World Heritage Sites

Protected Areas and World Heritage

SIAN KA'AN
MEXICO

This biosphere reserve on the east coast of the Yucatán peninsula is an undisturbed complex hydrological system containing tropical forests, sinkholes and swamps, mangroves and a large marine area bisected by a barrier reef. It provides a habitat for a remarkably rich flora and a fauna of more than 330 species of birds and many of the region's characteristic terrestrial vertebrates

COUNTRY
Mexico

NAME
Sian Ka'an

NATURAL WORLD HERITAGE SITE
1987: Inscribed on the World Heritage List under Natural Criteria vii and x.

STATEMENT OF OUTSTANDING UNIVERSAL VALUE [pending]

INTERNATIONAL DESIGNATIONS
1986: Designated a Biosphere Reserve under the UNESCO Man and Biosphere Programme (528,148 ha).
2003: Designated a Wetland of International Importance under the Ramsar Convention (652,193 ha).

IUCN MANAGEMENT CATEGORY
II National Park

BIOGEOGRAPHICAL PROVINCE
Campechean (8.01.01) / Yucatecan (8.15.04)

GEOGRAPHICAL LOCATION
Situated on the east side of the Yucatan Peninsula in the State of Quintana Roo, 50 km north of Chetumal and 130 km south of Cancún, between 19°05' to 20°06'N and 87°30'to 87°58'W.

DATES AND HISTORY OF ESTABLISHMENT
1982: Sian Ka'an declared a Reserve;

1986: Sian Ka'an designated a national biosphere reserve by the Federal Government and an international Biosphere Reserve by UNESCO;

1994: Uaymil Flora and Fauna Protection Area designated part of the national biosphere reserve; Espiritu Santo Bay declared a wildlife Refuge (89,000 ha);

1998: The Reefs *(Arrecifes)* of Sian Ka'an designated a national biosphere reserve (34,927 ha);

2002: Designated part of a Ramsar Wetland.

LAND TENURE
99% is federally owned, 1% privately owned.

AREA
528,000ha: 408,000ha terrestrial and 120,000ha marine. Contiguous with Uaymil Flora and Fauna Protection Area (89,118ha) in the south. The site includes the MAB core zone of two terrestrial areas, Uaimil and Muyil and one marine area, Cayo Culebras. Managed by the National Commission for Natural Protected Areas, *Comision Nacional de Areas Naturales Protegidas*, (CONANP) since 2000, under the National Secretariat for the Environment, Natural Resources and Fish, *Secretaría de Medio Ambiente, Recursos Naturales y Pesca* (SEMARNAP).

ALTITUDE
Sea-level to 10m.

PHYSICAL FEATURES
Sian Ka'an lies on a partially emerged coastal limestone plain which forms part of the extensive barrier reef system along the eastern coast of Central America. Over half the area as far as 40 km inland is salt and freshwater marshland in the catchments of the wide bays of Ascension and Espiritu Santo, 20% is semi-evergreen forest on slightly higher ground; 23% is reef and marine. Much of the Reserve is limestone of recent Pleistocene origin which still appears to be in a transitional stage; the higher ground is of late Tertiary age. Three geological faults cross the reserve from southwest to northeast under the bays, which have influenced the topography and hydrology. There is a large number of sink holes *(cenotes)* characteristic of the karst landscape of Yucatan, and Florida. The 120 km coastline includes white sand beaches, extensive mangrove stands and creeks, 105 freshwater and brackish lagoons, two wide shallow bays covering over 100,000ha, of varying salinity and dotted with islets and mangrove keys. There are 137 islands within the site. The floor of the bays is either sand or covered by seagrass. There are 68km of dunes. Coastal marshes and mangroves are invaded by the sea during tropical storms and hurricanes, but the system is largely protected from the sea by a 110 kilometer-long 15,000ha stretch of the 1,200km Mesoamerican reef. This is the second largest barrier reef in the world, the growth of which is partly due to the lack of erosion inland and consequent silt-free water (Lopez, 2003). The growth is most active on the windward side to the east, which absorbs the energy of the storm winds, and is less active and discontinuous on the west side (CONANP, 2005).

The hydrological cycle is complex. The water table is permanently close to the surface, never being deeper than 8m. As a result, each year during the dry season, about 20% of the terrestrial marshes remain flooded, increasing to about 70% by the end of the wet season. Canals cut by the Maya are once again in use. There is little surface running water as it filters fairly rapidly through the shallow red rendzina and *sashab* (granular whitish and brittle limestone) soils and the limestone rock to subterranean channels. Owing to their hardness and the lack of erosion the waters in the reserve are usually very clear. Communal farmland borders the reserve inland but in general its shallow stony nutrient-poor soils are not suitable for agriculture (CIQRO, 1983; Lopez, 1983; Consejo *et al*., 1987). The boundaries coincide with natural features: the sea and barrier reef to a depth of 50m in the east; the edge between the marshes and semi-evergreen forests in the south-east; the limit of the Espiritu Santo Bay catchment in the south and the borders of farming cooperatives in the north and north-east.

CLIMATE
The climate is tropical with summer rains and occasional cyclones. Data from Las Palmas north of the site give mean monthly temperatures of 22.7°C for January/February and 27.6°C for May/June; the mean annual temperature from 1961 to 1980 was 26.5°C, and the minimum and maximum temperatures were 4.5°C and 40.5°C respectively. The mean annual rainfall is 1,300mm, three-quarters of which falls between May and October. September is the wettest month and March the driest. Easterly winds blow almost continuously from May to November, while northerly winds, which may reach 100km/h, blow during the dry season. The area is cloudy for 200 days a year and the mean relative humidity is around 80%. Cyclones strike between June and October, peaking in September. Strong marine tornados or *mangueras* also occur between May and October, although their action is limited and brief (CIQRO, 1983). During the last century there has been an average of one hurricane every 8 years. The most recent to hit the site were Dean in 2007, Wilma in 2005, Iris in 2001 and Roxanne in 1995, which caused severe damage to structures and vegetation.

VEGETATION
Olmsted *et al*. (1990) describe the following vegetation types: medium altitude semi-evergreen forest (~108,500ha); medium and low altitude semi-deciduous forest (over 11,700ha); low altitude flood forest (~175,000ha); palm savanna *(tasistal)*; freshwater and saltwater marshes; hundreds of hardwood hammocks *(petenes)*, emerging islands of forest protected from saline intrusions; dwarfed

and fringing mangroves (nearly 90,000ha); dunes, widely planted to coconut *Cocos nucifera*, and vegetated keys. A total of 859 vascular plants was recorded in 1995: 15 pteridophyte, 21 bryophyte and 159 algal species; 14% are endemic (Kramer & Kramer, 2002; SEMARNAP, pers. comm., 1995). As a result of ongoing research, the total may become higher. Inventories are given in Olmsted *et al*. and Cabrera *et al*. (1983).

Medium altitude semi-evergreen forest is the climax vegetation in non-flooded areas, although where accessible it is scarce due to disturbance. 120 trees and shrubs are listed in Olmsted *et al.* (1990), some 100 tree and shrub species being identified in the medium and low semi-deciduous forests. Among the larger trees black poisonwood *Metropium brownei*, sapodilla *Manilkara zapota*, gumbo limbo *Bursera simaruba* and false tamarind *Lysiloma latisiliquum* are dominant; and in some areas *Brosinum alicastrum* and false mastic *Mastichodendron foetidissimum*. The height of dominant species in this forest can reach 14m but is generally between 10m and 12m. In the low altitude semi-deciduous forest Jamaican thatch *(chit)* palm *Thrinax radiata*, lancewood *Nectandra coriacea*, *N. salicifolia*, *Byrsonima bucidaefolia*, Mexican silver palm *Coccothrinax readii* and fiddlewood *Vitex gaumeri* are abundant. In this forest the height of dominant species ranges from two to nine metres. Selective felling has taken much mahogany *Swietenia macrophylla*, red cedar *Cedrela odorata*, white cedar *Simarouba glauca*, *Cordia dodecandra*, lignum vitae *Guaiacum sanctum*, black poisonwood and Jamaican thatch palm. Fires set for agricultural clearance mainly along the main approach roads, have burnt at least 14,000 ha, although only 3,000 ha of the area have been used. However, a recent restoration project has led to an increase in vegetative cover.

Flood forest is subdivided into low forest with closed and, in lower wetter areas, open canopy tree communities. Dominant trees in this community are black poisonwood, sapodilla, false tamarind, fishpoison tree *Piscidia piscipula,* guava *Psidium sartorianum*, and two characteristic palms, despeinada palm *Beaucarnea ameliae* and cherry palm *Pseudophoenix sargentii*, also spiny black olive *Bucida spinosa*, logwood *Haematoxylum campechianum*, and *Dalbergia glabra;* others include *Byrsonima bucidaefolia*, white poisonwood *Cameraria latifolia*, false cocaine *Erythroxylon areolatum* and *Malpighia lundellii*. The fire-resistant silver saw palm *Acoelorraphe wrightii (tasiste),* and *Crescentia cujete*are are found scattered in slightly higher areas which are frequently flooded, also in grass marshlands. Silver saw palm can form monospecific islands on patches of dark soil, and is often found in association with leather fern *Acrostichum danaeafolium*, spiny black olive, button mangrove *Conocarpus erectus*, *Dalbergia glabra*, cocoplum *Chrysobalanus icaco*, sawgrass *Cladium jamaicense*, and Jamaican thatch palm (Olmsted *et al*., 1990).

Grass communities cover large areas at both north and south ends of the Park and among mangroves and inland forests, though not in areas of high salinity. This vegetation type occurs as a mosaic with three intermingled associations dominated by sawgrass, black bog rush *Schoenus nigricans*, and gulfcoast spikerush *Eleocharis cellulosa* respectively. Other shrub and herb species found with these communities are *Cassytha filiformis*, *Ipomoea sagittata*, *Pluchea purpurascens*, *Crinum americanum*, *Fuirena breviseta*, *Dichromena ciliata*, *Eleocharis caribaea*, *Bletia purpurea*, *Agalinis* sp. and *Dichanthelium dichotomum*. Forested hammocks emerge from the flooded marshes, from tens of metres to more than a kilometre across. Larger hammocks may have a central waterbody. These islands are vegetated by aggregations of sawgrass, common reed *Phragmites australis*, spiny black olive, black poisonwood, *Crescentia* spp., *Ficus* spp., logwood, frangipani *Plumeria* spp., Jamaican thatch palm and sabal palm *Sabal palmetto*. There are extensive areas of scattered dwarf mangrove to the east of the freshwater marshes. Plants cover 35-40% of the substrate, with red mangrove *Rhizophora mangle* up to two metres high dominating. The main arboreal components of the fringing mangroves, in order of resistance to salinity are red mangrove, black mangrove *Avicennia germinans* and white mangrove *Laguncularia racemosa*. In drier areas, button mangrove, sapodilla and Jamaican thatch palm are present, with mangrove fern *Acrostichum daneaefolium* and the climber *Rhabdadenia biflora* (Olmsted *et al*., 1990). As salinity decreases inland, there are large areas of sawgrass marsh and freshwater stands of narrowleaf cattail *Typha angustifolia*.

Coastal dunes stretch along 68km of the coast, from the northern point of the Reserve to Punta Allen and on the south side of Ascension Bay from Punta Hualastoc to Punta Tupac. As Sian Ka'an lies so close to the Caribbean islands, there is a strong affinity between the floras (Espejel, 1983). Typical species of both the dunes and the islets are geiger tree *Cordia sebestiana,* Jamaican thatch palm, silver saw palm, bay cedar *Suriana maritima*, black poisonwood, gumbo limbo, *Ficus* spp., sea rosemary *Heliotropium gnaphalodes*, coastal ragweed *Ambrosia hispida*, spider lily *Hymenocallis latifolia*, sea purslane *Sesuvium portulacastrum*, sea grape *Coccoloba coxumelensis* and *Ageratum*

spp. The cultivation of introduced coconut has replaced about 60% of the natural vegetation of the dunes (Espejel, 1983). The bays have extensive beds of turtle grass *Thalassia testudinum* and other seagrasses.

FAUNA

Garcia (1983) gives a preliminary checklist of the vertebrate species found in the Reserve, and it is possible that all vertebrate species characteristic of the Yucatan region may occur there. A total of 103 species of mammals have been recorded including five species of cat, jaguar *Panthera onca*, puma *Puma concolor*, ocelot *Leopardus pardalis*, margay *L. wiedii* and jaguarundi *Puma yagouaroundi.* Other mammals include tamandua or lesser anteater *Tamandua tetradactyla*, two-toed anteater *Dasiprocta punctata*, spotted paca *Cuniculus paca*, a large rodent, the black-handed spider monkey *Ateles geoffroyi* (EN), Yucatan black howler monkey *Alouatta pigra* (EN), three mustelids, the kinkajou *Potos flavus*, the weasel-like tayra *Eira barbara*, and white-nosed coatimundi *Nasua narica*; Caribbean manatee *Trichechus manatus* (VU: 11-20 individuals in 2002), Central American tapir *Tapirus bairdii* (EN), whitelipped and collared peccaries *Tayassu pecari* and *Pecari tajacu*, white-tailed deer *Odocoileus virginianus* and red brocket deer *Mazama americana* (Consejo *et al*., 1987; Navarro *et al*., 1990).

Some 339 bird species have been recorded in Sian Ka'an (CONANP, 2005), of which 219 breed in the Reserve. Since the diversity of aquatic habitats is very high, marine and wading birds are well represented and this is the second largest waterbird community in Mexico (Kramer & Kramer, 2002). At least sixteen raptors are found including the king vulture *Sarcoramphus papa*; also brown pelican *Pelecanus occidentalis*, olivaceous cormorant *Phalacrocorax olivaceus*, frigate bird *Fregata magnificens*, great blue heron *Ardea herodias*, jabiru stork *Jabiru mycteria*, wood stork *Mycteria americana*, roseate spoonbill *Platalea ajaja*, greater flamingo *Phoenicopterus ruber*, ocellated turkey *Meleagris ocellata*, Yucatan amazon parrot *Amazona xantholora* and keel-billed toucan *Ramphastos sulfuratus* (Consejo *et al*., 1987). Forty-two species of reptile and amphibians include four of the six turtle species found along Mexico's coast: green turtle *Chelonia mydas* (EN), hawksbill *Eretmochelys imbricata* (CR), leatherback *Dermochelys coriacea* (CR) and loggerhead *Caretta caretta* (VU:>200 in 2002). All four turtles breed in the Reserve. Belize crocodile *Crocodylus moreletii* (556-705 in 1996) and American crocodile *C. acutus* (VU) also occur. Other species include Columbian boa *Boa imperator*, Yucatan rattlesnake *Crotalus durissus*, fer de lance *Bothrops asper*, black spiny-tailed iguana *Ctenosaura similis*, basilisk lizard *Basiliscus vittatus* and forest gecko *Thecadactylus rapicaudus*, gulfcoast toad *Incilius valliceps*, yellow cricket tree frog *Hyla microcephala*, and *Leptodactylus melanonotus*. There are some sinkholes where isolation has produced species endemic to the single waterhole. 550 terrestrial and 843 aquatic invertebrate species were noted in 1995 (SEMARNAP, pers. comm., 1995), but the total had increased to 1,719 by 2000 (Kramer & Kramer, 2002).

The 110km of barrier reef, which parallels much of the coast, is part of the second longest such reef in the world. There are shallow patch reefs and the deep fore reefs broaden out to the shelf edge. It is one of the richest coral reefs in Mexico with 83 recorded species of reef-building coral, 63% of Caribbean coral species (CONANP, 2005). It is dominated by dense thickets of elkhorn coral *Acropora palmata* and fire coral *Millepora complanata* which offer complex foraging areas and shelter. Back reefs are dominated by boulder star coral *Montastraea annularis* and lettuce coral *Agaricia tenuifolia*. Deeper slope reefs contain diverse communities of octocorals, sponges and algae, with a few scleractinian corals. Many of the more than 400 species of fish, reef, estuarine and pelagic, including several juvenile sharks, depend on the sheltered seagrass beds and mangroves as nurseries which also provide critical habitat for the endangered manatee. As well as the primary herbivore, planktivore and corallivore consumers, which include the rare local endemic, the splendid toadfish *Sanopus splendidus* (VU), the larger secondary consumers such as Lutjanidae (snappers) and Serranidae (groupers) form the basis of the commercial and artisanal fisheries, but are over-fished and have markedly declined. The structural complexity of the reef supports a very complex trophic chain. The accompanying macroinvertebrate life is abundant, with 103 species of mollusk, 24 sponges, 171 algae and a large number of echinoderms (CONANP, 2005). Estuarine fish like tarpon *Megalops atlanticus* and mullet *Mugil* spp. use the brackish inshore waters for a part of their life and are also economically important for artisanal and sport fishing. Pelagic fish includes some of the largest species and several species of shark. The largest populations of spiny lobster *Panulirus argus* in the region live in the two great bays and form the most economically significant fishery in the state (Kramer & Kramer, 2002).

CONSERVATION VALUE

Sian Ka'an preserves a complex hydrological system of tropical forests, marshes, mangroves, and a large barrier reef, providing habitat for a remarkably rich flora and fauna and many of the region's characteristic terrestrial vertebrates plus 23 sites of pre-hispanic culture. The Park lies within a Conservation International-designated Conservation Hotspot, a WWF Marine Global 200 Eco-region, and both a Ramsar wetland and a UNESCO Biosphere Reserve.

CULTURAL HERITAGE

In Mayan, Sian Ka'an means 'where the sky is born', referring to the whole of southern Quintana Roo. There is evidence that the area was occupied 2,300 years ago. Twenty-three Mayan sites are registered in the reserve, Chunyaxché, Vigia del Lago and Xamach in the north being the most accessible (notable sites also exist nearby). Most are from the late post-classical period (1200-1500CE). 10 km north of the site is the well maintained coastal archaeological zone of Tulum National Park, a postclassical Mayan walled port which was a centre of sea trade between the 13th and 15th centuries. In the reserve area the Maya developed a self-sustained shifting agriculture: in the 1980s a 24km-long Mayan irrigation canal was discovered (Consejo *et al*., 1987) and other canals have since been opened up. This was complemented by harvesting the forests and wetlands, still practiced today in some communities. The people made use of approximately 185 forest and wetland plants for over 300 different uses in food, chewing gum resin, medicine, clothing, dies, thatch palm leaves and all types of building materials.

LOCAL HUMAN POPULATION

The Reserve is located in the hitherto least developed part of Quintana Roo, and the population is predominantly of Mayan origin. Between 1910 and 1960, encouraged by the federal government, settlers from other areas of Mexico arrived, planted the coastal dunes with coconut palms and, given concessions, cleared the best grown forest for precious tropical woods such as red cedar and mahogany. Three manned lighthouses were built in the Reserve (CIQRO, 1983). However the historically low human usage which preserved many of the coastal habitats and fishing grounds has been altered by the current fast pace of development which threatens wetlands, beach areas, and coral reefs (Kramer & Kramer, 2004). In the 2000s, Cancún is the fastest developing city in the country and the expansion of the *Costa Maya* or Mayan Riviera between Cancún and Tulum may create thousands of hotel rooms in the next ten years. Tulum had a population in the mid 2000s of 12,000. Within the Reserve some inhabitants still depend on agriculture, and in 1996 there were some 1,352 ha of livestock pasture, 760 ha of copra and 75 ha of maize. There were reported to be some 800 inhabitants then living in the reserve mainly in Punta Allen and Punta Herrero, and in settlements scattered along the coast and in the forest. There are now some 600 living in settlements on the Punta Allen peninsula, reached from the nearest town of Felipe Carrillo Puerto to the west or from Tulum in the north. There are five unpaved roads in the reserve, whose margins are becoming increasingly disturbed. But as a result of the tourist boom in nearby Cancún and Tulum, a figure of 10,000 inhabitants of the Reserve is quoted in the mid 2000s, a high proportion being lobster fishermen, supplying the tourist trade.

VISITORS AND VISITOR FACILITIES

Tourism south of Cancún began to develop in the 1970s when the Tulum beaches started to attract foreign visitors. In 1983, tourist use of the area was low. By 2000, 36,000 annual visitors were recorded. To limit disturbance only 15% of the site is open to visitors, mainly along the coast, and no new access tracks have been built. On site, despite the lack of basic services such as electricity and drinking water, trailer parks and rustic huts extend south along the coastal strip. In the north, there are small hotels, fishing clubs, and areas for trailers and cabins reached by a track from Tulum. Elsewhere in the Reserve there was in 1996 a small hotel and cabin area at Punta Pajaros accessible only by boat or aeroplane (CIQRO, 1983). However, Tulum, with its imposing cliff-top temple/castle above the sea, well maintained ruins and sand beaches has, with Cancún, become one of Yucatan's major tourist attractions and attracts much international attention. A number of exclusive fishing lodges have developed in the Reserve (Kramer & Kramer, 2002). Community tours which are run with locally trained guides benefit the local economy, the environment and the consumer; a World Heritage site vacation package is offered. There now exists a Centro de Ecológico de Sian Ka'an near Tulum. A small ecotourism and education centre, it is a model for sustainable development in sensitive tropical ecosystems. The revenue generated through low impact tourism, accommodations, reef, lagoon and canal tours, fly fishing, birdwatching, kayaking and archaeological site visits, is used to fund public awareness, conservation and education programs within the Reserve (Centro de Ecológico de Sian Ka'an, n.d.).

SCIENTIFIC RESEARCH AND FACILITIES

Research in the area is coordinated by the Centro de Investigaciones de Quintana Roo (CIQRO), and extensive surveys by various research institutions have been made of different aspects of the Reserve's wildlife, ecology, geology and hydrology (CIQRO, 1983; Anon., 1988, 1989). An early ethnobotanical study described the wide use by Mayan peasants of 185 forest and wetland plant species. A team from the University of Mexico evaluated the marine resources (Consejo *et al.*, 1987). In the mid 1990s the crocodile population was studied. A private foundation of dedicated local people, los Amigos de Sian Ka'an, is carrying out researches funded by WWF, the Nature Conservancy and other NGOs. Lodging is available for visiting scientists. Two climatological stations have been donated by the National Metereological Service. El Ramonal experimental plot has been used to develop agricultural techniques that preserve the delicate Yucatan soil, using mixed cropping and crop rotation. Studies are also being carried out to ensure the sustainable exploitation of lobster and Jamaican thatch palm trees, both integral components of the local economy (Sheean-Stone, 1989). The Ecological Centre uses ecologically responsible systems for wetland waste management, rainwater collection, and solar and wind energy generation. It also operates educational outreach programs, biological research and a plant nursery to support restoration of dune vegetation (Centro de Ecológico de Sian Ka'an, n.d.). A Sian Ka'an Conservation Foundation has also been established in the U.S.A. to secure funding and promote research.

MANAGEMENT

In the past, inaccessibility, flooding and poor soils preserved the area as a little used wilderness. However, during the first half of the 20th century, the federal government and favourable credit terms offered by banks actively encouraged its development and settlement by incomers, especially the logging of valuable woods and the establishment of cattle ranches on the cleared land. In 1980 an ecological assessment made by CIQRO, the State Government research center (Lopez, 1981), and a forestry diagnosis developed by the government forestry agency, both with support from the German technical cooperation agency GtZ, revealed the extent of the degradation and unsustainable development. A public information project promoted the idea of a reserve through the media (Lopez, 1993).

In 1986, the national biosphere reserve was proclaimed, managed since 2000 by the National Commission for Natural Protected Areas (CONANP) under the Secretariat for the Environment, Natural Resources and Fisheries (SEMARNAP). It is subject to the Forestry law of 1960, and federal laws regulating agrarian reform and hunting enforcement of which has improved. In 1989, a rural training program was started as part of a regional development project by the Amigos de Sian Ka'an (ASK), which serves as a channel for private conservation in the region, collaborating with local, state and federal governments, the numerous national and international institutions, and local inhabitants. In 1993, as part of an agreement between the Federal government and the World Bank to finance ten Mexican reserves through the Global Environment Facility, a comprehensive official management program for Sian Ka'an was prepared which identified management zones and 16 objectives. These included protection, resource management, monitoring, environmental restoration, archaeological and cultural protection and management, social development, tourism, and appropriate infrastructure (SEMARNAP, pers. comm., 1995).

By 1995 a revised management plan was completed. The Quinanta Roo Secretariat for Urban Development and Ecology and the National Institute of Anthropology and History participated in the plan. Achievements include control of tree felling, reduction of commercial hunting, and of indiscriminate use of forest products in the central area, the removal of exotic casuarina trees (*Melaleuca* spp.), establishment of ecological regulations for the relocation of Colonia Punta Herrero, which was considerably damaged by cyclones; and the contracting of local inhabitants from Chunyaxché as reserve workers and their collaboration in captive breeding projects. No increase in cattle ranching occurred after 1985; new settlements were stopped, land-use rights granted, land-use regulations were set, tourism development within the Reserve was controlled and sustainable harvest of key natural resources initiated. Net fishing has been reduced by 95% and sport fishermen have been persuaded to adopt a largely catch and release approach. A community program training locals as tourist guides was started to manage tourism beneficially, and local technicians trained in Sian Ka'an are today holding key positions in most environmental programs in the country. Forest exploitation is now limited to the collection of useful wild plants and for subsistence hunting, although there is some commercial and sport hunting, which should be more regulated. In 1998, the reserve had adequate on-site staff and infrastructure; research and monitoring programs were in place, and community

outreach and environmental education programs. ASK was invited by the government to permanently assist in addressing the threat of growing tourism development around Sian Ka'an (Nature Conservancy, 2007). In 2002 a Development Plan for the Reserve was published by SEMARNAP. The Banco Chinchorro reef, 40 km southeast, was nominated but in 2007 not accepted for World Heritage status: future acceptance could come as an extension to Sian Ka'an (UNESCO, 2007).

MANAGEMENT CONSTRAINTS

All coastal areas and surrounding forests are owned by the Federal government and by law, those clearing and fencing land could claim it as legal property, a deliberate incentive for development. By the mid 1970's timber companies were approaching the coastal forests. Fire was used extensively to clear scrub and open areas for cattle ranching. Most non-flooded areas were rapidly transformed. At the same time, over 90% of the original dune vegetation was claimed for coconut palms and over 100 fishermen settled in the area with many more arriving seasonally, to provide fish and lobster to the fast growing tourist industry in Cancún. By 1980 unplanned development, mainly based on extractive forestry, tourism and unsustainable cattle ranching, was generating a 17% annual population increase in Quintana Roo. Deforestation grew at 6% a year; hunting and fires became general. Tourist facilities grew along the coasts reclaiming dunes, draining mangroves, and pumping from the scarce groundwater reserves which led to salinisation of coastal wells. In some places, wetlands were used as a sink for sewage and uncontrolled movements over the coral killed tracts of the reef. Timber and fisheries were both exploited far beyond natural recuperation rates; ranching was unsustainable; tourism was degrading water supplies and the fragile limestone landscape. Degrading reefs also threatened the fisheries and the protection of the coast against erosion.

The main problems still result from increasing tourism and urbanisation, over-fishing especially of spiny lobster, and to a lesser extent, agricultural pollution, forest fires and invasive species. The development of tourist facilities is profoundly modifying the coast north of the reserve. The uncontrolled urban growth with sewage systems discharging directly into the sea, seriously threatens the reef. Forest fires have occurred in the same area, affecting 135,000 ha, and soil erosion increased in deforested areas (Lopez *et al*., 1989). These, with the regular occurrence of cyclones, emphasise the fragility of this ecosystem. The great increase in popularity of the Cancún region has also increased tourist pressures on the bays such as wildlife spotting by speedboat. In addition to conflicts over the exploitation of natural resources, the tourism boom has exacerbated conflict between the Maya traditional culture, the conservation sponsored by major international NGOs and the UNDP, and increasingly intrusive but profitable tourism. The surrounding communities are abandoning the traditional Maya forest and land-use customs, sustained for centuries, in favour of more commercial practices. Maya from the community-owned lands *(ejidos)* lent their forests to timber companies, while the young lost interest in their land and left the area to get jobs as building workers in the tourist resorts on the coast.

At present, the 68 km-long coastal dune belt of the Reserve is mainly planted with copra on 25 small farms. During the 1990s, 95% of coconut palms were destroyed by disease, and farmers introduced a more resistant variety of palm (SEMARNAP, pers. comm., 1995). Valuable timber species such as mahogany, cedar, lignum vitae and geiger tree have been almost exhausted through over-extraction. Jamaican thatch palm is still much used in the construction of lobster traps. Inaccessibility provides a certain degree of protection, but at the same time hinders monitoring, research, administration and active protection (Consejo *et al*., 1987). In addition, there are rather few park rangers to patrol this huge area. Reserve boundaries are not easily defined due to the existence of peripheral *ejidos,* and their protection is difficult. Due to the high humidity, the cost of building and equipment maintenance is high. This is not helped by the high incidence of cyclones. Domestic, industrial or agricultural effluent from Felipe Carrillo and Andres Quintana Roo *ejidos* and other settlements within the catchment basin of the Reserve may penetrate the water table through absorption by calcareous soils. The use of water should be more controlled as excessive use could increase groundwater salinity (CIQRO, 1983).

STAFF

A director with a staff of 21 (SEMARNAP, pers. comm., 1995). 5 entrances are guarded.

BUDGET

Between 2001 and 2006 some US$135,000 came from the GEF to seven sites under the small grants program. Other financial support from CONABIO Mexico, the World Bank, European Union, UN and WWF-US is directed towards research and restoration programs (SEMARNAP, pers. comm., 1995).

Los Amigos de Sian Ka'an provide funds and technical support. In 2004 the Gillette Co. with the Nature Conservancy and the UN Fund granted US$750,000 towards increased protection of the Reserve.

LOCAL ADDRESSES

Direccion de la Reserva de la Biosfera de Sian Ka'an, Comision Nacional de Areas Naturales Protegidas, Secretaría de Medio Ambiente, Recursos Naturales y Pesca , Avda. Insurgentes s/n, entre av. Tec. de Merida y av. Tec. de Chetumal, Quintana Roo, Mexico 77039.

Amigos de Sian Ka'an, Apt. Postal 770, Cancún, Quinta Roo, Mexico 77500.

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DATE

June 1987. Updated 5-1990, 8-1995, 2-1996, 4-2008, May 2011.