

SURVEY AND ASSESSMENT OF ARIDLAND SPRING CIÉNEGAS IN THE SOUTHWEST REGION

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DEFINITION AND DESCRIPTION

'Ciénega' is Spanish for a swamp, bog, or marsh. It is also spelled 'ciénaga' throughout much of the Spanish-speaking world – especially South America and the Caribbean. The 'ciénega' spelling is prevalent in the American southwest and often used in northern México. The origin of the word 'ciénega' is thought to be a contraction of the Spanish words 'cien aguas' meaning 'a hundred waters or fountains' (Crosswhite 1985). This is an allusion to springs, seeps and wet ground over a large area instead of a single pool, slough, or stream channel.

Ciénegas gained acceptance as distinct climax communities of ecological significance when Hendrickson and Minckley (1985) made a thorough assessment of the ciénegas of southeastern Arizona. They defined the ciénega climax community as mid-elevation (1,000-2,000 m) freshwater wetlands with permanently saturated, highly organic, reducing soils occupied by a low-growing herbaceous cover of mostly sedges and rushes. Few woody plants occur in the ciénega flora and often only as riparian tree species around the drier margins. Ciénegas occur in arid landscapes with high rates of evaporation, so the soils at the drying wetland margins usually have surface crusts of alkali or salts that are the deposited dissolved solids of evaporated or transpired soil solutions.

Ciénega biotic communities of the southwestern United States and northern México are almost always features of springs and spring seeps (Brown 1982, Hendrickson and Minckley 1985, Dinerstein et al. 2000). Not all springs support ciénegas, but almost all ciénegas are supported by springs. These arid-land springs arise where stable aquifers intercept the ground surface in artesian basins or along geologic faults and fractures. They are generally not associated with fluctuating alluvial aquifers in channels that are flood-scoured, so are more likely to be found in the upper reaches of small drainages near geologic faults and igneous extrusions, in karst topography, and on gentle slopes where water-bearing strata have been exposed by river erosion or scarps. Size of individual ciénegas varies greatly from less than one acre to several hundred acres and is an expression of spring flow and topography.



Cloverdale Ciénega, Hidalgo County, NM

As climax communities associated with aridland springs of the southwest, ciénega-types of vegetation associations should be expanded to include more floristic regions and physical conditions than just the southeastern Arizona ciénegas described by Hendrickson and Minckley (1985). Ciénega synonyms in the Great Basin, Sonoran and Chihuahuan deserts can include 'vega', 'wet meadow', 'saltgrass meadow', 'alkali meadow' and 'inland salt marsh'. They are not necessarily confined to medium elevations and can also occur around desert springs at low elevations. Water coming from ciénega springs may be fresh or salty. In short, most ciénega-type habitats are the wet meadows that form around aridland springs and seeps.

It is the relative permanence of the spring features that make many ciénega habitats biologically distinct from other types of wetland communities. Ciénegas are typically positioned in the upper reaches of small drainages or above river channels where they are protected from the scouring floods that frequently modify river marshes and floodplains. Ciénega spring flows may vary, but are less susceptible to the flooding and drying than playa basin wetlands during moist and arid cycles of the climate. Sediment cores from San Bernardino Ciénega in southeastern Arizona show wetland conditions for most of the last 7,000 years (Minckley and Brunelle 2007) and at Cuatro Ciénegas in Coahuila the fossil pollen in sediments indicate nearly identical ecological conditions for more than 30,000 years (Meyer 1973). Such springs are refugia for species that may have been more widespread and common during wetter periods of the Quaternary. Several vertebrate and invertebrate animals still utilize aridland springs as core habitats in their overall distributions and some species are entirely confined to only one or a few aridland springs and ciénegas. Zoologists have long recognized that very

small aridland spring habitats may contain the only populations of rare and endemic animals and have actively searched for species that may be threatened with extinction (Table 1).

Table 1. Species of concern and threatened or endangered (state or federal) animals of Southwestern aridland springs and cienegas.

VERTEBRATES		AZ	NM	TX	Chih	Son
Chiricahua leopard frog	<i>Rana chiricahuensis</i>	X	X		X	X
Comanche Springs pupfish	<i>Cyprinodon elegans</i>			X		
Desert pupfish	<i>Cyprinodon macularius</i>	X				X
Leon Springs pupfish	<i>Cyprinodon bovinus</i>			X		
White Sands pupfish	<i>Cyprinodon tularosa</i>		X			
Pecos gambusia	<i>Gambusia nobilis</i>		X	X		
Big Bend gambusia	<i>Gambusia gaigei</i>			X		
Chihuahuan chub	<i>Gila nigrescens</i>		X		X	
Yaqui chub	<i>Gila purpurea</i>	X				
Gila topminnow	<i>Poeciliopsis occidentalis</i>	X	X			
Mexican tetra	<i>Astyanax mexicanus</i>		X	X	X	
CRUSTACEANS						
Socorro isopod	<i>Thermosphaeroma thermophilum</i>		X			
Noel's amphipod	<i>Gammarus desperatus</i>		X			
Diminutive amphipod	<i>Gammarus hyalleoides</i>			X		
INSECTS						
Stephan's Riffle beetle	<i>Heterelmis stephani</i>	X				
SNAILS						
Alamosa springsnail	<i>Tryonia alamosae</i>		X			
Gonzales springsnail	<i>Tryonia circumstriata</i>			X		
Phantom springsnail	<i>Tryonia cheatumi</i>			X		
Quitobaquito tryonia	<i>Tryonia quitobaquidae</i>	X				
Bylas springsnail	<i>Apachecoccus arizonae</i>	X				
Chupadera springsnail	<i>Pyrgulopsis chupaderae</i>		X			
Kingman springsnail	<i>Pyrgulopsis conica</i>	X				
Verde Rim springsnail	<i>Pyrgulopsis glandulosa</i>	X				
Gila springsnail	<i>Pyrgulopsis gilae</i>		X			
Fossil springsnail	<i>Pyrgulopsis simplex</i>	X				
Brown springsnail	<i>Pyrgulopsis sola</i>	X				
New Mexico springsnail	<i>Pyrgulopsis thermalis</i>		X			
Page springsnail	<i>Pyrgulopsis morrisoni</i>	X				
Roswell springsnail	<i>Pyrgulopsis roswellensis</i>		X			
San Bernardino springsnail	<i>Pyrgulopsis bernardina</i>	X				X
Socorro springsnail	<i>Pyrgulopsis neomexicana</i>		X			
Grand Wash springsnail	<i>Pyrgulopsis bacchus</i>	X				
Diamond Y springsnail	<i>Pseudotryonia adamantina</i>			X		
Koster's springsnail	<i>Juturnia kosteri</i>		X			
Phantom Lake cave snail	<i>Cochliopa texana</i>			X		
Ovate vertigo	<i>Vertigo ovate</i>	X	X	X		X
Pecos assiminea	<i>Assiminea pecos</i>		X	X		

CIÉNEGA VEGETATION

Ciénega vegetation is usually highly productive and dense. A list of plant species for southeastern Arizona ciénegas was assembled by Hendrickson and Minckley (1985). Peterson and David (1998), Milford et al. (2001) and Sivinski and Bleakly (2004) produced lists of ciénega plants for the Rio Pecos Basin of eastern New Mexico. Most individual ciénegas have relatively low plant species diversity, but contribute a productive and rare subset of wetland

species and habitats to an otherwise arid landscape. The most common ciénega plants of the southwestern region are the open water (when present) emergents of bulrush (*Schoenoplectus* spp., *Bolboschoenus maritimus* (Linnaeus) Palla) and cattail (*Typha* spp.); sedges and rushes of water-saturated soils (*Eleocharis* spp., *Carex* spp., *Cyperus* spp., *Fimbristylis puberula* (Michaux) Vahl); salt and alkali tolerant inland saltgrass (*Distichlis spicata* (Linnaeus) Greene), scratchgrass (*Muhlenbergia aperifolia* (Ness & Meyer) Parodi), and Mexican or Baltic rush (*Juncus arcticus* Willdenow vars. *mexicanus* (Willdenow) Balslev or *balticus* (Willdenow) Trautvetter) on seasonally saturated and sub-irrigated soils; and alkali sacaton (*Sporobolus airoides* (Torrey) Torrey) on the drier ciénega margins. Woody plants are usually not a significant part of ciénega vegetation cover, but patches of shrubby willows (*Salix* spp.) or baccharis (*Baccharis salicina* Torrey & Gray) may occur and the drier ciénega margins will often have riparian trees such as cottonwood (*Populus* spp.), Arizona ash (*Fraxinus velutina* Torrey), and tree willows (*Salix* spp.).

Very little is currently known about the locations, sizes, composition and conditions of Southwestern aridland spring ciénegas. The current survey of Southwestern ciénegas is an initial attempt to better describe the common and rare plant species that occupy these wetland habitats in the greater Southwest. The following are descriptions and illustrations of some common native plants frequently found at aridland spring ciénegas of the Southwestern states of Arizona, New Mexico and Texas.

***Distichlis spicata* (L.) Greene var. *stricta* (Torrey) Beetle**
Inland salt grass



As the name implies, saltgrass is tolerant of highly alkaline and salty substrates. It is strongly rhizomatous and can form a dense thatch that covers large areas. Often occurs on perpetually wet soils, but is usually found on soils with a dry surface and subirrigated wet soils in the root zone. This species is more common in the salty or gypseous cienegas of west Texas and New Mexico than in the cienegas with fresh water in Arizona and New Mexico.

***Muhlenbergia asperifolia* (Nees & Meyer) Parodi**
Scratchgrass, alkali muhly



Scratchgrass is a strongly rhizomatous, alkali-tolerant grass similar to inland saltgrass and sometimes co-occurring. Its delicate purplish-red inflorescence is almost cloud-like in large masses and very distinctive when in flower. It occupies wet soil or soil that is dry at the surface and subirrigated in the root zone.

***Sporobolus airoides* (Torrey) Torrey**
Alkali sacaton



The silty alkaline soils of Southwestern playa basins and river flood plains are frequently covered with alkali sacaton. This coarse bunchgrass also occurs in the drier, seasonally wetted or subirrigated soils of Southwestern ciénegas.

***Spartina pectinata* Bosc**
Prairie cordgrass



Prairie cordgrass is a rhizomatous tall species (about 2 m) that is confined to alkaline, permanently wet soils. In the Southwest, it only occurs in the ciénegas of the Pecos River basin of eastern New Mexico and western Texas.

***Phragmites australis* (Cavanilles) Trinius**
Common reed



Common reed is a tall (2-3 m), cane-like, strongly rhizomatous grass that forms dense patches, which can quickly cover large areas. It occasionally forms stolons up to 20 feet in

length (see above photo). There are two very similar native races in the Southwest – subsp. *americanus* Saltonstall, Peterson & Soreng and var. *berlandieri* (Fournier) Reed. An exotic race, subsp. *australis*, introduced from Europe, is spreading throughout North America. Common reed is often associated with saltgrass or scratchgrass, but can expand into wetter soils with cattails.

***Schoenoplectus americanus* (Persoon) Volkart
Chairmaker's bulrush**



Chairmaker's bulrush has great ecological amplitude and is found in a variety of ciénega habitats throughout the Southwest. It is strongly rhizomatous and its stems, which are sharply triangular in cross-section with rudimentary basal leaves, will often reach a height of 1 meter or more. *Schoenoplectus pungens* (Vahl) Palla (not shown) also has triangular stems and is called three-square bulrush. It is less common in ciénegas, and has shorter stems with long, well developed basal leaves.

***Schoenoplectus acutus* (Muhlenberg) A. & D. Löve var. *occidentalis* (S. Watson) Smith
Hardstem bulrush**



Hardstem bulrush is tall (1-2.5 m) and usually an emergent from open water portions of Southwestern ciénegas. Its stems are round in cross-section with a paniculate inflorescence of large spikelets that are often clustered together. *Schoenoplectus tabernaemontani* (C.C. Gmelin) Palla (softstem bulrush) (not shown) is a very similar, but less common emergent bulrush with round stems and is distinguished by its more open panicle with solitary (rarely clustered) spikelets.

***Bolboschoenus maritimus* (L.) Palla subsp. *paludosus* (A. Nelson) T. Koyama**
Saltmarsh bulrush



The leafy, triangular stemmed salt marsh bulrush is rhizomatous and forms patches on the salty or gypseous ciénega soils of southern New Mexico and western Texas.

***Carex praegracilis* W. Boott**
Field sedge



Carices are rare or nonexistent in the ciénegas of west Texas and most of New Mexico, but are sometimes dominant species in the ciénegas of southwest New Mexico and throughout Arizona. Field sedge can tolerate fairly alkaline conditions so is the most common ciénega sedge. It is strongly rhizomatous and can densely cover large areas of wet soil.

Other carices commonly found in Southwestern ciénegas include *Carex alma* L.H. Bailey (grass-leaf sedge), *Carex chihuahuensis* Mackenzie (Chihuahua sedge), and *Carex pellita* Muhlenberg (wooly sedge).

***Eleocharis* spp.**
Spike-rush



Spike-rushes have rounded or flattened stems that are terminated by a single spikelet at the apex. There are several species in Southwestern ciénegas, many of which are difficult to distinguish from one another. *Eleocharis macrostachya* Britton (pale spike-rush) (upper photo) is a common species in Arizona and western New Mexico ciénegas that is strongly rhizomatous and has fairly stout stems. The most abundant spike-rush in west Texas and the remainder of New Mexico's aridland spring ciénegas is *Eleocharis rostellata* (Torrey) Torrey (beaked spike-rush)(lower photo), which is not only rhizomatous, but also stoloniferous. It is easily distinguished by its long, lax stems that lay over and root where ever they touch the wet soil.

***Fimbristylis puberula* (Michaux) Vahl var. *interior* (Britton) Kral**
Hairy fimbry



Hairy fimbry is not a typical southwestern ciénega plant, but can be locally very abundant in the large ciénega remnants of the Pecos River Basin of eastern New Mexico and western Texas. In the Southwest, it only occurs in ciénega habitats associated with large aridland springs.

***Typha* spp.**
Cattail



Cattails are tall (1.5-3 m), strongly rhizomatous and confined to permanently saturated soils – often as emergents from open water. There are three species in the Southwest. The two native species *Typha latifolia* L. (right photo) and *Typha domingensis* Persoon (left photo) are commonly associated with aridland springs. The exotic *Typha angustifolia* is more often on

modified rivers and man-made wetlands. All three cattail species can form dense stands that exclude other plants and eliminate open, shallow water surfaces.

***Juncus arcticus* Willdenow**
Baltic rush, Mexican rush



This variable species of rush is ubiquitous and can be found at most aridland spring ciénegas in the Southwest. It is strongly rhizomatous and often abundant with saltgrass or scratchgrass.

There are two named varieties in the Southwest. Variety *balticus* (Willdenow) Trautvetter (Baltic rush) lacks blades on its leaf sheaths while var. *mexicanus* (Willdenow) Balslev (Mexican rush) has obvious blades on one or two leaves. Most populations of this species in the Southwest have the bladeless leaves of Baltic rush, but many also have the flattened twisted stems that are more characteristic of Mexican rush.

***Juncus torreyi* Coville**
Torrey's rush



Torrey's rush is a widespread species in Southwestern ciénegas where it is an occasional and never dominant plant. It has short rhizomes and can tolerate fairly alkaline soils.

***Berula erecta* (Hudson) Coville**
Water-parsnip



Water parsnip is a low-growing perennial herb that is common in wetlands throughout North America. It is frequently found in Southwestern aridland spring ciénegas and appears to be excluded only by very salty conditions.

Robert W. Freckmann Herbarium
University of Wisconsin-Stevens Point

***Asclepias verticillata* L.**
Whorled milkweed



In the arid Southwest, whorled milkweed is confined to the subirrigated soils of floodplains and ciénegas. In Arizona and New Mexico the sporadic ciénega populations of whorled milkweed are often misidentified as *Asclepias subverticillata* (A. Gray) Vail (horsetail milkweed) (not shown), a more common close relative of drier habitats. It is easily distinguished by its terminal and lateral umbels while whorled milkweed has only terminal umbels.

***Asclepias speciosa* Torrey**
Showy milkweed



Showy milkweed is a common wetland plant with great elevation and ecological amplitude. Its tall stems and pink flowers are sporadically found in Southwestern ciénegas.

Anemopsis californica
Yerba manza



Yerba manza is a common plant of aridland spring ciénegas and river floodplains in the Southwest (except Texas). It is strongly rhizomatous and stoloniferous and can form very large patches of clones. It is a popular folk remedy for many ailments and can withstand a great deal of harvest for that purpose.

***Samolus ebracteatus* H.B.K. var. *cuneatus* (Small) Henrickson**
Limey brookweed



In New Mexico and west Texas, limey brookweed occurs only on aridland spring habitats. It is distinguished by racemes of small white flowers and leaf blades that are decurrent on the stem.

A similar, but more delicate riparian species, *Samolus parviflorus* Rafinesque (seaside brookweed) (not shown) occasionally occurs at ciénegas in Arizona and New Mexico. It is distinguished by its petiolate leaves without decurrent blades.

***Eustoma exaltatum* (L.) Salisbury**
Prairie gentian



Arguably the most beautiful plant in Southwestern ciénegas. It is widespread in distribution, but in the Southwest is confined to aridland spring seeps and spring ciénegas. An annual plant with population densities varying from year to year with variations of soil moisture.

***Lobelia cardinalis* L.**
Cardinal-flower



Cardinal-flower is strikingly beautiful annual wetland plant. In the arid Southwest it is entirely confined to springs and seeps, especially those that deposit travertine.

***Limonium limbatum* Small**
Southwestern sea-lavender



This perennial herb is confined to the highly alkaline spring seeps and playas of New Mexico and west Texas – with a couple disjunct locations at springs in Arizona and Nevada. Southwestern sea-lavender is especially abundant in the gypseous spring ciénegas of the Pecos and Tularosa basins of New Mexico.

***Lythrum californicum* Torrey & Gray**
California loosestrife



California loosestrife is a perennial herb that sporadically occurs at springs and creek banks throughout the Southwest. It is a short, native species and not to be confused with the much taller *Lythrum salicaria* L. (purple loosestrife) (not shown), which is an exotic plant that threatens the freshwater wetlands of North America.

***Triglochin maritimum* L.**
Seaside arrow-grass



Seaside arrow-grass grows only on highly alkaline, water-saturated soils. In the Southwest, it is confined to permanent aridland springs, especially those that deposit travertine where this rhizomatous perennial can be quite abundant.

***Suaeda calceoliformes* (Hooker) Moquin-Tandon**
Low seepweed



Low seepweed is an annual herb that is common in the silty alkaline soils of floodplains and playas of western North America. It is abundant and well developed on the aridland spring ciénegas in the Pecos River basin of eastern New Mexico and west Texas.

***Sidalcea neomexicana* A. Gray**
New Mexico checker mallow



New Mexico checker mallow is a wetland species of mid-elevations and can tolerate fairly alkaline conditions. It is sporadic, but locally abundant in Southwestern ciénegas from western New Mexico through Arizona.

***Flaveria chlorifolia* A. Gray**
Clasping yellowtops



Clasping yellowtops is a bushy perennial herb with opposite, perfoliate leaves and is endemic to aridland spring ciénegas on gypsum. It is locally abundant on spring ciénegas in the Pecos River basin of eastern New Mexico and western Texas.

***Symphotrichum subulatum* (Michaux) Nesom**
New Mexico aster, lawn aster



New Mexico aster is a tall, annual wetland species that occasionally occupies Southwestern aridland spring ciénegas. There are two regional varieties. In eastern New Mexico and western Texas, var. *ligulatum* (Shinners) S.D. Sundberg is distinguished by relatively long ray flowers (see photo). Variety *parviflorum* (Nees) S.D. Sundberg (not shown) has short rays in inconspicuous flower heads and is common in western New Mexico and southern Arizona.

***Pluchea odorata* (L.) Cassini**
Sweet-scent



Sweet-scent is an annual plant of salt marshes, alkaline creeks and ciénegas. In the Southwest it sporadically occurs with saltgrass in some of the larger alkaline ciénegas.

***Pyrrhopappus pauciflorus* (G. Don) A.P. de Candolle**
Texas false-dandelion



In the arid Southwest, Texas false-dandelion is confined to river floodplains and spring ciénegas. It is a tap-rooted perennial on subirrigated soils that are permanently wet in at least the lower root zone.

***Pseudoclapia arenaria* Rydberg**
Trans-Pecos clapdaisy



Trans-Pecos clapdaisy is a short woody plant with succulent leaves and is one of the few shrub species in ciénega habitats. It occurs only on highly alkaline (usually gypseous) subirrigated soils associated with permanent springs and seeps in New Mexico, Texas, and adjacent Mexico.

***Apocynum cannabinum* L.**
Indian hemp



Indian hemp is a rhizomatous perennial that makes large patches of clones and is common in North American wetlands. It has milky sap and pairs of pods that are connected at the base.

***Glycyrrhiza lepidota* Nuttall**
American licorice



American licorice is a legume with white flowers and bur-like pods that stick tight to clothing and animal fur. It is a common riparian plant throughout most of western and central North America and can occupy fairly alkaline soils at spring ciénegas. This is another strongly rhizomatous species that can form large colonies.

***Baccharis salicina* Torrey & Gray**
Great Plains seep-willow



Seep-willows are among the few woody plants in Southwestern ciénegas. They usually occur on the drier, subirrigated ciénega margins. Great Plains seep-willow is common on alkaline soils while the more fresh water springs may have the larger *Baccharis salicifolia* (willow baccharis).

Southwestern ciénega plants include many additional native species of common grasses, sedges, rushes and forbs that are inconsistent in their distribution and abundance. For instance, the tall grass prairie species *Sorghastrum nutans* (L.) Nash (Indiangrass) and *Panicum virgatum* L. (switchgrass) are significant components of the Santa Rosa ciénegas in eastern New Mexico and the Cloverdale Ciénega in southwestern New Mexico, but are rare in other Southwestern ciénegas. Also, the aridland spring ciénegas in Arizona and western New Mexico have several species of *Cyperus* (flat-sedge) while that genus is sparse or absent from the ciénegas of eastern New Mexico and western Texas. There are vegetation similarities between most aridland spring ciénegas, yet each one is unique in overall species composition.

Some non-native plants are common, or becoming common, components of Southwestern ciénegas. A few, such as *Polypogon monspeliensis* (L.) Desfontaines (rabbitfootgrass), *Echinochloa crus-galli* (L.) Beauvois (large barnyardgrass) and *Rumex crispus* L. (curly dock), are ubiquitous and innocuous. Other exotic plants have potential to seriously impact the native community composition and ecological integrity of aridland springs and ciénegas. Exotic trees, especially *Tamarix chinensis* Loureiro (saltcedar) and *Elaeagnus angustifolia* L. (Russian olive), can almost completely convert a treeless ciénega to a dense woodland with little understory vegetation. Aggressive, rhizomatous non-native grasses and forbs compete with, and replace, native ciénega plants, especially in areas of soil disturbance. Herbaceous exotics that are currently degrading some aridland springs and ciénegas include *Sorghum halepense* (L.) Persoon (Johnsongrass), *Festuca pratensis* Hudson (meadow fescue) and *Lepidium latifolium* L. (perennial pepperweed).

RARE PLANTS OF SOUTHWESTERN CIÉNEGAS

While several animal species are endemic to particular aridland springs or areas of spring features, very few spring ciénega plants are so narrowly endemic. Some notable exceptions include *Nitrophila mohavensis* Muns & Roos (Amargosa niterwort), *Ivesia kingii* S. Watson var. *eremica* (Coville) Ertter (Ash Meadows mousetails), *Grindelia fraxinoprattensis* Reveal & Beatley (Ash Meadows gumplant), and *Centaurium namophilum* Reveal, Broome & Beatley (spring-loving centaury), which are endemic to Mohave Desert springs around the Ash Meadows region of southwestern Nevada and adjacent California.

In the arid Southwestern states of Arizona, New Mexico and Texas, there are only two rare ciénega plants that are endemic to a relatively small region and both are federally listed as endangered species.

***Spiranthes delitescens* Sheviak**

Canelo Hills ladies-tresses orchid, Madrean ladies-tresses



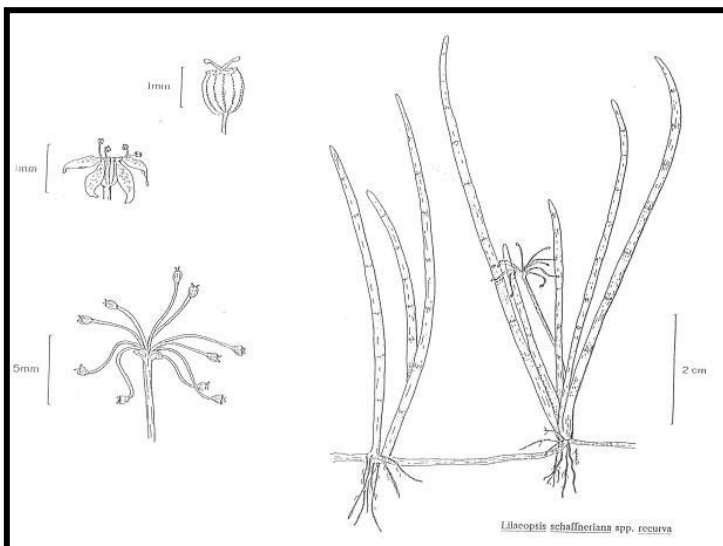
The Canelo Hills ladies-tresses is the most geographically restricted ciénega plant in the Southwest. It is presently known from only four spring ciénega habitats in the San Pedro River watershed in Santa Cruz and Cochise counties, Arizona just north of the Sonora border (Coleman 2000).

This rare orchid was listed as endangered under the federal Endangered Species Act in 1997 (FR Vol. 62, No. 3:665-689). The listing cited a total occupied habitat is less than 200 acres. Three of the known locations are on private land and the fourth is a preserve owned and managed by The Nature Conservancy. Threats to this species are loss of habitat from watershed degradation, groundwater depletion, improper grazing, agriculture, mining, road building, non-native species, and urbanization.

This endangered species lacks a recovery plan and critical habitat designation. Studies on the effects of fire and livestock grazing on the population dynamics of this rare orchid have resulted in some observations that controlled grazing may result in higher densities than in ungrazed habitat (McClaran and Sundt 1992). Ciénega habitats in adjacent Sonora need additional field surveys for the species.



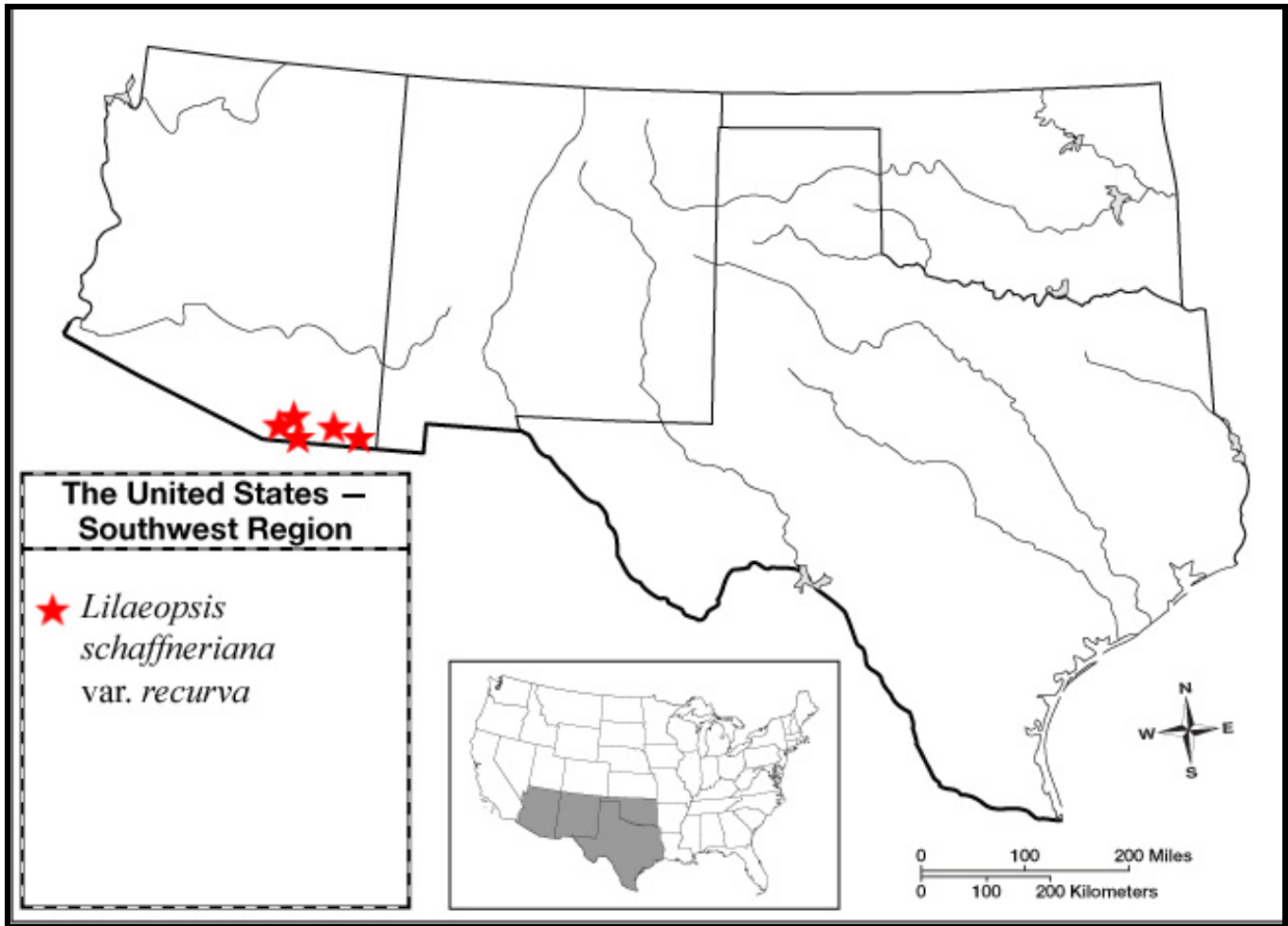
***Lilaeopsis schaffneriana* (Schlecht.) Coulter & Rose var. *recurva* (A.W. Hill) Affolter**
Huachuca water umbel



The Huachuca water umbel is endemic to a narrow geographic region in southwestern Arizona and adjacent Sonora. It occurs on wet soil and shallow water habitats along rivers, creeks, ponds and ciénegas. It was federally listed as endangered in the same 1997 Federal Register notice as the Canelo Hills ladies-tresses (FR Vol. 62, No. 3:665-689). Primary river habitats are threatened by watershed degradation, water diversion and scouring floods. Spring habitats along these water courses are significant refugia for this plant.

Arizona Rare Plant Committee. 2001. Arizona rare plant field guide.

Critical habitat was designated in 1999 as linear reaches of water courses in seven segments of watershed in Cochise and Santa Cruz counties, Arizona (FR Vol. 64, No. 132:37441-37453).

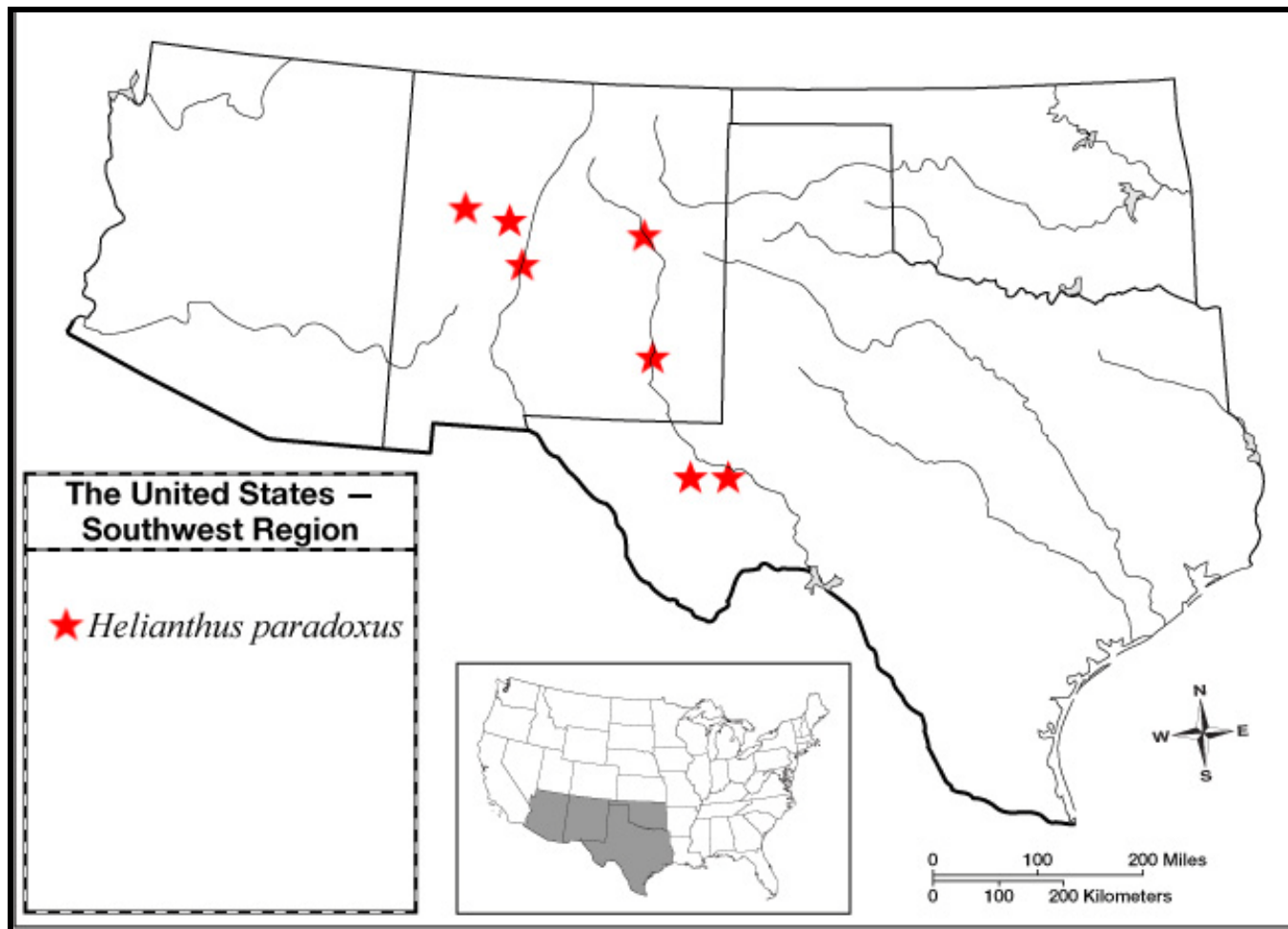


Most rare ciénega plants have very broad distributions of several hundred, or sometimes more than a thousand, miles in length. They are rare species because their ciénega habitats are very rare. Widespread wetland species usually do not get much attention from rare plant botanists because of multiple-state (or country) distributions and the difficulties of accessing a class of habitat that is predominantly on private property. A few widespread ciénega species, however, are starting to get some much needed scrutiny by botanists and land managers in southwestern states. The following are widespread and rare ciénega plants.

***Helianthus paradoxus* Heiser** **Pecos sunflower**

The Pecos sunflower occurs only in alkaline spring ciénegas from western Texas to west-central New Mexico. The dramatic and almost complete demise of aridland springs from aquifer depletion in the Chihuahuan Desert of Texas left only two populations Pecos sunflower in a region that retains only 13 of 61 original springs (Brune 1981, Poole and Diamond 1993). Some of the New Mexico populations are also damaged or threatened by aquifer depletion and

nearly all are degraded by exotic tree infestations (USDI-Fish & Wildlife 2008). Pecos sunflower was listed as a federally threatened species in 1999 (FR Vol. 64, No. 202:56582-56590) and critical habitat designated in 2008 (FR Vol. 73, No. 63:17762-17807). Critical habitat includes four core population areas – three in New Mexico and one in west Texas.



Pecos sunflower can occur in dense patches of several hundred thousand individuals in just a few acres of ciénega habitat (USDI-Fish & Wildlife 2008). It prefers habitats with soils that are wet during spring and early summer then dry at the surface and wet in the root zone while flowering in late summer. This is an annual sunflower that responds positively to fire, but can be severely reduced in density by intense cattle grazing (Sivinski-personal observations 2008 and 2010). It is sympatric in a few locations with the next two rare ciénega plants.

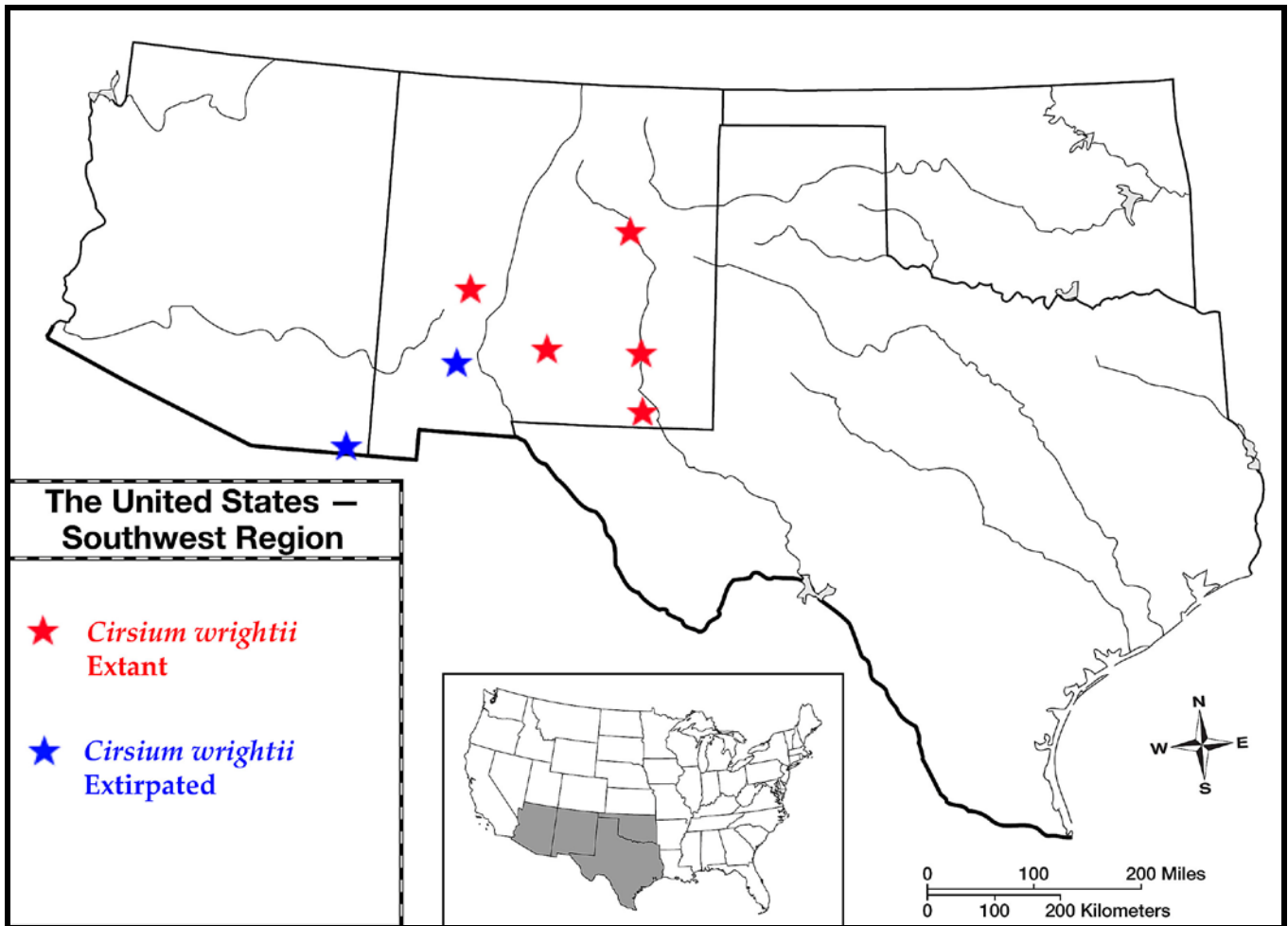
***Cirsium wrightii* A. Gray**
Wright's marsh thistle



Wright's marsh thistle sometimes occurs in the same New Mexican ciénegas occupied by Pecos sunflower. Overall, Wright's marsh thistle has fewer populations and is less abundant than Pecos sunflower. This wetland thistle ranges from southeastern New Mexico to southeastern Arizona and northern Chihuahua and Sonora. The type locality and single Arizona location at San Bernardino Ciénega has not been seen again since that ciénega was dried by down-cutting of the adjacent Black Draw. New Mexico populations at Lake Valley, some Sacramento Mountain springs, and the City of Roswell (Country Club) have also been extirpated (Sivinski 1995a, NMRPTC 1999, Sivinski 2005). This is clearly a threatened ciénega species in the United States and is listed as endangered by the State of New Mexico. The status of this plant in México is unknown. The only herbarium specimens of Mexico collections are one recent collection from Chihuahua and one historic collection from Sonora. The dismal trend of aridland spring loss in México (Contreras and Lozano 2002, Miller et al. 1989, Unmack and Minckley 2008) offers little hope that this species is faring better south of the border. A recent 12-month finding by the U.S. Fish and Wildlife Service on a petition to list Wright's marsh thistle as threatened or endangered concluded that listing is warranted, but precluded by other higher priority listing actions (FR Vol. 75, No. 213:67925-67944, 11/4/2010).

Wright's marsh thistle is an obligate wetland species confined to permanently water-saturated soils of spring ciénegas. There are two regional races. Populations in the Pecos River valley have pink flowers and dark green foliage (right photo) and the more western and

southern populations in New Mexico, Arizona and Mexico have white or pale pink flowers and pale green foliage (left photo).



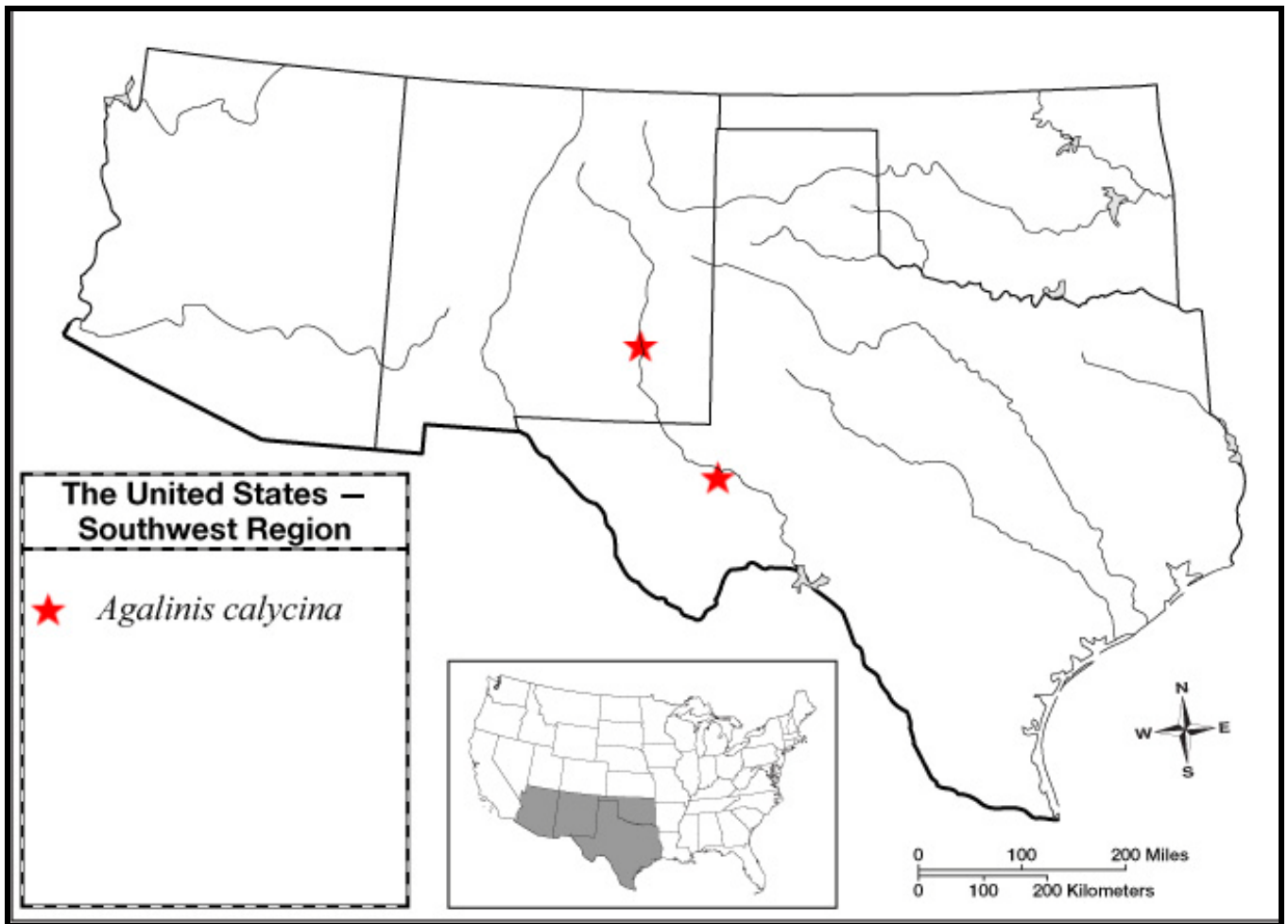
***Agalinis calicina* Pennell**
Leoncita false foxglove

Leoncita false foxglove also co-occurs with Pecos sunflower and Wright’s marsh thistle in a ciénega at Bitter Lake National Wildlife Refuge in southeastern New Mexico and with Pecos sunflower at Diamond Y Spring in west Texas. It is otherwise only known from an historic and ambiguous collection in western Texas, and two historic collections in Coahuila (Poole et al. 2007, Sivinski 2011). This is another species with almost no data available on its status in México. It seems to be exceedingly rare, but additional research is needed to support the initial appearance of extreme rarity.

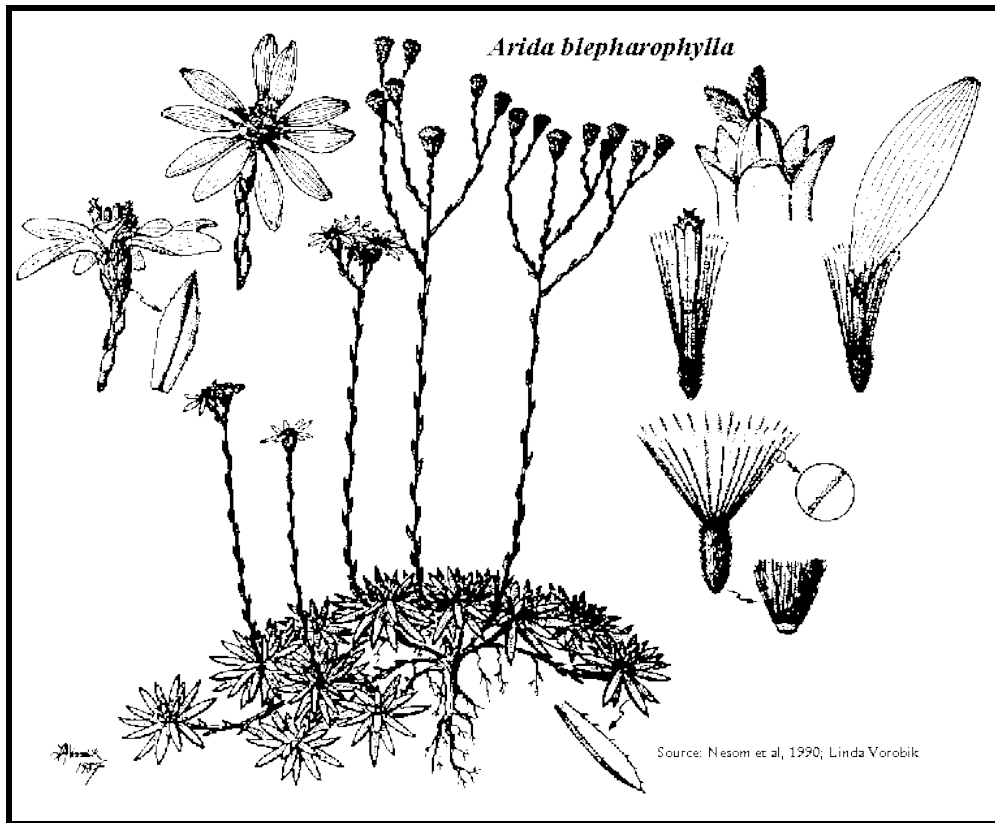
The two known populations are in aridland spring ciénega habitat with gypseous soil. The soil is permanently wet and the vegetation is saltgrass, cattail, common reed, saltmarsh bulrush, chairmaker’s bulrush, and prairie gentian. Like other annual ciénega plants, population density and extent fluctuate from year to year in response to spring flow and precipitation variations. The Texas population occurs on land owned by The Nature Conservancy and the New Mexico population is on a National Wildlife Refuge managed by USDI-Fish & Wildlife Service.



Agalinis calycina

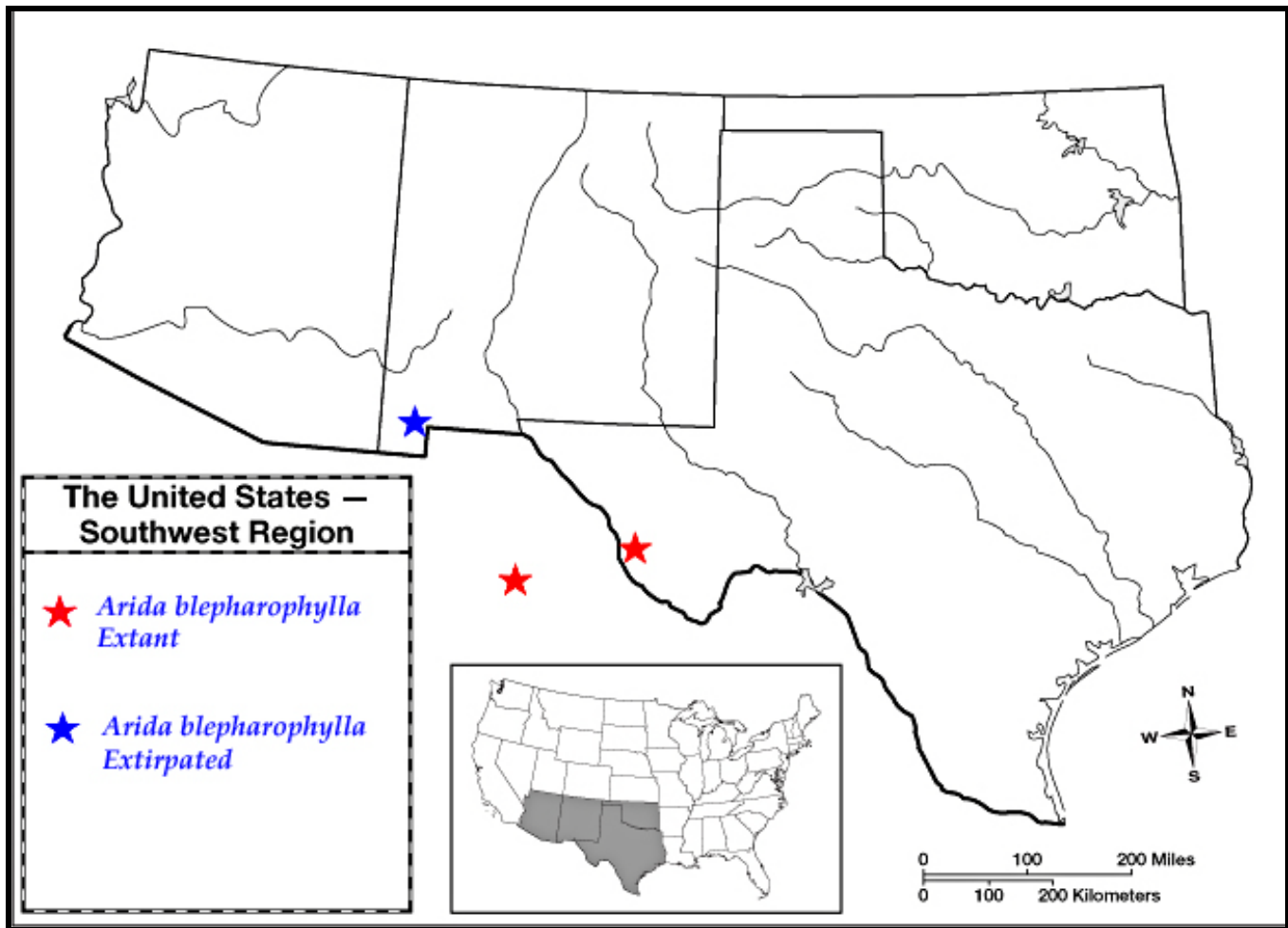


***Arida blepharophylla* (A. Gray) D.R. Morgan & R.L. Hartman**
La Playas Springs spine-aster



The first collection of La Playas Springs spine-aster was taken from a spring in the Playas valley of southwestern New Mexico in 1851 during the international border survey. There are only two springs in this area and both have been captured for livestock water and so trampled that no wetland vegetation remains and the spine-aster probably extirpated (Nesom et al. 1990, NMRPTC 1999). It was discovered again at some gypsum springs (Baños de San Antonio) southeast of Ciudad Chihuahua in Mexico in 1971, which was the only known extant population until more recent discoveries at a couple locations in Presidio County, Texas. The small Texas populations are the only known extant locations for this species in the United States (Poole et al. 2008).

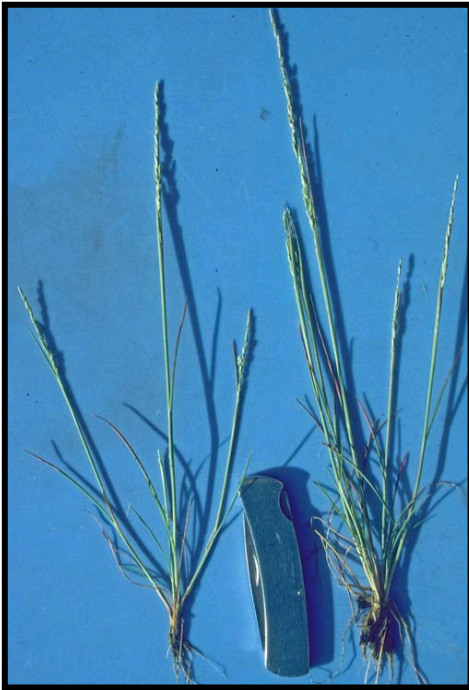
Although associated with spring seeps and perennial streams, the habitat for La Playas Springs spine-aster is not a typical ciénega. One of the Texas locations, however, also has Indiangrass and yerba manza, which are ciénega species in the Southwest, and also the only Texas location of slender spiderflower – a rare ciénega species discussed below.



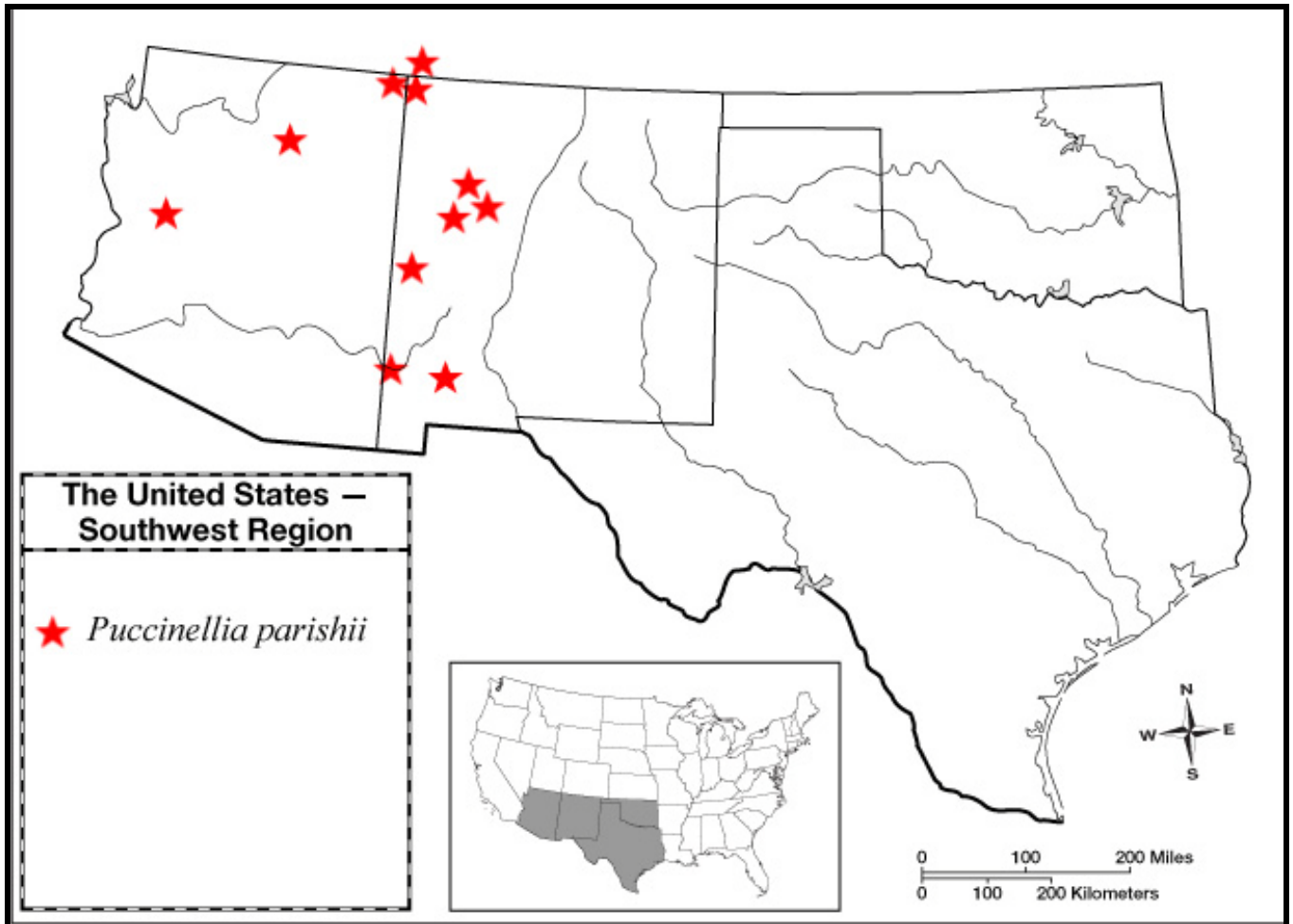
***Puccinellia parishii* A.S. Hitchcock** **Parish's alkali grass**

Only three extant populations of Parish's alkali grass (*Puccinellia parishii* A.S. Hitchcock) were known at the time this species was proposed for inclusion on the endangered species list in 1994. This annual grass occupies the highly alkaline soils of aridland spring seeps and spring ciénegas. The proposal to list gave southwestern field botanists the incentive (funding) to search for new populations, which located or confirmed a total of 30 population sites at seeps and ciénegas – 17 in New Mexico, 11 in Arizona, 1 in eastern California, and 1 in southwestern Colorado (FR Vol. 63, No. 186:51329-51332, 9/25/98). USDI-Fish and Wildlife Service withdrew the proposal to list in 1998, but New Mexico still lists this plant as state endangered because it is a wetland species with less than 100 acres of total known occupied habitat (NMRPTC 1999).

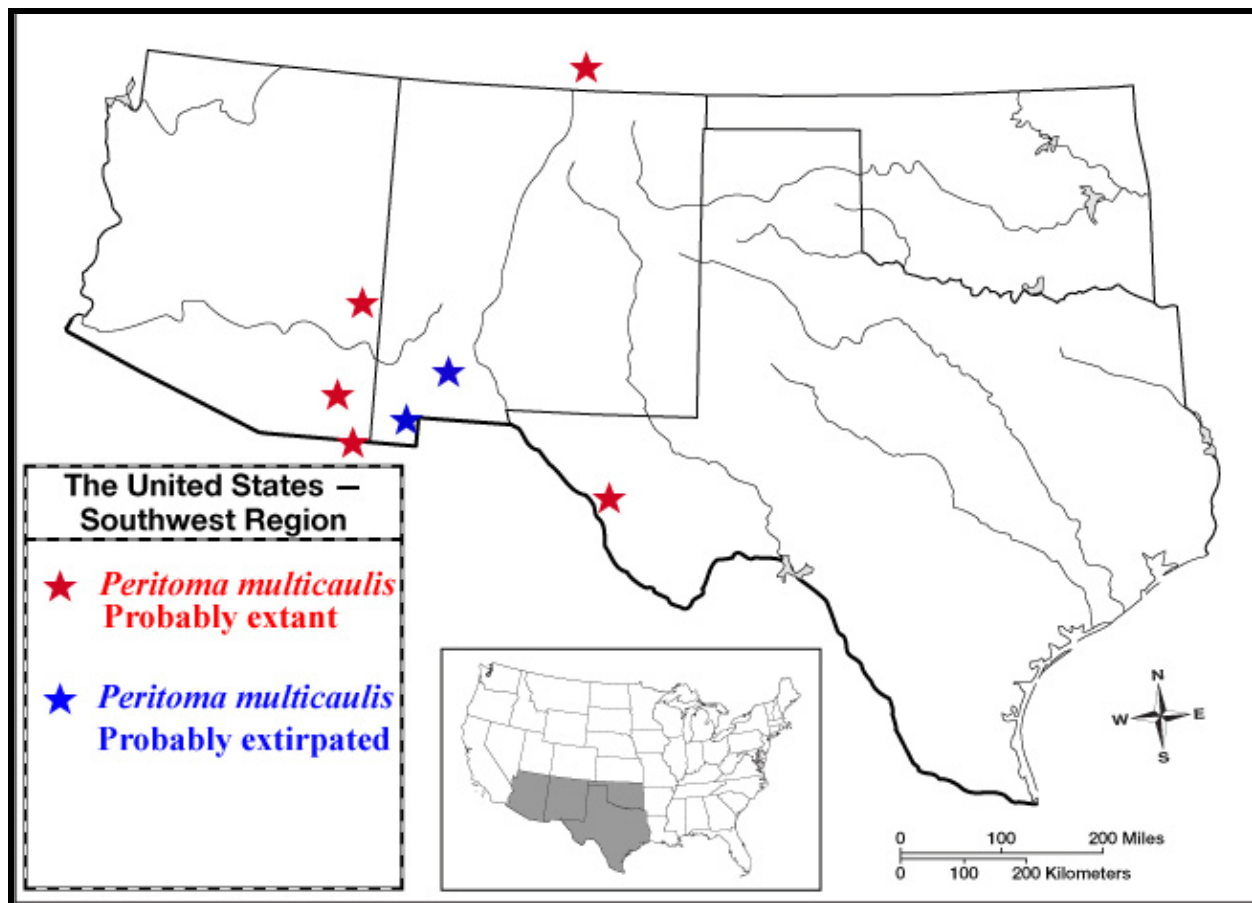
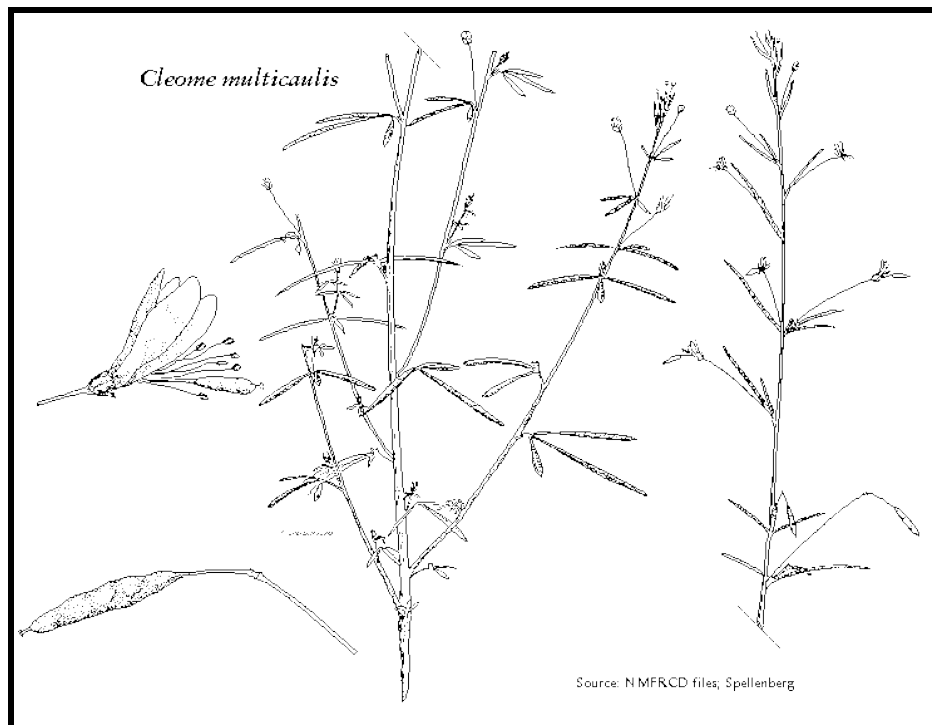
Intense livestock grazing and trampling are not detrimental to this short-lived annual grass and may actually benefit this small, annual species by removing competing vegetation (FR Vol. 63, No. 186:51329-51332, 9/25/98). Water capture for livestock, however, is serious threat at some springs where spring boxes have been installed and the water piped away from the habitat.



Puccinellia parishii



***Peritoma multicaulis* (A.P. de Candolle) Iltis**
Slender spider-flower

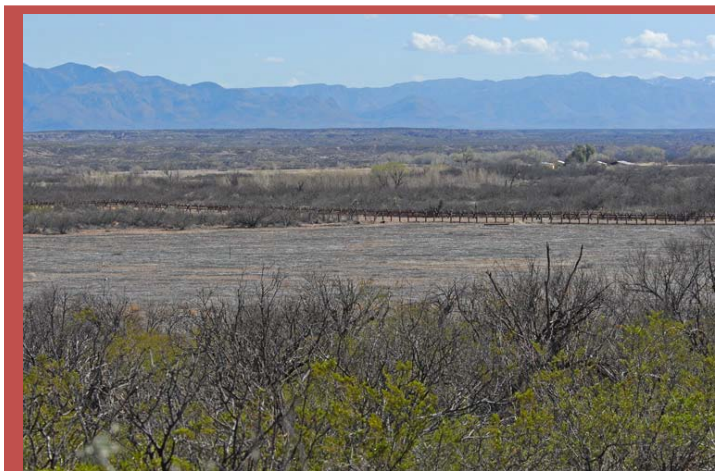


Slender spider-flower has a very widespread, sporadic distribution from south-central Wyoming to central Mexico. It has been found in less than 20 locations over the last two centuries and the only known large, extant populations are in the San Luis Valley of Colorado and Natrona County, Wyoming (Jennings 1998, Fertig 2000). It was initially discovered in the Southwest region during the 1851 international border survey in three places. One near the lower Rio Mimbres in southwestern New Mexico at a wetland that no longer exists (Jennings 1998, Spellenberg 2002) and another at the Las Playas basin in the boot heel of New Mexico. The third was likely in the Wilcox Playa of southeastern Arizona (Jennings 1998). The New Mexico populations have never been relocated and it is likely extirpated from that state. The Wilcox Playa population has been recollected in 1905 and 1944, so may still be extant. There are two other historic collections from southeastern Arizona – the most recent being 69 years ago. The Arizona side of San Bernardino Ciénega is dry and dead, but the remnant part of the ciénega on the Sonora side of the border had slender spider-flower in 1980 (Jennings 1998). Two small locations for slender spider-flower have been documented in Presidio County, Texas, one of which is recent and still extant (Poole et al. 2007).

Most habitats for slender spider-flower are on the margins of playa lakes and not always associated with permanent springs. Some, however, do occur at aridland spring habitats that support typical ciénega plant communities.

LOSING (WET) GROUND

The interaction of humans with aridland springs and ciénegas is a prehistoric tale of early and prolonged dependence (Haynes 2008; Rhea 2008) with a more recent history of almost universal destruction or diminution during the last two centuries (Unmack and Minckley 2008). The following examples of spring ciénega loss illustrate the activities that have destroyed and continue to threaten these desert wetlands. Hendrickson and Minckley (1985) documented the history and demise of many southeastern Arizona ciénegas – mostly by arroyo cutting that dropped spring aquifers below the ground surface. A classic example is the almost complete loss of San Bernardino Cienega in Cochise County, Arizona.



San Bernardino Ciénega – dry Arizona portion, March 2010. Mesquite bosque and farm fields (now abandoned) replaced this wetland. Distant line of trees shows location of Rio San Bernardino on the Mexican side.

San Bernardino Ciénega, 31.3339°N 109.2637°W, was in a broad reach of the Rio San Bernardino (a.k.a. Black Draw Wash) and was bisected by the international border between Arizona and Sonora. Frequent floods of sediment laden sheet flow grew this huge valley ciénega over a period of several thousand years (Minckley and Brunelle 2007). Over the last 150 years, human land use within the watershed and ciénega caused severe erosion of the Rio San Bernardino. The incised channel lowered the water table and dried the surface of this desert wetland.

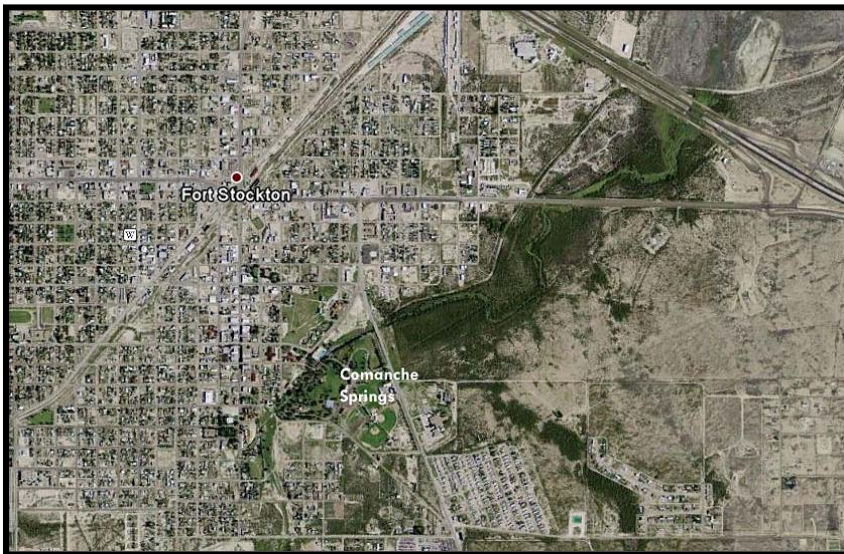


Abandoned irrigation well head at San Bernardino Ciénega.

Early visitors to Rancho San Bernardino describe several large springs at this location (Hendrickson and Minckley 1985). These may have emanated from an artesian aquifer that supplemented the adjacent alluvial aquifer and made that ciénega a permanent feature of the valley. Large artesian wells have been drilled into aquifer and diminished and rerouted the flow – first to agriculture and now a large farm pond on the Arizona side. One of the artesian wells on the Sonora side still maintains a small remnant of the ciénega.

The Arizona side of the side of the valley is now within the San Bernardino National Wildlife Refuge. The farm pond at the historic Slaughter Ranch headquarters is surrounded by manicured lawns and lacks a native wetland plant community. The pond itself, however, is a refuge for the federally endangered Chiricahua leopard frog, Yaqui chub, Gila topminnow, Yaqui beautiful shiner and Yaqui catfish. Drying of the adjacent natural ciénega caused the local extinction of many plants and animals including Wright's marsh thistle. Charles Wright first collected this thistle at San Bernardino in 1851 and it has not been collected there more recently – even in the remnant ciénega on the Sonora side (Marrs-Smith 1983; Bill Radke, Refuge Manager, personal communication 2010).

The tragic loss of most large springs and ciénegas by water withdrawals and aquifer depletion in the Chihuahuan desert of Trans-Pecos Texas is also well documented by Brune (1981), Poole and Diamond (1993), and El-Hage and Moulton (1998). Of the many dead and dying aridland springs documented by Brune (1981) one the most dramatic examples in west Texas is Comanche Springs. This cluster of springs had significant flow and supported a large wetland. The City of Fort Stockton grew up around Comanche Springs and gradually depleted



the aquifer. The death of Comanche Springs and adjoining ciénega caused the local extinction of several plants and animals including the endangered Pecos gambusia and Comanche Springs pupfish. There are extant populations of Pecos sunflower and Leoncita false foxglove at the nearby Diamond Y Spring ciénega, so it is likely these two rare ciénega plants also occurred at Comanche Springs before they stopped flowing.

Of all the southwestern states, the ciénegas of New Mexico are the least studied and documented in published literature. The following are a few examples of some historic and extant New Mexico ciénegas that have disappeared or significantly diminished.

San Simon Ciénega was one of the jewels in the crown of the southwest wetlands. It was about five miles long and a quarter mile broad wet valley bottom that straddled the New Mexico/Arizona border in the upper-most reach of the San Simon Valley of Hidalgo County, New Mexico and Cochise County, Arizona. The perennial spring-run creek had emergent marsh vegetation surrounded by wet meadow bordered with riparian woodland in sharp contrast to the adjacent Chihuahuan Desert scrub. San Simon Ciénega is now dead and being covered with *Prosopis glandulosa* Torrey (mesquite). Many dead or decadent cottonwood and willows trees are scatted along the margins as grim boundry markers for this former wetland.

The lower part of San Simon Ciénega in Arizona was destroyed just before the turn of the twentieth century by regional overgrazing of cattle and an eroded channel cut that lowered the water table (Hendrickson and Minckley 1985). The arroyo headcut was arrested by a dam near the New Mexico border and seemed to spare the New Mexican part of the ciénega. Then irrigated cotton farming moved into the Arizona side of the valley and intercepted the aquifer emanating from the Chiricahua Mountains. A file report at the New Mexico Energy, Minerals and Natural Resources Department (anonymous, no date) documents most of the following events. The spring-run creek stopped flowing in 1952, shortly after irrigated agriculture started and during severe drought. When the Mexican duck was listed as an endangered species, the New Mexico Game and Fish Department and federal Bureau of Land Management attempted to create some open-water nesting habitat in the still wet valley bottom by detonating powerful explosives. The resulting crater pools were not suitable nesting habitat, created soil conditions for weedy plants, and the valley bottom continued to dry from irrigated farming in the adjacent uplands. A nesting pond was excavated and frequently pumped full of water, but was eventually abandoned after the Mexican duck was removed from the list of endangered species for taxonomic reasons. All permanent wetlands quickly disappeared from the valley except for a couple small artesian wells on the Arizona side of the San Simon valley.

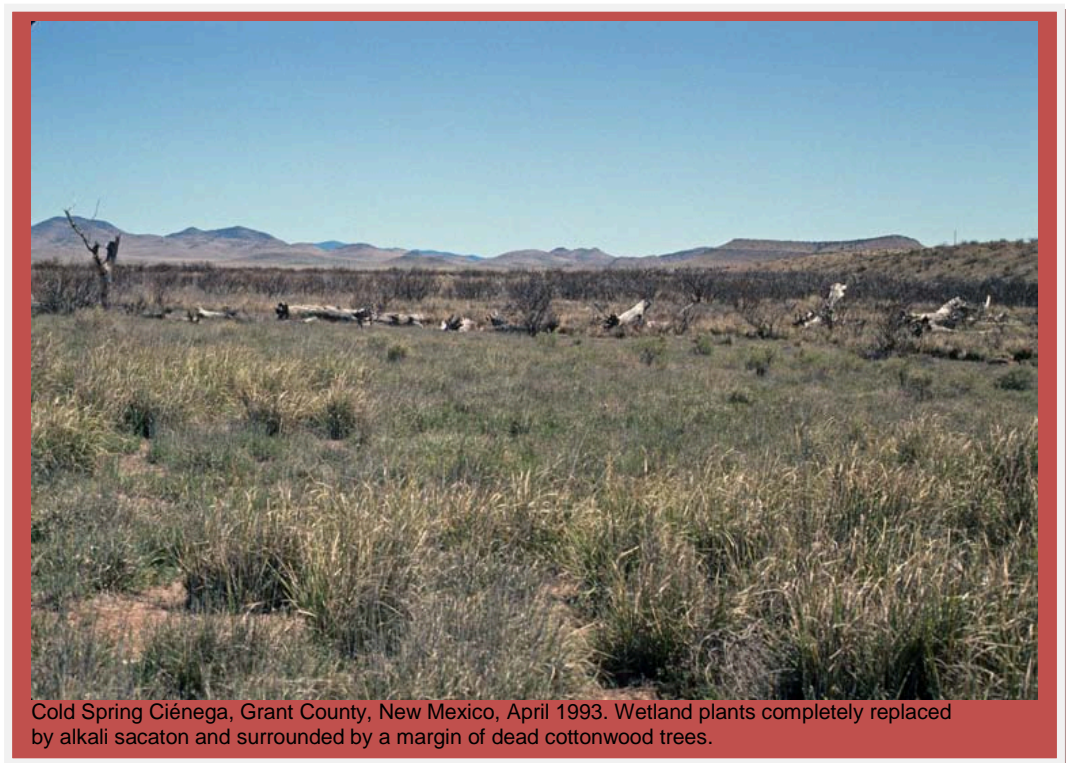


East side of San Simon Ciénega, Hidalgo County, New Mexico, April 2010. Former wetland extended from this line of cottonwood trees to the west across about ¼ mile of valley bottom.



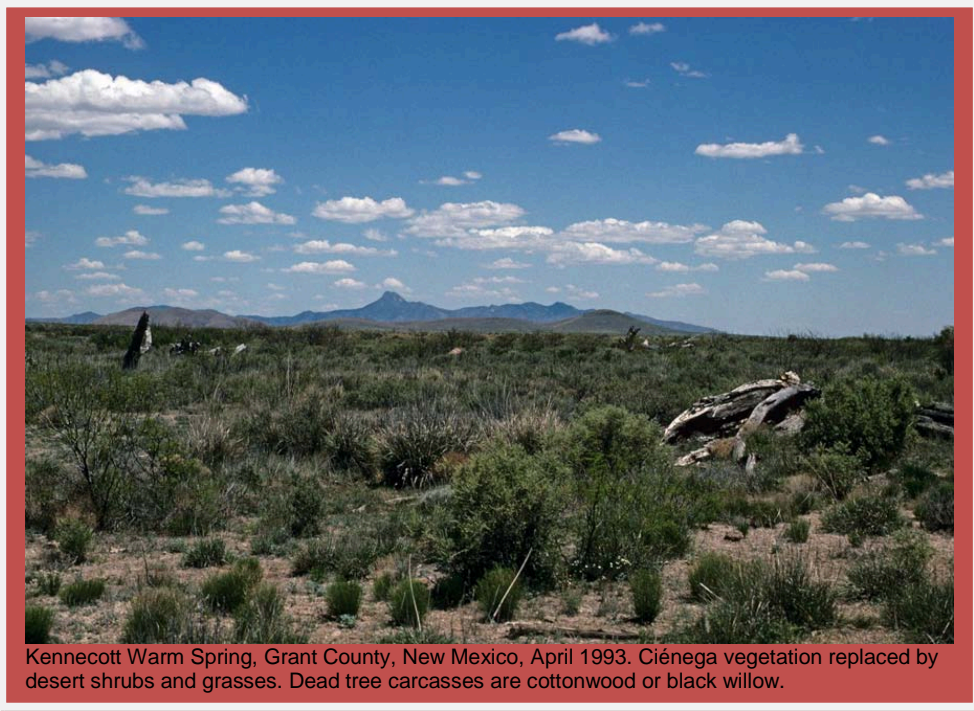
Middle of San Simon Ciénega, Hidalgo County, New Mexico, April 2010. A few old cottonwood trees on the margin are still living, but are not reproducing.

Another loss of New Mexico desert springs and ciénegas occurred at a cluster of large springs near the dry mouth of the Rio Mimbres in Grant County. The fates of Apache Tejo Spring, Cold Spring, Kennecott Warm Spring, and Kennecott Cold Spring were to be completely captured by wells to supply water to the copper mill at Hurley in the early twentieth century.



Cold Spring Ciénega, Grant County, New Mexico, April 1993. Wetland plants completely replaced by alkali sacaton and surrounded by a margin of dead cottonwood trees.

Walking from creosote desert into these former wetlands to find dusty gray organic soil supporting only clumpy alkali sacaton and surrounded by the decades-old carcasses of big cottonwood trees can only be described as shocking and depressing. Only two springs in the area remain wet to this day – Faywood Hotspring on its travertine hill with much reduced flow and no ciénega, and nearby Faywood Ciénega, which is supplemented and maintained by piped-in water from a distant upland spring. And what might we have lost from these wetlands? The type collection of *Cleome sonorae* A. Gray (= *Peritoma multicaulis*), slender spider-flower, was made “near the Mimbres” in 1851 and not seen again in New Mexico. Perhaps one of these dead spring ciénegas was the habitat for this rare wetland species



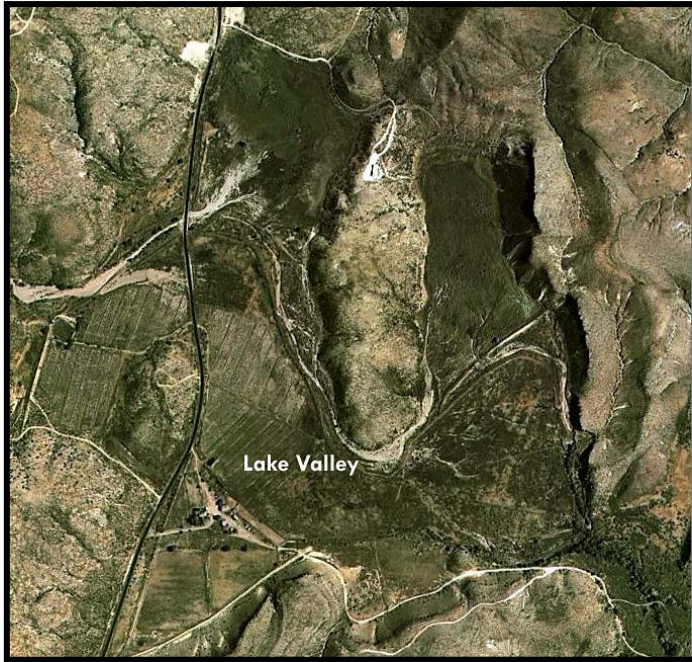
Burro Ciénega in the Burro Mountains of Grant County, New Mexico was apparently quite an oasis on 29 August 1852 when the U.S.-Mexico Boundary Commission team of surveyors came upon it. Commissioner Bartlett (1854) describes entering this desert valley and finding “a beautiful grassy meadow about three hundred yards wide, in which were many springs”. He walked up the ciénega for a mile wrote “The flat meadow-like appearance continued for a far as I could trace it...”. Bartlett named a spring in Burro Ciénega ‘Ojo de Inez’ for the Mexican girl they had rescued from the Apaches and was returning to her family in Sonora. This spring name did not persist.

Although a timeframe is not recorded, the Burro Ciénega Bartlett saw was essentially destroyed by the twentieth century from overgrazing and erosive floods that scoured the valley and caused channel down-cutting. The channel lowered the alluvial aquifer to the point where the springs and seeps in the floodplain meadows ceased to flow. Only a few seeps within the channel continued to exist. The current owners of the lower valley, Tom and Cinda Cole, are making extensive efforts to agrade the channel and restore the ciénega. Deflection and sediment trapping structures have been installed and hundreds of willow pole plantings have become trees that slow and spread flood flows across the valley bottom. A riparian forest is established, perennial flow of the spring run is restored, and the extirpated Gila topminnow

successfully introduced. Restoration of a flat grassy meadow with many springs however, may be far off in the future, but at least the water will be there.



Most New Mexicans think of Lake Valley as an abandoned mining town in Sierra County, but the original Lake Valley is three miles north of the town at Berrenda Creek. An igneous extrusion across the broad Lake Valley segment backed-up a series of seasonal marshes and



a permanent spring and seeps with ciénega vegetation. Berrenda Creek has only intermittent flow during wet seasons and storm events, but the runoff captured in Lake Valley sediments slowly discharged into a perennial spring run at the base of Lake Valley. A diversion levee around Lake Valley was constructed about a century ago that dried the wetlands, which were converted to irrigated agriculture. The diversion outlet caused the lower spring run to erode into a deeply incised channel that still supports riparian woodland, but has lost its ciénega habitats. Wright's marsh thistle was collected at Lake Valley in the early nineteen hundreds, but a recent attempt to relocate that population by the first author was unsuccessful.

SOUTHWESTERN ARIDLAND SPRING CIENEGA SURVEY

As the unique biological values aridland spring ciénegas become better understood, the need to assess the status of these wetlands is being recognized by biologists and land managers. The joint US Fish and Wildlife Service, New Mexico Forestry Division, and UNM-Natural Heritage New Mexico aridland spring ciénega survey is a two-year search for information on Southwestern aridland springs and actual field visits to those springs when possible. The first year focused upon aridland springs and identification of ciénega habitats in the State of New Mexico and the second year collecting information on spring cienegas in adjacent states.

The first phase of this study contacted New Mexico field biologists, plant ecologists, ichthyologists, and invertebrate biologists for information on desert springs and any potential ciénegas in the state. The parameters for the information request were simple any springs with marsh or wet meadow vegetation below an elevation of 6,500 feet. Surprisingly few responses were received and most of those were already known by the investigators. The only significant lead was the identification of Malpais Spring in Otero County as a significant desert wetland.

The next step was obtaining coordinates of all springs below 6,500 in the southern half of New Mexico that appear on USGS maps. Satellite imagery of each spring was viewed in an effort to detect any wetlands around them and ranked for potential of having significant wetland vegetation. A total of 51 aridland springs in southern New Mexico were ranked as moderate to high for potential ciénega habitat and worth the effort of a visit during the field assessment part of this survey. Ten county tax assessor offices were visited to determine ownership of each

spring. Unfortunately, at least 80% of springs of interest are privately owned and not readily accessible. Some private landowners have allowed us to assess their springs, but about half of the landowners contacted denied access for this survey or did not respond to a written request for access.

The private and public land aridland springs and ciénegas that were fully assessed during late summer of 2009 summer of 2011 are described in the following pages.

ROSWELL ARTESIAN BASIN CIÉNEGAS

Chaves County, New Mexico

Elevation: 3,470 – 3,490 feet

Owner: USDI-Fish & Wildlife Service, Bitter Lake NWR

33.4619°N 104.4014°W

The Pecos River valley from Bitter Lake south approximately 21 miles to the Town of Dexter was a complex series of sinkhole lakes, resurgent creeks, spring runs and vast spring seeps that combined to make one of the largest areas of aridland spring cienega in the Southwest. Most of the seeping ground is (or was) on the west side of the valley discharging from the regional aquifer of the Roswell artesian basin draining west slope including the Sacramento Mountains (Land and Huff 2010). More than half of the ciénegas on the west side of the valley have been eliminated or severely diminished by conversion to farmland, agricultural drains, and aquifer depletion by intensive irrigation water withdrawals. Fortunately, the northern Salt Creek portion of this regional aquifer passes through gypsum strata becoming less suitable for agriculture and emerging as Bitter Creek – a continuous spring run and ciénega nearly four miles long and 100-400 yards wide through Bitter Lake National Wildlife Refuge.

Bitter Lake National Wildlife Refuge: The natural ciénega at Bitter Lake NWR has been damaged or eliminated in several places by the construction of drainage channels, impoundment dikes, and subsequent inundation for waterfowl habitat. Large segments of ciénega, however, remain intact and support the greatest biological diversity of any ciénega in New Mexico. The sinkhole ponds, spring runs and marshes are renowned for having one of the largest concentrations of Odonate species in America. Threatened and endangered aquatic animals at Bitter Lake NWR include Pecos pupfish, Pecos gambusia, Mexican tetra, Roswell springsnail, Pecos assiminea, and Noel's amphipod.





Bitter Lake NWR, September 2009. Ciénega with prairie cordgrass (foreground), Pecos sunflower (yellow flowers) and young saltcedar (center) becoming established.



Bitter Lake NWR, September 2009. Ciénega with chairmaker's bulrush and Wright's marsh thistle (tall flowers).



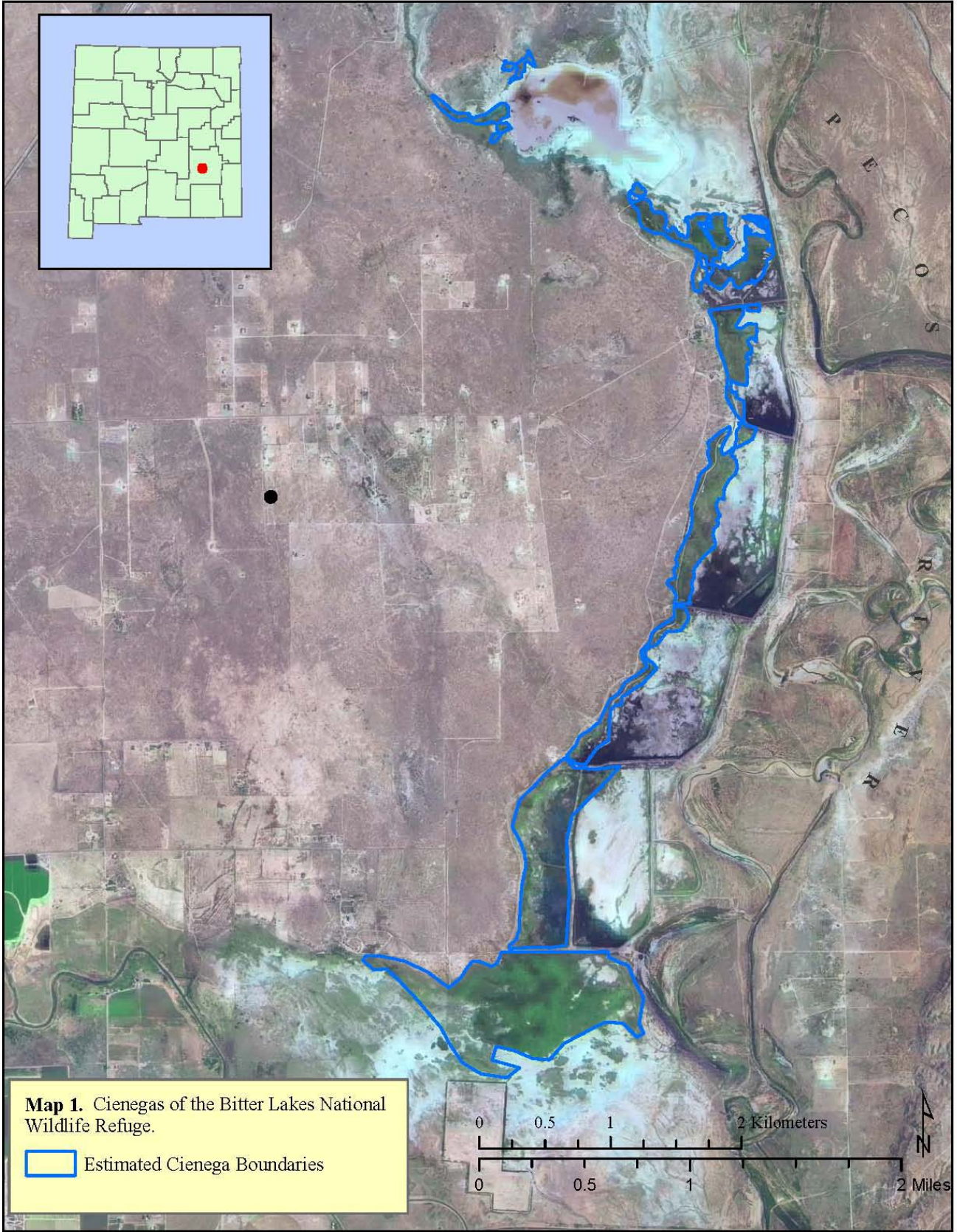
Bitter Lake NWR, September 2009. Ciénega. Leoncita false-foxglove (center) with saltgrass and saltmarsh bulrush.



Bitter Lake NWR ciénega. Pecos sunflower and Wright's marsh thistle growing in a stand of southern cattail and scratchgrass.

Plant diversity is also impressive in the Bitter Lake NWR ciénega including rare and endangered species. It supports one of the largest populations of the federally threatened Pecos sunflower, which is nearly continuous throughout the spring run and impoundment parts of the refuge consisting of a few million individuals in a good year. Bitter Lake NWR also contains several thousand individual plants of Wright's marsh thistle – the largest known population. It also has the only New Mexico population of the extremely rare Leoncita false-foxglove. The three refuge locations of Leoncita false fox-glove are only a few acres each of remnant ciénega and the only place in the world where all three rare plant species grow together in the same habitat (Sivinski 2011).

The total area of remnant natural ciénega habitat on Bitter Lake NWR is about 567 acres. The refuge and adjacent Bottomless Lakes in the Roswell Artesian Basin were designated a Ramsar Site (internationally important wetland) in 2010.





Bitter Lake NWR ciénega. Sympatry of three rare plants Leoncita false-foxglove (foreground), Wright's marsh thistle (midground), Pecos sunflower (background).



Rare color variant of Pecos sunflower that occurs at only two Spring locations on Bitter Lake NWR.

The historical refuge focus on wildlife has caused extensive damage to ciénega habitats with the numerous dikes, impoundments, diversions and drains constructed to enhance fish and waterfowl habitats – although this is recently changing with more attention being paid to rare wetland plants. There is some encroachment by non-native saltcedar into the ciénega, but this problem is mostly confined to disturbed areas and the drier margins of the wetland. Refuge managers are also concerned about the rapid expansion of common reed thickets in some parts of the ciénega, however, the common reed population consists of the native subspecies and expansion of coverage may only be indicative of a drying trend. One of the most serious management considerations at the refuge is protecting the ciénega remnants from inundation when filling waterfowl impoundments.

Changes in groundwater hydrology at Bitter Lake NWR have been thoroughly documented in the recovery plan for four endangered spring-dwelling invertebrates adopted by the New Mexico Department of Game and Fish (NMDGF) in 2005. In summary, several large spring runs and seeps in the Roswell area ceased flowing by 1931 from agricultural use and further pumping for irrigation continued to lower the regional level of groundwater until 1970. Well metering was required in the 1960s and between 1975 and 1995 groundwater levels recovered several meters to current levels. Yet the depleted springs have not resumed flowing. Surface water flows at Bitter Lake NWR were diminished by groundwater pumping however, springs there did not stop flowing through the 1950s and 1970s despite drought conditions during these decades. The State Engineer's Office hydrologist cited in the NMDGF (2005) recovery plan believes that under current pumping levels the spring flows at Bitter Lake NWR would be threatened only under extreme drought conditions exceeding those historically observed.

ROSWELL ARTESIAN BASIN CIÉNEGAS (CONTINUED)

Chaves County, New Mexico

Elevation: 4,530 – 4,590 feet

Owners: New Mexico State Parks Division

33.31488°N 104.33391°W

USDI Bureau of Land Management

33.301870°N 104.345030°W

33.26915°N 104.36353°W

USDI Fish and Wildlife Service

33.38369°N 104.42142°W

33.19419°N 104.34074°W

NM State Land Office

33.27894°N 104.35023°W

Oasis Dairy

33.31449°N 104.37120°W

Shirley Sears

33.24070°N 104.37015°W

Aside from the extensive complex of springs and ciénegas at Bitter Lake NWR the Roswell Artesian Basin has another very large wetland south of Bottomless Lakes State Park called the **Overflow Wetlands**. These wetlands spread across the east side of the Pecos River valley from the overflow of Lea Lake, a large sink hole, and other springs and seeps to the south. It extends 2.4 miles from Lea Lake to the Pecos River and occurs mostly on Bureau of Land Management (BLM) land. The northern part is mostly cattail/saltgrass marsh and the southern two-thirds is saltgrass ciénega and extensive shallow ponds of open water.

The overflow wetlands contracted and became more salty as regional irrigation pumping drew down the aquifer and the Pecos River. State monitoring of agricultural water use is allowing most of the aquifer to somewhat recover and stabilize, which is increasing discharge from the Bottomless Lakes springs and expanding the overflow wetland. This extensive wetland has a much less diverse flora than Bitter Lake and other smaller ciénegas in the area. It does have a few large patches of Pecos sunflowers in its southern half. Most of this wetland is undisturbed, except beneath an electrical transmission line where large vehicles have damaged the soil and vegetation.

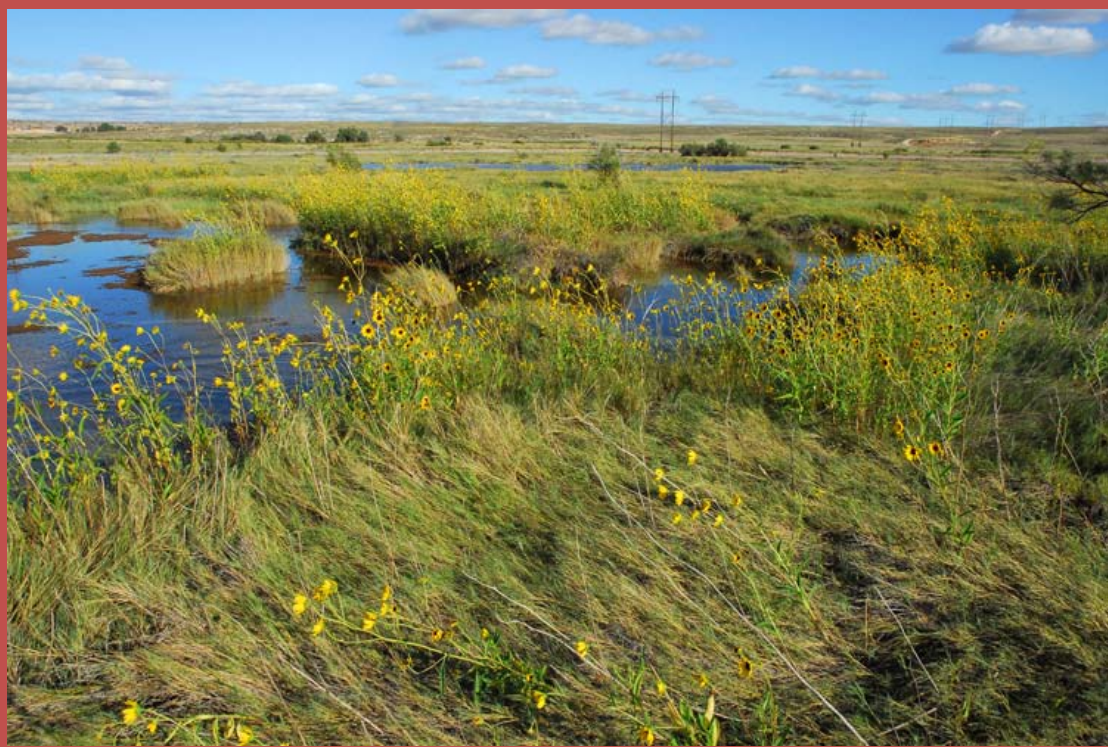
Pecos sunflowers also occur along the margins of Lea Lake in the state park and are abundant on the banks of the constructed spring run that flows from Lea Lake. Bottomless Lakes State Park has constructed a board walk with bird watching blinds along the spring run so visitors can view and enjoy the ciénega. This area of the park is significantly infested with salt cedar, which will be a perpetual maintenance problem. The less disturbed BLM part of the Overflow Wetlands has fewer salt cedar.



North end of BLM Overflow Wetlands 33.31334°N 104.34125°W is a cattail and flatgrass marsh.



Southern part of the BLM Overflow Wetlands has extensive pools of shallow open water surrounded by saltgrass ciénega.



Southern part of the BLM Overflow Wetlands with a few large patches of Pecos sunflowers.



Damage by large vehicle traffic under electrical transmission line on southern part of the BLM Overflow Wetlands.



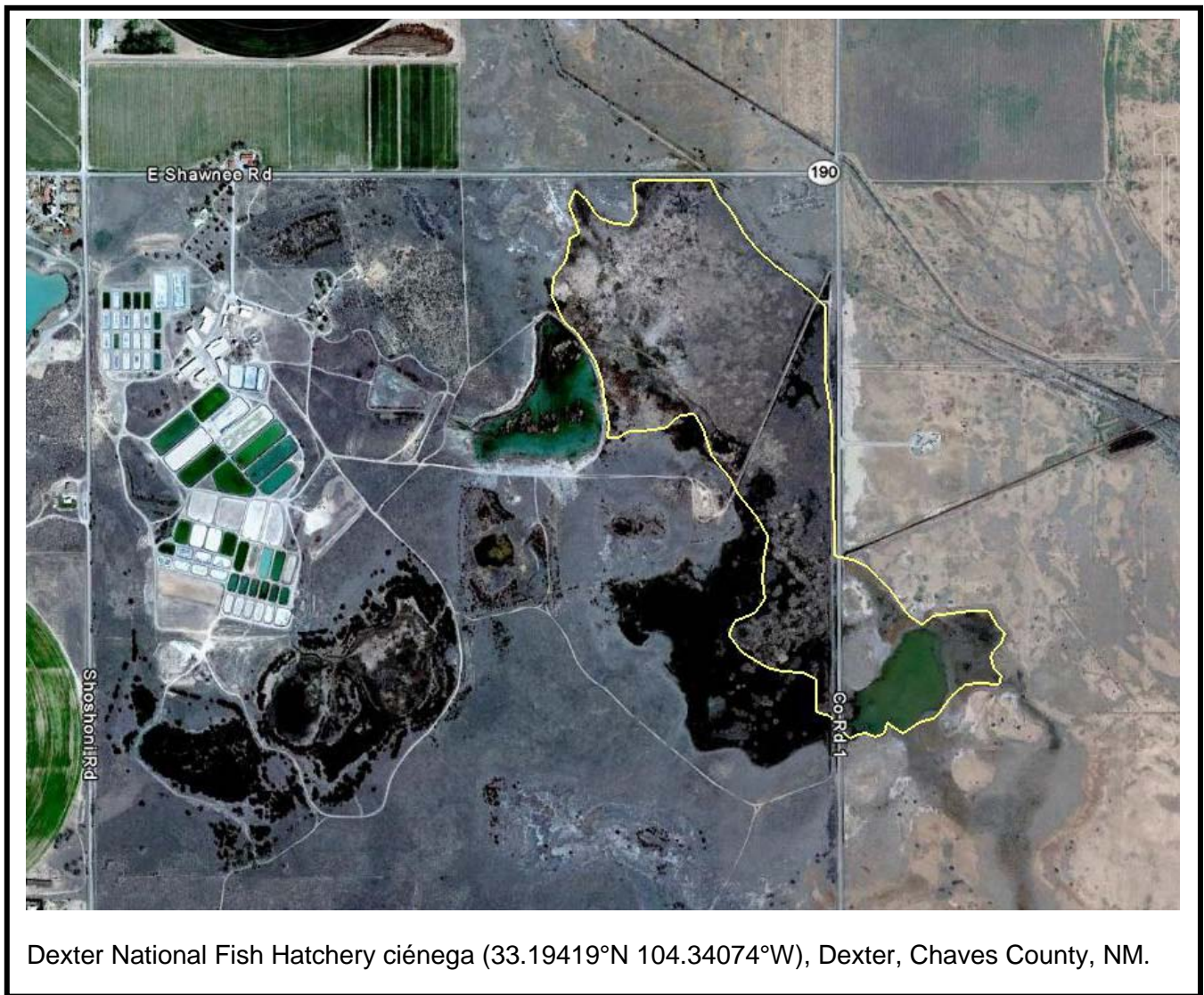
BLM Overflow Wetlands below Bottomless Lakes State Park. Lea Lake is in upper right corner and Pecos River on the left side.

Bitter Lake Farm: USDI-Fish and Wildlife Service has two additional spring ciénega habitats in the Roswell Artesian Basin. One is a small ciénega on the Bitter Lake NWR farm south of Highway 380. The up-slope portion is intact with a population of Pecos sunflowers, but the lower portion is severely impacted by dikes, impoundments and salt cedar.



Bitter Lake NWR agricultural farm ciénega (33.38369°N 104.42142°W) south of Hwy 380 and west of Pecos River.

Dexter Fish Hatchery: The other USDI-Fish and Wildlife Service ciénega along the Pecos River in Chaves County is adjacent to Dexter National Fish Hatchery. This ciénega is also severely impacted by roads, dikes, impoundments and changed hydrology. Effluent from the fish hatchery maintains some marshy places and the original size of the ciénega is unclear because the hydrology is so much changed by hatchery operations. Only one small patch of Pecos sunflowers occur at the base of the main dike.



Oasis Dairy: An unnamed spring (33.31449°N 104.37120°W) and associated large ciénega opposite Bottomless Lakes State Park west of the Pecos River had so many thousands of Pecos sunflowers in the mid-1990s they were visible in flower from the bluff above Lea Lake more two miles distant. This population is in the Oasis Dairy critical habitat designated by USDI-Fish and Wildlife Service in 2008 (FR Vol. 73, No. 63, 17762-17807). Although 2010 was a good precipitation year with wetter than normal ciénegas throughout the region (personal observations), the southern part of the Oasis Dairy ciénega was abnormally dry. The spring had ceased flowing and the vast stand of Pecos sunflowers had been replaced by the non-native weed *Kochia scoparia* (L.) Roth. Dry meadows of saltgrass were littered with thousands of dead sunflower stems that were at least two years old. Only a few hundred living Pecos sunflowers remained in the entire valley and were widely scattered among the kochia and salt cedars. Apparently, agricultural irrigation pumping has drawn down the aquifer in this area like no other place in the Roswell Artesian Basin. This large ciénega appears to be dying.



Oasis Dairy ciénega, Chaves County, NM (33.31449°N 104.37120°W), critical habitat for Pecos sunflower.



Single Pecos sunflower within thick stand of *Kochia scoparia* at Oasis Dairy ciénega in October 2010.

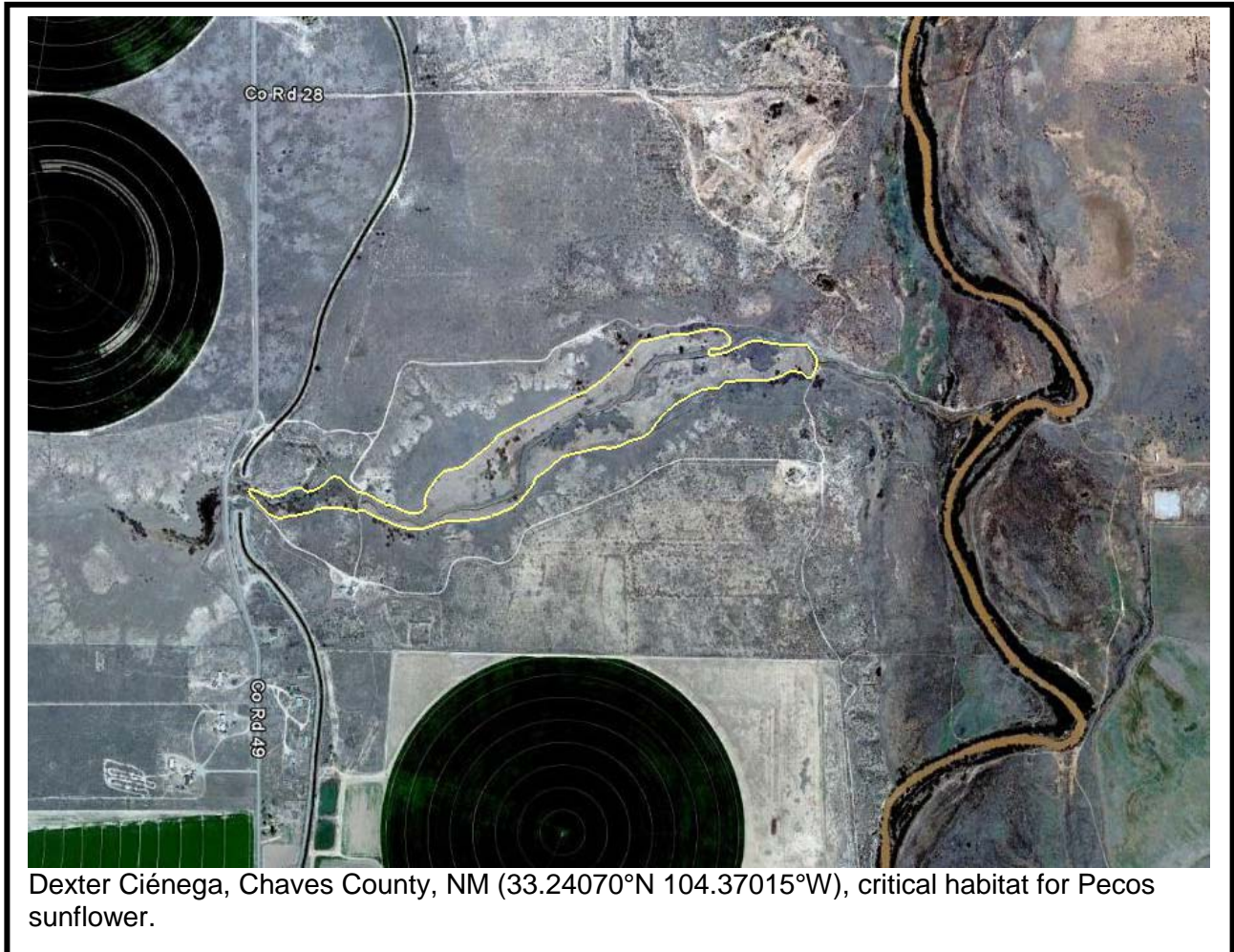


Non-native *Kochia scoparia* dominates the Oasis Dairy ciénega in October 2010. A few Pecos sunflowers are scattered within the weeds.



Saltgrass meadow in the Oasis Dairy critical habitat in October 2010. Dead gray stems of Pecos sunflower are at least two years old.

Dexter Ciénega: An unnamed spring seep 2.8 north of Dexter, New Mexico crosses beneath the Hagerman Canal and makes a 0.8 mile-long ciénega in the bottom of a narrow valley (33.24070°N 104.37015°W). This ciénega was designated critical habitat for the Pecos sunflower by USDI-Fish and Wildlife Service in 2008 (FR Vol. 73, No. 63, 17762-17807). Larger patches of Pecos sunflowers are visible in this valley from a distance, but this ciénega has not been accessible for detailed study.



Several other aridland springs on the Roswell BLM District are described in detail by Milford et al. (2001). Two of the many small ciénegas and ciénega remnants not included in that survey are worth mentioning because of the special attention they receive from the landowners.

BLM North Dexter Ciénega: Approximately 5 miles north of Dexter a spring at the head of a broad valley created a ciénega more than 1 mile long. Several decades ago, a well placed on the spring dried the ciénega and dike placed across the valley near the Pecos River. A 1994 field survey of this valley found only two Pecos sunflowers among the salt cedars in the impounded area (Sivinski 1995b). BLM purchased the land with the impoundment and began removing the salt cedars. The remnant ciénega below the impoundment is relatively dry and marginal for Pecos sunflower. In 2010 however, several hundred sunflowers flowered and made seed there indicating this ciénega remnant is still hanging on.



BLM North Dexter Ciénega (Lower left corner 33.26915°N 104.36353°W) and State Land Office Sinkhole (upper right corner 33.27894°N 104.35023°W).

State Land Office SinkHole: In the mid-1990s a new sinkhole opened in a small ciénega on the east side of the Pecos River and south of Bottomless Lakes State Park. The sinkhole made the site wetter and is located on State Trust Land (33.27894°N 104.35023°W). The State Land Office obtained seed from the Oasis Dairy population and introduced it to their sinkhole ciénega. This is a relatively small habitat, but by the summer of 2010 there were a few thousand Pecos sunflowers at this location.



Pecos sunflowers persisting in marginal habitat of alkali sacaton and saltgrass on BLM North Dexter ciénega in early September 2010.



Pecos sunflowers well-established at State Land Office Sinkhole in early September 2010.

Roswell Artesian Basin Ciénega Plant Species List

*Indicates non-native species

FERNS AND FERN ALLIES

Equisetaceae - Horsetail Family

Equisetum hyemale L. ROUGH HORSETAIL

Pteridaceae – Maiden-hair Fern Family

Adiantum capillus-vernus L.; SOUTHERN MAIDEN-HAIR

ANGIOSPERMS – Dicotyledonous Plants

Aizoaceae-Carpetweed Family

Sesuvium verrucosum Raf.; WESTERN SEA-PURSLANE

Apiaceae – Parsley Family

Berula erecta (Hudson) Cov.; WATER-PARSNIP

Apocynaceae - Dogbane Family

Apocynum cannabinum L.; INDIAN HEMP

Asclepiadaceae - Milkweed Family

Asclepias speciosa Torr.; SHOWY MILKWEED

Asteraceae - Aster Family

Ambrosia psilostachya DC.; PERENNIAL RAGWEED

Baccharis salicina Torr. & Gray; GREAT PLAINS SEEP-WILLOW

Chloracantha spinosa (Benth.) Nesom; MEXICAN DEVILWEED

Cirsium wrightii A. Gray; WRIGHT'S MARSH-THISTLE

Conyza canadensis (L.) Cronq.; CANADIAN HORSEWEED; BH-1 PD-1

Crepis runcinata (James) Torr. & Gray subsp. *glauca* (Nutt.) Babcock & Stebbins; FIDDLE-LEAF
HAWK'S BEARD

Euthamia occidentalis Nutt.; WESTERN GOLDENTOP

Flaveria campestris J.R. Johnst.; ALKALI YELLOWTOPS

Flaveria chlorifolia A. Gray; CLASPING YELLOWTOPS

Helianthus paradoxus Heiser; PECOS SUNFLOWER

Hymenoxys odorata DC. POISON RUBBERWEED

Isocoma pluriflora (Torr. & Gray) Greene; SOUTHERN JIMMYWEED

Pseudoclasia arenaria Rydb.; CLAPDAISY

**Sonchus asper* (L.) Hill; SPINY-LEAF SOW-THISTLE

Symphyotrichum ericoides (L.) Nesom; HEATH ASTER

Symphyotrichum subulatum (Michx.) Nesom var. *ligulatum* (Shinners) Sund.; NEW MEXICO
ASTER

Xanthium strumarium L.; COCKLEBUR

Brassicaceae – Mustard Family

Rorippa sinuata (Nutt.) Hitchc; CREEPING YELLOW-CRESS

Chenopodiaceae - Goosefoot Family

Allenrolfea occidentalis (S. Wats.) Kuntze; IODINEBUSH

Atriplex argentea Nutt.; SILVERSCALE
**Bassia hyssopifolia* (Pall.) O. Ktze.; SMOTHERWEED
**Chenopodium album* L.; LAMB'S QUARTER
**Kochia scoparia* (L.) Schrad.; KOCHIA
Sarcocornia utahensis (Tidestr.) Scott; UTAH GLASSWORT
Salicornia rubra A. Nels.; RED SALTWORT
Suaeda calceoliformis (Hook.) Moquin; LOW SEEPWEED

Convolvulaceae - Morning Glory Family

Cressa truxillensis H.B.K.; ALKALI-WEED

Elaeagnaceae - Oleaster Family

**Elaeagnus angustifolia* L.; RUSSIAN OLIVE

Fabaceae - Pea Family

Glycyrrhiza lepidota (Nutt.) Pursh; AMERICAN LICORICE
**Melilotus albus* Medicus; WHITE SWEET-CLOVER

Gentianaceae - Gentian Family

Eustoma exaltatum (L.) Salisbury ex G. Don; PRAIRIE GENTIAN

Malvaceae – Mallow Family

Malvella leprosa (Ortega) Krapovickas; ALKALI MALLOW

Moraceae – Mulberry Family

**Morus alba* L.; WHITE MULBERRY

Oleaceae - Olive Family

Forestiera pubescens Nutt.; NEW MEXICO OLIVE

Onagraceae - Evening Primrose Family

Gaura mollis James; VELVET-WEED

Plumbaginaceae - Plumbago Family

Limonium limbatum Small; SOUTHWESTERN SEA LAVENDER

Polygonaceae - Buckwheat Family

Rumex altissimus Wood; PALE DOCK

Primulaceae - Primrose Family

Samolus ebracteatus H.B.K. var. *cuneatus* (Small) Henrickson; LIMEY BROOKWEED

Rosaceae – Rose Family

Potentilla anserina L.; SILVERWEED

Salicaceae - Willow Family

Populus deltoides Bartram ex H. Marshall subsp. *wislizeni* (S. Wats.) Echenw.; RIO GRANDE
COTTONWOOD
Salix exigua Nutt.; COYOTE WILLOW

Sapindaceae – Soapberry Family

Sapindus drummondii Hook. & Arn.; SOAPBERRY

Sauruaceae – Lizardtail Family

Anemopsis californica (Nutt.) Hook. & Arn.; YERBA MANZA

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

Ulmaceae - Elm Family

**Ulmus pumila* L.; SIBERIAN ELM

Vitaceae – Grape Family

Parthenocissus vitacea (Knerr) A.S. Hitchc.; THICKET CREEPER

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Bolboschoenus maritimus (L.) Palla; SALTMARSH BULRUSH

Cyperus esculentus L.; YELLOW NUTSEGE

Eleocharis palustris (L.) Roemer & Schultes; MARSHY SPIKE-RUSH

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Fimbristylis puberula (Michx.) Vahl var. *interior* (Britt.) Kral; HAIRY FIMBRY

Schoenoplectus acutus (Muhl. ex Bigelow) A. & D. Löve; HARDSTEM BULRUSH

Schoenoplectus americanus (Pers.) Volk ex Schinz & R. Keller; CHAIRMAKER'S BULRUSH

Schoenoplectus pungens (Vahl) Palla var. *longispicatus* (Britt.) S.G. Smith; THREE-SQUARE BULLRUSH

Juncaceae - Rush Family

Juncus arcticus Willd. var. *mexicanus* (Willd.) Balslev; MEXICAN RUSH

Juncus torreyi Coville; TORREY'S RUSH

Juncaginaceae – Arrowgrass Family

Triglochin maritimum L.; SEASIDE ARROWGRASS

Liliaceae - Lily Family

**Asparagus officinalis* L.; ASPARAGUS

Poaceae - Grass Family

**Cynodon dactylon* (L.) Pers.; BERMUDAGRASS

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

Echinochloa muricata Beauv.) Fern.; COCKSPUR

Elymus canadensis L.; CANADA WILD RYE

Elymus smithii (Rydb.) Gould; WESTERN WHEATGRASS

Hordeum jubatum L.; FOXTAIL BARLEY

Hordeum pusillum Nutt.; LITTLE BARLEY

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Panicum obtusum H.B.K.; VINE MESQUITE

Panicum virgatum L.; SWITCHGRASS

Paspalum distichum L.; KNOTGRASS
Phragmites australis (Cav.) Steud.; COMMON REED
**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS
**Setaria magna* Griseb.; GIANT FOXTAIL
**Sorghum halepense* (L.) Pers.; JOHNSONGRASS
Sphenopholis obtusata (Michx.) Scribn.; PRAIRIE WEDGESCALE
Spartina pectinata Link.; PRAIRIE CORDGRASS
Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

Potamogetonaceae – Pondweed Family

Potamogeton pectinatus L.; SAGO PONDWEED

Ruppiaceae – Ditch-grass Family

Ruppia cirrhosa (Petagna) Grande; SPIRAL DITCH-GRASS

Typhaceae - Cattail Family

Typha domingensis; SOUTHERN CATTAIL

**Typha angustifolia* L.; NARROWLEAF CATTAIL

SANTA ROSA CIÉNEGAS

Guadalupe County, New Mexico

Elevation: 4,530 – 4,590 feet

Owners: New Mexico Forestry Division

34.9339°N 104.6750°W

City of Santa Rosa

34.9426°N 104.6762°W

34.9260°N 104.6727°W

34.9243°N 104.6639°W

34.9295°N 104.6791°W

Santa Rosa Country Club

34.9292°N 104.6681°W

Canuto Sanchez, Jr.

34.9386°N 104.6763°W

34.9144°N 104.6800°W

Virginia Freeman

34.9200°N 104.6690°W

Lady Hawk – Agua Negra Ranch

34.9079°N 104.6690°W

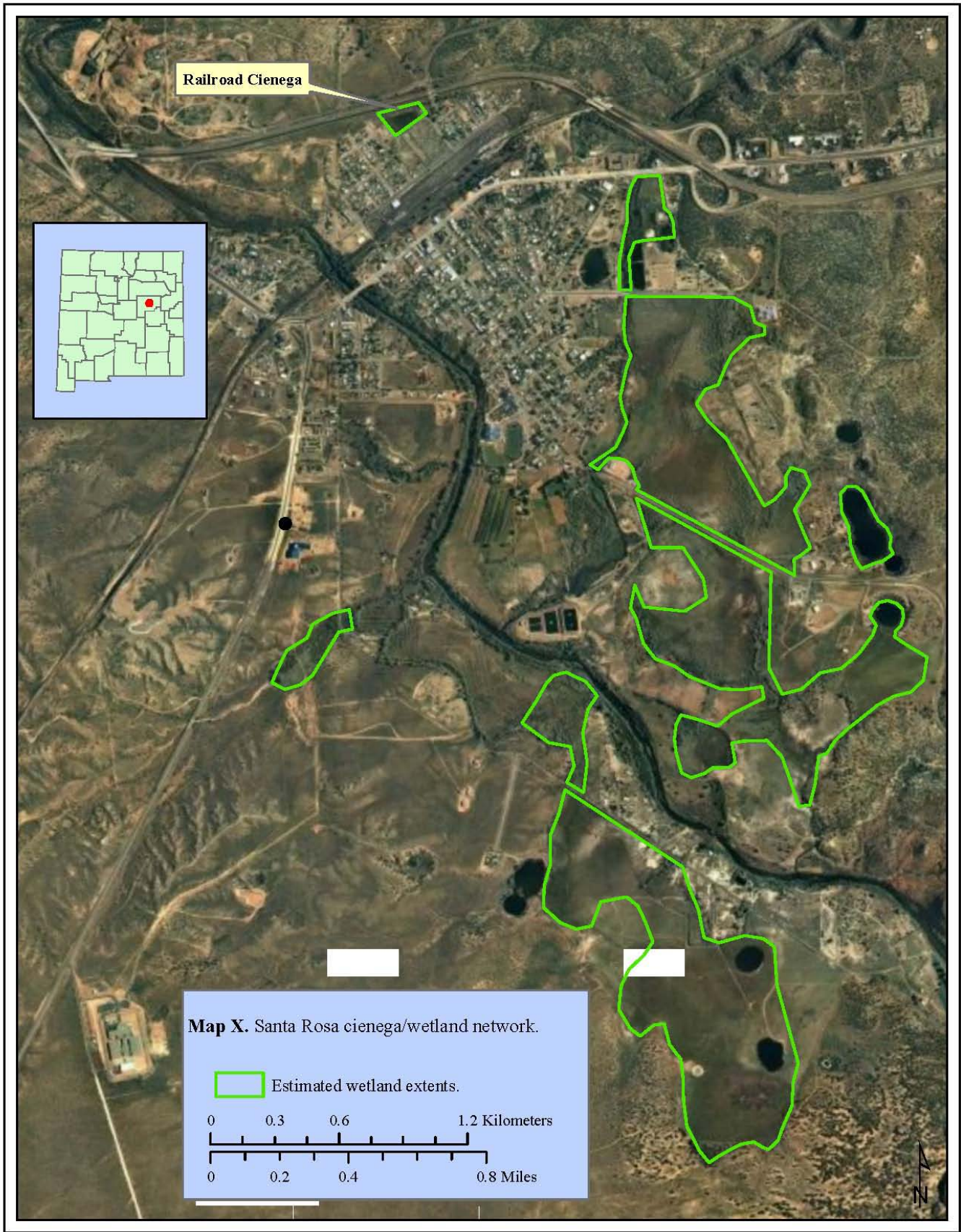
Albert Campos

34.9251°N 104.6927°W

The Santa Rosa area in Guadalupe County, New Mexico is well known among scuba divers for its Karst topography of numerous deep, spring-fed sinkholes. The fact that the Town of Santa Rosa sits within much of the last, best, aridland spring ciénega habitat in New Mexico is less well known. Relatively large expanses of state, municipal and private property in Santa Rosa consist of permanent ciénegas and the sinkhole lakes are ringed with excellent examples of fresh water and alkaline marshlands.

The Santa Rosa sink region lies within the Rio Pecos valley of east-central New Mexico at an elevation of about 1,400 meters. Santa Rosa and Blue Hole Spring, occur near the northeast edge of a six-mile-wide sink caused by the dissolution of the underlying San Andres limestone and gypsum and the collapse of the overlying Santa Rosa Sandstone (Kelley 1972). The strata dip to the east and water passing through the soluble layers comes to the surface in the sink creating numerous seeps and springs. Large springs, like Blue Hole Spring, are uncommon. The groundwater of this regional sink usually comes up in broad-area seeps that cause most of the soils to be saturated to the surface or root-zone. The Rio Pecos has cut through the sink probably at its deepest point (i.e., the deepest level of the dipping San Andres limestone), near its eastern edge. Within the Santa Rosa sink itself are smaller subsidence features, including six sink holes that fill with water and become small lakes.

There are no known endemic animals in the Santa Rosa wetlands, however, the invertebrate fauna has not been inventoried. Odonates are common and diverse. Some of the lakes and spring runs are occupied by native fishes including green sunfish (*Lepomis cyanellus*), roundnose minnow (*Dionda episcopa*), plains killifish (*Fundulus zebrinus*) and western mosquitofish (*Gambusia affinis*).





Santa Rosa, Blue Hole Spring – a small sinkhole spring developed for recreation.



Bass Lake Spring (34.9142°N 104.6802°W). Many Santa Rosa springs are unnamed, large area seeps that may or may not gather into spring runs. Their permanently soggy soils are covered with beaked spikerush (foreground) and chairmaker's bulrush (midground). Non-native Russian olive and saltcedar (background) occur in the wetland margins.



Some Santa Rosa springs, large and small, are elevated by the deposition of spring deposits – a gypsiferous limestone sand and silt. This view is from a large un-named spring (34.9260°N 104.6708°W) southwest of the Armory looking north – downslope.

The ciénegas of the Santa Rosa sink are among the most botanically diverse wetlands in the Southwest. Ciénega types vary with soil hydrology, texture and chemistry. The drier (subirrigated) and more alkaline soils are covered with alkali sacaton, saltgrass, alkali muhly, and Baltic rush. Soils deposited by spring seeps cover large areas with wet travertine sand that support a tall-grass prairie community with plants that are disjunct from the Great Plains region further east. This tall-grass association is predominantly Indiangrass, tall dropseed, switchgrass, hairy fimbry, and includes other plants typical of eastern prairies.

Some parts of the Santa Rosa sink ciénegas have dense and sparse patches of the threatened Pecos sunflower. The 116-acre Blue Hole Ciénega Nature Preserve has the largest stand of sunflowers in the Santa Rosa area. Blue Hole Ciénega is owned by the New Mexico Forestry Division and is designated as critical habitat for Pecos sunflower. There are several other smaller patches of Pecos sunflower in the Santa Rosa ciénegas. The municipal fishing ponds (old fish hatchery) and an un-named spring on the west side of the Pecos River are also designated as critical habitat.

Wright's marsh thistle is also scattered throughout the Santa Rosa sink where ever there are permanently soggy soils in the ciénegas. Most patches occur in the wettest ciénegas on the east side of the Pecos River where there are a few thousand thistles. Thus far, only one small patch of fewer than 100 Wright's marsh thistles is known on the west side in the ciénega below Bass Lake Spring.

A third very rare plant species in the Santa Rosa sink is the Great Plains ladies-tresses orchid (*Spiranthes magnicamporum*). This orchid is uncommon, but widespread throughout the Great Plains of central North America and has an unusual disjunction to the ciénegas of north-

central New Mexico. Fewer than 50 individuals have been found in the Santa Rosa ciénegas and almost half of those were eliminated by sidewalk construction near Blue Hole Spring and a parking area at the new baseball park. This orchid is listed as endangered by the State of New Mexico.



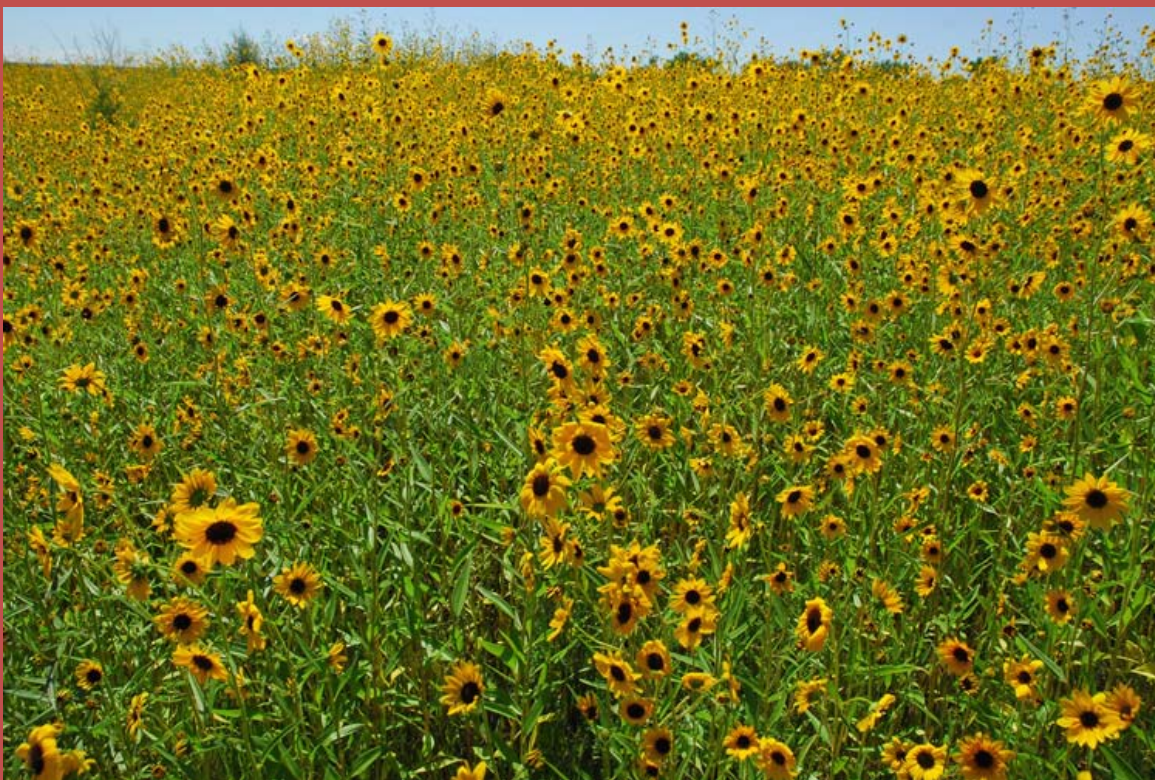
Santa Rosa, city land. Alkaline, subirrigated ciénega with alkali sacaton, saltgrass and Baltic rush. Young Russian olive trees (background) are increasing in cover and extent throughout the area.



Blue Hole Ciénega Nature Preserve. Ciénega with tall-grass prairie of Indiangrass and tall dropseed. White flowers are heath aster and yellow are clasping yellowtops.



Panorama of Pecos sunflower population at Blue Hole Ciénega in September 2004.



Some large Pecos sunflower patches at Blue Hole Ciénega are very dense and contain several hundred thousand individuals. September 2009.



Wright's marsh thistle beginning to bolt in the ciénega south of the new baseball park. August 2009.



Great Plains ladies-tresses orchid at Blue Hole Ciénega. Right photo September 2010.

Fortunately the spring waters of the Santa Rosa sink are very high in dissolved solids (sulfate and carbonate salts) and are unsuitable for municipal use. The City of Santa Rosa gets its municipal water from a different aquifer many miles to the west and does not threaten the aquifer that creates the Santa Rosa ciénegas. However, there have been, and still are, serious impacts to these ciénegas that both diminish and destroy them. Governments have played a leading role. New Mexico Department of Game and Fish excavated many acres of fish hatchery ponds into the ciénega west of Blue Hole Spring. When these ponds were abandoned, Department of Game and Fish excavated many additional acres of ciénega below the Rock Lake sinkhole for a new Fish Hatchery. Nearly all of the ciénega immediately adjacent to Blue Hole Spring has been replaced by roads, parking lots, buildings, playing fields, and fishing ponds constructed and maintained by the City of Santa Rosa. The City has also eliminated or degraded many acres of ciénega with roads, parking areas and recreational facilities at the Power Dam, Park Lake and Perch Lake municipal parks. Most recently, a large municipal baseball park and parking area was constructed on City-owned ciénega. State and county transportation departments have also built several roads across Santa Rosa ciénegas including Highway 91, Reilly Road, Blue Hole Road, and River Road.



New Santa Rosa Baseball Park constructed on ciénega. Playing field sod is proving difficult to establish on the wet, highly alkaline soil.

Private landowners have also taken a significant toll on the Santa Rosa ciénegas. Many acres of ciénega below Perch Lake and a few acres of Blue Hole Cienega were plowed and planted with an exotic pasture grass, meadow fescue (*Festuca pratensis*), before those ciénegas were acquired by the City and the State respectively. This tenacious non-native grass is persisting as a dense cover almost to the exclusion of native ciénega plants and is actually less palatable to livestock than the native forage. The disturbed soils of these planted pastures are also more susceptible to exotic tree infestation.

The Santa Rosa ciénegas have been intensively grazed by livestock for more than a century. Ranchers have rerouted many spring runs, dug conveyance ditches, and damaged springs in an effort drain bogs and spread water to drier areas. These actions have changed parts of ciénega hydrology and encouraged proliferation of exotic trees on the disturbed soils.



Large ciénega below Perch Lake planted with exotic meadow fescue and becoming infested with Russian olive trees.



Large un-named spring mound (34.9253°N 104.6739°W) near baseball park with side torn out to direct flow to conveyance ditches.



Ciénega cut and fill to redirect the Bass Lake Spring run along River Road. Bare soil and new microrelief may be suitable habitat for Pecos sunflower, but will also encourage exotic tree infestation.



Blue Hole Cienega, Russian olive forest in 2003 prior to exotic tree eradication efforts. By 2009 these trees were gone and the Pecos sunflower density dramatically increased.

Exotic Russian olive and, to a lesser extent, saltcedar trees are the most pernicious influence on the Santa Rosa ciénegas. Tall, dense forests of Russian olive have taken over large areas of ciénega in just the last 40 years and would convert most of the Santa Rosa sink to woodland in the absence of costly remediation. For the last five years, the State of New Mexico, City of Santa Rosa, and some private landowners have been clearing dense stands of Russian olive to restore the ciénega to its natural, treeless condition. These exotic trees are very difficult to kill. Follow-up treatments of crown and root sprouts must occur for several years and active elimination of new seedlings must be perpetual. On the Blue Hole Ciénega Nature Preserve, restoration costs over the last four years have almost equaled the purchase price of the property. Institutional dedication and long-term commitment are needed to ensure this ciénega does not revert to an exotic tree woodland.

Plant List for Santa Rosa Ciénegas

*Indicates non-native species

FERNS AND FERN ALLIES

Equisetaceae - Horsetail Family

Equisetum laevigatum A. Br. SMOOTH SCOURING RUSH

Pteridaceae – Maiden-hair Fern Family

Adiantum capillus-vernus L.; SOUTHERN MAIDEN-HAIR

ANGIOSPERMS – Dicotyledonous Plants

Apiaceae – Parsley Family

Berula erecta (Hudson) Cov.; WATER-PARSNIP

Apocynaceae - Dogbane Family

Apocynum cannabinum L.; INDIAN HEMP

Asclepiadaceae - Milkweed Family

Asclepias incarnata L. subsp. *incarnata*; SWAMP MILKWEED

Asclepias speciosa Torr.; SHOWY MILKWEED

Asteraceae - Aster Family

Ambrosia psilostachya DC.; PERENNIAL RAGWEED

Baccharis salicina Torr. & Gray; GREAT PLAINS SEEP-WILLOW

Cirsium wrightii A. Gray; WRIGHT'S MARSH-THISTLE

Conyza canadensis (L.) Cronq.; CANADIAN HORSEWEED; BH-1 PD-1

Crepis runcinata (James) Torr. & Gray subsp. *glauca* (Nutt.) Babcock & Stebbins; FIDDLE-LEAF
HAWK'S BEARD

Euthamia occidentalis Nutt.; WESTERN GOLDENTOP

Flaveria campestris J.R. Johnst.; ALKALI YELLOWTOPS

Flaveria chlorifolia A. Gray; CLASPING YELLOWTOPS

Helenium autumnale L. var. *montanum* (Nutt.) Fern.; FALL SNEEZEWEED

Helianthus paradoxus Heiser; PECOS SUNFLOWER

Isocoma pluriflora (Torr. & Gray) Greene; SOUTHERN JIMMYWEED

Pseudoclasia arenaria Rydb.; CLAPDAISY

Pyrrhopappus pauciflorus (D. Don) DC.; FALSE DANDYLION

Solidago canadensis L.; CANADA GOLDENROD

**Sonchus asper* (L.) Hill; SPINY-LEAF SOW-THISTLE

Symphyotrichum ericoides (L.) Nesom; HEATH ASTER

Boraginaceae – Borage Family

Heliotropium curassavicum (Nutt.) A. Gray; SEASIDE HELIOTROPE

Brassicaceae – Mustard Family

**Nasturtium officinale* R.Br.; WATERCRESS

Campanulaceae - Harebell Family

Lobelia cardinalis L.; CARDINAL-FLOWER

Chenopodiaceae - Goosefoot Family

Allenrolfea occidentalis (S. Wats.) Kuntze; IODINEBUSH

**Bassia hyssopifolia* (Pall.) O. Ktze.; SMOTHERWEED

**Chenopodium glaucum* L.; OAK-LEAF GOOSEFOOT

**Kochia scoparia* (L.) Schrad.; KOCHIA

Suaeda calceoliformis (Hook.) Moquin; LOW SEEPWEED

Convolvulaceae - Morning Glory Family

**Convolvulus arvensis* L.; FIELD BINDWEED

Elaeagnaceae - Oleaster Family

**Elaeagnus angustifolia* L.; RUSSIAN OLIVE

Fabaceae - Pea Family

Glycyrrhiza lepidota (Nutt.) Pursh; AMERICAN LICORICE

**Melilotus officinalis* (L.) Lam.; YELLOW SWEET-CLOVER

Gentianaceae - Gentian Family

Eustoma exaltatum (L.) Salisbury ex G. Don; PRAIRIE GENTIAN

Grossulariaceae – Gooseberry Family

Ribes aureum Pursh var. *villosum* DC.; BUFFALO CURRANT

Moraceae – Mulberry Family

**Morus alba* L.; WHITE MULBERRY

Onagraceae - Evening Primrose Family

Ludwigia repens Forst.; WATER PRIMROSE

Oenothera curtiflora Wagner & Hoch; VELVET-WEED

Plumbaginaceae - Plumbago Family

Limonium limbatum Small; SOUTHWESTERN SEA LAVENDER

Polygonaceae - Buckwheat Family

**Polygonum lapathifolium* L.; DOCK-LEAF SMARTWEED

Rumex altissimus Wood; PALE DOCK

Primulaceae - Primrose Family

Samolus valerandi L.; SEA-SIDE BROOKWEED

Rosaceae – Rose Family

Potentilla anserina L.; SILVERWEED

Salicaceae - Willow Family

Populus deltoides Bartram ex H. Marshall subsp. *wislizeni* (S. Wats.) Echenw.; RIO GRANDE
COTTONWOOD

Salix exigua Nutt.; COYOTE WILLOW

Sauruaceae – Lizardtail Family

Anemopsis californica (Nutt.) Hook. & Arn.; YERBA MANZA

Solanaceae – Nightshade Family

Solanum elaeagnifolium Cav.; SILVERLEAF NIGHTSHADE

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

Ulmaceae - Elm Family

**Ulmus pumila* L.; SIBERIAN ELM

Vitaceae – Grape Family

Parthenocissus vitacea (Knerr) A.S. Hitchc.; THICKET CREEPER

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Cladium californicum (S. Wats.) O'Neill; CALIFORNIA SAWGRASS

Cyperus odorata L.; RUSTY FLATSEDE

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Fimbristylis puberula (Michx.) Vahl var. *interior* (Britt.) Kral; HAIRY FIMBRY

Schoenoplectus acutus (Muhl. ex Bigelow) A. & D. Löve; HARDSTEM BULLRUSH

Schoenoplectus americanus (Pers.) Volk ex Schinz & R. Keller; CHAIRMAKER'S BULLRUSH

Schoenoplectus pungens (Vahl) Palla var. *longispicatus* (Britt.) S.G. Smith; THREE-SQUARE BULLRUSH

Iridaceae – Iris Family

Sisyrinchium montanum Greene; MOUNTAIN BLUE-EYED-GRASS

Juncaceae - Rush Family

Juncus arcticus Willd. var. *balticus* (Willd.) Trautvetter; BALTIC RUSH

Juncus torreyi Coville; TORREY'S RUSH

Juncaginaceae – Arrowgrass Family

Triglochin maritimum L.; SEASIDE ARROWGRASS

Liliaceae - Lily Family

**Asparagus officinalis* L.; ASPARAGUS

Orchidaceae – Orchid Family

Epipactis gigantea Dougl. ex Hook.; GIANT HELLEBORINE

Spiranthes magnicamporum Sheviak; GREAT PLAINS LADIES-TRESSES

Poaceae - Grass Family

**Agrostis gigantea* Roth; REDTOP

**Arundo donax* L.; GIANT REED

**Bromus catharticus* Vahl; RESCUE GRASS

**Cynodon dactylon* (L.) Pers.; BERMUDAGRASS

Dichanthelium acuminatum (Sw.) Gould & Clark; SLIMLEAF ROSETTEGRASS

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

Elymus canadensis L.; CANADA WILD RYE
Elymus trachycaulis (Link) Gould ex Shinnars; SLENDER WHEATGRASS
**Festuca pratensis* Huds.; MEADOW FESCUE
Hordeum jubatum L.; FOXTAIL BARLEY
Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS
Panicum capillare L.; WITCHGRASS
Panicum obtusum H.B.K.; VINE MESQUITE
Panicum virgatum L.; SWITCHGRASS
Phragmites australis (Cav.) Steud.; COMMON REED
Poa arida Vasey; PLAINS BLUEGRASS
**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS
**Sorghum halepense* (L.) Pers.; JOHNSONGRASS
Sorghastrum nutans (L.) Nash; INDIANGRASS
Spartina pectinata Link.; PRAIRIE CORDGRASS
Sporobolus airoides (Torr.) Torr.; ALKALI SACATON
Sporobolus compositus (Poiret) Merrill; TALL DROPSEED

Ruppiaceae – Ditch-grass Family

Ruppia cirrhosa (Petagna) Grande; SPIRAL DITCH-GRASS

Typhaceae - Cattail Family

Typha domingensis; SOUTHERN CATTAIL

Typha latifolia L.; BROADLEAF CATTAIL

MALPAIS SPRING CIÉNEGA

Otero County, New Mexico

White Sands Missile Range

Elevation: 4,130 feet

Owner: U.S. Department of Defense

33.2786°N 106.3101°W


Malpais Spring gushes from the southern terminus of the Carrizozo lava flow into the Tularosa Basin, which is a blind intermountain basin with no outlet. The spring water spreads across the flat basin floor wetting about 400 acres of salty, gypseous soil creating salt marsh and large areas covered by typical ciénega plants.

In the early twentieth century this large spring was captured in a conveyance ditch that took the water several miles south to irrigate farmland. The natural spring run that ran water about one mile to southwest and watered over 300 acres of salt marsh/ciénega was dried up and about 95% of the original wetland ecosystem eliminated. When the federal government acquired the land as a military reservation, the irrigation ditch was breached near the spring source allowing the water to flood the basin again. The breach, however, did not return the water to the original spring run so a large new area of ciénega was created closer to the spring.

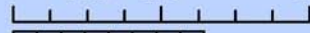
The spring run and many acres of shallow lake and emergent salt marsh are habitat for the largest population of the threatened White Sands pupfish, which is endemic to the Tularosa Basin. *Vesiculovirus* 'Malpais Spring virus' is also endemic to this location. It is carried by two mosquito species in the Malpais Spring wetland and infects indigenous mule deer and pronghorn and exotic gemsbok (Clark et al. 1988). No endemic or especially rare plant species were found in the 2009 field survey of the Malpais Spring wetland, but what this place lacks in species diversity – it makes up in importance as a vast area of rare ecosystem.



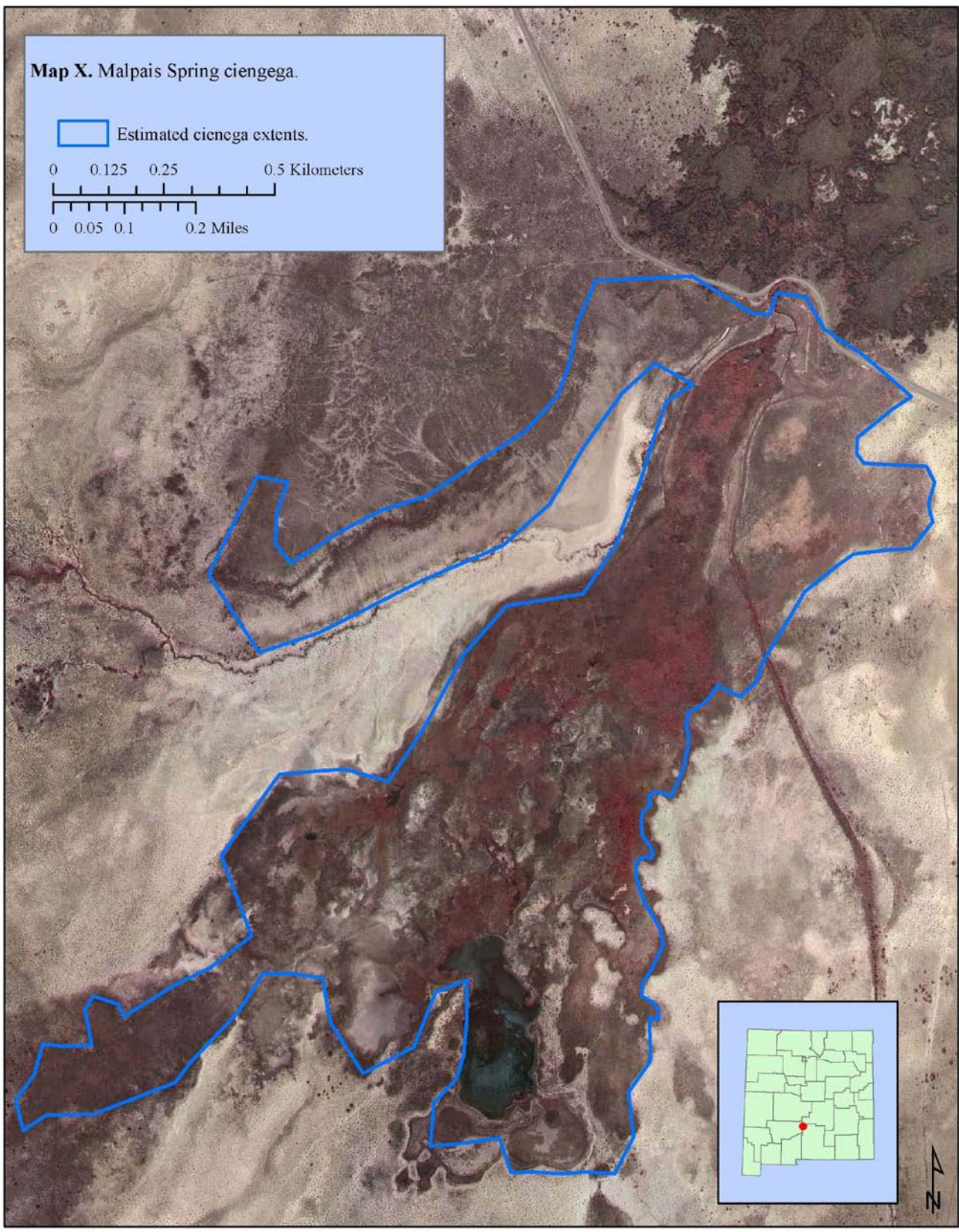
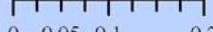
Map X. Malpais Spring cienega.

 Estimated cienega extents.

0 0.125 0.25 0.5 Kilometers



0 0.05 0.1 0.2 Miles





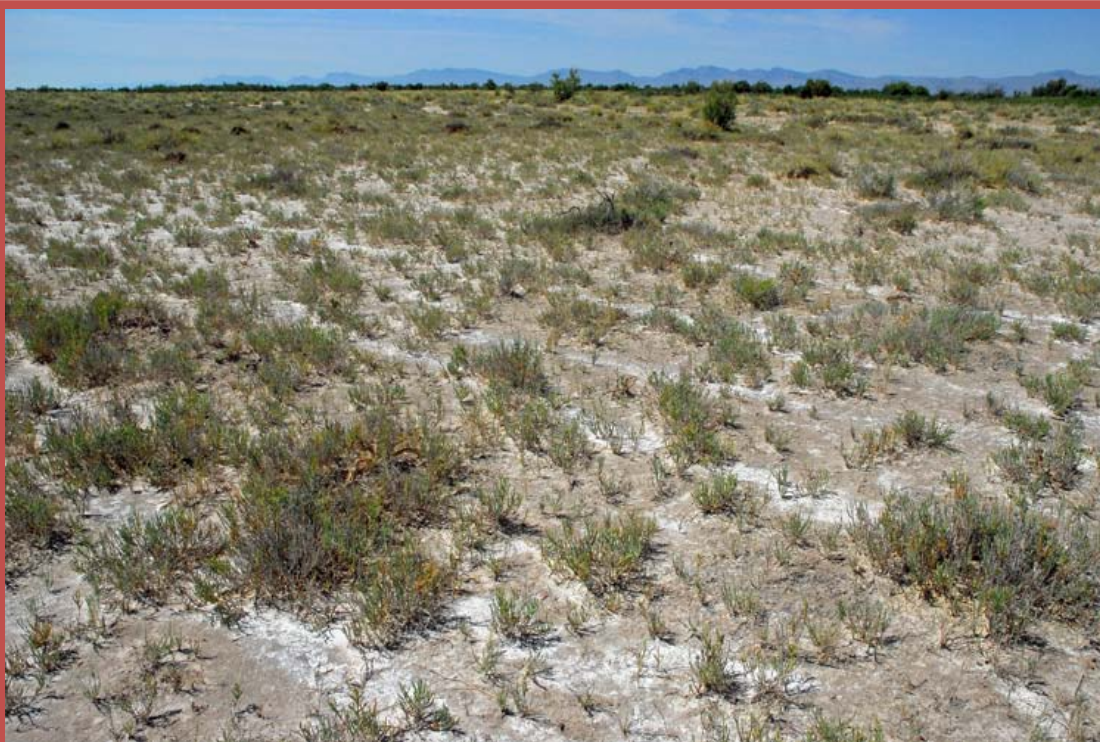
Large areas of the Malpais Spring wetland are densely covered with saltgrass and beaked spike-rush, which are typical cienega plants as is the prairie gentian (lavender flower).



Areas of wet soil with saltgrass and alkali sacaton are also common and large in the Malpais Spring *ciénega*.



Two permanent, shallow, salty lakes with emergent beaked spikerush and chairmaker's bulrush cover several acres of the Malpais Spring wetland.



The seasonally wet and otherwise subirrigated ciénega margins are salty and habitat for halophytic species such as Utah glasswort, Trans-Pecos claddaisy, and alkali-weed.



Subirrigated soils west of the original spring run channel and in a somewhat elevated position have a long patch of common reed – the only location for this species in the Malpais Spring ciénega.

The Malpais Spring wetlands are within the White Sands Missile Range military reservation and have no current consumptive land use. The area was previously grazed by a very large herd of feral horses, but these were eliminated by the 1990s and now only a few pronghorn and gemsbok graze the ciénega. Non-native saltcedar are abundant at the spring head near the edge of the malpais, but are rare out in the wetland and usually associated with areas of soil disturbance.

Malpais Spring Ciénega Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asteraceae - Aster Family

Pseudoclasia arenaria Rydb.; CLAPDAISY

Chenopodiaceae - Goosefoot Family

Allenrolfea occidentalis (S. Wats.) Kuntze; IODINEBUSH

**Bassia hyssopifolia* (Pall.) O. Ktze.; SMOTHERWEED

Sarcocornia utahensis (Tidestr.) Scott; UTAH GLASSWORT

Convolvulaceae - Morning Glory Family

Cressa truxillensis H.B.K.; ALKALI-WEED

Gentianaceae - Gentian Family

Eustoma exaltatum (L.) Salisbury ex G. Don; PRAIRIE GENTIAN

Plumbaginaceae - Plumbago Family

Limonium limbatum Small; SOUTHWESTERN SEA LAVENDER

Primulaceae - Primrose Family

Samolus ebracteatus H.B.K. var. *cuneatus* (Small) Henrickson; LIMEY BROOKWEED

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Schoenoplectus americanus (Pers.) Volk ex Schinz & R. Keller; CHAIRMAKER'S BULRUSH

Poaceae - Grass Family

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

Phragmites australis (Cav.) Steud. var. *berlandieri* (Fournier) Reed; COMMON REED

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

MOUND SPRINGS

Lincoln County, New Mexico

White Sands Missile Range

Owner: U.S. Department of Defense

Just west of the Carrizozo lava flow, dozens of spring deposit mounds rise from the floor of the Tularosa Basin. Most are naturally extinct, but a few still have pools of water perched on mounds of gypsum and salt precipitate. Five of the live springs were surveyed for wetland plants in 2009. These are isolated desert springs with very low plant species diversity and small areas of wetland vegetation cover. All have slightly different vegetation communities.

North Mound Spring

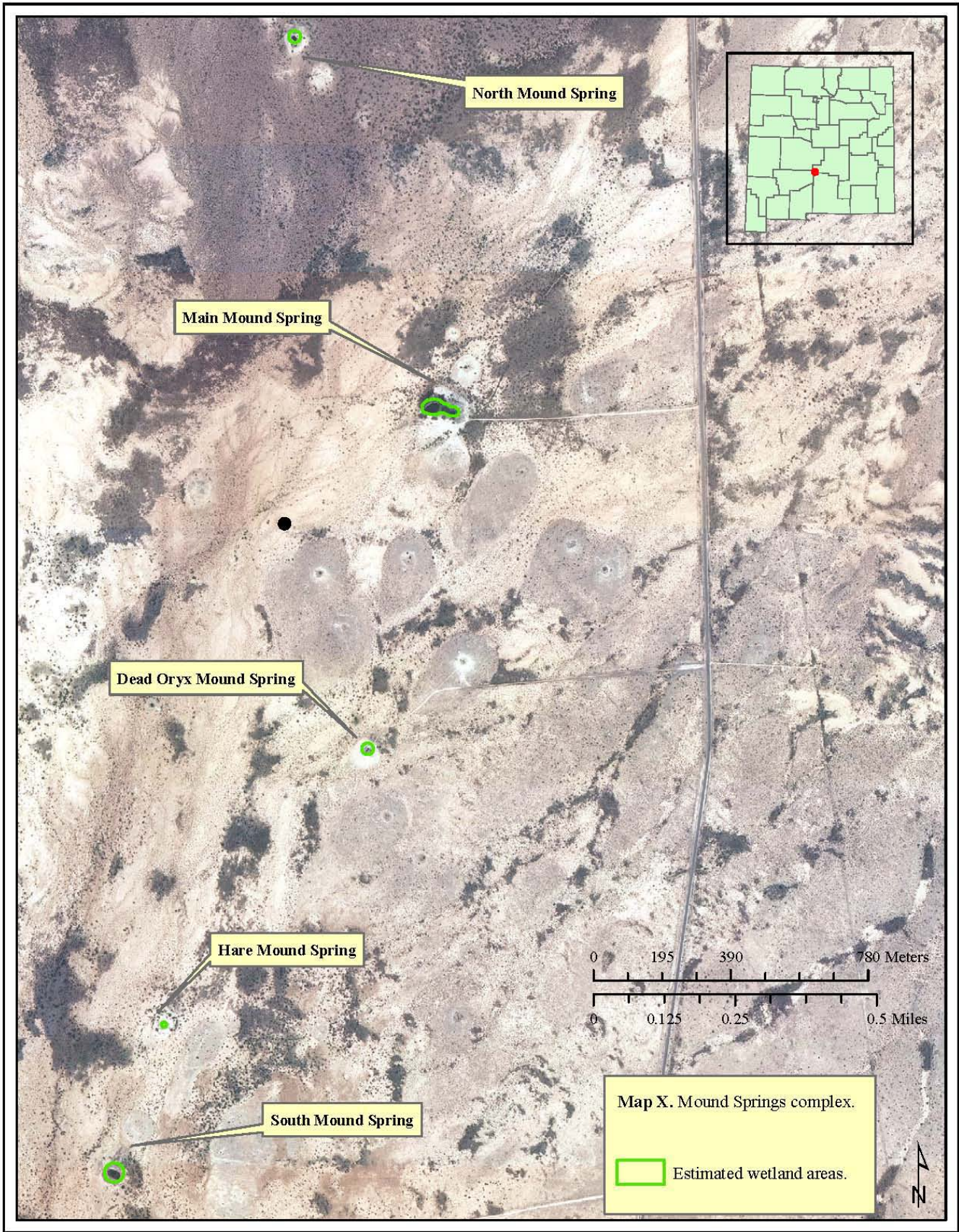
33.4353°N 106.2896°W

Elevation: 4,360 feet

The pool at North Mound is about 30 feet across and is recovering from being nearly obliterated by a large herd of feral horses that eventually died of thirst. A small population of White Sand pupfish has been introduced to this pool – probably from Main Mound Spring. There is very little wetland vegetation at the pool and on the mound. The few saltcedar have been treated with herbicide and killed.



North Mound Spring, August 2009. Pool surrounded by salt grass, saltmarsh bulrush, and Great Plains seep-willow. The aquatic algae is *Chara*.



Main Mound Spring

33.4257°N 106.2848°W

Elevation: 4,345 feet

Main Mound Spring is the Largest of the Mound Springs. The upper east pool is a natural pool and lower west pool is an excavated impoundment. This spring has a natural population of the threatened White Sands pupfish. It has more vegetation than the other Mound Springs, but also the most saltcedar. This spring is fenced from feral horses.



Main Mound Spring, August 2009. Upper natural pool with southern cattail and beaked spike-rush.



Lower west-side pool is an excavated impoundment. Aquatic algae is *Chara*.

Dead Oryx Mound Spring

33.4170°N 106.2864°W

Elevation: 4,320 feet

Dead Oryx is the least vegetated of the live Mound Springs. This mound has surprisingly little saltgrass. The few saltcedar have been treated with herbicide and are mostly dead. The small pool appears to have been dredged in the past.



Hare Mound Spring

33.4090°N 106.2932°W

Elevation: 4,305 feet

Hare Mound Spring is the smallest of the live Mound Springs and appears to be going naturally extinct. There is only a small pool about one-foot in diameter and little wetland vegetation.



Gypsum mound rising several feet above the basin floor.



Hare Mound Spring, August 2009. Very small pool surrounded by saltgrass and iodinebush.

South Mound Spring

33.4060°N 106.2946°W

Elevation: 4,295 feet

South Mound Spring is the second largest of the live Mound Springs. The mound is sparsely vegetated and lacks saltgrass. There are only a few saltcedar on the wet mound soil. This spring is fenced from feral horses. The pool is completely choked and covered with an eight-foot tall stand of broadleaf cattail.



Gypsum mound rising several feet above the basin floor.



South Mound Spring, August 2009. Pool completely covered by broadleaf cattail.

Mound Springs Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asteraceae - Aster Family

Baccharis salicina Torr. & Gray; GREAT PLAINS SEEP-WILLOW

Chenopodiaceae - Goosefoot Family

Allenrolfea occidentalis (S. Wats.) Kuntze; IODINEBUSH

Gentianaceae - Gentian Family

Eustoma exaltatum (L.) Salisbury ex G. Don; PRAIRIE GENTIAN

Primulaceae - Primrose Family

Samolus ebracteatus H.B.K. var. *cuneatus* (Small) Henrickson; LIMEY BROOKWEED

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Bolboschoenus maritimus (L.) Palla; SALTMARSH BULRUSH

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Schoenoplectus americanus (Pers.) Volk ex Schinz & R. Keller; CHAIRMAKER'S BULRUSH

Poaceae - Grass Family

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

Typhaceae - Cattail Family

Typha domingensis; SOUTHERN CATTAIL

Typha latifolia L.; BROADLEAF CATTAIL (ONLY SOUTH MOUND)

BARREL SPRING

Otero County, New Mexico

White Sands Missile Range

Owner: U.S. Department of Defense

Elevation: 4,120 feet

33.0558°N 106.1606°W

This Tularosa Basin spring emerges through gypsum in the basin floor and creates a small pool surrounded by gypsum spring deposit. It is severely impacted and appears to have been dredged in the past. A spillway has been cut on the north side to a constructed impoundment that is lower and larger than the spring pool. The impoundment is shallowly filled with water and southern cattails. Wetland vegetation is mostly aquatic/emergent and riparian woodland. Saltcedar is abundant and dominates the margins of the spring and lower impoundment.




Barrel Spring, August 2009. Small pool filled with southern cattail and surrounded by riparian woodland of saltcedar and Gooding's willow.



Lower impoundment filled with shallow water and southern cattail.



Map X. Barrel Spring.

 Estimated wetland extents.

0 0.04 0.08 0.16 Kilometers
0 0.025 0.05 0.1 Miles



Barrel Spring Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Anacardiaceae - Sumac Family

Rhus trilobata Nutt.; THREE-LEAF SUMAC

Boraginaceae – Borage Family

Heliotropium curassavicum (Nutt.) A. Gray; SEASIDE HELIOTROPE

Chenopodiaceae - Goosefoot Family

Allenrolfea occidentalis (S. Wats.) Kuntze; IODINEBUSH

Oleaceae - Olive Family

Forestiera pubescens Nutt.; NEW MEXICO OLIVE

Salicaceae - Willow Family

**Salix babylonica* L. WEEPING WILLOW

Salix gooddingii Nutt.; GOODDING'S WILLOW

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Poaceae - Grass Family

**Arundo donax* L.; GIANT REED

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

Typhaceae - Cattail Family

Typha domingensis; SOUTHERN CATTAIL

GUILEZ SPRING (TULA POND)

Otero County, New Mexico

White Sands Missile Range

Owner: U.S. Department of Defense

Elevation: 4,120 feet

33.0599°N 106.1537°W

This aridland spring is only half a mile northeast of Barrel Spring and forms a small pond about 50 feet in diameter within riparian woodland canopy of Rio Grande cottonwood, Goodding’s willow, velvet ash and saltcedar. There are some southern cattails in the open water. The spring was a recreational area for military personnel and is impacted by roads and exotic sport fish. Recreational use is presently not allowed by DOD and the picnic tables are in disrepair.





Guilez Spring Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Anacardiaceae - Sumac Family

Rhus trilobata Nutt.; THREE-LEAF SUMAC

Asteraceae - Aster Family

Baccharis salicina Torr. & Gray; GREAT PLAINS SEEP-WILLOW

Chenopodiaceae - Goosefoot Family

Allenrolfea occidentalis (S. Wats.) Kuntze; IODINEBUSH

Oleaceae - Olive Family

Forestiera pubescens Nutt.; NEW MEXICO OLIVE

Fraxinus velutina Torr.; VELVET ASH

Salicaceae - Willow Family

Populus deltoides Bartram ex H. Marshall subsp. *wislizeni* (S. Wats.) Echenw.; RIO GRANDE
COTTONWOOD

Salix exigua Nutt.; COYOTE WILLOW

Salix gooddingii Nutt.; GOODDING'S WILLOW

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

ANGIOSPERMS – Monocotyledonous Plants

Poaceae - Grass Family

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

Typhaceae - Cattail Family

Typha domingensis; SOUTHERN CATTAIL

UNNAMED SPRING (BATTE WAY CIÉNEGA)

Otero County, New Mexico

Owner: NM State Land Office

Elevation: 5,700 feet

33.0076°N 105.8709°W

The western foothills of the Sacramento Mountains in the vicinity of La Luz and Laborcita canyons had several small hillside and valley bottom aridland spring ciénegas. Most have been converted to livestock pastures or the springs captured to irrigate fruit orchards or create farm ponds. The endangered Wright's marsh thistle occurs in this area, but is unlikely to still occur on the most modified spring habitats.

A small, unnamed spring seep ciénega just above a road called Batte Way still exists and illustrates the relatively full suite of species that can occur in very small ciénega habitats. This spring lacks Wright's marsh thistle, but has several typical ciénega plant species. It is on a hillside and the lower end of the ciénega has been cut off by the Batte Way road cut exposing thick carbonate spring deposits that have been accumulating for a long time. The ciénega itself is about 70 x 30 meters, driest at the upper end, and boggy at the lower end where the road cut drains the seeping soil down to a road ditch.

In addition to the road cut damage, this small ciénega is severely grazed by cattle. There are a few saltcedar, but only along the wet road ditch of Batte Way.



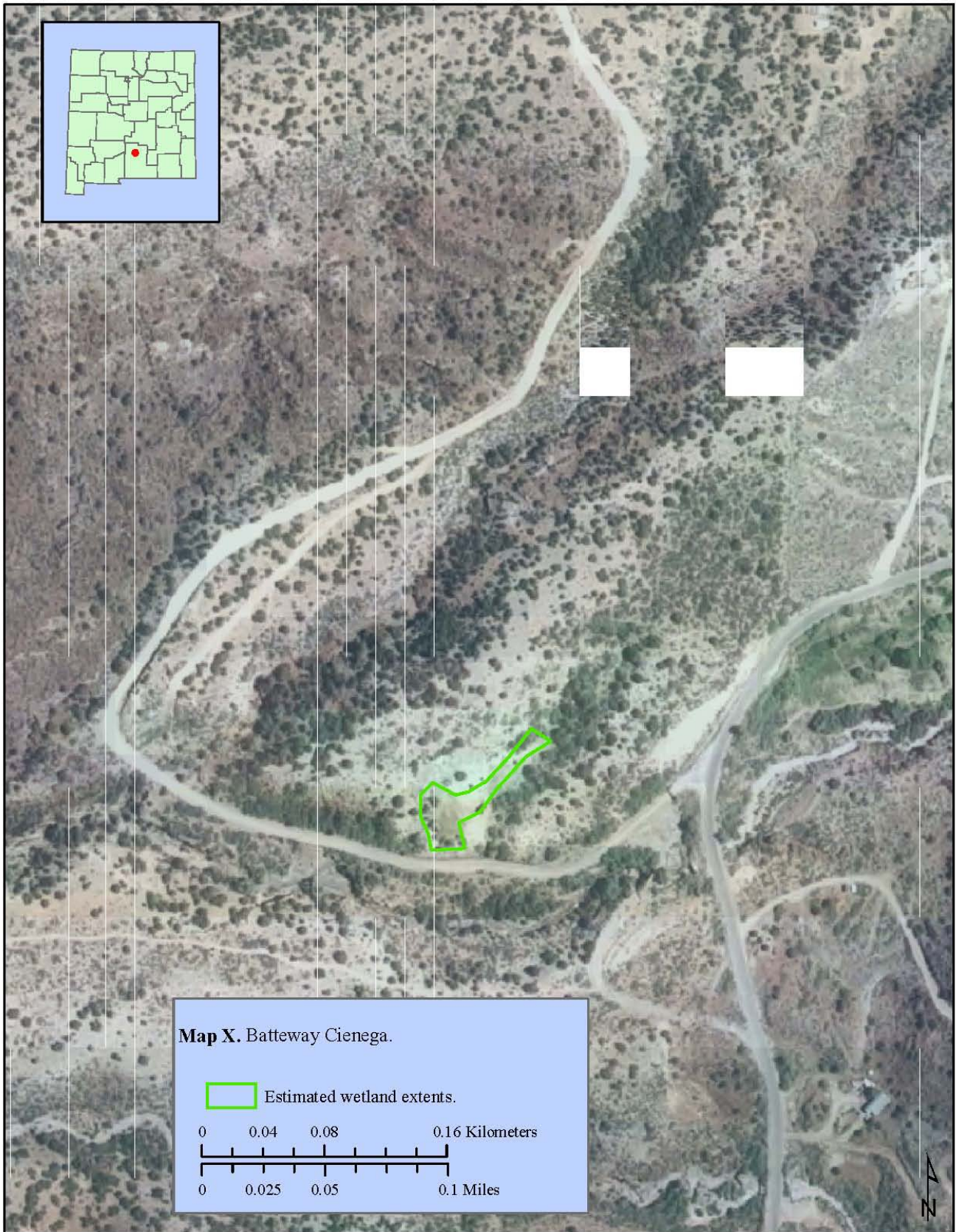
Batte Way road cut exposing spring deposits of carbonate sands and travertine above a darker layer with more organic material that may have been a period with productive wetland on oxygen-poor soil.



Batte Way Ciénega, July 2009. Dark green area at lower far end of ciénega is a dense patch of beaked spikerush over boggy ground.



Upper end of Batte Way Ciénega with drier subirrigated soils covered with scratchgrass and Mexican rush. August 2009.



Batte Way Ciénega Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asteraceae - Aster Family

Baccharis salicina Torr. & Gray; GREAT PLAINS SEEP-WILLOW

Pseudoclasia arenaria Rydb.; CLAPDAISY

Gentianaceae - Gentian Family

Eustoma exaltatum (L.) Salisbury ex G. Don; PRAIRIE GENTIAN

Plantaginaceae - Plantain Family

**Plantago major* L.; GREAT PLANTAIN

Onagraceae – Evening Primrose Family

Oenothera curtiflora Wagner & Hoch; VELVET-WEED

Primulaceae - Primrose Family

Samolus ebracteatus H.B.K. var. *cuneatus* (Small) Henrickson; LIMEY BROOKWEED

Ranunculaceae - Buttercup Family

Ranunculus cymbalaria Pursh; ALKALI BUTTERCUP

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Juncaceae - Rush Family

Juncus arcticus Willd. var. *mexicanus* (Willd.) Baskin, et al.; MEXICAN RUSH

Poaceae - Grass Family

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

**Polypogon viridis* (Gouan) Breistroffer; WATER POLYPOGON

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

KEWA MARSH

Sandoval County, New Mexico

Owner: Kewa Pueblo

Elevation: 5,190-5,200 feet
35.54590°N 106.35166°W

The most spectacular natural wetland remaining in the middle Rio Grande valley is the extensive ciénega and marsh on the east side of the valley north of Kewa (Santo Domingo) Pueblo. The wetland is 1.6 miles in length and covers approximately 500 acres. It is a complex wetland including shallow ponds; emergent bulrush/cattail marsh; spike-rush/knotgrass marsh in peach-leaf willow woodland; short ciénega of scratchgrass, three-square bulrush, and yerba-mansa; and a few acres of floating beaked spike-rush bog, which is a very rare habitat. The hydrology of this appears to include the alluvial aquifer of the Rio Grande and a series of springs and seeps (including thermal springs) on the east-central margin of the wetland. The surface is mostly intact except for a large drain on the west-central side that is dewatering that part of the wetland. Another threat is the dense stands of non-native Russian olive and salt cedar trees that shade the drier margins of the ciénega.

The field survey for this report was brief and covered only the central portion. This significant natural wetland deserves a great deal more study and protection.



Kewa Marsh – extensive ciénega of beaked spike-rush and water parsnip. Some parts of this habitat are floating bogs.



Kewa Marsh, Sandoval County, NM (35.54590°N 106.35166°W), just north of Kewa Pueblo and east of Rio Grande.



Kewa Marsh – extensive ciénega of scratchgrass, three-square bulrush, yerba-mansa, and silverweed. Russian olive woodland established on the drier margins and encroaching into the ciénega.



Kewa Marsh – spike-rush/knotgrass marsh with a high diversity of wetland forbs and scattered woodland of peach-leaf willow trees and New Mexico olive.



Kewa Marsh Plant List

* Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Apiaceae – Parsley Family

Berula erecta (Hudson) Cov.; WATER-PARSNIP

Asclepiadaceae - Milkweed Family

Asclepias speciosa Torr.; SHOWY MILKWEED

Asteraceae - Aster Family

Almutaster pauciflorus (Nutt.) Löve; MARSH ASTER

Bidens tripartita L.; BEGGARTICKS

**Cirsium vulgare* (Savi) Tenore; BULL THISTLE

Conyza canadensis (L.) Cronq.; CANADIAN HORSEWEED

**Eclipta prostrata* (L.) L.; FALSE DAISY

Flaveria campestris Johnston; ALKALI YELLOWTOPS

Helenium autumnale L. var. *montanum* (Nutt.) Fern.; FALL SNEEZEWEED

**Lactuca serriola* L.; PRICKLY LETTUCE

Solidago altissima L. subsp. *gilvocanescens* (Rydb.) Semple; TALL GOLDENROD

Xanthium strumarium L.; COCKLEBUR

Chenopodiaceae - Goosefoot Family

**Kochia scoparia* (L.) Schrad.; KOCHIA
Suaeda calceoliformis (Hook.) Moquin; LOW SEEPWEED

Elaeagnaceae - Oleaster Family

**Elaeagnus angustifolia* L.; RUSSIAN OLIVE

Lamiaceae - Mint Family

Lycopus asper Greene; ROUGH WATER-HOREHOUND

Oleaceae - Olive Family

Forestiera pubescens Nutt.; NEW MEXICO OLIVE

Onagraceae - Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Plantaginaceae - Plantain Family

**Plantago major* L.; GREAT PLANTAIN
**Veronica anagallis-aquatica* L.; BLUE SPEEDWELL

Polygonaceae - Buckwheat Family

**Persicaria lapathifolia* (L.) Gray; DOCK-LEAF SMARTWEED
**Persicaria maculosa* Gray; LADY'S THUMB
Polygonum erectum L.; ERECT KNOTWEED
**Rumex crispus* L.; CURLY DOCK

Ranunculaceae – Buttercup Family

Ranunculus cymbalaria Pursh; ALKALI BUTTERCUP
Ranunculus sceleratus L. *multifidus* Nutt.; CURSED BUTTERCUP

Rosaceae – Rose Family

Potentilla anserina L.; SILVERWEED

Salicaceae - Willow Family

Populus deltoides Bartram ex H. Marshall subsp. *wislizeni* (S. Wats.) Echenw.; RIO GRANDE COTTONWOOD
Salix amygdaloides Andersson; PEACH-LEAF WILLOW
Salix exigua Nutt.; COYOTE WILLOW

Sauruaceae – Lizardtail Family

Anemopsis californica (Nutt.) Hook. & Arn.; YERBA MANZA

Solanaceae – Nightshade Family

Solanum elaeagnifolium Cav.; SILVERLEAF NIGHTSHADE

Tamaricaceae - Tamarisk Family

**Tamarix chinensis* L.; SALT CEDAR

Vitaceae – Grape Family

Parthenocissus vitacea (Knerr) A.S. Hitchc.; THICKET CREEPER

ANGIOSPERMS – Monocotyledonous Plants

Alismataceae – Water Plantain Family

Sagittaria cuneata Sheldon; ARUM-LEAF ARROWHEAD

Cyperaceae - Sedge Family

Cyperus niger Ruiz & Pavon.; BLACK FLATSEEDGE

Eleocharis erythropoda Steudel; BALD SPIKE-RUSH

Eleocharis palustris (L.) Roe. & Schl.; MARSHY SPIKE-RUSH

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Schoenoplectus acutus (Muhl. ex Bigelow) A.& D. Löve; HARDSTEM BULLRUSH

Schoenoplectus pungens (Vahl) Palla var. *longispicatus* (Britt.) S.G. Smith; THREE-SQUARE BULLRUSH

Juncaceae - Rush Family

Juncus arcticus Willd. var. *balticus* (Willd.) Trautvetter; BALTIC RUSH

Juncus torreyi Coville; TORREY'S RUSH

Liliaceae - Lily Family

**Asparagus officinalis* L.; ASPARAGUS

Poaceae - Grass Family

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Beetle; INLAND SALTGRASS

**Echinochloa crus-galli* (L.) Beauv.; LARGE BARNYARDGRASS

Elymus canadensis L.; CANADA WILD RYE

**Festuca pratensis* Huds.; MEADOW FESCUE

Hordeum jubatum L.; FOXTAIL BARLEY

Leptochloa fusca (L.) Kunth subsp. *fascicularis* (Lam.) Snow; BEARDED SPRANGLETOP

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Paspalum distichum L.; KNOTGRASS

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

**Polypogon viridis* (Gouan) Breis.; WATER POLYPOGON

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

Potamogetonaceae - Pondweed Family

Potamogeton nodosus Poiret; LONG-LEAF PONDWEED

Typhaceae - Cattail Family

Typha domingensis; SOUTHERN CATTAIL

SHORTHORN SPRING

Sierra County, New Mexico

Owner: Lake Valley Ranch

Elevation: 4,470 feet

32.7578°N 107.3968°W

Shorthorn Spring is in the dry, lower Berrenda Canyon several miles downstream and east of the Lake Valley section of Berrenda Canyon. This spring seeped from the foot of the northern slope of the valley, but has been captured by spring tanks for livestock water. Surplus water overflows the spring tanks and irrigates a small grassy area of about 30 x 10 meters. There are still a few native wetland plants at this location.





Shorthorn Spring Plant List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Plantaginaceae - Plantain Family

Mimulus guttatus DC.; SEEP MONKEYFLOWER

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Cyperus odoratus L.; RUSTY FLAT-SEDGE

Eleocharis parishii Britt.; PARISH'S SPIKE-RUSH

Poaceae - Grass Family

**Cynodon dactylon* (L.) Pers.; BERMUDAGRASS

**Echinochloa crus-galli* (L.) Beauvois; LARGE BARNYARDGRASS

Paspalum distichum L.; KNOTGRASS

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

ALAMOSA SPRINGS CIÉNEGA

Sierra County, New Mexico

Owner: Monticello Community Ditch Association

Elevation: 6,210 feet

33.57258°N 107.60042°W

The Alamosa Springs are a complex of springs, seeps and spring runs on the north side of the Alamosa Creek valley on the west side of the igneous extrusion called the Monticello Box. Some springs here are warm, which accounts for the older name 'Ojo Caliente' currently out of use. The warmest spring is in a narrow canyon with natural hanging gardens on seeps from the canyon walls. The cienega is confined to the western springs on hill sides with two spring runs that terminate in marshy valley floor alluvium (see map). The water is alkaline enough to deposit some travertine in the spring runs.



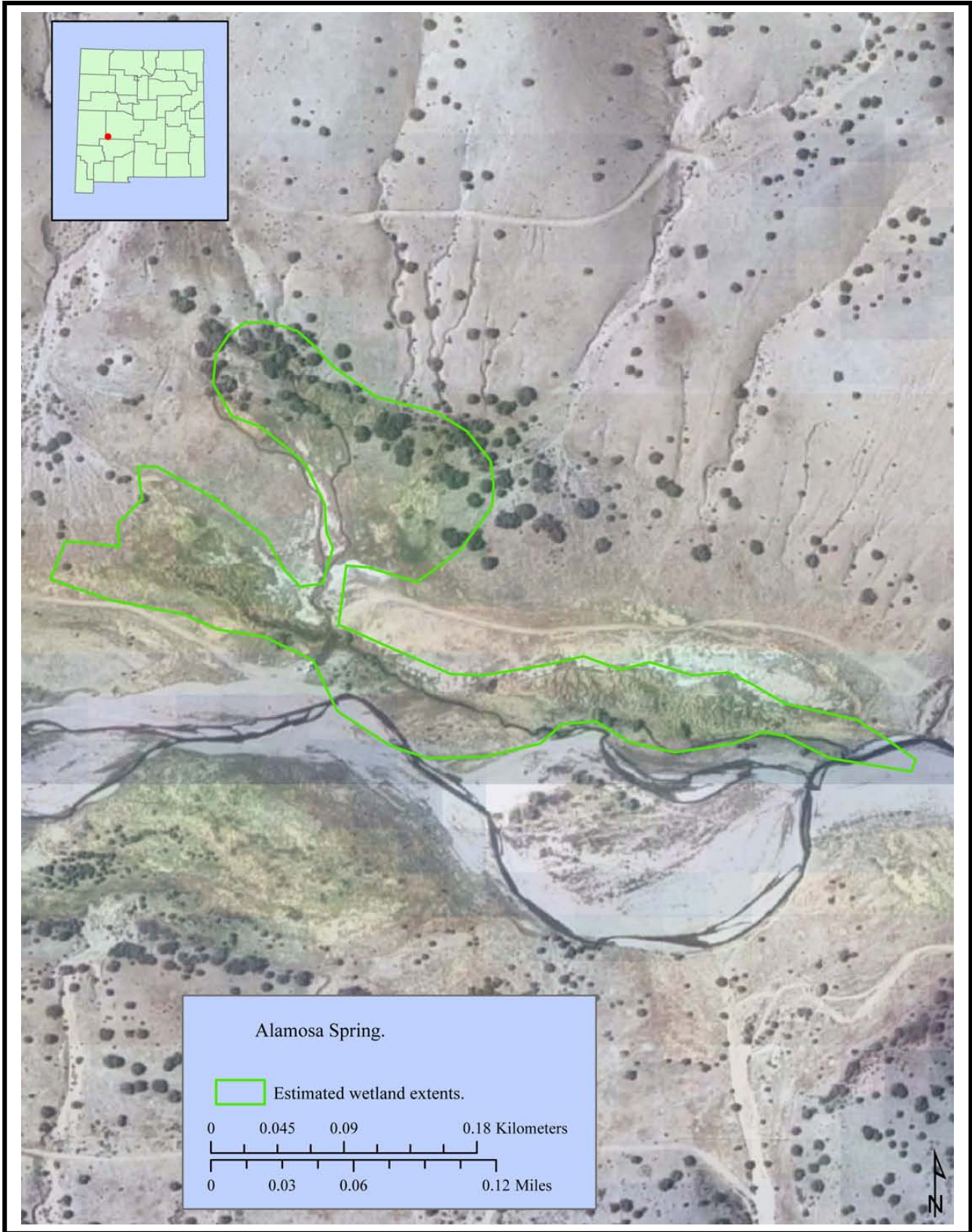
Alamosa Spring run from the western-most hillside springs. Tall, white-flowered plants are Wright's marsh thistle.

Ciénega habitats here vary and include constantly saturated hillside seeps and spring run creek covered with beaked spike-rush and alkaline, subirrigated soils with alkali sacaton, scratchgrass, yerba-mansa and Baltic rush. The lowest part of the ciénega near the valley is emergent marsh of chairmaker's bulrush and beaked spike-rush.

This ciénega is notable for its large population of the endangered Wright's marsh thistle, which is several hundred to a few thousand adults and juvenile rosettes. These are the western-most of the known populations and are confined here to the hillside springs and edges of the spring runs. This population is relatively short in stature and has white to pale pink flowers.

Alamosa springs also provide habitat for the federally endangered Chiricahua leopard frog and Alamosa springsnail. The very large California loosestrife and cardinal-flower populations at this location are unusual for southwestern ciénegas.

The irrigation association has used heavy equipment to dig-out the hillside springs to improve flow and has created some spring run channels to direct flow to Alamosa Creek. This earthwork however, has not significantly impacted the wetland. There are patches of non-native salt cedar along Alamosa Creek, but they are not abundant on the springs and spring runs. The greatest potential threat to the springs is a proposed beryllium mine south of Alamosa Creek directly opposite the springs.





Hideside spring seep with beaked spike-rush and Wright's marsh thistle at Alamosa Springs.



Lower ciénega near valley bottom at Alamosa springs with beaked spike-rush, Baltic rush, and chairmaker's bulrush.

Palomas Canyon Cienega Plant List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Apiaceae – Parsley Family

Berula erecta (Huds.) Cov.; WATER PARSNIP

Asteraceae – Aster

Almutaster pauciflorus (Nutt.) Löve; MARSH ASTER

Cirsium wrightii Gray; WRIGHT'S MARSH THISTLE

Pseudognaphalium stamineum (Kunth) Weber; COTTON-BATTING PLANT

Symphotrichum subulatum (Michx.) Nesom var. *ligulatum* (Shinners) Sundberg; NEW MEXICO

ASTER

Campanulaceae – Bellflower Family

Lobelia cardinalis L.; CARDINAL-FLOWER

Lythraceae – Loosestrife Family

Lythrum californicum Torr. & Gray; CALIFORNIA LOOSESTRIFE

Onagraceae – Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Plantaginaceae - Plantain Family

Mimulus glabratus H.B.K.; ROUND-LEAF MONKEYFLOWER

Polygonaceae – Buckwheat Family

**Rumex pulcher* L.; FIDDLE DOCK

Rumex triangulivalvis (Danser) Rech. f.; MEXICAN DOCK

**Persicaria lapathifolia* (L.) Gray; DOCK-LEAF SMARTWEED

Salicaceae – Willow Family

Salix gooddingii Ball; GOODDING'S WILLOW

Sauruaceae – Lizardtail Family

Anemopsis californica (Nutt.) Hook. & Arn.; YERBA-MANSA

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Eleocharis rostellata (Torr.) Torr.; BEAKED SPIKE-RUSH

Schoenoplectus americanus (Pers.) Volk.; CHAIRMAKER'S BULRUSH

Schoenoplectus pungens (Vahl) Palla var. *longispicatus* (Britt.)Smith; THREE-SQUARE BULRUSH

Iridaceae – Iris Family

Systirinchium demissum Greene; STIFF BLUE-EYED-GRASS

Juncaceae – Rush Family

Juncus arcticus Willd. var. *balticus* (Willd.) Traut.; BALTIC RUSH

Juncus ensifolius Wikst. var. *montanus* (Engelm.) Hitchc.; ROCKY MOUNTAIN RUSH

Poaceae - Grass Family

Muhlenbergia asperifolia (Nees & Meyer) Parodi; SCRATCHGRASS

**Festuca pratensis* Hudson; MEADOW FESCUE

Hordeum jubatum L; FOXTAIL BARLEY

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

PALOMAS CANYON CIÉNEGA

Sierra County, New Mexico

Owner: Ladder Ranch

Elevation: 5,375-5,390 feet

33.17133°N 107.56011°W

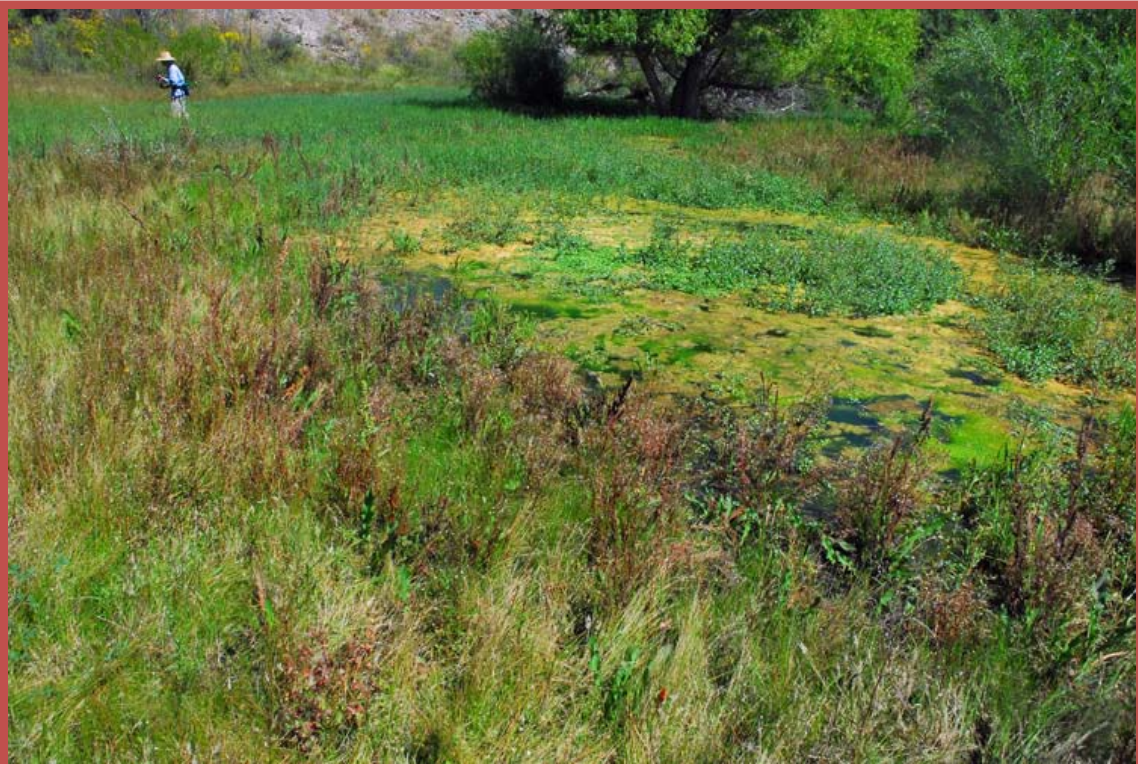
Upper Palomas Canyon on the east side of the Black Range contains a perennial creek that becomes intermitant a its lower elevations. A relatively small, previously unknown ciénega occur at mid-elevation where a broad segment of Palomas Canyon becomes narrow and forces alluvial water to the surface in the main channel and the canyon bottom above the channel. The ciénega is a seep about 300 m long and 20-40 m wide. It is subirrigated at the upper end, but flowing at the surface on the lower end where beaver have taken advantage of the spring run and built a dam. There are no non-native trees and the only physical impact to the ciénega is the road crossing an edge of its lower end.



Palomas Canyon Ciénega, Sierra County, NM (33.17133°N 107.56011°W).



Palomas Canyon Cienega, Sierra County, NM. Knotgrass and spikerush dominate the wettest areas.



Palomas Canyon Cienega, standing water near beaver dam. Edge of ciénega wooded with Goodding's willow

Palomas Canyon Cienega Plant List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asteraceae – Aster

Baccharis salicifolia (Ruiz & Pavon) Pers.; WILLOW BACCHARIS

**Pseudognaphalium luteoalbum* (L.) Hill. & Burt; JERSEY RABBIT-TOBACCO

Symphotrichum subulatum (Michx.) Nesom var. *parviflorum* (Nees) Sundberg; NEW MEXICO

ASTER

**Taraxicum officinale* Weber & Wiggers; COMMON DANDELION

Xanthium strumarium L.; COCKLEBUR

Gentianaceae – Gentian Family

Zeltnera arizonica (Gray) Mansion; ARIZONA CENTAURY

Onagraceae – Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Plantaginaceae - Plantain Family

Mimulus glabratus H.B.K.; ROUND-LEAF MONKEYFLOWER

**Plantago major* L.; GREAT PLANTAIN

**Veronica anagallis-aquatica* L.; BLUE SPEEDWELL

Polygonaceae – Buckwheat Family

**Rumex crispus* L.; CURLY DOCK

Ranunculaceae – Buttercup Family

Ranunculus cymbalaria Pursh; ALKALI BUTTERCUP

Salicaceae – Willow Family

Salix gooddingii Ball; GOODDING'S WILLOW

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Cyperus esculentus L.; YELLOW FLAT-SEDGE

Eleocharis sp.; SPIKE-RUSH

Juncaceae – Rush Family

Juncus arcticus Willd. var. *balticus* (Willd.) Traut.; BALTIC RUSH

Juncus longistylis Torr.; LONG-STYLE RUSH

Juncus torreyi Cov.; TORREY'S RUSH

Poaceae - Grass Family

Echinochloa crus-gavonis (Kunth) Schultes var. *macera* (Wiegand) Gould; GULF COAST
BARNYARDGRASS

Muhlenbergia repens (Presl) Hitchc.; CREEPING MUHLY

Paspalum distichum L.; KNOTGRASS

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

SECO CANYON CIÉNEGA
Sierra County, New Mexico

Owner: Ladder Ranch

Elevation: 5,515 feet
33.08991°N 107.55825°W

Seco Canyon Ciénega is associated with a spring that is perched just above the canyon floor. The spring seep quickly gathers into a spring run that flows to the canyon channel so the ciénega on the seep is small and only about 80 m long. There are no non-native trees and the physical setting is undisturbed.



Seco Canyon Ciénega, Sierra County, NM (33.08991°N 107.55825°W).



Seco Canyon Cienega on spring seep above spring run wooded with Goodding's willow in background.

Seco Canyon Cienega Plant List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asteraceae – Aster

Baccharis salicifolia (Ruiz & Pavon) Pers.; WILLOW BACCHARIS

Heliomeris multiflora Nutt. var. *nevadensis* (Nels.) Yates; SHOWY GOLDENEYE

**Pseudognaphalium luteoalbum* (L.) Hill. & Burt; JERSEY RABBIT-TOBACCO

Symphotrichum subulatum (Michx.) Nesom var. *parviflorum* (Nees) Sundberg; NEW MEXICO

ASTER

Gentianaceae – Gentian Family

Zeltnera arizonica (Gray) Mansion; ARIZONA CENTAURY

Onagraceae – Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Plantaginaceae - Plantain Family

Mimulus glabratus H.B.K.; ROUND-LEAF MONKEYFLOWER

Polygonaceae – Buckwheat Family

**Persicaria lapathifolia* (L.) Gray; DOCK-LEAF SMARTWEED

**Rumex crispus* L.; CURLY DOCK

Salicaceae – Willow Family

Salix gooddingii Ball; GOODDING'S WILLOW

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Cyperus esculentus L.; YELLOW FLAT-SEDGE

Eleocharis sp.; SPIKE-RUSH

Juncaceae – Rush Family

Juncus longistylis Torr.; LONG-STYLE RUSH

Juncus torreyi Cov.; TORREY'S RUSH

Poaceae - Grass Family

Echinochloa crus-gavonis (Kunth) Schultes var. *macera* (Wiegand) Gould; GULF COAST
BARNYARDGRASS

Panicum capillare L. var. *brevifolium* Rydb. & Shear; COMMON WITCHGRASS

Paspalum distichum L.; KNOTGRASS

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

CLOVERDALE CIÉNEGA

Hidalgo County, New Mexico

Owners: Coronado National Forest
Diamond A Ranch

Elevation: 5,385 feet
31.4367°N 108.9764°W

Cloverdale Ciénega consists of large discontinuous areas of wet valley bottom as Cloverdale Creek traverses the eastern foothills of Peloncillo Mountains. The historical extent of ciénega in this valley was much larger than today. Natural hydrology and topography of the valley have been modified by damming or excavating impoundments, pushing up spreader dikes, channel excavation and channel down-cut erosion. A large area of the upper ciénega was converted to non-native pasture by plowing and establishing an extensive stand of exotic *Eragrostis curvula* (Schrader) Nees var. *conferta* Stapf (Boer lovegrass) after that part of the ciénega had been dried. The Diamond A Ranch, State of New Mexico, and Sky Island Alliance are working cooperatively to restore natural sheet-flow during storm events across this upper part of the valley in an effort to reestablish the ciénega.

The wettest part of the valley still supports a 50-acre remnant of the ciénega on Coronado National Forest and adjoining Diamond A Ranch land. This portion of the valley floor appears to overlay an upward sloping area of bedrock that forces the alluvial aquifer to the surface. This area is permanently wet and supports a classic ciénega ecosystem.



Small area of open water on National Forest land at Cloverdale Ciénega surrounded by rushes, sedges and a few mature Goodding's willow trees.

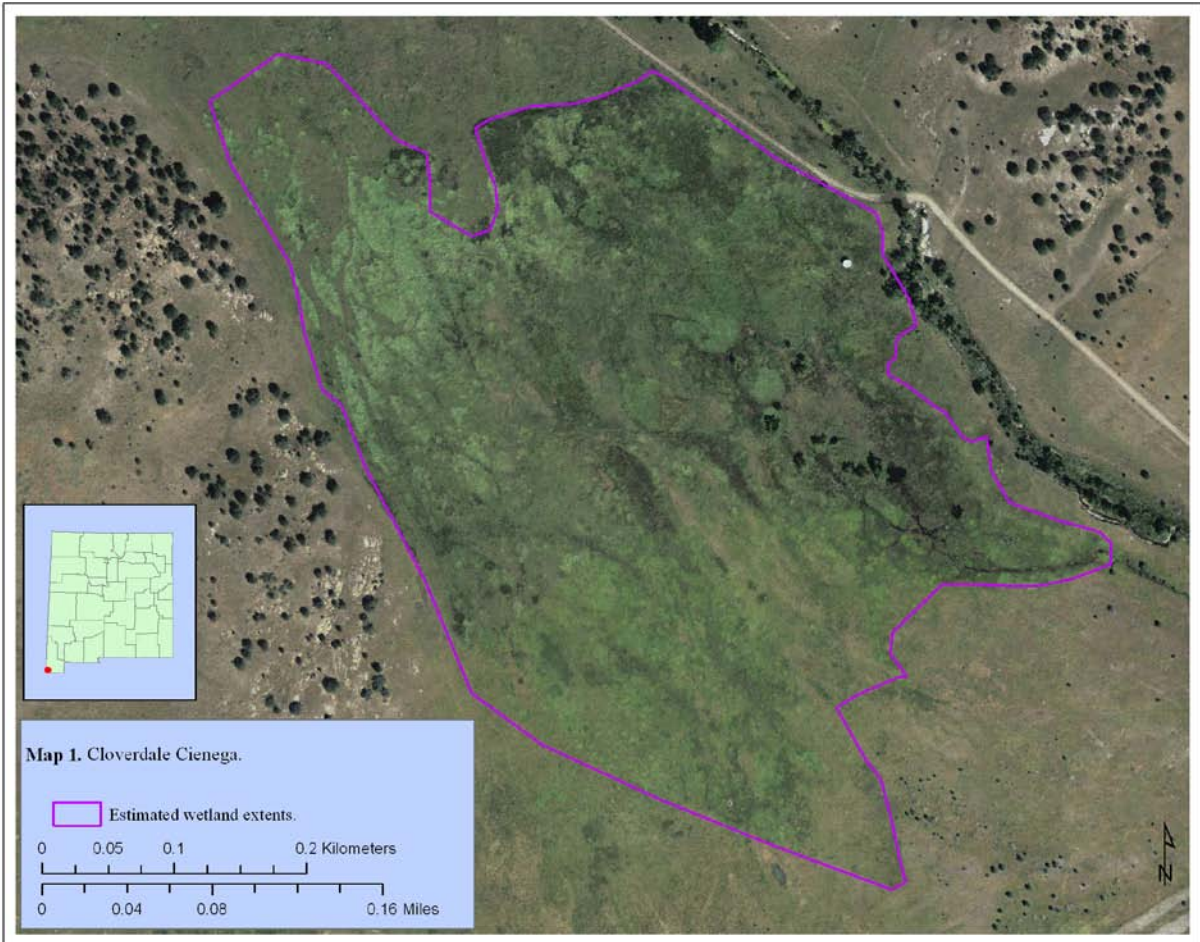
Plant diversity is especially high for a New Mexican ciénega with 38 obligate or facultative wetland species. Of particular interest is a stand of *Sorghastrum nutans* (Indian grass) and *Panicum virgatum* (switchgrass), which are common species of the tall grass prairie in the Great Plains ecoregion. These grasses occasionally occupy ciénega habitats in the arid Southwest. The largest stand of Indian grass and switchgrass in New Mexico occurs in the ciénegas at Santa Rosa. The most significant find at the Cloverdale Ciénega was a large population of *Heliomeris hispida* (rough goldeneye). This annual sunflower has a widespread distribution, but is rarely collected and may be a rare wetland plant. It is currently known from only a few salt marshes in California and Utah and from a few ciénega and riparian habitats in Arizona, New Mexico and Sonora.

No serious exotic plant infestations were observed during this survey. Additional plant species will likely be found in the Cloverdale Ciénega with more thorough searching and at different times of the year. The *Carex* (sedge) species forming dense rhizomatous patches with very long, broad leaves is especially puzzling and needs to be collected in fruit. The ciénega remnants further downstream near Cloverdale Spring also need to be botanically surveyed.

A large pond impoundment further up stream is occupied by a large population of the endangered Chiricahua leopard frog, but no amphibians were observed at the open water on the National Forest part of the ciénega during this visit. Density and diversity of invertebrates at Cloverdale Ciénega were not sampled, but were very impressive with an abundance of arachnids and numerous species of odonates, orthopterans and dipterans.



Dense mat of long sedge leaves in foreground and the tawny inflorescence of Indian grass in background before the trees. A Forest Service wildlife guzzler has been constructed on this cienega.



Cloverdale Ciénega Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asclepiadaceae - Milkweed Family

Asclepias subverticillata (Gray) Vail; HORSETAIL MILKWEED

Asteraceae - Aster Family

Ambrosia psilostachya DC.; PERENNIAL RAGWEED

Artemisia carruthii Wood; CARRUTH'S WORMWOOD

Bidens cernua L.; NODDING BEGGARTICKS

Conyza canadensis (L.) Cronq.; CANADIAN HORSEWEED

Heliomeris hispida (A. Gray) Cockerell; ROUGH GOLDENEYE

**Lactuca serriola* L.; PRICKLY LETTUCE

Solidago missouriensis; MISSOURI GOLDENROD

Symphotrichum ericoides (L.) Nesom; HEATH ASTER

Chenopodiaceae - Goosefoot Family

Chenopodium berlandieri Moquin-Tandon; PITTED GOOSEFOOT

Fabaceae - Pea Family

Trifolium wormskjoldii Lehm. var. *arizonicum* (Greene) Barneby; CUSP CLOVER

Malvaceae - Mallow Family

Sidalcea neomexicana A. Gray; NEW MEXICO CHECKERMALLOW

Onagraceae - Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Plantaginaceae - Plantain Family

Mimulus guttatus DC.; SEEP MONKEY-FLOWER

Polygonaceae - Buckwheat Family

Polygonum erectum L.; ERECT KNOTWEED

**Rumex crispus* L.; CURLY DOCK

Ranunculaceae – Buttercup Family

Ranunculus hydrocharoides A. Gray; FROG-BIT BUTTERCUP

Rubiaceae – Madder Family

Galium trifidum L. var. *subbiflorum* Wieg.; THREE-PETAL BEDSTRAW

Salicaceae - Willow Family

Salix gooddingii Ball; GOODDING'S WILLOW

Solanaceae – Nightshade Family

Solanum elaeagnifolium Cav.; SILVERLEAF NIGHTSHADE

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Carex praegracilis W. Boott; FIELD SEDGE

Carex sp.; SEDGE

Cyperus esculentus L.; YELLOW NUT-SEDGE

Juncaceae - Rush Family

Juncus arcticus Willd. var. *balticus* (Willd.) Truativ.; BALTIC RUSH

Juncus interior Wieg.; INLAND RUSH

Juncus torreyi Coville; TORREY'S RUSH

Poaceae - Grass Family

**Echinochloa crus-galli* (L.) Beauv.; LARGE BARNYARDGRASS

Echinochloa muricata (Beuv.) Fern.; COCKSPUR

Elymus canadensis L.; CANADA WILD RYE

Elymus longifolius (Smith) Gould; LONGLEAF SQUIRRELTAIL

Hordeum jubatum L.; FOXTAIL BARLEY

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Panicum obtusum H.B.K.; VINE MESQUITE

Panicum virgatum L.; SWITCHGRASS

Paspalum distichum L.; KNOTGRASS

**Poa pratensis* L.; KENTUCKY BLUEGRASS

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

Sorghastrum nutans (L.) Nash; INDIANGRASS

CIÉNEGA SPRING (LANG CIÉNEGA)

Hidalgo County, New Mexico

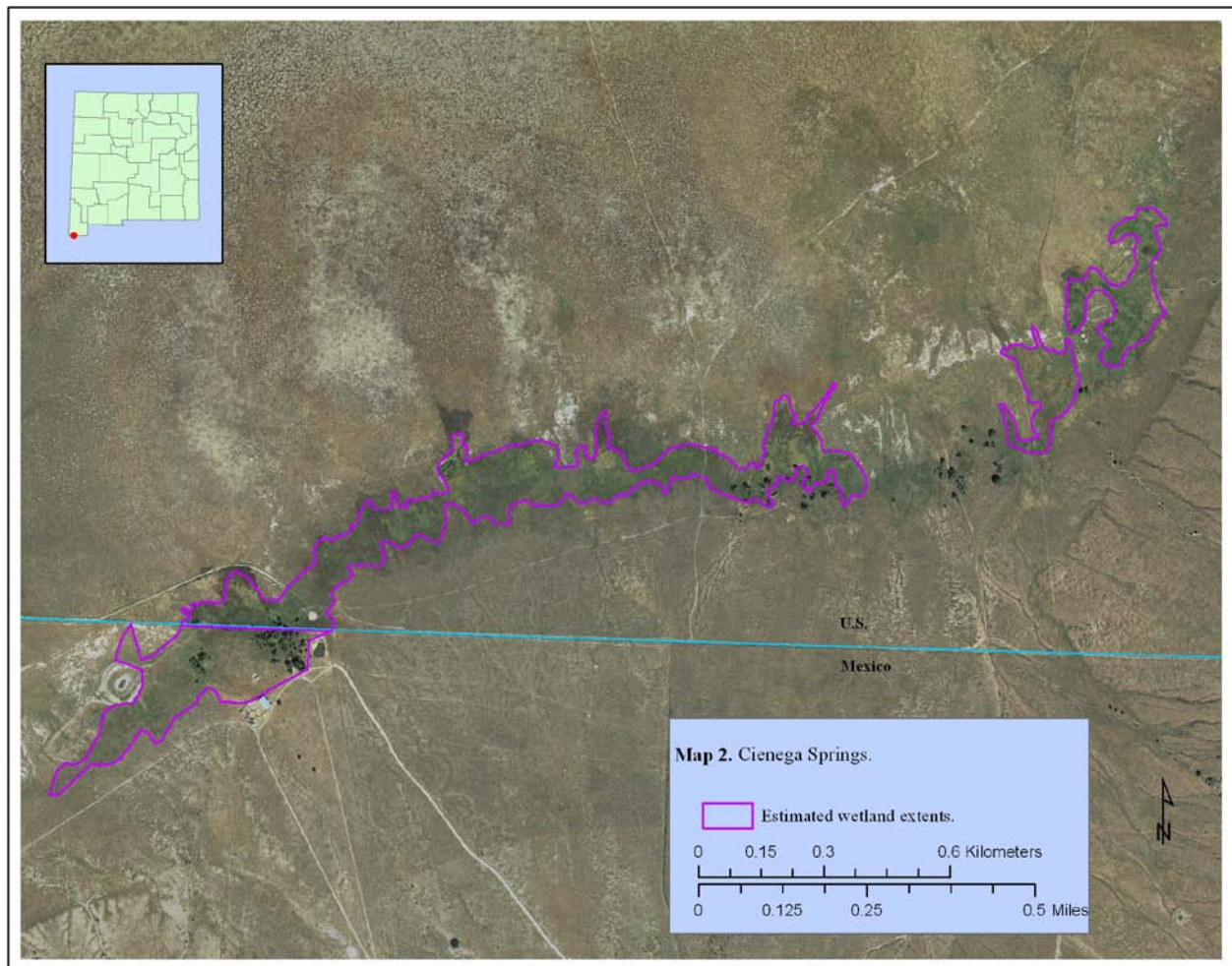
Owners: Diamond A Ranch

Elevation: 5,150 feet

31.3360°N 108.8109°W

Ciénega Spring occurs below an abandoned ranch house just north of the US/Mexico border at the south end of the Pleistocene lake bed of the Animas Playa. The spring itself is only a small surface seep in an extensive ciénega wetland called the Lang Ciénega. This ciénega is about 0.1 to 0.25 miles wide and 2.5 miles long covering approximately 60 acres. It apparently runs along a fault line on the northern toe of the Sierra San Luis. Satellite imagery shows the ciénega habitat extending across the international border about a quarter mile into Sonora.

The ciénega occupies two different types of topography. The western half is on a gentle north-facing slope and is intermittently wet at the surface or dry and subirrigated in the root zone. This part has a diverse flora of both obligate and facultative wetland plants. The eastern half seeps from the toe of the slope and into the playa bottom. It is generally wetter and dominated by obligate wetland species.



Plant diversity is especially high for a New Mexican ciénega with 50 obligate or facultative wetland species. Of particular interest is the population of *Hypericum mutilum* (dwarf St. John's wort) at Ciénega Spring, which is the first record for this species for the State of New Mexico. This small-flowered annual is wide-spread and relatively common, but had not been found in New Mexico before this survey. Additionally, *Cyperus acuminata* (taper-tip flat-sedge) and *Chamaecybe nutans* (eyebane) had each been found in New Mexico only one time before this survey found them in Lang Ciénega. Another significant find at Lang Ciénega was a large population of *Heliomeris hispida* (rough goldeneye). This annual sunflower has a widespread distribution, but is rarely collected and may be a rare wetland plant. It is currently known from only a few salt marshes in California and Utah and from a few ciénega and riparian habitats in Arizona, New Mexico and Sonora.

No serious exotic plant infestations were observed during this survey. Additional plant species will likely be found in Lang Ciénega with more thorough searching and at different times of the year. The *Carex* (sedge) species forming dense rhizomatous patches with very long, broad leaves is especially puzzling and needs to be collected in fruit.

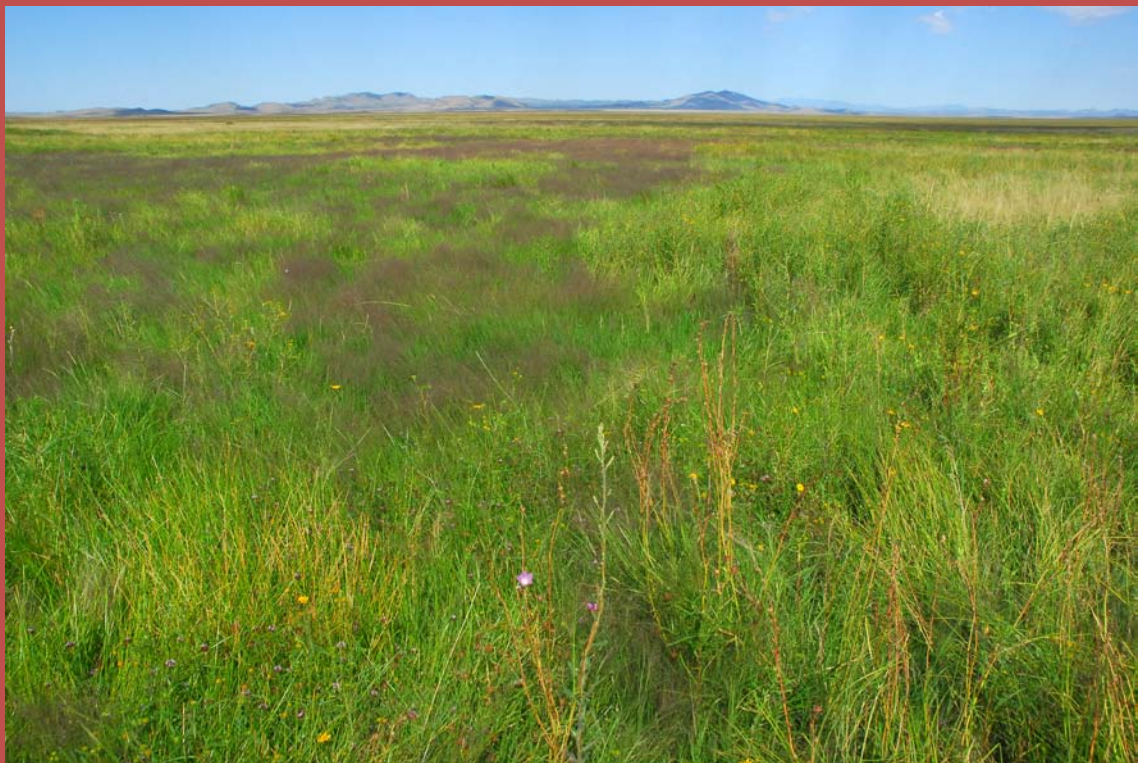
Density and diversity of invertebrates at Cloverdale Ciénega were not sampled, but were very impressive with an abundance of arachnids and numerous species of odonates, orthopterans and dipterans.



Western sloping part of Lang Ciénega with sedges, rushes, ragweed and goldenrod.



Seeping toe of slope near Ciénega Spring with scattered Goodding's willow, boggy soils with sedge, flat-sedge and scratchgrass.



Playa bottom portion of Lang Ciénega of mostly sedges and scratchgrass. Yellow flowers are rough goldeneye.



Boggy parts of Lang Ciénega are impacted by feral pigs wallowing and rooting for underground plant parts.



Feral pig wallows create openings and microtopography suitable for annual wetland plants, but may have already uprooted and eliminated uncommon perennial species.



Floating spike-rush bog with tall stand of hard-stem bulrush (right side) below stock tank at eastern end of Lang Cienega (31.33921°N 108.80347°W).

Ciénega Spring (Lang Ciénega) Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Apiaceae - Celery Family

Berula erecta (Huds.) Cov.; WATER PARSNIP

Eryngium heterophyllum Engelm.; WRIGHT'S ERYNGO

Asclepiadaceae - Milkweed Family

Asclepias subverticillata (Gray) Vail; HORSETAIL MILKWEED

Asteraceae - Aster Family

Ambrosia psilostachya DC.; PERENNIAL RAGWEED

Artemisia carruthii Wood; CARRUTH'S WORMWOOD

Conyza canadensis (L.) Cronq.; CANADIAN HORSEWEED

Heliomeris hispida (A. Gray) Cockerell; ROUGH GOLDENEYE

**Lactuca serriola* L.; PRICKLY LETTUCE

Pseudognaphalium stamineum (Kunth) W.A. Weber; COTTON-BATTING-PLANT

Solidago missouriensis; MISSOURI GOLDENROD

Symphotrichum ericoides (L.) Nesom; HEATH ASTER

Symphotrichum subulatum (Michaux) Nesom var. *ligulatum* (Shinners) Sundberg; NEW MEXICO ASTER

Chenopodiaceae - Goosefoot Family

Chenopodium berlandieri Moquin-Tandon; PITTED GOOSEFOOT

Euphorbiaceae - Spurge Family

Chamaesyce nutans (Lagasca) Small; EYEBANE

Euphorbia davidii Subils; DAVID'S SPURGE

Fabaceae - Pea Family

Hoffmannseggia glauca (Ortega) Eifert; WAXY HOG-POTATO

Trifolium wormskjoldii Lehm. var. *arizonicum* (Greene) Barneby; CUSP CLOVER

Hypericaceae – St. John's Wort Family

Hypericum mutilum L.; DWARF ST. JOHN'S WORT

Lythraceae - Loosestrife Family

Lythrum californicum Torr. & Gray; CALIFORNIA LOOSESTRIFE

Malvaceae - Mallow Family

Sidalcea neomexicana A. Gray; NEW MEXICO CHECKERMALLOW

Myrsinaceae - Myrsine Family

**Centunculus minimus* L.; CHAFFWEED

Onagraceae - Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Ludwigia palustris (L.) Elliott; MARSH PRIMROSE-WILLOW

Oenothera elata Kunth subsp. *hirsutissima* (A. Gray) Dietrich; HOOKER'S EVENING-PRIMROSE

Plantaginaceae - Plantain Family

Mimulus guttatus DC.; SEEP MONKEY-FLOWER

Polygonaceae - Buckwheat Family

**Persicaria lapathifolia* (L.) A. Gray; DOCK-LEAF SMARTWEED

**Persicaria maculosa* Gray; LADY'S-THUMB

Polygonum erectum L.; ERECT KNOTWEED

**Rumex crispus* L.; CURLY DOCK

Ranunculaceae – Buttercup Family

Ranunculus cymbalaria Pursh; ALKALI BUTTERCUP

Salicaceae - Willow Family

Salix gooddingii Ball; GOODDING'S WILLOW

Scrophulariaceae – Figwort Family

**Verbascum virgatum* Stokes; WAND MULLEIN

Solanaceae – Nightshade Family

Solanum elaeagnifolium Cav.; SILVERLEAF NIGHTSHADE

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Carex praegracilis W. Boott; FIELD SEDGE

Carex sp.; SEDGE

Cyperus acuminatus Torr. & Hook.; TAPER-TIP FLAT-SEDE

Cyperus esculentus L.; YELLOW NUT-SEDE

Cyperus niger Ruiz & Pavon; BLACK FLAT-SEDE

Eleocharis acicularis (L.) Roemer & Schultes; NEEDLE SPIKE-RUSH

Eleocharis macrostachya Britt.; PALE SPIKE-RUSH

Schoenoplectus acutus (Muhl.) Löve var. *occidentalis* (S. Wats.) Smith; HARDSTEM BULRUSH

Juncaceae - Rush Family

Juncus acuminatus Michaux; KNOTTY RUSH

Juncus arcticus Willd. var. *balticus* (Willd.) Truativ.; BALTIC RUSH

Juncus marginatus Rostk.; GRASS-LEAF RUSH

Juncus torreyi Coville; TORREY'S RUSH

Juncus xiphioides Meyer; IRIS-LEAF RUSH

Lemnaceae – Duckweed Family

Lemna gibba L.; INFLATED DUCKWEED

Poaceae - Grass Family

**Echinochloa crus-galli* (L.) Beauv.; LARGE BARNYARDGRASS

Elymus longifolius (Smith) Gould; LONGLEAF SQUIRRELTAIL

Eragrostis intermedia A.S. Hitchc.; PLAINS LOVEGRASS

Hordeum jubatum L.; FOXTAIL BARLEY

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Panicum obtusum H.B.K.; VINE MESQUITE

Paspalum distichum L.; KNOTGRASS

**Poa pratensis* L.; KENTUCKY BLUEGRASS

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

Sporobolus airoides (Torr.) Torr.; ALKALI SACATON

Sporobolus wrightii Munro; GIANT SACATON

ANIMAS CREEK CIÉNEGA

Hidalgo County, New Mexico

Owners: Diamond A Ranch

Elevation: 5,100 feet

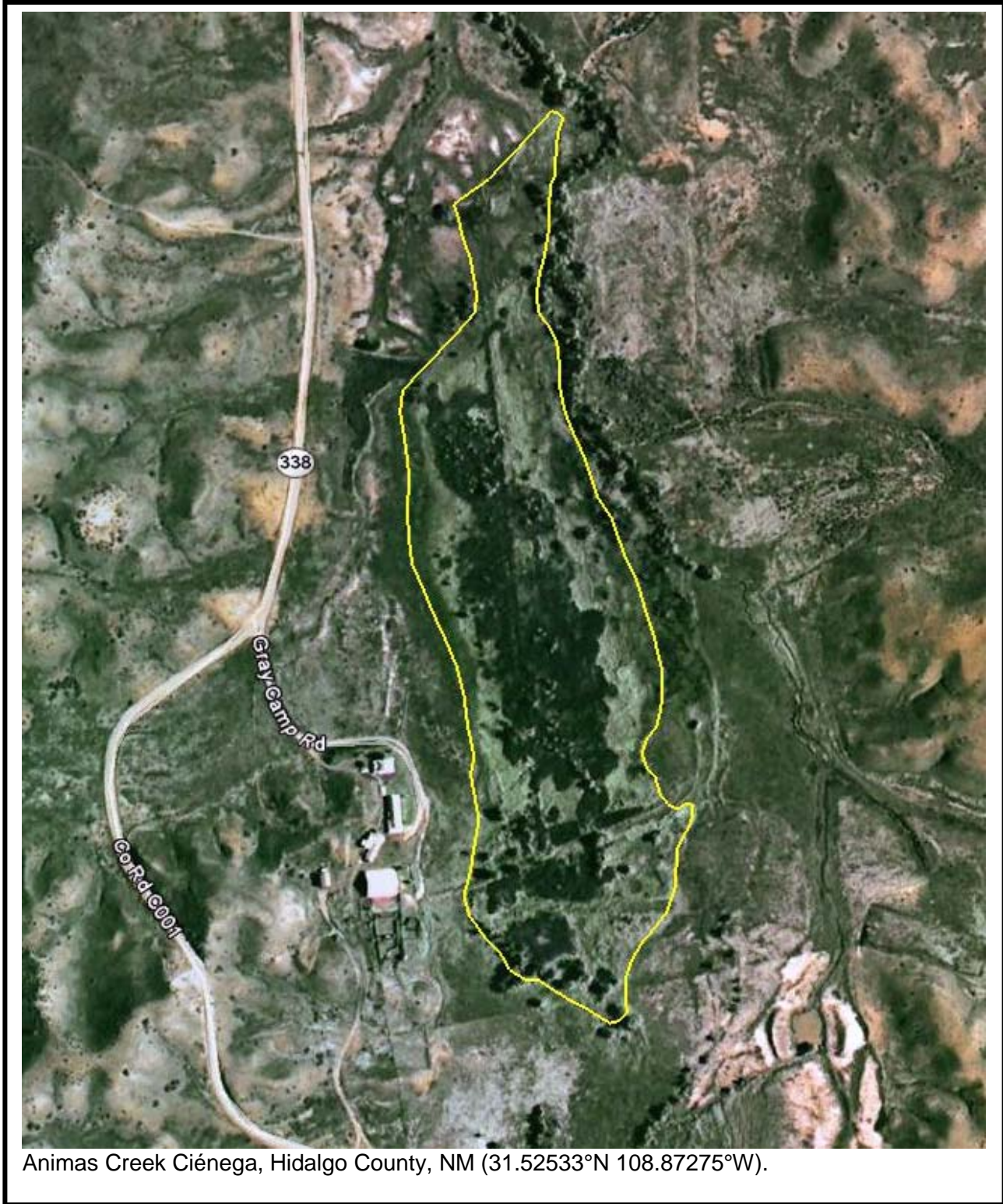
31.52533°N 108.87275°W

A third large ciénega on the Diamond A Ranch is in the Animas Creek valley close to the ranch headquarters. It occupies the flood plain adjacent to Animas Creek and is mostly within the alluvial aquifer. The springs at north end of the ciénega are perched somewhat above the creek channel and have dependable flow in dry years. The central part of Animas Creek Ciénega consists of large stands of cattails with scattered Goodding's willows surrounded by extensive sedge meadows. Plant species diversity in this ciénega is less than Cloverdale or Lang ciénegas (see preceeding).

There are no non-native trees in the physical setting is nearly intact. There is an old low dike on the southern end and a small part of the southwestern side has been recently replaced by construction of a large earth tank.



One of the springs with constant surface water near the north end of Animas Creek Ciénega (31.52817°N 108.87275°W).



Animas Creek Ciénega, Hidalgo County, NM (31.52533°N 108.87275°W).



Animas Creek Ciénega. Extensive segde meadows surround cattail stands with scattered Goodding's willows.



Large earth tank recently constructed in on southwestern part of Animas Creek Ciénega.

Animas Creek Ciénega Plant Species List

*Indicates non-native species

ANGIOSPERMS – Dicotyledonous Plants

Asclepiadaceae - Milkweed Family

Asclepias subverticillata (Gray) Vail; HORSETAIL MILKWEED

Asteraceae - Aster Family

Ambrosia psilostachya DC.; PERENNIAL RAGWEED

Conyza canadensis (L.) Cronq.; CANADIAN HORSEWEED

Heliomeris hispida (A. Gray) Cockerell; ROUGH GOLDENEYE

**Lactuca serriola* L.; PRICKLY LETTUCE

Fabaceae - Pea Family

Trifolium wormskjoldii Lehm. var. *arizonicum* (Greene) Barneby; CUSP CLOVER

Lamiaceae – Mint Family

Lycopus americanus Muhl.; AMERICAN WATER-HOREHOUND

Malvaceae - Mallow Family

Sidalcea neomexicana A. Gray; NEW MEXICO CHECKERMALLOW

Onagraceae - Evening Primrose Family

Epilobium ciliatum Raf.; FRINGED WILLOW-HERB

Ludwigia palustris (L.) Elliott; MARSH PRIMROSE-WILLOW

Plantaginaceae - Plantain Family

Mimulus guttatus DC.; SEEP MONKEY-FLOWER

Polygonaceae - Buckwheat Family

Persicaria amphibia (L.) S.F Gray; WATER SMARTWEED

**Rumex crispus* L.; CURLY DOCK

Salicaceae - Willow Family

Salix gooddingii Ball; GOODDING'S WILLOW

Solanaceae – Nightshade Family

Solanum elaeagnifolium Cav.; SILVERLEAF NIGHTSHADE

ANGIOSPERMS – Monocotyledonous Plants

Cyperaceae - Sedge Family

Carex pellita Muhl.; WOOLY SEDGE

Carex praegracilis W. Boott; FIELD SEDGE

Carex sp.; SEDGE

Cyperus esculentus L.; YELLOW NUT-SEDEGE

Juncaceae - Rush Family

Juncus interior Wieg.; INLAND RUSH

Juncus torreyi Coville; TORREY'S RUSH

Poaceae - Grass Family

**Echinochloa crus-galli* (L.) Beauv.; LARGE BARNYARDGRASS

Hordeum jubatum L.; FOXTAIL BARLEY

Muhlenbergia asperifolia ((Nees & Mey. ex Trin.) Parodi; SCRATCHGRASS

Panicum obtusum H.B.K.; VINE MESQUITE

**Polypogon monspeliensis* (L.) Desf.; RABBITFOOTGRASS

Typhaceae – Cattail Family

Typha latifolia L.; BROADLEAF CATTAIL

MANAGEMENT CHALLENGES

Some remnant southwestern ciénegas have been acquired by federal and state governments and The Nature Conservancy as natural preserves or wildlife refuges. These have usually been protected because of the rare or endangered animals inhabiting the actual spring features, but the rare ciénega plants also need to be considered in preserve management. Ciénegas are productive and dynamic biotic communities that have attracted use by large herbivores for millions of years. A protective fence and hands-off approach for preserve management may only yield a ciénega that is overgrown, thatchy, drying, and pest-ridden (Kodric-Brown and Brown 2007, Unmack and Minckley 2008). Needs for grazing or fire prescriptions, aquifer protection or restoration, and weed control calls for active management.

Restoration and management of ciénegas affected by arroyo cuts that have lowered the potentiometric surface of adjacent springs and seeps will require the very difficult task of aggrading incised channels (Minckley and Brunelle 2007, Turner and Fonseca 2008). The ground water of a dead or damaged ciénega may still be close to the surface, but requires significant sedimentation and restoration of sheet flow to bring the potentiometric surface back to ground level and re-establish a “living” ciénega. On the other hand, former ciénegas supported by spring aquifers that have been depleted by groundwater pumping are unlikely to resume surface flow and become “living” again for the foreseeable future.

Most southwestern ciénegas are in private ownership because the spring features associated with them are valuable assets in an arid region. Restoration, protection and management of these rare and unique habitats are costly and require perpetual effort. Government programs that acquire ciénegas or assist landowners with their management are greatly needed in the southwestern states.

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