Information Sheet on Ramsar Wetlands

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

2. **Country**: MEXICO

3. **Name of wetland**: Pantanos de Centla Biosphere Reserve

4. **Geographical coordinates**:

18° 21' North
92° 43' West

5. **Altitude**: sea level 6. **Area**: 302,706 hectares

7. **Overview**:

The state of Tabasco, in southeastern Mexico, covers 2,466,700 hectares of which 61 per cent are used for economic activities and 39 per cent are covered by tropical forest or aquatic vegetation. Tabasco, on the largest coastal alluvial plains in Mexico, is only one section of the humid and tropical coast in southeastern Mexico along the extreme southern part of the Gulf of Mexico. This state has the largest area of wetland (floodable areas) in the country. These characteristics give rise to a large diversity of fauna and flora, making it one of the most representative ecosystems of the biosphere (López-Hernández and Pérez, 1993).

The municipality of Centla is part of this area of rivers. It covers 324,500 hectares, 12.2 per cent of the total area of the state. In the north, it is bordered by the Gulf of Mexico; to the east by the municipalities of Jonuta and Macuspana and the state of Campeche; to the south by the municipalities of El Centro; and to the west by Paraíso and Nacajuca (López-Hernández and Pérez, 1993).

The Pantanos de Centla are found on the Holocene alluvial plain in the delta of the Grijalva-Usumacinta rivers. They cover an area of 302,706 hectares in the municipalities of Centla, Jonuta and Macuspana as well as a small part of the state of Campeche (López-Hernández and Pérez, 1993) (see map no. 1).

The most important towns in this area are (source, SEPESCA, 1990):

In the municipality of Centla: Arroyo Polo, Barra de San Pedro, Boca Chilapa, Frontera and Quintín Arauz (Indigenous community of Chontal); in the municipality of Jonuta: Pino Suárez; in the municipality of Macuspana: Bitzal.

8. **Wetland type**:

I, J, K, M, N, O, P, Q, R, S, T (see map no. 2) and 1, 2, 3, 4, 6, 9 (see map no. 4)

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**:

Criteria of representative or unique values of the Pantanos de Centla Biosphere Reserve

The Pantanos de Centla Biosphere Reserve should be considered of international importance because:

- It is an especially good example of a natural or almost natural wetland characteristic of this biogeographic region.

- It is an especially good and representative example of a wetland that plays an important hydrological, biological or ecological role in the functioning of a primary hydrological basin or a coastal system, especially when shared among several countries.

- It is the home to an appreciable number of species or subspecies of rare, vulnerable or endangered animals and plants or a substantial number of specimens of one or more of these species.

- It possesses special importance for the maintenance of the genetic and ecological diversity of a region owing to the quality and characteristics of its fauna and flora.

- It possesses special importance as the habitat for animals or plants during a crucial stage of their biological cycle.

- It possesses special importance for one or more species or communities of endemic animals or plants.

- It is the home to more than 20,000 aquatic birds regularly.

- It is the home regularly to an important number of specimens of particular groups of aquatic birds, indicative of the importance, productivity or diversity of the wetland.

- When data are available on populations, it is the home regularly to 1 per cent of the specimens of a population of a species or subspecies of aquatic birds.

The parameters of a wetland are determined in function of three considerations:

- Their origin: this determines the ionic composition, the degree of saturation with oxygen and the load of toxins and pollutants in the system;

- Their velocity: this determines their turbulence and the ability of the water to carry material in suspension;

- Their rate of renewal: this determines the frequency of the replacement of water and as a result the potential of the system to reach succession and maturity (Hersig, 1987).

In summary, the hydrological regime determines several very special characteristics inherent to the marsh, such as the composition and richness

of species, primary productivity, deposition and flow of organic material. The nature of these characteristics and the result of their interaction influences the functioning of the hydrological parameters. This creates the ecological dynamics so characteristic of this type of ecosystem (Hersig, 1987).

Every day, science generates more and more information about the value of these environments in relation to the water cycle: for example, as reservoirs, as links between surface and underground water, as modulators and as filters. By attenuating stream velocity, the marshes increase the time water remains in the ecosystem, permitting replenishment of the aquifers, absorbing the effects of flooding, slowing down the dynamics of erosive processes and creating ecological niches that make possible the proliferation of an abundant and varied life on the coast (Toledo, 1987).

13. **General location**:

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14. **Physical features**:

Climate - The area under study is influenced by a wet tropical climate --Am (f)--with abundant summer rainfall but a distinct dry period in the winter and a short dry period in the summer. The average annual temperature is 25°C in the delta of the Grijalva-Usumacinta system. Average annual precipitation is 1500-2000 mm, with variations during the cold and hot months. From May to October, precipitation is 1200 to 1400 mm, and from April to November, precipitation decreases gradually to between 500 and 600 mm.

Hydrology - The Grijalva and Usumacinta river systems are the most important drainage in the reserve. The latter has an annual volume of 55,832 million cubic metres at Boca de Cerro, which represents the largest flow in Mexico (West, 1985). In addition, this area is drained at the centre, north and east by tributaries of the Usumacinta such as the Palizada, San Pedrito and San Pablo y San Pedro rivers. Other important rivers are the Bitzal, Naranjos and Palomillan, which drain toward the Grijalva River in the southwest. The total length of active rivers in the reserve is 463 kilometres (see map 3).

There are 110 freshwater lakes in the reserve with an area of 13,665 hectares. About 84 per cent of the lakes are concentrated in the central and southern parts. The most important lakes are Chichicastle, Concepción, El Campo, Retiro, San Pedrito, Tasajera, Tintal and Viento. They all occupy depressions among the Bitzal, Grijalva and Usumacinta rivers. Other important lakes are Guao, San Isidro and Valencia, between the San Pedro y San Pablo and Usumacinta rivers and the Alegre, Chocal and Narváez lakes to the east. In addition to their importance for fishing, they are also important for their landscapes and as natural reservoirs for regulating flooding.

Among the important coastal lakes are El Cometa, which drains towards the San Pedro y San Pablo River; El Coco, which drains toward the Usumacinta River; and El Corcho, which drains toward the Santa Anita lagoon. They are not large, but according to Contreras (1993), they play an important role in the life cycle of many marine species in addition to their scenic value and importance for fishing.

An additional drainage pattern is that of the artificial drains in the east, southeast and south of the reserve, which provide access to lacustrine oil wells. The total length of these canals is almost 128 kilometres.

This biosphere is located in the Grijalva-Usumacinta watershed (RH30) (INEGI, 1985). It includes parts of three basins: Usumacinta (A) in the north and centre of the reserve; Terminos lagoon (C) in the eastern part of the reserve; and Río Grijalva-Villahermosa (D) to the south and west of the reserve. The latter is the most extensive (see map no. 3).

Geology - The geological province of southeastern Mexico, within the subprovince of the Tertiary basin in the southeast, is one of the most important provinces in Mexico from the point of view of geology because it is the centre of the convergence of several tectonic faults and communication with the Yucatan Peninsula.

The most recent cycle of sedimentation occurred during the Holocene and corresponds to the rise in sea level that accompanied and followed the Wodfordian thawing during the past 18,000 years. The area of alluvial deposits and marshes from the Quaternary are of sedimentary origin and produced by the Grijalva-Usumacinta river system, which drains the reserve (IREBIT, 1994).

Soils - The soils present in the area are primarily gleysols, approximately 50 centimetres deep, with agriculture potential, but remaining underwater during most of the year. Communities of primarily hydrophile plants grow there. There are also fluvisols of alluvial origin with a wide variety of fertility which are used for agriculture (López-Hernández and Pérez, 1993). These soils are the result of the influence of three fundamental factors: the accumulation of alluvial sediment, the water added to the rivers because of the high precipitation in their middle and upper courses and the types of vegetation found there.

a) **Eutrophic fluvisols** (Je) - They occupy 18.4 per cent of the reserve and are silt to sandy clay in the first 20 centimetres, with a moderately alkaline pH and a moderate to high content of organic material, fertile although sometimes with a low or moderate content of assimilable phosphorous. They are concentrated on the alluvial plain. They tolerate a wide range of crops and pastures.

b) **Mottled gleysols and eutrophic gleysols** (Gm and Ge) - They occupy 75.3 per cent of the reserve and are the most important soil type in terms of the area they occupy. Palma et al. (1985) describe them as having hydromorphic characteristics throughout their profile, grey in colour and with fine texture. The mottled gleysol has a surface horizon rich in organic material owing to its being almost permanently flooded. The eutrophic gleysol is found at slightly higher elevations, but nonetheless, is subject to prolonged flooding. It is related to the geomorphological units of the coastal dunes and permanently flooded freshwater marshes. The eutrophic gleysol is covered with emergent, hydrophytic, semi-deciduous, medium-height forests, scrubland subject to flooding and low thorn forests.

c) **Eutrophic regosols** (Rg) - They occupy 2.5 per cent of the reserve and are located in the north and northeast of the reserve in the geomorphological units of non-flooded or seasonally flooded coastal beaches. They are of sandy texture, neutral pH, with a moderate content of organic material and are infertile to moderately fertile. They are used for coconut plantations and introduced or cultivated pastures.

d) **Solonchak gleysols** (Zg) - They occupy 3.8 per cent of the reserve and are located on the river-marine plain and low fluvial plain near estuaries subject to tidal influence. They are of sandy texture near the coastal dunes or of fine texture on the alluvial plains. They are covered with mangrove vegetation or halophilic pastures.

Their potential use and their limiting factors makes it possible to manage them wisely in function of their aptitude and guarantees their conservation (Colegio de Posgraduados, 1982). A total of 84.4 per cent of the reserve has a use classification for wildlife or other uses (fishing) and only 18.6 per cent has an agriculture or livestock capacity. Of these areas, 15.9 per cent have a capacity for livestock use and only 2.7 per cent of the reserve is apt for agriculture.

Topography - The Pantanos de Centla are located in the physiographic province called "Llanuras y Pantanos Tabasqueños," where there are many coastal beaches. Among the flat topography of this area, there are areas of less than 1 metre in elevation in the extensive depressions between the river plains, predominantly at sea level along the Gulf of Mexico, and up to 7 metres in elevation along Río Bitzal in the south.

1) **Coastal plain** - Coastal plains are found in the north in a strip parallel to the coastline which penetrates inland 6 kilometres in the north and up to 12 kilometres in the western part of this area. The coastal plains were created by the accumulation of river sediments carried by the Grijalva, San Pedro y San Pablo and Usumacinta rivers. They are deposits of poorly consolidated sand that form a plain of coastal dunes with a distinct morphological development, indicating the position that the coastline occupied during the Quaternary-Holocene until it reached its present position. This is the most extensive coastal plain in the state of Tabasco and is formed by the following geomorphological units:

a) **Permanently flooded coastal dunes** - The dunes are oriented northeast to southeast and were formed by deposits from the Río San Pedro y San Pablo in the period of greatest fluvial activity. The dominant soil is gleysol, and the typical vegetation is rooted, emergent, hydrophytic communities.

b) **Depressions between permanently flooded coastal dunes** - These are areas where the coastal dunes have been covered by layers of organic soil.

c) **Temporarily flooded coastal dunes** - There is a strip 2 to 4 kilometres wide in the northern part of the reserve and to the east of the city of Frontera where the distance between dunes is 50 to 60 metres. This indicates a slow rate of coastal accretion. The dominant soil is regosol with some areas of gleysol in the depressions. The most frequent land use is that of cultivated exotic pastures and hydrophytic communities in low areas.

d) **Non-flooded coastal dunes** - These are isolated areas located in the western part of the reserve. The soil is a well-drained regosol with coconut plantations and family vegetable gardens.

2) **Fluvial-marine plains** - These are located at the mouth of the Grijalva-Usumacinta and San Pedro y San Pablo rivers. They occupy the depressions subject to flooding on the coastal plain system and form part of the most productive natural systems in the world. They are coastal ecotones linked to the Gulf of Mexico.

a) **Coastal saltwater lagoons** (Ramsar classification J and Q; see map no. 2)

b) **Permanently flooded intertidal plains** (Ramsar classification I) - These are found next to estuaries and coastal lagoons where there is permanent flooding and salt water remains for some time.

c) **Seasonally flooded intertidal plains with herbaceous halophytic vegetation** (Ramsar classification R) - These are located in areas behind the mangroves, at the mouth of the San Pedro y San Pablo rivers.

3) **Fluvial-paludal plain** - This is the most important morphogenetic unit because its area covers 71.29 per cent of the reserve. These are systems that occupy large depressions between coastal plains with characteristics such as the accumulation of permanent water, shallow water, irregular shores, substrata of fine alluvial sediment, accumulation of an organic cover from several centimetres up to 1 metre thick, no accumulated marine salt and emergent hydrophytic communities.

a) **Permanent freshwater lakes** (Ramsar classification K and O) - These lakes represent 4.51 per cent of the area of the reserve. There are a total of 110 separate lakes. The most important lakes are those in the south central part of the reserve where 84 per cent of the freshwater lakes are concentrated. They are also found in depressions between the coastal plains of the Bitzal and Usumacinta rivers, revealing their geomorphological origin by receiving less sediment than the areas near the river beds. The largest (El Viento and San Pedrito) have a rounded form.

b) **Seasonal freshwater lakes** (Ramsar classification P) - These lakes are very small and are located mainly in the southeastern part of the reserve.

c) **Permanently flooded freshwater swamps** (Ramsar classification S) - This is the largest geomorphological unit and occupies 65.76 per cent of the reserve. Most important is the depression between the Grijalva-Usumacinta system, the Río San Pedro y San Pablo and the coastal plain. This is also the case for the marsh area to the east of the reserve between Río Grijalva and the coastal plain. The most complex marsh area is in the south central area between the Bitzal, Grijalva and Usumacinta rivers. Many terrestrial systems have been created and isolated by the more raised narrow alluvial plains of these rivers and their tributaries (Hormiguero, Maluco, Naranjos, Palomillal and San Pedrito, among others). These swamps also have a high density of old river beds.

d) **Seasonally flooded freshwater swamps** (Ramsar classification T) - These are small areas of transition between permanently flooded marshes and the coastal plains. They are found, above all, in the southeast and northwest portions of the reserve where there is a greater density of river beds. After drying for several months, they are used for grazing cattle or for seasonal agriculture.

4) **Fluvial plain** - This is the second largest morphogenetic area and covers 18.7 per cent of the reserve. It has been built up by processes of accumulation of sediments of the powerful Río Usumacinta and the Naranjos, Palizada and San Pedro y San Pablo tributaries. Other rivers that have built alluvial terraces are the Bitzal and Grijalva, together with their tributaries. All together, more than 450 kilometres of active rivers and the same amount of former river beds cross the reserve for a total of approximately 925 kilometres of rivers with coastal plains of different lengths. Their fertility makes them apt for agriculture and grazing, human settlements and dirt roads, especially on the high plains near the main river beds which flood only during short periods.

a) **Active rivers** (Ramsar classification M) - The most important are the Bitzal, Grijalva, Palizada, San Pedro y San Pablo and Usumacinta rivers. They occupy 1.1 per cent of the reserve and have a total length of 463 kilometres. They are sinuous, sometimes with meanders, and their importance derives from their use as a source of freshwater for urban areas, natural

landscapes, fishery resources and as sources of organic and mineral nutrients that are deposited near river beds in the form of sedimentation during annual flooding. According to West et al. (1986), the Grijalva and Usumacinta rivers carry an annual sediment load of 7.6 million cubic metres. The Usumacinta carries 74 per cent of the sediment load and is responsible for 85.6 per cent of total annual erosion. Even in spite of their flow, the San Pedro y San Pablo and the Usumacinta are affected by intrusions of saltwater from the Gulf of Mexico during the dry season and during a period of strong northerly winds (the *nortes*), up to 22 and 30 kilometres inland respectively. This favours the formation of riparian mangroves along the edges of the rivers.

b) **Depressions temporarily flooded with salt water** (Ramsar classification L) - These are located in the final part of the Río Usumacinta, in the area where saltwater reaches in the presence of freshwater.

c) **Depressions temporarily flooded with freshwater for three to six months** (Ramsar classification N) - This is the most important geomorphological unit in terms of length because it occupies 13.9 per cent of the reserve and 74.3 per cent of the river plain. In the major rivers, there are areas of transition to the fluvial-paludal plain. Their width is variable with averages of 290 metres in the Río Usumacinta, 500 metres in the Río San Pedro y San Pablo, 180 metres in the Río Grijalva, 400 to 1000 metres in the Río Palizada, 170 metres in the Río Bitzal and 100 to 300 metres in several old river beds.

d) **Depressions temporarily flooded with freshwater for 1.5 to 3 months** (Ramsar classification N) - This covers 1.9 per cent of the reserve. In the Grijalva, Palizada and Usumacinta rivers it is located as an intermediate strip between the high and low plains subject to flooding for 3 to 6 months or as a natural dike along the beds of other active rivers.

e) **High ground occasionally flooded for less than 1.5 months** (Ramsar classification N) - Although they occupy only 0.6 per cent of the reserve, they are of strategic importance because of their slight exposure to annual floods. As a result, land use is more varied (agriculture, fisheries, forestry, urbanization, roads, fill) in light of the good drainage of the fluvisols.

15. **Hydrological values**:

One of the most characteristic aspects and of importance for the region's climate is the protection of the integrity of the basin. Pantanos de Centla is one of the most important areas in the lower basin of the Grijalva-Usumacinta system, which, in turn, is the most important in Central America and whose influence extends from southern southeast Mexico to northern Guatemala.

The Grijalva and Usumacinta basins have several tributaries in the area of the reserve among which are the Bitzal, Grijalva, San Pedro y San Pablo and the Usumacinta and the watershed of the Río Palizada. In terms of volume of water and transportation of organic material, these basins are considered to be the largest in Mexico and of greatest influence on the trophic zone and demersal fishing in the southern part of the Gulf of Mexico (see physical aspects under hydrology). It is important to point out the hydrodynamic balance that maintains the lower basin and the coastal plain, taking into account two regulating factors: increased salinity and decreased flow. Salinity has increased during the past few years as a result of a decrease in flow, destabilizing the esturarine systems. This same decrease in flow

has prevented an increase in organic material in the cyclical flooding, which, in turn, affects the fertility of the coastal plain.

All of the large rivers play a role in the hydrology of the basin. This role is appreciated only indirectly, however, because the social importance of the rivers lies in opportunities for navigation, transportation and provision of food. They are the main source of protein for local inhabitants.

16. **Ecological features**:

Flora - Approximately 260 species of plants have been identified in this area, belonging to 89 families. Of these, 76 species are edible, medicinal or used for construction, for fuel, fencing or handicrafts. Thirteen species have been reported as vulnerable or endangered. The following plant associations have been described for the area of the biosphere reserve. This area is floristically very important, both in terms of its extension and its conservation status. This list of plant associations and communities is base on work for the management plan proposed for the reserve. The following vegetation is present in the reserve (see map no. 4).

A) Hydrophytic communities
   - Emergent hydrophytic associations (neal)
   - Floating hydrophytic associations
   - Subaquatic (not mapped)

B) Medium-height, semi-deciduous forest of *Bucida buceras* (puktal)

C) Low, semi-deciduous forest of *Haematoxylon campechianum* (tintal)

D) Mangrove

E) Scrub forest of *Dalbergia brownii* (mucal)

F) Palm groves of *Acoelorraphe wrightii* (tasistal)

G) Palm groves of *Salbal mexicana* (guanal)

H) Riparian vegetation

A) **Hydrophytic communities** - The communities of hydrophytic plants occupy more than one third of the region of Pantanos de Centla and are the best developed and most extensive associations.

1. **Emergent hydrophytic associations** - The *neal* is part of the association that occupies the largest amount of land within the area. *Neal* is also known in the state of Tabasco as an area of bulrushes (*espadañal*) and occupies land belonging to two of the geomorphological areas identified in Centla: the coastal shore plain and its best habitat, referred to as the paludal plain and freshwater lagoons. The *neal* usually has a height of 1 to 3 metres, in function of the depth of water in which it grows.

The dominant species in the *neal* is *cola de gota* (*Typha latifolia*). It is a grass that roots in the substrata. In almost all cases, it is grows in pure stands, although there are some areas where it is associated with *chintul* (*Cyperus articulatus*) and with *siba* (*Claudium jamaicence*), with which it forms almost pure associations known locally as *sibal* (for example, the area of El Espadañal northeast of Frontera).

Among the species found in this association are: *Achrostrichum aureum, Cyperus articulatus, Cyperus ligularis, Eleocharis cellulosa, Eleocharys geniculata, Eleusine indica, Fimbristylis spadiceae, Gynerium sagitatum, Heliconia latispatha, Hydrocotyle umbellatus, Mimosa pigra, Panicum maximum, Paspalum fasciculatum, Paspalum paniculatum, Polygonum punctatum* and *Rumex verticilatus.*

This hydrophytic community is distributed throughout the area studied, including within the limits of the puktal and mangrove. It is, above all, directly related to the lakes and marshes.

During the dry season, when the water level is low, it is the custom to resort to slash and burn to eliminate the reeds. The reeds are burned even during the rainy season in order to sow aggressive pastures such as *zacate alemán*, *la estrella* and *el egipto*, which occupy some of the area where the reeds grow. This is one of the most widespread disturbances known of this association plus the disturbance caused by oil exploration.

2. **Floating hydrophytic associations** - This is found in clearly lacustrine environments and is invariably associated with the swamps shared with the *neal*. Some of the species in this type of vegetation in Centla are *Cabomba* spp., *Eichornia crassipes* (*jacinto*), *Heteranthera* spp., *Lemmna minor* (*oreja de ratón*), *Nelumbo lutea* (*pitahaya*), *Nymphaea amplia, N. odorata* (*hoja del sol*), *Nymphoides humboldtiana, Pistia stratiotes* (*lechuga de pantano*) and *Salvinia* spp. Some of the plants, for instance the *hoja de sol* (*Nymphaea amplia*) and *N. odorata*, are very much appreciated by fishermen, who use them to keep fish fresh.

3. **Subaquatic vegetation (submerged hydrophytes)** - The subaquatic vegetation is associated primarily with floating hydrophytes and maintains the same distribution a the floating associations in relation to the edges and the centre of the lagoons where it grows. The *sargazal* is the most typical underwater vegetation growing locally and is represented by *Cerathophyllum demersum* (*sargazo*), *C. echinatum* and *Utricularia* spp. Another recorded association is the *cintillal* where two species grow: *Vallisneria americana* (*cintilla*) and *Potamogeton* spp.

B) **Medium-height, semi-deciduous forest of *Bucida buceras*** (puktal) - This is one of the wooded communities of greatest importance together with the hydrophytic communities and the mangrove. The puktal is found in wide bands, patches or small islands among the aquatic vegetation. Occasionally, it is associated with the semi-deciduous low forest (tintal) or else is established as a mixed forest in the areas of mangrove. The puktal develops on completely flat terrain. Its structure is ordered, in a range between 15 and 25 metres, which can decrease when this forest enters in contact with hydrophytic communities and with the tintal, reaching heights between approximately 7 and 15 metres. The semi-perennial, medium-height forest is formed by approximately 30 per cent of deciduous species. The upper strata is formed by *Acacia spp. (kantemó), Albizzia longepedata (siete colmenas), Bucida buceras* (*pukté*), *Bursera simaruba* (*palo mulato*), *Callophyllum brasiliensis* (*bari*), *Ceiba pentandra* (*ceiba*), *Lonchorcarpus hondurensis* (*gusano*), *Spondias mombim* (*jobo*), *Tabebuia rosea* (*macuilis*) and *Vatairea lundellii* (*amargoso*). In addition, other species are usually associated in this section of the canopy. Among them are *Cedrela odorata* (*cedro*), *Cyospiros digina* (*taucho*), *Manilkara zapota* (*chicozapote*) and *Swietenia macrophylla* (mahogany).

The intermediate strata is composed of the following species: *Bactris balamoidea* (*jahuacté*), *Sabal mexicana* (*guano redondo*), *Erithryna* spp., *Thevetia ahouai* and an unidentified species known locally as "*caracolillo*."

As a result of the constant flooding of the forest, the undergrowth is poorly developed. It is very common to find a large quantity of epiphytes of the following families: Bromeliaceae, *Achmea bracteata*, *Tillandsia balbisiana*, *Tillandsia usneoides*; Orchidaceae, *Catasetum* spp., *Laelia anceps,* among others; Cactaceae, *Hilocereus undatus* and *Selenocereus testudo*. The distribution of the semi-deciduous middle forest of *Bucida*

buceras in the Pantanos de Centla is from the left bank of the Río San Pedro y San Pablo in the eastern part of this area.

The environmental impact on the puktal is primarily the extraction of wood, the cutting of species for building rural houses and the making of *cayucos* and utensils. There is also clearing of vegetation in some areas used for seasonal agriculture (using the slash and burn practices), cattle grazing, quite frequently oil extraction and the building of roads by PEMEX.

C) **Low, semi-deciduous forest of *Haematoxylon campechianum* (tintal)** - The presence of the tintal in Centla is produced by the constant flooding that affects the region, as a result of the development of its dominant component *Haematoxylon campechianum* (*palo de tinte* or *palo de Campeche*) at sites with a flat topography or parts of the low river plain, which is characterized by defective drainage and contains mud-clay materials that make it possible to maintain a high level of humidity.

The tintal reaches a height of between 6 and 12 metres, in pure, compact stands. In the municipio of Centla, it is possible to observe a large part of this community. The tintal is very frequently associated with the puktal and the hydrophyte communities. Nonetheless, it has a heterogeneous distribution in all of the area, where it is concentrated in small patches.

Haematoxylon campechianum grows mixed in the semi-deciduous, middle-height forest and the hydrophytic communities and occasionally in the mangrove, as is the case in the central region.

The use of the tintal now in Centla and throughout its distribution is limited to the following purposes: for the framing of houses, fencing in pastures, fuel and, occasionally, for use in manufacturing handicrafts. This limits its growth and expansion. Nonetheless, it is a resource that merits special attention. It has played an important economic role from the eighteenth century, primarily because of its use as a dye species.

D) **Mangrove** - The mangrove is found in this region of the state of Tabasco in places constantly subject to saline water from the Gulf of Mexico. This plant community is located on the river plain of clay-mud alluvial sediments in soils with a high concentration of organic material.

The structure of the mangrove is composed of characteristic species found in the state of Tabasco in the following order: *Rhizophora mangle* at the edges of the rivers and coastal lagoons of the Pantanos de Centla where it is densest and sometimes in continental lakes. This species is the vegetation that best controls the effects caused by the tides and the high concentration of salt. When it is found along the banks of rivers, it is very common to find it associated with the following riparian species: *Chrysobalanus icaco* (*icaco*), *Citharexylum hexangulare* (*palomillo*), *Dalbergia brownii* (*muco*), *Inga fyssicalix* (*chelele*) and *Pithecellobium lanceolatum* (*tucuy*).

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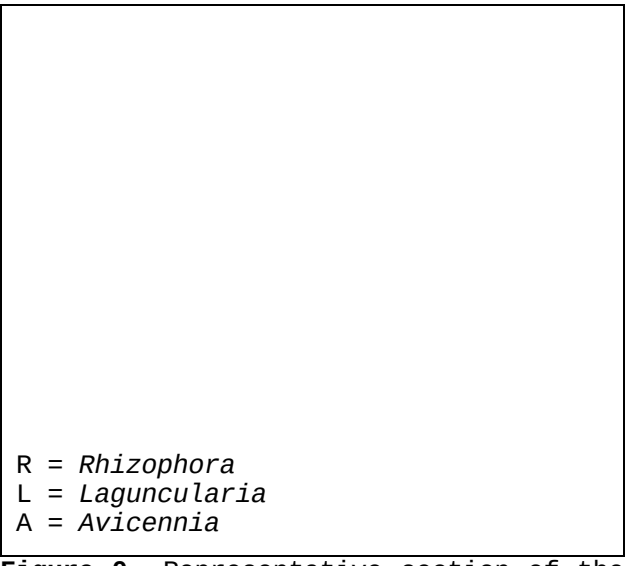

Figure 0 Representative section of the mangrove distribution perpendicular to the Río San Pedro y San Pablo (Thom, 1967)

Avicennia germinans grows behind the line formed by the *mangle rojo* in pure stands, but it most frequently forms mixed forests.

Laguncularia racemosa and *Conocarpus erectus* appear where salinity is apparently low. In this case, the mangrove is clearly associated with the medium-height, semi-deciduous forest (Laguna El Cometa), the mucal, tintal and the hydrophytic communities (Ejido Tembladeras, and Librillo and Concepción lakes), accompanied in this case by species characteristic of the strata of the puktal such as *Bactris balanoidea, Bucida buceras, Callophyllum brasiliensis, Dyospiros digina, Manilkara zapota, Pachira aquatica, Roystonea regia* and *Sabal mexicana*, among others.

The mangrove serves as a refuge for other species, among which are the epiphytes *Achmea bracteata*; parasites such as the *Phoradendron mucronatum* (*caballera*), *Helosis* spp.; several climbing vines such as the *Passiflora coriacea* and the characteristic fern of the mangrove *Achrostrichum aureum*; several Cyperaceae such as the *Cyperus surinamensis*, *Eleocharis cellulosa, E. geniculata*, and other species such as *Hydrocotyle umbellatus, Nymphaea amplia, Salvinia* and *Lemmna minor*, when it is part of the hydrophytic communities.

Human activities have already left their mark on this plant community by degrading it through destructive practices such as the replacement of the mangrove with cultivated pastures, which is a common practice in this area. Another negative effect is the construction and improvement of highways in land originally occupied by the mangrove. In addition, the timber in the mangrove is very appreciated for the construction of rural houses. *Mangle rojo* (*R. mangle*) is the timber most frequently used. This is a source of extra income for the loggers. It is also the mangrove species most widely used for the production of charcoal by most of the families living in this area. Other causes of the decrease in the area of mangroves are natural events such as strong winds and hurricanes.

E) **Scrub forest of *Dalgergia brownii* (mucal)** - This association is recognized throughout the region as the characteristic species. It is found in the puktal, mangrove, tintal and hydrophytic communities with which it sometimes forms ecotones or intermediate areas. This association is located on the banks of rivers and lakes, although it is possible to find it farther inland. When it is found farther inland, the mucal is usually formed by species that take on a riparian character such as *tucuy* (*Pithecellobium lanceolatum*), the *cheleles* (*Inga fyssicalix* and *I. spuria*), *gusano* (*Lonchocarpus hondurensis*) and *palomillo* (*Cytharexylum hexangulare*). In addition, it is possible that other components of the forest and mangroves develop in association including herbaceous and epiphytic species found in the region.

F) **Palm groves of *Acoellorraphe wrightii* (tasistal)** - This association forms pure stands between approximately 4 and 5 metres high, with varying distances, between 10 to 15 metres, between groves. The tasistal is found covered in mud most of the year and is present in small groves or isolated strips in two parts of the region: to the south of Frontera near Arroyo Polo, where cultivated pastures are grown and in the area of El Espadañal where it is mixed with *neal*. One of the most common uses of the tasistal

throughout its distribution in the reserve is for fence posts used in pastures. This is the most common form of human destruction of this community. Another negative effect for conservation is the opening of trails by PEMEX and the construction of canals and roads.

G) **Palm groves of *Salbal mexicana* (guanal)** - Gathered together under this name is a small portion of the vegetation of the Palmae family dominated by *Sabal mexicana*, which establishes as the result of constant burning for the sowing and introduction of pastures in its area of distribution. This coincides with the areas that have been most affected by human intervention, agriculture and livestock grazing in this region. This community prospers on the better-drained land, which are the low river plains of fluvisols.

H) **Riparian vegetation** - These communities are located on the margins of the rivers, streams and canals of the region in this area. This community is strongly influenced by seasonal changes in water level. The species that characterizes this vegetation in the area are the *sauzo* or *sauce* (*Salix chilensis*), the *cheleles* (*Inga fisicalyx* and *I. spuria*), *tucuy* (*Pithecellobium lanceolatum*), *gusano* (*Lonchocarpus hondurensis*), (*Lonchocarpus* spp.), *palomillo* (*Cytharexylum hexangulare*), *tinto* (*Haematoxylum campechianum*) and *muco* (*Dalbergia brownii*).

Fauna - All of the state of Tabasco is part of the biotic province of Campeche, which extends from south of Veracruz towards the east through Tabasco up to Quintana Roo. In the region of marshes, there is a wide diversity of species, mainly birds, including both resident and migratory. Most of the birds in this area are from aquatic environments. The delta of the Grijalva-Usumacinta river is also one of the areas of sanctuary and greatest concentration of manatees in Mexico, primarily toward the region of Emiliano Zapata (Alvarez et al., 1988). The wildlife surveys carried out by IREBIT for preparation of the management plan report that at least 51 species of fish, 67 species of amphibians and reptiles, 56 species of mammals and 191 species of birds live in this part of the delta.

Aquatic fauna - The fish that live in this area represent different types of habitat. There are fish from the lentic and lotic systems, as well as fish that tolerate different levels of salinity, such as those that are exclusively freshwater, euryhaline and stenohaline fish. There are fish that remain year round in the area, fish that are present only during a certain season and those that visit sporadically. There are species of fish recorded in 11 orders, 24 families, 33 genera and 51 species. In 1982, a survey found that at least 38 species of fish live in the delta (see appendix 2) (INIREB, 1985).

It is important to mention the use and consumption of aquatic species. Most of the animal protein consumed in the area is from native species, mainly fish among which the most important are those of the Cichlidae family and the *pejelagarto* (*Lepisosteus tropicus*). The molluscs, for example the snail *Pomacea flagellata* and the clam *Mercenaria campechiensis*, are native to the estuarine systems.

Crustaceans are found in several systems: *acamalla* (*Machrobrachium acanthurus*) and *pigua* (*M. carcinus*) in freshwater, with migration for reproduction toward the coast in the rainy season; *jaiba* (*Callinectes* spp.) in estuarine and marine conditions, spending part of its life cycle in coastal lagoons.

It is possible to find species in the area whose populations have seriously decreased locally, regionally and worldwide to such an extent that some of them are endangered. This is the case of the manatee (*Trichechus manatus*),

crocodile (*Crocodylus moreletii*) and Central American river turtle (*Dermatemys mawii*) (López-Hernández and Pérez, 1993).

Terrestrial fauna - The class that is best represented are the birds. There are 15 orders, 57 families, 140 genera and 191 species (see appendix 2). In order of importance in terms of number of species are the mammals with 56 species, 44 families, 24 genera and 10 orders. After this class come the fish representing 11 orders, 24 families, 33 genera and 51 species. The class of the reptiles has 4 orders, 13 families, 38 genera and 49 species, while the last class, the amphibians, has only 3 orders, 7 families, 12 genera and 18 species. The vertebrate fauna of the reserve is divided into 44 orders, 119 families, 267 genera and 365 species from 5 classes.

Of the 49 species of reptiles reported, 6 are included in the appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

17. **Noteworthy flora**:

Approximately 260 species of plants belonging to 89 families have been identified. This represents approximately 11.8 per cent of the estimated number of species in the state of Tabasco. Of these, 76 species are edible, medicinal, used in construction, as fuel, live fences or for handicrafts. Thirteen species are considered by the World Conservation Union (IUCN) to be vulnerable or endangered (see appendix 1).

The vegetation in the Pantanos de Centla forms a very important nature area in terms of its extension and conservation status. Some of its more important values are that 260 plant species have been identified, in 89 botanical families. About 70 of these species are used traditionally for human use.

This marsh region is considered to be one of the most important samples of vascular aquatic flora in Central America (López-Hernández and Maldonado, 1992).

18. **Noteworthy fauna**:

The wide variety of plant communities serves as a refuge for many species of vertebrate fauna. The most abundant groups of animals in the marsh are fish, represented by 51 species, plus a reported presence of 67 species of reptiles, 67 amphibians, 56 mammals and, above all, more than 191 species of both migratory and resident aquatic birds.

As in the case of the flora, the surveys of fauna are only preliminary. Nonetheless, nine endangered species have been identified including the jabiru, jaguar, lagarto, mantled howler, manatee and Central American river turtle (see appendix 2).

There are several sites where a large number of bird colonies are concentrated. Two lakes, referred to locally as *pajarales,* are northwest of the town of Quintín Arauz: "Laguna Pajaral Primera" and "Laguna Pajaral Segunda." Unfortunately, one of these sites is disappearing owing to hunting. As a result, it is necessary to take a series of protective measures to ensure the conservation of these concentrations of birds.

Several species are found in this area that because of the current conservation status of their populations have been listed by international conservation agencies for special treatment in order to ensure their permanence in this area. Among these are the manatee (*Trichechus manatus*), Belize crocodile (*Crocodilus moreletti*), Central American river turtle

(*Dermatemys mawii*), jaguar (*Panthera onca*), osprey (*Pandion haliaetus*) and the jabiru (*Jabiru mycteria*).

19. **Social and cultural values**:

Historical, socioeconomic and cultural aspects - The word "centla" has several meanings; one of which is that of "ear of corn." This term has been used by the local inhabitants from pre-Hispanic time. The area of Centla has been inhabited from around 1000 B.C. (West, 1985). Garibay et al. (1987) reported that in 1987 the population was 10,552 inhabitants, mainly young people.

Historic evolution of settlement in Centla

Pre-Hispanic period - The pre-Hispanic inhabitant from the dawn of civilization until the Spanish conquest has had 3000 years of continuous experience with the complex and varied environment of the lowlands in the state of Tabasco.

The most important city in the state of Tabasco was Comalcalco, whose splendour reached its peak between 700 and 900 A.D., in the most western area of the Mayan cultural influence. Comalcalco was one of the most important centres of a broad network of city states that functioned as commercial centres, interconnected by the Río Usumacinta. The sites were Bonampak, Jonuta, Palenque and Yachilán plus the Mayan cites in Guatemala and Honduras.

There are 19 unstudied archaeological sites (IREBIT, 1994):

1. Aculzingo
2. Buenos Aires
3. Concepción
4. El Encanto
5. Encarnación
6. Frontera
7. Las Minas
8. Oaxaca
9. Paraíso
10. Pedrito
11. Pino Suárez
12. Ramonal
13. San Ramon
14. Santa Rita
15. Sitio Nuevo
16. Zapotal
17. Zaragoza
18. El Coco
19. Boquerón

Agriculture was practised along the rivers and on the coastal strips using the ancestral system of slash and burn, in contrast to the system used in the hills where crops were seasonal and not itinerant. Annual flooding of the lowlands with the silt carried by the water fertilized the soil and obviated the need to rotate crops, producing a high level of productivity in the harvests. Maize was sown with *macana* and was probably also associated with squash and beans. There was perhaps a garden around every house, which provided a supplement to the rich diet of the pre-Hispanic small farmer.

Even though no vestiges of tropical *chinampas* or *camellones* have been found in Centla, examples of *rompidos* have been found made along the rivers by farmers in order to take advantage of the river depositing its sediment load in a marsh and, in this way, building a sort of *camellon* that makes it possible to increase the area under cultivation.

In the environment of the marsh, fishing and hunting were an important protein complement for the pre-Hispanic farmer. Tools such as the *cayuco*, the paddle, fishnets, fishhooks of bone and obsidian were adapted from earlier times to daily use.

Colonial period - The most densely populated part of the lowland was on the eastern side of the Río Mezcalapa up to what is now known as Pantanos de Centla. South of Pantanos de Centla, there was also a heavily populated area. According to West (1969), "... this political region could have included the two towns of Tamulte, located on the Pleistocene outcropping along the middle course of the Grijalva river. Tabasco was the first territory with which the Spanish entered into contact. This chiefdom must have been well populated to have the capacity to gather an army of 40,000 men to face the small number of Cortés's soldiers in 1519..." There is also information about settlements in the centre of the marshes, at Potonchán, Tabasquillo and Xonuta.

In 1579, date of the first census carried out since the conquest, the total population of the low lands was only 9,750 inhabitants. In 1639, the Indian population dropped to 4,630 persons, probably the lowest level in its history. This drop in population, accompanied by slavery, the sale of Indians, the collapse of trade and disease, contributed to widespread economic depression in the low lands of Tabasco. Except for Jonuta, Tamulté and Villa Victoria (which disappeared several years after its foundation), Pantanos de Centla remained completely unpopulated until well into the nineteenth century.

Nineteenth and twentieth centuries - It was only in the nineteenth century that Pantanos de Centla became a place of economic activity: the exploitation of forests of mahogany and cedar that grew along the Río Usamacinta up to the Lacandona forest in Chiapas. The Río Usumacinta is the means for transporting large rafts of valuable logs that were then sawn and loaded in Ciudad del Carmen, Campeche and Frontera.

The population did not increase during the nineteenth century and was concentrated along the edges of the Río Usumacinta, its tributaries and along the coast. "The marshes between the rivers have been uninhabited almost from the time of the conquest" (West, 1969).

Between 1859 and 1950, the population of the Usumacinta basin in the state of Tabasco (the municipalities of Balacán, Emiliano Zapata, Jonuta, Tenosique and the southern part of Centla) contained approximately 8 per cent of the state's population (West, 1969). In 1960, this percentage increased to 10 per cent, after a large increase in the number of small farmers and ranchers living on the dikes of the Usumacinta River, already famous for their cattle ranches from the middle of the nineteenth century (Heller, 1956).

The population along the present course of the Río Grijalva also increased. The towns known as "Las Chilapas" up to Tamulté de la Sabana grew at the time of the banana boom between 1920 and 1940. The two banks of the Río Grijalva were planted by small producers with plantations of banana. The boats that carried the bananas abroad entered the river up to a place known as Boca Chilapa, approximately 30 kilometres upstream from Puerto de Frontera. Later, the natural increase in population, improvements in communications, an increase in ranching and above all the creation of *ejidal* property in the sixties and seventies led to population of the marshes as a solution to the lack of land in Chontalpa.

The following figures present an analysis of the towns and settlements within the reserve. It should be noted that the population in the reserve does not exceed 10,000 inhabitants, primarily because of the limitations of dry land. In figures 3 through 7, it is possible to see the distribution of the settlements along the main rivers. The main municipios in which there are inhabitants in the reserve are the municipios of Centla and Jonuta, as can be seen from figures 8 and 9.

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Towns along the Río Usumacinta

Towns along the Río San Pedro y San Pablo and adjoining marsh areas

Towns along the edge of the Río Bitzal in the area of Centla

Towns along the Río Grijalva in the area of Centla

Towns along the Río Maluco

Total population of the Municipio of Centla

Age groups

Total population in the Municipio of Jonuta

Age groups

Source: Resumen Anuarios Estadístico del Estado de Tabasco, 1985; IREBIT, 1994

20. **Land tenure/ownership of**:

A declaration by the president stipulated the following with regard to the biosphere reserve:

In the provisional article, it is declared that:

"The present decree informs the *ejidatarios*, owners and occupiers of land within the biosphere reserve 'Pantanos de Centla'. In the event that their names and addresses are not known, the second publication of this decree in the "Diario Oficial de la Federación" will have the effect of a personal notification to the *ejidatarios*, owners or occupiers who will have 30 days from the time of the notification's taking effect to inform the Secretaría de Desarrollo Social of their rights in relation to this decree. The Secretaría de Desarrollo Social shall register the present decree in the appropriate public property registry within 90 days from the time of its publication in the "Diario Oficial de la Federación". All legislation that is in contradiction to this decree is hereby revoked."

In the decree, the status of land tenure is given importance, requiring the registration of the various types of property ownership, given that there is no clear definition of the property rights of owners ("Diario Oficial de la Federación", 6 August 1992). The three types of land tenure that exist in the reserve are: a) land held under the *ejidal* system; b) private property; and c) vacant land. There is no data on the proportion of these three types of tenure.

21. **Current land use**:

Use of the environment

Productive aspects - There is agriculture, livestock raising and fishing. The agriculture practised is traditional, being basically for self-sufficiency. There is almost no use of machinery and agricultural inputs; only the family's effort is used for agricultural production. Maize, beans, sweet potato and squash are grown, depending on the soil and rainfall.

Livestock raising is extensive, oriented to the production of cattle for supplying meat for the regional and national markets.

Normally, the cycle of dry seasons is reduced to three months a year: March, April and May. During these months, vegetation remains green because of the moisture in the marsh. Nonetheless, the surface water dries up in the lakes, rivers and canals. During this period, large areas of reeds are burnt and pasture is sown to start pastures. If pasture has already been established, grass is cut in order to obtain fresh and rapid growth. Heavy rains begin in June in the hills and sporadically in the marshes, producing a rise in the water level in the rivers. Heaviest rainfall is during September, October and November.

Agricultural activities - The agricultural cycle is strongly influenced by the seasons. As water retreats from the land, cultivation is begun along the rivers, normally between December and January during which maize is sown to be harvested in March or April. This is referred to locally as the "*siembra de tornamil*." It is common that when maize is harvested from the milpa in March, the growing of the next cycle is begun for harvesting in June. This cycle is known as "the March planting" (*siembra del marceño*). When maize is harvested in June, the annual crop (*siembra del año*) is begun, which is harvested in September before the period of flooding begins.

The average area under cultivation by local inhabitants in Centla is usually very small: between one and two hectares per family. In many cases, as a reply to this lack of arable land, local inhabitants have adapted the practice of opening breaches (*rompidos*) along the edges of the rivers in order to allow the river to overflow and deposit part of its sediment load in the marsh. In this way, a greater area of arable land is obtained, plus the addition of fauna in the flood that the opening of the canal brings.

The most important aspect of agriculture in the areas subject to flooding is related, as would be expected, to the water cycle. When the flood water leaves the land, the land is ready to be farmed with maize, without inputs except for seeds, the nutrients incorporated in the soil from the hydrophytic vegetation and human labour. Advantage is taken of the residual humidity in the ground (Siemens, 1981). It is important to point out that in this production system for maize two types of land are used: land that drains flood water off naturally in the dry season and land that are drained artificially. The small area of land available for this type of agriculture, however, limits production, but, at the same time, makes it possible to renew the generation of the *popal* and, as a result, this resource is conserved indefinitely.

Near the areas of water, it is possible to find fields of rice (*Oryza sativa*), *macal* (*Xanthosoma* spp.) and *malanga* (*Colocasia* spp.); all plants which are adapted to this type of soil conditions. On the lower land, there are fields of other crops, family vegetable gardens, *acahuales* and the savannah, but these are ecosystems and agriculture that go beyond the scope of this study. The following information, however, is important: the function of these systems is multiple and provides various materials of animal and vegetable origin needed by the local inhabitants for their subsistence. Each component of the agro-ecosystem is nurtured by the local inhabitants within a broader cultural system, or cosmic vision, that has allowed the conservation of this resource and the regeneration of these ecosystems.

When the inhabitants of the areas subject to flooding decide to convert them for their use and into permanent agro-ecosystems, they have the following possibilities: to drain them or to flood them. This leads, of course, to the construction of small hydraulic works. In the event that it is decided

to drain them, usually the "patio," the land in front of the house, is lowered, converting it into a "*préstamo,*" which is the local term for an artificial pond where ducks and fish can be raised, but whose main function is to store water for livestock during the dry season. The local inhabitant in Tabasco has a store of technical and ecological knowledge, which, unfortunately, is being lost. Together, we can learn to manage an economy that respects nature, "based on a very delicate operation of recovery and internal conservation, perhaps through the intervention of institutions that go beyond endorsement. This makes the environment the centre of a permanent exchange of perceptions and ideas. At the same time, this will make it possible to obtain two objectives: to learn, save and validate the experience of the ecological management of the original inhabitant of the areas subject to flooding in Tabasco and to conserve these areas for future generations" (Funes and Martinez, 1983) (see map no. 4).

Fishing activities - Fishing is without a doubt the most import source of income for local inhabitants. There are three types of fishermen: 1) those that are involved with one of the state-organized fishing co-operatives; 2) independent fishermen that work on their own; 3) employees of owners of modern equipment.

The independent fishermen, those that use a low technological level, are characterized by:

1) A culture of adjusting to the environment with a detailed knowledge of the ecological system and its possibilities;
2) Tacit and express awareness that it is inconvenient to degrade the environment;
3) Low technology: use of the "hoop and basket" to fish crustaceans; use of the *cayuco* with paddles, *fisga* and nets (paños and fishnets).

The fishermen participating in co-operatives are no different from the independent fishermen as to their standard of living, although, of course, they have some facilities to acquire equipment with credit granted by the government and to benefit from profits if, when the time comes, there are no human errors in the administration of the co-operative's resources.

Use of regional fauna and flora - It is well recognized that the paludal resources are among the most productive of the biosphere. Their high net productivity makes it possible to harvest a high value of food. At the same time, this has made it possible for several centuries to establish human groups that naturally obtained a large part of their susistence through the fauna in wetlands. For more than 300 years, human groups that settled in this area have made use of this resource, both for consumption and for trade. With the passage of time, some of these resources have acquired greater commercial importance and have been exploited on a larger scale to the extent that some of them are now endangered or vulnerable.

Use of flora - There are at least 76 species of plants used by the inhabitants of this area. Most of these are perennial plants from family vegetable gardens, some of which are used for local consumption. Sometimes, they are ornamental or used in construction, as fence posts or as fuel. Another important use that the local population gives to plants is that of medicines (López-Hernández and Pérez, 1993).

Use of fauna - At the present time, most of the animal protein consumed in the region proposed as a reserve comes from native species; primarily fish among which the most important are robalo (*Centropomus* spp.), the *mojarras* (*Cichlasoma fenestratu, C. urophtalmos* and *Petenia splendida*) and the *pejelagarto* (*Lepisosteus tropicus*).

The *camarón blanco* and the *pigua* (*Panaeus* spp. and *Macrobrachium* spp.) are important commercial species. They became the object of intense capture for trade and one of the main resources for monetary income of fishermen. Unfortunately, captures were so excessive that these species have now decreased to one-fifth of what was captured 15 to 20 years ago.

The local diet includes turtles, for example the Central American river turtle (*Dermatemys mawii*), *pochitoque* (*Kinosternon leucostomum*), *hicotea* (*Pseudemys scripta*), *guao* (*Staurotypus triporcatus*), *chiquiguao* (*Chelydra serpentina*) and to a lesser extent the *mojina* (*Rhinoclemys areolata*) and the Belize crocodile (*Crocodylus moreletii*), whose meat, skin and fat are used as food.

Among other mammals eaten for food are the armadillo (*Dasypus novemcinctus*), American manatee (*Trichechus manatus*), *tepescuintle* (*Agouti paca*) and the Guatemalan white-tailed deer (*Odocoileus virginianus*). This group is usually hunted during periods of flooding. Also hunted are the *zorro espino* (*Sphiggurus mexicanus*) and the *mapache* (*Procyon lotor*), which are truly pests.

Finally, it should be noted that there is trade in young animals as mascots. This is the case of the Guatemalan howler and the already-mentioned Belize crocodile.

Another species that has suffered the effects of intensive hunting for commercial purposes is the long-tailed otter (*Lontra longicaudis*), whose skin is used to manufacture wallets, belts and other articles. Several species of migratory birds are also captured: for example, the peregrine falcon (*Falco peregrinus*) and the osprey (*Pandion haliaetus*), which are now endangered at the world level. Because of a decrease in their habitat, the jaguar (*Panthera onca*) and the ocelot (*Leopardus pardalis*) are considered vulnerable. The conservation status of the Guatemalan howler (*Alouatta pigra*) is uncertain. It is felt that because of the destruction and disturbance of the habitat of the jabiru (*Jabiru mycteria*), this bird is in danger of disappearing from Cental America (Correa et al., 1988). Some measures have been studied for the protection of the recovery of the Everglade kite (*Rostrhamus sociabilis*). Populations of this species are found in the Grijalva-Usumacinta delta (López-Hernández and Pérez, 1993).

Class	Species Total of species	Common name
Fish		
Reptiles		
Birds		
Mammals		

Figure 0 Vertebrate species that form part of the diet of the inhabitants of the low lands in Tabasco (Arriaga, 1987)

Use of underground resources by Petroleos Mexicanos (PEMEX) - Exploration and extraction in Pantanos de Centla have caused the oil company PEMEX to invest in the construction of canals. Given the topography, the canals serve to transport perforation machinery, pipes and other equipment that would otherwise be impossible to transport to the places of drilling. The exploitation of oil in the southeastern part of the municipio of Centla and north of Macuspana began with the discovery of the oil field of San José Colomo in 1951, in the municipio of Macuspana. In 1953, the Cantemoc oil field was discovered; and in 1959 that of El Hormiguero. At about the same time, the oil fields of El Bitzal and Cobo were discovered in the municipio of Jonuta, all in areas of marsh.

In 1970, three oil fields, Lirios, Boca del Toro and Usumacinta, were discovered farther to the east of the municipio of Centla and five more in the municipio of Jonuta. In 1984, the oil field of El Espadañal, near the city of Frontera, entered into production, although at a low level. The extraction of crude oil and gas by PEMEX in the marshes of Centla has been concentrated in the eastern part of the municipios of Centla, Jonuta and northern Macuspana. This has resulted in a large network of canals.

Potential uses

Project for sustainable development proposed by the government of the state of Tabasco - One of the most serious problems facing tropical areas is that of finding more efficient hydro-agricultural systems for the production of food, using improvements in culturally accepted regional technologies. Among the places most recent opened for the use of the tropical agro-ecosystems is found in the high-altitude fields of Chinampas and Camellones.

The production system of high-altitude fields is based on two subsystems: one aquatic and the other terrestrial. Each has its function and different levels of agricultural production. On the one hand, there are conditions of flooding and, on the other hand, favourable conditions of humidity.

The application of inadequate technologies and indifference to indigenous knowledge about production systems have led, in most cases, to the failure of development models. This requires the creation of agricultural production systems linked to cultural patterns of productive development to guarantee the integrated use of the ecosystem in a wise and sustainable way.

The project for sustainable development proposed by the government of the state of Tabasco constitutes the first stage of the implementation of productive ecological projects that make it possible to promote sustainable development in the reserve. They include the following sub-projects:

- establishment of hydro-agricultural systems
- programme of small fruit orchards
- pens for the reproduction of the *pejelagarto*
- pens for the reproduction of the Costa Rica *mojarra*
- ranching schemes for the reproduction of the Guatemalan white-tailed deer

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

Changes - Until now, the most significant changes affecting the reserve are considered to be the damming of water, as the result of changes in the natural flow of the rivers, streams and swamps caused by the construction of infrastructure for the exploitation of oil through the creation of access roads to the oil camps which form dikes that prevent the normal evacuation of water and natural variations in water level. This phenomenon occurs over hundreds of hectares of the floodplain in the southeastern part of the reserve (López and Zavala, 1987).

The construction of roads and dikes creates changes in the natural drainage patterns of the swamps, especially infrastructure constructed parallel to the coast line. Oil spills and the seepage of grease and oils into the reserve occurs from decantation basins, storage areas, dehydration plants, settlement ponds and wild oil wells. When this is combined with the retention of water, the effects remain for years, causing serious damage to the vegetation, especially trees and shrubs. The toxicity of the compounds produced by the spills have not yet been well studied. Nonetheless, the results of a large part of the spills follow dispersal patterns that lead eventually to the coastal lagoons of Tabasco, as documented by the work of Botello in 1978 and 1983 (López and Zavala, 1987).

The salinization of marshes is associated with the extraction of oil and occurs through decantation basins, dehydrating plants, compression stations, waste basins and pipeline ruptures. Salt spills occur sometimes, which unfortunately impose limitations on native species and the propagation of introduced species (López and Zavala, 1987).

Access canals for barges to the oil fields, the constant dragging of the lagoons and surrounding area and infrastructure that changes the shape of rivers and canals can lead to important modifications. A study of aerial photos taken in 1972 and 1984 revealed the following alterations (López and Zavala, 1987):

- seasonal wetlands became permanent lagoons
- marsh areas of poplar and reeds were invaded by permanent and seasonal wetlands
- inactive former river channels became tidal channels
- erosional processes increased in the coastal lagoons
- several grasslands disappeared

See figure 2 and the section on present land use for information on the use of fauna and hunting.

Threats - Persistence of conflicts in the reserve among which are the following important interactions:

Increase in the percentage of grazing land and modification of native vegetation - Livestock raising and grazing land are considered to cause a serious impact because of the change in land use. To clear new land, it is necessary to burn native vegetation (*espadañal*) and introduce species eaten by cattle.

Increase in exploration and extraction by PEMEX affecting maintenance of hydrological conditions - In 1985, PEMEX presented plans for exploiting oil in most of the floodable areas and wetlands in the state of Tabasco, with a concentration in the Centla area. The Centla area was declared an area for

the exploitation of oil in 1987. For this reason, every effort should be made to take into account the negative experiences in other wetlands. There are government agencies with capacity to carry out specific measures, and there are no technical impossibilities or lack of technical staff to achieve efficient extraction with a minimum of disturbance.

Exhaustion of fishing resources leading to smaller catches of commercial species - A characteristic symptom of the overexploitation of fishing resources of commercial importance is a decrease in the size of catches. This is the case of species of *pejelagarto* (*Lepisosteus tropicus*) and *camaron blanco* (*Peneaus* spp.). To remedy the decline, specific regulations and the establishment of reserves and fishing seasons are required for the capture of species of commercial value.

Limits to social development as opposed to a decrease in the quality of life and the environment - There are no significant development or social welfare programmes for towns in this area. Construction of roads and projects sponsored by the Programa Nacional de Solidaridad have been undertaken in the area to the benefit of specific towns.

The geography, climate and traditional attitudes toward the use of water in Pantanos de Centla are social considerations that provide few possibilities for development. Any action should be the result of specific needs proposed by the local towns in order not to impose social development models incompatible with the region.

The exploratory and extractive activities by PEMEX have changed the attitude of local inhabitants about development prospects. The indemnity received by the *ejidatarios* and landowners has changed the perception of the economic benefits that a landowner receives for extractive activities because in the short-run the exploitation of oil resources becomes more attractive than the traditional use of land.

Ignorance of the importance of natural resources countered by the development of regulatory guidelines - Implementation of a management plan for the reserve will promote the establishment of regulatory guidelines for the use of resources and activities within the buffer areas. There is also a need to co-ordinate the efforts of several federal and state agencies that have acted independently until now.

23. **Conservation measures taken**:

A detailed planning document has been prepared for the management programme for the Pantanos de Centla biosphere reserve. This document is in the final stage of revision by the federal government and, after approval, will be the basis for a management programme through an operations plan.

The biosphere reserve and its relation to the world conservation strategy

The Pantanos de Centla has regional aspects that justify its inclusion in a worldwide network of biosphere reserves under UNESCO's programme "Man and the Biosphere" (MAB).

A biosphere reserve is defined as an area of protection for land and coastal environments formed by one or more representative areas of natural biomass, unique communities or natural characteristic of exceptional interest, examples of modified or degraded ecosystems that can be restored to their original conditions or where there are examples of landscapes derived from traditional practices of land use.

The establishment and management of a reserve have been defined for the conservation of ecosystems, their species and core areas in ecosystems modified or unmodified, even if the reserve is restricted to the conservation of wildlife. This is also the case in buffer zones where local population lives and the regulated use of natural resources is permitted and in the areas of public use et aside for visitor activities.

On 6 August 1992, Pantanos de Centla biosphere reserve was created. After this, legislation was passed requiring the preparation of a management programme for the reserve by a decree in the "Diario Official." The decree specified in its provisional article: "Two - The management programme of Pantanos de Centla biosphere reserve should be prepared within 365 days from the date at which this decree enters into effect. There will be sixty additional days for the preparation of provisions for its implementation."

The state government has taken account of the importance of the reserve by incorporating it into the system of protected nature areas of the state of Tabasco (SANPET). Its importance is reflected in the creation of basic infrastructure for programmes of research, monitoring and protection provided for in the reserve's management plan.

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

The Secretaría de Comunicaciones, Asentamientos y Obras Públicas of the state of Tabasco and the Secretaría de Desarrollo Social (SEDESOL) are preparing a programme for operations in Pantanos de Centla biosphere reserve. According to the programme, a series of mandatory and complementary measures are to be carried out to ensure wise management of the reserve. The following actions are being carried out or will be carried out:

- creation of a management board for operations in the reserve
- preparation and publication of the management plan
- delimitation and marking of the reserve's boundaries
- construction and equipping of infrastructure
- operations and administration
- research
- sustainable development

The management programme for Pantanos de Centla biosphere reserve has the following objectives:

a) conservation of representative samples of ecosystems, ecological zones or biomass that are ecologically self-sustaining and have legal and political protection

b) promotion of basic research, surveys and applied research on the use and proper management of the reserve through studies of existing and experimental uses

c) provision of opportunities and installations for education and training of the general public, staff of wildlife areas and scientists at all levels

d) promotion of the use of the reserve's natural and cultural resources through appropriate practices, ensuring sustainable use and productivity

e) promotion of appropriate and integrated development of the biomass through the study, conservation and spread of practices appropriate for the region (López and Pérez, 1993)

Division into zones - For practical and theoretical management, this area has been divided by planners into several zones, each corresponding to specific characteristics, based on the following criteria: fragility,

uniqueness, present land use, land tenure, presence of potential natural resources and existence of development projects (governmental or non-governmental). The zones have been defined in the following manner (INIREB), 1985) (see map no. 5).

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Zone	Sector	Area (hectares)	Percentage
Core zone	Españadal-Cometa Los Negritos Chichicastle Quintín Arauz Los Naranjos	148,716	51.12
Buffer zone	Faisán-Tembladeras Grijalva-De los Ríos Bitzal, Naranjos and San Pedro y San Pablo	136,732	47.00
Cultural zone	Quintín Arauz	4,481	1.54
Extensive use	Españadal Arroyo Sabalo	593	0.20
Intensive use	San Pedrito	412	0.14
Special use	Arroyo Polo	-	-
Total protected area		**290,937**	**100**

Figure 0 Zones in Pantanos de Centla biosphere reserve, Tabasco, Mexico

Core zone - This is permanently flooded land corresponding to three of the four land systems in the area. It is mostly paludal plains and freshwater lakes. The care area is of difficult access and are unaltered or little affected by human disturbance. The core area is where the main sites for reproduction, feeding and sanctuary for birds and fish are concentrated. They are usually in situ germ plasm banks that allow biological and ecological processes to continue forever. Only scientific research and non-manipulative surveys should be permitted in this zone.

Buffer zone - This zone is on the alluvial plains and the coastal beach plain. Human settlements and productive activities are concentrated in this zone. Both manipulative and non-manipulative basic and applied research are permitted. The results are applied to the management and use of the biotic resources in the region. Only activities compatible with the objectives of the reserve and the needs of the local population will be permitted.

Cultural zone - This zone is managed for the protection and the study of human cultures. These are areas with archaeological and ethnological vestiges of human settlements, whose activities are based on the use of resources. It is hoped that these models will provide information on traditional practices of land use in order to develop and transfer this technology to similar areas. This includes the town of Quintín Arauz, the surrounding land and archaeological sites near the San Pedro lagoon.

Public-use zone - This zone covers areas that have been altered to some degree owing to human activities but that retain the general characteristics of the landscape and examples of the most significant characteristics. In addition to promoting human activities, a complementary objective is to facilitate recreation, environmental education and nature interpretation. This zone is divided into areas of intensive and extensive use, which are located in the buffer zone, around Arroyo Sabalo and Españadal (for extensive use) and San Pedrito (for intensive use) (López-Hernández and Pérez, 1993).

Special-use zone - In this zone, the areas are usually small and are essentially for administrative activities, maintenance, servicing of the area and staff housing. They are used to keep environmental impact to a minimum and discretely provide administrative facilities and enhance the landscape. They are concentrated in Arroyo Polo (López-Hernández and Pérez, 1993).

25. **Current scientific research and facilities**:

Government of the state of Tabasco - The government of the state of Tabasco through the Secretaría de Comunicaciones, Asentamientos Humanos y Obras Públicas and the Dirección de Ecología has provided infrastructure and basic equipment for the reserve for its operation and has constructed the reserve's headquarters, located strategically in the area known as Tres Brazos. A floating administrative station is being built, capable of moving about the reserve and functioning as a liaison centre making it possible to expand the work programme.

General objectives - General objectives are to participate in the fulfilment of the aims of Pantanos de Centla biosphere reserve, providing installations and basic services for support of the administrative, educational, training and ecological development activities, as well as protection, research, monitoring, promotion.

Background - Ever since Pantanos de Centla biosphere reserve was created in August of 1992 by a decree of the federal executive branch, the government of the state of Tabasco, through its "Programa Tabasco de Educación, Gestión y Mejoramiento Ecológico (PROTEGEME)," has been developing several measures designed to achieve the integrated management of the reserve, in accordance with the objectives for which it was created and in co-ordination with several levels of government. One of these measures was the construction of the reserve's headquarters with housing, a laboratory, an office, a multi-use room, a storage room and a dock, all well equipped. In addition, a floating station will support the functions of the headquarters.

In light of the above, the activities that the station must carry out are as diverse as each of the components or aspects of the reserve's management programme. For this, each activity must be defined and co-ordinated within the general framework. Wise management of the protected nature area will depend on this.

Location and description - The headquarters of the biosphere reserve are located in the northwestern part of the reserve, at kilometre 12 of the Frontera-Jonuta highway at San Juanito, at the place known as Tres Brazos in the municipio of Centla. The headquarters occupy an area of 2 hectares on the right bank of the Río Grijalva. This location is determined by the nearby junction of the Grijalva, San Pedrito and Usumacinta rivers which allows easy access to any place in the reserve by water. In addition, the headquarters is only 10 minutes from the city of Frontera.

The headquarters has three buildings:

Building 1 - This building is 18 by 8 metres and is divided into three sections:

Administrative section - In this section are located the offices for the reserve's administrative activities (reception and the director's office), a library and a meeting room.

Laboratory section - This area has a sterile room, two work benches with basic infrastructure for the work of monitoring and research, as well as laboratory equipment and basic equipment for the preparation and preservation of biological, water and soil samples.

Multi-use room - This room has the capacity to teach up to 40 persons in support of training and environmental education activities.

Building 2 - This is the largest building, 33 by 8 metres, where the living accommodations are concentrated, which are divided into two sections:

Dining room - This includes a kitchen and dining room for 30 persons.

Dormitory - There are two collective dormitories with a capacity of ten persons each, another for eight persons and three individual rooms. There are two bathrooms, a laundry room, a resting room and a small work room.

Building 3 - This building is 21 by 8 metres and is divided into two sections.

Storage room - For the storage of material used in the operation of the reserve.

Shed - Constructed with the intention of serving as temporary storage of possible confiscations.

Other services - There is also a radio room, reaching all of the reserve and maintaining direct communication with the offices of the Dirección de Ecología in Villahermosa. The boats available to the administration are three motorboats of 18 pieds with 40-HP motors and boat crews.

26. **Current conservation education**:

The government of the state of Tabasco through the Programa Tabasco de Educación, Gestión y Mejoramiento Ecológico (PROTEGEME) has taken important steps to promote awareness among the inhabitants of Tabasco to take advantage of this type of programme (State government, 1988). This programme is, however, in the initial stages (second year), and it is necessary to continue to promote efforts to evaluate the programme's effect on improvement of the region's ecology.

In the specific case of Pantanos de Centla biosphere reserve, the programme is in a stage of diagnosis and social awareness. The lack of a management plan has delayed implementation of this type of activity in the region.

27. **Current recreation and tourism**:

There are many activities and programmes implemented by the state government. One of the most important in relation to Pantanos de Centla biosphere reserve is the programme of ecotourist routes in the state of Tabasco. The government of Tabasco has defined the following conservation objectives for the state:

a) provision of facilities to contribute to the education and recreation of the population in order to form awareness about the value and importance of the state's natural resources

b) protection of sites of historical, cultural and archaeological interest as well as the traditional management of natural resources in harmony with the environment

c) protection of scenic resources to ensure environmental quality and promotion of ecotourism

In Tabasco, the areas suited for integration into a system of protected nature areas in the state of Tabasco (SANPET) were selected during the administration of 1982-1988.

The system of protected nature areas in the state of Tabasco (SANPET) was designed for planning and implementing measures to protect and conserve the environment. This programme seeks to improve the living standard of the local inhabitants with a minimum of ecological deterioration of the nature areas. The objectives for which these areas were created are:

- conservation of representative natural environments of the state's ecosystems
- formation of centres for the conservation of endangered native fauna and flora
- promotion of recreation and education for the general public
- creation of awareness about the importance of natural resources
- promotion of scientific research
- wise use of natural resources
- protection of sites of historical, cultural and archaeological interest

Five protected nature areas have been created so far: one biosphere reserve, two state parks, an ecological reserve and a natural monument. They have a total area of 321,989 hectares, which represents 12.87 per cent of the total area in the state. There is a proposal to included three more areas that will incorporate an additional 48,752 hectares into the system.

Ecotourist itineraries in the municipio of Centla in Pantanos de Centla biosphere reserve

1. Tourist ecological itinerary Arroyo Polo
2. Tourist ecological itinerary Quintín Arauz
3. Tourist ecological itinerary Río San Pedro y San Pablo
4. Tourist ecological itinerary Isla del Sábalo and Laguna Cometa
5. Tourist ecological itinerary El Españadal, Faisán and La Pera
6. Tourist ecological itinerary Boquerón
7. Tourist ecological itinerary Tamulté de las Sabanas, Laguna del Viento

28. **Jurisdiction**:

The following is a summary of the official decree by which the region of Pantanos de Centla was declared a biosphere reserve:

"Decree by which the area known as Pantanos de Centla with an area of 302,706 hectares located in the municipios of Centla, Jonuta and Macuspana in the state of Tabasco is declared a protected biosphere nature reserve.

This region is located within the large Grijalva-Usumacinta morphogenetic delta and presents a wide variety of ecosystems, such as semi-perennial, medium-height forest, mangroves, hydrophytic communities and low, semi-perennial forest.

The area has four systems of river plain, paludal plain, freshwater lake and coastal plain. This gives the reserve an important resource of the typical geomorphology of low dunes and a unique landscape.

Endemic, rare and endangered species live in this area.

There are many vestiges of the pre-Hispanic Maya-Chontal culture in this area.

This area is divided into *ejidal* land, private property and government land.

The main objectives of the biosphere reserve are the preservation of the genetic diversity of the fauna and flora and promotion of regional socioeconomic development through the sustained and integrated use of its natural resources, plus the promotion of research and the use of applied technology, environmental education and recreational and tourist activities.

Within Pantanos de Centla biosphere reserve, two core areas are created whose areas are 57,738 and 75,857 hectares and whose limits are described in the next-to-last paragraph of this decree.

Within this reserve, a buffer zone is established with an area of 169,111 hectares.

The hunting and capture of species of manatee, Belize crocodile, Central American river turtle, jaguar, Guatemalan howler, ocelot, jabiru, Peregrine falcon and osprey are prohibited throughout the biosphere reserve.

Temporary provisions

Two - The management programme for Pantanos de Centla biosphere reserve shall be prepared within 365 days from the date that this decree enters into force. An additional 60 days are granted for the preparation of regulations and implementation.

Four - The Secretaría de Desarrollo Social shall register this decree in the public property record within 90 days of its publication in the "Diario Oficial."

All legislation in conflict with this decree is superseded.

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29. **Management authority**:

The Comisión para la Aplicación de una Política Integral en la Reserva de la Biosfera Pantanos de Centla was created within the Comité de Planeación para el Desarrollo of the state of Tabasco under the Subcomité Especial de Ecología. This commission brings together the three levels of the public sector, the private sector and local communities that live in the reserve in order to undertake activities propitious for the protection and conservation of the reserve.

30. **Bibliographical references**: