

Information Sheet on Ramsar Wetlands

1. **Date this sheet was completed/updated:**

2. **Country:** MEXICO

3. **Name of wetland:** Cuatrociénegas Valley

4. **Geographical coordinates:**

26°45' N - 27°00' N
101°48'49" W - 102°17'53" W

5. **Altitude:** between 740 and 3000 metres

6. **Area:** approximately 150,000 hectares

7. **Overview:**

Cuatrociénegas Valley is a small horseshoe basin near the centre of the state of Coahuila, approximately 176 kilometres northwest of the city of Monterrey. It extends for about 40 kilometres east to west and 30 kilometres from north to south in the centre of the hills of the Sierra Madre Oriental.

There is pressure on the natural resources of the valley because of extraction of minerals from the valley floor, indiscriminate collecting of fauna and flora and use of water, the resource that makes this site unique (Carrera et al., 1989).

The valley's environment is threatened by human settlement, the construction of many irrigation canals and deviation of water from pools and lakes. This has produced a dramatic drop in the water level. Previously submerged ground along the shores is now exposed and is being rapidly colonized by new land habitats that destroy the habitat of many aquatic species (SEDUE, 1987).

This is an intermontane valley, surrounded to the northwest by the Sierra La Madera, to the southwest by the Sierra La Fragua, to the northeast by the Sierra de la Menchaca, to the south by the Sierra de San Marcos y Pinos, to the southeast by the Sierra La Purísima and to the east by the Sierra de San Vicente. The wetlands are in the form of pools (the local term is *pozo*) that range from several metres to almost 500 metres in diameter. The best known pools are Churince, El Mojarral, El Venado, Escobedo, La Tecla, Los Cuates, Poza de la Becerra and Pozos Azules. The largest pools are Laguna Churince and Puente Zumbadora. Many of these pools are interconnected by a system of permanent channels, sometimes underground, that maintain the water in constant movement. The valley's floor is flat, and the surrounding floodplain is quite extensive. In the lowest part of the valley, there is a deposit of gypsum in the form of dunes; a landscape that is unique in Mexico.

In addition to the uniqueness of its landscape, the valley's real value lies in the species of fauna and flora living there, some of which are endemic (the case of 18 species of fish) and others that are threatened by inadequate management (Carrera et al., 1989).

The political divisions of the state of Coahuila are not uniform. Some of the smaller municipalities are found in the eastern central part of the state; these include the administrative municipal centres, which are usually small towns where agriculture is the main activity. Many of the inhabitants now work in the city of Monclova, the largest and most important city in the region (Carrera et al., 1989). There is also a significant number of inhabitants that depend directly or indirectly on the gypsum mines exploited in the valley. According to data from the tenth general census of inhabitants and housing (SPP, 1982), the municipio of Cuatrociénegas has 10,850 inhabitants of which 3,257 (30 per cent) are economically active. This represents 0.67 percent of the active population of the state of Coahuila.

8. Wetland type:

Y, Z, 1, 6, 9

9. Ramsar criteria:

10. Map of site included? Please tick yes -or- no

11. Name and address of the compiler of this form:

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12. Justification of the criteria selected under point 9, on previous page:

Cuatrociénegas Valley represents a wetland of international importance for the following reasons:

1. Criteria of a representative or unique wetland

Constitutes an outstanding example of a natural wetland characteristic of a specific biogeographical region

The importance of the number of endemic species present in this area is greater than in any other consideration in a wetland in the region of the Chihuahua desert.

Is an outstanding or representative example of a wetland that plays a significant hydrological, biological or ecological role in the functioning of a major watershed

The geological and geomorphological characteristics of the floor of the Cuatrociénegas Valley have made possible the development of pools of underground water stored in the aquifers and areas of runoff that surround the valley. This supply of water promotes development of wide areas of halophilic grasses. Even more important, this supply of water supports irrigation systems that are limited only by the saline characteristics of the soils found there. The complex system of underground channels has permitted the perpetuation of endemic molluscs and endemic ichthyofauna, both of considerable taxonomic importance.

Is an example of a specific type of rare or unusual wetland in a specific biogeographic region

The importance of the valley's uniqueness can be compared only to the endemism found on oceanic islands.

2. General criteria based on plants or animals

Has a special importance as a habitat for plants or animals during a crucial stage of their biological cycle

Is especially important for one or more species or communities of endemic plants or animals (see appendices 1 and 2).

13. General location:

This wetland is located in the province of the Sierra Madre Oriental, in the subprovince of the Coahuila hills and plains, according to the Instituto Nacional de Estadística, Geografía e Informática (INEGI, 1994). The valley is in eastern central Coahuila, in the municipality of Cuatrociénegas, bordering on the north with the municipio of Ocampo, on the east with La Madrid, Sacramento and Castaños, on the south with Ramos Arispe and Parras and on the west with San Pedro and Sierra Mojada (Carrera et al., 1989).

14. Physical features:

Climate - The climate on the broad plains of western and central Coahuila is very dry, semi-arid with summer rains and high temperatures but cold winters. INEGI classifies this region as a very dry, semi-warm climate with a low percentage of winter rain. This is the most widespread climate in the western and central parts of the state of Coahuila, dominating the wide desert plains and the lower slopes of the hills on land usually below 1400 metres in altitude with soils typical of the cold areas and scrub or even halophytic vegetation.

The light precipitation, an average of between 100 and 400 mm, falls as rain primarily during the summer in a few rain showers. Heat waves and intense dry periods are relatively common, especially in Ocampo and Mayran. The winter rains are between 5 and 10.2 per cent of total rainfall.

This climate is characterized by a wide variation in temperature with more than 14°C between the hottest month (June) and the coldest month (January). Average annual temperature ranges between 18° and almost 22°C. The highest average monthly temperature reaches 30°C and the lowest is below 12°C. In this type of dry continental climate, it is common that annual average precipitation varies. There are dry years and other years that are quite humid. However, the dry years are more prevalent (Carrera et al., 1989).

Soils - In the hills of the subprovince and on the Coahuila plains, lithosols dominate. They are brown in colour, of medium texture and associated with deeper and darker soils (rendzinas) that lie under calcareous material in the highest parts of this region. Lithosols are also found associated with calcareous regosols. On the slopes of some hills, for example La Madera, xerosols of medium texture dominate. Next in importance are calcarious regosols.

The plains in the southern part of the subprovince frequently have bedrock bases. The calcareous regosols are limited by lithic and calcarious horizons that sometimes contain gravel or rocky surfaces. In areas where water accumulates, there are xerosols and gypsum that present problems of salinity and accumulation of sodium. In addition, there are very alkaline lacustrine or alluvial solonchak soils (Carrera et al., 1989).

The main geological characteristic of the province is the predominance of Mesozoic rocks of marine sedimentary origin that were submitted to tension

and compression and then rose during the abrupt uplifting of hills composed of limestone alternating with intermontane valleys.

The predominant geological strata in the mountains of Coahuila are from the Mesozoic. In the centre of the state, there is granite bedrock. In the north, Precambrian strata together with material from the Palaeozoic indicate that there was a landmass adjacent to a sea during the Permian at these sites. In the Mesozoic, the Coahuila hills emerged, and the sea receded, forming the Coahuila Peninsula. Deposits of gypsum in the central part of Coahuila indicate the former coastline and recession of the sea. Igneous deposits from the Tertiary and lacustrine sediments have been eroded, but not modified. The same occurs with the conglomerates deposited in the intermontane valleys and at the base of slopes.

Data available on erosion and drainage in the region show that intermontane valleys such as Cuatrociénegas are the result of erosion cycles that cut through the mountains. An example is the Cañón del Agua in the northern part of the valley which formed wide alluvial fans. During more recent stages, they formed lacustrine deposits, but at the site occupied by Cuatrociénegas there is evidence of only the edges near Rancho San Marcos. This can be attributed to the action of persistent drainage (Lasso, 1988).

Hydrology - Cuatrociénegas Valley is part of the intermediate Cuatrociénegas subbasin within the area of influence of the Falcón-Río Salado dam in the Bravo-Conchos hydrological region. This region produces underground water in Cretaceous limestone. The intermittent isolation of the valley was caused by water-born deposition of materials and by tectonic movement that formed new mountains. During periods of increased rainfall, the lakes probably overflowed and were again interconnected, creating a drainage system from the southwest in the Sierra de Parras and what is now the lake region passing through Cuatrociénegas up to the Río Bravo.

The current sources of surface water in the valley range from ephemeral deposits formed by rain to permanent bodies of water such as lakes, rivers and springs. The natural drainage of the valley has been modified by the extraction of water through a system of canals.

What are known locally as rivers are natural canals that run through part of the valley. The main river is the Río Mezquites, which begins at a site known as Tierra Blanca and then receives water from springs following the Sierra de San Marcos in the east where it receives water from a system of springs known as the Mohorral. Its flow is slow forming a series of lakes and small streams through the quagmire where it is channelled. Río Puente Chiquito passes to the south of the town and undergoes important fluctuations in water level. The Río Cañón begins in the Cañón del Agua to the north of the town and is a source of water supply for the population. Water is extracted by a system of pumps, but its flow has decreased compared to previous years, possibly because of the exploitation of water in the valleys farther north.

The lakes and other bodies of water are divided by Minckley (1969) into three categories: the first category includes the lakes fed by underground water that forms marshes; the second category, a later stage of the first, includes lakes fed by springs that are found in the lower parts of the valley; the third category includes lakes that form only from rainwater (see map no. 2).

15. **Hydrological values:**

There are surface deposits of gypsum, which form dunes and extensive areas of unconsolidated material in the region. It is important to point out the

purity of these deposits of calcium sulphate. The dunes have determined the abundance of the specific and characteristic fauna and flora in the region with a high number of endemics and unique associations for the desert region of northern Mexico.

The area has a hydrology with a special system of underground rivers, pools and lakes that create places of great scenic and recreational importance. Within the enclosed intermontane basin of Cuatrociénegas, a network of underground water has produced a wide range of aquatic habitats, which sustain a wide diversity of endemic species. Springs and lakes form the larger habitats in the basin and possibly represent the initial stages of the continuous process of formation of marshes. The pools in the Cuatrociénegas basin vary between 90 and 460 metres in diameter. In some pools, the water is replaced constantly, and visibility is seldom less than 9 to 14 metres (Ono et al., 1983).

The Cuatrociénegas basin has abundant water, most of which is underground. There are seven drainage systems, the largest of which is the Río de San Marcos (locally known as Río Mezquites) which is 2.20 metres wide by 2.5 metres deep. Clear water is transported across the Bahía through travertine canals at a rate up to 75 centimetres per second.

The basin is drained by a series of canals that flow to the east through Puerto Salado toward Río Grande. The rivers in the region begin in cold or hot springs that surface in canals or pools. Río Churince begins in a large pool and empties into a large, shallow, mineralized lake called Laguna Grande. Evaporation results from the drying of pure gypsum salt along the shore of the lake and the action of the wind (especially winds blowing to the northwest). The gypsum forms a complex series of dunes of various ages.

There are also several underground channels, especially along the base of the mountains. The covering of parts of these canals (local activity) created hundreds of pools. The progressive sinking of the underground canals into a line of pools can result in the formation of an open body of water, which fills up to create a larger area (Pinkava, 1979).

A pool will usually have an unstable entrance and exit. If the exit closes, the water overflows the banks, creating deposits of travertine and springs like Pozo Escobeda. If water flow is blocked at the entrance, eutrophication occurs, creating large marshes (Minckley, 1969). After evaporation, the large lakes become saline and form lakes or sandy areas such as Laguna Grande and Laguna Salada. The channels are subject to considerable modification caused by the presence of salts, primarily sulphates (Minckley and Cole, 1968). The stable pools and narrow canals can be covered by the development of carpets of vegetation over the flowing water and salt deposits.

Río Cañón is, nonetheless, a very different system. It is freshwater and forms well-defined reservoirs and chains of pools that support vegetation that forms along the shores. This river is a source of domestic water and is also used for irrigation. Although water in the main rivers of the basin are used for irrigation, not all is used and wetlands have formed to the south of the village. Dunes are also formed here from the saline accumulations (Pinkava, 1979).

There are deeper areas in the basin, some are well defined and others are irregular, formed by floods flowing out of dry gullies. Upstream from them are the abrupt limestone hills. They are usually oriented northwest to southeast on the eastern side of the basin. These hills, in a range from the coastal province to the central plateau--just to the west of the Sierra

Carmen, act as a barrier to the moist winds from the Atlantic Ocean and Gulf of Mexico moving toward the central plateau (see map no. 2).

16. Ecological features:

Because of the effects of climate and soils, the enclave of the Cuatrociénegas Valley has, like most of the state of Coahuila, plant associations characteristic of the Chihuahua desert. The following plant associations are found there.

1. Desert scrubland and forested areas
 - a. Microphyllous desert shrubs
 - b. Rosulate desert shrubs
 - c. *Izotal*
 - d. Halophytic scrubland
 - e. Gypsum-tolerating scrubland
 - f. Cylindrical, thick-stemmed shrubs
 - g. Riparian forest
2. Grasslands
 - a. *Navajita* grassland
 - b. *Zacatonal*
 - c. *Toboso* grassland
3. Chaparral
 - a. Montane chaparral
4. Mountain forests
 - a. Juniper and pine forest
 - b. Encino pine forest
 - c. Pine forest
 - d. Mixed-fir forest

The most abundant communities are composed of desert shrubs, which cover approximately 70 per cent of the Chihuahua desert, mentioned in the list above, except the cylindrical thick-stemmed scrubland that occurs in the eastern central part of the state. Grass pastures are not abundant in this area, like in other parts of this desert. Pastures are restricted to the mountains. They are rare in this region like the forests that are found only in the higher mountains of the region such as the Sierra de San Marcos or Sierra La Madera (Carrera et al., 1989).

The following plant associations are found in this region (Lasso, 1988).

- Almost thornless shrubs with:
 - Nopalera* and thorny, thick-rosulate plants
 - Nopalera*
 - Thorny, thick-rosulate plants
 - Halophilic vegetation
- Almost thornless shrubs associated with:
 - Nopalera*
 - Nopalera* and thick-rosulate shrubs
 - Thorny thick-rosulate plants
 - Thorny, thick-rosulate plants and natural pasture
 - Natural pasture and pine forest
 - Chaparral and pine forest
 - Halophytic vegetation
- Halophilic pasture associated with:
 - Thorny shrubs

Gallery vegetation

- Halophilic vegetation associated with:
 - Almost-thornless shrubs
 - Thorny and *izotal* shrubs

- Thorny, thick-rosulate shrubs associated with:
 - Natural pasture
 - Natural pasture and almost thornless shrubs
 - Thornless shrubs and natural pasture
 - Almost-thornless shrubs and *izotal*

- *Nopalera* associated with:
 - Almost-thornless shrubs
 - Almost-thornless shrubs and thorny, thick-rosulate plants
 - Thornless shrubs and thorny, thick-rosulate plants

- Thorny shrubs associated with:
 - Halophilous pastures
 - Introduced pastures
 - Halophilous vegetation

- Natural pasture associated with:
 - Thornless shrubs and pine forest

Although the climate is dry, seasonal agriculture is also practised in this region of annual crops. There are small areas without apparent vegetation, although the area is still almost completely occupied by rosulate desert shrubs and microphyllous desert shrubs in the associations previously mentioned (see map no. 3).

17. Noteworthy flora:

Cuatrociénegas Valley has a very rich flora, one of the most varied in the Chihuahua desert that includes, according to Pinkava (1984), 879 different taxa distributed in 114 families, 456 genera, 860 species and 19 additional subspecies. Because of its geomorphological characteristics, the valley is a closed basin with a high percentage of endemics. In the case of higher vascular plants, 23 species are endemic to the region. A unique case and of great interest to the area is the association of gypsum-tolerant plants with clearly halophytic species. According to Pinkava (1979), this association forms because of certain particularities in the area's soil. Nonetheless, this association, which is unique to this place, is endangered by the continued extraction of gypsum (see appendix 1).

<u>Family</u>	<u>Species</u>
	<u>Conservation status</u>

Figure 0 Endangered plants in the reserve and their conservation status (Pinkava, 1984) ("Diario Oficial de la Federación", 16 May 1994)

18. Noteworthy fauna:

The desert springs in the valley range from rapid flowing springs, deep and stable year-round, or there are areas in the valley where cycles of flooding and dry periods provide a large variety of aquatic habitats. Some species have evolved morphologically and physiologically from ancestral species as they adapt to environmental conditions such as hot springs and high salinity. As a result, more than half of the twenty species of native fish are endemic to the Cuatrociénegas basin. Other fish have adapted to a special habitat without undergoing changes and over the passage of time have retained many of the morphological and physiological characteristics of the ancestral stocks (Ono et al., 1983).

The endemic and relic fish were first surveyed in 1939. Later, it was noted that there was a high degree of endemism among the species. In 1985, field trips collected specimens from the basin, and additional endemic species were found, as well as other species of vertebrates (turtles) and invertebrates (snails and crustaceans).

According to the Red Book of Invertebrates, six genera of snails and ten other species in the basin are endemic and vulnerable (Wells et al., 1983). Three species of turtles are endemic (Brown, 1974; Contreras, 1984). *Terrapene coahuila* is vulnerable according to the IUCN Red Book of Amphibia-Reptilia (Hershler, 1982). Three species of endemic fish are vulnerable, three species are endangered and one species has a critical conservation status, according to the Red Book of Fish of the American Fisheries Society (Deacon et al., 1984). Eight species of fish are considered endangered, two species are threatened and one species is of concern, according to Contreras (1984). Four endemic underground isopods have been described in the basin, according to Minckley and Cole (1968) and Contreras (1984).

The species that are hunted in the region were abundant at one time and were of special importance for the state. An example is the *venado bura*, which is now rare or has disappeared locally. The hunting region around Cuatrociénegas is region number 4. The species that may be hunted according to the hunting calendar vary with the type of hunting permit (Carrera et al., 1989). There are two hunting reserves closed to hunting in this region: Serrania de Zapalinamé and Cuatrociénegas.

<u>Order</u>	<u>Family</u>	<u>Species</u>
<u>Common name</u>		
Aves	Rallidae	<i>Fulica</i>
<i>americana</i>	<i>Galleareta</i>	
Mammalia		

Figure 0 Fauna found in this region

19. Social and cultural values:

In addition to its historic value, a large part of the town of Cuatrociénegas conserves its architectural integrity. It is an example of the traditional construction from the first half of the century and even the nineteenth century of the centre of the region of Coahuila. In the town, there are buildings of architectural relevance, for example the town hall (Presidencia Municipal) and the church. In the surrounding area, there are still vineyards and warehouses that are part of the wine making tradition of Cuatrociénegas. There is also a train station: El Molino del Rey. To the north of the town, there are traditional gardens that form part of the farming culture of this region (Carrera et al., 1989).

20. Land tenure/ownership of:

There are two types of land tenure in the Cuatrociénegas valley: small holdings and *ejido* property. There are 32 properties with a total surface of 51,897 hectares, located primarily on the slopes of the Sierra de San Marcos, near the city of Cuatrociénegas and in the centre of the valley. There are small properties surrounded by *ejidos* in the sandy area and at the foot of the Sierra de La Madera and Sierra La Fragua. The small properties range from 35.96 hectares to 7,855 hectares, according to the Secretaría de Reforma Agraria (SRA) in Coahuila. Not all of these properties are fenced, which makes it difficult to establish their boundaries.

Nonetheless, it is in the *ejidos* that there is the greatest difficulty in determining the real boundaries because many of the extensions have been referred to as "various" in the land registry, and the land is listed as unnamed. The *ejidos* that have land in the valley are Antiguos Mineros, Cuatrociénegas, El Anteojo, El Venado, La Viga, Las Palmas, Nueva Atalaya, San Lorenzo, San Vicente and Santa Teresa de Sofía. Antiguos Mineros, El Venado, La Vega and San Vicente face the Sierras de la Purísima; Agua Chiquita, Nueva Atalaya and San Lorenzo face the Sierra de la Fragua; Cuatrociénegas, El Anteojo and Santa Teresa are near the town of Cuatrociénegas. Part of the *ejidal* land is in the valley, and another part is in the surrounding hills. The total area occupied by the *ejidos* within the reserve is 69,601 hectares, divided into 28 parcels (Carrera et al., 1989).

The current status of land use and land tenure within the area of the reserve are an important consideration in the planning process because they represent the interests of those who live in or near the valley and who should be considered in the question of land use and the human settlements that exist there.

21. Current land use:

Forestry - The inhabitants of the reserve gather several useful species from the arid areas: plants such as *candelilla* (*Euphorbia antysiphilitica*) for the extraction of its wax and *lechugilla* (*Agave lechugilla*) for the extraction of its fibre, especially in the *ejidos* of San Marcos el Nuevo (Nueva Atalaya), Palmira and 6 de Enero. This activity seems to be an

important year round, given that these communities have neither irrigated areas nor fishing resources of any importance.

These activities probably do not significantly affect the desert scrub vegetation. However, they probably alter the plant composition, given that these two species have now disappeared over large areas (for commercial exploitation); from the Sierra de La Madera and Sierra de la Fragua.

On a smaller scale, alcohol is produced using species such as *sotol* (*Dasyilirion palmeri*) and *maguey serrano* (*Agave* spp.). The exploitation in some areas of halophytic vegetation where mezquite (*Prosopis glandulosa*) predominates is important as a source of firewood and fence posts.

Fisheries - The areas occupied by the halophilic pasture and vegetation are used as grazing areas, primarily for horses. The most appetizing species of the halophilic vegetation are in the genus *Atriplex*. Because the species in the halophilic pastures are usually rough, inedible or grow only during the period of rains and growth when it is possible to use new shoots, it is common to stimulate new vegetation in the spring by burning. A deleterious effect of the burning is that grazing has apparently favoured an increase in populations of mezquite (*Prosopis glandulosa*).

The microphyllous desert shrubs are used for grazing goats, although this type of grazing is very limited in the area. The extensive grazing of goats is a difficult activity to manage.

Extraction of gypsum - The extraction of gypsum, in what Pinkava (1984) called the Churince complex, the gypsum dunes, has seriously affected the specific vegetation that grows there. In addition, the association of gypsum-tolerant vegetation with specific halophiles is a special case for the region and there are very few studies on the distribution of these communities endangered by the continuous extraction of gypsum, which reaches 100 to 150 cubic metres per day. Because the industry that processes the gypsum began operations before the creation of the Ley General del Equilibrio Ecológico y de Protección al Ambiente, there has been no environmental impact study. Nonetheless, it is required that the industry establish mitigation measures and regulations for the activities of extraction.

Agriculture - This activity is currently practised on a small scale. Most of the cultivated areas are under irrigation, given the soil limitations here. Nonetheless, there are seasonal lands, such as in the *ejido* 6 de Enero where farms have been abandoned and where a secondary growth halophilic vegetation now grows. Here, it is common to find *maroma* (*Salsola iberica*), *costilla de vaca* (*Atriplex canescens*), *saladillo* (*Atriplex acanthocarpa*) and *gigantillo* (*Nicotiana glauca*). The valley has soils poorly apt for agriculture or livestock grazing. Nonetheless, the water found there is used in other parts of the region of central Coahuila.

Recreation - The outstanding beauty of some of the sites of rivers and pools and the possibility of using them for recreation have resulted in interest at the local and regional levels to visit the area. There is interest in developing this area as a beach area. This is especially the case in the well-known area of Poza de la Becerra on the Río Mezquites and at an artificial pool at the place called Las Tortugas. There is interest in establishing trails around Poza La Becerra, using the most accessible trails to reach the middle of the Sierra de San Marcos from the north. At some sites, the pools are used for sport fishing.

22. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land use and development projects:

The true value of Cuatrociénegas Valley is in the species of fauna and flora that exist there. Some of the species are endemic and others are considered to be vulnerable. The commitment of Mexico to the conservation of biological diversity makes it necessary to give more attention to the often forgotten northern part of the country, where there are a large number of endemic species. Cuatrociénegas is possibly the best example of an area rich in endemic species (Carrera et al., 1989).

The loss of species or habitats, in spite of their having been quantified on several occasions, is the best testimony of the lack of management and conservation of natural resources in this region. Unfortunately, some species are threatened or endangered. In order to avoid further loss, it is necessary to create strategies for conserving habitat.

According to Carrera (1989), pressure on the natural resources of Cuatrociénegas Valley comes from the following sources:

a) **Extraction of minerals from the valley floor** - The commercial exploitation of deposits associated with the pools and the dunes in the valley. The dunes in the valley are calcium sulphate with a content greater than 95 per cent (Minckley and Cole, 1968). They are unique in Mexico and are one of only three such sites in North America. Because of their high quality, the dunes have been exploited since 1968. At the beginning, there was a low level of extraction, but since 1979 extraction has been carried out on an industrial scale. Five hectares have been affected up to a depth of 6 metres (Contreras, 1984b). These dunes, like other deposits of gypsum, maintain many taxa of endemic plants, as well as scorpions (Williams, 1968).

b. **Indiscriminate gathering of fauna and flora** - The unregulated collection of plant species from the desert around Cuatrociénegas is summarized in the following figure.

<u>Species name</u>	<u>Use</u>	<u>Common</u>
<i>Agave lechugilla</i>	extraction of fibre	<i>lechugilla</i>
<i>Agave spp. serrano</i>	production of alcohol	<i>maguey</i>
<i>Dasylirion palmeri</i>	production of alcohol	<i>sotol</i>
<i>Euphoria antysiphilitica</i>	extraction of wax	<i>candelilla</i>

Figure 0 Plant species collected in the Cuatrociénegas desert

The abundant fauna that is exploited in the Cuatrociénegas region is usually hunted. Hunted species are described in figure 3.

c. **Inadequate use of aquifers** - The use of the water in the valley has been a concern of the inhabitants of the region. They have built a series of canals that exit some of the larger lakes or rivers and collect the water to distribute it to the *ejidos* in the southeastern part of the valley or to irrigate other areas outside the valley. At the present time, water is taken away through a system of canals forming irrigation units managed and administered by the Secretaría de Agricultura y Recursos Hidráulicos (SARH) with a total average flow of 3,279 litres per second for an irrigated area of 4,626 hectares divided into eight projects: Antiguos Mineros del Norte, El Venado, La Becerra, La Vega, Saca Salada, San Pablo, Santa Tecla and San Vicente. The total equivalent length of the canal is approximately 205 kilometres. The irrigation system that is used entails capture at a spring, transportation and then irrigation by gravity.

The construction of extensive irrigation canals and the subsequent drawing-off of water from pools and lakes have produced a dramatic drop in the water level (Ono et al., 1983; Contreras, 1984). The ground that was formerly underwater along the shores is now exposed and is quickly colonized by *tulillos* (*Eleocharis rostellata*) and bulrushes (*Typha* spp.). This creates new terrestrial habitats, but destroys the habitats of many aquatic species.

The drop in water level also concentrates the remaining species in smaller volumes of water. This results in an increase in competition for food and predation, altering the population structure and the population of most species. The canals create links among the aquatic habitats that had been isolated for centuries. Species that have evolved separately are suddenly put together and face possible extinction through widespread hybridization among reproductively compatible species (Ono et al., 1983).

A dramatic example of the effects of the canals on the aquatic ecosystem of the watershed is that of Poza La B Herrera, one of the most important and most complex habitats in the region. There was a disturbance in 1961 caused by the construction of an area for bathers, but in 1964 this was drastically changed by the construction of a canal that led to a drop in the water level of almost 36 centimetres in two days (Wells et al., 1983). In addition, bathers have seriously disturbed the bottom with debris and have caused an increase in turbidity. The snails that were once common (*Mexipyrgus* spp., *Mexithauma* spp. and *Nymphophilus* spp.) have decreased in population and very few are now found alive (Wells et al., 1983). This reduction in the number of snails has led to the concentration of the *cíclido caracolero*, endemic to a small area, increasing competition for food. In December 1965, few snails were still alive in La B Herrera, and the survival of this fish was considered doubtful (Ono et al., 1983). Nonetheless, other estimates suggest that only 0.25 to 0.5 square kilometres of the original habitat was lost (Brown, 1974). This discrepancy requires further studies.

Canals are not the only danger to the basin's ecosystem. Other important threats are the expansion of human settlement and agriculture in the Cuatrociénegas basin. An increase in demand for water decreases the flow in the desert; this, in turn, increases the water's temperature. Clear water becomes turbid and deep ponds, in both rapid streams and low-lying areas that form the habitat for several native species, have disappeared (Ono et al., 1983).

The current pressures exerted on the aquatic habitat of Cuatrociénegas are not completely clear. Some information suggests that the watershed has suffered little additional destruction since the 1960s. Nonetheless, several impacts have been recorded there (Contreras, 1984), and it is thought that during the 1980s the area of El Mojarral increased in aridity (Garstka, 1979; Hershler, 1982). Canals are being constructed or have been deepened to provide sufficient flow towards the Río Salado de Nadadores, the primary supplier of water for a larger steel plant in Monclova, Coahuila. Several unnamed pools with populations of the endemic snail *Mexipyrgus churinceanus* have had their flow canalized to increase the flow of the Río Mezquites. One long-term consequence of the system of canals will be the mixing of currents and populations that were once naturally separated. This change has already begun to affect fish and endemic turtles (Taylor, 1979; Smith and Smith, 1983).

The use of this area by the local population has increased enormously, and, in 1979, the Río Mezquites, formerly accessible only by a trail, became a commercial area for recreation and swimming (Hershler, 1982). Construction of a highway from Cuatrociénegas to San Pedro de las Colonias has now made access possible to this area from the south and the east, permitting many

more visitors to the area and exerting even more pressure on the basin (McCoy, 1981).

d. **Other disturbances** - The pressure for development and the urgent need for water, food, roads and leisure areas have affected the valley for some time, but it is in the past few years that they have threatened to damage the local ecosystems seriously. Disturbances and trash are more and more frequent. Destructive exploitation, degradation and the burning of pastures for livestock have left enormous and indelible scars on important areas such as the gypsum dunes, Poza la B Herrera, Pozo Mojarral, Río Mezquites and other places. In addition, the use of the gypsum-tainted water from Cuatrociénegas for irrigation outside the valley damages the soil and decreases agricultural productivity (Contreras, 1986) (see map no. 5).

23. **Conservation measures taken:**

To date, no conservation measures have been taken for the valley. The only steps for conservation and protection have been through municipal proposals for the environment and a proposal to create a protected nature area in the valley.

24. **Conservation measures proposed but not yet implemented:**

There are presently two proposals for the conservation of Cuatrociénegas Valley and the surrounding area: the creation of a protected area and ecological planning for the region of Cuatrociénegas, Coahuila.

Proposed protected area

It is proposed to create a protected area in Cuatrociénegas Valley, which will provide an opportunity to promote the protection of endangered species.

In addition, this will provide greater opportunity for research and education. At the same time, it will regulate the use of renewable and non-renewable natural resources in the area and can give the inhabitants of the region greater alternatives for land use (Carrera et al., 1989).

Currently, one of the most useful conservation strategies is the creation of protected areas, in all forms. In accordance with Mexican legislation, the creation of categories gives an opportunity to select the option that gives the best possibility to preserve a harmonious relationship between conservation and traditional activities in this region.

The creation of a protected area in the Cuatrociénegas Valley should permit:

- a) solution of current problems at the site
- b) restoration of renewable natural resources whenever necessary
- c) conservation of productive capacity, taking into account the needs of the local inhabitants
- d) recreational needs in this area

Conservation of Cuatrociénegas Valley is important from the point of view of biodiversity. This implies having an administrative tool, such as a management plan, that will make it possible to establish criteria for strategies to be used for the general development of the area.

The management plan proposed for this area by Carrera (1989) includes the following objectives:

1. Administration of the area in order to ensure wise use of its resources without losing the current composition.

2. Creation of administrative measures that make possible the conservation of the protected area. This includes guards, services, concessions, agreements and determination of the public's rights and obligations.

3. Creation and promotion of management practices for natural resources that can be extended to other areas.

The following steps have been established to fulfil these objectives:

1. Preservation of representative areas in the valley, especially aquatic systems considered unique.

2. Conservation of biological diversity with emphasis on endemic and endangered species.

3. Protection of the cultural and historic heritage of the area.

4. Control of the extraction of water from the valley and proposals for alternative use.

5. Determination of the best forms of production in terms of sustainable development.

6. Promotion of the wise use of resources and establishment of rural development programmes compatible with conservation in the areas surrounding the reserve.

7. Establishment of research and management programmes for natural resources in co-operation with other institutions that help ensure the future of the resources and possible reintroduction of species at the site.

8. Establishment of programmes of environmental education for the benefit of local inhabitants and visitors.

The proposed area includes approximately 120,000 hectares which are in *ejidal* and private lands. Whenever possible, natural limits and roads are taken as boundaries. In the event that a natural boundary is not available, the first choice is an altitude. The limits of the proposed protected nature area promote protection of the valley floor and the Sierra de la Madera. Nonetheless, this will be revised in order to facilitate administration.

To name the area as a biosphere reserve will make it possible to permit development of extractive and productive activities under the control and regulations of the area's administrator. It is important not to include settlements in the reserve that would increase the difficulty of administration and development of the reserve. In light of these considerations, boundaries are often drawn around urban areas (see map no. 1).

Ecological regulations for the region of Cuatrociénegas, Coahuila

The ecological regulations for this region have the objective of establishing criteria to regulate activities that promote raising the quality of life of the inhabitants, promoting sustainable productive activities and protection of biodiversity and the ecosystem (SEDESOL, 1994).

In order to achieve this, a study was made of the biotic, abiotic, social and economic environment of the region at the request of the Dirección General de Planeación Ecológica of the Instituto Nacional de Ecología (INE) of the Secretaría de Desarrollo Social (SEDESOL).

As a result of the study, a proposal for the organization of the ecology of the area was divided into two approaches: region of Cuatrociénegas, Coahuila and the subregion of the Cuatrociénegas Valley, Coahuila. The area of Cuatrociénegas Valley is a priority in light of the considerable human pressure and because of the presence of relevant biological and geological elements.

The proposal for the ecological organization of all of the area lays out the ecological policy (use, conservation, restoration or protection) to be adopted for each environmental unit defined. Land use is defined on the basis of environmental attributes and criteria for ecological organization that will regulate productive activities and the use of existing natural resources.

The proposal for the ecological organization of all of the area is centred on the conservation of wildlife living in the mountains around Cuatrociénegas Valley. This will permit the following productive activities:

1. Extensive raising of sheep subject to a load factor in accordance with the region's capacity for producing pastures
2. Extraction of plants for domestic consumption, except species with a vulnerable conservation status
3. In low-lying area, activities are subject to a use policy under which there are regulations for productive activities such as agriculture, livestock raising and use of plants

The proposed ecological organization of the area of the valley includes among its most relevant points the creation of a biosphere reserve for the wetland system in which the ecosystems of the gypsum dunes and fauna and flora endemic to the marshes and pools are concentrated. It is proposed to set aside an area for the establishment of industries, essentially assembly plants consuming little water and producing a low level of pollutants.

The following important aspects of the ecological organization are the most important:

1. In areas with a slope greater than 40 per cent and soils shallower than 10 centimetres, the original plant cover should not be removed.
2. The use of the pools should be only for recreation with regulated activities. No infrastructure should be created for these activities, and equipment should be restricted to only the indispensable (trash receptacles, palm shelters, septic tanks).
3. Extraction of water from pools in this area should be without the use of pumps.
4. Use of *candelilla* (*Euphorbia antysiphilitica*) is subject to forest management that ensures the sustainable use of this resource.
5. No industry will be allowed to operate in this area.
6. No species with a vulnerable conservation status can be exploited (see figure 3).
7. The area used for agriculture should be cultivated with species tolerant of the high levels of salinity present in the short cycle.

8. Seasonal agricultural should be oriented toward the use of crops that slow down the process of soil salinization. Likewise, pastures resistant to saline conditions should be used to control erosion in these areas.

9. Human settlements should not be permitted in this area.

The proposed ecological organization of the priority subregion of the valley takes into account the best land use, the characteristics of each defined environmental unit and the corresponding ecological policy and an alternative use of productive activities within a sustainable development scheme, even when they are not the best from the point of view of the soil.

The conditioned use should be subject to a series of strict regulations of the productive activities carried out there, but which it is impossible to eliminate in order to build the basis for the economic development of the region or the country. These regulations are designed to mitigate the environmental impact that the productive activities produce or might produce by incompatible uses that are those in opposition to the sustainability of productive activities and the conservation of natural resources.

In the ecological organization of the priority subregion the following criteria stand out:

1. Infrastructure should be introduced for irrigation in areas used for seasonal agriculture.

2. Before clearing land for industrial activities, vegetation should be saved on the land to be used. Special importance should be given to species with a vulnerable conservation status.

3. In the short run, a system for treating municipal waste water should be created using the wetlands. Rehabilitation of a previously constructed waste treatment plant should be undertaken.

4. Existing livestock production must be concentrated near agricultural areas, whenever this activity is carried out far from human settlement and sources of water.

5. The processing of gypsum cannot be carried out at the same site as its extraction. At the extraction site, only an access road can be built from the highway. All of the extracting companies must take measures to conserve vegetation in the dune area over areas equivalent to their concessions in the environmental impact studies.

6. Use of the gypsum is subject to the following restrictions:

a) provisions must be made to collect periodically raw material and solid waste dropped accidentally.

b) no housing may be constructed in the areas subject to exploitation. Housing must be in towns close to the area.

c) a solid and liquid waste management programme must be provided for.

7. The environmental impact resulting from the removal of vegetation must be mitigated through reforestation of exploited areas.

8. There will be no exploitation of species with a vulnerable conservation status listed in figure 3.

9. Agriculture can be expanded on lightly saline yermosols with moderate potential for erosion.

10. Areas of seasonal agriculture must use agricultural practices that favour the use of plants resistant to salinity and that increase soil productivity.

11. The burning of vegetation must be avoided in order to promote the growth of pasture for livestock.

12. There will be no construction of infrastructure for recreation within the area. Infrastructure is limited to indispensable equipment.

13. Pools will be used only for recreation under regulated conditions.

14. There is to be no expansion of farming.

15. The introduction or development of aquaculture using exotic species will be prohibited in bodies of water because of the negative impact that this activity can have on endemic species.

16. It is prohibited to increase infrastructure for channelling water (wells, pools and marshes), and only maintenance of the present infrastructure will be allowed.

17. It is prohibited to drill wells in the urban area of Cuatrociénegas for supplying potable water.

18. Water for the industrial area should be supplied by pumping from the nearest aquifer, always avoiding extraction that exceeds the capacity for recharging the aquifer.

19. The extraction of water by pumping should be subject to a preliminary study that measures flow. Extraction should not exceed the aquifer's capacity for replenishment.

20. Within the proposed reserve, before approval of any proposal for the opening of new areas for the extraction of gypsum, a preliminary study should be carried out. Before beginning any work, a study must be made that evaluates the possibility of sparing gypsum-tolerant vegetation from an invasion of opportunistic species encouraged by clearing operations, both for the opening of roads as well as in extraction areas. This study should also evaluate the possibility of saving and propagating plant species and of integrating alternatives for the selection of extraction sites and sites for reforestation or relocation of specimens recommended by the study.

25. Current scientific research and facilities:

Research activities are carried out in this area by educational institutions, both Mexican and foreign, governmental institutions and NGOs, primarily because of the unique characteristics of the region. These activities concentrate on monitoring changes to both the environment and to the fauna and flora. In the proposed protected nature area, there are plans for a research area in an area where unique or fragile species of fauna and flora and ecosystems or natural phenomena worthy of concentrated attention for scientific purposes of environmental regulation are normally found.

For the purpose of management in the proposed protected nature area, three scientific areas have been defined which do not communicate among each other. For this reason they are described independently (Carrera et al., 1989).

1. Scientific area of gypsum dunes - This covers the largest part of the dunes and a surrounding grassland to minimize impact on the area. Its importance lies in the presence of endemic flora limited by the soil conditions at the site.

2. Scientific area of the Pozos Azules corridor - This area lies to the east of the Sierra de San Marcos and extends to the west up to the road that goes to Santa Tecla. In its north-south dimension, it extends from Pozo del Tío Cándido to the main canal of Santa Tecla, including all of the system known as Pozas Azules which is probably the area of ponds with the best conservation status.

3. Scientific area of Salinas - This area covers the eastern part of the valley, subject to flooding, because this site still conserves important examples of fauna such as turtles. This site was frequently burned with a loss of fauna (see map no. 4).

The main Mexican institutions for research and education that have a presence in the area are the Universidad Autónoma Agraria Antonio Narro, Laboratorio de Itiología Escuela de Graduados, Facultad de Ciencias Biológicas de la Universidad Autónoma de Nuevo León and a diverse group of universities from the southern United States.

A large number of studies have been made in the area on various aspects. The most numerous studies cover taxonomy of molluscs (snails), crustaceans, fish, desert flora, descriptions of several associations of fauna and flora, both interspecific as well as of subspecies. In addition, studies have been made of the impact of the extractive activities in the area on biotic, geological and hydrological resources.

The recognition by Mexican and foreign scientists of the biological importance of Cuatrociénegas Valley has been confirmed by the 50 years of a tradition of systematic scientific research.

26. Current conservation education:

The area occupied by Cuatrociénegas Valley, from the beginning of scientific research almost fifty years ago, has been a site used primarily by foreign scientists, although also by Mexican researchers, in search for taxonomic and ecological information considered to be important from the point of view of biology. Production of scientific material in the form of articles and theses is important, but up to now this material has not been used in public education programmes. This has produced a misleading impression about the true value of the site and represents an obstacle for its conservation.

Nonetheless, there are proposals by government agencies and NGOs for education programmes in the area which are included in the proposal for the protected nature area within the management plan for the valley. In order for the educational programmes to be successful, it is recommended that research not be limited to activities in the area. Advantage should be taken of the existence of primary and technical schools to carry out co-ordinated programmes dealing with the reserve. Not only schools but also the general public should participate in the programmes. To reach the public, it is proposed to create a permanent exhibition in one of the historical or cultural buildings as well as temporary exhibitions, a visitors centre and a museum of natural history. The fact that the city is considered to be a cultural and historic area is helpful.

Within the reserve, there are plans to use interpretive programmes including guided and self-guided walks, exhibitions and audiovisual sessions. These

programmes deal with the geology, natural history, cultural and historical values and management of the reserve. At the same time, these activities serve to promote an appreciation of the scenic value of the site.

There is a group of environmentalists that meets with local officials to discuss conservation of the valley. The group is not a local group, but it is supported by the current municipal authorities and state-wide NGOs located in Saltillo, Coahuila.

Unfortunately, any initiative for education about the biological importance of Cuatrociénegas Valley depends on external initiatives. There is no recognition by local inhabitants of the ecological importance of the Cuatrociénegas area. There is also no local centre focusing on the scientific research produced. This indicates that there has been no feedback leading to an awareness of the importance of the reserve where in order to promote its protection, conservation and administration.

27. Current recreation and tourism:

The most popular recreational activity is the use of the ponds as beach areas. Some areas are more developed, for example La Becerra, and because of this, are more frequented. Their value as a site for recreation are currently restricted to places that have sufficient surface water to serve as reservoirs. Recreation takes place only during the hot seasons, because the winter climate in this region is cold. In addition, the vegetation in this area does not offer the possibility for use as a recreational site.

Recreational activities produce modification of resources (contamination of pools and disturbance of the bottoms of aquatic environments) and accumulation of trash.

These aspects are symptoms of a lack of recreational programmes or overuse of the site. Whatever the origin of the problem, this can be remedied through regulatory measures and management of recreation. This is provided for in the proposal for a protected nature area in the management plan. In order to do this, it is necessary to know the carrying capacity of this site, taking into account the number of users, the capacity of installations, the capacity of resources to recover from the impact of visitors and the quality of the recreation. It is also necessary to diversify recreation in order to avoid concentration of recreational activities in a single activity. Recreation should be viewed as another component of the cultural integration of a society with the environment using guided visits along specific routes on foot, horseback or bicycle, where the public can appreciate the geomorphology, geology, biology, ecology and scenic values available at the reserve.

In order to avoid problems of overuse, it is necessary to adopt three different strategies depending on the needs of each specific site: use limitation, through a reduction in the number of visitors, reduction of the concentrated or dispersed impact of use and maintenance of favourable condition for this resource, using vegetation as a natural limit for certain activities or using gravel roads in the areas most exposed to deterioration (Carrera et al., 1989).

It is important to consider the natural vocation of an area and its association with recreational and tourist activities. In these terms, traditional tourism has no place in this type of habitat, and an appreciation of the true value of the area is limited to small groups from other regions. Among the alternatives to be considered for tourism are low-impact tourism and very selective ecotourism. The creation of sites of

special interest can perhaps serve an increase in visits to the area in the future, orienting the interest to know the unique values of this reserve.

28. Jurisdiction:

At the present time, the only persons responsible for the Cuatrociénegas region are private owners, *ejidatarios* and the federal government in a few areas. The agencies responsible for the administration of the renewable natural resources and non-renewable resources are part of the federal government, for example the Secretaría de Agricultura y Recursos Hidráulicos for the use of hunting and water administration. The Secretaría de Energía, Minas e Industria Paraestatal is responsible for the regulation and administration of the surface deposits of gypsum in the region of Churince.

Recent administrative changes and new management policies for both renewable and non-renewable resources have resulted in former regulations and administrations being unsatisfactory in terms of maintenance of ecological equilibrium. The general law for ecological equilibrium and environmental protection (LGEEPA) establishes the requirement to carry out environmental impact studies and corrective and mitigation measures of former extraction techniques. It also deals with protection, given the unique characteristics of the site. Chapter two of the LGEEPA proposes guidelines for the declaration and organization of the protected areas describing categories recognized by the system. Given the importance of Cuatrociénegas Valley, the endemic species that live there, the surrounding mountains and valley floor with components and representative communities of the Chihuahua desert, the legal status that best suits the size of the protected areas is that of biosphere reserve.

In order to give this area that status, it is necessary to form a commission including the Secretaría de Agricultura y Recursos Hidráulicos (SARH) and the Secretaría de Pesca (SEPESCA). Article 70 of the LGEEPA provides for the requirement of a prohibition in core areas of the biosphere reserve to deviate or interrupt the flow of water. This provision will limit the future use of water, which will necessitate participation of the Comisión Nacional del Agua.

In November 1994, 83,347 hectares of the region of Cuatrociénegas, Coahuila, were declared an area for the protection of fauna and flora. Administration is the responsibility of SEDESOL which co-ordinates the participation of state and municipal governments.

The decree provides for regulation of the use of water, fauna and flora. Government property will be regulated and the activities on private and *ejidal* land must be regulated in accordance with the management plan to be prepared within one year (by 7 November 1995) ("Diario Oficial de la Federación"; 7 November 1994; pp. 5-11).

29. Management authority:

The agency responsible at the federal level for the administration of the reserve is the Secretaría de Desarrollo Social (SEDESOL), through the national system of protected nature areas (SINAP), which, according to the legislation, can organize the joint administration of the reserve with the state and municipal authorities and private parties.

In the surrounding area within the states of Coahuila and Nuevo Leon, there are several groups of NGOs active in research and education that have assumed responsibility for managing the conservation of the Cuatrociénegas area. Members of UANL, UAAAN and the Profaua group are the main proponents of many of the proposals for protection of this site. State authorities and

representatives of the Secretaría de Desarrollo Social and the national government have promoted studies of the ecological organization of the Cuatrociénegas region and the proposed protected nature area. Unfortunately, all of these efforts have not born fruit for several reasons, among which is the lack of involvement of the local population that would lead to a request for regulatory and protective measures for their own resources.

In light of this, it is necessary to consider the creation of an interdisciplinary group oriented specifically toward management of the conservation of the Cuatrociénegas region, with representation of non-governmental groups (representatives of a certain sector of society), educational and research institutions, federal authorities and state authorities, as well as representatives of the local inhabitants of the Cuatrociénegas region in order to prepare global objectives for conservation.

30. Bibliographical references: