communities upslope throughout the San Pedro Valley that would indicate a change in climate over the last 90 years or so.

Just using the records of mean precipitation for the region is not a safe way of evaluating the effect of rainfall on vegetation. Too many other factors are involved: seasonality of precipitation, intensity of rainfall, type of rainfall (convective or frontal), temperature during the rainy period, amount of rainfall, capacity of the soils to hold groundwater, etc. Hastings (1959: 36) expressed an idea which he eventually abandoned but which I believe accounts for many of the landscape changes occurring on the upper San Pedro and Babocomari in the last 90 years:

But these reservations notwithstanding, when one looks at the facts of cattle population in the 80's, when one looks at the incidence of flooding and cutting; when one sees in 1882, 7.08 mean inches of summer rainfall and 50,000 cattle produced no unusual flood conditions, whereas in 1886, 4.63 inches and 156,000 cattle did — when one looks at the damage 7.92 inches and 253,000 cattle did in 1890 — there is certainly a very tempting conclusion, and it involves the coming of cattle, the effect of overgrazing on vegetation, and the effect that the depletion of vegetation, in turn, had on runoff and erosion.

DRAINAGE, ARROYO CUTTING, AND STREAM CHANNEL DEEPENING. — Though climatic change, diastrophism, and other environmental events have been responsible for channel entrenching and headward cutting throughout geological history, the initiation of stream channeling and headward cutting in the San Pedro Valley in the 1890's and the Babocomari in the 1900's appears to have been primarily the result of the overgrazing of thousands of head of cattle in the upper San Pedro and Babocomari drainages in the late 1880's and early '90's. The destruction of the vegetation by overgrazing and the trampling and compaction of the soil by cattle must have decreased the interception of

surface water flow as well as increased overland flow by decreasing soil water infiltration and storage. Increased overland flow resulted in increased discharge, greater stream velocities, increased capacity of the streams to do work, and, eventually, channel deepening and headward cutting of the major streams and their tributaries.

According to Richard Reeves (personal communication), co-author with Ron Cooke of *Arroyos and Environmental Change in the American Southwest* (1976), the runoff generated on the higher slopes by vegetation destruction and soil compaction was probably insignificant, especially when compared with discharges resulting from disturbances in the valley bottoms. Disturbances in the valley bottoms, such as the removal of vegetation by overgrazing or clearing for agriculture, could double the velocity of streams. Reeves believes that disturbances in the valley bottoms, such as the overgrazing of cattle, clearing, and the destruction of beaver dams, were the major factors leading to increased stream discharges, and eventually to stream entrenching in the upper San Pedro Valley.

Both the San Pedro and the Babocomari were perennial streams until sometime after 1890, though there is evidence that they still had perennial flow as late as 1915 and 1905 respectively. In the 1870's and early 1880's both rivers were slow moving streams, flowing in shallow beds, and had periodically inundated floodplains, verdant cienegas, and beaver dams. Both were teeming with fish and malaria. River overflows in conjunction with beaver dams created cienegas all along the Babocomari, at the junction of the Babocomari and San Pedro, and on the San Pedro near St. David (Rogers, 1965: 81-82). By 1900, however, the stream regimes had changed completely — the beaver were eradicated; the cienegas had dried up; malaria had disappeared; and the headward cutting of the San Pedro had reached south past the Boquillas Ranch. According to Kirk Bryan (1925: 342), "the trench on the San Pedro River was cut progressively headward between the years 1883, when the arroyo first formed at the mouth of the river, and 1892, when its head waterfall cut through the boundaries of the Boquillas Grant 125 miles upstream."

In 1905 a government surveyor described the Babocomari as still having permanent flow (U.S. Bureau of Land Management, *Field Notes*, 1909). In fact, the first mention of the upper San Pedro having an intermittent flow is found in a surveyor's report dated 1915 (*Ibid.*, 1915). Channel cutting on the San Pedro River proceeded slowly, and the continuously entrenched channel of the river did not reach the junction of the San Pedro and Babocomari rivers until the turn of this century. Indeed, the confluence of the San Pedro and Babocomari was described as a swamp in 1902 (U.S. Bureau of Land Management, *Field Notes*, 1902). Today, however, the Babocomari is dry near Fairbank and entrenched below its 1900 stream bed by more than 15 feet.

Hastings (1959: 38) notes that early descriptions

of the San Pedro River point out that although the San Pedro had no continuous channel trench prior to 1890, before 1890 and as far back as the 1850's it did have a discontinuous one. Only after the 1890's does the San Pedro seem to have a continuous channel trench (*Ibid.*, 33).

There are a number of other hypotheses on the origins of channel trenching and arroyo cutting in the Southwest besides the one already described by Reeves. The other hypotheses can be divided into two groups: first, that the depletion of the vegetative cover by overgrazing has led to the present arroyo cutting (Thornber, 1910; Bailey, 1935; Thornthwaite, Sharp, and Dosch, 1942; and Antevs, 1952); and second, that overgrazing has been the initiating factor, but the chief cause of arroyo cutting has been climatic change (a) to a drier climate (Bryan, 1925), (b) to a more humid climate (Huntington, 1914; and Bryan, 1922: 85), (c) to either a drier or to a more humid climate (Richardson, 1945), or (d) to a change in rainfall intensities (Leopold, 1951).

Recent research on rainfall intensity, runoff, and channel erosion in the Tombstone area indicates that heavy runoff in the upper San Pedro occurs only in the summer and that channels are rarely if ever flooded in the winter (Paul Martin, personal communication). This research tends to support the notion that recent arroyo cutting in the region correlates with a modern climatic trend in the Southwest toward bigger summer storms with high runoff and fewer small storms with moderate runoff. The existence of this climatic trend is questioned, however, and since these summer storms are quite localized, their influence on arroyo cutting over a large region may be disputed.

Although it appears as though a number of cultural and environmental factors were responsible for the initiation of arroyo cutting and stream entrenching in the San Pedro and Babocomari drainages in the 1890's and 1900's, the primary factor or the "triggering event" seems to have been the overstocking and overgrazing of livestock, especially in the valleys in the 1880's. According to Antevs (1952):

if left alone, the native vegetation could have weathered the droughts during which arroyo erosion set in during the 1880's. The impoverishment of the plant cover which permitted the channeling must have been caused by new and foreign detrimental agencies, and the few factors during the 1870's and 1880's were large herds of cattle and sheep and numerous settlers.

Presently, the headward cutting of streams and their tributaries is occurring on certain parts of the Ranch, especially near East Corrals. Erosion control dams seem to have slowed arroyo cutting on some parts of the Ranch, however.

GRAZING. — Probably no single activity has had more impact on the evolution of the wild landscape of the upper San Pedro and Babocomari watersheds than the long history of domestic livestock grazing. Though

cattle, sheep, and goats had accompanied the Coronado expedition into Arizona in 1540, no domestic livestock was ranching in southeastern Arizona until the end of the 17th century. Indeed, it was not until the 1880's that the cattle industry began to flourish and dominate the land use of the upper San Pedro and Babocomari. From 1880 until 1934, the date the Taylor Grazing Act controlled the number of livestock placed on public lands, the cattle industry was characterized by overstocking and overgrazing. In the drought of 1891-1893 alone, between 50 and 75 percent of the cattle in southeastern Arizona died of starvation and thirst. During the drought, the Babocomari was described as a huge bone yard, and Mexicans came across the border to collect bones to sell for fertilizer. It was during the 1880's and '90's that catastrophic changes in the landscape took place — the cienegas were destroyed; the San Pedro and Babocomari rivers ceased being perennial; the bottomlands around water were turned into mudholes; springs dried up; the short-grass prairie was grazed to the ground and invaded by weedy shrubs and trees; and headward cutting and channel entrenching began on the San Pedro River. One has only to examine the early photographs of the region to see the desolation brought to the short-grass prairies of the upper San Pedro and Babocomari by man and his cattle.

The selective destruction of plant species, overgrazing, trampling, and the spreading of weeds are but a few of the ways in which cattle have directly effected changes in the land. The systems of livestock tenure, however, and the increasing emphasis on livestock production, generally at the cost of those plant species least palatable to *Bos*, have led to even greater changes in the wild lands than have the cattle themselves. Range appraisals biased to the "best" forage plants to cattle, rotational and deferred grazing, fences, supplemental feeding, fire suppression, contour plowing, the construction of check and spreader dams, intentional burning to green pastures, insect and rodent control programs designed to improve forage, the intentional introduction of exotic grasses, brush conversion programs, livestock predator control programs, and the chaining of oaks and mesquite are but a few of the ways in which ranchers and the Forest Service have brought about changes in the wild lands of southeastern Arizona used for the grazing of domestic livestock.

Until 1915 the whole Babocomari watershed was open range, and the only fence in the region followed the railroad right-of-way. There was no restraint on how many cattle could be stocked on the range or on where the cattle wandered. National forest lands were not fenced until the 1930's, and the public lands were some of the most abused. The introduction of fences, however, was met with resistance by many of the ranchers, and even today many oldtimers feel that fencing the open range resulted in the land having a

lower carrying-capacity because the cattle were concentrated in small areas and worse overgrazing resulted. According to oldtimers, the cattle went where the feed was when there was open range, whereas today, with fences and supplemental feeding, the cattle stay in pastures far longer than the grass can feed them, thus ruining the land.

The overstocking and overgrazing of the rangelands affected the land primarily by changing the composition, diversity, and density of the grass species through selective grazing, trampling, soil compaction, and the introduction and/or spreading of exotic and endemic weeds. Many weeds have become dominants in the vegetative landscape of heavily grazed areas simply because they have managed to survive and prosper through being unpalatable or poisonous to cattle.

Grazing on the lands of the Research Ranch appears not only to have weakened the native vegetative cover and created openings for the establishment of other plants, but to have exposed the soil to differential erosion. In fact, differential erosion on heavily grazed or trampled areas on the Ranch has left a landscape of small, grass-barren swales in the once dense short-grass prairie. Terrasettes resulting from soil and rock creep caused by cattle walking on sloped ground are also seen on the Ranch. Cattle have affected oak regeneration, since oaks do not regenerate on heavily grazed areas as well as on ungrazed areas. In fact, differences in oak regeneration are particularly noticeable along the fence line dividing Ranch and private property in Post Canyon. In general, few plants in a grazed area appear to escape the influence of cattle. Cattle even knock down yucca in order to eat the flowering stalks. Indeed, one rancher in the Elgin area had a "yucca chopper" which he used to chop yucca up for cattle fodder.

Both public and private lands in the Elgin area as well as on the upper San Pedro and Babocomari drainages have been managed in such a way as to increase livestock production. The bulk of the range management practices have been diffused by the U.S. Forest Service through their livestock management program on national forest lands. Most ranchers seem to lack a concept of good or bad rangelands in terms of plant species composition and diversity, ground cover, seed formation, etc. In many cases, when ranchers are asked what characteristics of the range indicate to them that it has been overgrazed they usually reply that an overgrazed range "looks like a carpet."

In order to appreciate how the lands of the Research Ranch have been affected by land management practices geared to cattle production, I have taken some excerpts out of the Coronado National Forest range conservation plans, permittee plans, and range inspection reports for the "Chuney Allotment" (national forest lands presently included within the holdings of the Research Ranch).⁷

To provide more accessible green feed in the spring and to build up soil protecting mulch — about 1/3 of the sacaton in the floodplains will be

⁷ Since 1934, the National Forest Service has not allowed more than 120 head of cattle on "Chuney Allotment."

mowed each year. Mowing will be at the 8 to 10 inch height so that the stubble will protect plant crowns from too close grazing.

Rat and pocket gopher infestations will be controlled by the use of poisoned grain as needed.

No clumps (of grass) should be grazed below 2 inches stubble. Leave 1/4 of the low lying runners for correct utilization.

A good rule of thumb in the use of perennial grasses is to take half and leave half of the annual growth. This applies to the important forage plants which we are trying to encourage and increase. It does not apply to plants of lower forage value unless they are the only plants present.

Because of the generally favorable soil and moisture conditions, the lands within the ranch (Research Ranch — East Corrals) are capable of producing large amounts of high quality forage. There, present condition is such that rapid improvements can be expected under good management practices.

Cattle will be moved from one pasture to another when the operator determines that the forage in a particular area has been properly utilized.

Salt blocks moved to get uniform utilization of pasture.

In order to maintain the permittee registered herd units, the permittee will practice rotation-deferred grazing using a three pasture system with one pasture deferred during the summer growing season.

These excerpts emphasize the role of livestock tenure in the evolution of the Ranch's ecosystems. Add to these few management practices many others such as contour plowing, reseeding with exotic grasses, the construction of check and spreader dams, and brush conversion projects, the Ranch lands begin to take on a quite disturbed appearance. A range inspection report made in September 30, 1931 (Grazing Records, Coronado National Forest, Sierra Vista, Arizona), notes that the "Chuney Allotment" is the best in the district. However, in another Forest Service Note (*Ibid.*) dated August 29, 1962, "The Chuney Allotment is rated in low fair condition. There are several roads in the allotment which are eroding . . . the soils show heavy compaction and finally there are scattered light stands of mesquite throughout the allotment." A fair rating for range conditions, according to Forest Service records, means only 25 to 50 percent of the original range cover is present. The method by which the original range cover is determined is unexplained.

The tenure of domestic livestock has brought about considerable change in the wild lands of southeastern Arizona, and most of the catastrophic transformations in the wild landscape of the region in the late 19th century are related to the overstocking and overgrazing of cattle. Paul Martin (1975: 47) points out that continuing to structure our native grassland ecosystems to the maximizing of cattle production may be a

mistake:

The loss of the American megafauna has implications for modelers of ecosystems. They should recognize that direct measurement of energy flow under 'natural' or 'virgin' conditions is not possible. I suggest that grasslands could not have evolved without the variety of large mammals once found in them, and that grasslands of the future should be stocked with a variety of large mammals. The development of American game ranching is the best trade-off the ecologist has to counter the massive destruction of whatever plants *Bos* will not eat.

CONCLUSIONS. — During the past century a full-blown set of legends has grown up about the man-induced changes that have occurred in the wild landscape of the upper San Pedro. In no place are these legends better expressed than in the following excerpts from Herbert Brant's *Arizona and Its Bird Life* (1951: 226-28):

'The San Pedro is wonderful! It is one of the relatively few rivers in this whole nation that flows north throughout its entire length, and is the one river in southern Arizona with running water the year round,' boasted an old-time cowpuncher to me . . .

When you gaze across this enormous Arizona landscape with its far-flung plains and endless towering mountains it seems impossible that destruction by man and livestock, in a relatively short time, could have so drastically altered its complexion. Yet sad as it is to admit, not only has man changed much of its formerly abundant vegetation but also, by ruining nature's original design for drainage, he is rapidly transforming this noble paradise into a worthless desert.

What a wonderful land, especially for the naturalist, this must have been when, in 1540, Coronado marched his army down its length searching for the seven fabled cities of gold! At that time the climax grasses were so luxuriant as to hide a man on horseback; the now deep, shifting river channel and its affluents were an almost continuous, broad marsh; thousands of beaver saw to that. The relatively few mesquites and catclaws were confined to the first bench above the willows and baccharis which is their normal habitat. Mosquitos swarmed, and the Sonoran otter enjoyed its slide; antelope, black-tailed and white-tailed deer, elk, wild turkey, quails, and other game were abundant in this land of the Apache; prairiedog towns flourished, while a host of other small mammals, those furred earthworms of the sun-baked Arizona soil, scampered everywhere. During migration time great swarms of waterfowl, shorebirds, and other transients winnowed the air along this flyway, while the gaudy Avocet and Black-necked Stilt remained to scream above their nests in the long valley where flowed the placid

San Pedro.

Thus we find that small four-footed animals, by conserving the scanty water supply with dams, and by opening pores in the hard earth, had made this a well-vegetated land of natural abundance. Along came a larger animal, this time a pale, two legged one distinguished, according to Webster, by his extraordinary mental development; he and his agencies, in a comparatively brief time, destroyed what the smaller animals and Mother Nature had been building up for countless centuries, and made it a semidesert.

First the beaver and other fur animals were trapped out; that is how the Indian bought his weapons, whiskey, and other goods. The early Spaniards sowed the seeds of the vast herds of domestic animals; how the latter prospered on the lush open range! They fattened in the lowlands in season and the highlands in summer. Even as late as the turn of the present century more than a thousand cattle grazed successfully on Huachuca's wooded crown; now there are few if any. Then came the small land owner, the nester with his barbed-wire fence who, the year around, gave the dry land no rest. But a worse scourge was the man-lighted fire after fire, with the intent of increasing tender grazing grass, which finally destroyed the climax roots. Then an all-wise government agency poisoned the very last prairiedog in the southeastern counties and the ground there is now a hard, almost grassless mesquite chaparral.

With the passing of the beaver dams stream head-cutting took hold with vigor and Arizona is today the nation's most glaring example of the force of erosion. Meanwhile the tough mesquite and catclaw were being spread by cattle throughout the richest land in the great valleys, to the detriment of the declining grass growth. So we find that the beef supply so vital for the children of man, has deteriorated to a trickle of what it once was and should now be. All this destruction has taken place almost in our time in the mighty valley of the flowing San Pedro, our ornithological paradise in the warm heart of audacious Arizona.

As this investigation has demonstrated, man has induced manifold and profound changes in the wild lands of the region. Not all of these changes, however, have occurred in the ways Brandt suggests nor have they always been as destructive or as extreme. For example, there is no historical evidence that the grass on the San Pedro in the 1850's was high enough to "hide a man on horseback;" that mesquite and catclaw were scarce and confined only to the river valleys; that man-caused fires were frequent; or finally, that the gross physiognomy of the vegetation was different from that of today. On the other hand, man's activities in the region have led to the destruction of the native grasslands, stream channeling, weed invasions and/or

increases, faunal extinctions, deforestation, soil erosion, and alterations in the regional fire ecology, as well as to other changes, many of which are far more complex and in some ways more destructive than the changes envisioned by Brandt. Cattle ranching appears to have had the greatest impact on the wild landscape in the last 90 years; indeed, most of the recent catastrophic changes in the biological environment of the upper San Pedro relate to the overstocking and overgrazing of cattle.

Since it has been set aside as a preserve, the Research Ranch is one of the few "control areas" in the short-grass prairies of southeastern Arizona in which man can tap knowledge needed for maintaining man-made climax communities in southern Arizona without destroying the environment upon which they are based. Preserving wild ecosystems may be essential to our survival, especially when man continues to simplify and destroy ecosystems to meet his immediate needs. The wild ecosystems as buffers against changes may be our only salvation when our man-made simplified ecosystems start to break down.

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