CENTRES OF PLANT DIVERSITY

A Guide and Strategy for their Conservation

Project Director: **V.H.** HEYWOOD
Project Coordinator: **S.D.** DAVIS

VOLUME 3
THE AMERICAS

edited by

S.D. DAVIS, V.H. HEYWOOD, 0. HERRERA—MACBRYDE, J. VILLA—LOBOS AND A.C. HAMILTON

published by
The World Wide Fund For Nature (WWF)
and IUCN — The World Conservation Union

with financial support from the
European Commission (EC) and the
U.K. Overseas Development Administration (ODA)

WWF

IUCN
The World Conservation Union

NATIONAL MUSEUM of
NATURAL HISTORY

1997

MEXICO: CPD SITE MA1 0

CUATRO CIENEGAS REGION
Mexico

Location: Intermontane basin in central Coahuila State, northern Mexico, between approximately latitudes **26°45'-27°05'N** and longitudes **102°05'-102°20'W.**

Area: **c. 2000** km².

Altitude: From **c. 740** m on basin floor to over **3000 m** in Sierra de la Madera.

Vegetation: Grasslands with aquatic, semi-aquatic and gypsum-dune habitats in valley; desert scrub and chaparral on mountain slopes; oak-pine woodlands, and montane forests of pine, fir and Douglas fir.

Flora: Diverse flora of eastern **Chihuahuan** Desert, rich in endemics; **860** native species in **458** genera of **114** families, with **23** species endemic; threatened species.

Useful plants: Principally for grazing and forestry; also **medicinals.**

Other values: Tourism, aquatic resources, refuge for fauna – including relict populations and at least **33** endemics; threatened species.

Threats: Logging, mining, extraction of gypsum, grazing, agriculture, as well as contamination and depletion of water.

Conservation: None.

Geography

The region is within the Coahuilan subprovince of the Chihuahuan-Coahuilan Plateaux and Ranges morphotectonic province (Ferrusquía-Villafranca 1993). The BolsOn de Cuatro Ciénegas is a naturally closed-drainage intermontane basin measuring c. 40 km east-west and 25-30 km north-south (cf. Pinkava 1979). It is nearly bisected by the north-jutting Sierra de San Marcos (Map 21). North-centrally in the basin (at 26°59'N, 102°02'W), the town of Cuatro Ciénegas de Carranza prospers near the mouth of the Cañón River, with its fresh water flowing through Cañón del Agua, which is the northern portal between Sierra de la Madera and Sierra de Menchaca.

The basin is bounded on the east by Sierra San Vicente and Sierra de la Purisima, and on the west by Sierra de la Fragua. A railway (Ferrocarriles Nacionales de Mexico) roughly parallels an east-west road across the basin from Puerto Salado to Puerto de Jora. Mexico Highway 30 extends across the municipality of Cuatro Ciénegas southward along the western flank of Sierra de San Marcos toward San Pedro by way of Puerto San Marcos. Minckley (1969) stated that the basin has abundant water, much of it subterranean.

There are seven major above-ground drainage systems, the largest being the San Marcos River (locally the Mesquites River). According to Rodríguez-González (1926), the valley had no outlet but drained through ponds into a large depression in the eastern lobe of the basin, giving the town of Cuatro Ciénegas its name ("Four Marshes"). However, the basin is now drained by a series of constructed canals which ultimately pass eastward through Puerto Salado to the Río Grande (– Río Bravo del Norte). The basin's rivers originate as cool or usually thermal springs (25°-38°C) emerging from travertine-lined tubes or from pits ("pozos", locally "posos") (Minckley 1969). Churince River originates in a large poso and terminates in a large shallow mineralized lake, Laguna Grande. Here evaporation results in the production of nearly pure gypsum salts which dry along the shores and are blown into a very complex series of dunes of varied ages, particularly to the north and west.

There are also subterranean channels, notably along the bases of mountains. Localized foundering of channel roofs has resulted in hundreds of posos. This may be due to lowering of the water table and general sag of the basin floor (Minckley 1969). The posos vary in depth from less than 1 m to more than 10 m, and in diameter from but a few cm to more than 200 m by slumping of their walls; the largest generally are called "lagunas". Progressive foundering of subterranean channels in linear series of posos leads to open channels occupied by swift-flowing streams.

Usually a poso has inflow and outflow. If the outflow becomes plugged, the overflowing water produces travertine deposits, or even cone springs such as Poso Escobeda. If the inflow stops, eutrophication follows, resulting in extensive marshes (Minckley 1969). Large downflow lagunas salinize by evaporation and form miry lakes or playas such as Laguna Grande and Laguna Salada. Waterways are subject to great modification by salts, principally carbonates and sulfates (Minckley and Cole 1968; Wood 1975).

The Cañón River, however, is very different. Its fresh cool water forms well-developed pools and riffles, and supports a rich vegetation along its banks. It is the source of water for the town and irrigation. Although the central basin's rivers are also used for irrigation, some fallow fields south of town blown into dunes apparently testify to accumulation of salts from those sources.

Well-developed and arroyo-dissected alluvial slopes ("bajadas") rise above the basin floor. Towering above them are the massive limestone sierras, part of a system of mountains

trending north-west to south-east that form a barrier, keeping moisture-laden winds from the Atlantic Ocean and Gulf of Mexico from passing on to the arid Central Plateau. The mean annual precipitation in the basin is less than 200 mm (Shreve 1944). Air temperatures range locally from below 0°C in winter to over 44°C in summer (Marsh 1984).

Vegetation

The vegetation of the Cuatro Ciénegas region may be divided into the following major groupings (Pinkava 1984):

1. Basin grassland

The saline valley floor supports an extensive grassland dominated by such salt-tolerant species as *Distichlis* strict a, *Monanthochloe* littoralis and Sporobolus airoides — largely replaced in less saline areas by S. wrightii and S. spiciformis. Portions of the grassland are cultivated or used for pasturage. Secondary succession on fallow or abandoned fields usually results in open stands of species of Atriplex, Suaeda and Prosopis (if dunes form) before returning to grassland.

2. Aquatic and semi-aquatic habitats

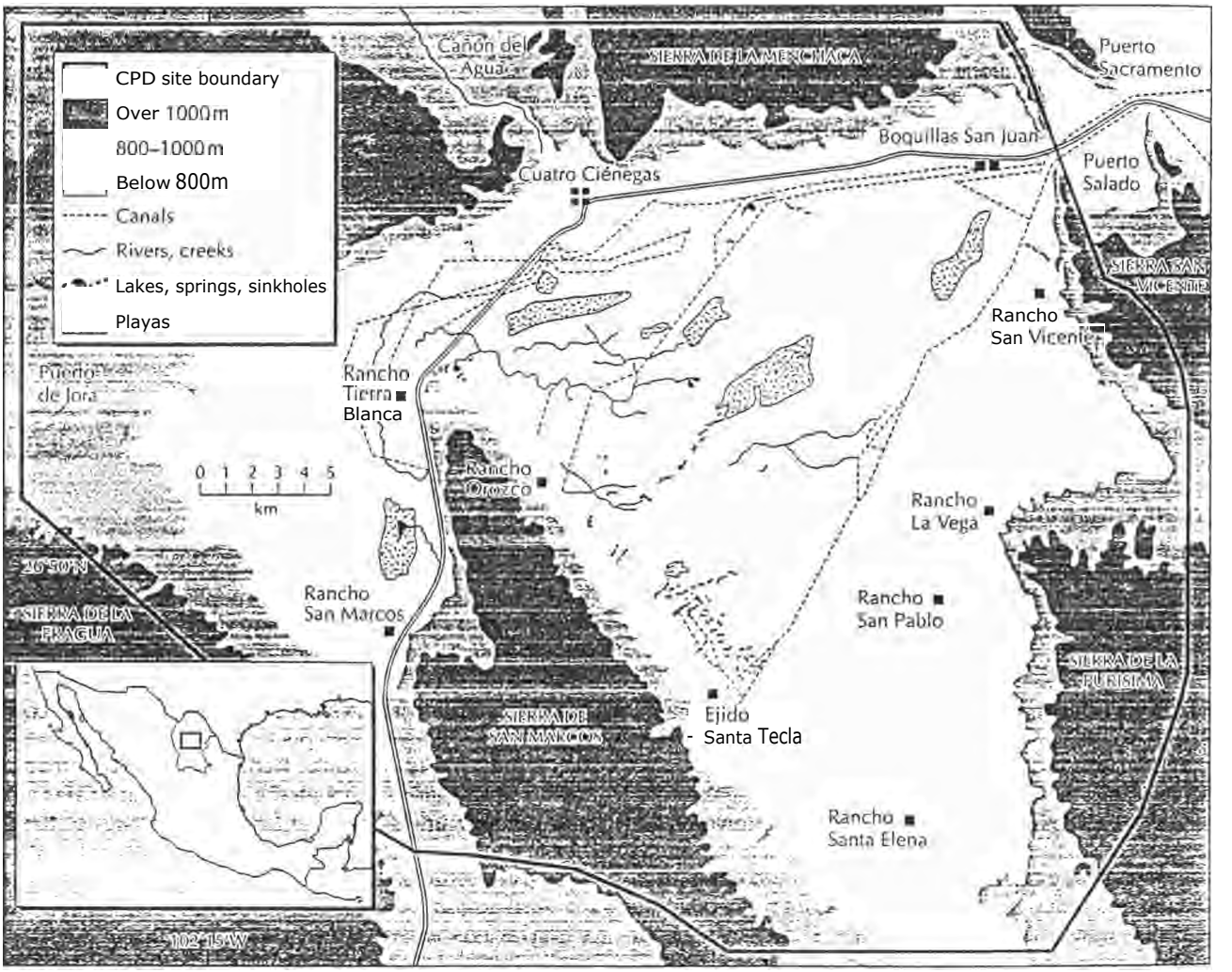
A series of vegetational changes may be witnessed indirectly by observing posos of varying ecological maturities. The slumping banks of the newly founded poso are soon populated by sedges (*Eleocharis*, Carex), additional grasses (*Phragmites*, *Spartina*, Selaria) and species of Polygala, Eustoma and Flaveria. The poso enlarges and matures and ultimately contains the aquatics *Nymphaea ampla*, *Utricularia obtusa* and *Chara*. The shores support Fimbristylis *thermalis*, Fuirena simplex, Heliotropium curassavicum, Bacopa monnieri, Ludwigia *octovalvis*, Anemopsis *californica*, *Ipomoea* sagittata, *Eupatorium betonicifolia*, and the trees and shrubs Prosopis glandulosa (mesquite), Acacia greggii, Fraxinus berlandieriana and Salix nigra.

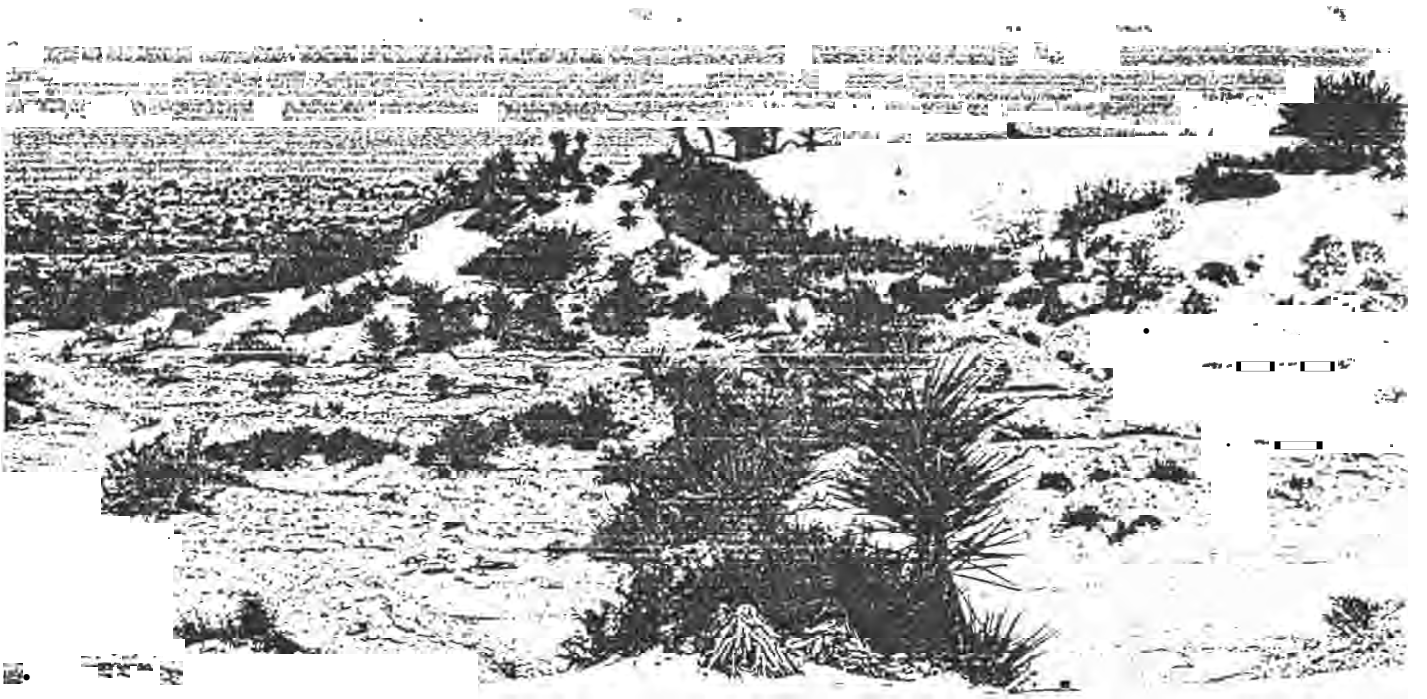
3. Gypsum dunes

White gypsum salts blown from evaporating lakebeds form the dunes. Active dunes up to 6-9 m high encroach upon streams, posos, older dunes and the surrounding plains. Important in stabilizing the dunes are mesquite trees (often nearly completely buried in the sand) and Acacia greggii, Yucca treculeana and *Varilla* mexicana.

Upon stabilization, a greyish crust forms at the surface, apparently by recrystallization. Occupying the dunes are gypsophilous species, particularly some bizarre endemic Compositae — *Machaeranthera restiformis*, M. *gypsophila*, Gaillardia *gypsophila*, Dyssodia *gypsophila* and *Haploesthes* robusta. Also present are Selinocarpus purpusianus,

MAP 21. CUATRO CIENEGAS REGION (CPD SITE MA10), MEXICO (after Minckley 1969)





CPD Site MA10: Cuatro Cienegas region, Mexico. Dunes formed from white gypsum salts blown from evaporating lakebeds. Photo: Patricia Almada-Villela.

Nerisyrenia incana, Petalonyx crenatus, *Chamaesyce* astyla, Fouquieria splendens and Echinocereus *enneacanthus.*

4. Transition zone

Encircling the basin and its [illegible] is an interrupted band of shrubs and trees. These small islands or "[illegible]" are comprised of Condalia warnockii, Suaeda palmeri, *Allenrolfea* occiden*talis,* Atriplex canescens, *Acacia* greggii, *A. neovernicosa* and Prosopis glandulosa.

5. Desert scrub

The bajadas and the lower mountain slopes and arroyos support a rich shrub flora. Characteristic are Larrea *tridentata* with varying combinations of co-dominants – *Agave* lechuguilla, *A.* striata [illegible]. falcata, *Hechtia scariosa, Opuntia bradtiana, Yucca rostrata,* Corclia *parviflora, Jatropha* dioica, *Euphorbia antisyphilitica, Parthenium* incanum and Selaginella *lepidophylla.* In certain areas Flourensia *cernua* and Sericodes greggii largely replace the Larrea.

6. Chaparral zone

Chaparral is widespread, but best developed on northerly and easterly exposures in protected arroyos and canyons and in areas near montane forests. Its often dense growth consists of oaks (*Quercus hypoxantha*, Q. intricata, *Q. in vagina*ta, *Q. pringlei*), heaths *(Arbutus* texana, *Arctostaphylos* pungens), scattered pines (Pinus *remota)* and numerous shrubs and small trees.

On drier sites and on south-facing slopes occur Quercus *hypoxantha,* Q. intricata, Flourensia retinophylla, Sophora *secundiflora,* Cercocarpus montanus, *Nolina cespitifera* and species of *Salvia, Agave* and Dasylirion.

7. Pine-oak and oak woodlands

On higher, moister slopes in protected canyons and at cliff bases, chaparral grades into woodlands of oaks (Quercus gravesii, *Q.* glaucoides, *Q.* pringlei), [illegible] (Pinus *johannis*) and junipers *(Jun*iperus *erythrocarpa* var. *coahuilensis, J. flaccida*). Associates include *Garrya* ovata, *Cercocarpus* [illegible]., *Rhamnus* betulifolia, *Prunus* serotina, *Arbutus* texana, Vitis arizonica and *Ptelea trifoliata.* The palm *Brahea berlandieri* borders pine-oak woodlands, chaparral and lower montane forests on mid-slopes of the sides of north-facing canyons.

8. Montane forest

The [illegible] montane forest is best developed in the upper north-facing canyons of the sierras. Forming the canopy are Pseudotsuga menziesii, Abies durangensis var. *coahuilensis* and *Pinus strobiformis.* The [illegible] includes primarily Quercus gravesii, *Arbutus* texana, Acer *grandidentatum* and *Corn us sericea.* The forest floor is moss-covered, with only scattered herbs and small shrubs.

On more exposed areas *Pin us arizonica* and *Cupressus arizonica* predominate. Below the montane forest on north-facing slopes are pine-oak and oak forests or chaparral. On exposed drier south-facing slopes below the crest and cliffs are scattered pines *(Pin us arizonica, P. remota)*, oaks *(Quercus intricata, Q. hypoxantha, Q. greggii)* and shrubs *(Xerospiraea hartwegiana, Abelia coriacea, Arctostaphylos pungens, Garrya ovata, Nolina cespitifera* and species of *Agave, Opuntia* and *Dasylirion).*

Flora

The native vascular flora of the Bolsón de Cuatro Ciénegas and the surrounding sierras (except the unstudied Sierra de la Fragua) consists of 879 taxa distributed among 860 species in 458 genera of 114 families (Pinkava 1984). Plants normally cultivated but distant from habitation account for an additional 6 genera and species in 3 families.

The basin is known to support a flora and fauna rich in endemics (Marsh 1984). The very rich flora is one of the most varied in the Chihuahuan Desert; 49 taxa have been described with type localities in the region. Of these, 45 are considered accepted taxa, and 23 endemic (Pinkava 1984). An even greater number of taxa are only found in the region and immediately adjacent areas. Concentrations of endemic taxa include: (1) c. 12 endemics in the Laguna Grande-Laguna Churince complex, northward to the Mesquites River, eastward onto the north tip of Sierra de San Marcos; (2) c. 10 endemics in canyons and bajadas of canyons of the Sierra de la Madera's east-facing slope to the crest and partly down the west-facing slope; and (3) an additional 2 endemic taxa in south-facing bajadas and canyons just above Poso Anteojo. These areas need to be correlated with the endemic fauna and afforded protection, in coordination with the people living there.

Useful plants

Many plants of this flora are used in traditional medicine in the rural communities. The extraction of wood from the Sierra de la Madera is the most extensive exploitation, which little by little diminishes the sparse forest, and puts in danger the population *ofAbies durangensis* var. *coahuilensis.* The endemic species are potential genetic resources whose uses and properties should be studied.

Social and environmental values

The Bolsón de Cuatro Ciénegas is unique in having such notable posos of thermal waters and white dunes of gypsum. There are only three such dune formations in North America. Since c. 1964 the striking scenery has attracted the attention of people who consider this oasis a place for recreation (Wood 1975).

The fauna and flora are special, including at least 56 endemics. Some species have been studied considerably; the c. 33 faunal endemics include fishes, turtles, lizards, crustaceans, snails and scorpions. Establishing a biological station in the region would help safeguard the biota, and would enable future generations to learn about the biota, which readily exhibits an interesting array of evolutionary processes such as isolation, adaptation, sympatry, niche segregation, character displacement, speciation and endemism (Taylor and Minckley 1966; Marsh 1984).

Threats

The region has been occupied by agricultural people since the 16th century, but remained little developed by 1959. Contreras-Balderas (1984) has assessed the impacts of people on the environment of the Cuatro Cienegas Basin. Its ecosystems and biota are now suffering accelerating anthropogenic damage because of the drainage of water, temperature imbalances and losses of habitat, population and species. The gypsum dunes are undergoing extraction and destruction, since 1979 on an industrial scale, affecting endemic species. Other notorious effects are irrational development of agriculture and pasturage, overgrazing by goats and horses and depositions of trash. The exploitation of Cactaceae is frequent for sale in the U.S.A., Europe and Japan. Increasing needs of the increasing human population threaten to escalate damage to local ecosystems and to endemic species, possibly causing extinctions.

Conservation

Mexico's Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP) (formerly in SEDESOL), with funding from the World Bank, is studying the region to establish policies for protection and conservation, and planning to develop rationale use and management, including restoration and reforestation efforts (A. Rodríguez 1993, pers. comm.). Because of the rich desert biota, the large number of endemic taxa of plants and animals, the unusual and fragile habitats, as well as the intriguing scenery, there is urgent need to preserve representative portions of this region. This remarkable natural heritage is being degraded more and more, and much could be lost (Marsh 1984; Pinkava 1987). The Cuatro Ciénegas Basin is included in The (U.S.) Nature Conservancy's Parks in Peril Program to help establish a long-term base for preservation (TNC 1990).

References

Contreras-Balderas, S. (1984). Environmental impacts in Cuatro Ciénegas, Coahuila, Mexico: a commentary. *J. Ariz.-Nev. Acad. Sci.* 19: 85-88.

Ferrusquía-Villafranca, I. (1993). Geology of Mexico: a synopsis. In Ramamoorthy, T.P., Bye, R., Lot, A. and Fa, J.E. (eds), *Biological diversity of Mexico: origins and distribution.* Oxford University Press, New York. Pp. 3-107.

Marsh, P.C. (ed.) (1984). Biota of Cuatro Ciénegas, Coahuila, México. Proceedings of a special symposium. *J. Ariz.-Nev. Acad. Sci.* 19(1): 1–90.

Minckley, W.L. (1969). *Environments of the Bolsón of Cuatro Ciénegas, Coahuila, Mexico, with special reference to the aquatic biota.* University of Texas, El Paso. Science Series No. 2.65 pp.

Minckley, W.L. and Cole, G.A. (1968). Preliminary limnologic information on waters of the Cuatro Cienegas Basin, Coahuila, Mexico. *Southwestern Nat.* 13: 421-431.

Pinkava, D.J. (1979). Vegetation and flora of the Bolsón of Cuatro Ciénegas region, Coahuila, Mexico — I. *Bol. Soc. Bot. Méx.* 38: 35-73.

Pinkava, D.J. (1984). Vegetation and flora of the Bolsón of Cuatro Ciénegas region, Coahuila, Mexico: IV. Summary, endemism and corrected catalogue. *J. Ariz.-Nev. Acad. Sci.* 19: 23-47.

Pinkava, D.J. (1987). An urgent need for preservation: Cuatro Cienegas. *Agave* 2: 7-9.

Rodríguez-González, J.(1926). *Geogrea delestado de Coahuila.* Soc. Edición y Librería Franco-Americana, Mexico, D.F.

Shreve, F. (1944). Rainfall of northern Mexico. *Ecology* 25: 105–111.

Taylor, D.W. and Minckley, W.I.. (1966). New world for biologists. *Pacific Discovery* 19(1): 18-22.

TNC (1990). *Parks in Peril: a conservation partnership for the Americas.* The Nature Conservancy (TNC), Arlington, Virginia. 24 pp.

Wood, P. (1975). A nature walk in Cuatro Ciénegas Basin. In Jackson, D.D., Wood, P. and the editors of Time-Life Books, *The Sierra Madre.* Time-Life Books, New York. Pp. 68-83.

Authors

This Data Sheet was written by Dr Donald J. Pinkava (Arizona State University, Department of Botany, Tempe, Arizona 85287-1601, U.S.A.) and Jose A. Villarreal-Quintanilla (Universidad Autónoma Agraria Antonio Narro, Departamento de Botánica, C.P. 25315, Buenavista, Saltillo, Coahuila, Mexico).