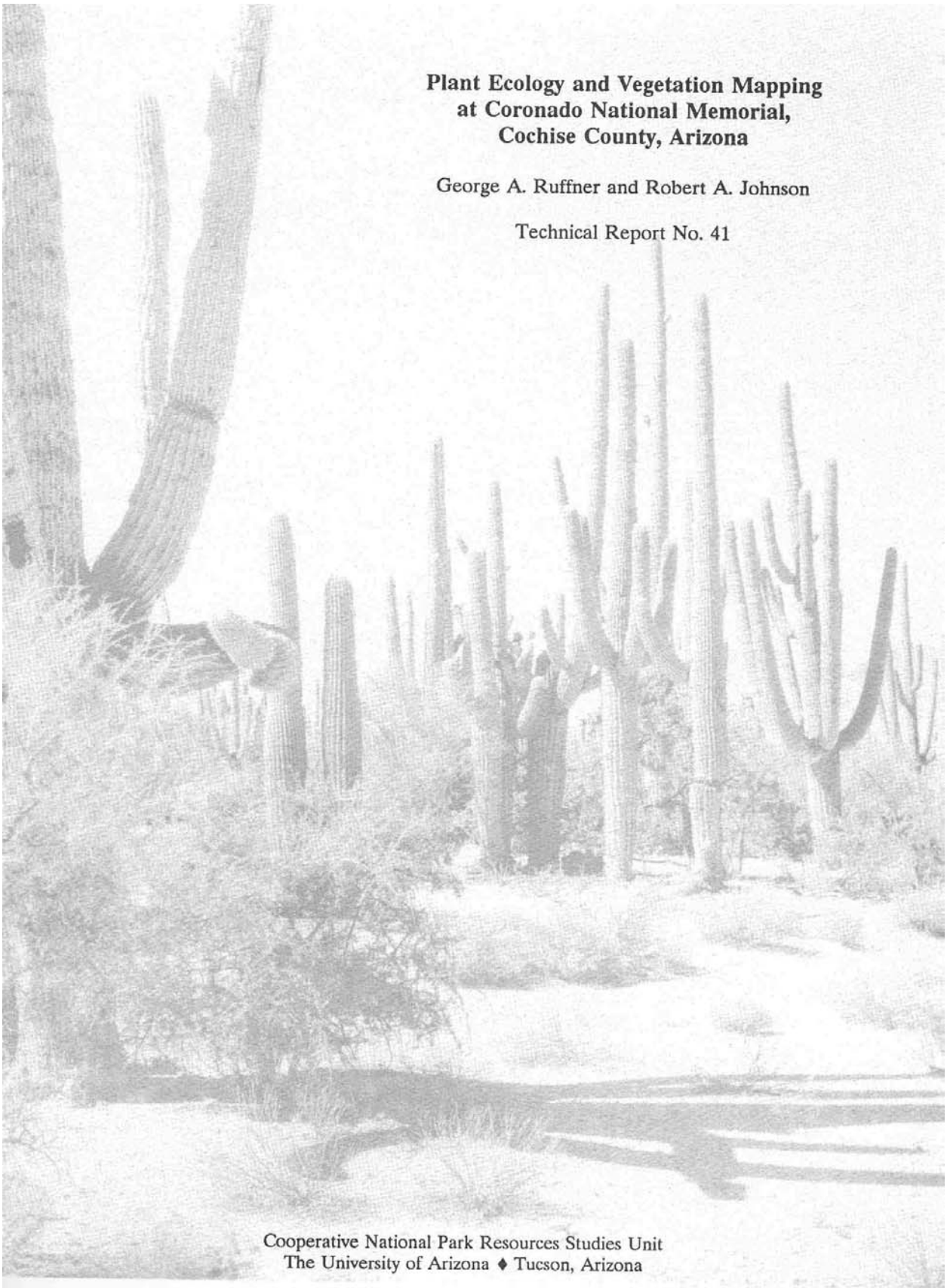


Plant Ecology and Vegetation Mapping at Coronado National Memorial, Cochise County, Arizona

George A. Ruffner and Robert A. Johnson

Technical Report No. 41

Cooperative National Park Resources Studies Unit
The University of Arizona ♦ Tucson, Arizona



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The University of Arizona, Tucson

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Plant Ecology and Vegetation Mapping at Coronado National Memorial, Cochise County, Arizona

George A. Ruffner and Robert A. Johnson

Technical Report No. 41

Ruffner Associates

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CONTENTS

LIST OF FIGURES iv

LIST OF TABLES v

ABSTRACT vi

INTRODUCTION 1

DESCRIPTION OF STUDY AREA 2
Physiography 2
Climate 2
Soils 4
Geology 7

METHODS AND MATERIALS 8
Biotic Community Mapping 8
Monitoring Plots 8
Plant List 10
Matched Photography 10

RESULTS AND DISCUSSION 11
Biotic Communities 11
Monitoring Plots 12
Plant List 17
Special Status Plants and Animals 17
Matched Photography 17
Impacts of Historical Land Uses 37

LITERATURE CITED 41

APPENDICES
Appendix 1. Directions To Vegetation Monitoring Plots At Coronado National Memorial, Cochise County, Arizona 44

Appendix 2. Map Of Biotic Communities And Monitoring Plot Locations, Coronado National Memorial, Cochise County, Arizona 46

Appendix 3. Map Of Fire Spread, Coronado National Memorial, Cochise County, Arizona 48

Appendix 4. Vegetation Monitoring Plot Data 1988 And 1989, Coronado National Memorial, Cochise County, Arizona 50

Appendix 5. Plant List For Coronado National Memorial, Cochise County, Arizona 60

FIGURES

Figure 1. Area map, Coronado National Memorial and vicinity, Cochise County, Arizona 3

Figure 2. Total annual precipitation over the period of record, 1956-1980, at Coronado National Memorial, Cochise County, Arizona 5

Figure 3. Soil associations within Coronado National Memorial, Cochise County, Arizona 6

Figure 4. Cumulative number of plant species in four plots within the Grama Grass-Mixed Grass-Mixed Shrub Grassland Association and Oak-Mexican Pinyon Pine-Juniper Woodland Association at Coronado National Memorial, Cochise County, Arizona 16

Figure 5. Pair of photographs taken from the north edge of the roadway and looking northwest at the east (main) entrance to Coronado National Memorial, Cochise County, Arizona 22

Figure 6. Series of three photographs looking to the northwest toward the stake marking the center of Plot 2 in the Grama Grass-Mixed Grass-Mixed Shrub Grassland Association at Coronado National Memorial, Cochise County, Arizona 24

Figure 7. Series of three photographs looking north toward the stake marking the center of Plot 4 in Grama Grass-Mixed Grass-Mixed Shrub Grassland Association at Coronado National Memorial, Cochise County, Arizona 26

Figure 8. Looking east from the residence area at Coronado National Memorial, Cochise County, Arizona towards a low limestone hill in the Oak-Mexican Pinyon Pine-Juniper Woodland Association 28

Figure 9. Series of three photographs looking west toward the stake marking the center of Plot 7 in the Oak-Mexican Pinyon Pine-Juniper Woodland Association at Coronado National Memorial, Cochise County, Arizona 30

Figure 10. Series of three photographs looking west toward the stake marking the center of Plot 6 in the Arizona Sycamore-Arizona Walnut-Oak Riparian Forest Association at Coronado National Memorial, Cochise County, Arizona 32

Figure 11. Series of three photographs looking north toward the stake marking the center of Plot 8 in the Oak-Mexican Pinyon Pine-Juniper Woodland Association at Coronado National Memorial, Cochise County, Arizona 34

Figure 12. Series of three photographs looking west toward the stake marking the center of Plot 9 in the Oak-Mexican Pinyon Pine-Juniper Woodland Association at Coronado National Memorial, Cochise County, Arizona 36

TABLES

Table 1. Mean daily minimum and maximum temperature and mean monthly precipitation at Coronado National Memorial Headquarters, Cochise County, Arizona (1960-1970) 4

Table 2. Attributes for the 10 plant monitoring plots established in Coronado National Memorial, Cochise County, Arizona 9

Table 3. Acreage of the four biotic communities within Coronado National Memorial, Cochise County, Arizona 12

Table 4. Special status plant species that may occur in Coronado National Memorial, Cochise County, Arizona 18

Table 5. Special status animal species that may occur in Coronado National Memorial, Cochise County, Arizona 19

ABSTRACT

This report presents an analysis of biotic communities of Coronado National Memorial (CORO) in southeastern Arizona. In general, grasslands, locally dominated by shrubs, occur at lower elevations and oak (*Quercus* spp.)/Mexican pinyon pine (*Pinus discolor*)/alligator juniper *(Juniperus deppeana)* woodland occurs at higher elevations in the memorial. Soils, geology, human impacts, and special status plant and animal species are summarized.

Four biotic communities occur in CORO: Oak-Mexican Pinyon Pine-Juniper Woodland Association, Grama Grass *(Bouteloua* spp.)-Mixed Grass-Mixed Shrub Grassland Association, Western Honey Mesquite (*Prosopis glandulosa*)-Mixed Short Tree Woodland Association, and Arizona Sycamore (*Platanus wrightii*)- Arizona Walnut (*Juglans ma*jor)-Oak Riparian Forest Association. The most extensive biotic community in CORO is the Oak-Mexican Pinyon Pine-Juniper Woodland Association covering 3,400 a of the memorial (total CORO acreage is 4,750). The Peak Fire of June 1988 affected most of the memorial to a moderate degree and the western portion to a severe degree. Of the 3,700 a burned, 2,600 a were in the Oak-Mexican Pinyon Pine-Juniper Woodland Association. Effects of the fire, as well as other changes, are described for 10 long-term vegetation monitoring plots in representative areas of the memorial. In burned areas, many plants in monitoring plots, and elsewhere, had resprouted by August 1989. Species composition of the understory was also greatly altered by the fire. Matched photographs document vegetation change with intervals from 3 months to 10 years. Several photographs show changes following the Peak Fire. A vascular plant list was compiled from existing information and additional species encountered during the study.

INTRODUCTION

The southern Huachuca Mountains in Arizona offer good visitor accessibility to a primarily interpretive site overlooking the probable route of Francisco Vasquez de Coronado's expedition into the present-day United States. Coronado's expedition initiated the beginning of Spanish influence in northern Mexico and the southwestern United States, and the region's Hispanic heritage is directly attributable to this event. In 1952, Congress established Coronado National Memorial (CORO), a 4,750-a area administered by the National Park Service (NPS), to commemorate, interpret, and symbolize the Coronado Entrada. It also promotes international amity and cultural understanding with Mexico and Spain.

Ruffner Associates was contracted by the Southern Arizona Group Office of the NPS to analyze biotic communities of CORO. Specific objectives of the project were to:

1. map biotic communities of the memorial;
2. establish 10 long-term vegetation monitoring plots in representative areas of the memorial;
3. compile a checklist of vascular plants using current lists and identification of additional species encountered during this study;
4. locate old photographs of the memorial and rephotograph the sites to document vegetation change;
5. prepare a soils map and describe soil types using existing information;
6. describe the geology of the memorial using existing information;
7. review the human history of the memorial in terms of historical land use and its impact on vegetation and soil;
8. prepare a written report summarizing the findings.

DESCRIPTION OF THE STUDY AREA

Coronado National Memorial is 20 mi south of Sierra Vista, Cochise County, Arizona, on State Highway 92 (Fig. 1). The memorial lies north of the international boundary at the southern end and eastern slopes of the Huachuca Mountains. The natural environment is typical of the Upper Sonoran Zone and the mountains of southeastern Arizona. Vegetation includes various desert grasses and shrubs at lower elevations and oak (*Quercus* spp.)/Mexican pinyon pine (*Pinus discolor*)/alligator juniper (*Juniperus deppeana*) forests at higher elevations.

PHYSIOGRAPHY

The Huachuca Mountains consist of a primary central ridge, oriented along a northwest to southeast trending axis that is about 25 mi long and 4 mi wide. The central ridge is secondarily faulted and dissected with numerous canyons heading along the ridge and draining east and west. Miller Peak, 0.25 miles north of CORO, reaches an elevation of 9,445 ft (Wallmo 1955; Toolin 1980). Elevations in the memorial range from 4,700 ft in the southeastern corner to 7,676 ft at Montezuma Peak along the northern boundary. Steep terrain predominates in the northern and western portions, particularly in Montezuma Canyon, though the eastern scarp rises most steeply at higher elevations. The southeastern quarter of the memorial is a broad grassland plain dissected by numerous drainages. The eastern and southern portions of the Huachuca Mountains, including CORO, drain into the San Pedro River.

A few seeps and springs occur in the memorial and some streams in the area were probably perennial before Tombstone began to divert streamflow for municipal use (Hoffmeister and Goodpaster 1954). Two well sources have been developed for livestock use, and a water tank occurs just north of the visitor center and residences. There are also two wells within the memorial, one south of the State of Texas Mine and an NPS well northwest of the boneyard.

CLIMATE

Weather data from four localities (Fort Huachuca since 1900, CORO Headquarters since 1956, and the Flying H and Y Lightning Ranches for an unknown time) show that two climatic features-mild annual temperatures and abundant summer precipitation predominate throughout this area (Sellers and Hill 1974; T. Adcock, pers. com. 1989). Mean monthly temperature is approximately 61° F (Table 1); January is usually the coldest month, while June is the warmest month.

Precipitation varies from 12 to 31 in. per year and averages about 20 in. (Fig. 2). The wettest months are July through September when about 60% of the annual precipitation falls (Table 1). Snow accumulation averages about 4 in. per year at the memorial headquarters and has fallen in February, March, April, May, November and December.

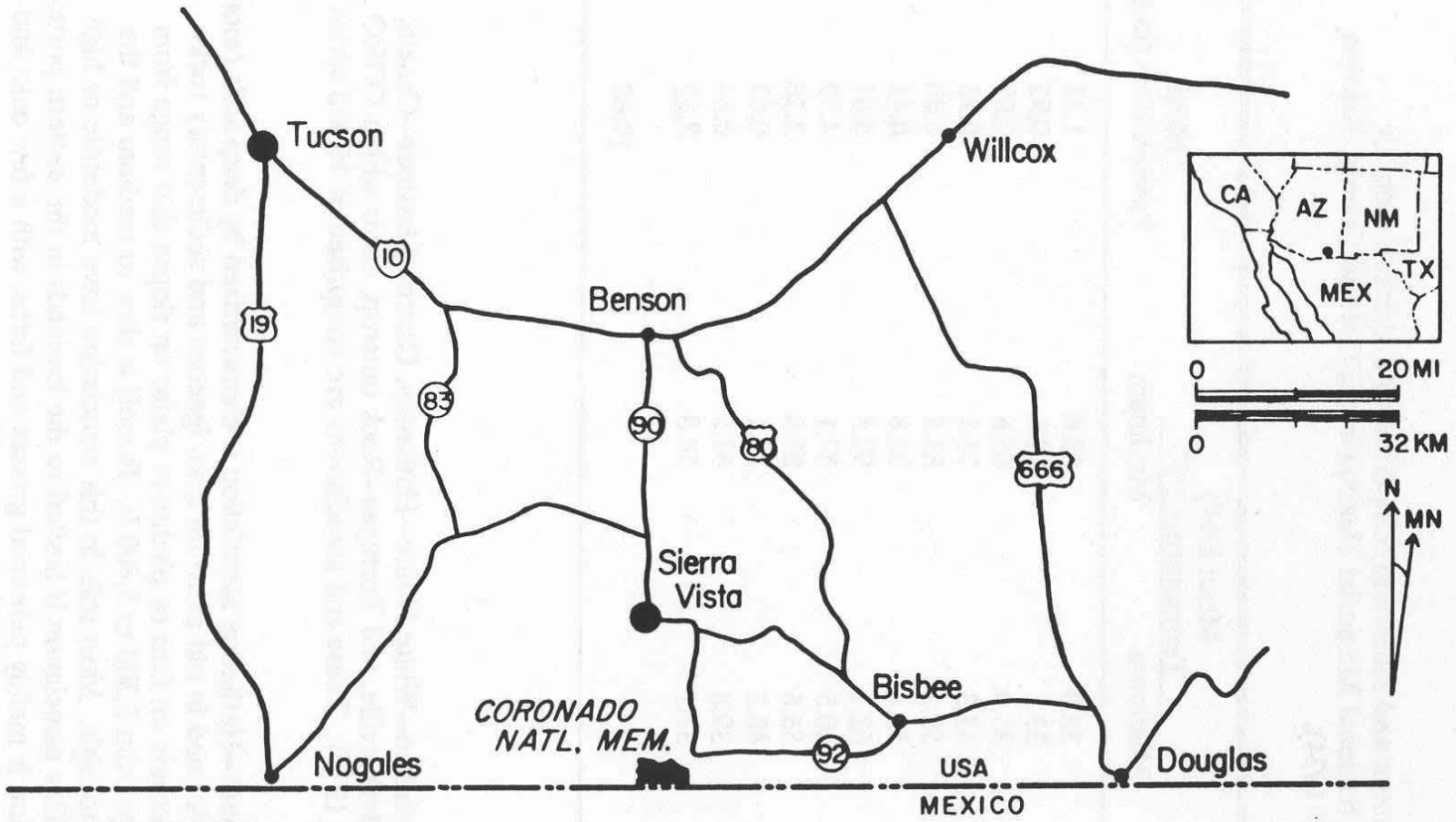


Figure 1. Area map, Coronado National Memorial and vicinity, Cochise County, Arizona.

Table 1. Mean daily minimum and maximum temperatures and mean monthly precipitation at Coronado National Memorial Headquarters, Cochise County, Arizona, 1960-1970 (Sellers and Hill 1974).

Month	Mean Daily Temperature (°F) Minimum	Maximum	Mean Precipitation (in.)
January	32.0	58.6	1.31
February	33.1	62.1	0.95
March	35.9	66.6	1.09
April	42.3	75.1	0.23
May	50.2	83.5	0.08
June	58.4	90.8	0.41
July	62.1	90.5	4.64
August	60.5	87.1	4.59
September	56.6	83.8	2.36
October	48.2	78.1	0.63
November	39.8	67.5	0.84
December	33.2	58.8	2.55
TOTAL			19.68

SOILS

Four soil associations, Bernadino-White House-Hathaway, Castro-Martinez-Canelo, Faraway-Rock outcrop-Barkerville, and Tortugas-Rock outcrop, occur within CORO (Fig. 3) (Richardson et al. 1979). These soil associations are comprised of 10 soil series within the memorial.

The Bernadino-White House-Hathaway association is characterized by deep soils (more than 60 in. deep) that are formed in old alluvium from igneous and sedimentary rocks. This association generally occurs on fans or piedmont plains on slopes that range from 0 to 45%. Elevations range from 3,300 to 5,400 ft. Runoff is slow to medium and the hazard of erosion is slight to high. Most soils in this association have moderate or high available water capacity. This association is limited to the lowlands in the eastern portion of the memorial. Vegetation is mainly perennial grasses and forbs, with a few oaks and juniper trees at higher elevations (Richardson et al. 1979).

The Castro-Martinez-Canelo association is characterized by deep soils (more than 60 in. deep) that are formed in old alluvium from mixed sedimentary and igneous rocks. This association generally occurs on dissected fans and piedmonts on slopes that range from 1 to 40%. Elevations range from 5,000 to 6,500 ft. Runoff is slow or medium and the and the hazard of erosion is

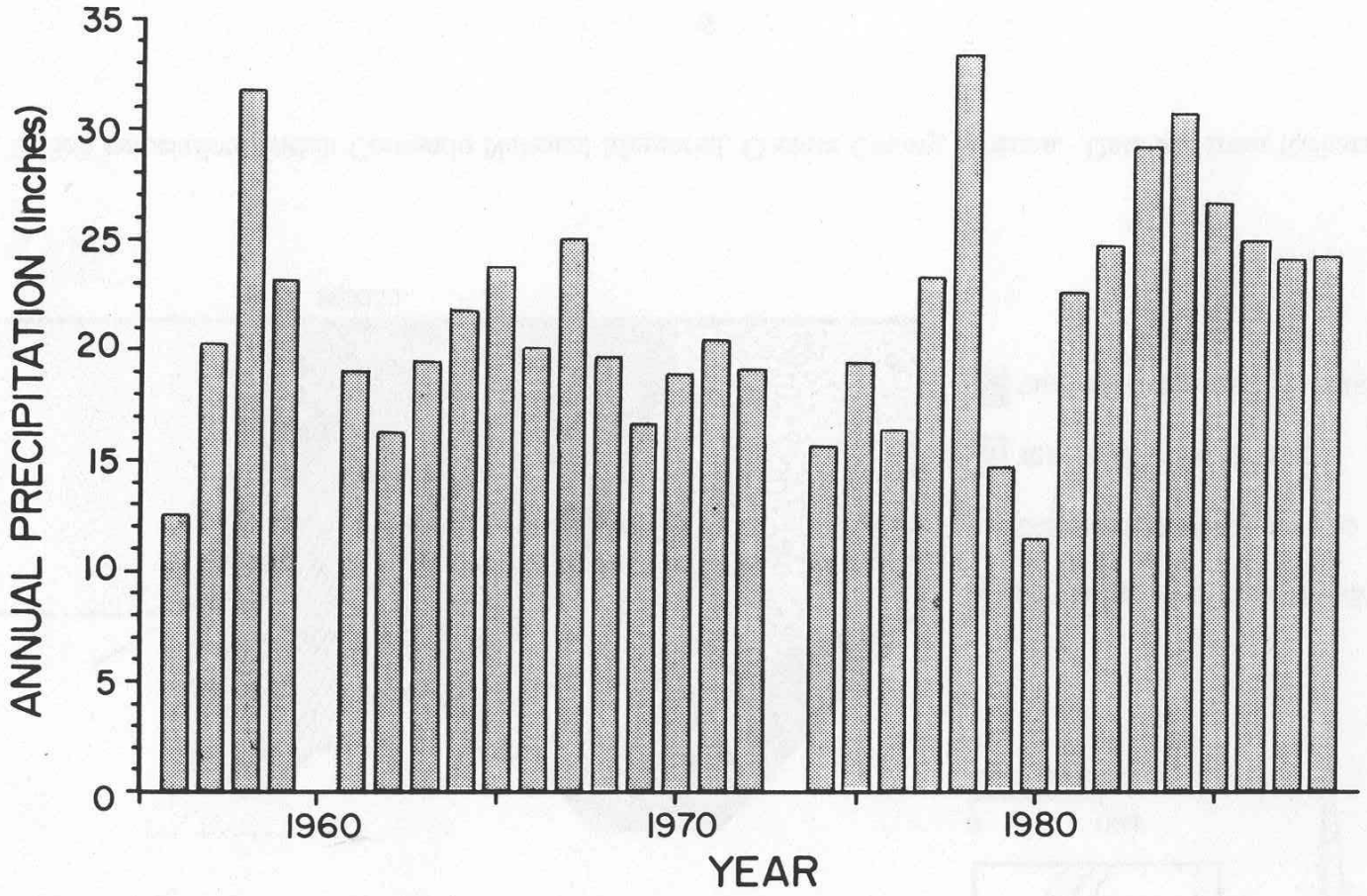


Figure 2. Total annual precipitation over the period of record, 1956-1988, at Coronado National Memorial, Cochise County, Arizona.

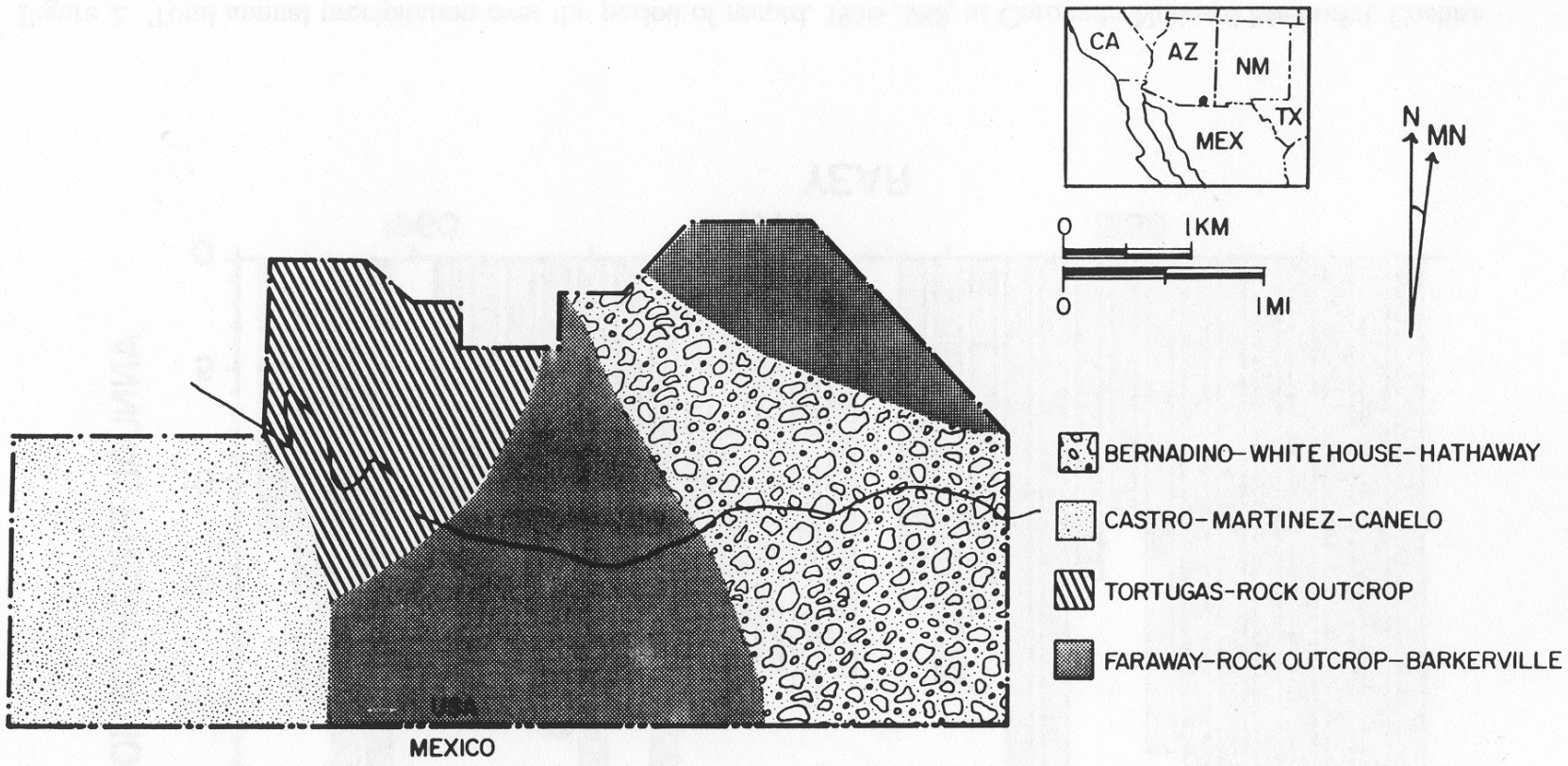


Figure 3. Soil associations within Coronado National Memorial, Cochise County, Arizona. Data are from Richardson et al. (1979).

slight to high. Permeability is slow to very slow, and available water capacity is low to high. This association is limited to high elevations in the western portion of the memorial. Vegetation is oak and juniper trees, shrubs, and grasses (Richardson et al. 1979).

The Faraway-Rock outcrop-Barkerville association is characterized by shallow soils, usually less than 20 in., that occur on slopes that range from 10 to 60%. Elevations range from 5,000 to 7,000 ft. Runoff is medium to rapid, and the hazard of erosion is moderate or high. These soils have very low available water capacity because they are shallow and have a high content of rock fragments. This is the most extensive soil association in the memorial, and encompasses all but the eastern, western, and northwestern portions of the memorial (Fig. 3). Vegetation is oak and juniper trees, Mexican pinyon pine and Arizona madrone (*Arbutus arizonica*). Shrubs and grass form the understory (Richardson et al. 1979).

The Tortugas-Rock outcrop association is characterized by shallow soils, usually less than 20 in., that occur on slopes that range from 5 to more than 60%. Elevations range from 4,800 to 7,000 ft. Runoff is medium or rapid, and the hazard of erosion is slight to moderate. The soils have very low available water capacity because they are shallow and have a high content of rock fragments. This association is limited to high elevations in the northwestern portion of the memorial. Vegetation is oak, juniper, and pine trees at higher elevations and brush and grass at lower elevations (Richardson et al. 1979).

GEOLOGY

Geological events that have occurred in CORO and throughout much of southeastern Arizona are represented in the vicinity of Montezuma's Cave. Doe (1986) constructed a geologic map and cross section of the area around and including Montezuma Cave (Appendix 1) and summarized the geological events as follows: "In this area, Late Paleozoic strata were invaded, lifted and metamorphosed as a stock of Jurassic Quartz Monzonite was emplaced. During the Triassic, volcanic material was deposited in a basin to the southwest. East of the basin, Early Cretaceous erosion resulted in deposition of Bisbee Group fluvial, estuarine and marine deposits. Mid- to Late Cretaceous Laramide compression resulted in complex, high angle, northwest tending, reverse faults and northeasterly directed thrust faulting.

"'The body of Jurassic Quartz Monzonite stock was a resistant obstacle within the compressional regime. The structural response was Montezuma Canyon Fault, a high angle, reverse fault tracing the canyon bottom. Around the same time, Concha Limestone overlaid by volcanic materials in the basin to the southwest was thrust-faulted into and over folded units of the Bisbee Group within the mapped area" (Doe 1986).

METHODS AND MATERIALS

BIOTIC COMMUNITY MAPPING

Biotic communities of CORO were mapped at a 1:6000 (1 in. = 500 ft) scale using the system of Brown et al. (1979). A preliminary map of biotic community distribution and composition was made using field observations in September and October 1987, previous studies (Wallmo 1955; Cockrum et al. 1979), and conversations with NPS personnel. The map was then amended based on aerial and ground checks made in October 1987, and March and July 1988. The area encompassed by each biotic community was estimated using a compensating polar planimeter.

The "Peak Fire" of June 1988 burned 3,700 a of the memorial. The distribution and intensity of affected areas were mapped at a 1:6,000 scale by Kathy Davis, Resource Manager in the Southern Arizona Group Office, NPS.

MONITORING PLOTS

Ten vegetation monitoring plots were located during March 1988 using a randomly stratified design; i.e., plots were randomly located in each of the four biotic communities in CORO. Plot attributes are summarized in Table 2. The center of each plot was marked with a 0.5-in. rebar stake and a 2.75- x 1-in. oval tag indicating the plot number and date of establishment. Relocating the plots involves using local topographic features, distance in paces, and compass bearing from the starting point (Appendix 1). Each center stake was photographed to facilitate plot relocation. These photographs are archived in NPS files at CORO.

Three circular plots of 0.001, 0.01, and 0.1 a, nested around each center stake, were used to sample forbs and grasses, succulents and shrubs, and trees (James and Shugart 1970). Trees were defined as those individuals that had stem diameters _> 4 in., 1 ft above ground level. All plots, with the exception of five 0.01- and 0.1-a plots, were sampled on 22-23 March 1988, 21-23 July 1988, and 29-31 August 1989. The five previously noted 0.01- and 0.1-a plots were not sampled in July 1988 because they were only slightly modified by the June 1988 fire (Table 2). Brad Ruess of Ruffner Associates assisted with sampling in July 1988. All plants within each plot were identified and counted; counts included only individuals that had at least part of the basal stem in the plot. Two perpendicular diameters of canopy that occurred within the plot were also measured on all trees and for a maximum of five individuals for each non-tree species. Cover of each individual was estimated as:

$$\text{COVER} \quad \frac{(\pi \times D1 \times D2)/4}{4}$$

Table 2. Attributes for the 10 plant monitoring plots established in Coronado National Memorial, Cochise County, Arizona. Number of species prior to and after the June 1988 fire does not include unidentified species.

Plot	Soil	Biotic Comm.	Elevation (Feet)	Aspect/ Slope	Burned	Number Of Species		
						Pre-Burn	Post-Burn*	
1	BWH	GMM	5,075	SE/1	+	10	7	13
2	BATH	GMM	5,050	SE/1	+	7	5	13
3	BATH	GMM	5,025	SE/1	-	4	n/a	12
4	BATH	GMM	5,075	SE/1	-	5	n/a	12
5	BWH	WM	4,975	ESE/3	-	11	n/a	15
6	TR	AAO	5,650	N/2	-	13	n/a	15
7	FRB	OMJ	5,350	NE/2	++	6	7	22
8	CMC	OMJ	6,675	ENE/3	++	8	4	21
9	TR	OMJ	6,675	ESE/3	+	6	6	14
10	FRB	OMJ	5,750	S/1	-	8	n/a	19

BWH = Bernadino-White House-Hathaway Soil Association
CMC = Castro-Martinez-Canelo Soil Association
FRB = Faraway-Rock outcrop-Barkerville Soil Association
TR = Tortugas-Rock outcrop Soil Association

GMM = Grama Grass-Mixed Grass-Mixed Shrub Grassland
WM = Western Honey Mesquite-Mixed Short Tree Woodland
AAO = Arizona Sycamore-Arizona Walnut-Oak Riparian Forest
OMJ = Oak-Mexican Pinyon Pine Juniper Woodland

1 = < 21 % slope
2 = 21-50% slope
3 = > 50% slope

+ + = severe burn
+ = moderate burn
-- = unburned

* Post-burn data are for July 1988 (left) and August 1989 (right).

Total cover for each non-tree species was estimated as the mean cover of the five measured individuals multiplied by the number of individuals in the plot.

PLANT LIST

An updated plant species list (including subspecies and varieties) was compiled using the most recent plant checklist and collections of unknown specimens encountered during this study. Collected specimens were pressed, identified by Bruce Parfitt of Ruffner Associates, and then accessioned to the Arizona State University Herbarium in Tempe, Arizona. Unknown plants that occurred within the study plots were identified from voucher specimens collected nearby.

MATCHED PHOTOGRAPHY

Photographs of vegetation at CORO are limited. Two photos were matched from plates in Cockrum et al. (1979). Neither slides nor negatives of the original photographs in Cockrum et al. (1979) could be located by Cooperative Park Service Unit/University of Arizona personnel or by Terry B. Johnson, who was a junior author responsible for photography in that study. The plates were photographed from the original publication and these sites were then rephotographed using a 35 mm camera and black and white Plus X film. There was a 10-year interval between the two sets of photographs.

Photographs were also taken of six monitoring plots in March 1988, July 1988, and August 1989 using a 35 mm Pentax camera, a 1:1.4/50 Super-Takumar lens, and Kodachrome 64 slide film, unless otherwise noted. Black and white negatives were subsequently made.

RESULTS AND DISCUSSION

BIOTIC COMMUNITIES

Four biotic communities occur in CORO (Table 3). The distribution and approximate boundaries of these communities are shown in Appendix 2.

The most extensive biotic community in CORO, covering almost 3,400 a, is the Oak-Mexican Pinyon Pine-Juniper Woodland Association, which is an open, evergreen woodland community. Grasses typically comprise most of the understory. In CORO, this association occurs mostly on the north- and south-facing slopes of the Huachuca Mountains. Dominant species vary with site, slope, and exposure. For example, nearly pure stands of oak occur on the south face of Montezuma Peak, while pinyon pine and juniper predominate the north face near the head of Joe's Canyon. Typical plant species include alligator juniper, Arizona white oak *(Quercus arizonica),* Emory oak (*Q. emoryi),* manzanita *(Arctostaphylos* spp.*),* Mexican blue oak *(Quercus oblongifolia),* mountain mahogany *(Cercocarpus montanus),* beargrass *(Nolina microcarpa),* desert spoon *(Dasylirion wheeleri),* and side oats grama *(Bouteloua curtipenudula).*

The Grama Grass *(Bouteloua* spp.)-Mixed Grass-Mixed Shrub Grassland Association is largely a Chihuahuan semidesert grassland community dominated by perennial grasses and shrubs. This association encompasses over 1,000 a in the eastern third of the memorial. Characteristic plant species include fairy duster *(Calliandra eriophylla),* rabbit brush *(Chrysothamnus nauseosus),* hedgehog cactus *(Echinocereus pectinatus),* Palmer agave *(Agave parryi),* Lehman lovegrass *(Eragrostis lehmanniana),* and blue grama *(Bouteloua gracilis).* Lehman lovegrass, a species introduced from South Africa, appears to be spreading naturally throughout much of southern Arizona to the detriment of more palatable native grasses (Brown 1982). Arizona white oak, Emory oak, and honey mesquite *(Prosopis glandulosa)* are scattered throughout the habitat.

The Western Honey Mesquite - Mixed Short Tree Woodland Association is a type of Sonoran Desert riparian forest that typically occurs below 3,900 ft and is restricted to streams, springs, along ephemeral drainages, and areas that have a shallow water table. Trees do not usually form a closed canopy in this association. This association is a minor biotic community in the memorial. It covers only 224 a and occurs in the eastern third of the memorial along drainages of lower Montezuma Canyon. Typical species of this association include Arizona white oak, desert *willow (Chilopsis linearis),* Emory oak, honey mesquite, poison *ivy (Rhus radicans),* rabbit brush, sumac *(Rhus virens),* cane cholla *(Opuntia spinosior),* Lehman lovegrass, and side oats grama. Relatively dense stands of desert willow and occasional honey mesquites are scattered along drainages in the southeastern corner of the memorial.

The Arizona Sycamore (Platanus wrightii)-Arizona Walnut (Juglans major)-Oak Riparian Forest Association is a mixed-broadleaf forest community that often forms a well-developed gallery, but has a depauperate understory flora. This association occurs along major and secondary drainages in which water is perennial or seasonally intermittent, such as in middle and upper Montezuma Canyon. Consequently, this association comprises only about 100 a, a minor portion of the memorial. Plant species typical of this association include Arizona white oak, Arizona rosewood *(Vauquelinia californica),* Arizona sycamore, catclaw acacia *(Acacia greggii),* manzanita, brickellia *(Brickellia sp.),* wild grape (*Vitis arizonica),* and needle grass (*Stipa* sp.).

Table 3. Acreages of the four biotic communities that occur in Coronado National Memorial, Cochise County, Arizona. Numbers following each plant association refer to the system used by Brown et al. (1979).

Plant Association	Acreage
Oak-Mexican Pinyon Pine Juniper Woodland (123.316)	3,363
Grama Grass-Mixed Grass-Mixed Shrub Grassland (143.114)	1,063
Western Honey Mesquite-Mixed Short Tree Woodland (224.522)	224
Arizona Sycamore-Arizona Walnut-Oak Riparian Forest (223.225)	101
TOTAL	4,751

The Peak Fire of June 1988, originated in Mexico, but spread into the United States, and affected most of CORO. The Oak-Mexican Pinyon Pine-Juniper Woodland Association was most affected, as about 2,600 a of the 3,700 a that burned were in this habitat (Appendix 3). Most of this biotic community was burned to a moderate degree, except for some severely burned areas in the western portion of the memorial. The Oak-Mexican Pinyon Pine-Juniper Woodland Association was probably most affected by the fast-moving, intense fire in continuous grass fuels. However, many of the trees in the vegetation monitoring plots and elsewhere had either resprouted from the roots or from undamaged areas of the trunk by August 1989. The species composition of the woodland understory was significantly changed after the fire, probably due to the influx of nutrients and/or appropriate conditions for germination of numerous herbaceous species that were either rare or absent before the fire.

The Grama Grass-Mixed Grass-Mixed Shrub Association was relatively unaffected by the fire because little fuel was present to sustain a high temperature fire. Consequently, the effect of the fire on this habitat was largely ephemeral as most of these species are fire adapted and quickly resprout from roots. Effects of the Peak Fire on vegetation monitoring plots are discussed below.

MONITORING PLOTS

Four monitoring plots (1-4) are located in the Grama Grass-Mixed Grass-Mixed Shrub Grassland Association. Sixteen to 18 plant species occurred in these plots (Appendix 4). Lehman lovegrass, plains lovegrass *(Eragrostis intermedia),* and blue grama were the most prevalent herbaceous species in these plots, both in number and canopy cover. Wright buckwheat *(Eriogonum wrightii)* and fairy duster were the most common grassland shrubs. Rabbit brush, hedgehog cactus, and species of agave *(Agave* spp.*)* occurred in low densities. Emory oak was the only tree species in these plots. Mexican blue oak and honey mesquite occurred nearby.

The Peak Fire had a short-lived affect on plant species composition in the Grama Grass-Mixed Grass-Mixed Shrub Grassland Association monitoring plots. Succulent and woody species were mostly absent during the July 1988 sample period, but most of these plant species had resprouted from roots by August 1989. Species most affected by the fire were hedgehog cactus of which

only two of six individuals survived the fire, and rabbit brush of which none of eight individuals survived the fire. The effect on annual and perennial herbaceous plants is less clear. Many of these plants, particularly sod-forming bunch grasses (e.g., blue grama), are well adapted to survive fires. Changes in composition of annual plant communities are likely due to the response of these plants to burning and to normal year-to-year variability in species composition at a given site.

Plot 5, which is in the Western Honey Mesquite-Mixed Short Tree Woodland Association, is located in an ephemeral drainage near the eastern entrance of the memorial. At least 25 plant species occurred in this plot (Appendix 2). The dominant herbaceous species were Lehman lovegrass, panicum grass (*Panicum* spp.), and tick clover *(Desmodium rosei).* Morning glory *(Ipomoea heterophylla)* and rabbit brush were the dominant sub-shrub and shrub species, respectively, while desert willow was the dominant tree.

Although Plot 5 was not burned in the Peak Fire, it was modified by a flash-flood event shortly after the fire, which substantially altered the streambed structure in and near the monitoring plot. Though this event had little effect on sub-shrubs, shrubs and trees, it did influence the herbaceous plants. The unknown Poaceae found in July was probably Lehman's lovegrass even though it lacked diagnostic characters. While density of this species was not affected, its cover was reduced by almost 60%. Side oats grama was also reduced in density and cover during July 1988. Herbaceous plants had increased to twice their pre-scour density by August 1989.

Plot 6, which is in the Arizona Sycamore-Arizona Walnut-Oak Riparian Forest Association, is located west of the memorial headquarters in the ephemeral drainage of Montezuma Canyon. It had 23 plant species, 16 of which were tree species, more than in any other plot. This reflects the exclusive presence of many riparian plant species (e.g., Arizona rosewood, Arizona walnut, and Arizona madrone). Herbaceous plants, subshrubs, and shrubs were rare in this plot because the center stake was near the margin of the ephemeral stream channel. This was especially true in August 1989, as a recent flood had deposited 2-3 ft of sand and gravel in the stream channel. Arizona white oak dominated the tree stratum, followed by Emory oak, silverleaf oak *(Quercus hypoleucoides),* and Arizona wild grape.

Plots 7-10 are in the Oak-Mexican Pinyon Pine Juniper Woodland Association. The species composition of these plots varied considerably due to their relative position, elevation, and aspect on the slopes of Montezuma Canyon (Table 2). Plots 7 and 10 are in an almost pure oak woodland, though density of dominant oaks differed considerably. Plots 8 and 9 were dominated by Mexican pinyon pine and alligator juniper. All four of these plots were affected by the Peak Fire.

Plot 7 supported at least 26 species of plants. Characteristic grasses were side oats grama, beggar-tick three-awn *(Aristida orcuttiana),* and bullgrass *(Muhlenbergia emersleyi).* New Mexican copperleaf and tick clover were the numerically dominant herbaceous species during August 1989. Rabbit brush and squaw bush *(Rhus trilobata)* were only present during the August 1989 sampling period. Emory oak was the dominant tree species, followed by beargrass, Arizona white oak, and desert spoon.

This plot was significantly altered by the Peak Fire. The most significant change was in the understory flora, the cover of which increased over 15-fold after the fire. Several new herbaceous species occurred on the plot after the fire. The presence of at least some of these species is

undoubtedly due to establishment of suitable germination conditions and to the regenerating effects of the fire. This may be especially true for morning glory and nightshade *(Solanum deflexum),* which occurred in high numbers immediately after the fire, but were greatly reduced or absent by August 1989. Rabbit brush and squaw bush were also first observed in the plot during August 1989. The fire appeared to have had a short-term affect on the trees, as 20 of 28 oaks had resprouted from the roots or from undamaged above-ground tissue by August 1989. Burning had little effect on beargrass or desert spoon density, although cover of these succulent species was reduced substantially. By August 1989, four additional individuals of desert spoon occurred in the plot, and the cover of both desert spoon and beargrass had largely recovered to its pre-fire level.

Plot 8 supported 26 species of plants. Side oats grama was the most common grass, though cane bluestem *(Bothriochloa barbinodis)* and beggar-tick three-awn were also present. Several new herbaceous species also occurred during August 1989, after the fire, the most numerous being *Pectin felipes* and *Sanvitalia abertii.* Shrubs and succulents included mountain mahogany, cat's claw mimosa (*Mimosa biuncifera),* and cane cholla. Beargrass, Mexican pinyon pine, Schott's yucca (*Yucca shottii*), and alligator juniper occurred in the 0.1 plot. The canopy was dominated by Mexican pinyon pine and juniper.

This plot has been modified substantially by the Peak Fire. Beggar-tick three-awn, a perennial, was not located on the plot in March, but several occurred in July. Cane cholla, mountain mahogany, Mexican pinyon pine, and alligator juniper have been eliminated from the plot. Density and cover of beargrass and Schott's yucca were substantially reduced.

At least 23 species of plants were present on Plot 9. Panicum and Lehman lovegrass were the most common grasses on the plot. The number and cover of herbaceous plants were much greater in August 1989; cover was approximately 15-fold greater than during either of the two previous sampling periods. Succulents and shrubs present in March included cane cholla and rabbit brush, respectively. Beargrass and Mexican pinyon pine occurred in the 0.1 plot, the canopy of which was relatively open.

Plot 9 was modified substantially by the Peak Fire. Rabbit brush and Mexican pinyon pine had been eliminated, while only one of six cane chollas remained. Cover of beargrass was reduced almost 20-fold in July 1988, but had increased to near pre-fire levels by August 1989. Burning revealed that there were actually 8 individuals of beargrass, not 5 as recorded in March 1988. Several new herbaceous species occurred in the plot after the fire, again probably due to the regenerative effects of the fire. Morning glory and beggar-tick three-awn appeared to be short-lived after the fire, as they appeared in relatively high numbers during July 1988, but were absent or largely reduced in number by August 1989. Cover of understory species had increased about 15-fold from one month after the fire to the following year.

Plot 10 supported at least 22 species of plants. The dominant herbaceous plant was Lehman lovegrass, though an unknown grass seedling was numerically dominant during August 1989. Low numbers of cane cholla and goldeneye *(Viguiera sp.)* occurred in the 0.01 plot. Emory oak was the dominant tree, followed by squaw bush, manzanita, and Arizona white oak. This plot was largely unaffected by the Peak Fire as it lay at the margin of the burned area (Appendix 3).

Vegetation monitoring plots were undersampled in all four biotic associations, both in terms of substrate types sampled and number of replicates in each association. Substrate types of the existing plots were representative of each biotic association, but because of the small number of plots, some substrate types such as limestone outcrops were excluded.

The adequacy of the number of monitoring plots may be examined by plotting the cumulative number of plant species that occurred in plots within each biotic association.

This technique is also known as a species-area curve (Mueller-Dombois and Ellenberg 1974). An adequate sample size is indicated by a plateau in the number of new plant species encountered in additional monitoring plots. Such plots in the Grama Grass-Mixed Grass-Mixed Shrub Grassland and Oak-Mexican Pinyon Pine-Juniper Woodland Associations, both before and shortly after the fire, and one year later, showed a continuing upward trend in the number of plant species encountered (Fig. 4). Such a trend indicates that previously unencountered plant species will occur in additional monitoring plots, and that additional monitoring plots are required to adequately sample each biotic association.

The average number of plant species per plot was 11.4 (range 8 to 16) and 15.9 (range 12 to 22) during the 1988 and 1989 sampling periods, respectively, about 4% of flora of the memorial. That the monitoring plots encompassed a wide variety of habitats and areas within the memorial was attested by the occurrence of at least 88 plant species, about 27% of flora at the memorial, within the 10 monitoring plots.

Approximately 8 person-hours are required to sample and analyze data for each monitoring plot. Additional plots should be established within the two riparian associations if future funding allows a larger scale monitoring effort. Subsequent to these efforts, additional plots should be established in the woodland and then the grassland association.

Future monitoring of the vegetation plots should use annual photography from established photo points, such as toward the center stake from a fixed point on the perimeter of the 0.1 circle. Photos should be taken with a 35 mm camera, a standard 50 mm lens, and black and white film, preferably Kodak Plus X or its equivalent. A small chalk board giving the plot number, date, and photographer should be included in each photo. All photos and the photographer's annual notes should be archived at the memorial. Changes in the plant community, as documented by annual photographs, could be quantified periodically by re-sampling the vegetation monitoring plots and comparing those data with existing baseline data (Appendix 4).

Equipment needed for these monitoring efforts includes a compass, directions for finding the plots, maps of the plot locations, data sheets, a rope marked off at 37.25 ft, 11.8 ft, and 3.75 ft, a 3-ft tape measure (in 0.1-ft intervals), a 100-ft tape measure, chalkboard and chalk, and a 35 mm camera with a 50 mm lens and plus X black and white film. The plots are inventoried by attaching the rope to the center stake and then identifying, quantifying, and measuring the appropriate plants within the 0.1-a circle (37.25-ft arc), 0.01-a circle (11.8-ft arc), and 0.001-a circle (3.75-ft arc) (see "Methods and Materials").

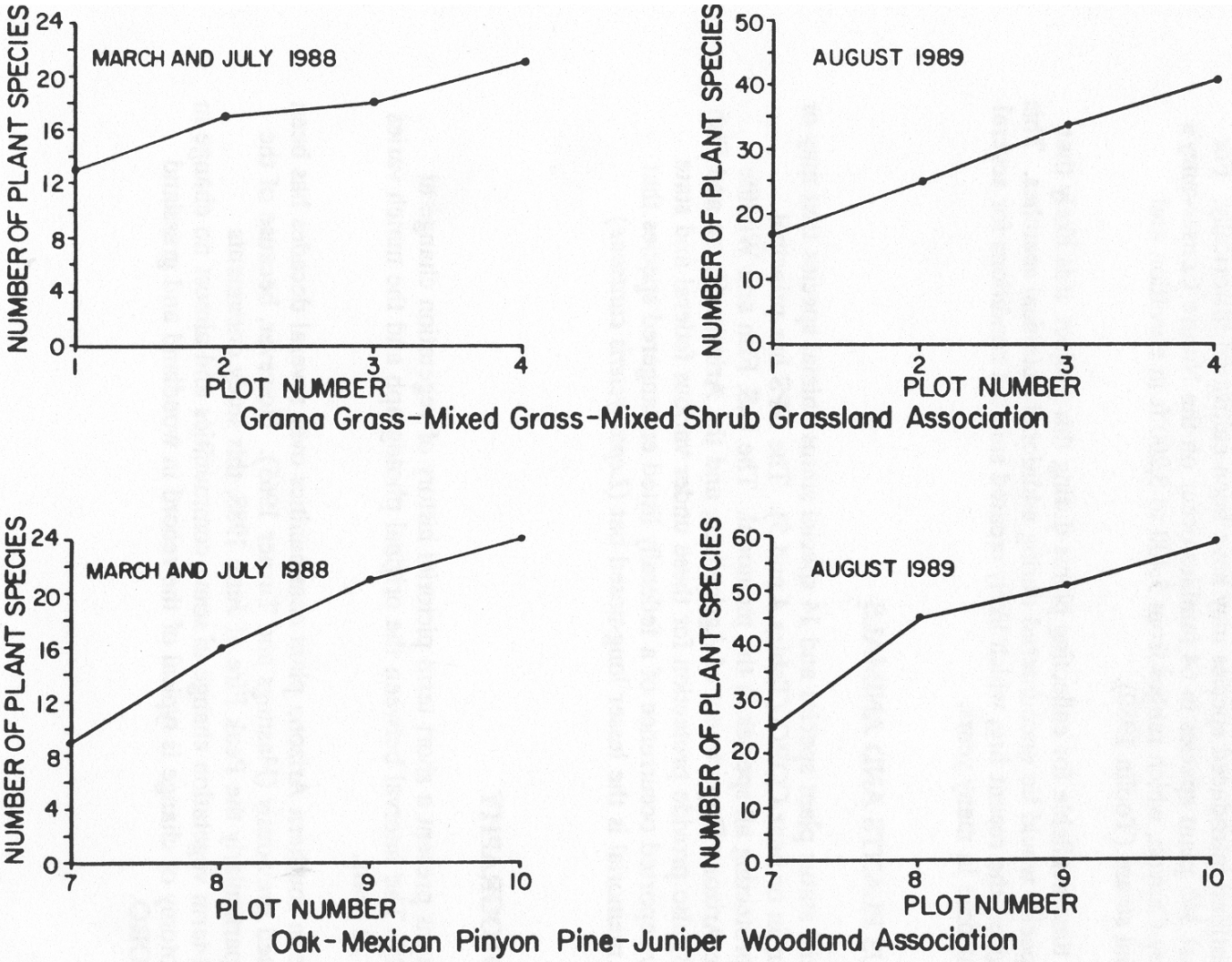


Figure 4. Cumulative number of plant species in four plots within the Grama Grass—Mixed Grass—Mixed Shrub Grassland Association and the Oak—Mexican Pinyon Pine Juniper Woodland Association at Coronado National Memorial, Cochise County, Arizona.

PLANT LIST

The current flora of CORO consists of 327 species in 64 families (Appendix 5). This study added 107 species, 101 native and 6 introduced, and 12 families to the known flora of the memorial. None of these new species were records for the United States. Several of the 6 newly identified introduced species may have been cultivated historically. For comparison, at least 343 plant species in 64 families occur on the Nature Conservancy's property in Ramsey Canyon, which ranges from 5,400 to 8,200 ft in elevation and includes a perennial steam (Toolin 1980).

Given the limited time available for collecting plants during this project, it is likely that numerous other species would be encountered during additional botanical searches. This is especially true given the recent fire, which likely created suitable conditions for several species for the first time in many years.

SPECIAL STATUS PLANTS AND ANIMALS

There are 23 special status plant species and 14 special status animal species that may or are known to occur in or near CORO (Tables 4 and 5). The NPS has principal responsibility for protecting all species in the memorial. The U.S. Fish and Wildlife Service (1988), the Arizona Department of Agriculture, and the Arizona Game and Fish Commission (1988) also provide protection for these under various federal and state statutes. The only reported occurrence of a federally listed endangered species that resides within the memorial is the lesser long-nosed bat *(Leptonycteris curasoae)* (Cockrum 1989).

MATCHED PHOTOGRAPHY

Matched photographs present a short term pictorial history of vegetation change at CORO (Figs. 5-12). The interval between the original photograph and the match varies from 3 months to 10 years.

Vegetation change in southern Arizona plant communities over several decades has been clearly demonstrated previously (Hastings and Turner 1965). However, because of the course of events, particularly the Peak Fire of June 1988, this study documents considerable short-term vegetation change in some communities and almost no change in others. This dichotomy of change is typical of the record in woodland and grassland communities at CORO.

Table 4. Special status plant species that may occur in Coronado National Memorial, Cochise County, Arizona. In addition to NPS protection, these species receive varying degrees of protection from the U.S. Fish and Wildlife Service and the Arizona Department of Agriculture.

Species	Range	Comments
US. Fish and Wildlife Service		
Candidate Category 1		
Senecio huachucanus	Huachuca Mountains	moist loam soils in ponderosa pine forests at elevations of 7,300-8,400 ft; probably does not occur in CORO.
Candidate Category 2		
Astragalus hypoxylus Huachuca milk vetch	Huachuca Mountains	stony openings on limestone derived soils in oak-pine. juniper woodlands; historic locations in the Huachucas.
Cynanchum wigginsii	Huachuca Mountains	under shrubs in chaparral or in openings within woodlands; usually twining on grasses and other understory vegetation.
Erigeron lemmonii Lemmon's fleabane	Huachuca Mountains	understory species in evergreen woodlands; present in Ramsey Canyon at elevations -above 6,400 ft.
Lillium parryi	Huachuca Mountains	primarily in shaded canyons having deep, rich wet soils;
Lemon lily		probably does not occur in Coronado.
Margaranthus lemmonii	Huachuca Mountains	primarily dry stream channel in the Huachucas; 1982 survey did not locate only known population.
Talium marginatum	southeastern Arizona	thin gravelly soils at elevations above 7,100 ft;
Tepic flame flower		known only from isolated sites in lowland and upland habitats.

Arizona Commission of Agriculture and Horticulture

Anthericum torreyi	*Dasylirion wheeleri*	*Opuntia chlorotica*
Asparagus officinalis	*Nolina rnicrocarpa*	*Opunta engelmannii*
Dichelosternma pulchellum	*Yucca schottii*	*Opunta spinosior*
Agave palmeri	*Prosopis glandulosa*	*Fouquieria splendens*
Agave parryi	*Echinocereus pectinatus*	
Agave schottii	*Mammillaria heyderi*	

References: Arizona Native Plant Law Arizona Revised Statutes, Chapter 7, Sections 3-901/3-910, inclusive; Rutman (1989); Toolin (1980); U.S. Fish and Wildlife Service (1988).

Table 5. Special status animal species that may occur in Coronado National Memorial, Cochise County, Arizona. In addition to NPS protection, these species receive varying degrees of protection from the U.S. Fish and Wildlife Service and the Arizona Game and Fish Commission.

Species	Range	Comments
U.S. Fish and Wildlife Service		
Endangered		
Falco peregrinus anatum American peregrine Falcon	statewide	high cliffs of south-facing slopes of the memorial could provide nesting substrate.
Falco femoralis sepentrionalis Northern Aplomado Falcon	southeast Arizona	extirpated from southeast Arizona grasslands, however, unconfirmed sightings have been reported; still known from adjacent Mexico.
Canis lupus baileyi Mexican grey wolf	southeast Arizona	extirpated from southeast Arizona; occasional unconfirmed sightings of wolves have been reported; still known from adjacent Mexico.
Leptonycteris curasoae lesser long-nosed bat	southern Arizona	records from caves in Miller Canyon; recorded in CORO
Candidate Category 2		
Ambystoma tigrinum stebbinsi Sonoran tiger salamander	Huachua Mountains	records from the Huachucas; suitable habitat exists within CORO for this species
Myotis velifer velifer Cave myotis	Huachuca mountains	records from the Huachucas; suitable habitat for this species exists in CORO
Cynomys ludovicianus arizonensis Arizona prairie dog	Huachuca Mountains	historical specimens known from Fort Huachuca and vicinity including the San Pedro River, probably extinct.
Stygobromus arizonensis Arizona spring amphipod	southeast Arizona	subterranean pools.
Speyeria nokomis caerulescens	Huachuca Mountains	habitat unknown; thought to be extinct.
Arizona Game and Fish Commission		
Endangered		
Hylactophyrene augusti Barking frog	Huachuca Mountains	vocalizations from limestone outcrop north of CORO maintenance yard in Montezuma Canyon.
Sistrurus catenanus edwardsi Desert-grassland massasauga	southeast Cochise Co.	known from grasslands adjacent to CORO; suitable habitat for this species exists in the memorial.
Leptonycteris sanborni Sanborn long-nosed bat	Huachuca Mountains	see above.
Threatened		
Choeronycteris mexicana long-tongued bat	Huachuca Mountains	suitable habitat for this species exists in CORO

Table 5 (continued)

Species	Range	Comments
Candidate Species		
Crotalus willardi willardi Ridge-nosed rattlesnake	Huachuca Mountains	suitable habitat for this species exists in CORO.
Falco peregrinus anatum American peregrine Falcon	statewide	see above.
Extinct		
Falco femoralis sepentrionalis Northern Aplomado Falcon	southeast Arizona	see above.
Cynomys ludovicianus Arizona prairie dog	southeast Arizona	see above.
Canis lupus bayleyi Mexican grey wolf	southeast Arizona	see above.
Ursus arctos Grizzly bear	statewide	extirpated within historical range.
Antilocapra americana mexicana Chihuchuan pronghorn antelope	southeast Arizona	reintroductions are underway; this species was not reported after 1920; CORO is within the historic range.

References: Arizona Game and Fish Commission 91988); Cockrum et al. (1979); Hoffmeister (1986); Hoffmeister and Goodpaster (1954); U.S. Fish and Wildlife Service (1988).



Figure 5b. July 1988

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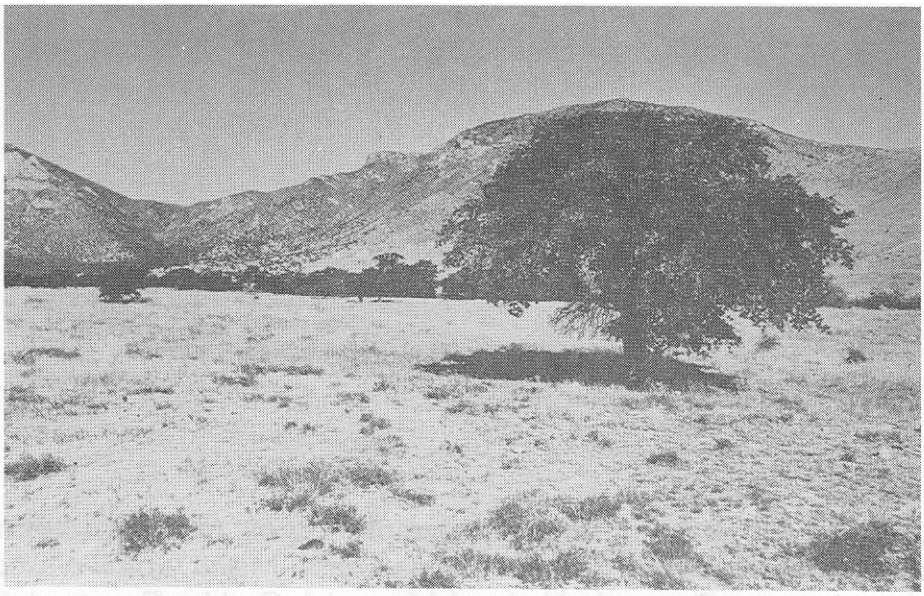


Figure 5a. 1978

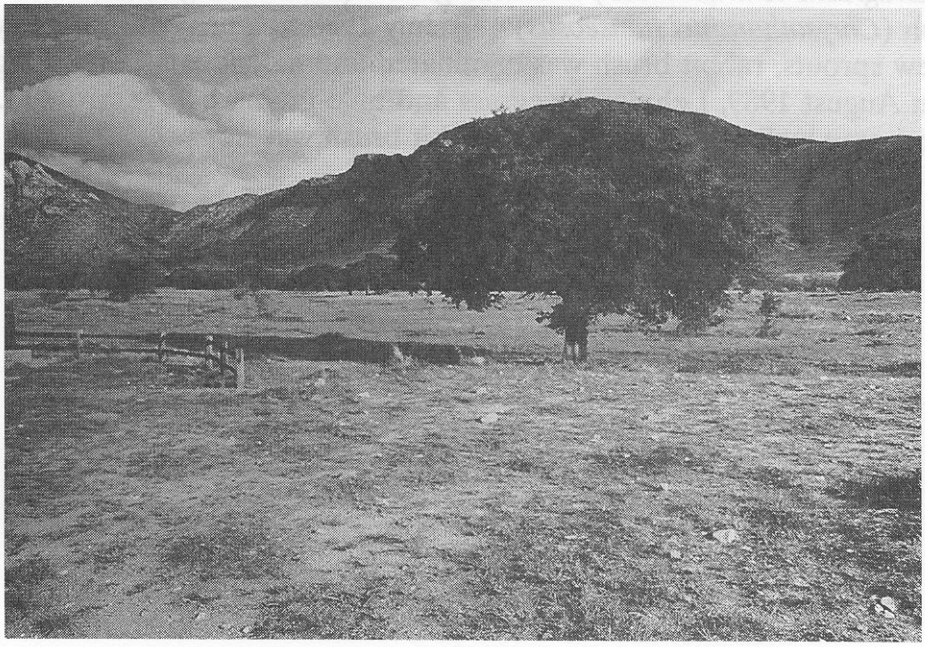


Figure 5b. July 1988

Figures 6a, 6b, and 6c. Series of three photographs looking to the northwest toward the stake marking the center of Plot 2 in the Grama Grass-Mixed Grass-Mixed Shrub Grassland Association at Coronado National Memorial, Cochise County, Arizona. The photographs were taken in March 1988, July 1988, and August 1989. The area was burned in June 1988. In March 1988 grasses were dominant, particularly Lehman lovegrass (*Eragrostis lehmanniana)* and blue grama *(Bouteloua gracilis*). The shrub is rabbit brush *(Chrysothamnus nauseosus).* By July 1988, the grasses had not yet begun to produce new sprouts, rabbit brush was eliminated and individuals of morning glory were present. In August 1989, Lehman lovegrass and blue grama had resprouted. Morning glory had become well established, while rabbit brush was not present.



Figure 6a. March 1988

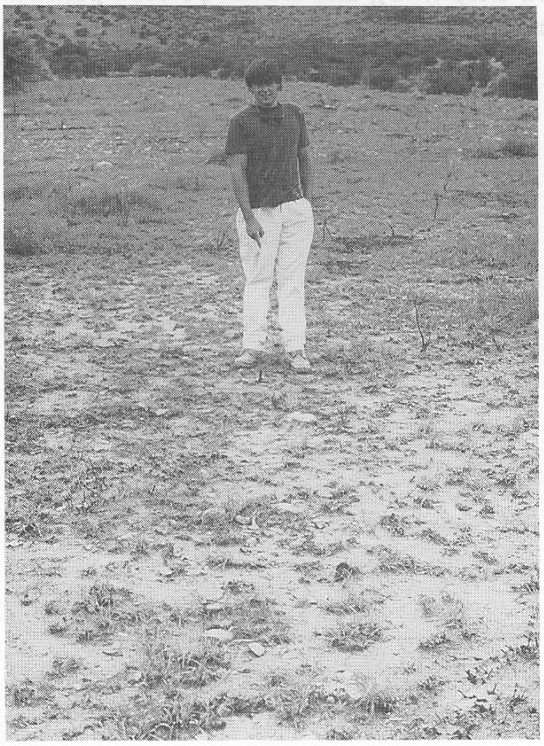


Figure 6b. July 1988

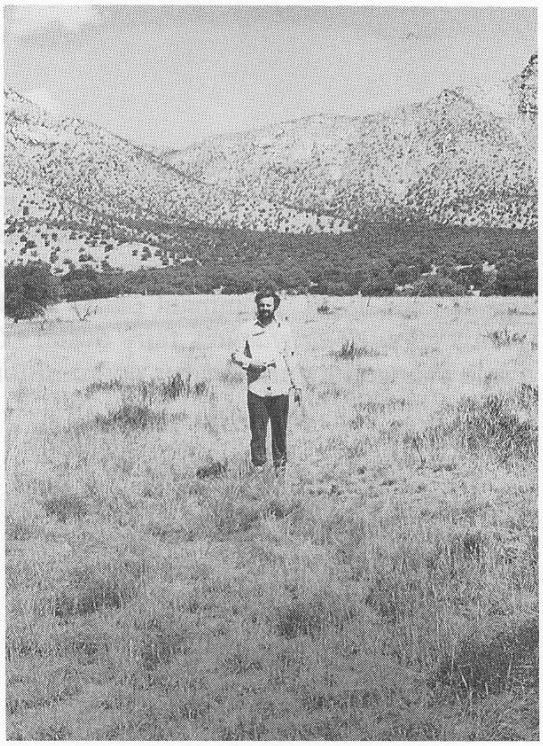


Figure 6c. August 1989

Figures 7a, 7b, and 7c. Series of three photographs looking north toward the stake marking the center of Plot 4 in the Grama Grass-Mixed Grass-Mixed Shrub Grassland Association at Coronado National Memorial, Cochise County, Arizona. The photographs were taken in March 1988, July 1988, and August 1989. This plot was not burned in the fire of June 1988. Dominant plants are Lehman lovegrass *(Eragrostis lehmanniana),* blue grama *(Bouteloua gracilis),* fairy duster *(Calliandra eriophylla),* and croton *(Croton pottsii).* Little change in plant species composition is apparent.

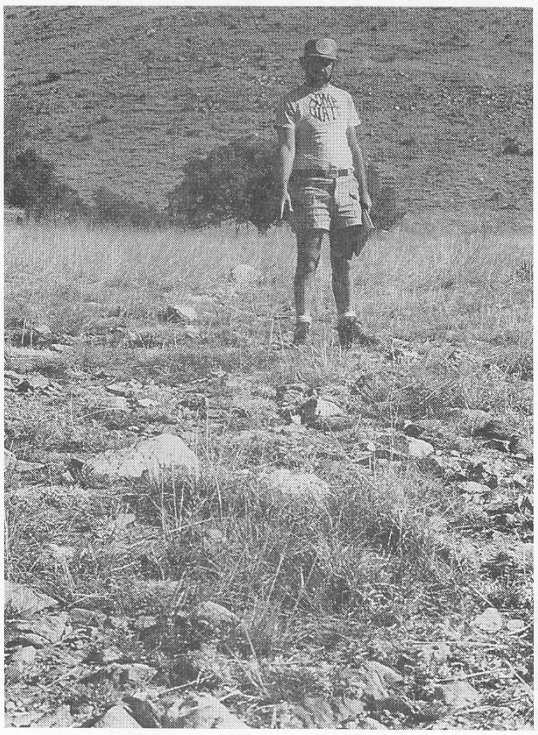


Figure 7a. March 1988

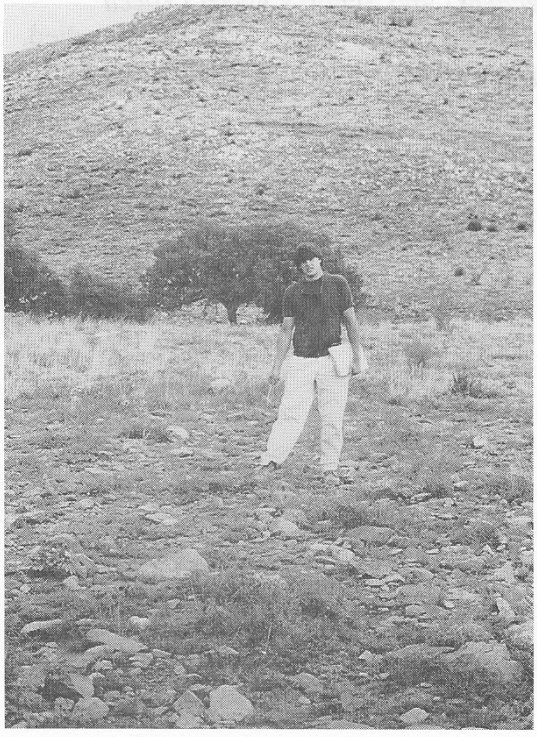


Figure 7b. July 1988

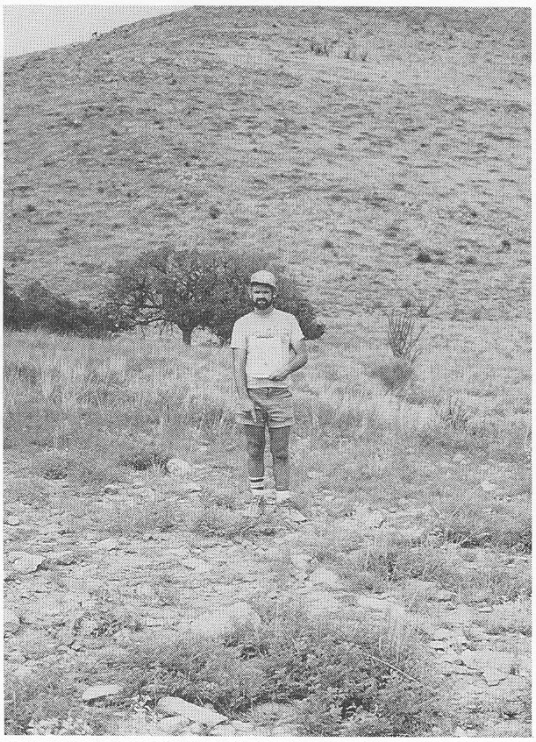


Figure 7c. August 1989

Figures 8a and 8b. Looking east from the residence area at Coronado National Memorial, Cochise County, Arizona, towards a low limestone hill in the Oak-Mexican Pinyon Pine-Juniper Woodland Association. The current maintenance yard is near the base of this hill on the south-facing slope. The photograph pair shows little apparent change in plant species composition between 1978 (Fig. 6 in Cockrum et al. 1979) and July 1988. Emory *(Quercus emoryi)* and Mexican blue oaks *(Quercus oblongifolia)* are dominant along the drainage in the foreground. On the slope, dominants include alligator juniper *(Juniperus deppeana),* Mearns sumac *(Rhus choriophylla),* manzanita *(Arctostaphylos pungens),* ocotillo *(Fouquieria splendens)* and Schott's yucca *(Yucca schottii).* In the intervening 10 years, a large manzanita on the crest of the hill has died, and the number of ocotillo, particularly to the right of the rock outcrop below the crest, has apparently increased.

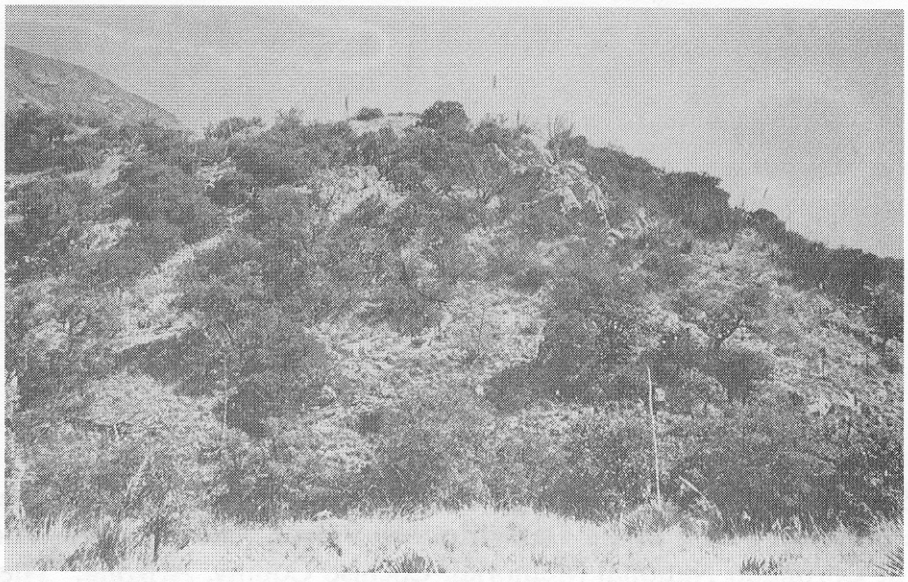


Figure 8a. 1978

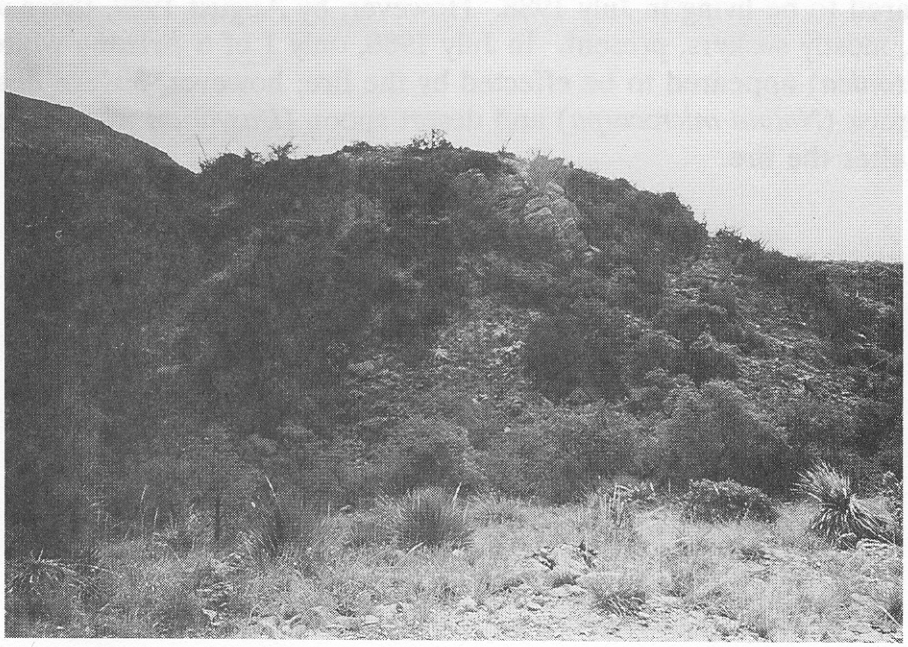


Figure 8b. July 1988

Figures 9a, 9b, and 9c. Series of three photographs looking west toward the stake marking the center of Plot 7 in the Oak-Mexican Pinyon Pine-Juniper Woodland Association at Coronado National Memorial, Cochise County, Arizona. The photographs were taken in March 1988, July 1988, and August 1989. The area was burned in June 1988. Immediate effects of the fire on understory plants is relatively apparent, as is the rapid response. Of 22 Emory oaks *(Quercus emoryi)* present on the plot in March 1988, only 1 appeared to be living in July 1988. However, by August 1989, there were 17 Emory oaks, mostly suckers, present. In July 1988, only 1 of 6 Arizona white oaks *(Quercus arizonica)* appeared to be effected by the fire; however, 3 were dead by August 1989. Beargrass *(Nolina microcarpa)* and desert spoon *(Dasylirion wheeleri)* were resprouting after the fire.

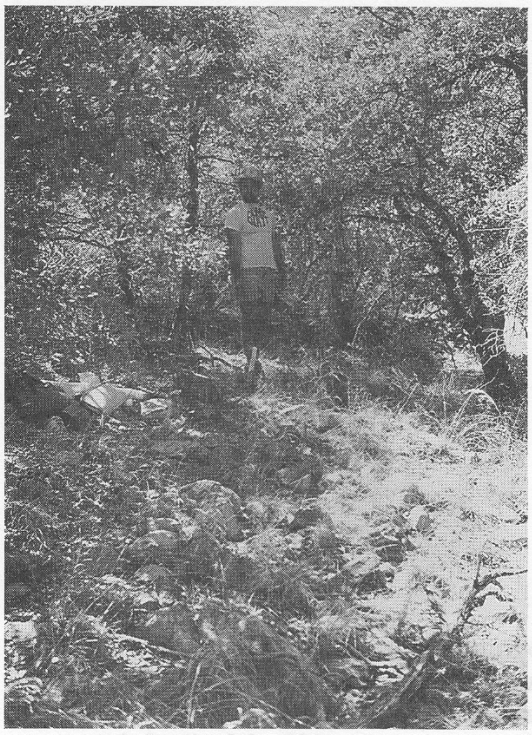


Figure 9a. March 1988

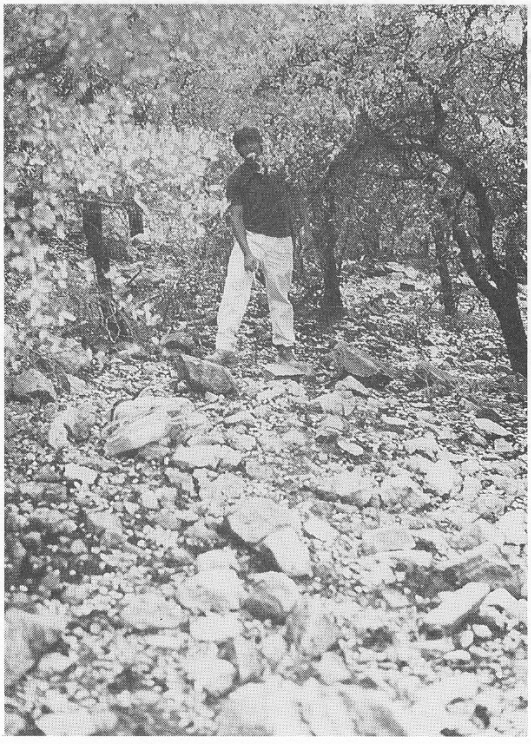


Figure 9b. July 1988



Figure 9c. August 1989

Figures 10a, 10b, and 10c. Series of three photographs looking west toward the stake marking the center of Plot 6 in the Arizona Sycamore-Arizona Walnut-Oak Riparian Forest Association at Coronado National Memorial, Cochise County, Arizona. The photographs were taken in March 1988, July 1988, and August 1989. Much of the watershed above the photograph point was burned in the June 1988 fire. By July 1988 two boulders were deposited in the channel. Approximately 2 ft of moderately coarse sediment accumulated in the ephemeral channel of Montezuma Canyon by August 1989. By this time, only the top of the large boulder on the left side of the photograph was visible near the right foot of R. A. Johnson. The concrete drainage structure in the Montezuma Pass Road provided gradient control immediately west of the photo point.



Figure 10a. March 1988

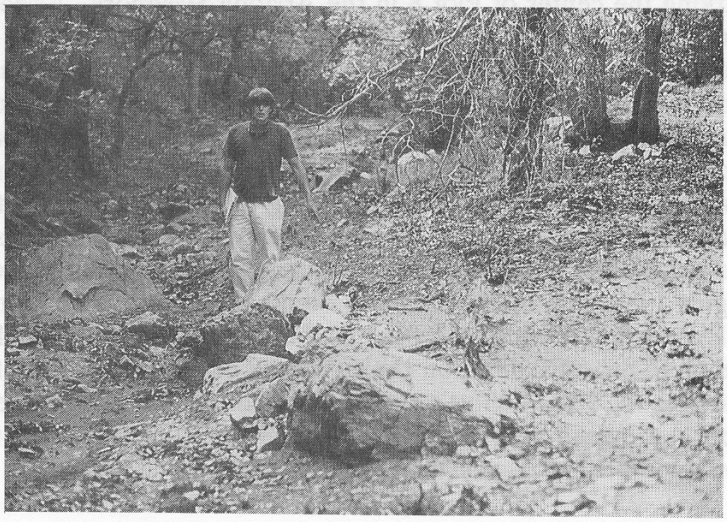


Figure 10b. July 1988

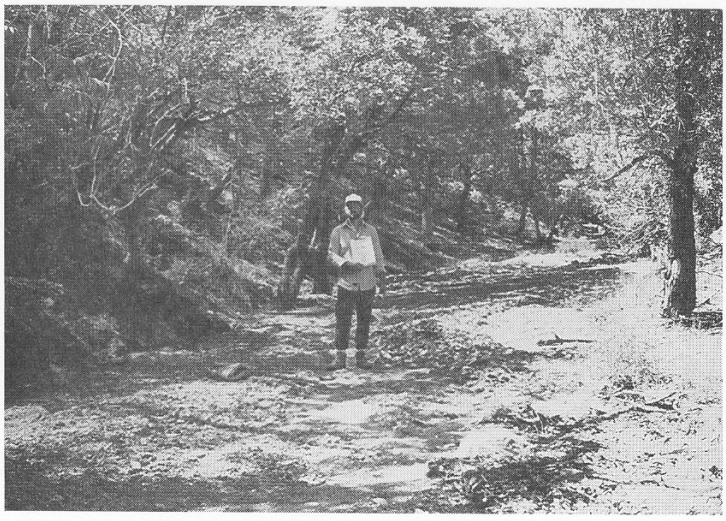


Figure 10c. August 1989

Figures 11a, 11b, and 11c. Series of three photographs looking north toward the stake marking the center of Plot 8 in the Arizona Sycamore Arizona Walnut-Oak Riparian Forest Association at Coronado National Memorial, Cochise County, Arizona. Photographs were taken in March 1988, July 1988, and August 1989. The area was burned in June 1988. In March 1988, the dominants included side oats grama *(Bouteloua curtipendula),* Schott's yucca *(Yucca schottii),* cane cholla *(Opuntia spinosior),* beargrass *(Nolina microcarpa),* alligator juniper *(Juniperus deppeana),* and Mexican pinyon pine *(Pinus discolor).* In July 1988, following the fire, beggar-tick three-awn *(Aristida orcuttiana),* beargrass, and Schott's yucca were present. Density of the latter two species was reduced by half while alligator juniper and Mexican pinyon pine were eliminated. By August 1989, side oats grama was dominant among understory species. Cane cholla suckers appeared from the base of the stem of two individuals present prior to the fire. The large Schott's yucca on the right side of the photograph flowered and produced fruit following the fire. Schott's yuccas damaged by the fire seemed to flower earlier than unburned individuals. In August of 1989, the formerly living top had died and suckers developed at the base of the plant.

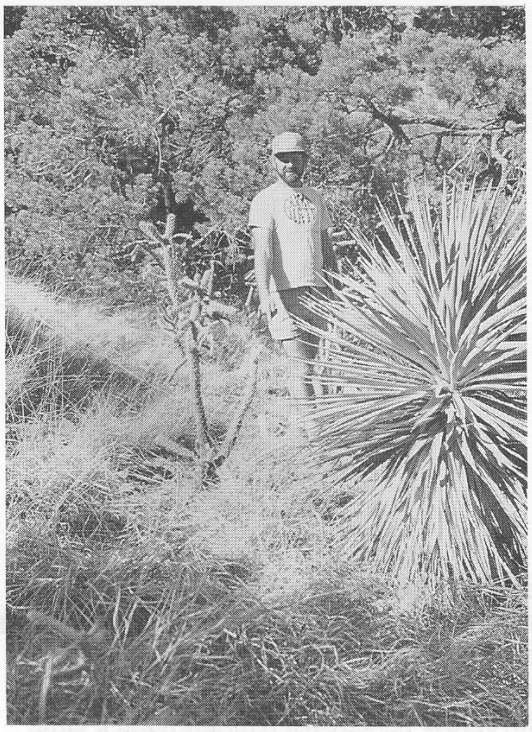


Figure 11a. March 1988

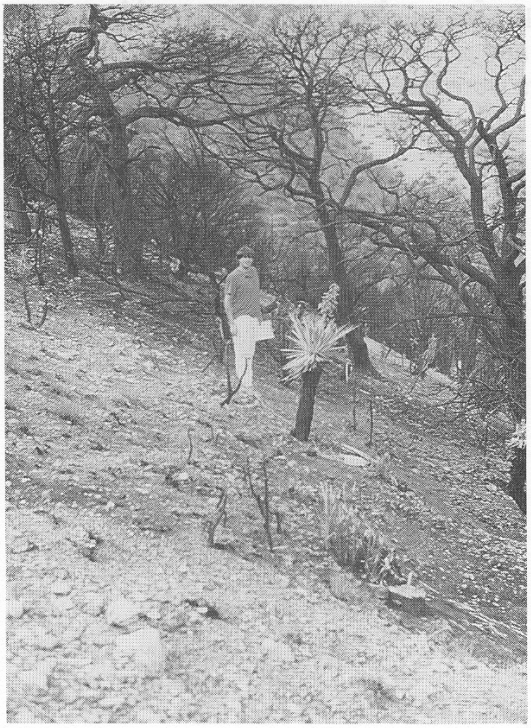


Figure 11b. July 1988

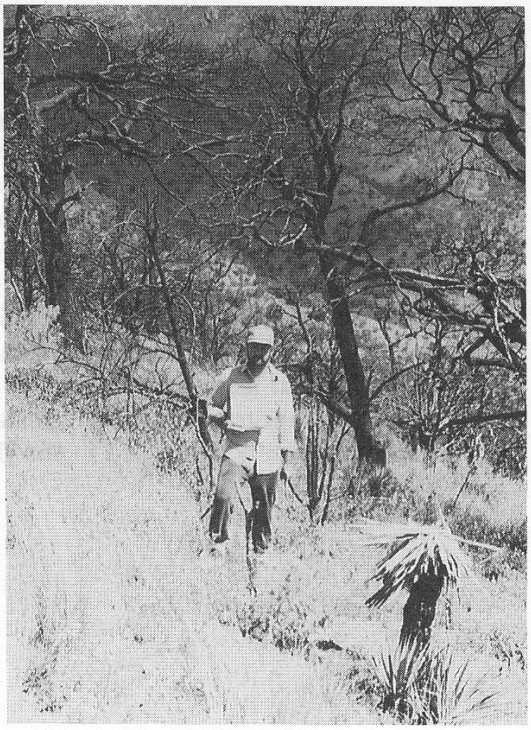


Figure 11c. August 1989

Figures 12a, 12b, and 12c. Series of three photographs looking west toward the stake marking the center of Plot 9 in Arizona Sycamore-Arizona Walnut-Oak Riparian Forest Association at Coronado National Memorial, Cochise County, Arizona. Photographs were taken in March 1988, July 1988, and August 1989. The area was burned in June 1988. In March 1988 dominants were Lehman lovegrass (*Eragrostis lehmanniana),* cane cholla *(Opuntia spinosior),* beargrass *(Nolina microcarpa)* and Mexican pinyon pine *(Pinus discolor).* The shrubs to the west of the stake were alder-leaf mountain mahogany *(Cercocarpus montanus).* Following the fire, in July 1988, the number of herbaceous understory species increased from 2 to 6; however, grasses present in March appeared to have been eliminated. Beargrass and cane cholla also appeared to have been eliminated. By August 1990, at least four species of grasses and nine species of herbaceous dicots were present. Beargrass and cane cholla suckers were also present at the bases of individuals apparently destroyed in the fire.

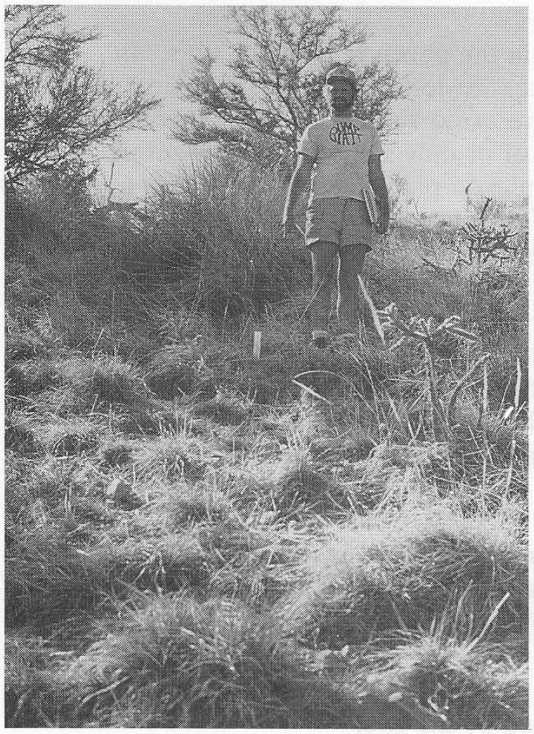


Figure 12a. March 1988

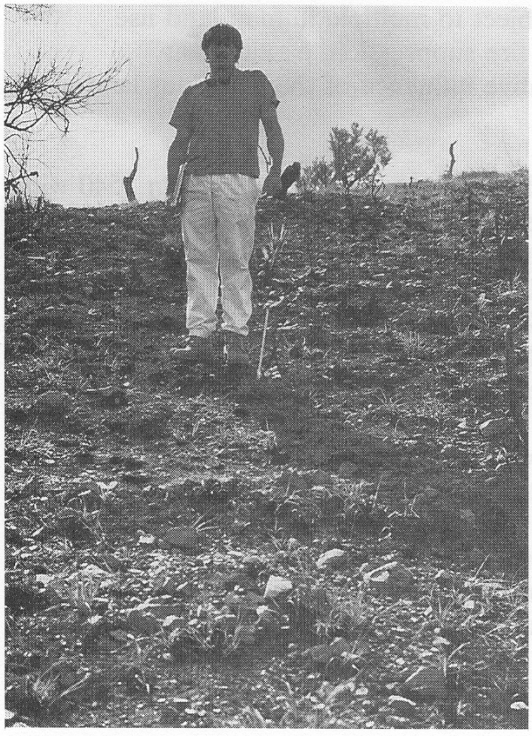


Figure 12b. July 1988

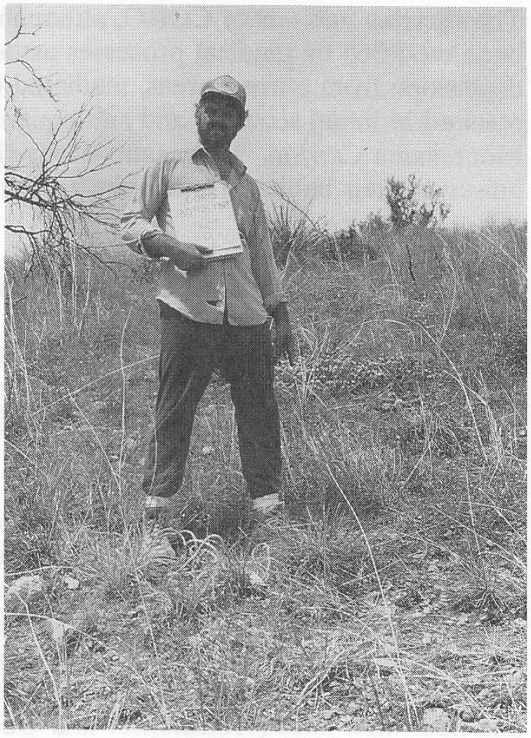


Figure 12c. August 1989

The woodland communities are relatively stable in the absence of major fires. In portions of the memorial burned in the Peak Fire, fire tolerant species like Emory and Arizona white oaks are able to survive intense fire as do succulents such as beargrass, desert spoon, and cane cholla. Plants incapable of or only sometimes resprouting, however-notably alligator juniper and Mexican pinyon pine-have been largely eliminated by the intense fires in woodland communities. There has been a noticeable increase in species diversity of the herbaceous understory plants in woodland communities following the fire.

Grassland communities of the memorial indicate little effect due to burning. Rabbit brush and hedgehog cactus have been eliminated or reduced in density on grasslands as a result of the Peak Fire. Honey mesquite and other woody species may be increasing within the grassland communities of the memorial. Aperiodic fire is an important mechanism in maintaining dominance of grasses in these communities.

The riparian habitats of CORO, although not directly affected by the Peak Fire, have been modified by physical processes associated with it. Transport of sediments downslope from burned areas, mediated by heavy summer rains following the fire, resulted in initial scouring and subsequent filling of the ephemeral channel of Montezuma Canyon. Dominant woody riparian plant species were not directly affected; however, their habitat has definitely been modified by the fire.

IMPACTS OF HISTORICAL LAND USE

The lands encompassed by CORO have been subject to multiple human land use practices including grazing, mining, woodcutting, fire suppression, exotic plant introduction, settlement, and visitation. The relative influence of these various land uses has varied temporally.

Grazing in the San Pedro River valley and Huachuca Mountains area began in 1540 with the introduction of horses, cattle and other domestic livestock by Coronado. Subsequently, there was about a 100-year lapse until the mid-1600s, after which the San Pedro watershed has probably been grazed regularly. By 1700 cattle and other livestock occurred in southeastern Arizona and adjacent Sonora (Wagoner 1952). Cattle probably ranged into the Huachuca Mountains by the early 1800s when ranches began operating at and near their base (Hoffmeister and Goodpaster 1954).

The number of cattle in southeastern Arizona increased dramatically following the Civil War and cessation of Indian raids. Arizona's cattle industry was centered in the extensive grasslands of southeastern Arizona. In 1880, 35,000 domestic cattle roamed throughout Arizona (20,000 south of the Gila River). Over one million cattle were in the area by 1890 (Wagoner 1952). One ranch grazed up to 40,000 cattle in or near the Huachuca Mountains (Hoffmeister and Goodpaster 1954).

Grazing within CORO is now limited to that which does not interfere with recreation development, as per legislation establishing the memorial. The NPS has responsibility to manage the lands for NPS values given that grazing is required. These management values, now in force as a long-term grazing management through allotment plans, minimize over-grazing in the memorial. The two existing grazing allotments, Joe's Spring and Montezuma, occur primarily in

the grasslands in the eastern portion of the memorial. Both allotments are administered by the U.S. Forest Service through NPS.

Joe's Spring Allotment consists of 1,369 a and lies entirely within the memorial. This allotment occurs in the northeastern part of the memorial, and extends from Montezuma Peak eastward along the northern boundary to the eastern boundary of the memorial and south to the township boundary just north of the entrance road. Since 1942, grazing in the Joe's Spring Allotment has been 432 animal unit months (AUM's), whether grazed seasonally or yearlong. Currently, grazing is restricted to mid-November through mid-July. The only water source on this allotment is a stock tank bounded by a corral. This allotment was judged to be in fair and good condition in April 1989, with browse utilization ranging from 0-65% (Coronado National Forest 1989). The most heavily used pasture within this allotment is an area just east of Montezuma Peak, where utilization ranges from 46-65% (Coronado National Forest 1989). Livestock use of browse, however, is contributing to a downward trend in range condition near the southeastern boundary of the allotment (Deecken 1989). Thirty-one percent of this allotment, particularly in the northern portion, is considered to have no capacity for grazing due to steep slopes and rough terrain. This allotment will be subject to a new grazing management plan in 1991.

The Montezuma Allotment consists of 2,067 a, which includes a state land lease to the east of the memorial. Within the memorial, this allotment lies directly south of the Joe's Spring Allotment and extends south to the international border and east to the memorial boundary, and continues onto the state land lease. This allotment excludes the Montezuma Ranch inholding along the eastern edge of the memorial.

Grazing in the Montezuma Allotment is set at 504 AUM's (Coronado National Forest 1986). The only water source on this allotment is a stock tank, which was formerly surrounded by a corral. This allotment is grazed yearlong. The most heavily utilized pastures surround the stock tank, where utilization exceeds 65%. Other heavily utilized pastures, 46-65% utilization, are along the east entrance road and lower Montezuma Canyon. The least utilized pastures, because of steep terrain and lack of water, are at the western end of the memorial in upper Montezuma Canyon (Coronado National Forest 1986). Approximately 1,600 a of this allotment are suitable for grazing, while only about 1,000 a are actually used. A new grazing management plan was initiated in 1988 for this allotment.

Grazing has caused extensive changes in the composition and structure of biotic communities in the memorial and throughout southeastern Arizona. For example, blue grama is the most widespread and abundant native grass on the Sonoita Plain west of the Huachuca Mountains (Bock and Bock 1986) and over much of the shortgrass prairie in North America (Detling 1979). However, the dominance of blue grama may be "... an artifact of historical patterns of grazing by domestic livestock" (Bock and Bock 1986), because it is very tolerant of grazing and trampling by livestock. Cox et al. (1983) suggested that much of southeastern Arizona may have been dominated by sacaton (*Sporobolus wrightii*) prior to grazing by domestic livestock.

Extensive cattle grazing in the late *1800s,* however, was apparently only an interacting component, along with long-term shifts in seasonal distribution of precipitation and freezing temperatures, to cause these vegetation changes and the accompanying cycles of erosion and arroyo cutting. Hastings and Turner (1965) concluded, "About cause then, the best answer seems to be that the new vegetation-if one may call it that has not arisen from climatic variation alone, but in

response to the unique combination of climatic and cultural stresses imposed by the events of the past eighty years; that climate and cattle have united to produce it." Fire suppression and eruptions of lagomorph and rodent populations have also been suggested as possible processes causing change in southwestern plant communities.

Coronado National Memorial has also been attractive to miners and prospectors, especially for lead and zinc ores, due to mineralization in the area. At least 17 mines and as many prospects occur within the memorial, mostly in the more rugged western portions (Appendix 2), as well as claims at the State of Texas Mine and Montezuma Cave. The largest and most successful of these mines was the State of Texas Mine, which was an underground mine that operated from 1889-1906 and again from 1943-1947. Mining had a relatively low impact in the memorial because the lower quality ores found in the memorial made this area less popular than nearby Tombstone, Bisbee, and Douglas, and because the mined ores were hauled to the Shaddox Den Smelter in Bisbee (Will Sparkes, pers. com. 1989). Consequently, the primary impacts of mining are the remaining scattered tailings dumps and mine shafts. The memorial was closed to all mining activity on 28 September 1976, and all hazardous mine shafts and adits have been filled or closed with cable netting.

Woodcutting has been of minor concern since the memorial was established. Prior to this time, it is very likely that woodcutters from both sides of the boundary were active in the area, although their impacts are unknown.

Field evidence and written records show that fire has occurred historically in the memorial as a natural factor until the early 1900s. At that time, the episodic natural fire regime ceased due to the implementation of fire suppression as an actively pursued management policy, first by the U.S. Forest Service and later by NPS. Conversations with resource management personnel indicate that only 1-2 small fires (about 1-2 a each) now occur within the memorial each year (no official records have been kept).

Active pursuance of fire suppression has an associated cost, however, in terms of changes to the vegetative community. Suppression also causes a large buildup of fuelwood, as observed during this project, which eventually leads to larger fires than those that occurred in the historical regime (Horn 1976; Minnich 1983). The Peak Fire, which originated in Mexico and burned lands administered by Coronado National Forest, the State of Arizona, private lands, and 3,700 a in CORO (K. Davis, pers. com. 1989), was such an event. This fire also demonstrated potential difficulties of fire management in the memorial due to the relatively small area of the unit, its proximity to Mexico, and differing practices of agencies that administer adjacent lands. A recently updated interagency agreement with the U.S. Forest Service provides for mutual aid in controlling wildfires.

Coronado National Memorial was established from existing U.S. Forest Service lands on 5 November 1952. The memorial was reshaped on 10 November 1978, in a land exchange with the U.S. Forest Service. This exchange added 3,040 a and deleted 1,200 a to the west with the intent of including the entire Montezuma Canyon watershed as one ecological and management unit.

The primary road through the memorial is the Coronado Memorial Highway, which begins at the east entrance and follows the valley floor up to Montezuma Pass. Access roads extend from this highway to Montezuma Ranch, to the corral on the Joe's Spring Allotment, to the two 1-a

inholdings, and to the picnic area and visitor center. Several other roads, including those that extended from the highway to Joe's Spring, to the State of Texas Mine and also along the east boundary of this property, the road extending to the boneyard, and all of this same road north of the highway, have been closed or abandoned (Appendix 2).

Several buildings and other features occur within the memorial. These include the visitor center and residences, the parking lot and restrooms at Montezuma Pass, and the graveyard to the east of the picnic area. Several other historical features have also been removed from the memorial, including the stone house near Joe's Spring, the white house west of Montezuma Ranch, and the boneyard along the south boundary (Appendix 2).

Fences in the memorial extend along the south boundary of Joe's Spring Allotment and on the northern and western edge of Montezuma Allotment, and function to keep cattle away from the highway. The Montezuma Ranch and about 100 a directly south are also bounded by a fence. The fence extending from the stock tank on the Montezuma Allotment southeast to the southwest corner of the fence bounding the Montezuma Ranch and areas south was removed recently as was the fence along the east boundary of the State of Texas Mine property (Appendix 2).

Three private in-holdings, one of 82 a and two of 1 a, exist near the east entrance of the memorial. The NPS purchased a scenic easement for Montezuma Ranch in 1985. The two smaller parcels are 1-a home sites (J. Sewell, pers. com. 1988). The NPS purchased the State of Texas Mine (51.25 a) in 1986.

Five trails--Cave Trail, Picnic Trail, Joe's Canyon Trail, Coronado Peak Trail, and Miller Peak Trail-occur in CORO (Appendix 2). Cave Trail begins at the visitor center and goes northwest to Montezuma Cave. Picnic Trail begins at the visitor center and goes southeast to the picnic area. Joe's Canyon Trail starts at the visitor center and goes south and west, contouring the north-facing slope and ends at the parking lot at Montezuma Pass. Coronado Peak Trail starts at the parking lot at Montezuma Pass and goes south up to Coronado Peak. Miller Peak Trail also starts at the parking lot at Montezuma Pass and goes north out of the memorial to Miller Peak (Appendix 2).

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APPENDIX
1

DIRECTIONS FOR LOCATING VEGETATION MONITORING PLOTS, CORONADO NATIONAL MEMORIAL, COCHISE COUNTY, ARIZONA

Plot 1: 72 paces from cairn at southeast corner of graveyard; Emory oak @ 45° at a distance of 39 ft 8 in.; only Emory oak on ridge.

Plot 2: 138 paces southeast of Plot 1 along crest of low ridge; 41 paces to stake from gray oak ca. 15 ft tall with 3 stems at 210-215° (tree to stake).

Plot 3: Go to fence line beyond north side of drainage (Montezuma Canyon; locate gate in fence; count 21 metal fenceposts (heading west along fenceline); locate cairn at base of 21st metal fencepost; second cairn located 15 ft south of centerstake between fencepost and centerstake.

Plot 4: 85 paces west (between 270-280°) of Plot 3; pace parallel to small drainages north and south; alternatively, locate cairn at base of 35th metal fencepost (heading west along fenceline); second cairn located 15 ft south of centerstake between 35th fencepost and centerstake.

Plot 5: Riparian woodland in drainage south of Plots 3 and 4; locate stake by taking a bearing of 0° at a point on entrance road 26 paces east of sign stating "Do Not Travel Off Roadway"; approximately 1.5-2 ft of sediments have been removed from area in vicinity of stake since it was placed in March 1988; center stake is now a rock cairn with a wood stake in substrate underneath; if this marker has been obliterated, a large Emory oak with cover on plot but stem out at a bearing , of 350° from centerstake to Emory oak.

Plot 6: Riparian forest; site is in drainage ca. 20 ft northwest of last bridged crossing on Montezuma Pass road; stake is at northern edge of drainage so that half of 0.001 and 0.01 a plots are in the creek bottom (sand only).

Plot 7: Oak woodland; site is on north-facing slope near picnic grounds; take 130 paces up Joe's Canyon trail from its junction with picnic ground road and then 20 paces to east of 7th waterbar in trail.

Plot 8: 148 paces on Joe's Canyon trail from junction of Coronado Peak and Joe's Canyon trail near Montezuma Pass; prior to fire the site was located by pacing 100 paces from the gate on upper Joe's Canyon trail and then turning west (upslope) for 28 paces.

Plot 9: Begin at northern side of cattleguard at Montezuma Pass; take 70 paces up Montezuma Peak trail then turning west (uphill) for 50 paces.

Plot 10: In saddle above maintenance yard; on second ridge ca 270 paces from point on road 45 ft west of maintenance yard entrance; start at point 5 paces west of manhole cover and follow a bearing of 315° for 164 paces to the first cairn (you will cross a fence at 84 paces); follow a bearing of 340° for 76 paces to the second cairn; follow a bearing of 10° for 29 paces to the center stake.

APPENDIX 2

MAP OF BIOTIC COMMUNITIES AND MONITORING PLOT LOCATIONS, CORONADO NATIONAL MEMORIAL, COCHISE COUNTY, ARIZONA

This topographic map delineates areas encompassed by each of the four biotic communities locations of the 10 long-term vegetation monitoring plots in Coronado National Memorial. Vegetation monitoring plots are shown as the encircled numbers 1-10. Biotic community classification (shown below) follows the system of Brown et al. (1979). Plant taxa have been changed to conform with current nomenclature.

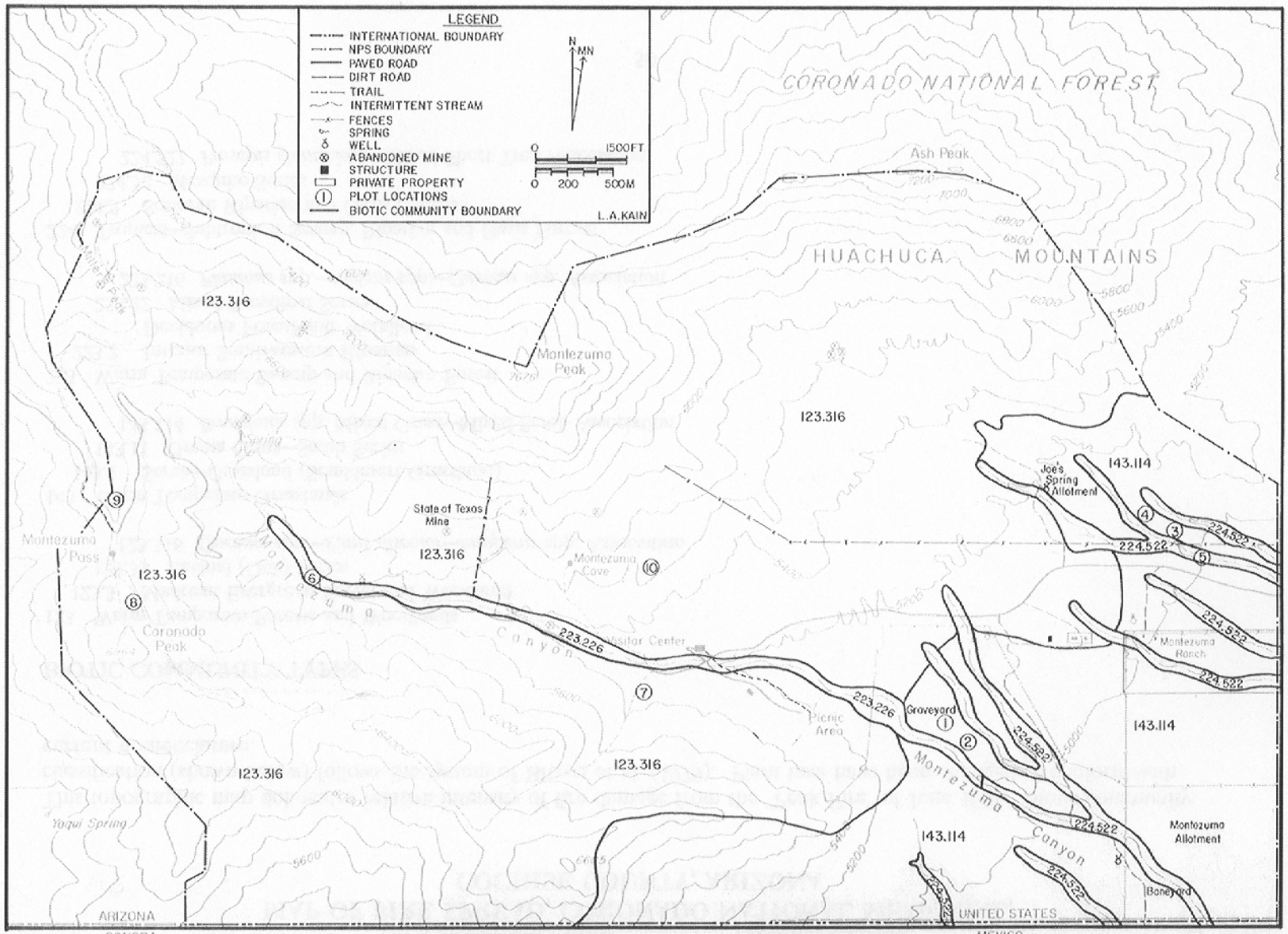
BIOTIC COMMUNITY TYPES

123 Warm Temperate Forests and Woodlands
- 123.3 Madrean Evergreen Forest and Woodland
  - 123.31 Encinal (Oak) Series
    - 123.316 *Quercus* spp.-*Pinus discolor*-*Juniperus* spp. Association

143 Warm Temperate Grasslands
- 143.1 Scrub--Grassland (Semidesert Grassland)
  - 143.11 Grama Grass-.Scrub Series
    - 143.114 *Bouteloua* spp. :Mixed Grass Mixed Scrub Association

223 Warm Temperate Swamp and Riparian Forest
- 223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
  - 223.22 Mixed Broadleaf Series
    - 223.216 *Platanus* spp.-*Juglans* spp.-*Quercus* spp. Association

224 Tropical-Subtropical Swamp, Riparian and Oasis Forests
- 224.5 Sonoran Riparian and Oasis Forests
  - 224.52 Mesquite Series
    - 224.522 *Prosopis glandulosa*-Mixed Short Tree Association



CORONADO NATIONAL MONUMENT

APPENDIX 3

MAP OF FIRE SPREAD, CORONADO NATIONAL MEMORIAL, COCHISE COUNTY, ARIZONA

This topographic map delineates relative intensity of fire damage from the "Peak Fire" of June 1988. Biotic community classification (shown below) follows the system of Brown et al. (1979). Plant taxa have been changed to conform with current nomenclature.

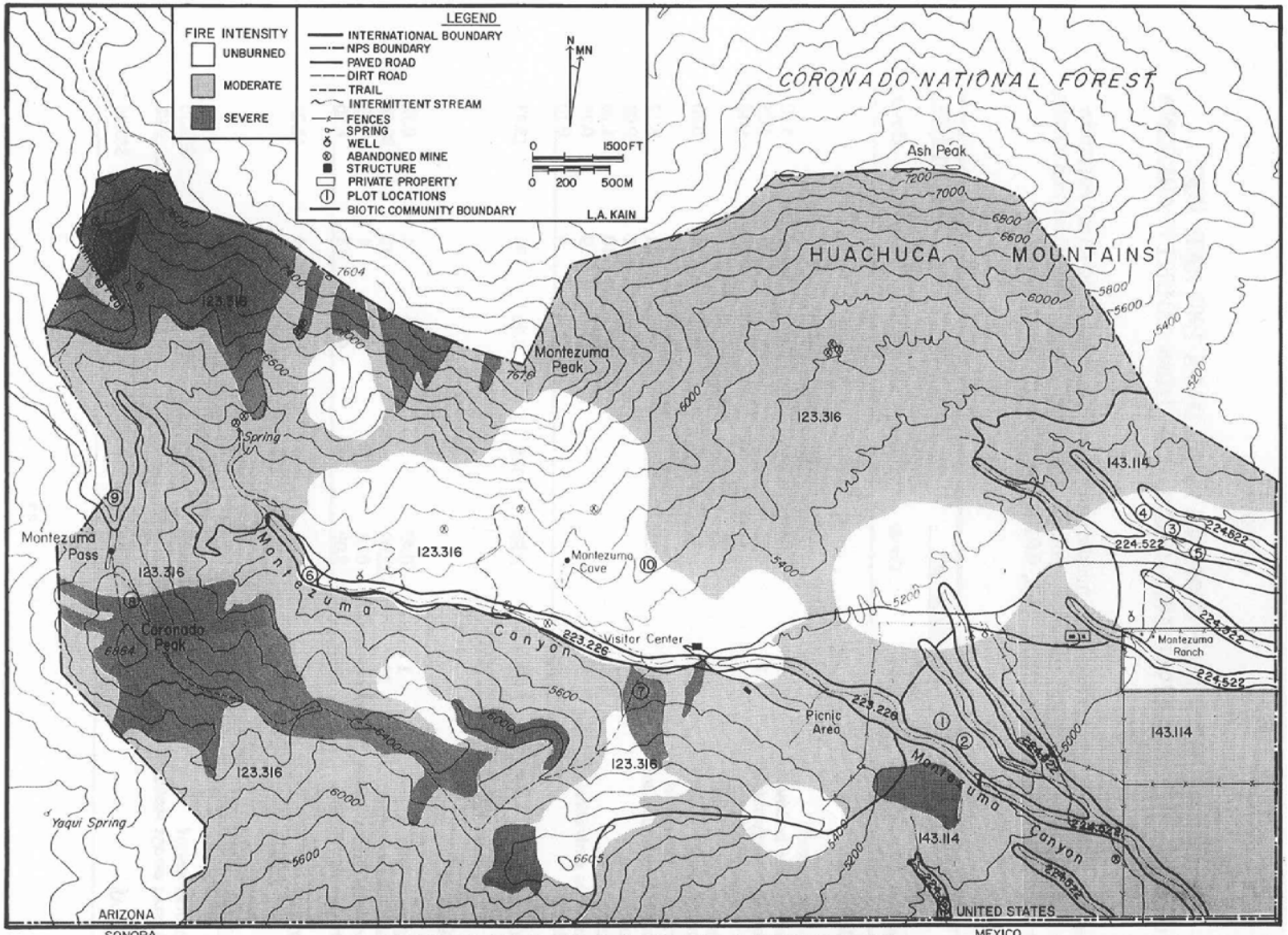
BIOTIC COMMUNITY TYPES

123 Warm Temperate Forests and Woodlands
123.3 Madrean Evergreen Forest and Woodland
123.31 Encinal (Oak) Series
123.316 *Quercus* spp. Pinus discolor *Juniperus* spp. Association

143 Warm Temperate Grasslands
143.1 Scrub-Grassland (Semidesert Grassland)
143.11 Grama Grass-Scrub Series
143.114 *Bouteloua* spp. Mixed Grass-Mixed Scrub Association

223 Warm Temperate Swamp and Riparian Forest
223.2 Interior Southwestern Riparian Deciduous Forest and Woodland
223.22 Mixed Broadleaf Series
223.216 *Platanus* spp.-*Juglans* spp.-*Quercus* spp. Association

224 Tropical-Subtropical Swamp, Riparian and Oasis Forests
224.5 Sonoran Riparian and Oasis Forests
224.52 Mesquite Series
224.522 Prosopis glandulosa-Mixed Short Tree Association



CORONADO NATIONAL MONUMENT

51

APPENDIX 4

VEGETATION MONITORING PLOT DATA 1988 AND 1989, CORONADO NATIONAL MEMORIAL, COCHISE COUNTY, ARIZONA

Summary of plant species and their number and cover within ten long-term vegetation monitoring plots during three sample periods. Forbs and grasses, succulents and shrubs, and trees were sampled in the 0.001-a, 0.01-a, and 0.1-a plots, respectively.

PLOT 1

	MARCH 1988		JULY 1988		AUGUST 1989	
Species	Number in plot	Cover	Number in plot	Cover	Number in plot	Cover
0.001 Acre						
Ayenia filiformis			19	0.07		
Bothriochloa barbinodis	5	0.26			4	1.10
Bouteloua curtipendula	1	0.02			5	1.25
Bouteloua gracilis	11	0.95			36	5.76
Cirsium spp.	2	0.66				
Croton pottsii			2	0.01	11	0.70
Eragrostis intermedia			94	3.78		
Eragrostis lehmanniana	38	2.03			12	3.12
Panicum sp.					*1*	0.03
Portulaca sp.					10	1.10
Portulaca umbraticola					9	0.27
Sida sp.					8	0.10
TOTAL	57	3.92	115	3.86	96	13.43
0.01 Acre						
Agave palmeri	1	0.49	1	0.05	1	0.78
Calliandra eriophylla	13	32.00			42	38.56
Echinocereus pectinatus	4	0.41	2	0.19	1	0.33
Eriogonum wrightii	10	5.09	1	0.01	15	8.36
TOTAL	28	37.99	4	0.25	59	48.03
0.1 Acre						
Quercus emoryi	0	306.00	0	306.15	0	389.36
Quercus emoryi seedlings					3	0.09
TOTAL	0	306.00	0	306.15	3	389.45

PLOT 2

Species	MARCH 1988 Number in Plot	Cover	JULY 1988 Number in Plot	Cover	AUGUST 1989 Number in Plot	Cover
0.001 Acre						
Bouteloua chondrosioides					7	1.85
Bouteloua curtipendula					1	3.78
Bouteloua gracilis	14	4.13			2	6.16
Croton pottsii			16	0.16	7	1.12
Eragrostis intermedia			109	6.63		
Eragrostis lehmanniana	44	5.98			3	7.04
Evolvulus alsinoides					1	0.42
Heterotheca psammophila	7	0.31				
cf *Lithospermum* sp.			3	0.13	1	0.20
Lycurus setosus					4	0.09
Portulaca sp.					2	0.16
Sida sp.					1	0.10
TOTAL	65	10.42	128	6.92	10	20.92
0.01 Acre						
Calliandra eriophylla	3	6.97			12	5.64
Chrysothamnus nauseosus	8	6.44				
Echinocereus pectinatus	2	0.06	1	4.91???	1	0.03
Eriogonum wrightii	14	25.94			2	8.06
Ipomoea longifolia			1	38.98	1	63.58
TOTAL	27	39.41	2	43.89	40	77.31
0.1 Acre						
none						

PLOT 3

Species	MARCH 1988 Number in Plot	MARCH 1988 Cover	JULY 1988 Number in Plot	JULY 1988 Cover	AUGUST 1989 Number in Plot	AUGUST 1989 Cover
0.001 Acre						
Anthericum torreyi					1	0.16
Aristida sp.					2	0.45
Ayenta compacta					3	0.05
Bouteloua gracilis	31	6.01				
Bouteloua sp.			37	5.11	2	2.43
Croton pottsii					5	0.13
Eragrostis lehmanniana	46	2.48	39	1.87	2	2.30
Evolvulus arizonicus					1	0.05
Jatropha macrorhiza			1	0.10	1	0.38
Lycurus setosus					1	0.44
Portulaca sp.					1	0.01
Unknown Malvaceae			1	0.03		
Unknown Poaceae	3	0.10	8	0.10		
TOTAL	80	8.59	86	7.21	70	6.40
0.01 Acre						
Agave palmeri					1	0.01
Calliandra eriophylla	29	36.62	NOT SAMPLED		1	21.32
Mimosa biuncifera	2	9.51				
TOTAL	31	46.13			165	21.33
0.01 Acre						
none						

PLOT 4

Species	MARCH 1988		JULY 1988		AUGUST 1989	
	Number in Plot	Cover	Number in Plot	Cover	Number in Plot	Cover
0.001 Acre						
Ayenia compacta					3	0.84
Baccharis pteronoides					1	0.09
Bouteloua gracilis	20	2.12	31	2.05		
Bouteloua spp.					21	2.52
Convolvulus equitans			2	0.03		
Convolvulus sp.					2	0.39
Croton pottsii			11	0.39	1	0.90
Eragrostis lehmanniana	71	4.54	65	3.77	4	11.89
Evolvulus arizonicus					2	0.12
Evolvulus sericeus					1	0.09
Gnaphalium wrightii					1	0.16
Heteropogon contortus	2	0.21				
Machaeranthera pinnatifida			1	0.03		
Portulaca sp.					3	0.08
Unknown 9			2	0.04		
TOTAL	93	6.87	112	6.24	85	17.08
0.01 Acre						
Calliandra eriophylla	39	30.07	NOT SAMPLED		12	76.23
Convolvulus sp.					1	0.38
Eriogonum wrightii	1	0.06				
TOTAL	40	30.13			122	76.61
0.1 Acre						
none						

PLOT 5

Species	MARCH 1988 Number in Plot	MARCH 1988 Cover	JULY 1988 Number in Plot	JULY 1988 Cover	AUGUST 1989 Number in Plot	AUGUST 1989 Cover
0.001 Acre						
Amaranthus spp.					5	0.31
Astragalus hypoxylus	1	0.12				
Boerhaavia coccinea					2	0.35
Bouteloua curtipendula	4	1.27	1	0.34	1	2.04
Bouteloua gracilis	2	1.22				
Conyza canadensis					2	2.55
Desmodium rosei					10	0.25
Eragrostis lehmanniana	16	3.97				
Guardiola platyphylla			1	1.38		
Hedeoma dentatum					1	0.01
Heterotheca psammophila	1	0.1				
Ipomoea heterophylla					2	1.27
Kallstroemia parviflora					1	0.03
Panicum sp.					23	0.65
Portulaca sp.					4	0.14
Sarcostemma cynanchoides			2	1.65	1	1.18
Stipa spp.	1	0.04				
Unknown Poaceae			14	1.58		
TOTAL	25	6.63	18	4.95	52	8.78
0.01 Acre						
Chrysothamnus nauseosus	2	21.50			1	4.27
Guardiola platyphylla	2	16.74	NOT SAMPLED			
Ipomoea longifolia					2	30.42
Opuntia spinosior	1	0.20				
TOTAL	5	38.44			3	34.69
0.01 Acre						
Chilopsis linearis	18	1266.99			18	1467.16
Quercus emoryi	0	112.65	NOT SAMPLED		0	109.90
Rhus virens	0	10.99			0	18.84
TOTAL	18	1290.63			18	1595.90

Plot 6

	MARCH 1988		JULY 1988		AUGUST 1989	
Species	Number in plot	Cover	Number in Plot	Cover	Number in Plot	Cover
0.001 Acre						
Artistida orcuttiana	3	0.55				
Desmodium neomexicanum			2	0.01		
Desmodium spp.					2	0.02
Euphorbia brachycera	1	0.15				
Ipomoea spp.					5	0.04
Unknown Asteraceae			1	0.08		
Viguiera dentata			3		0.16	
TOTAL	4	0.70	6	0.25	7	0.06
0.01 Acre						
Unknown Asteraceae	9	85.48	NOT SAMPLED			
Viguiera spp.					3	9.99
TOTAL	9	85.48			3	9.99
0.01 Acre						
Acacia greggii	1	11.00				
Arbutus arizonica	1	23.00				
Arcostaphylos pungens	1	188.00			1	127.17
Juglans major	2	519.00			2	263.75
Juniperus deppeana					2	66.72
Pinups discolor					4	4.12
Prunus serotina					1	7.06
Quercus arizonica	11	2291.00			10	2157.97
Quercus emoryi	3	614.00	NOT SAMPLED		1	672.74
Quercus hypoleucoides					5	431.75
Rhus trilobata					8	156.22
Rhus virens	4	190.00			2	7.85
Toxicodendron radicans	1	6.00			1	12.56
Vauquelinia californica	1	125.00				
Vitis arizonica	3	341.00			3	414.68
Yucca schottii	1	9.00			0	21.39
TOTAL	29	4317.00			40	4344.98

Plot 7

Species	MARCH 1988		JULY 1988		AUGUST 1989	
	Number in Plot	Cover	Number in Plot	Cover	Number in Plot	Cover
0.001 Acre						
Acalypha neomexicana					56	10.6
Amaranthus torreyi					7	29
Aristida orcuttiana	2	0.06				
Bouteloua curtipendula	14	1.15			3	3.19
Conyza canadensis					3	2.77
Cyperus huarmensis					1	0.05
Desmodium rosei					46	1.10
Eragrostis sp.					3	5.38
Gnaphalium wrightii					1	0.47
Heterospermum pinnatum					2	0.92
Heterotheca psammophila					2	2.11
Ipomoea heterophylla			66	1.02	5	1.90
Mentzelia texana			4	0.09	1	1.03
Muhlenbergia emersleyi						
Portulaca sp.					1	0.02
Quercus emoryi seedling					1	0.01
Solanum deflexum			36	0.17		
Stipa sp.					1	4.90
Viguiera dentata					1	0.56
TOTAL	16	1.21	106	1.28	134	24.76
0.01 Acre						
Chrysothamnus nauseosus					9	3.53
Rhus trilobata					1	9.61
TOTAL					10	13.14
0.1 Acre						
Dasylirion wheeleri	2	49.00	2	7.64	7	60.44
Nolina microcarpa	5	331,99	5	6,34	6	177.41
Quercus arizonicus	6	735.00	5	190.87	3	127.17
Quercus emoryi	22	3426.00	1	33.17	17	557.35
Unknown shrub 1	1	27.00				
TOTAL	36	4568.00	13	239.02	32	992.37

Plot 8

Species	MARCH 1988		JULY 1988		AUGUST 1989	
	Number in Plot	Cover	Number in Plot	Cover	Number in Plot	Cover
0.001 Acre						
Aristida orcuttiana			11	1.23	3	5.40
Boerhaavia purpurascens					5	0.04
Bothriochloa barbinodis	1	0.65				
Bouteloua curtipendula	23	4.97			8	10.69
Commelina dianthifolia			2	0.07		
Crotalaria pumila					14	0.06
Desmodium sp.					3	0.02
Dichelostemma pulchellum					2	0.03
Glandularia bipinnatifida					12	13.99
Ipomoea costellata					13	0.12
Ipomoea heterophylla					1	0.02
Ipomoea purpurea					1	0.01
Lycurus setosus					1	0.20
Pectis filipes					336	2.69
Portulaca sp.					1	0.03
Salvia subincisa					6	0.05
Santavalia aberti					296	2.37
Sisymbrium linearifolium					1	0.03
Viguiera dentata					1	0.09
TOTAL	24	5.62	13	1.30	704	36.14
0.01 Acre						
Cercocarpus montanus	1	0.24				
Mimosa biuncifera					1	1.32
Opuntia spinosior	8	1.48			2	0.20
TOTAL	9	1.72			3	1.52
0.1 Acre						
Juniperus deppeana	2	520.00				
Nolina microcarpa	14	659.00	6	9.62	7	163.27
Pinus discolor	7	2333.00				
Yucca schottii	4	27.00	2	3.27	6	42.68
TOTAL	27	3539.00	8	12.89	13	205.95

Plot 9

Species	MARCH 1988		JULY 1988		AUGUST 1989	
	Number in Plot	Cover	Number in Plot	Cover	Number in Plot	Cover
0.001 Acre						
Aristida orcuttiana			24	1.95		
Bothriochloa barbinodis	5	1.75			2	7.40
Bouteloua curtipendula					3	3.03
Commelina dianthifolia			1	0.08		
Dichelostemma pulchellum					1	0.50
Eragrostis lehmanniana	28	1.33			17	19.38
Ipomoea costellata			98	1.06	8	0.06
Ipomoea heterophylla					7	0.63
Ipomoea purpurea			12	0.11		
Panicum hirticaule					200	1.60
Pectis filipes					31	0.25
Portulaca coronata			3	0.05		
Portulaca sp.					195	14.04
Sanvitalia aberti					7	0.06
Sida neomexicana					2	1.02
Sisymbrium linearifolium					2	0.18
Unknown Malvaceae			1	0.04		
TOTAL	33	3.08	139	3.29	475	48.15
0.01 Acre						
Chrysothamnus nauseosus	*1*	0.49				
Opuntia spinosior	6	7.99			1	0.03
Unknown Shrub #32					5	16.46
Unknown Asteraceae	7	18.59				
TOTAL	14	27.07			6	16.49
0.1 Acre						
Nolina microcarpa	5	238.00	8	13.94	9	198.64
Pinus discolor	2	142.00				
TOTAL	7	380.00	8	13.94	9	198.64

Plot 10

Species	MARCH 1988		JULY 1988		AUGUST 1989	
	Number in Plot	Cover	Number in Plot	Cover	Number in Plot	Cover
0.001 Acre						
Bothriochloa barbinodis	1	0.16			4	3.43
Bouteloua curtipendula	2	0.47	3	0.60	1	4.76
Desmodium sp.					9	0.07
Dichelostemma pulchellum					1	0.09
Diplachne dubia					2	0.14
Eragrostis lehmanniana	21	1.37	27	20.28	14	10.28
Euphorbia hyssopifolia					3	0.20
Evolvulus arizonicus			1	0.04		
Lycurus setosus					1	0.44
Mitracarpus brevifolus					1	0.01
Pectis felipes					1	0.01
Portulaca umbraticola					4	0.07
Unknown Poaceae seedling					460	3.68
Viguiera cordifolia					2	0.35
Viguiera dentata					1	0.01
TOTAL	24	2.00	31	20.92	504	23.54
0.01 Acre						
Opuntia spinosior	3	0.63	NOT SAMPLED		3	2.72
Unknown Asteraceae	2	2.44				
Viguiera cordifolia					8	17.28
TOTAL	5	3.07			11	20.00
0.1 Acre						
Arctostaphylos pungens	1	268.00			1	271.61
Nolina microcarpa	1	50.00	NOT SAMPLED		1	50.24
Quercus arizonicus					0	244.92
Quercus emoryi	15	1951.00			15	1935.81
Rhus virens	4	643.00			3	605.24
TOTAL	21	2012.00			20	3107.82

APPENDIX 5

PLANT LIST FOR CORONADO NATIONAL MEMORIAL, COCHISE COUNTY, ARIZONA

This is an updated list of families, genera, species, subspecies, and varieties of vascular plants known to occur in CORO. This list is based on the CORO plant checklist and species found during this study (indicated with *). Introduced species are denoted by an {I} prior to the scientific name. In this list, families are arranged in the sequence used by Kearney and Peebles (1960). Species within each family are listed alphabetically. Taxa and forms *(forma)* of species that have not been documented in the memorial are excluded.

Family nomenclature follows Cronquist (1981), except when this system separates closely related groups. The list follows the modern tendency to standardize (i.e., -aceae) the endings for all families: thus Compositae = Asteraceae; Gramineae = Poaceae; Guttiferae = Clusiaceae ; Labiatae = Lamiaceae; Leguminosae = Fabaceae; Palmae = Arecaceae; and Umbelliferae = Apiaceae. Plant names that were formerly used (synonyms) are placed in brackets: []. The remaining nomenclature follows Lehr (1978) and Lehr and Pinkava (1980, 1982, 1985 unpublished). Author abbreviations follow Munz (1959). Common names (in quotation marks) follow the nomenclature of Lehr (1978).

POLYPODIACEAE

* *Cheilanthes wootonii* Maxon "Beaded Lip Fern"
Notholaena sinuata (Lag.ex Sw.) Kaulf. *[Cheilanthes s.* (Lag. ex Sw.) Domin] "Wavy Cloak Fern"
N. standleyi Maxon *[Cheilanthes s.* (Maxon) Mickel] "Cloak Fern"

PINACEAE

Pinus discolor Bailey & Hawksworth [P. *cembroides Zucc.]* "Mexican Pinyon, Pino, Pinonero"

CUPRESSACEAE

Juniperus deppeana Steud. var. *pachyphlaea* (Tory.) Martinez "Alligator Juniper"
J. erythrocarpa Cory [J. *monosperma* (Engelm.) Sarg., in part] "One-seed Juniper"

[GRAMINEAE: see POACEAE]

POACEAE [Gramineae]

Aristida adscensionis L. "Six Weeks Three-awn"
A. divaricata H. & B. "Poverty Three-awn"
A. hamulosa Hen. "Three-awn"
A. orcuttiana Vasey "Beggar-tick Three-awn"
A. pansa Woot. & Standl. "Wooton Three-awn" *A. ternipes* Cav. "Spider Grass"
[*Andropogon barbinodis:* see *Bothriochloa barbinodis*]
Andropogon cirratus: see *Schizachyrium cirratum*]
[*Andropogon scoparius:* see *Schizachyrium scoparium*]
Blepharoneuron tricholepis (Torr.) Nash "Hairy Drop-seed"

Bothriochloa barbinodis (Lag.) Herter *[Andropogon barbinodis* Lag.] "Cane bluestem" *Bouteloua aristidoides* (HBK.) Grisb. "Six-weeks Needle Grama"
B. barbata Lag. "Six-weeks Grama" var. *barbata* [*B. barbata* Lag.]
var. *rothrockii* (Vasey) Gould [B. *rothrockii* Vasey]
B. chondrosioides (HBK.) Benth. ex Wats. "Grama"
B. curtipendula (Michx.) Torr.
var. *caespitosa* Gould & Kapidia "Side Oats Grama"
B. eriopoda (Torr.) Torr. "Black Grama"
[B. *filiformis:* see *B. repens*]
B. gracilis (HBK.) Lag. ex Steud. "Blue Grama"
B. hirsuta Lag. var. *glandulosa* (Cerv.) Gould "Hairy Grama
B. radicosa (Fourn.) Griffiths "Grama
B. repens (HKB) Scribn. & Merr. [B. *filiformis* (Fourn.) Griffiths] "Slender Grama"
[*B. rothrockii:* see *B. barbata*]
Bromus anamalus Rupr. ex Fourn. "Bromegrass"
Cenchrus insertus M.A. Curtis [*C. pauciflorus* Benth.] "Field Sandbur"
Chloris virgata Sw. "Feather Fingergrass"
{I} *Cynodon dactylon (L.)* Pers. "Pato de Gallo"
* *Digitaria sanguinalis (L.)* Scop. "Common Crabgrass"
Diplachne dubia (Kunth) Scribn. *[Leptochloa dubia (H.B.K.)* Nees] "Green Sprangletop"
Elyonurus barbiculmis Hack.
{I} *Eragrostis cilianensis (All.)* Vign.-Lutati ex Janchen [E. *frankii* C.A.Meyer, of AZ authors] "Stink Grass"
[E. *diffusa:* see *E. mexicana]*
E. intermedia Hitchc. "Plains Lovegrass" {I}
E. lehmanniana Nees "Lehman Lovegrass"
E. mexicana (Hornem.) Link. [E. *diffusa* Buckl.; *E. minor* Host, of AZ authors; *E. neomexicana* Vasey; *E. poaeoides* P.Beauv. ex Roem. & Schult., of AZ authors] "Mexican Lovegrass"
[E. *neomexicana:* see *E. mexicana]*
Eriochloa lemmonii Vasey & Scribn. "Small Southwestern Cupgrass" var. *lemmonii [E. lemmoni* Vasey & Scribn.]
var. *gracilis* (Fourn.) Gould [E. *gracilis* (Fourn.) Hitchc.]
Erioneuron pulchellum (HBK.) Tateoka *[Tridens pulchellus* (HBK.) Hitchc.] "Fluff Grass"
Heteropogon contonus (L.) Beauv. ex R. & S. "Tangle Head"
Hilaria belangeri (Steud.) Nash "Curly Mesquite Grass"
H. mutica (Buckl.) Benth. 'Tobosa Grass, Tobosa"
[*Leptochloa dubia:* see *Diplachne dubia*]
Lycurus setosus (Nutt.) C.Reeder [*L. phleoides,* sensu Kearney & Peebles] "Wolf-tail"
Muhlenbergia arizonica Scribn. "Muhly"
M. emersleyi Vasey "Bullgrass"
M. minutissima (Steud.) Swallen [M. *sinuosa* Swallen; *M. texana* Buck].] "Muhly"
M. montana (Nutt.) Hitchc. "Mountain Muhly"
M. porteri Scribn "Bush Muhly"

M. rigens (Benth.) Hitchc. "Deer Grass"
M. rigida (HBK.) Kunth "Purple Muhly"
[*M. sinuosa:* see *M. minutissima]*
* *Panicum arizonicum* Scribn. & Merr. "Arizona Panicum"
* *P. capillare* L.
var. *brevifolium* Vasey ex Rydb. & Shear "Witchgrass"
* *P. hallii* Vasey "Hall's Panicum'
* *P. hirticaule* Presl. "Panicum"
P. obtusum HBK. "Vine Mesquite"
Piptochaetium fimbriatum (HBK.) Hitchc. "Pinyon Ricegrass"
Schizachyrium cirratum (Hack.) Woot. & Standl. *[Andropogon cirratus* Hack] 'Texas Beardgrass"
S. scoparium (Michx.) Nash
var. *neomexicanum* (Nash) Gould *[Arulropogon scoparius* Michx. var. *neomexicanus* (Nash) Hitchc.] "Little Bluestem"
Scleropogon longisetus Beetle [S. *brevifolius,* sensu Kearney & Peebles] "Burro Grass"
Setaria grisebachii Fourn. "Grisebach Bristlegrass"
Sitanion hystriz (Nutt.) J.G.Sm. "Squirreltail"
{I} * *Sorghum halepense (L.)* Pers.
Sporobolus airoides (Torr.) Torr. "Alkali Sacaton"
var. *airoides [S. airoides* (Torr.) Torr.]
var. *wrighth* (Munro ex Scribn.) Gould [S. *wrightii* Munro ex Scribn.]
S. cryptandrus (Torr.) Gray "Sand Dropseed"
Trachypogon secundus (Presl.) Scribn. "Crinkle-awn"
Trichachne califoniica (Benth.) Chase "Cotton-top"
Tridens muticus (Tory.) Nash "Slim Tridens"
[*Tridens pulchellus:* see *Erioneuron pulchellum*]
Tripsacum lanceolatum Rupr. "Mexican Gamagrass"

CYPERACEAE

* *Cyperus fendlerianus* Boeckl. "Flat Sedge"
* *C. huarmensis* (HBK.) Johnst. [C. *flavus* (Vahl) Nees] "Flat Sedge"
C. niger Ruiz & Pavon var. *capitatus* (Britt.) O'Neill ."Flat Sedge"

* **COMMELINACEAE**
* *Commelina dianthifolia* Delile "Dayflower, Widow's Tears"

LILIACEAE
Anthericum torreyi Baker "Crag Lily, Amer Lily" {I}
* *Asparagus ofcinalis* L. "Garden Asparagus"
[*Dasylirion:* see Agavaceae]
Dichelostemma pulchellum (Salisb.) Heller "Bluedicks, Coveria"
Milla bif lora Cav. "Mexican Star"
[*Nolina:* see Agavaceae]
[*Yucca:* see Agavaceae]

[AMARYLLIDACEAE: see AGAVACEAE]

AGAVACEAE [Amaryllidaceae, in part; Liliaceae, in part]
Agave palmeri Engelm. "Palmer Agave"
A. parryi Engelm.
var. *huachucensis* (Baker) Little ex L.Benson "Parry Agave"
A. schottii Engelm.
var. *schottii* "Schott Agave"
Dasylirion wheeleri Wats. "Sotol, Desert Spoon"
Nolina microcarpa Wats. "Beargrass, Sacahuista"
Yucca schottii Engelm. "Schott's Yucca"

SALICACEAE
Populus fremondi Wats.
ssp. fremonth "Fremont Cottonwood"

* *Salix gooddingii* Ball "Goodding Willow"

JUGLANDACEAE
Juglans major (Torr.) Heller "Arizona Walnut, Nogal Silvestre"

FAGACEAE
Quercus arizonica Sarg. "Arizona White Oak"
Q. dunnii Kell. [Q. *palmeri* Engelm., in part] "Palmer Oak"
Q. emoryi Ton. "Emory Oak, Belota"
Q. gambelh Nutt. "Gambel Oak"
Q. hypoleucoides Camus "Silverleaf Oak"
Q. oblongifolia Torr. "Mexican Blue Oak"
Q. pungens Liebm. "Sandpaper Oak"
Q. rugosa Nee [Q. *reticulata* Humb. & Bonpl.] "Netleaf Oak"
Q. toumeyi Sarg. "Tourney Oak"
Q. turbinella Greene
ssp. *turbinella* "Shrub Live Oak, Turbinella Oak"

ULMACEAE
Celtis reticulata Torr. "Net-leaf Hackberry, Palo-blanco"

MORACEAE
Morus microphylla Buckl. 'Texas Mulberry"

[LORANTHACEAE: see VISCACEAE]

VISCACEAE [Loranthaceae]
[*Phoradendron bolleanum:* see P. *capitellatum*]
Phoradendron capitellatum Ton. ex Trel. [P. *bolleanum* (Seem.) Eichler
var. c. (Tory. ex 'Trel.) Kearney & Peebles] "Mistletoe"
[P. *coryae:* see *P. villosum*]

P. juniperinum Engelm. "Mistletoe"
P. villosum (Nutt.) Nutt.
ssp. coryae (Trel.) Weins [P. *coryae* Trel.] "Mistletoe"

POLYGONACEAE
Eriogonum abertianum Torr. "Wild Buckwheat"
[E. *densum:* see *E. palmerianum]*
E. palmerianum Reveal [E. *densum,* sensu Kearney & Peebles] "Wild Buckwheat"
E. wrightii Torr. ex Benth. "Wright Buckwheat"

CHENOPODIACEAE
Atriplex elegans (Moq.) D.Dietr.
ssp. *elegans* "Salt Bush" *Chenopodium fremondi* S.Wats. "Goosefoot"
C. graveolens Willd. [Teloxys g. (Willd.) W.A.Webber; C. *incisum* Poir]
var. *neomexicanum* (Aellen) Aellen "Goosefoot"

AMARANTHACEAE
Amaranthus hybridus L. "Spleen Amaranth, Quelito Morado"
A. torreyi (A.Gray) Benth. 'Torrey's Amaranth"
Froelichia arizonica Thornber ex Standl. "Arizona Snake Cotton"
Gomphrena caespitosa Torr. "Globe Amaranth"
G. nitida Rothr. "Globe Amaranth" *G. sonorae* Torr. "Globe Amaranth"
Guilleminea densa (Willd.) Moq.in DC. *[Brayulinea d.* (Willd.) Small] "Small Matweed"

NYCTAGINACEAE
Allionia incamata L. 'Trailing Four-O'Clock, Windmills"
Boerhaavia coccinea Mill. "Red Spiderling"
B. erecta L. "Spiderling"
B. purpurascens A.Gray "Purple Spiderling"
Mirabilis coccineus (Torr.) B. & H. *[Oxybaphus coccineus* Torr.]
M. linearis (Pursh) Heimerl. *[Oxybaphus linearis* (Pursh) Robins.]
* *M. longif lora* L. "Sweet Four O'Clock"
[Oxybaphus: see *Mirabilis]*

* **MOLLUGINACEAE**
* *Mollugo venicillata* L. "Indian Chick Weed"

PORTULACACEAE
* *Portulaca mundula* Johnst. "Chisme"
{I} * *P. oleracea* L. "Purslane"
* *P. suf frutescens* Engelm. "Purslane"
P. umbraticola HBK. [P. *coronata* Small, P. *lanceolata* Engelm.] "Purslane"
**Talinum aurantiacum* Engelm. "Flame Flower"

* **RANUNCULACEAE**
* *Thalictrum fendleri* Engelm. "Meadow Rue"

PAPAVERACEAE
Argemone pleiacantha Greene
ssp. *pleiacantha [?A. platyceras* Link & Otto] "Bluestem Pricklepoppy"

[CRUCIFERAE: see BRASSICACEAE]

BRASSICACEAE [Cruciferae]
Descurainia pinnata (Walt.) Britt. "Tansy Mustard"
Lepidium thurberi Woot. "Pepper Grass, Pepperwort"
Schoencrambe linearifolia (Gray) Rollins *[Sisymbrium linearifolium* (Gray) Payson; *Thelypodiopsis linearifolia* (Gray) AI-Shehbaz]
{I} * *Sisymbrium Trio* L.
[S. *linearifolium:* see *Schoencrambe*]

SAXIFRAGACEAE (included here for convenience: **GROSSULARIACEAE** and **HYDRANGEACEAE**)
Heuchera sanguinea Engelm. "Coral Bells"
Philadelphus microphyllus Gray
ssp. *stramineus* (Rydb.) C.L.Hitchc. "Mock Orange, Syringa"

PLATANACEAE
Platanus wrighth Wats. "Sycamore, Button Wood, Plane Tree"

ROSACEAE
Cercocarpus montanus Raf. "Alder-leaf Mountain Mahogany"
var. *glaber* (Wats.) F.L.Martin [C. *betuloides* Nutt.]
var. *paucidentatus* (Wats.) Martin [C. *breviflorus* Gray]
Cowania mexicana D.Don
var. *stansburiana* (Torr.) Jeps. "Quinine Bush"
{I} * *Prunus armeniaca* L. "Apricot"
P. serotina Ehrh.
ssp. *virens* (Woot. & Standl.) McVaugh
var. *virens* [*P. virens* (Woot. & Standl.) Shreve] "Southwestern Black Cherry"
{I} * *Pyracantha koidsumii* Rehd. "Fire Thorn"
Vaquelinia califomica (Tory.) Sarg. "Arizona Rosewood"

[LEGMINOSAE: see FABACEAE]

FABACEAE [Leguminosae] (for convenience includes: **CAESALPINIACEAE**, **MIMOSACEAE)**
Acacia angustissima (Mill.) O.Ktze. "White-ball Acacia"
A. constricta Benth. "Mescat Acacia, White-thorn"
A. greggii Gray
var. *arizonica* Isely "Catclaw Acacia"
Amorpha fruticosa L.
var. *occidentalis* (Abrams) K. & P. "Bastard Indigo"
Astragalus hypoxylus Wats. "Milk Vetch, Locoweed"

A. lentiginosus Dougl. ex Hook.
var. *australis* Barneby "Milk Vetch, Locoweed"
{I} *Caesalpinia gilliesii* (Wall ex Hook.) Dietrich "Bird of Paradise Flower"
Calliandra eriophylla Benth. "Fairy Duster"
[*Cassia:* see *Senna*]
Clitoria mariana L. "Butterfly Pea"
* *Cologania angustifolia* Kunth
* *Cracca edwardsii* A.Gray
Crotalaria pumila Ort. "Rattle Box"
* *C. sagittalis L.* "Rattle Box"
Dalea albiflora Gray "Indigo Bush, Pea Bush"
* *D. exigua* Barneby *[Petalostemon exile* A.Gray] "Indigo Bush, Pea Bush"
* *D. versicolor Zucc.*
var. *sessilis* (Gray) Barneby [D. *wislizenii* Gray var. *sessilis* (Gray) Gentry] "Indigo Bush"
* *Desmanthus cooleyi* (Eaton) Trel. "Bundleflower"
Desmodium batocaulon Gray "Fick Clover, Tick Trefoil" *
D. neomexicanum A.Gray "Tick Clover, Tick Trefoil"
* *D. retinens* Schlect "Tick Clover" * *D. rosei* Schubert "'Tick Clover"
* *Erythrina flabelliformis* Kearney "Southwestern Coralbean"
* *Eysenhardtia orthocarpa* (Gray) Wats. [E. *polystachya* (Ort.) Sarg.] "Kidney Wood"
[*Krameria:* see Krameriaceae]
Lathyrus graminifolius (Wats.) White "Peavine"
Lotus greenei (Woot. & Standl.) Ottley ex K. & P. "Deer Vetch, Bird's Foot Trefoil"
* *L. oroboides* (Kunth) Ottley ex Kearney & Peebles "Deer Vetch"
L. wrighth (Gray) Greene "Wright Lotus"
Lupinus palmeri Wats. "Lupine"
* *Macroptilium gibbosifolium* (Ortega) A.Delgado *[Phaseolus heterophyllus* Willd.] "Bean"
Mimosa biuncifera (Benth.) B. & R. "Wait-A-Minute, Cat's Claw Mimosa"
* *M. dysocarpa* Benth. "Mimosa, Gatuno"
M. grahamii Gray "Mimosa"
[*Phaseolus heterophyllus:* see *Macroptilium*]
Phaseolus ritensis M.E.Jones [P. *metcalfei* Woot. & Standl.] "Bean"
Prosopis glandulosa Ton. [*P. juliflora* (Swartz) DC., in part] "Honey Mesquite"
Robinia neomexicana Gray "New Mexican Locust"
* *Senna hirsuta (L.)* Irwin & Barneby
var. *glaberrima* (M.E.Jones) Irwin & Barneby [*Cassia leptocarpa* sensu Kearney & Peebles] "Slim Pod Senna"
S. lindheimerana (Scheele) Irwin & Barneby [*Cassia lindheimerana* Scheele] "Senna"

KRAMERIACEAE [Leguminosae in part]
Krameria parvifolia Benth. [incl. var. *glandulosa* (Rose & Painter) Macbr., and var. *imparata* Macbr.] "Little-leaved Ratany"

LINACEAE
Linum puberulum (Engelm.) Heller "Plains Flax"

ZYGOPHYLLACEAE *Kallstroemia parviflora* Norton

POLYGALACEAE
Polygala obscura Benth. "Obscure Milkwort"

EUPHORBIACEAE
* *Acalypha neomexicana* Muell.Arg. "New Mexican Copperleaf"
Croton pottsii (Klotzsch) Muell.-Arg. "Croton"
Euphorbia brachycera Engelm. "Spurge"
* *E. dentata* Michx. "Toothed Spurge"
* *E. heterophylla* L. "Painted Spurge, Catalina"
* *E. hyssopifolia* L. "Hyssop Spurge"
* *E. indivisa* (Engelm.) Tidestrom "Spurge"
* *E. prostrata* Sit. "Groundfig Spurge"
Jatropha macrorhiza Benth.
var. *septemfida* Engelm.

ANACARDIACEAE
Rhus glabra L. "Smooth Sumac"
[*R choriophylla:* see *R virens*]
[*R radicans:* see *Toxicodendron*]
R trilobata Nutt.ex T.& G.
var. *racemulosa* (Greene) Barkley "Squaw Bush"
R virens Lindheimer ex Gray
var. *choriophylla* (Wont.& Standl.) Young [R *choriophylla* Woot. & Standl.] "Mearns Sumac"
Toxicodendron radicans (L.) Ktze. *[Rhus radicans* L. in part] "Poison Ivy"

SAPINDACEAE
Sapindus saponaria L. var. *drummondii (H.* & A.) Benson "Western Soapberry"

RHAMNACEAE
Ceanothus fendlei Gray "Buck Brush, Deer Brier"
C. greggii Gray
[*Condalia lycioides:* see *Ziziphus*]
Ziziphus obtusifolia (Hook. ex T. & G.) Gray
var. *cansecens* (Gray) Johnst. *[Condalia lycioides* (Gray) Weberb.] "Gray Thorn, Gray-leaved Abrojo"

VITACEAE
Vitis arizonica Engelm. "Canyon Grape, Parro del Monte"

* **MALVACEAE**
* *Anoda cristata (L.)* Schlecht. "Spurred Anoda" * *Sida neomexicana* A.Gray
* *S. procumbens* Sw.

*** STERCULIACEAE**
* *Ayenia compacta* L. (A. pusilla L.) * *A. filiformis* S.Wats.

LOASACEAE
Mentzelia multiflora (Nutt.) Gray [M. *pumila* (Nutt.) T. & G. var. *m.* (Nutt.) Urb. & Gilg.] "Blazing Star"
* *M. texana* Urban & Gilg. (M. *asperula* Woot. & Stand].) "Blazing Star"

CACTACEAE
* *Coryphantha vivipara* (Nutt.) Britt. & Rose "Pincushion Cactus"
Echinocereus pectinatus (Scheidw.) Engelm. "Rainbow Cactus, Hedgehog Cactus"
var. *pectinatus*
var. *rigidissumus* (Engelm.) Engelm. ex Rumpler
Mammillaria heyderi Muhlenpf. [M. *gummifera* Engelm.]
var. *macdougalii* (Rose) I-Benson [M. *macdougalii* Rose; M. *gummifera* var. *macdougalii* (Rose) L.Benson] "Fishhook Cactus, Pincushion Cactus"
* *Opuntia chlorotica* Engelm. & Bigel. "Silver-Dollar, Clock-Face Prickly-Pear"
O. engelmannii Salm-Dyck ex Engelm.
var. *engelmannii [O. phaeacantha* var. *discata* (Griffiths) L. Benson & Walkington]
* *O. macrorhiza* Engelm.
var. *macrorhiza* "Plains Prickly Pear"
* *O. phaeacantha* Engelm. [O. p. var. *major* Engelm.] "Brown Spine"
[O. *phaeacantha* var. *discata:* see O. *engelmannii*]
O. spinosior (Engelm.) Tourney "Cane Cholla"

*** LYTHRACEAE**
* *Cuphea wrightii* A.Gray

ONAGRACEAE
Oenothera albicaulis Pursh "Prairie Evening Primrose"
O. brachycarpa Gray
var. *wrightii* (Gray) Leveille "Evening Primrose, Sun Drops"

[CORNACEAE: see GARRYACEAE]

GARRYACEAE [Cornaceae in part]
Garrya wrightii Torr. "Silk-tassel"

ERICACEAE
Arbutus arizonica (Gray) Sarg. "Arizona Madrone"
Arctostaphylos pringlei Parry "Manzanita"
A. pungens HBK. "Mexican Manzanita"

FOUQUIERIACEAE
Fouquieria splendens Engelm. "Ocotillo, Coach Whip"

OLEACEAE
Fraxinus velutina (*Ton.*) Mill. "Velvet Ash"

GENTIANACEAE
Centaurium calycosum (Buck].) Fern.
var. *calycosum* "Buckley's Centaury"

APOCYNACEAE
Macrosiphonia brachysiphon (Torr.) Gray "Rock Trumpet"

ASCLEPIADACEAE
* *Asclepias elata* Benth. "Milkweed, Silkweed"
A. engelmanniana Woodson "Milkweed, Silkweed"
* *A. macrods Torr.* "Milkweed, Silkweed"
* *Sarcostemma cynanchoides* Decne. [*Funastnan cynanchoides* (Decne.) Schlecter]
var. *hartwegii* (Vail) Shinners [ssp. *h.* Vail) R.Holm] "Climbing Milkweed"

CONVOLULACEAE
Convolulus equitans Benth. [C. *incanus* Vahl] "Hoary Bindweed"
* *Evolvulus alsinoides L.* "Dip de Vibora"
*E. arizonicus G*ray
E. sericeus Sw.
* *Ipomoea capillacea* (Kunth) G.Don "Morning Glory"
* *I. costellata Ton.* "Morning Glory"
I. heterophylla L. [I. *coccinea L.]* "Morning Glory"
I. longifolia Benth. "Morning Glory"
I. purpurea (L.) Roth
var. *diversifolia* (Lindl.) O'Donnell [I. *hirsutula* Jacq. f.] "Tall Morning Glory"

POLEMONIACEAE
[*Gilia:* see *Ipomopsis*]
Ipomopsis longiflora (Torr.) V.Grant [*Gilia 1.* (Torr.) G.Don] "White-flowered Gilia"
I. thurberi (Torr.) V.Grant [*Gilia t.* Torr.]
Phlox longifolia Nutt.
var. *stansburyi* (Torr.) Gray [*P.* s. (Torr.) Heller]

VERBENACEAE
Aloysia wrighth Heller ex Abrams "Oreganillo, Wright Lippa"
* *Bouchea prismatica (L.)* Kuntze
Glandularia bipinnatifula (Nutt.) Nutt. [*Verbena b.* Nutt.; V. *ciliata* Benth.] "Dakota Vervain, Small-flowered Verbena"
[G. *wrightii* (Gray) Umber does not occur in Arizona; specimens so identified must be referred to another species]
[*Verbena bipinnatifuia:* see *Glandularia*]

Verbena bracteata Lag. & Rodr. "Prostrate Vervain"
[*Verbena wrightii* Gray does not occur in Arizona; specimens so identified must refer to another species of *Glandularia*] "Desert Vervain"

[LABIATAE: see LAMIACEAE]

LAMIACEAE [Labiatae]
Agastache wrightii (Greenm.) Woot. & Stand]. "Giant Hyssop"
* *Hedeoma dentatum* Torr. "Mock-pennyroyal"

* *Salvia lemmonii* A.Gray "Sage"
* *S. panyi* A.Gray "Sage"
* *S. subincisa* Benth. "Sage"
Stachys coccinea Jacq. 'Texas Betony"
* *Dichostema arizonicum* Gray "Blue Curls"

SOLANACEAE
{I} *Datura stramonium L.* "Jimson Weed, Toloache"
D. wrightii Regel [D. *meteloides* DC. ex Dunal] "Sacrad Datura, Tolguacha"
Solanum eleagnifolium Cav. "Silverleaf Nightshade, Trompillo"
* *S. deflexum* Greenm. "Nightshade"

SCROPHULARIACEAE
Brachystigma wrightii (Gray) Penn.
Castilleja laxa Gray "Indian Paint Brush"
Mimulus guttatus Fisch. ex DC. "Monkey Flower"
M. nasutus Greene "Monkey Flower"
Penstemon dasyphyllus Gray "Beard Tongue"
P. panyi (Gray) Gray "Beard Tongue"
P. virgatus Gray "Beard Tongue"

BIGNONIACEAE

Chilopsis linearis (Cav.) Sweet "Desert Willow"

* **MARTYINIACEAE**
* *Proboscidea parvif lora* (Woot.) Woot. & Stand].
var. *parvif lora* "Devil's Claw, Cinco Llagas"

* **ACANTHACEAE**
* *Dyschoriste decumbens* (A.Gray) Kuntze

PLANTAGINACEAE
Plantago patagonica Jacq. [P. *purshii R. & S.]* "Pursh Plantain"

RUBIACEAE
Bouvardia glabenima Englm.
* *Galium aparine* L. "Bedstraw, Cleavers"
* *G. microphyllum* A.Gray "Bedstraw, Cleavers"
* *Mitracarpus breviflorus* A.Gray

* **CAPRIFOLIACEAE**
* *Lonicera albiflora T. &* G. "White Honeysuckle"

VALERIANACEAE
Valeriana arizonica Gray "Valerian, Tobacco Root"

CUCURBITACEAE
* *Cucurbita digitata* Gray "Finger-leaved Gourd"
C. foetidissima HBK. 'Buffalo Gourd, Calabazilla"
* *Sicyos ampelophyllus* Woot. & Standl. "One-seeded Bur-Cucumber"

ASTERACEAE
* *Ambrosia psilostachya* DC. "Western Ragweed"
[*Aplopappus gracilis:* see *Machaeranthera gracilis*]
[*Aplopappus laricifolius:* see *Ericameria laricifolia*]
[*Aplopappus spinulosus:* see *Machaeranthera pinnatifida*]
[*Aplopappus tenuisectus:* see *Isocoma tenuisecta*]
[*Aster arenosus:* see *Chaetopappa ericoides*]
[*Aster hirtifolius:* see *Chaetopappa ericoides*]
[*Aster parvulus:* see *Machaeranthera parviflora*]
[*Aster tanacetifolius:* see *Machaeranthera tanacetifolia*]
* *Baccharis bigelovii* A. Gray "Groundsel Tree"
B. glutinosa Pers. "Seep Willow, Batamote, Jara"
B. neglecta Britt. "Linearleaf Baccharis, Jara Dulce"
B. pteronioides DC. "Yerba-de-Pasmo"
Bahia absinthifolia Benth.
Baileya multiradiata Harv.& Gray ex Torr. "Wild Marigold, Desert Baileya"
Brickellia baccharidea Gray
[B. *chlorolepis:* see *B. eupatorioides*]
* *B. eupatorioides* (*L.*) Shinners
var. *chlorolepis* (Woot. & Standl.) B.Turner [B. *chlorolepis* (Woot. & Standl.) Shinners; *B. rosmarinifolia* (Went.) W.A. Weber
ssp. c (Woot. & Standl.) W.A. Weber; *Kuhnia rosmarinifolia* Vent.
var. r.; *K r.* var. c. (Woot. & Standl.) Blake]
B. grandiflora (Hook.) Nutt. "Large-flowered Thoroughwort"
* *B. simplex* A.Gray
* *Carminatia tenuiflora* DC. "Plume Weed"

Chaetopappa ericoides (Ton) Nesom *[Leucelene e.* (Torr.) Greene; *Aster arenosus* (Heller) Blake; *Aster hirtifolius* Blake] "White Aster, Rose Heath"
Chrysothamnus nauseosus (Pall.ex Pursh) Britt. "Rabbit Brush, Rayless Goldenrod"
Cirsium arizonicum (Gray) Petrak "Arizona Thistle"
C. neomexicanum Gray "Thistle"
* *Conyza canadensis (L.)* Cronq. "Horseweed"
* *C. coulteri* A.Gray
* *C. sophiaefolia* Kunth
* *Cosmos parviflorus* (Jacq.) Pers.
Dyssodia acerosa DC. "Dogweed, Fetid Marigold"
Ericameria laricifolia (Gray) Shinners *[Aplopappus laricifolius* Gray] *Erigeron divergens T.&* G. "Spreading Fleabane"
E. neomexicanus Gray "Fleabane"
Eupatorium herbaceum (Gray) Greene "Thoroughwort, Boneset"
* *Gnaphalium* wrightii Gray "Cudweed"
Guardiola platyphylla Gray
Gutierrezia microcephala (DC.) Gray [G. *lucida* Greene] "Three Leaf Snakeweed"
Helianthus petiolaris Nutt.
ssp. fallax Heiser "Sunflower"
* *Heterosperma pinnatum* Cav.
Heterotheca psammophila Wagenkn. [H. *subaxillaris* (Lam.) Britt. & Rusby] "Camphor Weed"
* *Hymenothrix wislizenii* A.Gray
Isocoma tenuisecta Greene [*Aplopappus tenuisectus* (Greene) Blake]

* *Lasianthaea podocephala* (Gray) K.Becker [*Zexmenia p.* (Gray) Gray]
[*Leucelene:* see *Chaetopappa*]
Machaeranthera gracilis (Nutt.) Shinners *[Aplopappus gracilis* (Nutt.) Gray]
M. parvif lora Gray *[Aster parvulus* Blake]
M. pinnatifida (Hook.) Shinners *[Aplopappus spinulosus* (Pursh) DC.]
M. tanacetifolia (HBK) Nees *[Aster tanacetifolius H.B.K.]*
Malacothrix fendleri Gray
* *Melampodium longicorne* A.Gray "Black Foot"
* *M. strigosum* Steussy [M. *hispidum* auct. non Kunth] "Black Foot"
* *Pectis* filipes Harv. & A.Gray
var. *subnuda* Fern.
* *P. imberbis* A.Gray
* *Sanvitalia abertii* A.Gray
Senecio douglash DC.
var. *longilobus* (Benth.) Benson [S. *longilobus* Benth.] “Three Leaf Grounsel”
* *Solidago altissima* L. '"Tall Goldenrod"
* *Stephanomeria exigua* Nutt. "Annual Mitra"
* *Trixis californica* Kellogg
Verbesina encelioides (Cav.) Benth.& Hook.ex Gray "Yellowtop, Cowpen Daisy"
Viguiera cordifolia Gray "Goldeneye"
* *V. dentata* (Cav.) Spreng. "Goldeneye"

Xanthium strumarium L. [X. *saccharatum* Wallr.] "Common Cocklebur, Abrojo"
[*Zexmenia:* see *Lasianthaea*]
Zinnia grandif lora Nutt. "Prairie Zinnia"