Information Sheet on Ramsar Wetlands

1. Date this sheet was completed/updated: 15 August 2001

2. Country: Mexico

3. Name of wetland: Wetlands of the Rio Colorado Delta

4. Geographical coordinates:

31º 50´ North latitude
114º 59´ West longitude

5. Altitude: 0 to 5 metres above sea level

6. Area: 250,000 hectares

7. Overview:

The wetlands of the Colorado River delta form a unique system broken into natural and artificial wetlands created and maintained by the basin of the Colorado River (main branch), the hydrological system of the Irrigation District 014 Colorado River (valleys of Mexicali and San Luís-Colorado River), the farming valleys of Yuma and Wellton, Mohawk in Arizona and the intertidal seawater of the Upper Gulf of California (Alto Golfo de California), also known as the Sea of Cortes. There are several types of wetlands: freshwater, brackish, intertidal marine with an extensive area of riparian vegetation (poplar (*alamo*)-willow (sauce)-mesquite) emergent aquatic vegetation (*tular-carrizo-junco*), coastal halophytic vegetation, also known as *saladar* (*batis*, *pasto salado*, *Salicornia*) and large areas of invasive plants (*pino salado*). Part of the site forms part of the Upper Gulf of California Biosphere Reserve and delta of the Colorado River, especially the nucleus of the Delta of the Colorado River and part of the buffer area. Productivity in the Upper Gulf of California depends in large part on this broken-up system of wetlands. Together, they are the site of large biological diversity and productivity, making this system of wetlands unique and important for the conservation of endemic and endangered species and migrational habitat for thousands of migratory aquatic and terrestrial waterfowl.

8. Wetland type:

Marine/Coastal wetlands: F and H

Inland wetlands: N and R

Artificial wetlands: 1, 5, 6 and 9

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Marine/coastal wetlands
F: Estuarine waters; permanent water of estuaries and estuarine systems of deltas;
H: Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes;

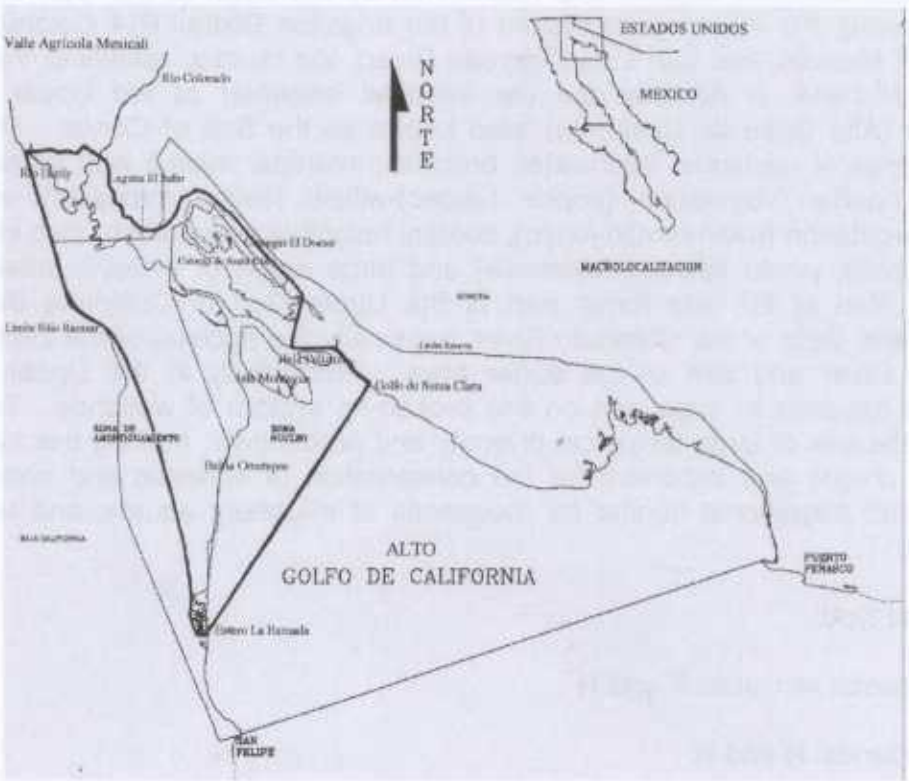
Inland wetlands
R: Seasonal/intermittent saline/brackish/alkaline lakes and flats;

Human-made wetlands
1: Aquaculture (e.g., fish/shrimp) ponds;
5: Salt exploitation sites; salt pans, salines, etc.;
6: Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 hectares);
9: Canals and drainage channels, ditches;

9. Ramsar criteria: 1–6 and 8

Criteria that best characterize the site: 5

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:

Criterion 1: This is the delta area of one of the most important hydrographical basins in North America. Several regulations have provided protection for this nature area at the federal level. It has been designated as a site of national and international importance within the hemisphere's network of shore bird reserves, as well as other designations such as area of importance under the management plan for aquatic birds in North America, an area of importance for bird conservation (AICA), priority region for conservation by CONABIO (region hydrological). It maintains remnant natural communities of past conditions in the delta. It is the site of semi-natural wetlands of great bi-national importance such as the Ciénaga de Santa Clara. It has a high potential for management, conservation and use by the local communities. It is an excellent site for promoting scientific research and restoration of ecology.

Criterion 2: It is a critical habitat for rare, endemic and endangered species at the national and international levels (Mexico-United States).

Criteria 3 and 4: This site is of great relevance within the Pacific migratory corridor for aquatic birds (ducks, geese and shorebirds) and is a corridor for Neotropical terrestrial birds.

Criterion 5: This criterion is applicable because of large concentrations of aquatic birds during the winter months. Recorded sightings show that the wetlands in the farming areas of Mexicali and San Luis R.C. (Hardy-Colorado rivers, the wetlands of the Ciénaga de Santa Clara and El Doctor) maintain relatively high numbers of birds. Together provide an important habitat for the following species:

Cerceta aliverde (*Anas crecca*) with more than 40,000 specimens
Gallareta (*Fulica americana*) with more than 12,000 specimens
Ganzo nevado (*Chen caerulescens*) with more than 6,000 specimens
Pelicano pardo (*Pelecanus occidentalis*) with more than 10,000 specimens

In the coastal environments, chiefly on the coast around the islands (Montague and Pelicano) in the delta, there are a large number of birds, especially marine-coastal birds. It is estimated that there are approximately 163,744 specimens of shore birds, especially the *playerito occidental* (*Calidris mauri*), *avoceta americana* (*Recurvirostra americana*) with about 9,000 specimens and *playero Pihuihui* (*Catopthrophorus semipalmatus*) with about 8,000 specimens.

Criterion 6: More than 90 per cent of the world population of *rascón picudo* (*palmoteador de Yuma*) (*Rallus longirostris yumanensis*) lives at the site, especially within the Ciénaga de Santa Clara with more than 6,000 specimens. This subspecies is endemic to the Lower Colorado River in the United States and Mexico and is considered to be an endangered species.

Criterion 8: There are areas of important organic productivity that support commercial populations in the Upper Gulf of California.

13. General location:

This site occupies most of the floodplain of the delta of the Colorado River from the junction of the main river with Río Hardy up to its mouth in the Upper Gulf of California. It is located on the state borders between Baja California and Sonora, although most of the site is in the state of Baja California in the municipio of Mexicali. In Sonora, it is in the municipio of San Luís-Colorado River. The cities closest to the site are Mexicali (50 kilometres away) and San Luís-Río Colorado (45 kilometres away).

14. Physical features:

Climate: The climate for the area is very dry (BW) with two subtypes, using the Köeppen classification modified by García (1973): subtype BW hw (x')(e'), very dry semi-hot with extremes, which covers the Sonora Coast, and subtype BW (h') hw (x')(e') very dry very hot and very extreme hot in most of the delta of the Colorado River and the coasts of Baja California. In the northern part of the gulf, there are two seasons: winter from November to May and a subtropical summer from June to October. The climate is more continental than oceanic because it is surrounded by the Sonora Desert and by the mountain chain of Baja California (with altitudes of 1000 to 3000 metres), which decreases the influence of the Pacific Ocean.

Temperature: The average annual temperature for the region is 22.6° C. In the Gulf of Santa Clara, the average annual temperature is 23.1° C, with an average monthly maximum of 38° C in August and an average monthly minimum of 12.6° C in January. In San Felipe, the average annual temperature is 24.8° C, with an average monthly maximum of 33.4° C in July and average monthly minimum temperature of 16.1° C in January. In Puerto Peñasco, the average annual temperature is 20.1° C, the average maximum monthly temperature is 29.7° C in August and an average monthly minimum of 11.2° C in January (Records of CNA). The winter of 1987–1988 was the coldest winter registered in the region during recent years with temperatures of less than 0° C on twelve nights in December to January (Records of SARH). The highest temperatures registered at the site were at Estación Riíto, where in July 1958 a temperature of 59.5° C was recorded. This area is considered to have one of the most extreme temperature ranges in the world.

Precipitation: The average annual precipitation in the area is extremely low, with rainfall occurring mainly in the winter, although some rains do occur in summer with an overall average for the region of less than 100 millimetres. The number of days

with annual rainfall is approximately five, from the central part of the coast of Lower California up to the head of the Gulf.

Winds: During the winter, three to six days of winds from the northwest (8–12 metres/second) occur along the axis of the Gulf, bringing cold air from the desert over the Gulf. The winds that cross the Gulf from the Pacific are influenced by topographic features when they pass over the Baja California Peninsula and are especially intense in the northwest. In summer, large-scale pressures create light winds from the southeast (2–5 metres/second) oriented mainly along the Gulf, which bring squalls (*chubascos*) and torrential tropical storms. The action of these winds on the surface of the sea brings high humidity to the northern part of the Upper Gulf and to the delta.

Geology: The sandy plateau to the east of the mouth of the Colorado River is formed by consolidated sediments from the Pleistocene, chiefly sandstone and layers of lutite with a thickness of less than one metre. In the area surrounding the town of Golfo de Santa Clara, fossils of several species of vertebrates have been found including two of birds, six of reptiles, 27 of mammals, one amphibian and undetermined parts of several fish.

The sedimentary deposits that characterize the site are of diverse origin:

1. Of alluvial origin, the deposits of the delta of the Colorado River and the deposits of the El Moreno and El Chinero llanos on the coast of Baja California formed by runoff from the Agua Dulce-Santa Clara and Laguna Salada-Arroyo El Diablo basins and the deposits of La Salina;

2. Of coastal origin, along the coastline with areas exposed to waves in Sonora and Baja California;

3. Of lacustrian origin in areas of low wave energy, such as on the large floodplains to the west of the Delta of the Colorado River, Estero La Ramada and Estero La Ventana, on the coast of Baja California and in the Ciénaga del Doctor and the Estero Las Lisas in Bahía Adair along the coast of Sonora;

4. Of paludal origin, found mainly in the Ciénaga de Santa Clara (recent origin).

Most of the sediments transported to the northern part of the Upper Gulf are alluvial from the Colorado River. Additional inorganic material is of volcanic and benthic origin from erosion of granite rocks on the Baja California Peninsula. They represent a small amount compared to the contribution of sediments transported by the Colorado River. Small outcroppings of Palaeozoic rocks (schist) are located on the western edge of the site, and there are outcroppings of Cretaceous granodiorite rocks near San Felipe.

As for seismic activity, the delta of the Colorado River is one of the most active seismological areas in the world because it is located in the area where the Pacific Plate and the North American Plate meet. The delta is crossed by several known faults, including the Imperial, Cerro Prieto and Laguna Salada Faults along which tremors of various magnitudes have been recorded since 1852 with magnitudes from

4 to more than 7.0 degrees on the Richter scale. These geological faults have led to creation of the famous San Andres Fault.

The recent deposits on the delta plain of the Colorado River north of San Felipe are made up of mostly silt and fine sand. In them are located a series of elongated barriers also known as *conchales* (*cheniers*), composed of mollusc shells, chiefly the delta clam (*almeja del delta*) (*Mulinia coloradoensis*). This endemic species to the delta is currently almost extinct for lack of fresh water from the river.

The *cheniers* have been constructed by fluctuations in the discharge of sediment from the Colorado River. In the low parts, there is more supply of sediment than erosion of fine material, mixing and concentrating the shells in mounds by the effect of the waves. The *cheniers* are arranged parallel to the coastline and ordered chronologically from the oldest inland to the most recent on the current coastline. The most recent have been dated by radiocarbon between 215 and 650 years old. However, there are shells from 2000 to almost 5000 years old in the oldest mounds.

Geomorphology: The terrestrial topography of the area is very regular, characterized by wide plains on the western side with gradual slopes of less than two percent with several very localized hills, Cerro El Moreno, Cerro Lágrimas de Apache and Cerro El Chinero, with average elevations of 200 metres. In the eastern part of the reserve is located the sandy plateau, which is characterized by alluvial terraces originating in the delta, with an average elevation of 50 metres above sea level and the dunes of the Altar Desert, which are characterized by heights between crest and valley of an average of 80 metres.

The intertidal area between San Felipe, Baja California, and the mouth of the Colorado River is characterized by an uneven substratum in a direction approximately parallel to the axis of the gulf. The north-south orientation of the channels acts to concentrate the flow of the tides and, therefore, affects turbidity, location of springs and productivity.

Hydrology: The site forms part of two hydrological regions: the first, Four, called Baja California Noreste (Laguna Salada), and the other, Seven, called Colorado River. Part of hydrological region Four, with a slope of runoff of 5–10 percent, occupies the western part of the reserve from Puerto de San Felipe to the mouth of the Colorado River at the same latitude as the southern portion of Montague Island. It is divided into the Agua Dulce-Santa Clara and Laguna Salada-Arroyo El Diablo basins. The first drains into the Salinas de Ometepec, Estero la Ramada and the sandy beaches north of San Felipe, and the second drains into the Bahía de Ometepec.

Hydrological region Seven includes the mouth of the Colorado River, divided into two basins: the right bank (eastern), Bacanora-Mejorada, with a slope of 0–5 percent and the left bank (west), with a slope of runoff of 5 to 10 percent (Colorado River). On the right bank, there are freshwater springs (El Doctor), which has created a lentic environment. In addition, since 1979 water from the Wellton-Mohawk canal has restored the Ciénaga de Santa Clara, the last remnant of the original vegetation of the Colorado River delta. The water that flows through this canal comes from the Wellton-Mohawk Irrigation District in the United States and is the result of the use

and reuse of water used for agricultural irrigation, containing approximately 3.2 percent dissolved solids.

Fresh water contributions: The only significant source of surface water at the site comes from the Colorado River. Before completion of Hoover Dam in 1935, the annual volume of the Colorado was almost 500 cubic metres/second and contributed 50 percent of the total fresh water that entered the Gulf of California. Recently, the flow of the river to the Gulf has been drastically and continually reduced. The annual average volume between 1935 and 1965 was about 4,934 million cubic metres. At the beginning of the 1970s, the annual discharge according to the El Marítimo station (Mexico) was only 104 to 620 million cubic metres and for 1963–1964 no water reached the Gulf from the river. In fewer than 100 years, the Colorado River has been transformed drastically and irreversibly into a system of controlled segments. Completion of the Hoover Dam marked the final free flow of the river. Since then, the system has become one of the most altered and closely controlled in the United States and Mexico. There is a system of dams, diversion of water and channelled parts of the river. In addition to having one of the most arid outlets in the world, the river provides more water for farming and urban consumption than any other river in the United States.

On 3 February 1944, the Treaty on Borders and Water was signed, which still today regulates runoff of the Tijuana, Grande/Bravo and Colorado rivers. This treaty guarantees Mexico an annual volume of water from the Colorado River of 1,850 million cubic metres, in a first condition considered to be normal. A second condition is when there is excess water in the upper river basin when annual supply would be increased to 2,096 million cubic metres. A third condition is the case of a serious drought in the upper basin, when the volumes of water supplied to Mexico would be reduced proportionally to that of the reduction in the United States.

On 30 August 1973, Act 242 of the Comisión Internacional de Límites y Agua (CILA) entered into force to solve the problem of the drainage water that Mexico receives on the northern border. That document requires construction of a concrete drainage diversion from Morelos Dam to the former point of discharge of the Santa Clara-Riíto drain, previously known as Riíto Salado, to discharge brackish drainage water from the Wellton-Mohawk District. The first runoff occurred on 23 June 1977 and created and still maintains what is now the Ciénaga de Santa Clara with an area of 12,000 hectares of which 4,000 have emergent vegetation (*tular*). In 1990, the volume of water carried in the Wellton-Mohawk canal monitored by the Comisión Nacional del Agua is estimated to be 55 million cubic metres and minimum recorded salinity was 2.9 percent.

Soils: In the area of the site, there are predominantly solonchak and regosol soils. The first occupy the large floodplains of the Delta of the Colorado River.

Water quality: The current over-appropriation of water from the Colorado River presents a discouraging panorama for Mexico as final user of the basin. The keen struggle for appropriation of water from the river among users in the upper and lower basins, between California and Arizona, and between agriculture and urban use is a result of overexploitation of the resource. Overexploitation has a direct impact on

loss of water quality in the basin because the salt content and other agricultural and industrial pollutants increase in proportion to their use in the basin.

In 1902, salinity of the water in the Colorado River was 400 mg/litre; in 1932, it was 600 mg/litre; in 1948, the concentration was 760 mg/litre and in 1960 it increased to 800 mg/litre. Currently, it is about 1000 mg/litre. Analysis of lineal regression found an annual increase in mineralization of the water of about 0.5 mg/litre ($r^2=0.87$). Based on this analysis, it is estimated that by 2010 salinity of the Colorado River on the Mexico-United States border will reach 1150 mg/litre.

With the gradual decrease in the volume of the Colorado River with periods without flow and the high evaporation, conditions in the Delta of the Colorado River changed from a positive estuary to that of a negative estuary with conditions of hyper salinity (salinity close to 40 percent) and high temperatures.

Tidal regime: There are diurnal and semidiurnal cycles with variations in sea level of 6.95 metres in San Felipe and up to 10 metres in the of the Colorado River delta, creating tidal currents with velocities of 0.21 metres/second along the Sonora coast and 0.89 metres/second on the coast of Baja California. This series of processes in turn causes a phenomenon of vertical homogenization of the water column. Tides in the Upper Gulf are considered among the largest and most spectacular in the world, which create large intertidal areas of up to five kilometres wide. It has been confirmed that tides move through the delta of the Colorado River at velocities of 3–4 metres/second.

Watershed and runoff of the basin: This river begins in the Rocky Mountains west of Denver, and its basin has an area of 631,700 square kilometres, (10,025 square kilometres in Mexico) that concentrate 18,000 million cubic metres annually and benefit more than 19 million inhabitants of which 17.5 million are located in the United States and the rest in Mexico in the state of Baja California and a small part in the state of Sonora. The Colorado River flows 2,320 kilometres from its origin to its mouth on the Gulf of California, and its flow generates 12 million kW of electricity per year. It is fed by several tributaries, the most important of which are Río Gila, Río Virgen and Río Pequeño del Colorado, all in the United States.

15. Hydrological values: Hydrology is relevant for control of branches of the Colorado River, especially in the spring. The discharge of water and sediments at the mouth leads to a loss of nutrients to the coastal waters of the Delta, thus increasing productivity there. Ciénega de Santa Clara is an important receptor of the Wellton-Mohawk irrigation district in Arizona and the Valle de San Luis in Mexico, as well as the main source of sediments for the Gulf of California.

16. Ecological features:

Colorado River Delta: The Colorado River Delta is within the nucleus of the Reserve. It extends along the coast of Baja California to the Estero La Ramada and along the coast of Sonora to near the town of Golfo de Santa Clara, covering an area of approximately 120,000 hectares. Until construction of dams on the Colorado River, the delta was considered a positive estuary. However, the current low supply of fresh water does not compensate high rates of evaporation, creating anti-estuarine

characteristics. The delta is characterized as a portion of the reserve with high hydrodynamics (high tides and strong currents) and high primary productivity. There are diverse habitats such as floodplains, tidal channels and islands. On the islands, there is halophyte vegetation. These characteristics convert the delta into an important area for reproduction, the laying of eggs and growth of marine species, among which stand out the *totoaba* (*Totoaba macdonaldi*) and *gruñón del Delta* (*Colpichthys hubbsi*) whose distribution is restricted to the Colorado River delta and several species of commercial interest such as the prawn (*Penaeus* spp.), *chanos* and *curvinas*. Furthermore, the channels and intertidal areas, floodplains and associated halophyte vegetation convert the delta into a region of great importance for shore birds, among which *chorlitos* (*Calidris* spp.) are important because of their numerical importance. The islands that form the delta (Montague and Pelicano) are breeding sites for birds such as the *perro del agua* (*Nycticorax nycticorax*), garzas (*Ardea herodias*, *Hardea thula*), *gaviota* (*Larus atricilla*) and *gallitos de mar* (*Sterna antillarum*, *S. elegans*, *S. nilotica*).

17. Noteworthy flora:

Halophyte vegetation: This type of vegetation, known as *saladar*, is found in relatively small local areas along the coast of the Upper Gulf of California and in several areas in the delta of the Colorado River. They grow in the lower parts of closed basins in arid and semiarid areas, as well as in tidal areas. The characteristic topography is sandy areas or small dunes with very little elevation above sea level. Soils are sandy with a high salt content. Vegetation is formed by an association of low halophyte shrubs with stems or leaves, succulents, grasses and several perennial grasses (*zacates*). The main species are *saladito* (*Frankenia palmeri*), *sosa* (*Suaeda estereoa* and *S. puertopeñascoa*), *hierba del burro* (*Allenrolfea occidentalis*), *hielito* (*Sesuvium verrucosum*)*, zacate salado* (*Distichlis palmeri*), the only pasture endemic to the Sonora Desert, and the *zacatón alcalino* (*Sporobolus airoides*).

Emergent aquatic vegetation: This type of vegetation is found in the Ciénega de Santa Clara and in the Ciénega El Doctor. It is dominated by *tule* (*Typha domingensis*), several sections with *carrizo* (*Phragmites australis*) and *junco* (*Juncus acutus*). The edges of these sites are dominated by halophyte vegetation. This vegetation is considered a remnant of what were the brackish and freshwater wetlands of the former delta of the Colorado River.

18. Outstanding fauna

The freshwater ichthyofauna of the Lower Colorado River included about eight native species at the beginning of the century. Currently, the *pez cachorrito del desierto* (*Cyprinodon macularius*) is the only survivor of the former native species in the reserve. The rest of the freshwater ichthyofauna is represented by 19 exotic species and three invasive marine species (*Elops affinis*, *Gillichthys mirabilis* and *Mugil cephalus*).

At the site, the main habitat of the *pez cachorrito del desierto* is the Ciénaga de Santa Clara and the Ciénega El Doctor. This species was once widely distributed throughout southern Arizona and southeastern California in the United States and in northern Baja California and Sonora in Mexico. This species became extinct in

Arizona in the 1950s and in 1986 was listed as an endangered species by the government of the United States and recently by the government of Mexico. The reasons for listing it include loss and modification of its habitat because of the draining of streams and swamps, blocking of streams, channelling of streams, grazing of cattle, mining, pollution, interactions with predators and exclusion by exotic fish.

In the Ciénaga de Santa Clara, the *pez cachorrito del desierto* lives in shallow water (less than 40 centimetres) with little vegetation and has adapted to changes in conditions. It can maintain permanent populations in small areas. It is unlikely that the *pez cachorrito del desierto* lives permanently in the main body of the Ciénaga because of the presence of competitors such as *molies* and *pez mosquito* (*Poecilia latipinna* and *Gambusia affinis*) and predatory exotic fish such as the *lobina negra* (*Micropterus salmoides*) and common carp (*Cyprinus carpio*). In the Ciénaga El Doctor, there are shallow areas at or near the freshwater ponds where there are also exotic species such as the *pez mosquito*, *mollis* and tilapias.

Among the fauna, birds are widely represented with about 210 species of resident and migratory, terrestrial and aquatic birds, which characterize the area with wide diversity. They are concentrated in shallow bodies of water such as the Ciénaga de Santa Clara, Ciénega El Doctor and the mouth of the Colorado River near Montague and Pelicano Islands.

Several relevant species present in the area are the osprey (*águila pescadora*) (*Pandion haeliaetus*), *águila calva* (*Haliaetus leucocephalus*), *Peregrine falcon* (*Falco peregrinus*), *pelicano blanco* (*Pelecanus erythrorhynchos*), *pelicano pardo* (*P. occidentalis)*, *gaviota* (*Larus delawarensis)*, *golondrina de mar menor* (*Sterna antillarum*), cormorant (*Phalacrocorax auritus*), duck (*Anas crecca*), Canadian goose (*Branta canadensis*), *gallareta* (*Fulica americana*), *palmoteador de Yuma* (*Rallus longirostris yumanensis*) and *rascón negro* (*Laterallus jamaicensis*). A good number of terrestrial Neotropical birds use the region of the delta of the Colorado River during their migration in the spring and autumn; for example *mosquero* (*Empidonax* spp.), *chipe amarillo* (*Dendroica petechia*), *tangara rubra* (*Piranga rubra*) and *picogordo azul* (*Passerina caerulea*).

The *rascón picuado* (*palmoteador de Yuma*) (*Rallus longirostris yumanensis*) uses freshwater habitats, marshes of the Lower Colorado River, the southeastern part of the Salton Sea in California and isolated patches of the Gila River. Apparently, the delta of the Colorado River was the nucleus of its historic distribution. With the almost complete elimination of the delta in the last century, the significant remnant habitats of the delta of the Colorado River in Mexico are Ciénaga de Santa Clara, El Doctor, Laguna El Indio and the Río Hardy wetlands.

The wetlands in the reserve, especially the marginal habitats of Ciénaga de Santa Clara, have been affected by periodic changes in levels of flooding caused by the contributions of the Wellton-Mohawk Canal. These changes have produced changes in the populations of *pez cachorrito del desierto* (*Cyprinodon macularius*) whose survival depends on stability in levels of flow. Another cause of the decrease in population of this species is competition with other exotic syntopic fish, especially with tilapia and the *pecílidos* (*Poecilia latipinna* and *Gambusia affinis*). In addition to

these species, another twenty forms of exotic fish are known to live in the area of the reserve, which are important because of their abundance and importance for recreational fishing or for subsistence of two species of tilapias or *mojarras* (*Tilapia zilli* and *Oreochromis aureus*), five of *ictalúridos* (catfish) (*Pylodictis olivaris*, *Ictalurus punctatus*, *I. furcatus*, *Ameiurus melas* and *A. natalis*) and six *centrárquidos, lobinas, bocones* or *mojarras* (*Micropterus salmoides, Chaenobryttus macrochirus*, *C. gulosus*, *C. cyanellus*, *Pomoxis nigromaculatus* and *P. annularis*).

There are several species of introduced invertebrates such as the *acocil rojo de río* (*Procambarus clarkii*), *almeja asiática* (*Corbicula fluminea*) and one species of estuary prawn (*Palaemonetes paludosus*). The effect of these species on native populations is still unknown and should be studied. Several plants, such as the *pino salado*, date palm and *zacate buffel*, also are not native to this region.

19. Social and cultural values:

Fisheries in continental waters: Fishing is considered to be one of the most important and traditional activities in the area. This has been documented since the beginning of the twentieth century. There have been several places where fishing was practiced, primarily in the main branch of the Colorado River.

Ciénaga de Santa Clara represents a vast lacustrian system that can be used for capturing non-native fish, especially species such as the common carp (*Cyprinus carpio*), tilapia (*Tilapia* sp.), *lisa rayada* (*Mugil cephalus*), *lobina* (*bocón*) (*Micropterus salmoides*) and *bagre de canal* (*Ictalurus punctatus*), among others. The capture of these species, low rates of capture based on minimum sizes, closed season and maximum volume of capture per season should be established for sustainable management of this resource. It is recommended that biological-fishery studies of species in this region be carried out in order to produce information required for this management purpose.

Several species that occur in the Reserve may be found on the national fisheries map:

Common carp (*Cyprinus carpio*)
Bagre cabeza de toro (*Ameiurus melas*)
Bagre de canal (*Ictalurus punctatus*)
Mojarra agalla azul (*Lepomis macrochirus*)
Tilapia (*Tilapia zilli* and *Oreochromis aureus*)
Lobina (*Micropterus salmoides*)

Cultural values

First Inhabitants: Archaeological findings from 9350 B.C. helped establish that the first inhabitants of the region of the Upper Gulf of California were the San Dieguito people, ancestors of several groups such as the Cucapá (*gente del río*), which occupied the delta and the shores of the Colorado River, and the O'odham (Pinacateños and Areneños) who occupied the dunes, bays and areas of El Pinacate. The first archaeological studies in the area were those of Gifford (1946), who, using fragments of ceramic and artefacts in shell mounds found in the area of

Puerto Peñasco, suggested an ethnic border between the Yumano and Hohokam between Punta La Choya and Estero Morua.

Culture Hakataya: Most of the archaeological sites that surround the delta of the Colorado are associated with the Yumano Cucapá and Quechan groups. However, given the ethnographic connotation of this term the term Hakatay has been suggested. This group occupied from 200 A.D until several centuries ago an area made up of southern California, southern Nevada, south-western Arizona and northern Lower California, including the area of the Colorado River in north-western Sonora. According to Schroeder (1960), the distinctive characteristics of this group are lightly polished gold jewellery worked on an anvil, a few stone artefacts and rare shells without changes. These traces apparently are those that exist in shell mounds in the area of Golfo de Santa Clara. Because there has been no archaeological research in this area, apparently these traces are related to the Hakataya and more closely with the Patayan division established by Schroeder (1988), which is limited to northern Lower California, southern California and western Arizona.

Culture Cucapá: The people belonging to this culture call themselves “the river people” (Cucapá) and are direct descendents of the Yumanos. Their culture, which dates from the past 400 years, was closely linked to the Colorado River and its delta, and their lives always (according to their tradition) depended on the river. They used the shores of the river for planting, preparing the soil fertilized and wetted by the delta after spring and mid-summer flooding. Formerly, the delta had very dense vegetation, made up of willows, poplars, mesquite and annual plants. As part of their diet, they collected *péchitas* de mesquite, *palo verde, palo fierro, verdolagas* and *quelites*. On the savannahs, they collected seeds from annual and perennial grasses (*zacates*). In the spring, they travelled on the river on large reed rafts, travelling to the mouth where there were large areas of *trigo gentil* (*salado*) (*Distichlis palmen*).

On the river, they captured *charal del Colorado*, *lisa* and *matalote jorobado*, which moved upriver with the tides. They also travelled toward the mouth of the river to capture *totoabas*, prawns and other species that reproduce in this area. On the banks of the river and nearby, there was abundant hunting of *venado bura* and *berrendos*. Several of these animals were objects of adoration and used as symbols of totemic ancestral lines. Rattlesnakes had a religious status.

20. Land tenure/ownership of:

(a) At the site: Land at the site includes government land (80 percent) made up of mainly areas subject to flooding known as federal channels or federal maritime-terrestrial areas; ejidales (15 percent) with ejidos located in the Colorado River irrigation district 014 and (5 percent) in concession to private parties, especially for aquaculture activities.

(b) In the surrounding area: In the surrounding area, the land is held as ejidales (Mesa Rica, Luis E. Johnson, Flor del Desierto, Rosa Morada, Lagos de Moreno in Sonora and Oviedo Mota, Cauces Federales and Plan de Ayala in Lower California, communal property of the Cucapah community) and some land as private property or under concession.

21. Current land use:

(a) At the site: Small-scale fishing, ecotourism, aquaculture (semi-intensive ranching of prawns), scientific research and environmental education;

(b) In the area surrounding the watershed: Irrigated farming, extensive grazing, hunting, agro-industrial activities, urban development, mining and industry.

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

At the site: The main adverse factor is the availability of volumes of water for maintaining or increasing existing wetlands, either freshwater directly from Morelos Dam or brackish water from farm drainage in the farming valleys. Expansion of exotic species such as the *pino salado* (*Tamarix* sp.) has moved into large parts of the wetland, especially into areas where there is high soil salinity and limited open water. In this sense, there is a major limitation to restoration of several areas because of the dense cover of this species and the difficulty of controlling or removing it.

In the surrounding area: In the surrounding area, there are the farms in the San Luis and Mexicali valleys and several human settlements that produce solid waste.

23. Conservation measures taken:

Background:

In 1955, the Direction de Pesca e Industrias Conexas (Diario Oficial of 23 February, No. 43, Vol. CCVIII) declared the area to be a refuge for all species. The area was defined as the water between the mouth of the Colorado River towards the south up to an imaginary line from the southern part of Bahía Ometepec, Baja California, to the mouth of Río Santa Clara on the coast of the state of Sonora.

In 1974, (Diario Oficial of 30 May), a reserve for raising and repopulation for all species of fish was declared in the area of the delta of the Colorado River in the Gulf of California bounded by an imaginary line from Punta Machorro in Sonora to Punta Zacatoza in Baja California, tangent to the extreme southern tip of Montague and Gore islands from the coast of the Gulf of Santa Clara on the eastern coast of Lower California.

In August 1990, a meeting was held at the offices of the Centro Ecológico de Sonora on conservation in the Upper Gulf of California with representatives of several institutions with interest in the area in order to form a working group and a preliminary action plan for conservation in this area. As a result of this meeting, within the framework of the Mexico-USA-Canada Tripartite Commission, the Secretaría de Desarrollo Urbano y Ecología requested the government of the state of Sonora to prepare a study as background for a proposal for conservation for the area. This project received financial support from the North American Wetland Conservation Council, the Nature Conservancy and Conservation International.

On 2 March 1992, after a series of meetings convened at the initiative of the president by the Instituto Nacional de Pesca concerning the question of La Totoaba and La Vaquita in the Upper Gulf of California a technical committee for preservation of La Totoaba and La Vaquita in the Upper Gulf of California was formed.

In June 1992, a workshop was held in Puerto de Mazatlán, Sinaloa, for identification of priority marine areas for conservation, organized by the Secretaría de Desarrollo Urbano y Ecología and the World Wildlife Fund focusing on the Upper Gulf of California as the third priority marine area for conservation in the country.

On 19 February 1993, at the request of the Direction General de Aprovechamiento Ecológico de los Recursos Naturales del Instituto Nacional de Ecología of the Secretaría de Desarrollo Social, Wetlands for the Americas declared the Delta of the Colorado River to be an international reserve of the Hemispheric Network for Shore Birds (RHRAP). In March 1993, under the framework of the Technical Committee for Preservation of La Totoaba and La Vaquita in the Upper Gulf of California, a document was presented to the federal authorities entitled "Proposal for the Declaration of the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve", prepared jointly by several governmental and non-governmental institutions. Based on this proposal, on 10 June 1993, the president of Mexico, at Cerro Prieto, municipio de Puerto Peñasco, Sonora, declared the region of the Upper Gulf of California and Delta of the Colorado River a biosphere reserve. This decree was published in the Diario Oficial on 10 June 1993 (annex I).

The management programme for the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve was prepared and submitted to the community on 5 June 1996 by the president of Mexico. That document was made official through publication in the Diario Oficial on 2 July 1996.

The document for the management programme presents a proposal for land use and for use of soil and natural resources (scale 1:250,000), including environmental policies for each natural unit, guidelines, criteria ecological and activities and actions planned for the short, medium and long term, for drafting the annual action programmes (POA). It also establishes two main components: use and protection for sustainability with subcomponents of protection and conservation, research and monitoring and environmental education.

In 1997, a letter of intention was signed by SEMARNAP-DOI in which was designated as a sister reserve the Imperial reserve of the Upper Gulf Reserve and cooperation was begun.

24. Conservation measures proposed but not yet implemented:

Several proposals are under consideration for conservation or management of wetlands in this region that include:

Carrying out direct management activities at the juncture of Río Hardy and the Colorado River for restoration of wetlands;

International management to obtain permanent freshwater quotas for the delta and Upper Gulf of California.

25. Current scientific research and facilities:

Federal Research Institutions

Centro de Investigation en Alimentation y Desarrollo (CIAD) Unidad Guaymas

Reproductive success of the *palmoteador de Yuma* and *tecolote llanera* around Ciénega de Santa Clara

Centro de Investigation Científica y de Education Superior de Ensenada (CICESE)

Monitoring nesting birds on the islands of the Delta of the Colorado River (ongoing)

Universities and Institutions of Higher Education

Universidad Autónoma de Baja California (UABC)

Phytoplankton and bacterial productivity in the delta of the Colorado River (1990)

Geochemical description of organic material at the mouth of the Colorado River, Sonora

Effects of discharges of the Colorado River on the geochemistry of the Upper Gulf of California (1995–1997)

Distribution and movement of dissolved gases in seawater: Chemical-biological interrelations in the Gulf of California (1994–1996)

Estuary of the Colorado River: Functioning of the breeding area and growth cycles in the life cycle of the prawn and other ecologically and commercially important species (ongoing)

Population study of *Chione cortezi* in the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve (1994–1997)

Biology and ecology of three species of clams in the Upper Gulf of California (1994)

Biological diversity and database for the natural coastal-peninsular ecosystems of the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve, Baja California, Mexico (1994–1996)

Universidad de Sonora (UNISON)

Evaluation of the situation of the populations of *pez cachorrito del desierto* (*Cyprinodon macularius*) in the lower basin of the Colorado River, Sonora and Baja California, Mexico (1996–1997)

Centro de Estudios Superiores del Estado de Sonora (CESUES)

Perspectives for ecological tourism in Ciénega de Santa Clara (1996–1997)

Universidad Nacional Autónoma de México (UNAM)

Palaeontology and changes in the vegetation in the Ciénegas de Santa Clara and El Doctor (ongoing)

Instituto Tecnológico y de Estudios Superiores de Monterrey, Campus Guaymas (ITESM-CECARENA)

Water balance in the region of the delta of the Colorado River (ongoing)

Database of information and local programme for restoration of the Río Hardy wetlands in the delta of the Lower Colorado River, Baja California and Sonora, Mexico Phases I, II y III (ongoing)

Habitat management and monitoring of migratory waterfowl and associated wildlife in the Colorado River delta: a binational joint venture (1998–2000)

Instituto Tecnológico del Mar, Guaymas, Sonora (ITMAR)

Ecology and growing of *totoaba* (Phase I)

Ecology and growing of *totoaba*: Experimentation with pellets (Phase II)

Ecology and growing of *totoaba*: Nutritional aspects of juveniles (Phase III)

Distribution and growth of juvenile organisms of *Totoaba macdonaldi* in relation to environmental parameters in the Gulf of California

University of Arizona

Level of exposure of the *cachorrito del desierto* (*Cyprinodon macularius*) to trace metals and organo-cloride pesticides in the wetlands of the delta of the Colorado River, Mexico (ongoing)

One thousand years of Colorado River flow: The proxy record of oxygen isotopes in marine molluscs from the Colorado Delta (ongoing)

Selenium in the remnant wetlands of the delta of the Colorado River, Mexico (ongoing)

Evaluation of the population of *palmoteador de Yuma* (*Rallus longirostis yumanensis*) in the delta of the Colorado River, Mexico (ongoing)

Arizona Western College

Geologic survey of the Sonora plateau (ongoing)

State Governments

Instituto del Medio Ambiente y Desarrollo Sustentable de Sonora (IMADES)

Field station for evaluation and management of the wetlands of the nucleus of the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve, Mexico (1996–1998)

Public participation and restoration of the wetlands of the nucleus of the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve, Mexico, Phase II (ongoing)

Population study of the *chano norteño* (*Micropogonias megalops*) (*Pisces: Sciaenidae*) and the *curvina golfina* (*Cynoscion othonopterus*) endemic species to the Upper Gulf of California (1997–1999)

Strengthening of capacity for serving ecotourism in the Ejido Luis E. Johnson, Municipio of San Luís-Colorado River (1998–1999)

Study of the structure of the population of *chano norteño* (*Micropogonias megalops* Gilbert), an endemic species to the Upper Gulf of California (1996–1998)

Discovering the wetlands of the Colorado River delta (ongoing)

Non-governmental Organizations

Conservation International Mexico, A.C. (CIMEX)

Portfolio of sustainable projects for diversification of the economy of the inhabitants of the Reserve (1996–1997)

Strengthening of community development, health and conservation in the Gulf of Santa Clara, Sonora, Mexico (ongoing)

Centro Intercultural de Estudios de Desiertos y Océanos, A.C. (CEDO)

Preparation of didactic and training materials for teachers in the Upper Gulf of California and Delta of the Colorado River Biosphere Reserve (1997–1999)

Community action: children and teachers of the Reserve (1996–1997)

Pronatura, Sonora Chapter

Public involvement in the delta of the Colorado River (1998–2000)

United States Geological Service (USGS)

Use of the Colorado River, Delta and Biosphere Reserve by Neotropical migrant land birds (ongoing)

Mapping *Typha domingensis* in the Ciénaga de Santa Clara using satellite images, Global Positioning System and spectrometry (1997–2000)

26. Current conservation education:

During the past four years, the Reserve has promoted the component of environmental education and community development in the communities there. This programme covers activities ranging from promotion of educational activities, provision of information and cooperation with institutions that carry out educational activities in the Reserve. Among the most relevant projects are elaboration of didactic materials, pamphlets, posters, a video on the wetlands in the Reserve, a video on the delta of the Colorado River, t-shirts, cards, calendars for 1998 and 2000 for the wetlands of the Colorado River, a travelling exposition, "Colorado River: Water of life", and participation in various workshops and conferences.

One of the main activities is celebration of three dates of special importance: World Wetlands Day (February 2), the Week for the Environment and anniversary of the Reserve (June 5 and 10) and the World Bird Festival (October). During these celebrations, expositions, conferences, visits to the Reserve with schoolchildren, drawing or poetry contests, among others, are held.

There are two visitors' centres that serve groups and carry out environmental education activities. In Puerto Peñasco, Sonora, is located the Centro Intercultural de Estudios de Desiertos y Océanos, A.C. (CEDO), which has carried out projects for preparing didactic material about the Reserve for primary schools. The Instituto del Medio Ambiente y Desarrollo Sustentable de Sonora (IMADES) operates a field station in the town of Golfo de Santa Clara, which maintains exhibits on the site, information and receives groups and scientists who visit the site. In the Ejido Luis E. Johnson located near Ciénega de Santa Clara, there is a visitor's centre where there is an exhibit on the delta and the Ciénaga. In the town of El Mayor Cucapah, there is a museum on Cucapah culture, which has important vestiges and historical documents on the delta of the Colorado River.

27. Current recreation and tourism:

At the site, there are several areas where tourist and recreational activities are carried out among which stand out are Ciénaga de Santa Clara where for the past several years hunting has been replaced by ecotourism and sport fishing. Likewise, at several places on the Colorado River near the junction with Río Hardy there are several tourist camps many of which have been abandoned because of recent flooding. Near the mouth of the main river, there is recreational fishing.

There is an ecotourism association called “La Ruta de Sonora”, which promotes visits to the reserve especially in the Ciénega de Santa Clara, and the Cucapah community has built a recreational camp in the town of El Mayor.

28. Jurisdiction:

Territorial: The site is located in north-western Mexico in the states of Baja California and Sonora. In Baja California, it is located in the municipio of Mexicali and in Sonora in the municipio of San Luis-Río Colorado.

Administrative: Because there are a floodplain and intertidal wetlands, this area is considered an area of federal channels for which the administration is designated by the federal government, specifically the Comisión Nacional del Agua. Part of the site which is part of the Reserve is managed by the Comisión Nacional de Areas Naturales Protegidas (CONANP) of the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). At the site, is found the administration of the Reserve that is responsible for overall management of the site.

Jurisdiction of the proposed site includes the federal government through the following secretariats and their state delegations in Baja California and Sonora:

Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT)
Instituto Nacional de Ecología
Comisión Nacional de Agua
Comisión Nacional de Areas Naturales Protegidas
Procuraduría Federal de Protection al Ambiente (PROFEPA)
Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA)
Secretaría de Turismo (SECTUR)
Secretaría de Marina (SEMARINA)
Secretaría de Education Pública (SEP)
Secretaria de Relaciones Exteriores (SER)
Comisión Internacional de Límites y Aguas (CILA)
Secretaria de Salud (SSA)
Instituto Nacional Indigenista (INI)

On the regional level, there are several secretariats, research institutions, development institutions and centres of higher education of the governments of the state of Baja California and Sonora. The municipios of Mexicali in Baja California and San Luís-Río Colorado contribute to its management in their respective jurisdictions. Participation of the Oficina de Coordination para la Gestión de los Humedales de México located in Guaymas, Sonora, is also important. It has promoted and supported management activities for conservation of the wetlands of the Delta through several means among which are creation of the National Network of Wetlands and the proposal for the national wetlands programmes. Locally, it is important to point out participation of ejidal and indigenous communities of the region.

29. Management authority:

SEMARNAT
Direction General de Vida Silvestre
Comisión Nacional de Areas Naturales Protegidas

30. References: