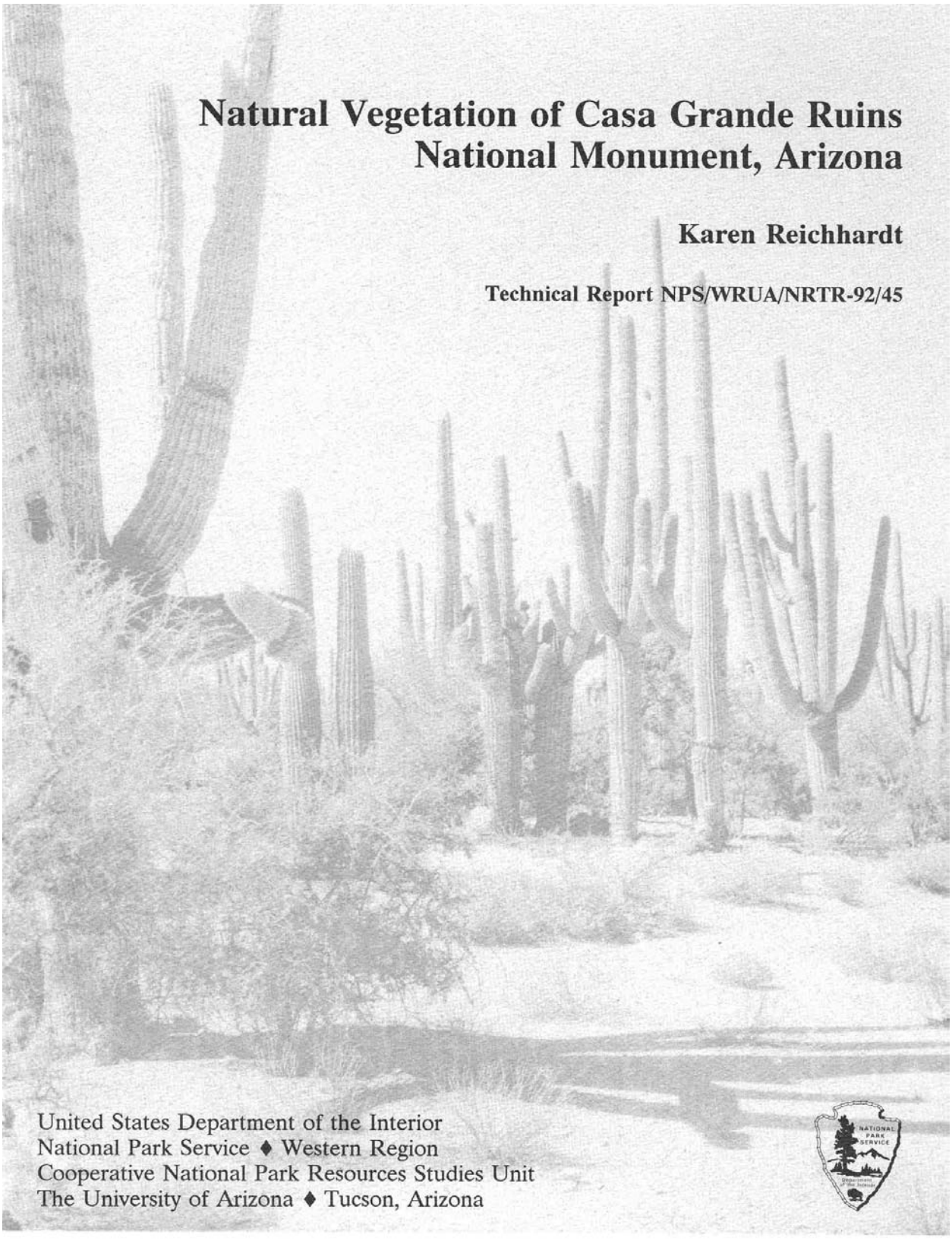

Natural Vegetation of Casa Grande Ruins National Monument, Arizona

Karen Reichhardt

Technical Report NPS/WRUA/NRTR-92/45

United States Department of the Interior
National Park Service ♦ Western Region
Cooperative National Park Resources Studies Unit
The University of Arizona ♦ Tucson, Arizona

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June 1992

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[1]Karen Reichhardt was a contract biologist working for the National Park Service at the time she made the vegetation survey of Casa Grande Ruins National Monument.

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ABSTRACT

This report presents the results of a survey of the abiotic environment and natural vegetation of Casa Grande Ruins National Monument. The monument is located on a desert plain in the Gila River basin in south-central Arizona that has been irrigated by both prehistoric peoples and modern man. The monument itself has not been cultivated in modern times and thus represents a landmark of comparison with the surrounding agricultural landscape. Permanent vegetation monitoring plots were established, and a checklist of native and naturalized non-cultivated plants was produced as a baseline for future studies of vegetation change. Plantings near the visitor center were not inventoried. A comparison of vegetation on the monument through matched historic and recent photographs shows that composition of vegetation has not changed significantly; however, the same plant species have redistributed over time. The most significant change is the reduction of mesquite (*Prosopis velutina)* trees, attributed to the drastically lowered groundwater levels during this century. Creosote bush *(Larrea tridentata)* has encroached into the now degraded saltbush (*Atriplex polycarpa)* community. Permanently established monitoring plots will help determine future vegetation changes.

INTRODUCTION

Casa Grande Ruins National Monument (CAGR) is located in Pinal County of south-central Arizona, midway between Phoenix and Tucson. It is 1.6 km (1 mi) north of Coolidge (within Coolidge city limits) on State Highway 87, and 14.4 km (9 mi) west of Florence on Highway 287. The monument is 191.2 ha (472.5 a) in size, and its elevation ranges from 435.2 m (1,428 ft) in the southeast corner to 430 m (1,413 ft) in the northwest corner.

Topographically the monument is positioned 2.4 km (1.5 mi) south of the Gila River in a desert valley that has been irrigated for agriculture by both prehistoric and modern day peoples. The climate is a subtropical desert, where the majority of sparse precipitation is received from storms originating to the south during the summer monsoon season in July and August. Lesser amounts of rain fall in the winter from storms originating west of the Pacific Coast, while spring and fall months commonly remain dry. During recent years, precipitation has been about equally distributed between summer and winter. Mean annual rainfall is 20.22 cm (7.96 in.); monthly averages vary from 0.25 cm (0.06 in.) in June to 2.77 cm (1.23 in.) in August (CAGR weather data summary for 1956 to 1985). Daytime temperatures frequently exceed 37.7°C (100°F) in summer. Winter temperatures are cooler, but are considered mild, commonly above 26.6°C (80°F) in daytime and rarely below 0°C (32°F) for more than a few hours at night. . The mean daily maximum for July is 41.6°C (107°F) and the mean daily minimum for January is 0.7°C (33.4°F) (Sellers and Hill 1974).

The monument was established in 1918. The land was never plowed during historic times, although it is currently surrounded by groundwater- and river-irrigated agriculture. The boundary was fenced to protect it from livestock grazing in 1934. Decline of the water table caused the native mesquite trees to die during the 1940s (Judd 1971). It is conceivable that the effects of grazing, water table decline, and possibly pesticide drift from aerial spraying of nearby cotton fields have reduced or eliminated other floral elements as well.

GEOLOGY AND SOILS

The south-central Arizona region is part of the Basin and Range physiographic province. This province was formed 65 to 1.8 million years ago during the Cenozoic by a gradual extension or enlargement of the land surface where rocks were pulled apart under tension, creating block-fault mountains (horsts). These were rapidly eroded, leaving valleys filled with alluvial debris (grabens) (Nations and Stump 1981). The monument is situated on one of these alluvial deposits composed of Quaternary age gravel, sand, and silt (Wilson et al. 1959; Wilson et al. 1969). At the Gila River, 2.4 km (1.5 m) north of CAGR, the alluvium is less than 122 m (400 ft) thick. The depth of alluvium drops sharply-at State Highway 287 along the northern boundary of the monument, the alluvium is 244-366 m (800-1,200 ft) thick. It becomes a deep basin more than 366 m (1,200 ft) thick in the Coolidge area near the monument (Cooley 1973).

According to Wilson et al. (1959) and Wilson et al. (1969), the isolated mountain outcrops to the north and west are composed of a mixture of rocks. These include older Precambrian granite, small Quaternary dikes and plugs (mainly basaltic in composition), metamorphic schist of Precambrian origin, Tertiary rhyolite from the Laramide, and Tertiary-Quaternary basalt, which may locally include tuff and agglomerate.

The Casa Grande-Gila River area soils are generally classified as Hyperthermic Acid soils. These soils have mean annual soil temperatures of more than 22°C (72 °F) and less than 250 mm (10 in.) mean annual precipitation (Hendricks 1985).

Coolidge sandy loam is the predominant soil type. In general, soils are "deep, well drained on fan terraces and stream terraces. They are formed in fan and stream alluvium derived from mixed sources. The hazard of water erosion is slight. The hazard of soil blowing is moderate" (Soil Conservation Service 1991).

Modern day irrigation of these and soils using pumped groundwater has- caused a severe decline in the groundwater levels of the alluvial basins. Babcock (1977) reported groundwater of the Coolidge area to be 55.5 m (182 ft) below the surface. At the time of his reporting, most wells were capable of producing 3,785 litre (1,000 gal) per minute or more. In the Lower Santa Cruz Valley 47,742,993,000 m^3 (38,721,000 acre-feet [a-ft]) were pumped by 1977 (Babcock 1977). In areas of greatest agricultural concentration, land subsidence and earth fissures have formed. As water is removed from the water table, the alluvium becomes compacted, causing subsidence and fissures. The compacted alluvium has a reduced water storage capacity, so that even if basins were recharged, there would be less available pore space for holding it. At present, no land fissures are documented at CAGR. The closest fissures are on the south edge of Black Butte, both about 16 km (10 mi) southwest of the monument. The nearest documented land subsidence is at Randolph, Arizona, 8 km (5 mi) south of the monument, where the surface had dropped 1 m (3.4 ft) by 1978 (Laney et al. 1978).

VEGETATION SURVEY

VEGETATION CLASSIFICATION MAP AND DISCUSSION

For this project a vegetation map was completed using the Brown et al. (1979) classification system for natural vegetation. This will provide a basis of comparison for any future changes that may occur in the distribution of plant communities at the monument. The map was produced with air photo interpretation techniques, and transference of photo information to a base map. A blackline copy of the map appears in the back pocket of this report (Appendix 2).

METHODS

An aerial photo taken June 1986 (scale 1:200 ft) covers the entire area of CAGR and was used for field verification of vegetation types. An acetate overlay was taped over the photo, and boundaries and human-made landmarks were traced onto the overlay. The photo was previewed before field use.

All living mesquite (*Prosopis* spp.) trees growing at the monument were traced from the photo onto the overlay. The trees appeared bright green in contrast to other more shrubby species, which were generally darker in color on the aerial photograph. Every tree recognized on the photo was field-checked, and the crown circumference was circled on the overlay. Individual species were identified on the map using symbols explained in the map legend.

To delineate the vegetation type lines, I paced the extent of the pure creosote bush *(Larrea tridentata)* stands in the field and located the outline on the photo overlay while walking stand boundaries. I then paced the extent of pure saltbush *(Atriplex polycarpa)* stands and again located the outlines on the map while in the field. The result was the mapping of three distinct plant associations.

The vegetation types are discussed below using the Brown et al. (1979) format, with one level added to reflect the actual vegetation types found. In the legend, asterisks indicate the vegetation types that actually occur at the monument. These plant assemblages are distributed throughout according to topography. At the higher elevations, where soils appear to have more drainage capacity, creosote bush is widespread. Saltbush dominates in the northwestern corner, although there is no direct correlation with reported soil types. The native velvet mesquite (*Prosopis velutina)* remains in a few places, especially in depressions or where surface runoff collects. Judd (1971) reported mesquite trees he sampled to be 110 years old at the time of his publication. The trees that have survived often have multiple prostrate branches, with shoots of new growth. Wolfberry *(Lycium exsertum*) often grows in the depressions with velvet mesquite.

VEGETATION TYPES OF CASA GRANDE RUINS NATIONAL MONUMENT

The vegetation classification system used for the monument (Sensu Brown et al. 1979) follows. Vegetation types with an asterisk (*) are found in the monument.

150 Desertland Formation

154 Tropical-Subtropical Desertlands

154.1 Sonoran Desertscrub

154.11 Creosote Bush-Bursage et al. Series

154.111 *Larrea tridentata* Association

* 154.1111 *Larrea tridentata*, *Lycium* spp., *Prosopis velutina*

* 154.1112 *Larrea tridentata* Disturbed Land

154.17 Saltbush Series

154.174 *Atriplex polycarpa Lycium* spp. *Prosopis vel*utina Association

* 154.1741 *Atriplex polycarpa, Lycium* spp.

* 154.1742 *Atriplex polycarpa, Larrea tridentata, Lycium* spp. Ecotone

CHECKLIST OF NON-CULTIVATED PLANTS

During the course of fieldwork, native and naturalized perennial and annual plants in flower and fruit were collected at the monument. I excluded all cultivated shrubs and succulents growing in the display gardens in front of and inside the headquarters (A plant list of these species was compiled by Park Ranger John Andresen and is on file at headquarters). The trees planted from nursery stock in the picnic area and along the walkway to the residences are included, because they appear on the vegetation map, and it was essential to distinguish between planted and natural mesquite for population demography studies of the latter. The ocotillos and saguaros planted in fence rows near the visitor center are cultivated-and thus do not appear in this checklist.

An alphabetical list of plants that I collected, or that were collected at the monument in the late 1930s and 1940s is presented in Table 1 according to life form. Specimens were deposited in the monument herbarium. Annotation information includes scientific authority, common name, synonymy, growth form and size, location in monument, abundance, and flowering season when this information is known. If the plants are nonnative, the place of origin is also listed (as per Kearney and Peebles 1960). I also made a note as to whether plants were collected previously and deposited in the CAGR herbarium, but were not re-collected by me. A few cultivated species (i.e., oleander *[Nerium oleander])* appear on the list because these were growing away from the visitor center and are not currently under horticultural care.

Table 1. Plants collected according to life form on Casa Grande Ruins National Monument, Arizona, in the late 1930s and 1940s or in the current study.

Shrubs and Trees

Acacia greggii Gray var. *arizonica* Isely Catclaw
Perennial shrub to 4 m (13 ft) tall; planted near visitor center; occasional; April to October.

Atriplex canescens (Pursh) Nutt. Fourwing Saltbush
Shrub to 1.5 m (4.9 ft) tall; in disturbed areas; occasional.

Atriplex polycarpa (Torr.) S. Wats. All Scale, Cattle Spinach
Shrub to 1 m (3.2 ft) tall; replaces *Larrea tridentata* as dominant in northwest portion of monument; abundant.

Carnegiea gigantea (Engelm.) Britt. and Rose Saguaro
(*Cereus giganteus* Engelm.) Arborescent cactus; a single plant in southeast corner of monument and several planted near visitor center; flowering May and June.

Cercidium floridum Benth. Blue Paloverde
Also treated as *Parkinsonia florida* (Benth. ex Gray) S. Wats. (Kartesz and Kartesz 1980). Tree to 6 m (16.4 ft) tall; from imported nursery stock planted around visitor center; occasional; May to June.

Isocoma wrightii (Gray) Rydb. Jimmy Weed
(*Happlopappus heterophyllus* [Gray] Blake) Shrub to 1 m (3.3 ft) tall; surrounding parking lot; uncommon; June to October.

Larrea tridentata (Sesse and Moc. ex DC.) Coville Creosote Bush
Shrub to 1.8 m (5.9 ft) tall; dominant species of all but in northwest portion of monument where *Atriplex polycarpa* replaces it; abundant; flowering from time to time throughout the year, but most profusely in spring.

Lycium exsertum Gray Wolfberry, Desert Thorn, Tomatillo
Shrub to 2.7 m (9 ft) in gentle depressions with *Prosopis velutina*; occasional; February to April (August and September).

Nerium oleander L. Oleander
Shrub to 3 m (8.8 ft) tall; planted next to residences; from Europe.

Table *1-continued.*

Nicotiana glauca Graham Tree Tobacco
Arborescent shrub; distribution in monument unknown; flowering nearly throughout the year; naturalized from South America; based on specimen collected by Dodge in 1941 near sewer pump, and deposited in monument herbarium.

Prosopis glandulosa Torr. Honey Mesquite
Tree to 6 m (19.7 ft) tall; from nursery stock planted in the picnic area and near visitor center; rare; spring.

Prosopis glandulosa Torr. var. *glandulosa* South American Mesquite
(P. *chilensis* [Molina] Stutz var. *g.* [Tory.] Standl.) Tree to 6 m (19.7 ft) tall; from nursery stock planted in garden area next to visitor center; identification of the trees at the monument is tentative, because they may actually be of hybrid nursery stock; spring.

Prosopis velutina Woot. Velvet Mesquite
Tree to 6 m (19.7 ft) tall; very old trees are still living in gentle depressions where surface runoff is available, but otherwise this native species died during the late 1940s when the water table receded; occasional; spring and sometimes fall. Another genetic variation of this species is found planted, from nursery stock, at the visitor center, picnic area, and residential area it has a greater number of leaflets on the rachis than do other mesquites.

Tamarix chinensis Lour. Tamarisk
Tree; young saplings found along road easement next to canal in northeast corner; rare; March to August; naturalized from Europe.

Grasses

Aristida purpurea Nutt. Purple Three-awn
Perennial grass; along roadsides; common; spring.

Bromus rubens L. Red Brome, Foxtail Chess
Annual grass; along roadsides, near residences and visitor center and beneath dead mesquite trees; common; spring; from Europe.

Cynodon dactylon (L.) Pers. Bermuda Grass
Perennial grass; mostly near residential area; occasional; introduced in America. Dodge and Elmore collected in 1941.

Table *1-continued.*

Eragrostis lehmanniana Nees Lehman Lovegrass
Perennial grass; along roadside outside monument; common; introduced from South Africa by the Soil Conservation Service.

Hordeum leporinum Link Wild Barley
Annual grass; along roadsides, near buildings and beneath living or dead mesquite trees and creosote bush; common; abundant where found; mostly April to June; widespread in United States; introduced from Europe.

Poa bigelovii Vasey and Scribn. Bigelow Bluegrass
Annual grass; distribution unknown in monument; introduced from Europe; based on single specimen in herbarium collected by Dodge and Elmore in 1941.

Schismus arabicus Nees Arabian Grass
Annual grass; grows in same habitat with S. *barbatus;* abundant; spring; introduced from western Asia.

Schismus barbatus (L.) Thell. Mediterranean Grass
Annual grass; widespread throughout monument, often aligning on top of buried archeological walls; abundant; spring; introduced from Old World.

Herbs

Ambrosia psilostachya DC. Western Ragweed
Perennial herb; along roadsides; rare; July to October.

Amsinckia intermedia F. and M. Coast Fiddleneck
Annual herb; common throughout monument in partially shaded areas; abundant; March to May.

Amsinckia tesselata Gray Checker Fiddleneck
Annual herb; common throughout monument in partially shaded areas; abundant; February to June.

Atriplex elegans (Moq.) D. Dietr. Wheelscale Saltbush
Perennial herb; along roadsides, especially outside monument; occasional.

Baileya multiradiata Harv. and Gray ex Ton. Desert Marigold
Perennial herb; along road easement next to canal in northeast corner; abundant; March to November.

Table *1--continued.*

Bowlesia incana Ruiz and Pavon Hairy Bowlesia
Annual herb; grows in moister shady places beneath *Larrea tridentata* and mesquite trees; common; February to May.

Brassica tornefortii Gouan Mustard
Annual herb; on outside of north boundary fence around to west boundary and along entrance on roadside; abundant where found; spring; introduced from Europe. Has potential to become more widespread and disrupt native roadside flora in California. Introduced since 1960 (Kearney and Peebles supplement by Howell and McClintock). Specimen 55, deposited at ASU, has 2 rows of seeds per loculus.

Chamaesyce albomarginata (Ton. and Gray) Small Rattlesnake Weed
(Euphorbia albomarginata T. and G.) Perennial herb; along roadsides; February to October.

Centaurea melitensis L. Starthistle, Knapweed
Annual herb; along roadside outside boundary; occasional; May to July.

Chenopodium murale L. Nettleleaf Goosefoot
Annual herb; on roadside along north boundary; occasional; winter; widely distributed in North America; naturalized from Europe.

Conyza coulteri Gray
(Erigeron schiedianus Lees) Distribution in monument unknown; collected by Dodge near sewer pump in 1941 and deposited in monument herbarium.

Cryptantha angustifolia (Tory.) Greene Narrow-leaved Cryptantha
Annual herb; distribution in monument unknown. Based on collection by Dodge in 1942 near equipment shed and deposited in monument herbarium.

Eucrypta micrantha (Torr.) Heller Small-flowered Eucrypta
Distribution in monument unknown; based on collection by Elmore in 1941 and deposited in monument herbarium.

Eriastrum sp. Eriastrum
Annual herb; scattered throughout creosote bush association; rare; March to June.

Erigeron divergens T. and G. Spreading Fleabane
Annual or biennial herb; distribution in monument unknown; based on a specimen collected by Dodge in 1942 near residential area and deposited in monument herbarium.

Table *1-continued.*

Eriophyllum lanosum Gray Woolly Eriophyllum
Annual herb; scattered throughout creosote bush association; rare; February to May.

Erodium cicutarium (L.) L'Her. Filaree, Afillerillo, Afileria
Annual herb; in creosote flats; abundant; February to July; extensively naturalized in United States; from Europe.

Erodium texanum Gray Large-flowered Stork's Bill
Annual herb; in creosote bush association; common; February to April.

Eschscholtzia californica Cham. California Poppy
Annual herb; distribution in monument unknown; name probably incorrect; based on specimen collected by Dodge in 1941 and deposited in monument herbarium.

Helianthus annuus L. Sunflower
Annual herb; distribution in monument unknown; March to October; introduced from Midwest; based on specimen collected by Dodge in 1941 east of sewer pump and deposited in monument herbarium.

Heterotheca sp. Telegraph Weed
Annual or biennial herb; distribution in monument unknown; based on specimen collected by Dodge in 1941.

Lasthenia califomica DC. ex Lindl. Goldfields
(*Lasthenia chrysostoma* [F. and M.] Greene)
(*Baeria chrysostoma* F. and M.) Annual herb; distribution in monument unknown; based on collection in herbarium by Dodge in 1942 from residential area.

Lepidium lasiocarpum Nutt. Sand Peppergrass
Annual herb; in creosote flats; occasional; January to April.

Monolepis nuttalliana (Roemer and Schult.) Greene Poverty Weed Annual herb; canal bank in northeast corner; common; spring.

Nama hispidum Gray var. *spathulatum* (Ton.) C. L. Hitchc. Hispid Nama
Annual herb; distribution in monument unknown; spring; based on specimen collected by Dodge in 1942 in residential quadrangle, and placed in monument herbarium.

Nicotiana trigonophylla Dunal Desert Tobacco
Annual or perennial herb; distribution in monument unknown; flowering year round; based on specimen collected by Dodge in 1941 near sewer pump and deposited in monument herbarium.

Table *1-continued.*

Oenothera caespitosa Nutt. ssp. *marginata* (Nutt.) Munz Large White Desert Primrose
Perennial herb; distribution in monument unknown; April to August; based on specimen collected by Dodge in 1942 near entrance, and deposited in monument herbarium.

Oenothera primiveris Gray Large Yellow Desert Primrose
Annual herb; distribution in monument unknown; March to May; based on specimen collected by Dodge in 1941 near sewer pump and placed in monument herbarium.

Pectis papposa Harv. and Gray Chinchweed
Annual herb; distribution in monument unknown; June to November; based on specimen collected by Dodge in 1941 in industrial area and deposited in monument herbarium.

Pectocarya heterocarpa Johnst. Hairy-leaved Comb Bur
Annual herb; widely distributed throughout monument; March and April; abundant.

Pectocarya penicillata (Hook. and Am.) A. DC. Comb Bur
Based on collection by Elmore in 1941 and placed in monument herbarium; this specimen should be renamed.

Pectocarya platycarpa Munz and Johnst. Broad-nutted Comb Bur
Annual herb; widely distributed throughout monument; February to April; abundant.

Phacelia distans Benth. var. *australis* Brand Wild Heliotrope
Annual herb; beneath shade of dead mesquite trees; rare to locally common; February to May.

Phoradendron californicum Nutt. Desert Mistletoe
Perennial herb; parasitic on trees; primarily on trees planted near residences and sometimes on native mesquite; occasional.

Plagiobothrys arizonicus (Gray) Greene ex Gray Blood Weed, Arizona Popcorn Flower
Annual herbs; widely distributed throughout monument; occasional; March to May.

Plantago insularis Eastw. Wooly Plantain
Annual herb; formed carpets of up to 1800 individuals/m^2 in spring of 1987; abundant; January to May.

Polygonum argyrocoleon Steud. Silversheath Knotweed
Annual or perennial herb; in road easement next to canal on northwest corner of monument; common; April to October; naturalized from Central Asia.

Table *1-continued.*

Salsola iberica Sennen and Pau. Russian Thistle
(S. *kali* L. var. *tenuifolia* (Tausch.) Annual herb; found where there has been recent disturbance, along roadside or sometimes beneath dead mesquite trees; common; spring; extensively naturalized in western United States; from Eurasia.

Sisymbrium irio L. London Rocket
Annual herb; in disturbed soil and near buildings; abundant; winter and early spring; introduced from Europe.

Sisymbrium pinnatum Greene Tansy Mustard
Based on specimen collected by Dodge in 1941 and placed in herbarium.

Sonchus oleraceus L. Annual Sow Thistle
Annual herb; along roadside outside monument; occasional; March to September; an abundant weed in most parts of North America; naturalized from Europe.

Sphaeralcea laxa Woot. and Standl. Caliche Globe Mallow
Suffrutescent shrub; along roadside; common; March to November.

Stephanomeria pauciflora (Ton.) Nutt. Wire Lettuce, Desert Straw
Perennial herb; along roadside outside monument; occasional; flowering throughout the year.

Suaeda torreyana S. Wats. Desert Seepweed
Based on collection by Elmore in 1941 from monument, and placed in herbarium there.

Verbesina encelioides (Cav.) Benth. and Hook. var. *exauriculata* Robins. and Greenm.
Golden Crownbeard. Annual herb; near parking area; April to November; based on specimen by Dodge in 1941 that was placed in monument herbarium.

In summary, 13 trees and shrubs, 8 grasses, and 45 herbs have been collected. Nomenclature largely follows Lehr (1978) and Kartesz and Kartesz (1980). Locations of origin are listed for non-native species.

PERMANENT PLOTS FOR MONITORING VEGETATION CHANGE

Methods for Establishing Plots

Permanent plots were established in 11 locations for monitoring vegetation in future years. (See Appendix 3 for exact location of plots.) The plots were nested plots consisting of a 20-m (65.6-ft) line transect (length aligned with true north), a square with 10-m (32.8-ft) sides, one side of which was concurrent with the southern half of the 20-m (65.6-ft) line. A 1-m nested plot was then placed at the northeast comer of the larger square plot (Fig. 1). The ends of the transect and all 4 comers of the 10-m- (32.8-ft-) sided plot were marked with 30-cm (1-ft) lengths of rebar.

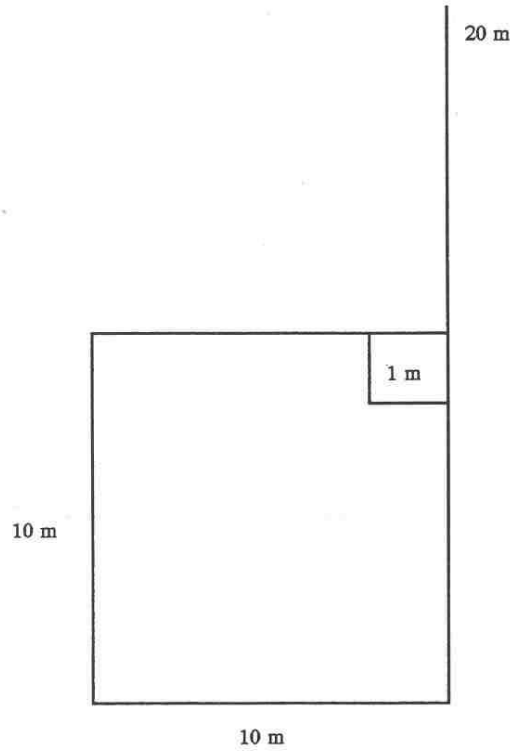

Figure 1. Design of permanent vegetation monitoring plots at Casa Grande Ruins National Monument, Arizona. North is at the top of the page.

The field location of each of the 11 monitoring plots was randomly located to avoid biases. The vegetation map was subdivided into a grid pattern having 100 squares, and a random numbers table of 100 numbers was generated. Eleven random numbers were chosen, 5 of which fit into vegetation type 154.1111, 4 into 154.1741 and 2 plots into 154.1742 (refer to page 4).

In the field, the center point of each of the 11 chosen grids was found, and then each plot was located by walking 6 paces north and 17 paces west from the center. The beginning point of each plot was started with the southeast corner.

Data from the permanent plots were recorded on work sheets. The following criteria were used for recording the data onto the sheets:

1. 20-m (65.6-ft) line transect All living perennial vegetation covering the line was measured (in cm) and recorded by species.

2. 10-m^2 (32.8-ft2) plot All plants were counted if the stem base at ground level was inside the plot. The maximum and minimum diameters were measured (in cm) for all perennial plants with stem bases inside the plot. An individual creosote bush was considered to include all stem bases up to 0.5 m (1.7 ft) apart to accommodate for the cloning nature of that species.

3. One-m^2 (3.3-ft^2) plot Annuals were counted inside these plots at the date when most of the species were in flower so the individual species could be recognized. For speed and accuracy in counting, I used a wooden plot with nylon strings, subdividing it into 100 subplots, each 10 cm (3.9 in.). I counted 10 plots in a row along the north-south axis, and recorded the data on a separate sheet. I then compiled these numbers for recording on the data sheet.

4. Photograph-Each plot was photographed along the 20-m (65.6-ft) line from the southeast corner; a photo was also made of the 1-m2 (3.3-ft) plot.

5. Reading the plots-The 20-m (65.6-ft) line transect and the 10-m^2 (32.8-ft) plots do not need to be read more often than every three years. Significant differences from year to year will be evident in the 1-m^2 (3.3-ft) plots, so they should be read in the spring and fall of each year.

Report of Data from 1987 Season of Sampling

Three vegetation types were delineated on the map. The cover and density were calculated from the permanent plot data. The creosote bush vegetation type contained 13.62% cover, and the density was 560 plants/ha (226 plants/a), all of creosote bush. The saltbush vegetation type contained 0.61% cover and the density was 400 plants/ha (162 plants/a) being comprised primarily of saltbush (325 plants/ha [132 plants/a]) and the rest creosote bush (75 plants/ha [30 plants/a]). The mixed saltbush/creosote bush type contained 2.12% creosote bush and 1.54% saltbush. The density was 250 plants/ha (101 plants/a).

The annual vegetation of spring 1987 is summarized in Table 4. Plantain *(Plantago* spp.*)* and Mediterranean grass (*Schismus barbatus)* were abundant throughout the monument that year in all vegetation types. No annuals grew on the plots in summer-fall 1987.

Table 2. Cover of perennial plants per 20-m (66-ft) line intercept, Casa Grande Ruins National Monument, Arizona, spring 1987.

Vegetation	Species name	Range (cm)	Mean (cm)	Cover %
154.1111	*Larrea tridentata*	0-493	272.4	13.62
154.1741	*Atriplex polycarpa*	5-97	48.6	0.61
154.1742	*Atriplex polycarpa*	0-121	60.5	1.54
	Larrea tridentata	48-122	85.0	2.12

Table 3. Density of perennial plants per 10-m^2 (33-ft^2) plot, Casa Grande Ruins National Monument, Arizona, spring 1987.

Vegetation	Species name	Density		No. per hectare
		Range	Mean	
154.1111	*Larrea tridentata*	3-8	5.6	560
154.1741	*Atriplex polycarpa*	2-5	3.3	325
	Larrea tridentata	0-3	0.8	75
154.1742	*Atriplex polycarpa*	0-4	2.0	200
	Larrea tridentata	0-1	0.5	50

Table 4. Density and percent frequency of annuals in 1-m^2 (3.3-ft^2) plots, Casa Grande Ruins National Monument, spring 1987.

	Vegetation Type								
	154.1111 (Creosote bush)			154.1741 (Saltbush)			154.1742 (Mixed)		
	Density		Frequency	Density		Frequency	Density		Frequency
Species Name	range	mean	%	range	mean	%	range	mean	%
Amsinckia spp.	0-1	0.2	0.0	0-47	12.5	0.9	0-3	1.5	0.1
Bowlesia incana	0-0	0.0	0.0	0-147	36.7	2.6	0-0	0.0	0.0
Erodium cicutarium	0-60	12.2	7.3	0-157	40.5	2.8	1-66	33.5	2.0
Erodium texanum	0-17	3.4	0.2	0-0	0.0	0.0	0-0	0.0	0.0
Lepidium lasiocarpum	0-9	5.6	0.3	0-1	0.2	0.0	0-1	0.5	0.0
Lotus sp.	0-1	0.2	0.0	0-0	0.0	0.0	0-0	0.0	0.0
Pectocarya spp.	17-377	106.2	6.4	3-31	11.7	0.8	31-69	50.0	3.0
Phacelia sp.	0-0	0.0	0.0	0-10	2.5	0.2	0-0	0.0	0.0
Plagiobothrys arizonicus	0-4	0.8	0.0	0-3	1.0	0.7	0-0	0.0	0.0
Plantago spp.	953-1708	1358.6	82.3	0-2378	1211.5	85.1	1099-1777	1438.0	85.1
Schismus barbatus	29-272	131.6	7.9	1-226	94.5	6.6	60-272	166.0	9.8
Sisymbrium irio	0-0	0.0	0.0	0-47	11.7	0.8	0-0	0.0	0.0
Stylocline sp.	0-111	23.2	1.4	0-0	0.0	0.0	0-0	0.0	0.0
Totals	1448-1849	1651.0		483-2563	1424.3		1506-1873	1689.5	

Methods for Sampling Mesquite Mortality, 1931-1987

The actual density of living native mesquites (not planted by groundskeepers) was determined by plotting and counting the live trees on the 1987 vegetation map. Mesquites were also mapped in 1931; 5 of the existing 11 maps were available to me for study. I compared 1931 to 1987 mesquite density by drawing a square to scale as if it were a 50-m^2 (164-ft^2) plot on the ground. All mesquites were counted in the 12 "plots" or squares placed in the exact same locations on the 1931 and 1987 maps. The locations of the plots are shown on the map in Appendix 2.

Results of Mesquite Sampling-Documentation of Mesquite Mortality

In 1987, 186 live mesquite trees native to the monument had not been planted by groundskeepers. Along the fence line, 59 trees appeared to be newly recruited, possibly sustained by surface water or road runoff. The remaining 127 trees were old individuals that probably became established before the groundwater table dropped but continued to survive from surface water. Mesquite data for the 50-m^2 (1^{64}-ft) plots from the 1987 and 1931 maps (all plots were placed away from the fenceline to depict the demography of the older individuals) are shown in Table 5.

Table 5. Number of mesquite trees counted in 1931 and 1987 in 50-m^2 (164-ft^2) plots.

Plot sample no.	Number of mesquites 1931	1987
1	8	0
2	12	0
3	10	0
4	10	0
5	4	0
6	8	2
7	16	4
8	33	0
9	10	0
10	3	0
11	16	3
12	5	0

The 1987 mean was 0.1 mesquite/ha (0.04/a), whereas in 1931, the mean was 45 trees/ha (18.2 trees/a).

Photo Documentation

I located several photos in the Western Archeological and Conservation Center and CAGR photo archives that showed natural vegetation and community structure. To rephotograph the prints chosen, I used a 35mm SLR camera with a 28-70 mm macro lens. The older photos were taken with fixed lenses and a 5- x 7-in. format camera.

Results of Photo Documentation

The composition of vegetation on the monument does not appear to have changed significantly. The same species are present in both old and new photographs (i.e., creosote bush, saltbush, mesquite, tomatillo). What has changed is their distribution. Mesquite has declined sharply. Creosote bush and saltbush appear to be changing in relative density. Some new photos show creosote bush where it was not present in the older photos. Figures 2-7 are a series of paired photographs illustrating these vegetation changes that have occurred at CAGR in recent years.

The most striking vegetation change shown in the 1987 photos is the loss of the native mesquite trees. Saltbushes are present in robust and healthy stands of uneven age classes in the older photos. In nearly every 1987 photo, saltbushes appear to have diminished in stature and appearance. In the 1987 photo of the pumphouse where rainwater runoff may still collect, saltbushes look healthier. Creosote bushes have invaded some of the saltbush stands. The 1987 photos also show (in the foreground) evidence of trampling, more bare soil, and fewer desert herbs and grasses. Cultivated plants in the foreground are common in the 1987 photos of the visitor center area. The mesquites in the picnic area have persisted and continue to thrive with supplemental irrigation.

Figure 2a. Main building of Casa Grande Ruins National Monument, Arizona, seen from the northeast August 21, 1934. The photo shows the typical desert growth of mesquite (*Prosopis velutina*) and saltbush (*Atriplex polycarpa*). The mesquite to the left of the ruin looks robust and in full leaf, apparently having 2 mistletoe (*Phoradendron californicum*) plants in its branches. A few large creosote bushes (*Larrea tridentata*) are visible in front of the mesquite. The saltbush appears robust, and the ground surface shows little evidence of trampling or disturbance except for the road track. Unidentified herbs are scattered among the saltbushes. Photo by George A. Grant.

Figure 2b. Main building, October 1987. The large mesquites have disappeared in the background. The saltbush community has persisted in a much degraded condition. A saguaro (*Carnegiea gigantea*) is present only in the 1987 photo. Because of its large size and appearance of stress (uneven wavy arms), this cactus was possibly planted. The ground surface appears to be significantly trampled; little evidence of herbaceous undergrowth can be seen. Trampling evidence in this area of the monument is to be expected due to proximity to the Casa Grande ruin.

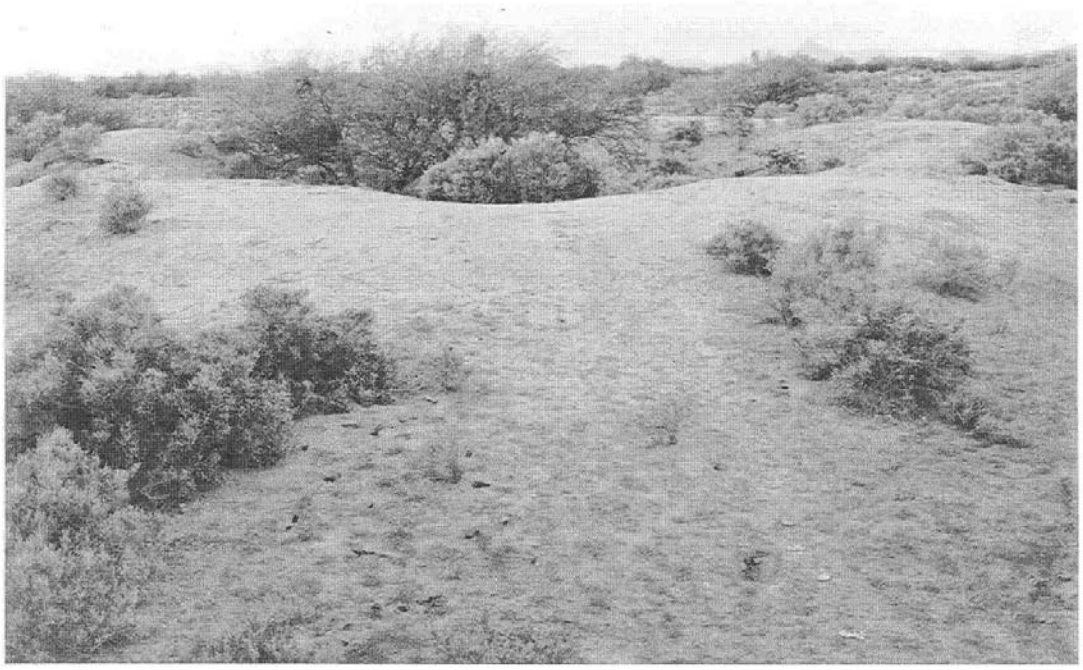

Figure 3a. View of ballcourt, Casa Grande Ruins National Monument, Arizona, 1928. A large mesquite (*Prosopis velutina*) is growing on the lip of the ballcourt. Saltbush (*Atriplex polycarpa*) appears healthy and exhibits various size classes, indicative of the occurrence of reproduction. The ground surface appears undisturbed and shows a prolific cover of desert grasses and herbs. Photo by Newcomer (Arizona Republic photographer).

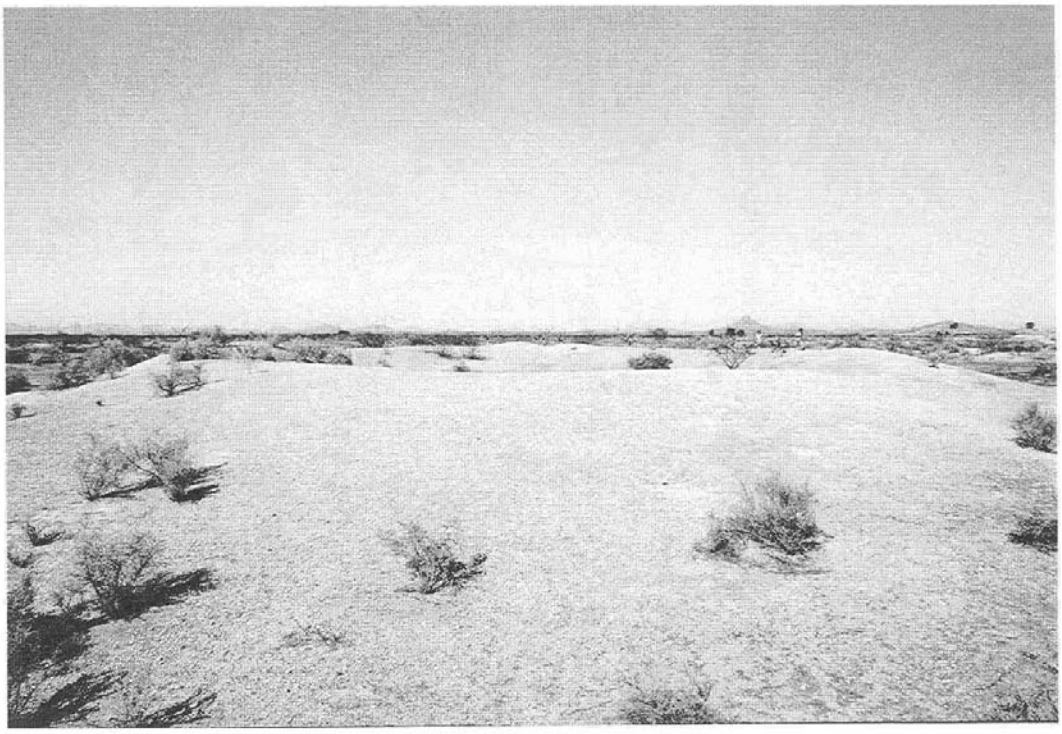

Figure 3b. View of ballcourt, October 1987. The 1987 photo shows fewer, less dense saltbushes, all severely degraded, the disappearance of one or more mesquite trees in the center of the compound, and barren soil. The overall indication is that all plant species are in decline, leaving a depauperate condition. The ballcourt may also experience trampling from visitors, which may explain the lack of soil cover by desert herbs and grasses.

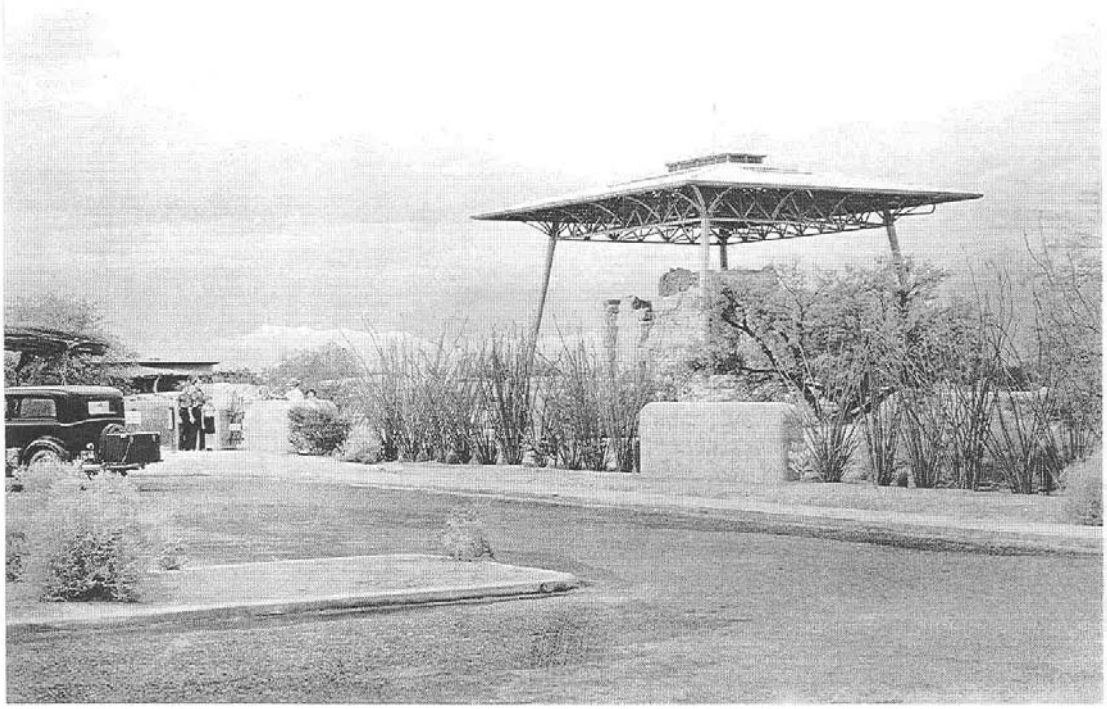

Figure 4a. West end of parking area at Casa Grande Ruins National Monument, Arizona, showing the entrance gate to Compound A and some of the planting, August 21, 1934. Ocotillo (*Fouquieria splendens*) is used along the west end wall. The median has not been planted—saltbush (*Atriplex polycarpa*) is present. A mesquite (*Prosopis velutina*) in the background appears to be native and in a healthy condition. Photo by George A. Grant.

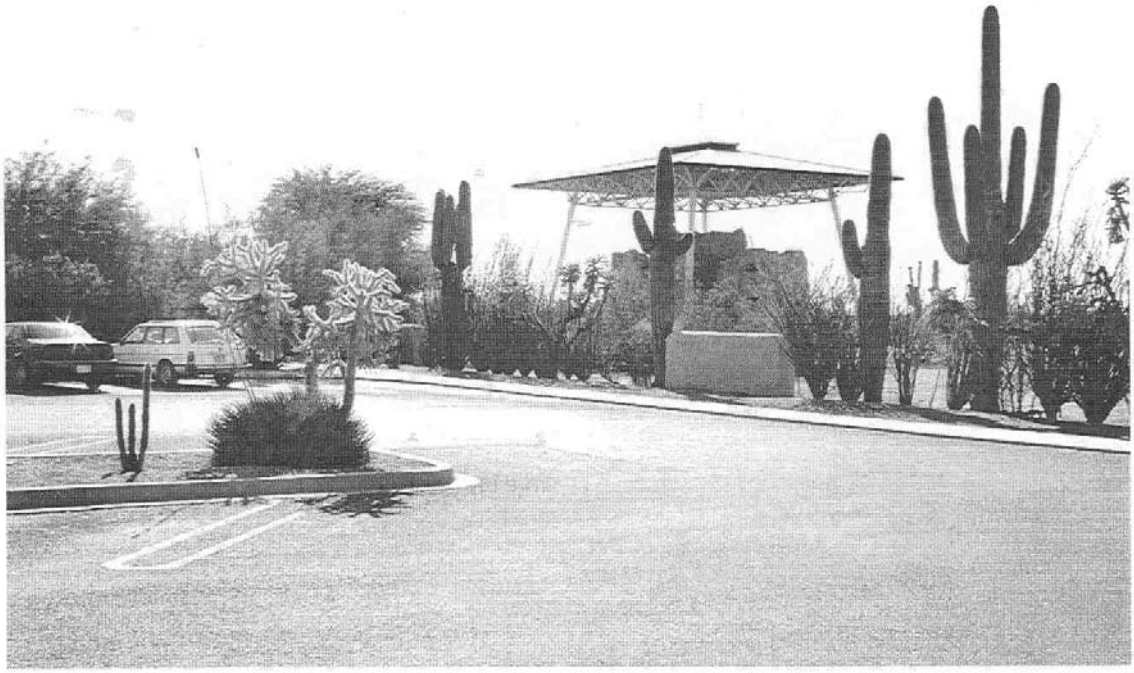

Figure 4b. West end of parking area, October 1987. The large mesquites that were growing in the desert behind the wall have died. Saguaros (*Carnegiea gigantea*) have been planted along the wall, and an agave (*Agave* sp.) and cholla (*Opuntia fulgida*) have been added in the parking lot median. Newly planted mesquite (*Prosopis glandulosa* var. *glandulosa*) trees are visible in the left of the photo in front of the visitor center.

Figure 5a. Compound B from top and east end of administration building with Walker Butte in center distance, Casa Grande Ruins National Monument, Arizona, August 21, 1947. No cultivated plants are present in the photo. The mesquite (*Prosopis velutina*) trees providing shade for picnic tables are native. Saltbushes (*Atriplex polycarpa*) are scattered throughout the median and sides of the parking lot. Photo by George A. Grant with Schumacher and Steen.

Figure 5b. Compound B from top and east end of administration building, October 1987. Many of the original mesquites still remain in the picnic area. These receive irrigation water and have large trunks. Saltbushes have been cleared from the median but still grow in the desert area. The compound is not visible because picnic area plantings in the foreground are quite tall.

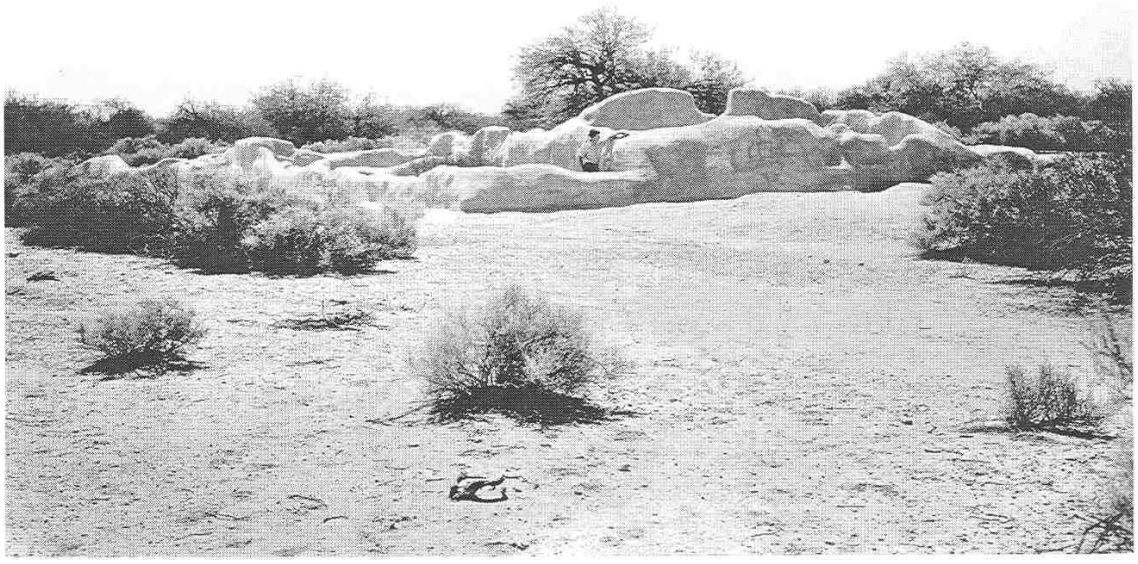

Figure 6a. Clanhouse east of Compound A, Casa Grande Ruins National Monument, Arizona, July 6, 1929. Mesquite (*Prosopis velutina*) trees are present in the background. The foreground is covered with robust saltbushes (*Atriplex polycarpa*), but the soil appears barren. This could possibly be due to trampling by visitors to the ruins. The barren soil may also indicate a lack of vegetative growth of desert herbs and grasses prior to the rainy season. Photo by George A. Grant.

Figure 6b. Clanhouse east of Compound A, October 1987. The clanhouse has been filled in; the mesquite trees in the background are still standing but are now dead and not visible in the photo. Creosote bush (*Larrea tridentata*) has replaced saltbush. The barren soil texture has a less trampled appearance, possibly because visitors no longer frequent this ruin.

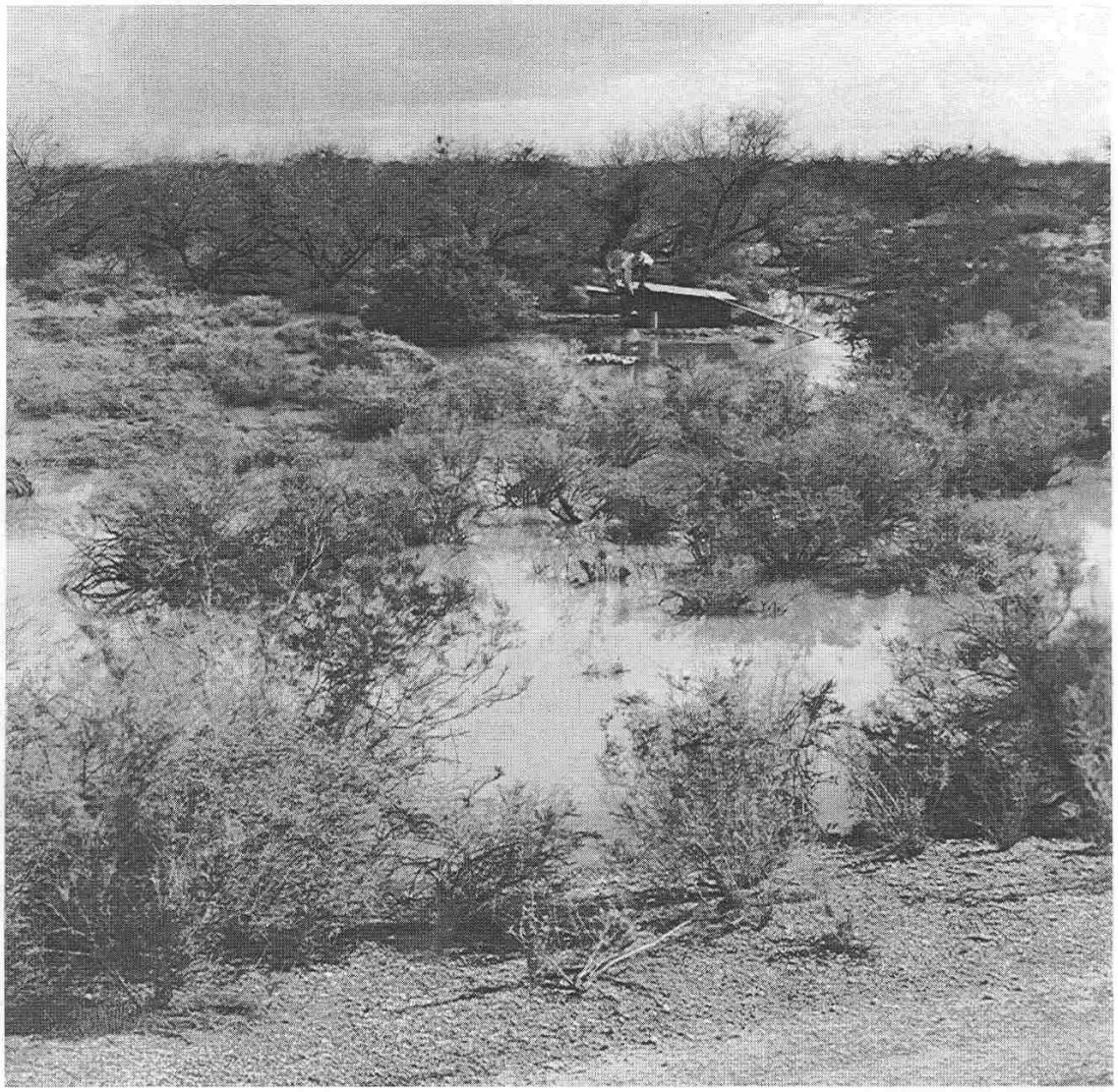

Figure 7a. Sewer pump house showing standing water following rain, Casa Grande Ruins National Monument, Arizona, January 1941. Large mesquite (*Prosopis velutina*) trees, in winter condition without foliage and possibly exhibiting small mistletoe (*Phoradendron californicum*) infestation in the branches, are located behind the pumphouse. Foreground vegetation is composed of saltbushes (*Atriplex polycarpa*) and possibly a few creosote bushes (*Larrea tridentata*). Photo by N. Dodge and C. Richey.

Figure 7b. Sewer pump house area, October 1987. The native mesquite trees in the background are still living. The foreground vegetation composition appears to have changed. Saltbush is now less common but appears more robust than in other recent photos. Creosote bush is present in both the immediate foreground and middle foreground, showing the encroachment of this species. The continued existence of the native mesquites may be attributed to increased surface water that collects after rains in a depression at the site.

IMPACT OF HISTORICAL LAND USE ON THE VEGETATION AND SOIL RESOURCES OF THE MONUMENT

The most influential and destructive land use impacts affecting the monument during historic times have been grazing and groundwater pumping. Another impact that has not been investigated is herbicide and insecticide drift from neighboring agricultural fields.

Cattle grazing, which began when Europeans entered the area in the late 1800s, has severely altered the appearance of the landscape. Miksicek (1984) recognized grazing as "the most profound insult to the Sonoran Desert grasslands [that] resulted from overgrazing in the 1800s." He added that "the dominance of creosotebush (*Larrea tridentata)* today is probably a direct result of the removal of grass cover with its consequences of soil compaction and erosion." The invasion and replacement by creosote bush and loss of grass cover and herbs in the photos seem to support this trend.

According to the Soil Conservation Service report, the soils at the monument are not easily eroded. Some compaction from the effects of an old stagecoach road can still be seen, but for the most part erosion itself is minimal except for the walls of the ruins. Groundwater depletion has also played a major role in environmental change at the monument. The monument was once a mesquite woodland, and trees were documented by Judd (1971) to be at least 100 years old. There is no way of knowing what was growing there previously, but as mentioned above, Miksicek (1984) suggested grassland. The trees for the most part died in the 1940s because the water table dropped and mistletoe began infesting the trees. Secondary infestations of insects, the age of the trees, and natural succession contributed to the lethal decline of the trees (Judd 1971). Judd also reported that in 1902 the water table was 4-5 m (10-16 ft) below the surface. By 1952 the water level was 55 m (180 ft) below the surface, and the monument well was producing insufficient quantities for water supply.

The overall picture of vegetation as it would have been during prehistoric times when the Hohokam people irrigated the area is much different. Rea (1979) described what remained in Pima agriculture along the Gila River. The riparian system supported a number of trees and shrubs. These communities extended along the canals and served to enhance the overall environment.

During this century, the trend has been toward degradation. Modern agriculture has obliterated the natural ecosystem. The monument remains as an island within the surrounding development, but much of the original integrity is lost.

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APPENDIX 1

CASA GRANDE RUINS NATIONAL MONUMENT
PERMANENT VEGETATION PLOT FIELD FORM

Plot: _____ Date: _____ Persons: _____

Photo No.: _____ Film Roll No.: _____ Transect Orientation: _____

20-m Line Transect—Perennial Vegetation Data

Species	CM	CM	Total cm
Total			

10-m^2 Plot—Perennial Vegetation Data

Species	Count	Max. width	Min. width
Total			

Appendix 1—*continued*.

1-m^2 Plot—Annual and Herbaceous Count Data

Species	Count

Notes:

APPENDIX 2

CASA GRANDE RUINS NATIONAL MONUMENT
VEGETATION MAP

NOTE:

Map too large to include. To obtain contact:

USGS – Sonoran Desert Research Station
125 Biological Sciences East Building
University of Arizona
Tucson, AZ 85721

Phone: 520-621-1174

APPENDIX 3

CASA GRANDE RUINS NATIONAL MONUMENT
MAP OF PERMANENT VEGETATION PLOTS

NOTE:

Map too large to include. To obtain contact:

USGS – Sonoran Desert Research Station
125 Biological Sciences East Building
University of Arizona
Tucson, AZ 85721

Phone: 520-621-1174

The cover photograph was taken October 4, 1935, in Saguaro National Monument by the first National Park Service photographer, George Alexander Grant (1891-1964).

As the nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting fish, wildlife and plants, preserving the environmental and cultural values of national parks and historic places, and providing for enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-15 June 1992