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VASCULAR FLORA OF BUENOS AIRES NATIONAL WILDLIFE REFUGE (INCLUDING ARIVACA CIENEGA), PIMA COUNTY, ARIZONA

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ABSTRACT

Buenos Aires National Wildlife Refuge in southeastern Arizona spans a relatively narrow elevation range and does not encompass much topographic diversity, yet possesses a diverse flora of 566 native species. A biseasonal rainfall regime and the presence of many aquatic habitats contribute to the high diversity. Floristic analysis shows that the Refuge belongs in the Apachian District of the Madrean Floristic Province. Most of the vegetation on the Refuge is grassland, much of it dominated by introduced species. There are, however, remnant areas of grassland with a dense cover of native, perennial grasses. These grasslands occur at a surprisingly low elevation for this vegetation type, probably because of the relatively high rainfall in the Altar Valley. Also included in the Refuge is a unique low elevation ciénega where many aquatic and mesophytic species occur at their lowest elevational limits.

KEY WORDS: Arivaca Ciénega, Buenos Aires National Wildlife Refuge, Desert Grassland, Flora, Southeastern Arizona.

INTRODUCTION

The Buenos Aires National Wildlife Refuge was established in 1985 to preserve the habitat of the endangered masked bobwhite quail. Prior to 1985 all of the holdings were in active cattle ranches; there has been no cattle grazing since the Refuge was created. Within the Refuge there are desert grasslands composed of native, perennial species, that have been lightly grazed, and have not been extensively invaded by woody plants; there is also a low elevation ciénega (marshland) along Arivaca Creek at Arivaca. The objective of this

paper is to catalogue the flora of Buenos Aires National Wildlife Refuge and briefly describe its vegetation.

STUDY AREA

The Refuge is located 90 km southwest of Tucson and covers 45,540 ha (Fig. 1). It lies mostly in the Altar Valley east of the Baboquivari Mountains; elevation ranges from 925 m, where the Altar Wash leaves the Refuge along its northern boundary, to 1400 m in the low lying Las Guijas Mountains along the eastern boundary. Most of the area within the Refuge occurs within an elevation range of only 200 m from 950 to 1150 m. In July 1989 a 660-ha parcel at Arivaca Ciénega was purchased by the Nature Conservancy and transferred to the Refuge. Arivaca Ciénega lies about 5 km upstream (east) of the Refuge on Arivaca Creek at an elevation of 1110 m.

Climatic data for stations nearest the Refuge are shown in Table 1 (data from Sellers *et al.* 1985). Mean monthly temperatures reach maxima of 35° to 38° C in June and July and minima of 0° to 2° C in December and January. Winter minimum temperatures are probably low enough to exclude many Sonoran Desert species. Creosote bush (*Larrea tridentata* [DC.] Cov.), for example, has not been found within the Refuge. The distribution of rainfall is biseasonal with a distinct summer peak in July and August and a less marked winter peak from December to February. The driest months are May and June; this time of year, known as the arid foresummer in southeastern Arizona, is the season most unfavorable to plant growth and survival.

METHODS

I initiated this study in March 1988. I spent a total of 35 days in the field between March 1988 and April 1991. During this time I made approximately 920 plant collections which have been deposited in the University of Arizona Herbarium (ARIZ). While in the field, I made notes on vegetation and on the distributions of the few taxa that were not collected (Cactaceae, Agavaceae, and some common trees and shrubs). Floristic affinities were investigated by assigning all species into floristic elements as defined in McLaughlin (1992) following the procedures in McLaughlin & Bowers (1990).

FLORA

The total known flora of the Refuge consists of 93 families, 352 genera, 566 native species, 7 subspecific taxa, and 49 introduced species. The introduced

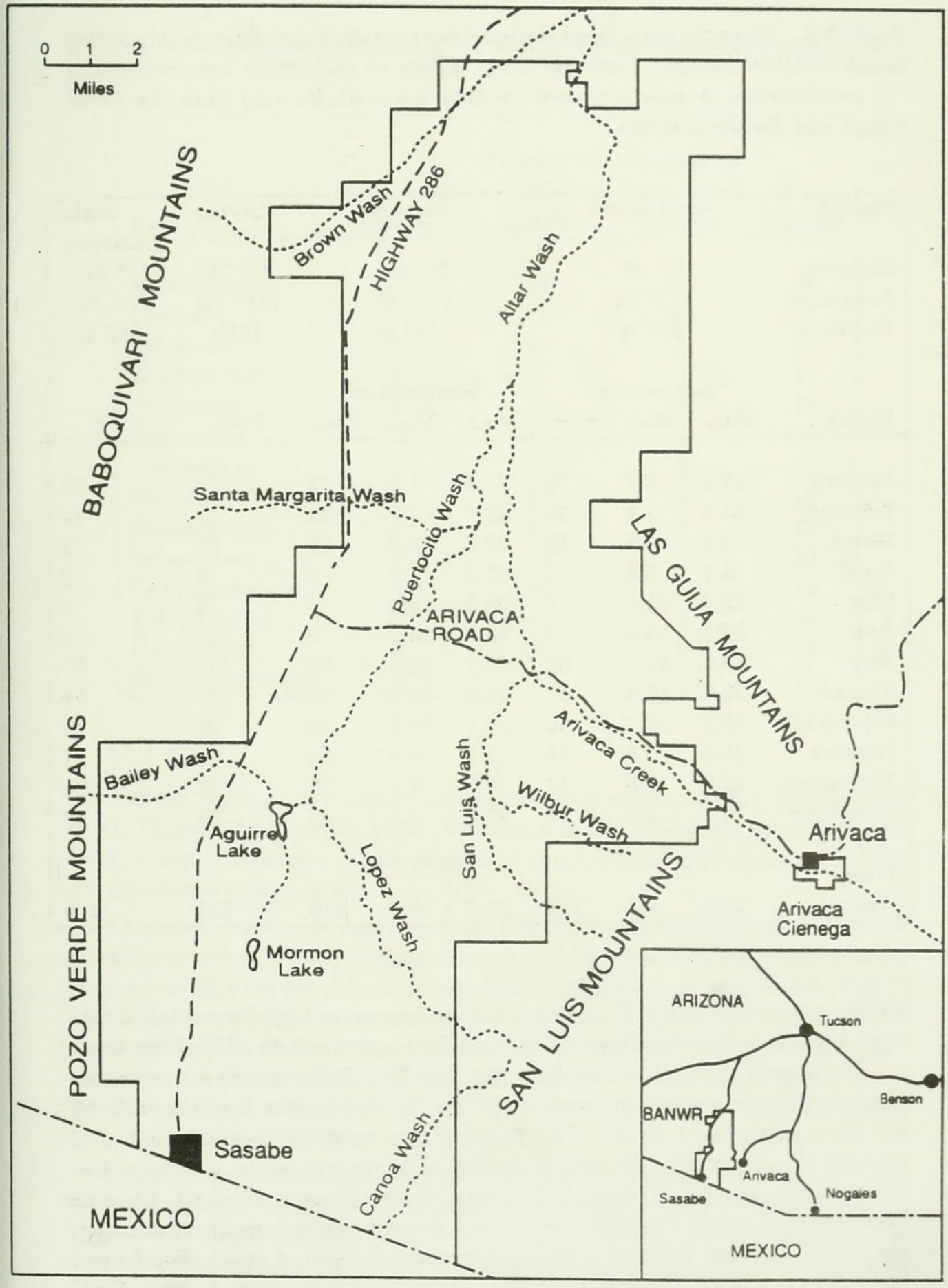

Fig. 1. Map of Buenos Aires National Wildlife Refuge, Pima County, Arizona.

TABLE 1. Climatic data from stations in the vicinity of Buenos Aires National Wildlife Refuge. Data are from Sellers *et al.* (1985); temperature in °C, precipitation in mm; temperature data are available only from the Anvil Ranch and Sasabe stations.

Station:	Anvil Ranch			Sasabe			Arivaca	Santa Margarita
Latitude:	31° 59′			31° 29′			31° 35′	31° 41′
Longitude:	111° 23′			111° 35′			111° 19′	111° 35′
Elevation:	840 m			1100 m			1120	1200 m
	Temperature			Temperature				
Month	Max.	Min.	Prec.	Max.	Min.	Prec.	Prec.	Prec.
January	19.1	0.4	19	17.2	1.7	32	24	26
February	21.1	1.5	15	19.1	2.8	30	22	34
March	23.5	3.8	18	20.8	4.3	25	24	23
April	28.1	6.8	7	25.2	7.2	7	6	9
May	32.7	11.0	5	29.3	10.3	4	4	4
June	38.3	16.6	7	34.7	16.1	6	11	11
July	38.0	21.1	66	35.1	19.2	89	107	97
August	36.7	19.9	57	33.5	18.3	75	88	94
September	35.5	16.2	36	32.1	15.8	46	45	49
October	30.6	9.8	19	27.8	10.5	24	30	12
November	23.8	3.6	13	21.6	5.4	25	23	24
December	19.7	0.4	25	17.6	2.2	48	39	27
Mean Annual	28.9	9.3	287	26.2	9.5	410	423	410

species account for 8% of the total, which is somewhat high for a flora of this size. Aquatic and wetland species account for approximately 13% of the flora.

The largest families in the flora are listed in Table 2. The composites (Asteraceae) and grasses (Poaceae) are by far the largest families with 96 and 88 species, respectively. The Poaceae also have the largest number of introduced species–18. Genera with five or more species in the flora are: *Chamaesyce* (spurges, 11 spp.), *Bouteloua* (grama grasses, 10 spp.), *Cyperus* (flat sedges, 9 spp.), *Opuntia* (chollas and prickly pears, 9 spp.), *Muhlenbergia* (muhly grasses, 7 spp.), *Aristida* (three-awn grasses, 6 spp.), *Boerhaavia* (spiderlings, 6 spp.), *Brickellia* (6 spp.), *Eragrostis* (lovegrasses, 6 spp.), *Eriogonum* (wild buckwheats, 6 spp.), *Ipomoea* (morning glories, 6 spp.), *Asclepias*

TABLE 2. Largest plant families in the flora of Buenos Aires National Wildlife Refuge.

Family	Number of Genera	Number of Native Species	Number of Introduced Species	Total Species
Asteraceae	56	94	2	96
Poaceae	41	70	18	88
Fabaceae	26	40	3	43
Euphorbiaceae	9	21	0	21
Cactaceae	6	18	0	18
Malvaceae	11	17	1	18
Cyperaceae	6	17	0	17
Brassicaceae	13	12	4	16
Boraginaceae	6	13	0	13
Solanaceae	6	13	0	13
Convolvulaceae	4	12	1	13
Polygonaceae	3	9	4	13
Onagraceae	5	12	0	12
Scrophulariaceae	8	10	1	11

(milkweeds, 5 spp.), *Astragalus* (milkvetches, locoweeds, 5 spp.), *Baccharis* (5 spp.), *Cryptantha* (5 spp.), *Lotus* (vetches, 5 spp.), *Oenothera* (evening primroses, 5 spp.), *Panicum* (panic grasses, 5 spp.), *Phacelia* (5 spp.), and *Polygonum* (knotweeds, 5 spp.).

The total number of native species (566) is rather high given the narrow elevational range (475 m), limited amount of field work, and relatively uniform vegetation. In a survey of local floras of Arizona, Bowers & McLaughlin (1982) found that areas with a large amount of elevational relief, oak woodland and aquatic habitats, and a long collecting history had the richest floras. Their model would predict a flora of just 240 species for the Refuge based on its elevational range and collecting history (3 years–the Refuge area was rarely collected prior to 1988).

Despite the low elevation range and lack of vegetational diversity, several ecological features at the Refuge contribute to its high species richness. One is the biseasonal distribution of rainfall. Winter rainfall and temperatures are high enough to support a significant winter annual flora of about 90 species. Many of these winter annuals are widespread in the Sonoran Desert, including several species of Asteraceae, Boraginaceae, Brassicaceae, Fabaceae,

Hydrophyllaceae, and Polemoniaceae. The majority of the herbaceous species, however, are phenologically active in the late summer and fall months following the summer rains.

Riparian areas have many species that are absent from or uncommon in the surrounding grasslands. Major riparian areas on the Refuge include Arivaca Creek, Brown Wash, San Luis Wash, Altar Wash, Puertocito Wash, Lopez Wash, and Canoa Wash (Fig. 1). The most common riparian tree is *Celtis reticulata* Torrey (hackberry); *Prosopis velutina* Wooton (mesquite), *Chilopsis linearis* (Cav.) Sweet (desert willow), and *Parkinsonia aculeata* L. (Mexican paloverde) are also common, especially in the lower elevation areas. Other species of trees and shrubs found mostly along watercourses include: *Aloysia gratissima* (Gill. & Hooker) Troncosa, *Brickellia californica* (Torrey & A. Gray) A. Gray, *Brickellia floribunda* A. Gray, *Fraxinus velutina* Torrey, *Juglans major* (Torrey) Heller, *Populus fremontii* S. Watson, *Quercus emoryi* Torrey, *Q. oblongifolia* Torrey, *Salix gooddingii* Ball, *Salix taxifolia* H.B.K., *Sapindus saponaria* L. var. *drummondii* (Hooker & Arn.) L. Benson, and *Vitis arizonica* Engelm. Many herbaceous species are more abundant in the shade of trees either in or along watercourses than in the adjacent grasslands, but few appear to be completely restricted to riparian sites. *Lythrum californicum* Torrey & A. Gray and *Oenothera rosea* Ait. are found only at Arivaca Ciénega and along Arivaca Creek; *Helenium thurberi* A. Gray occurs only along Arivaca Creek.

Several species in the flora are found only along Brown Wash in the northwestern corner of the Refuge. Many of these are relatively mesophytic species that are more common at higher elevations in the Baboquivari Mountains to the west; because of the drainage of moisture and cold air down Brown Canyon these species are able to extend their ranges into the Refuge at lower elevations. Species that have so far been found only in Brown Wash are: *Agastache wrightii* (Greenman) Wooton & Standley, *Cocculus diversifolius* DC., *Desmodium batocaulon* A. Gray, *Heterosperma pinnatum* Cav., *Hybanthus attenuatus* (Humb. & Bonpl.) G.K. Schulze, *Phacelia ramosissima* Douglas, *Sicyosperma gracile* A. Gray, *Sideroxylon lanuginosa* Michx., *Simmondsia chinensis* (Link) Schneid., *Sphaeralcea fendleri* A. Gray, *Thelypodiopsis linearifolia* (A. Gray) Al-Shehbaz, and *Tithonia thurberi* A. Gray.

The presence of aquatic habitats can greatly increase the plant diversity of an area (Bowers & McLaughlin 1982). On the Refuge, stock tanks and reservoirs support species not found in the grasslands or riparian (wash) areas. Relatively few strict aquatics (submerged, floating, and emergent plants) occur in the many impoundments found on the Refuge, possibly because these small bodies of water dry up frequently. Aquatics that have been found in tanks and reservoirs are: *Heteranthera limosa* (Swartz) Willd., *Lemna minima* H.B.K., *Marsilea vestita* Hooker & Grev., *Polygonum pensylvanicum* L., *Potamogeton foliosus* Raf., *Potamogeton pusillus* L., and *Scirpus californicus* (C.

Mey.) Steud. Aquatic plants have excellent mechanisms for dispersal; it seems likely that additional species will be found in areas such as Aguirre Lake and Mormon Lake if they are periodically monitored.

Several species, which appear to depend on periodic desiccation of the lakes and tanks, are found almost exclusively along lake margins and dry bottoms, a habitat similar to the well known "vernal pools" of cismontane California. Species occurring exclusively or predominantly in this habitat include: *Alopecurus carolinianus* Walt., *Astragalus nuttallianus* DC. var. *cedroensis* Jones, *Eryngium heterophyllum* Engelm., *Hordeum pusillum* Nutt., *Lobelia fenestralis* Cav., *Myosurus minimus* L., *Oenothera flava* (A. Nelson) Garrett, *Potentilla rivalis* Nutt., *Verbena bracteata* Lag. & Rodr., and *Veronica peregrina* L. ssp. *xalapensis* (H.B.K.) Pennell.

The vegetation map of Brown & Lowe (1977) shows the entire area occupied by Buenos Aires National Wildlife Refuge as being desert grassland. This vegetation type varies considerably in its physiognomy and species composition, however, depending on land use, soil depth, and slope aspect and angle. Most of the grasslands on the Refuge occur on relatively deep alluvial soils in the valley bottom. Although rocky, upland sites are not extensive on the Refuge, these sites do support a community with increased diversity of lifeforms and species. Species restricted to such upland grasslands include: *Agave parviflora* Torrey, *Anthericum torreyi* Baker, *Bouteloua eludens* Griffiths, *Cheilanthes* spp., *Coreocarpus arizonicus* (A. Gray) Blake, *Digitaria insularis* (L.) Mez, *Dryopetalon runcinatum* A. Gray, *Ericameria laricifolia* (A. Gray) Shinners, *Erigeron neomexicanus* A. Gray, *Erythrina flabelliformis* Kearney, *Eysenhardtia polystachya* (Ortega) Sarg., *Galactia wrightii* A. Gray, *Herissantia crispa* (L.) Briz., *Heteropogon melanocarpus* (Ell.) Bentham, *Mammillaria heyderi* Muehl., *Notholaena* spp., *Passiflora foetida* L., *Pellaea truncata* Goodding, *Phaseolus heterophyllus* Willd., *Schizachyrium cirratum* (Hack.) Wooton & Standley, *Tecoma stans* (L.) H.B.K., and *Trachypogon secundus* (Presl) Scribn.

Several species have so far been found in the Refuge only on the western and southern slopes of the Las Guijas Mountains. These include: *Aloysia wrightii* (A. Gray) Heller, *Cynanchum arizonicum* (A. Gray) Shinners, *Eupatorium solidaginifolium* A. Gray, *Haplophyton crooksii* L. Benson, *Iresine heterophylla* Standley, *Plumbago scandens* L., *Quercus turbinella* E. Greene, *Senecio lemmoni* A. Gray, and *Waltheria americana* L. Since neither the Las Guijas nor the San Luis Mountains have been thoroughly explored, additions to the flora are likely to be found in these areas.

A few mesophytic species that are usually found in Arizona at much higher elevations (often in pine forests) occur on the Refuge in grasslands but are very rare. Three such species co-occur just a few miles southeast of Refuge headquarters: *Eryngium heterophyllum*, *Heterotheca rutteri* (Rothrock) Shinners, and *Aster falcatus* Lindl. ssp. *commutatus* (Torrey & A. Gray) A.G. Jones–the latter is also found at Arivaca Ciénega. Two other higher elevation grassland

species, *Berlandiera lyrata* Bentham and *Cirsium ochrocentrum* A. Gray, are also restricted to a small area south of Refuge Headquarters.

VEGETATION

The dominant vegetation on the Refuge is grassland. There is no oak woodland, although three species of oaks do occur in the flora: *Quercus emoryi* (Emory oak) and *Q. oblongifolia* (Mexican blue oak) are found only along a few watercourses in the southeast part of the Refuge, and *Q. turbinella* (scrub oak) is scattered in the Las Guijas Mountains.

The grassland vegetation in the valley bottom varies in aspect and species composition across the Refuge. Areas mapped as grasslands just to the north of the Refuge on private and state owned lands are dominated by *Prosopis velutina*, *Isocoma tenuisecta* E. Greene (burroweed), and *Opuntia* species; perennial grasses here essentially have been eliminated by overgrazing. Regrettably, much of the grassland in the Altar Valley and elsewhere in southeastern Arizona is in this poor condition. Within the Refuge, the grasslands on the northern, central, and western portions have a lush aspect but are dominated by a single species, the exotic perennial, *Eragrostis lehmanniana* Nees (Lehmann lovegrass). *Prosopis velutina*, *Opuntia* spp., *Acacia greggii* A. Gray (catclaw acacia), *Mimosa biuncifera* Bentham (wait-a-bit), and other woody plants are often abundant. Another introduced species, *Sorghum halepense* (L.) Pers. (Johnson grass), dominates the floodplains along the major washes.

Along the eastern edge of the Refuge, up to the base of the Las Guijas and San Luis Mountains, where elevations are higher, slopes are steeper and rockier, and soils are more variable (including many calcareous sites), the grasslands are less disturbed and more diverse. The grassland southeast of Refuge Headquarters is dominated by several native perennials, including *Aristida ternipes* Cav., *Bouteloua curtipendula* (Michx.) Torrey, *B. hirsuta* Lag., *B. repens* (H.B.K.) Scribn. & Merr., *Bothriochloa barbinodis* (Lag.) Herter, *Digitaria californica* (Bentham) Henr., *Eragrostis intermedia* A.S. Hitchc., and *Leptochloa dubia* (H.B.K.) Nees. Also present are many native perennial herbs, *Fouquieria splendens* Engelm. (ocotillo), large and small cacti, and several Agavaceae [*Agave palmeri* Engelm., *Dasylirion wheeleri* S. Watson (sotol), *Nolina microcarpa* S. Watson, and *Yucca elata* Engelm. (beargrass)]. On low ridge tops in this area the grass cover is dominated by *Aristida purpurea* Nutt. var. *longiseta* (Steud.) Vasey, *Bouteloua chondrosioides* (H.B.K.) Bentham *ex* S. Watson, *B. eriopoda* (Torrey) Torrey, *B. hirsuta*, and *Heteropogon contortus* (L.) P. Beauv. *ex* Roemer & Schultes; associated with these grasses are several low shrubs including *Calliandra eriophylla* Bentham, *Krameria parvifolia* Bentham, and *Zinnia acerosa* (DC.) A. Gray.

TABLE 3. Precipitation in major valleys in southeastern Arizona. Elevations (in meters) and precipitation (in mm) are from weather stations given in Sellers *et al.* (1985).

Altar		Santa Cruz		San Pedro		Sulphur Springs		San Simon	
Elev.	Prec.	Elev.	Prec.	Elev.	Prec.	Elev.	Prec.	Elev.	Prec.
		460	226						
		573	244	632	340				
		692	282	646	373				
840	287	820	272						
		945	330	957	340			884	218
		981	348						
		996	368	1085	335			1113	198
1094	424			1094	290			1100	229
				1125	320			1149	254
1196	411	1161	399	1173	295	1231	340		
						1273	292		
				1387	325	1347	297		
		1445	429	1405	338	1485	323		

These desert grassland communities are occurring at a very low elevation (1100 m) in Arizona for this vegetation type. Shreve (1951) states that true grasslands in Arizona are not found below 3500 feet (1067 m). The upper Altar Valley can support this native, perennial grassland at such a low elevation because it receives relatively high rainfall, comparable to that of other valleys in southeastern Arizona at higher elevations. In this part of the state there is a gradient of decreasing rainfall in going from west to east (Table 3). At 1200 m elevation the Altar and Santa Cruz Valleys receive about 400 mm of precipitation annually; rainfall at comparable elevations going eastward is about 300 mm in the San Pedro and Sulphur Springs Valleys and about 250 mm in the San Simon Valley.

Most desert grasslands of the Southwest have been dramatically degraded by overgrazing and the introduction of exotic plant species. The extensive monospecific stands of Lehmann lovegrass that dominate the central portions of the Refuge probably developed no more than 20-30 years ago. This species was first introduced into southern Arizona in 1932 by the Soil Conservation Service (Freeman 1979); this exotic grass now infests over 200,000 ha of formerly native grassland (Cox & Ruyle 1986).

The spread of Lehmann lovegrass on the Refuge was probably facilitated

by grazing, since this exotic is less palatable than the native perennial grasses it has replaced (Cable 1971; Freeman 1979). The nearly monospecific stands of this species are not good habitat for the masked bobwhite, which requires more diverse grass-herb vegetation (Goodwin & Hungerford 1977) with legumes to provide seed and cover during the winter. Lehmann lovegrass stands have low diversity of native grasses, herbs, shrubs, grasshoppers, rodents, and birds, in comparison to stands of native perennial grasses (Bock *et al.* 1986).

There are no records of what the grasslands looked like on the lower elevations at the Refuge prior to the introduction of Lehmann lovegrass. Haskell (1945) described a lightly grazed grassland at similar elevations (1130 m) on the Page Ranch on the northwest side of the Santa Catalina Mountains. This grassland was dominated by *Aristida hamulosa* Henr., *A. purpurea* var. *longiseta*, *Bouteloua rothrockii* Vasey, *B. curtipendula*, *B. eriopoda*, and *Hilaria belangeri* (Steud.) Nash. Brown (1982) suggests that the grasslands of the Altar Valley, prior to overgrazing and invasion of exotics, were similar to the Sonoran savanna grassland communities of the Plains of Sonora (one of Forrest Shreve's geographic subdivisions of the Sonoran Desert), which were dominated by *Bouteloua rothrockii*, several species of three-awn (*Aristida californica* Thurber, *A. hamulosa*, *A. ternipes*, *A. wrightii* Nash), other grama grasses (*Bouteloua aristidoides* [H.B.K.] Griseb., *B. parryi* [Fourn.] Griffiths, *B. radicosa* [Fourn.] Griffiths, *B. repens*), *Chloris* spp., and *Heteropogon contortus*.

Today Rothrock grama (*Bouteloua rothrockii*), poverty three-awn (*Aristida hamulosa*), spidergrass (*A. ternipes*), Arizona cottontop (*Digitaria californica*), and slender grama (*Bouteloua repens*) are most common along roadsides and in patches not dominated by Lehmann lovegrass. Spiderlings (*Boerhaavia* spp.), spurges (*Chamaesyce* spp.), purslanes (*Portulaca* spp.), globe amaranths (*Gomphrena* spp.), and *Gaura* spp. are the commonest herbs. All these species were doubtless more abundant prior to the introduction of Lehmann lovegrass. Within the Lehmann lovegrass dominated areas there are occasional patches of curly mesquite grass (*Hilaria belangeri*); these patches have several characteristic herbs including *Allium macropetalum* Rydb. and *Lupinus brevicaulis* S. Watson.

ARIVACA CIENEGA

The term "ciénegas" is used in the Southwest for midelevation wetlands with saturated, organic, reducing soils (Hendrickson & Minckley 1984). These wetlands were once much more abundant in the Southwest. They have been severely altered and diminished in areal extent by grazing, introduction of exotic plants, and downstream arroyo cutting. Arivaca Ciénega is one of the better preserved ciénega wetland communities in southeastern Arizona, and

it is also the most xeric, occurring further west and at a lower elevation than other remaining ciénegas in the region.

Hendrickson & Minckley (1984) suggested that a relatively impermeable dike of shales, sandstone, conglomerate, and limestone outcropping below Arivaca has forced groundwater up to the surface, creating permanent surface flow and marshlands. They stated that the current meadow area south of Arivaca (now incorporated into the Refuge) is a remnant of a once more extensive ciénega system. The wetlands are now maintained by a concrete ford across Arivaca Creek which acts as a check dam to prevent upstream arroyo cutting.

The vegetation at Arivaca Ciénega can be divided into four communities or zones. Along the periphery there is a mesquite zone with *Isocoma tenuisecta* (burroweed), *Gutierrezia microcephala* (DC.) A. Gray (snakeweed), *Acacia greggii*, *Zizyphus obtusifolia* (Hooker) A. Gray (gray thorn), and other spiny shrubs. This area was badly overgrazed prior to being added to the Refuge; most native perennial grasses and palatable forbs have been completely eliminated.

Inside the mesquite zone is a zone of *Sporobolus wrightii* Munro *ex* Scribn. (sacaton), best developed on the northern end of the ciénega. This too has been heavily grazed but has withstood the stress of cattle much better than has the mesquite zone. Many forbs that are most abundant in the meadow zone extend sporadically into the sacaton zone.

The meadow zone, the third community type, is a sward of grasses, sedges, and forbs that is wet in the spring and in the late summer following the summer rains. It differs from less heavily grazed southeastern Arizona ciénegas in having a high cover of weedy forbs and grasses: *Ambrosia confertiflora* DC. and *A. psilostachya* DC. (ragweeds), *Xanthium strumarium* L. (cocklebur), *Poa annua* L., and *Polypogon monspeliensis* (L.) Desf. (rabbitfoot grass). Nevertheless, numerous native ciénega species not found elsewhere on the Refuge have persisted in the meadow zone; many of these are high elevation plants reaching their lower limits at Arivaca Ciénega: *Agropyron trachycaulum* (Link) Malte, *Ambrosia trifida* L., *Bothriochloa saccharoides* (Swartz.) Rydb., *Carex chihuahensis* Mack., *Chamaesyce vermiculata* (Raf.) House, *Juncus balticus* Willd., *J. torreyi* Cov., *Muhlenbergia asperifolia* (Nees & Mey.) Parodi, *Nothoscordum texanum* Jones, *Oenothera speciosa* Nutt., *Pyrrhopappus rothrockii* A. Gray, *Ranunculus macranthus* Scheele, *Setaria geniculata* (Lam.) Beauv., *Sidalcea neomexicana* A. Gray, *Sisyrinchium demissum* E. Greene, and *Trifolium wormskioldii* Lehm.

Many of the native perennials that are dominant in the meadow now (e.g., *Bidens aurea* [Ait.] Sherff and *Ranunculus macranthus*) probably increased as a result of grazing. Cover of grasses and sedges is likely to increase in the meadow zone as the area recovers from grazing.

The innermost zone of the ciénega consists of springs and permanently wet ground. Along many of the springs there are stands of *Salix gooddingii*

(willow) with occasional *Populus fremontii* (cottonwood). These springs support numerous species of wetland and aquatic plants not found elsewhere on the Refuge: *Azolla mexicana* Presl, *Berula erecta* (Huds.) Cov., *Bidens laevis* (L.) BSP., *Ceratophyllum demersum* L., *Cyperus odoratus* L., *Eleocharis bella* (Piper) Svenson, *Hydrocotyle ranunculoides* L. f., *Leersia oryzoides* (L.) Swartz., *Lemna gibba* L., *L. minor* L., *Myriophyllum exalbescens* Fern., *Paspalum distichum* L., *Polygonum punctatum* Ell., *Ranunculus hydrocharoides* A. Gray, *Scirpus olneyi* A. Gray, *Typha latifolia* L., and *Zannichellia palustris* L.

FLORISTIC AFFINITIES

I have divided the western United States into three sets of floristic areas–5 floristic provinces for widespread species, 9 floristic subprovinces for species of intermediate range, and 20 floristic districts for narrowly distributed species (McLaughlin 1992). Widespread species were defined as those occurring in >20% of a set of 101 local floras covering the entire western U.S.A. west of the Great Plains; narrow species were defined as those occurring in <10% of these local floras. Associated with each floristic area is a floristic element–a group of species with more or less coincident ranges centered on the floristic area. Table 4 presents a summary of the floristic affinities of the flora of Buenos Aires National Wildlife Refuge, listing the numbers and percentages of species associated with the various floristic elements.

The Refuge lies near the boundary of the Sonoran Floristic Province to the south, west, and north, and the Madrean Floristic Province to the east. Desert species are common, especially at the north end of the Refuge and among the winter annuals. Nevertheless, the species of Madrean and Apachian affinities clearly dominate in the flora, placing the Refuge in the Apachian District of the Madrean Province.

Among widespread species, all 5 floristic elements are represented. The Madrean element is best represented (7.1% of the total flora), followed by the Sonoran (5.8%) and Californian (2.7%) elements. Among species with intermediate size ranges, the Madrean (20.1%), Sonoran (7.6%), and Californian (4.6%) elements are most important. The Apachian element (27.6%) accounts for more than half of the species with narrow ranges; Arizona Upland Desert (9.0%) and Chihuahuan Desert (5.3%) elements are also well represented.

The techniques used here to classify species into floristic elements work best for species with more or less continuous ranges; *i.e.*, most terrestrial species of upland, nonweedy habitats. Aquatic and wetland species often have wide, discontinuous ranges. Among the sample of 101 local floras from the western United States used to develop the floristic classification, aquatic habitats are well represented only in those floras from the California Floristic Province. Widespread and intermediate aquatic and wetland plants thus tend to be

TABLE 4. Floristic affinities of the flora of Buenos Aires National Wildlife Refuge.

Distribution Category	Floristic Element	No. Species	%
Widespread Species:	Madrean element	39	7.1
	Sonoran element	33	5.8
	Californian element	15	2.7
	Intermountain element	13	2.3
	Cordilleran element	8	1.6
Intermediate Species:	Madrean element	113	20.1
	Sonoran element	44	7.6
	Californian element	26	4.6
	Other elements	7	1.2
Narrow Species:	Apachian element	154	27.6
	Arizona Upland Desert element	51	9.0
	Chihuahuan Desert element	29	5.3
	Peninsular California element	11	1.9
	Other elements	18	3.2

grouped into the Californian elements and narrowly distributed wetland plants tend to be placed in the Peninsular (southern) California element.

THREATENED AND ENDANGERED SPECIES

Thus far, few plants have been discovered in the Refuge that are on Federal Threatened or Endangered Species lists or are candidates for these lists. *Coryphantha scheeri* (Kuntze) L. Benson var. *robustispina* (Schott) L. Benson (Pima pineapple cactus) is proposed endangered (Rutman 1992). Steve Dobrott, wildlife biologist at the Refuge, has found 21 individuals south of the Refuge headquarters on reddish adobe soil. *Agave parviflora* (small flowered agave) is a Category 2 species (Rutman 1992). It is widespread but rather uncommon on the Refuge, occurring occasionally on rocky hilltops in the southeastern portion of the Refuge north of the Las Guijas Mountains. *Heterotheca rutteri* is a Category 2 species known on the Refuge from a single population in desert grassland south of the Headquarters. *Amsonia grandiflora* Alexander (Category 2), *Coryphantha recurvata* (Engelm.) Britton & Rose (Category 1),

Cynanchum wigginsii Shinners (Category 2), and *Phaseolus supinus* Wiggins & Rollins (Category 2) are known from sites adjacent to the Refuge.

CHECKLIST

The following checklist includes all vascular plants known to occur on Buenos Aires National Wildlife Refuge. Nomenclature in the following checklist follows Lehr (1978) and the supplements to that work (Lehr & Pinkava 1980, 1982), except for the Euphorbiaceae, which follows Kartesz & Kartesz (1980), and where otherwise noted. Taxa preceded by an asterisk (*) are introduced exotics.

Pteridophyta

ADIANTACEAE–*Cheilanthes lindheimeri* Hooker; *C. wootoni* Maxon; *C. wrightii* Hooker; *Notholaena grayi* Davenp.; *N. integerrima* Hooker; *N. sinuata* (Lag.) Kaulf.; *N. standleyi* Maxon; *Pellaea truncata* Goodding.

AZOLLACEAE–*Azolla mexicana* Presl.

MARSILEACEAE–*Marsilea vestita* Hooker & Grev.

Gymnospermae

EPHEDRACEAE–*Ephedra trifurca* Torrey.

Dicotyledonae

ACANTHACEAE–*Anisacanathus thurberi* (Torrey) A. Gray; *Carlowrightia arizonica* A. Gray; *Siphonoglossa longiflora* (Torrey) A. Gray; *Tetramerium nervosum* Nees [*T. hispidum* Nees].

AIZOACEAE–**Glinus radiatus* (Ruiz & Pavón) Rohrb.; **Mollugo verticillata* L.; *Trianthema portulacastrum* L.

AMARANTHACEAE–**Amaranthus albus* L.; *A. palmeri* S. Watson; *A. torreyi* (A. Gray) Bentham; *Froelichia arizonica* Thornber; *Gomphrena caespitosa* Torrey; *G. sonorae* Torrey; *Guilleminea densa* (Willd.) Moq.; *Iresine heterophylla* Standley; *Tidestromia lanuginosa* (Nutt.) Standley.

APIACEAE–*Berula erecta* (Huds). Cov.; *Bowlesia incana* Ruiz & Pavón; *Daucus pusillus* Michx.; *Eryngium heterophyllum* Engelm.; *Hydrocotyle ranunculoides* L. f.; *Lomatium nevadense* (S. Watson) Coult. & Rose var. *pseudorientale* (Jones) Munz; *Spermolepis echinata* (Nutt.) Heller; *Yabea microcarpa* (Hooker & Arn.) K.-Pol.

APOCYNACEAE–*Haplophyton crooksii* L. Benson; *Macrosiphon brachysiphon* (Torrey) A. Gray.

ARISTOLOCHIACEAE–*Aristolochia watsoni* Wooton & Standley.

ASCLEPIADACEAE–*Asclepias asperula* (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson; *A. brachystephana* Engelm.; *A. involucrata* Engelm.; *A. nyctaginifolia* A. Gray; *A. subverticillata* (A. Gray) Vail; *Cynanchum arizonicum* (A. Gray) Shinners; *Sarcostemma crispum* Bentham; *S. cynanchoides* Decne. ssp. *cynanchoides*; *S. cynanchoides* Decne. ssp. *hartwegii* (Vail) R. Holm.

ASTERACEAE–*Acourtia nana* (A. Gray) Reveal & King; *A. thurberi* (A. Gray) Reveal & King; *A. wrightii* (A. Gray) Reveal & King; *Ambrosia confertiflora* DC.; *A. psilostachya* DC.; *A. trifida* L. [*A. aptera* DC.]; *Artemisia ludoviciana* Nutt.; *Aster falcatus* Lindl. ssp. *commutatus* (Torrey & A. Gray) A.G. Jones; *A. subulatus* Michx. var. *ligulatus* Shinners; *Baccharis brachyphylla* A. Gray; *B. glutinosa* Pers.; *B. pteronioides* DC.; *B. sarothroides* A. Gray; *B. thesioides* H.B.K.; *Bahia absinthifolia* Bentham var. *dealbata* A. Gray; *Baileya multiradiata* Harvey & A. Gray; *Berlandiera lyrata* Bentham var. *macrophylla* A. Gray; *Bidens aurea* (Ait.) Sherff; *B. bigelovii* A. Gray; *B. ferulaefolia* (Jacq.) DC.; *B. laevis* (L.) BSP.; *B. leptocephala* Sherff; *Brickellia baccharidea* A. Gray; *B. californica* (Torrey & A. Gray) A. Gray; *B. chlorolepis* (Wooton & Standley) Shinners; *B. coulteri* A. Gray; *B. floribunda* A. Gray; *B. venosa* (Wooton & Standley) Robins.; *Calycoseris wrightii* A. Gray; *Carminatia tenuiflora* DC.; *Chaenactis stevioides* Hooker & Arn.; *Cirsium neomexicanum* A. Gray; *C. ochrocentrum* A. Gray; *Conyza canadensis* (L.) Cronq.; *C. coulteri* A. Gray; *Coreocarpus arizonicus* (A. Gray) Blake; *Dyssodia pentachaeta* (DC.) Robins.; *Encelia farinosa* A. Gray; *Ericameria laricifolia* (A. Gray) Shinners; *Erigeron divergens* Torrey & A. Gray; *E. neomexicanus* A. Gray; *Eriophyllum lanosum* A. Gray; *Eupatorium pycnocephalum* Less.; *E. solidaginifolium* A. Gray; *Evax multicaulis* DC.; *Filago californica* Nutt.; *F. depressa* A. Gray; *Gnaphalium chilense* Spreng.; *G. leucocephalum* A. Gray; *G. purpureum* L.; *G. wrightii* A. Gray; *Gutierrezia microcephala* (DC.) A. Gray; *G. sarothrae* (Pursh) Britton & Rusby; *Helenium thurberi* A. Gray; *Helianthus annuus* L.; *H. petiolaris* Nutt.; *Heterosperma pinnatum* Cav.; *Heterotheca rutteri* (Rothrock) Shinners; *H. subaxillaris* (Lam.) Britton & Rusby; *Hymenoclea monogyra* Torrey & A. Gray; *Hymenothrix wislizenii* A. Gray; *Isocoma tenuisecta* E. Greene; **Lactuca serriola* L.; *Lagascea decipiens* Hemsley; *Lasthenia chrysostoma* (Fischer & Meyer) E. Greene; *Leucelene ericoides* (Torrey) E. Greene; *Machaeranthera gracilis* (Nutt.) Shinners; *M. pinnatifida* (Hooker) Shinners ssp. *pinnatifida*; *M. tagetina* E.

Greene; *M. tephrodes* (A. Gray) E. Greene; *Malacothrix californica* DC. var. *glabrata* Eaton; *M. clevelandii* A. Gray; *M. fendleri* A. Gray; *M. sonchoides* (Nutt.) Torrey & A. Gray; *Melampodium longicorne* A. Gray; *Microseris linearifolia* (DC.) Schultz-Bip.; *Parthenice mollis* A. Gray; *Pectis longipes* A. Gray; *Porophyllum gracile* Bentham; *P. ruderale* (Jacq.) Cass. ssp. *macrocephalum* (DC.) R.R. Johnson; *Pyrrhopappus rothrockii* A. Gray [*P. multicaulis* DC.]; *Rafinesquia californica* Nutt.; *R. neomexicana* A. Gray; *Senecio douglasii* DC. var. *douglasii*; *S. douglasii* DC. var. *longilobus* (Bentham) L. Benson; *S. lemmoni* A. Gray; *Solidago sparsiflora* A. Gray; **Sonchus asper* (L.) Hill; *Stephanomeria exigua* Nutt.; *S. pauciflora* (Torrey) A. Nelson; *Tithonia thurberi* A. Gray; *Trixis californica* Kellogg; *Verbesina encelioides* (Cav.) Bentham & Hooker; *Viguiera dentata* (Cav.) Spreng. var. *lancifolia* Blake; *V. multiflora* (Nutt.) Blake; *Xanthium strumarium* L.; *Zinnia acerosa* (DC.) A. Gray.

BERBERIDACEAE–*Berberis haematocarpa* Wooton.

BIGNONIACEAE–*Chilopsis linearis* (Cav.) Sweet; *Tecoma stans* (L.) H.B.K.

BORAGINACEAE–*Amsinckia intermedia* Fischer & Meyer; *Cryptantha angustifolia* (Torrey) E. Greene; *C. barbigera* (A. Gray) E. Greene; *C. micrantha* (Torrey) I.M. Johnston; *C. nevadensis* A. Nelson & Kenn.; *C. pterocarya* (Torrey) E. Greene; *Harpagonella palmeri* A. Gray var. *arizonica* I.M. Johnston; *Lappula redowskii* (Hornem.) E. Greene; *Pectocarya heterocarpa* I.M. Johnston; *P. platycarpa* Munz & I.M. Johnston; *P. recurvata* I.M. Johnston; *Plagiobothrys arizonicus* (A. Gray) E. Greene; *P. pringlei* E. Greene.

BRASSICACEAE–*Arabis perennans* S.Watson; **Capsella bursa-pastoris* (L.) Medic.; *Caulanthus lasiophyllus* (Hooker & Arn.) Payson; *Descurainia pinnata* (Walt.) Britton ssp. *halictorum* (Cockl.) Detl.; **D. sophia* (L.) Webb; *Draba cuneifolia* Nutt. var. *integrifolia* S. Watson; *Dryopetalon runcinatum* A. Gray; *Erysimum capitatum* (Douglas) E. Greene; *Lepidium lasiocarpum* Nutt. var. *lasiocarpum*; *L. thurberi* Wooton; *L. virginicum* L. var. *medium* (E. Greene) C.L. Hitchc.; *Lesquerella gordoni* (A. Gray) S. Watson; **Nasturtium officinale* R. Br.; **Sisymbrium irio* L.; *Thelypodiopsis linearifolia* (A. Gray) Al-Shehbaz; *Thysanocarpus curvipes* Hooker var. *elegans* (Fischer & Mey.) Robins.

CACTACEAE–*Carnegiea gigantea* (Engelm.) Britton & Rose; *Coryphantha scheeri* (Kuntze) L. Benson var. *robustispina* (Schott) L. Benson; *C. vivipara* (Nutt.) Britton & Rose var. *bisbeeana* (Orcutt) L. Benson; *Echinocereus fasciculatus* (Engelm.) L. Benson var. *fasciculatus*; *E. fendleri* (Engelm.) Rumpler; *E. pectinatus* (Scheidw.) Engelm. var.

rigidissimus (Engelm.) Engelm.; *Ferocactus wislizenii* (Engelm.) Britton & Rose; *Mammillaria heyderi* Muehl. var. *heyderi* [*M. gummifera* Engelm. var. *applanata* (Engelm.) L. Benson]; *M. macdougalii* Rose [*M. gummifera* Engelm. var. *macdougalii* (Rose) L. Benson]; *M. microcarpa* Engelm.; *Opuntia arbuscula* Engelm.; *O. engelmannii* Salm-Dyck [*O. phaeacantha* Engelm. var. *discata* (Griffiths) L. Benson & Walkington]; *O. fulgida* Engelm. var. *mammillata* (Schott) Coulter; *O. leptocaulis* DC.; *O. macrorhiza* Engelm. var. *macrorhiza*; *O. phaeacantha* Engelm. var. *major* Engelm.; *O. spinosior* (Engelm. & Bigelow) Toumey; *O. versicolor* Engelm.; *O. violacea* Engelm. var. *santa-rita* (Griffiths & Hare) L. Benson.

CAMPANULACEAE–*Lobelia fenestralis* Cav.; *Triodanis biflora* (Ruiz & Pavón) E. Greene; *T. holzingeri* McVaugh.

CAPPARIDACEAE–*Polanisia dodecandra* (L.) DC. ssp. *trachysperma* (Torrey & A. Gray) Iltis.

CAPRIFOLIACEAE–*Sambucus mexicana* Presl.

CARYOPHYLLACEAE–*Loeflingia squarrosa* Nutt.; *Silene antirrhina* L.

CERATOPHYLLACEAE–*Ceratophyllum demersum* L.

CHENOPODIACEAE–*Atriplex canescens* (Pursh) Nutt.; *A. elegans* (Moq.) D. Dietr. ssp. *elegans*; *Chenopodium berlandieri* Moq. var. *sinuata* (Murr.) Wahl; *C. desiccatum* A. Nelson var. *leptophylloides* (Murr.) Wahl; *C. incanum* (S. Watson) Heller; *Monolepis nuttalliana* (Schult.) E. Greene; **Salsola iberica* Sennen & Pau.

COCHLOSPERMACEAE–*Amoreuxia palmatifida* Moç. & Sessé.

CONVOLVULACEAE–**Convolvulus arvensis* L.; *C. equitans* Bentham; *Cuscuta erosa* Yuncker; *Evolvulus alsinoides* L.; *E. arizonicus* A. Gray; *E. pilosus* Nutt.; *E. sericeus* Swartz; *Ipomoea barbatisepala* A. Gray; *I. coccinea* L.; *I. costellata* Torrey; *I. hederacea* (L.) Jacq.; *I. leptotoma* Torrey; *I. purpurea* (L.) Rothrock.

CRASSULACEAE–*Crassula erecta* (Hooker & Arn.) Berger [*Tillaea erecta* Hooker & Arn.]

CUCURBITACEAE–*Apodanthera undulata* A. Gray; *Cucurbita digitata* A. Gray; *C. foetidissima* H.B.K.; *Echinopepon wrightii* (A. Gray) S. Watson; *Marah gilensis* E. Greene; *Sicyosperma gracile* A. Gray.

EUPHORBIACEAE–*Acalypha neomexicana* Muell.-Arg.; *A. ostryaefolia* Riddell; *Argythamnia neomexicana* Muell.-Arg.; *Chamaesyce albo-marginata* (Torrey & A. Gray) Small; *C. arizonica* (Engelm.) Arthur; *C. capitellata* (Engelm.) Millsp.; *C. florida* (Engelm.) Millsp.; *C. hirta* (L.) Millsp.; *C. hyssopifolia* (L.) Small; *C. melanadenia* (Torrey) Millsp.; *C. pediculifera* (Engelm.) Rose & Standley; *C. serpyllifolia* (Pers.) Small; *C. setiloba* (Engelm.) Millsp. *ex* Parish; *C. vermiculata* (Raf.) House; *Croton pottsii* (Klotzsch) Muell.-Arg.; *Euphorbia exstipulata* Engelm.; *Jatropha cardiophylla* (Torrey) Muell.-Arg.; *J. macrorhiza* Bentham; *Manihot angustiloba* (Torrey) Muell.-Arg.; *Poinsettia heterophylla* (L.) Klotzsch & Garke var. *heterophylla*; *P. heterophylla* (L.) Klotzsch & Garke var. *graminifolia* (Michx.) Engelm.; *Tragia nepetaefolia* Cav.

FABACEAE–*Acacia angustissima* (Mill.) Kuntze; *A. greggii* A. Gray; *Astragalus allochrous* A. Gray; *A. arizonicus* A. Gray; *A. nothoxys* A. Gray; *A. nuttallianus* DC. var. *nuttallianus*; *A. nuttallianus* DC. var. *cedroensis* Jones; *A. wootoni* Sheldon; *Calliandra eriophylla* Bentham; *C. humilis* Bentham var. *reticulata* (A. Gray) L. Benson; *Cercidium floridum* Bentham; *Chamaecrista nictitans* (L.) E. Greene; *Crotalaria pumila* Ort.; *Dalea nana* Torrey var. *carnescens* (Rydb.) Kearney & Peebles; *D. pogonathera* A. Gray; *D. pulchra* Gentry; *Desmanthus cooleyi* (Eaton) Trel.; *Desmodium batocaulon* A. Gray; *Erythrina flabelliformis* Kearney; *Eysenhardtia orthocarpa* (A. Gray) S. Watson; *Galactia wrightii* A. Gray; **Lotus corniculatus* L.; *L. greenei* (Wooton & Standley) Ottley; *L. humistratus* E. Greene; *L. oroboides* (H.B.K.) Ottley; *L. salsuginosus* E. Greene; *Lupinus brevicaulis* S. Watson; *L. concinnus* Agardh.; *L. sparsiflorus* Bentham; *Macroptilium heterophyllum* (Willd.) Marechel & Baudet; *Marina calycosa* (A. Gray) Barneby; **Medicago polymorpha* L.; **Melilotus indicus* (L.) All.; *Mimosa biuncifera* Bentham; *M. dysocarpa* Bentham; *Nissolia schottii* (Torrey) A. Gray; *Parkinsonia aculeata* L.; *Prosopis velutina* Wooton; *Rhynchosia texana* Torrey & A. Gray; *Senna bauhinioides* (A. Gray) Irwin & Barneby; *Senna hirsuta* (L.) Irwin & Barneby; *Tephrosia tenella* A. Gray; *Trifolium wormskioldii* Lehm. var. *wormskioldii* [*T. lacerum* E. Greene]; *Vicia ludoviciana* Nutt.

FAGACEAE–*Quercus emoryi* Torrey; *Q. oblongifolia* Torrey; *Q. turbinella* E. Greene.

FOUQUIERIACEAE–*Fouquieria splendens* Engelm.

GERANIACEAE–**Erodium cicutarium* (L.) L'Her.; *E. texanum* A. Gray

HALORAGACEAE–*Myriophyllum exalbescens* Fern.

HYDROPHYLLACEAE–*Eucrypta micrantha* (Torrey) Heller; *Nama hispidum* A. Gray var. *spathulatum* (Torrey) C.L. Hitchc.; *Phacelia affinis* A. Gray; *P. arizonica* A. Gray; *P. coerulea* E. Greene; *P. distans* Bentham; *P. ramosissima* Douglas.

JUGLANDACEAE–*Juglans major* (Torrey) Heller.

KRAMERIACEAE–*Krameria parvifolia* Bentham var. *imparata* Macbr.

LAMIACEAE–*Agastache wrightii* (Greenman) Wooton & Standley; **Lamium amplexicaule* L.; **Marrubium vulgare* L.; *Stachys coccinea* Jacq.

LINACEAE–*Linum lewisii* Pursh; *L. puberulum* (Engelm.) Heller.

LOASACEAE–*Mentzelia albicaulis* Douglas; *M. asperula* Wooton & Standley; *M. multiflora* (Nutt.) A. Gray; *M. pumila* (Nutt.) Torrey & A. Gray.

LYTHRACEAE–*Lythrum californicum* Torrey & A. Gray.

MALPIGHIACEAE–*Janusia gracilis* A. Gray.

MALVACEAE–*Abutilon californicum* Bentham; *A. parvulum* A. Gray; *A. sonorae* A. Gray; *Anoda abutiloides* A. Gray; *A. cristata* (L.) Schlecht.; *Gossypium thurberi* Todaro; *Herissantia crispa* (L.) Briz.; *Hibiscus biseptus* S. Watson; *H. coulteri* Harvey; **Malva parviflora* L.; *Malvella leprosa* (Ort.) Krap.; *Rhynchosida physocalyx* (A. Gray) Fryxell; *Sida procumbens* Sw.; *S. spinosa* L. var. *angustifolia* (Lam.) Griseb.; *Sidalcea neomexicana* A. Gray; *Sphaeralcea angustifolia* (Cav.) G. Don; *S. emoryi* Torrey; *S. fendleri* A. Gray var. *venusta* Kearney.

MARTYNIACEAE–*Proboscidea altheaefolia* (Bentham) Decne.; *P. parviflora* (Wooton) Wooton & Standley.

MENISPERMACEAE–*Cocculus diversifolius* DC.

MORACEAE–*Morus microphylla* Buckl.

NYCTAGINACEAE–*Allionia incarnata* L.; *Boerhaavia coccinea* Mill.; *B. coulteri* (Hooker *f.*) S. Watson; *B. erecta* L.; *B. gracillima* Heimerl; *B. intermedia* Jones; *B. spicata* Choisy; *Commicarpus scandens* (L.) Standley; *Mirabilis longiflora* L.

NYMPHAEACEAE–**Nymphaea mexicana* Zucc.; **N. odorata* Ait.

OLEACEAE–*Forestiera shrevei* Standley; *Fraxinus velutina* Torrey var. *toumeyi* (Britton) Rehd.

ONAGRACEAE–*Camissonia californica* (Nutt. *ex* Torrey & A. Gray) Raven; *C. chamaenerioides* (A. Gray) Raven; *Epilobium canum* (E. Greene) Raven ssp. *latifolium* (Hooker) Raven; *Gaura coccinea* Nutt. var. *arizonica* Munz; *G. gracilis* Wooton & Standley; *G. parviflora* Douglas; *Ludwigia palustris* (L.) Ell.; *Oenothera albicaulis* Pursh; *O. flava* (A. Nelson) Garrett; *O. primiveris* A. Gray; *O. rosea* Ait.; *O. speciosa* Nutt.

OROBANCHACEAE–*Orobanche cooperi* (A. Gray) Heller.

OXALIDACEAE–*Oxalis albicans* H.B.K. ssp. *pilosa* (Nutt.) Eiten; *O. stricta* L.

PAPAVERACEAE–*Argemone pleiacantha* E. Greene ssp. *pleiacantha*; *Corydalis aurea* Willd.; *Eschscholtzia californica* Cham. ssp. *mexicana* (E. Greene) C. Clark.

PASSIFLORACEAE–*Passiflora foetida* L.; *P. mexicana* Juss.

PHYTOLACCACEAE–*Rivina humilis* L.

PLANTAGINACEAE–**Plantago major* L.; *P. patagonica* Jacq. var. *gnaphaloides* (Nutt.) A. Gray; *P. virginica* L.

PLUMBAGINACEAE–*Plumbago scandens* L.

POLEMONIACEAE–*Allophyllum gilioides* (Bentham) A. & V. Grant; *Eriastrum diffusum* (A. Gray) Mason; *Gilia mexicana* A. & V. Grant; *G. ophthalmoides* Brand. ssp. *australis* A. & V. Grant; *Ipomopsis longiflora* (Torrey) V. Grant; *Linanthus aureus* (Nutt.) E. Greene; *Microsteris gracilis* (Hooker) E. Greene.

POLYGALACEAE–*Polygala barbeyana* Chodat.

POLYGONACEAE–*Eriogonum abertianum* Torrey; *E. deflexum* Torrey var. *turbinatum* (Small) Reveal; *E. polycladon* Bentham; *E. thurberi* Torrey; *E. trichopes* Torrey; *E. wrightii* Torrey; **Polygonum aviculare* L.; **P. lapathifolium* L.; *P. pensylvanicum* L.; **P. persicaria* L.; *P. punctatum* Ell.; **Rumex crispus* L.; *R. hymenosepalus* Torrey.

PORTULACACEAE–*Calandrinia ciliata* (Ruiz & Pavón) DC.; *Calyptridium monandrum* Nutt.; *Portulaca retusa* Engelm.; *P. suffrutescens* Engelm.; *P. umbraticola* H.B.K.; *Talinum aurantiacum* Engelm.; *T. paniculatum* (Jacq.) Gaertn.

PRIMULACEAE–*Androsace occidentalis* Pursh.

RANUNCULACEAE–*Anemone tuberosa* Rydb.; *Clematis drummondii* Torrey & A. Gray; *Delphinium scaposum* E. Greene; *Myosurus cupulatus* S. Watson; *M. minimus* L.; *Ranunculus hydrocharoides* A. Gray; *R. macranthus* Scheele.

RHAMNACEAE–*Condalia mexicana* Schlecht.; *C. spathulata* A. Gray; *Sageretia wrightii* S. Watson; *Zizyphus obtusifolia* (Hooker) A. Gray var. *canescens* (A. Gray) M.C. Johnst.

ROSACEAE–*Potentilla rivalis* Nutt.

RUBIACEAE–*Diodia teres* Walt.; **Galium aparine* L.; *G. microphyllum* A. Gray; *G. proliferum* A. Gray; *Mitracarpus breviflorus* A. Gray.

SALICACEAE–*Populus fremontii* S. Watson; **Salix* cf. *babylonica* L.; *S. gooddingii* Ball; *S. taxifolia* H.B.K.

SAPINDACEAE–*Dodonaea viscosa* Jacq. var. *angustifolia* (L. *f.*) Bentham; *Sapindus saponaria* L. var. *drummondii* (Hooker & Arn.) L. Benson.

SAPOTACEAE–*Sideroxylon lanuginosa* Michx. [*Bumelia lanuginosa* (Michx.) Pers.

SAURURACEAE–*Anemopsis californica* (Nutt.) Hooker & Arn.

SCROPHULARIACEAE–*Antirrhinum nuttallianum* Benth.; *Linaria texana* Scheele; *Maurandya antirrhiniflora* Humb. & Bonpl.; *Mecardonia vandellioides* (H.B.K.) Pennell; *Mimulus floribundus* Douglas; *M. guttatus* DC.; *M. nasutus* E. Greene; *Orthocarpus purpurascens* Bentham; *Penstemon parryi* A. Gray; **Veronica anagallis-aquatica* L.; *V. peregrina* L. ssp. *xalapensis* (H.B.K.) Pennell.

SIMMONDSIACEAE–*Simmondsia chinensis* (Link) Schneid.

SOLANACEAE–*Datura meteloides* DC.; *Lycium andersonii* A. Gray; *L. exsertum* A. Gray; *Nicotiana trigonophylla* Dunal; *Petunia parviflora* Juss.; *Physalis hederaefolia* A. Gray; *P. longifolia* Nutt.; *P. pubescens* L.; *P. wrightii* A. Gray; *Solanum deflexum* Greenman; *S. douglasii* Dunal; *S. elaeagnifolium* Cav.; *S. lumholtzianum* Bartlett.

STERCULIACEAE–*Ayenia compacta* L.; *Waltheria americana* L.

TAMARICACEAE–**Tamarix ramosissima* Ledeb.

ULMACEAE–*Celtis pallida* Torrey; *C. reticulata* Torrey.

URTICACEAE–*Parietaria hespera* Hinton.

VERBENACEAE–*Aloysia gratissima* (Gill. & Hooker) Troncosa; *A. wrightii* (A. Gray) Heller; *Glandularia bipinnatifida* (Nutt.) Nutt. var. *bipinnatifida*; **Phyla cuneifolia* (Torrey) E. Greene; *Tetraclea coulteri* A. Gray; *Verbena bracteata* Lag. & Rodr.; *V. gracilis* Desf.; *V. neomexicana* (A. Gray) Small.

VIOLACEAE–*Hybanthus attenuatus* (Humb. & Bonpl.) G.K. Schulze; *H. verticillatus* (Ort.) Baill.

VISCACEAE–*Phoradendron californicum* Nutt.; *P. tomentosum* (DC.) A. Gray ssp. *tomentosum*.

VITACEAE–*Vitis arizonica* Engelm. var. *arizonica*

ZYGOPHYLLACEAE– *Kallstroemia californica* (S. Watson) Vail; *K. grandiflora* Torrey *ex* A. Gray; **Tribulus terrestris* L.

Monocotyledonae

AGAVACEAE–*Agave palmeri* Engelm.; *A. parviflora* Torrey; *A. schottii* Engelm. var. *schottii*; *Dasylirion wheeleri* S. Watson; *Nolina microcarpa* S. Watson; *Yucca arizonica* McKelvey; *Y. elata* Engelm.

COMMELINACEAE–*Commelina erecta* L.

CYPERACEAE–*Bulbostylis capillaris* (L.) C.B. Clarke; *Carex chihuahensis* Mack.; *C. praegracilis* W. Boott; *Cyperus dipsaceus* Liebm. [*C. wrightii* Britton]; *C. esculentus* L.; *C. flavicomus* Michx. [*C. albomarginatus* Mart. & Schrad.]; *C. mutisii* (H.B.K.) Griseb.; *C. odoratus* L.; *C. pallidicolor* (Kuk.) G. Tucker [*C. flavus* (Vahl) Nees]; *C. sphaerolepis* Boeck. [*C. rusbyi* Britton]; *C. squarrosus* L. [*C. aristatus* Rottb.]; *Eleocharis bella* (Piper) Svenson; *E. montevidensis* Kunth; *E. palustris* (L.) Roemer & Schultes; *Hemicarpha micrantha* (Vahl) Pax; *Scirpus californicus* (C. Mey.) Steud.; *S. olneyi* A. Gray.

IRIDACEAE–*Sisyrinchium demissum* E. Greene.

JUNCACEAE–*Juncus balticus* Willd.; *J. bufonius* L.; *J. tenuis* Willd. var. *tenuis*; *J. torreyi* Cov.

LEMNACEAE–*Lemna gibba* L.; *L. minima* H.B.K.; *L. minor* L.

LILIACEAE–*Allium macropetalum* Rydb.; *Anthericum torreyi* Baker; *Calochortus ambiguus* (Jones) Ownbey; *C. kennedyi* Porter var. *munzii* Macbr.; *Dichelostemma pulchellum* (Salisb.) Heller; *Nothoscordum texanum* Jones; *Zephyranthes longifolia* Hemsley.

POACEAE–*Agropyron trachycaulum* (Link) Malte; *Alopecurus carolinianus* Walt.; *Aristida adscensionis* L.; *A. hamulosa* Henr.; *A. orcuttiana* Vasey; *A. purpurea* Nutt. var. *longiseta* (Steud.) Vasey; *A. purpurea* Nutt. var. *purpurea*; *A. ternipes* Cav.; **Avena fatua* L.; *Bothriochloa barbinodis* (Lag.) Herter; *B. saccharoides* (Swartz.) Rydb.; *Bouteloua aristidoides* (H.B.K.) Griseb.; *B. barbata* Lag.; *B. chondrosioides* (H.B.K.) Bentham *ex* S. Watson; *B. curtipendula* (Michx.) Torrey; *B. eludens* Griffiths; *B. eriopoda* (Torrey) Torrey; *B. gracilis* (H.B.K.) Lag. *ex* Steud.; *B. hirsuta* Lag.; *B. repens* (H.B.K.) Scribn. & Merr.; *B. rothrockii* Vasey; *Brachiaria arizonica* (Scribn. & Merr.) S.T. Blake [*Panicum arizonicum* Scribn. & Merr.]; *Bromus arizonicus* (Shear) Stebbins; **B. catharticus* Vahl; *B. marginatus* Nees; **B. rubens* L.; *Cenchrus insertus* M.A. Curtis; *Chloris crinita* Lag.; *C. virgata* Swartz; *Cottea pappophoroides* Kunth; **Cynodon dactylon* (L.) Pers.; *Digitaria californica* (Bentham) Henr. [*Trichachne californica* (Bentham) Chase]; *D. cognata* (Schult.) Pilger [*Leptoloma cognatum* (Schult.) Chase]; *D. insularis* (L.) Mez *ex* Ekman [*Trichachne insularis* (L.) Nees]; **D. sanguinalis* (L.) Scop.; **Echinochloa crusgalli* (L.) Beauv.; *Elymus elymoides* (Raf.) Swezey [*Sitanion hystrix* (Nutt.) J.G. Smith]; *E. triticoides* Buck.; *Elyonurus barbiculmis* Hack.; *Enneapogon desvauxii* Beauv.; **Eragrostis curvula* (Schrad.) Nees var. *conferta* Nees [*E. chloromelas* Steud.]; **E. cilianensis* (All.) Vign.-Lutati *ex* Janchen; **E. echinochloidea* Stapf; *E. intermedia* A.S. Hitchc.; **E. lehmanniana* Nees; *E. pectinacea* (Michx.) Nees var. *miserrima* (Fourn.) J. Reeder; *E. pectinacea* (Michx.) Nees var. *pectinacea*; *Eriochloa acuminata* (Presl) Kunth [*E. gracilis* (Fourn.) Hitchc., *E. lemmonii* Vasey & Scribn.]; *Erioneuron pulchellum* (H.B.K.) Takeota; *Heteropogon contortus* (L.) P. Beauv. *ex* Roemer & Schultes; *H. melanocarpus* (Ell.) Bentham; *Hilaria belangeri* (Steud.) Nash; **Hordeum murinum* L. ssp. *glaucum* (Steud.) Tzvel. [*H. leporinum* Link]; *H. pusillum* Nutt.; *Leersia oryzoides* (L.) Swartz; *Leptochloa dubia* (H.B.K.) Nees; *L. filiformis* (Lam.) P. Beauv.; *Leptochloa viscida* (Scribn.) Beal; *Lycurus setosus* (Nutt.) C. Reeder; *Muhlenbergia arizonica* Scribn.; *M. asperifolia* (Nees & Mey.) Parodi; *M. emersleyi* Vasey; *M. fragilis* Swallen; *M. microsperma* (DC.) Kunth; *M. porteri* Scribn. *ex* Beal; *M. rigens* (Bentham) A.S. Hitchc.; **Panicum antidotale* Retz.; *P. hirticaule* Presl; *P. obtusum* H.B.K.; *P. pampinosum* A.S. Hitchc. & Chase; *P. stramineum* A.S. Hitchc. & Chase; *Paspalum distichum* L.; *Phalaris caroliniana* Walt.; **Poa annua* L.; *P. bigelovii* Vasey & Scribn.; **P. pratensis* L.; **Polypogon monspeliensis* (L.) Desf.; **Schismus barbatus* (L.) Thell.; *Schizachyrium cirratum* (Hack.) Wooton & Standley; *Setaria arizonica* Rominger; *S. geniculata* (Lam.) Beauv.; *S. grisebachii* Fourn.; *S. leucopila* (Scribn. & Merr.) K. Schum.; **Sorghum halepense* (L.) Pers.; *Sporobolus contractus* A.S. Hitchc.; *Sporobolus cryptandrus* (Torrey) A. Gray; *Sporobolus*

wrightii Munro *ex* Scribn.; *Trachypogon secundus* (Presl) Scribn.; *Trisetum interruptum* Buckl.; * *Triticum aestivum* L.; *Vulpia octoflora* (Walt.) Rydb.

PONTEDERIACEAE–*Heteranthera limosa* (Swartz) Willd.

POTAMOGETONACEAE–*Potamogeton foliosus* Raf.; *P. pusillus* L.

TYPHACEAE–*Typha domingensis* Pers.; *T. latifolia* L.

ZANNICHELLIACEAE–*Zannichellia palustris* L.

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