Marine Protected Areas Needs in the South Asian Seas Region

Volume 4: Pakistan

A Marine Conservation and Development Report

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Marine Protected Area Needs in the South Asian Seas Region Volume 4: Pakistan

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Published by: IUCN, Gland, Switzerland

Citation: Pernetta, J.C. (Ed). 1993. *Marine Protected Area Needs in the South Asian Seas Region. Volume 4: Pakistan.* A Marine Conservation and Development Report. IUCN, Gland, Switzerland. vii + 42 pp.

ISBN: 2-8317-0177-5

Printed by: SADAG, Bellegarde-Valserine, France

Cover Photo: Camels on a Baluchistan beach; IUCN/Danny Elder

Editing and Layout by: Sarah Humphrey, IUCN

Available from: IUCN Marine and Coastal Areas Programme,
Rue Mauverney 28,
1196 Gland, Switzerland

Marine Protected Area Needs in the South Asian Seas Region Volume 4: Pakistan

Edited by John C. Pernetta
1993

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Acknowledgements

This report was prepared as one of five background documents for a review of marine protected areas needs in the South Asian Seas Region. The draft report was prepared in 1989 by Ms S. Wells, consultant to IUCN and subsequently edited for publication by Dr John C. Pernetta. Additional information on legislation was provided by Mr L. Gündling of IUCN's Environmental law Centre. The opinions expressed in this document do not necessarily reflect the views of IUCN or UNEP.

1. General Description: Pakistan

1.1.1. Geography & Geology

Area:	803,941 km^2;
Coastline:	1,046 km;
EEZ:	196,600 km^2;
Territorial waters:	23,820 km^2;
Population:	Approximately 122,700,000 (1990).

The Islamic Republic of Pakistan is situated at the junction of three major regions of Asia: Central Asia to the north, the Middle East to the west and the Indian Subcontinent to the east and southeast.

The coast-line stretches from the Iranian border, along the Makran coast of Baluchistan to Karachi and then along the Sind coast, including the Indus Delta to the Indian border. The total length including bays is estimated at 1,500 miles (2,414 km) (Snead, 1965). There are few offshore islands. Burbridge (1989) has produced an annotated bibliography of the coastal region and Ataur-Rahim (1986a;1986b) provide long bibliographies to marine publications. General information is given in Snead (1965; 1969), Haq & Milliman (1984) discuss marine geology and oceanography and UNEP (1986) details oil pollution and other marine issues.

1.1.2. Climate

The coast of Pakistan is essentially a subtropical desert with an average annual rainfall of between 4 and 8 inches (10-20 cm) except on the eastern side of the Indus Delta where it increases to about 12 inches (30 cm) (Snead, 1969). according to UNEP (1986), rainfall on the Sind coast averages about 20 mm a year and on the Baluchistan coast about 10 mm a year. However, rainfall is extremely sporadic and inter-annual variation is high. West of Las Bela valley, maximum rainfall occurs in winter as short showers and drizzle; to the east, rainfall is greatest during the summer monsoon depressions. Spring and autumn cyclones from the Arabian Sea result in torrential downpours with consequent flooding and erosion.

Wind speeds during the southwest monsoon, May - September, are about 25 knots, and during the northeast monsoon, November - March, about 5-10 knots. In the southwest monsoon, winds blow from the sea to the coast, reversing direction in the northeast monsoon.

Temperatures are highest (around 80 °F, 27 °C) from April to the first half of June and again in October. The other summer months tend to be cooler owing to cloud cover, and high humidity. During this period seas are normally rough and shoreline erosion is extensive. From November to February, diurnal breezes blow off the Arabian Sea during the day, and off the land at night; temperatures range from 80 °F (27 °C) in the day to 50 °F (10 °C) at night and the weather is clear and bright (Snead, 1969).

1.1.3. Coastal and off-shore topography

The Baluchistan coast is about 700 km in length and comprises about 75% of the Pakistan coastline. It is steep with rocky outcrops, the 200 m contour lying 16-42 km from shore. The area is tectonically active with mud volcanoes in the Dhal plains east of Ormara along the Makran coast and sulphur springs in the adjacent hills. The coast consists largely of sandy beaches only a few yards wide at high water, backed by high, near-vertical cliffs, or occasionally by sandy plains or dunes. There are a few small rivers such as the Hingol, Hab, Basul and Dasht, their flow being dependent on the monsoon rains (Groombridge, 1989; UNEP, 1986).

In the west, pouch-shaped Gwatar bay lies between the headlands of Iran and the rocky platform of Jiwani, bordered by a swampy region which is the delta of the Dasht Kaur, one of the largest rivers in Baluchistan. This river is an intermittent stream and floods only once every 2-3 years. There is a wide beach along the bay, behind which are barrier bars, islets, mud flats and tidal lagoons, with clumps of low mangroves. The 45 km stretch of coast from Ras Jiwani to Ras Pishukan is comprised of cliffs, straight sandy beaches backed by ridges or sand dunes and large shallow bays. The almost straight cliffs of Ras Jiwani reache 30 m. Short rivers cross the flat coastal plan to the east of the headland and the narrow beach is exposed to strong waves.

At Ras Pishukan there are two small rocky headlands separated by a small pocket beach. Gwadar West Bay is very shallow and tectonically active, and is the outflow for the Akara River. At the eastern end of the bay, a large tombolo of accretion ridges and shifting sand dunes extends 8 km seaward to connect the rocky platform of Gwadar with the mainland. The headland is 145 m in height and forms a rocky tableland similar to those of Jiwani and Pishukan. The coastline of Gwadar East Bay is similar to that of Gwadar West Bay but is not as shallow and is more exposed. North of the tombolo, the coastal plain narrows to a sandy plain less than 152 m wide, behind which rises the Jabal-i-Mehdi with high cliffs and hanging valleys.

From the headland at Jabal Sur, the coastline runs east for nearly 66 km, starting with a flat plain, before the long stretch of low, rugged mountains, Koh Dimak, which end at Ras Shamal Bandar with cliffs of 183 m. From here the coast runs straight east to the rocky headlands of Jabal Zarain and Ras Jaddi, bordering dunes and sandy ridges. The coast from Ras Jaddi to the West Bay of Ormara has steep cliffs and dissected uplands, with the exception of the bay near Pasni which is backed by a sandy coastal plain.

The Shadi River reaches the coast to the north of Pasni, its mouth being partly closed by an alluvial spit. East of this lies a narrow, un-vegetated coastal plain backed by low mountains, with some cliffs. Near the Rumro River, the coastal plain widens around the tidal embayment of Kalmat Khor, one of the largest tidal lagoons on the Makran coast. It is closed off at the coast by a barrier beach, behind which lie dunes up to 15 m high. The lagoon encompasses mudflats, saltflats, tidal channels and some mangroves. No large rivers flow into the lagoon but small streams deposit large quantities of sediment which appear to be filling the lagoon. East of this the Garuki and Kamgar Hills extend to the coast forming rocky headlands and high cliffs; the two ranges are separated by a coastal plain between Ras Basol and Ras Sakanni.

East of the hills, the coast curves in a wide arc around Ormara West Bay to the rocky headland

of Ormara, which is a tombolo very similar to the one at Gwadar, but higher at 474 m, and more massive. East of Ras Ormara, the coast runs almost straight to the massive headland of Ras Malan, bordering a wide, flat, sandy plain, the Gwaz region, on which there is a group of white mud volcanoes, some of which are active. East of this the coastal plain narrows and is backed by high mountains, the Hinglaj range, which abut the coast as sheer cliffs forming the most rugged section of the Makran coast. Cliffs around Ras Malan reach 300-610 m and from Ras Malan to the Hingol River, there are sand beaches backed by low cliffs or sandy plains and some rocky headlands. The large alluvial plain of the Hingol River, or Dhak region, is about 32 km long and 13-16 km wide. There is a small delta and dunes, and occasionally a large brackish lagoon is formed behind the river mouth. To the west, a series of mud volcanoes are found on the slopes of the Sarpai the largest of which, the Chandragup mud volcano rises to a height of 104m. The coast in this area is cliffed with numerous rugged scarps, sea caves, sea stacks and rocky coves.

East of this, the coast forms a 145 km arc around Sonmiani Bay to Cape Monze. The Las Bela coastal plain runs east of the Sarpai, narrows near the Haro Mountain range, and widens again across the Las Bela coastal area, forming a plain second only in size to the Dasht Kaur valley. It resembles the Kalmat Khor embayment, with a long, nearly straight sandy beach backed by accretion ridges and dunes. Behind these lies the lagoon, Miani Khor, which opens to the sea between Adi and Sonmiani Spits, and is tidal. The lagoon is about 48 km in length, has extensive mud flats on the west side, and is silting up rapidly. Small clumps of mangrove (*Avicennia alba* and *Rhizophora conjugata*) are found on the east side. The lagoon is backed by older dunes, some vegetated sand flats and salt playas. The Windar and the Porali are the main rivers draining into this area. On the east side of the Las Bela valley a large sand complex, 30-60 m high, is being heavily weathered and undercut by the sea. From this, a series of small rocky outcrops extend past Gadani south to the headlands of Cap Monze. The Hab River enters the sea a few kilometres north of Cape Monze but has only a small delta. Cape Monze is the southwestern tip of the Kirthar Mountain Range and is about 210-245 m high; Churma Island lies off its west coast (Snead, 1969).

The Sind coast is relatively shallow and flat bottomed, the 200 m contour lying 70-120 km from shore. From Cape Monze to Clifton beach the coast is composed of sand barrier bars, low cliffs and scallop shaped bays. Sandspit is a 14.5 km long barrier bar which connects the rocky headland of Manora with the mainland; in places it is less than 305 m wide. The beach on the seaward side of the bar is backed by low dunes. Behind the bar there is an 8 km long tidal lagoon with clumps of low mangroves (*Avicennia alba*), once more widespread but now restricted to a few tidal channels. The lagoon has been greatly altered through development. Manora Head is 28 m high, with low cliffs and sea caves at the base. To the east, at the entrance to Karachi Harbour are three small sandstone islands, Oyster Rocks.

Across the mouth of Karachi Harbour another sand barrier bar connects with Clifton beach which is backed by dunes. The Lyari River flows out at Karachi Harbour through the Manora Channel, its run-off increases in the monsoon season, and the water is highly polluted (UNEP, 1986). Both the beach and Kiamari Spit are made of very fine sand which has been carried west from the Indus Delta. From here, a series of barrier spits and barrier bars extend southeast along the edge of the Indus delta. The Karachi coastal zone is described in NIO (1989).

The Indus is the main river and has shifted course within the delta several times. The shoreline of this section of coast once lay much further north at about the latitude of Karachi. The Indus discharges some 200 km^3 of water and 450 million tonnes of suspended sediment annually. This creates the Indus Cone, a 2,500 m deep pile of loose sediment on the floor of the Arabian Sea, which fans 1,500-2,000 km away from the mouth of the river as a subaqueous delta (Nair, 1984). The outflow of the delta formerly lay near Karachi and a major earthquake in 1819 appears to have shifted the main outflow 150 km to the south leaving much of the former delta southeast of Karachi, as a vast area of brackish backwaters and tidal creeks with high salinity. The river and its tributaries are now used so extensively as an irrigation system that the delta is only functional as an estuary for two months of the year (UNEP, 1986). The delta still appears to be growing although dams upstream have slowed the movement of sediment. At high tide the coastal strip is submerged 5-6.5 km inland and in the monsoon the delta is flooded up to 32 km inland. Tidal waters ascend the Indus as far as Tatta, 97 km inland, and at times form a tidal bore (Snead, 1969). There are numerous papers on aspects of the physical processes underway in the delta such as Rabbani & Khan (1986), Milliman *et al.* (1984), Schubel (1984) and Wells & Coleman (1984). Snead (1965) describes recent morphological changes along this coast and Burbridge (1989) gives a number of other references covering sedimentology, geomorphology and geology.

The entire area is traversed by tamarisk-fringed creeks, active and dead Indus distributaries, with a littoral fringe of mudflats, mangrove creeks, relatively fresh rain-fed lagoons (**dhands**) and near barren, sandy islands. When high tides and Indus floods (now much reduced) coincide, the coast may be flooded for over 30 km inland (Groombridge, 1983). Most of the material making up the delta consists of fine silts and clays with a high percentage of micaceous sands. At the coast, the fine materials are carried offshore and coarser sands are left to form a series of barrier bars with hooks and spits at the ends. Most of the beaches along the outer bars are very wide, and the tidal channels between the bars vary in width; in some places there are low dunes. The shapes and sizes of the bars are continually changing. Mud flats behind the bars are scattered with mangrove shrubs and trees, of which *A. alba, R. conjugata* and *Rhizophora mucronata* are the dominant species reaching 12-15 m in height along tidal channels. In a very few areas dense forest occurs, mainly near the site of the active delta where large freshwater flows occur. In the south, where the delta is active, mud flats extend to the coast and there are fewer bars. South of the active part of the delta, there are large salt flats which become increasingly extensive towards the Rann of Kutch.

1.1.4. Oceanographic features

Sea surface temperatures to 10 m depth range from 21-24 °C in February to 28 -30 °C in June/ July. Tides are mixed, semidiurnal with two highs and two lows every day. Tidal range is about 3.5 m with a slightly higher range on the Sind coast. Average salinity values for the Arabian Sea are 34-37‰ while salinity in the inshore waters of the Karachi area averages 35.5 - 36.9‰ and may rise to 41-42‰ in backwaters and tidal creeks. There are no major upwellings along the coast but small-scale wind-induced upwellings of nutrient-rich cool water do occur. However productivity is not high, possibly because the effects of upwelling are annulled by the excessive turbidity (UNEP, 1986).

In general, during the southwest monsoon and for a period before and after, currents in the Arabian Sea are clockwise. Currents are reversed for a shorter period of 2-4 months during the northeast monsoon, when winds are from the northeast. The Somali current flows northwest up the African coast and then eastward along Arabia, Pakistan and northwest India (UNEP, 1986).

The sea off the Makran coast is said to become discoloured and foul-smelling at certain times of year (Groombridge, 1989) presumably as a consequence of low flushing and development of a strong thermocline. Phytoplankton in the Arabian Sea are described in Gentsch (1986); bacterioplankton by Azam (1982); and, zooplankton by Huda & Munir (1988).

2. Marine and Coastal Ecosystems

2.1.1. Coastal vegetation types

The biogeographical regions of Pakistan have been described by Champion *et al.* (1965), Beg (1974), Roberts (1977) and Khan & Hussain (1985). Of greatest significance on the coast is littoral mangrove forest although other vegetation types also occur in some areas (Scott, 1989). In the more arid reaches the coastline is mainly devoid of vegetation except for date palms (UNEP, 1986). The coastal vegetation described by Snead (1969) may be divided into the following types:

1. Arid and semi-arid subtropical scrub: found in arid tropical areas under the influence of the monsoon, such as those near Karachi, and in Sind, Kohistan, Kirthar and Lasbella; in areas with a less pronounced monsoonal influence and with a semi-mediterranean climate, such as the Salt Range, Kala Chitta Hills and eastern hills of Waziristan; and in desert areas with no monsoonal influence.

2. Tropical thorn forest: occurring in the Indus Flood Plains; the Thal, Cholistan and Thar deserts; and, in the sand dune areas of Nushki and Chagai.

3. Riverine and marsh vegetation: occurring as riverine tracts in the immediate vicinity of the Indus River and its distributaries from the coast to the northern foothills, and in the inundation zone, seepage zones, **jheels** and **dhands** throughout the Indus Flood Plains. The dominant vegetation of the riverine tracts includes *Tamarix dioica, Tamarix aphylla, Populus euphratica, Acacia nilotica* and *Saccharum spontaneum*; the aquatic vegetation of the inundation zone includes *Phragmites karka, Tamarix dioica, Typha angustata, Typha elephantina, Arundo donax, Paspalum distichum, Saccharum spontaneum* and *Erianthus spp.*

Snead (1969) also briefly describes the vegetation of the coastal plains. Immediately behind the beach, low salt tolerant shrubs (*Salsola foetida, Calligorum polyonoides, Holoxylon salicornicum*) and vines (*Ipomea pescaprae*) are found. Desert plants such as *Suaeda fruticosa, Aerua persica, Heliotropium curassavicum, Sericostum pauciflorum, Atriplex stocksii and Tamarix spp.*, are generally found behind the salt spray zone but often also occur on dunes. Vegetation in the tidal marshes, riverine tracts, and sand and rock areas is described in Snead & Tasnif (1966). Vegetation in the Las Bela region is described by Snead (1965) and that around Karachi by Chaudri (1961).

2.1.2. Mangroves

The dominant mangrove species are *Avicennia marina, Rhizophora conjugata* and *Ceriops tagal* (Saifullah, 1982). Recent estimates of the area of coastal mangrove swamps have ranged from about 250,000 ha to 283,000 ha (Saenger *et al.*, 1983). Remote sensing has been used in

several projects to estimate areal coverage of mangrove forests Mirza *et al.* (1983). There are numerous reports and studies covering aspects of mangrove biology including Ahmad (1983a) on management; Tirmizi & Khan (1983) on uses; Siddiquie & Ilyas (1983) on phytochemistry; and, Kogo (1980; 1985) on mangrove ecology and management.

Most mangroves are found in Sind, the main area being the Indus Delta (Figure 1), but they are also found in creeks near Karachi and have been mapped by Kogo (1985). The most complete description of Sind mangroves appears to be that of Ansari (1986). Mirza *et al.* (1983) have prepared a vegetation map of the Indus Delta at the scale of 1:250,000 based on 1976-78 images. This reportedly revealed that 44% of the intertidal zone, or about 260,000 ha (0.65 million acres) of the Delta (total area 1.5 million acres) was covered in mangroves (Ansari, 1987). 'Dense' mangrove covered 0.13 million acres while 'normal' mangrove covered 0.52 million acres. In contrast Snedaker (1984) states that only 1% of the original 0.25 million ha of the delta are now covered with mangroves. The principal species in the Indus Delta are *Avicennia officinalis, Rhizophora conjugata, Ceriops tagal, Salsola foetida* (Groombridge, 1983). Vannucci (1986) describes the overall productivity of mangroves in the Delta.

Baluchistan has yet to be fully surveyed (Davie, in prep.), although Burbridge (1989) states that a 1:250,000 'thematic' map of most of this coast has been produced. According to a thematic map (1:100,000) produced by Mirza *et al.*, (1986) the main areas of mangrove are at Miani Khor, Kalmat Khor, in the extensive tidal lowlands around the Dasht estuary (Groombridge, 1989; Mirza *et al.*, 1986), and in Sonmiani Bay and other bays along the Makran coast. The main species are *Avicennia alba* and *Rhizophora conjugata*, the former being more common and the only species recorded at Dasht Kaur by Snead (1966). Mangrove quality declines westward as less favourable conditions, including suboptimal temperatures and migrating sand dunes become more frequent (Snead, 1966).

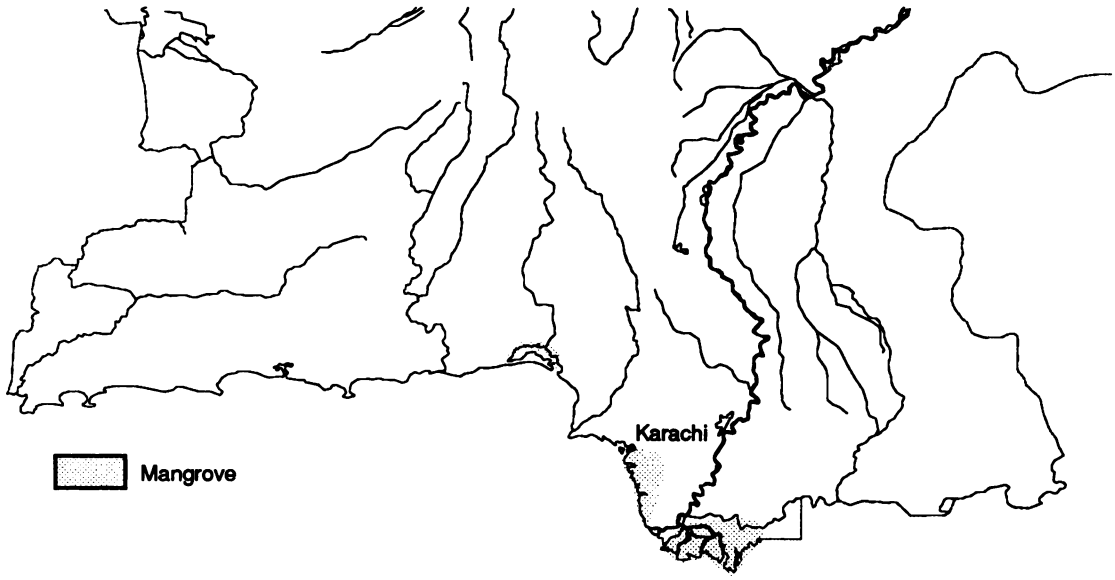
There are numerous publications on the mangrove fauna of Pakistan in general, including those of Ahmad (1983), Ahmed (1980), Ahmed *et al.*, (1985; 1986), Barkati & Tirmizi (1988), Ahmed *et al.* (1987), and Tirmizi (1985); and on specific taxonomic groups such as those of: Huda & Ahmad (1986a; 1986b) on zooplankton; Tirmizi (1980), Tirmizi *et al.* (1983) and Tirmizi *et al.* (1986) on crustacea; Ahmad, 1986b; Tirmizi & Barkati (1983; n.d.), Barkati & Tirmizi (1986) on molluscs; Ahmed (1986) and Hoda & Akhtar (1983) on fishes; Karim (1986) and Khanum & Ahmed (1986) on birds of the Sind and Karachi mangroves respectively; and Ahmad (1983b) on vertebrates.

2.1.3. Marshes and wetlands

In addition to mangroves, there are a number of deltas and estuaries with extensive intertidal mudflats and an estimated total area of 300,000 ha of delta marshes in the Indus Delta (Naik, 1986). These are less well studied than either the mangroves or other vegetation types.

The importance of Pakistan's wetlands was first brought to the notice of the international community at a Technical Meeting on Wetland Conservation held in Ankara, Turkey, in October 1967 (Savage, 1968; Carp, 1980). Subsequently a large number of publications have appeared on waterfowl and wetlands including Roberts (1982; 1984a; 1984b), Roberts *et al.*

Figure 1.
Mangrove areas on the coast of Pakistan



(1986), Savage (1972a; 1972b), and Savage & Isakov, (1970). Between 1971 and 1976, the International Waterfowl Research Bureau sponsored a series of annual mid-winter waterfowl counts at many of the major wetlands in Pakistan. In their recent synopsis of the waterfowl of Pakistan, Ghalib *et al.* (1988) have listed 119 wetlands.

2.1.4. Coral reefs

Coral reefs are not at present known from Pakistan (UNEP, 1986). However, Qureshi (1961) describes the seabed on the Makran or Baluchistan coast as being muddy but with patches of coral and rocks in some areas. It is possible that this coast would be more suitable for coral growth than the Sind area as it has harder substrates and less turbid water. It is thought that further research may reveal more extensive coral communities, particularly around Astolla Island, near Pasni, and Ormara (UNEP, 1986). According to Snead (1969), several submerged coral reefs have been mapped to the southwest of Cape Monze.

2.1.5. Seagrass beds and algal communities

Patches of seagrass have been observed from the air along the coast of Baluchistan but need further investigation (Groombridge, 1983). Penhale (1986) gives information on seagrass ecology. More than 45 species of green and 79 species of red seaweed have been recorded, but abundance does not appear to be sufficient for sustained yields (UNEP, 1986). Seasonal changes in the standing crops of intertidal seaweeds from the Karachi coast are described by Qari & Qasim (1986).

2.1.6. Beaches

Southwest of Karachi, a 20 km beach, (Hawksbay and Sandspit beaches) stretches west from Manora Point at the mouth of Karachi Harbour which is probably the country's most important. It is backed by creeks and shallow tidal lagoons with mudflats and mangroves. Tables 2 and 4 in UNEP (1986) provide some information on beaches and further general descriptions are provided in the section on coastal and off-shore topography above.

2.1.7. Islands

The only offshore islands are Haft Talar and a few small islets near Karachi, including Chirma Island off Cape Monze and Oyster Rocks off Karachi Harbour. However, there are numerous unstable sandy islets in the Indus Delta.

3. Economic Aspects of Marine and Coastal Resource Use

Karachi is the largest industrial centre in the country and the only major centre on the coast; the population of the Greater Karachi area is some 7 million and is projected to reach 13 million by the year 2000. The remainder of the coast is very sparsely populated except for small towns at Keti Bundar, Ormara, Pasni, Gwadar and Jiwani and a number of fishing villages (UNEP, 1986). Snead (1969) describes population density along the coast in the 1960s which has changed greatly since that time.

3.1.1. Fisheries

Burbridge (1989) provides a bibliography of numerous references including Abildgaard *et al.* (1986), Williams (1984), Ahmad & Niazi (1988), Schatz *et al.* (1987), and Majid (1986). Ataur-Rahim (1986a;1986b) provide bibliographies with many references to marine fauna. A checklist of the marine fauna of the country is being continuously updated by the Zoological Survey of Pakistan. Jaleel & Uddin (1981) provide a checklist of 400 fish species, and several others have been identified since then. Sardines and anchovies are particularly abundant in coastal waters (Ahmed, 1985). Juveniles of mullet and other fish, and mud skippers are abundant in tidal creeks. The mangrove fish fauna is described by Ahmed (1986). Other publications on fish include Qureshi & Bano (1971), Ahmad & Ghalib (1975), Niazi (1976), and Ahmed *et al.* (1984). Schatz *et al.* (1987) provide an overview of the Fisheries Sector.

Landings of marine species totalled 341,222 tonnes in 1989, with the most important catches from the provinces of Sind and Baluchistan (Government of Pakistan, 1991). Indian sardine, skates and rays make up a significant proportion of this total. *Hilsa* landings decreased from 9,594 tons in 1976 to 3,923 tons in 1981. A potentially important resource is offshore squid which have been found in high densities by a Japanese research vessel. There is some tuna fishing, the main species being skipjack and kawakawa (UNEP, 1985).

The crustacean fauna is rich and includes about 25 species of penaeid shrimps, and three species of edible crab (*Scylla serrata, Portunus pelagicus, P. sanguinolentus*) (UNEP, 1986). Commercial crustacean (shrimp and crabs) fisheries information is given in Ahmed (1985), Zalinge *et al.* (1986a; 1986b), Zalinge & Khaliluddin (1985), Zupanovic (1973), and Zalinge (1984). Shrimp provide about 80% of export earnings in the fisheries sector and and account for 85% of total marine product exports, around 9,000 tonnes being exported annually (UNEP, 1986). Japan is the major market followed by the USA and UK. There are 17 freezer plants and 11 canneries but these do not work at their full capacity.

Both subsistence and commercial prawn fishing are important. The commercial fleet, which consists mainly of Karachi-based trawlers, has increased greatly and the prawn stocks are now considered fully or even over exploited (Groombridge, 1983). Any increased in effort could

lead to collapse of this industry (Government of Pakistan, 1991). Keti Bunder is particularly rich in shrimp and fish juveniles (UNEP, 1986; Hassan, 1983) and subsistence fisheries are also very important in Miami and Kalmat Khor, especially in the latter area where very high quality prawns are found. Off-shore trawlers illegally enter the lagoons for these prawns, which are important to the subsistence sector since they can be fished during the monsoon season when subsistence fishing boats cannot go to sea.

The Indus Delta is a critically important fisheries area and plays an essential role in the life cycles of most of the species that contribute to the country's shrimp fishery, and also for many economically important fish, crabs, molluscs and other invertebrates. The potential for commercial exploitation of mangrove mudskippers is described in Hoda & Akhtar (1983).

Oyster resources are described in Hasan (1960), but according to UNEP (1986) the stocks are no longer commercially exploitable. About eight species in the genera *Crassostrea* and *Saccostrea* have been recorded (Ahmed *et al.*, 1982); four species occur in the West Bay at Gwadar. The largest stocks of edible oysters (*Crassostrea ensis, Crassostrea rivularis* and *Crassostrea gryphoides*) occur in the Hab River Delta in Baluchistan. *Placuna placenta* and *Atrina* are found in very small numbers in Sind and the pearl oyster *Pinctada* is neither widespread nor common. The Green Mussel *Perna viridis* is most common in Baluchistan but also occurs in Sind. Large mussel beds at Pasni might be sustainably exploitable but are not exploited at present. The local people do not eat molluscan shellfish and the only demand is from tourists and for export (UNEP, 1986).

Information on crustaceans is given in Manning (1986), Kazmi (1986), Tirmizi & Ghani (1986), Khan (1975), Khan & Farooq (1975), Mustaquim & Rabbani (1976), Ahmad & Khan (1970), Karim (1973), Ahmad (1976), Khan & Ahmad (1975) and Masihuzzaman (1973). Publications on molluscs include Hasan (1960), Ahmed (1971), Ashraf (1969), Khan & Dastagir (1970), Ahmed *et al.*, (1982). Echinoderms are described in Haque (1969).

There are large resources of small shoaling pelagic fish such as anchovy and whitebait (Clupeidae) on the west coast from October to May at 25-35 m associated with small scale seasonal upwelling. The potential yield in the pelagic fisheries sector in the 1970's was estimated at 3-4 times the actual catch (UNEP, 1982). FAO estimates the maximum sustainable yield to be 2 million tonnes per year. Catches of small pelagics could be increased from 160,000 tonnes to 200,000 tonnes and large pelagics from 25,000 tonnes to 30,000 tonnes. The catch of demersal species, at 190,000 to 200,000 tonnes is probably near the sustainable limit (Government of Pakistan, 1991).

3.1.2. Aquaculture

Shrimp farming has been started on an experimental basis near Garo in the creeks of the Indus Delta (UNEP, 1986). Aquatic Farms Ltd (1987) discusses the environmental limitations to shrimp farming in Pakistan which include: extremes of temperature, salinity fluctuations in creeks, and degradation of estuarine systems due to artificially reduced river flow. Due to environmental degradation is seems unlikely that shrimp produced from semi-intensive shrimp farms constructed in the Indus Delta would be able to compete in the world export market. The

potential for cultivation of molluscs in mangroves is discussed in Tirmizi & Barkati (n.d.).

3.1.3. Mangrove exploitation

The arid nature of Pakistan and the absence of well developed forest in the interior means that mangroves are considered a major forest resource (Davie, in prep.). Information on mangrove usage is given in Ahmad (1983a), Tirmizi & Khan (1983), Saifullah (1982), Ansari (1986) and Marker (1987). Mangroves are traditionally used for construction timber; fuelwood, both domestic and for fish/shrimp drying; and for fodder, mainly for camels. Mangrove leaf fodder is used by small scale operators and by professional camel farmers and an estimated 5,000 camels graze in the mangroves, principally on *Avicennia marina* during the dry season from June to October. It is anticipated that establishment and proper management of mangroves will become an essential part of the national forestry and energy programmes of the country (Davie, in prep.).

3.1.4. Non-living marine resource use: minerals and sands

The hydrocarbon potential of the coast is described in Harms *et al.* (1984).

3.1.5. Coastal tourism

At present there is little international tourism in Pakistan and local people are not yet oriented towards coastal and marine-based recreation. However, certain sandy beaches such as Clifton Beach and Hawkes Bay are popular. The recreational potential of the Karachi coastline is described in NIO (1989).

4. Conservation Issues and Problems

4.1. Habitat Degradation and Destruction

4.1.1. Mangroves

Mangroves have been overgrazed by camels particularly in areas where mangrove regeneration has been reduced as a consequence of lowered freshwater inputs. Increasing salinity is a problem due to decreased river flow in the Indus as a consequence of dam construction. All accessible mangroves have been cut near habitation. Conversion of mangrove habitats to aquaculture ponds and for urbanization are not yet severe but may become so in the future (Davie, in prep.).

Snedaker (1984) concludes that the major threat to mangroves on the Sind coast is the reduction in freshwater discharge from the Indus which has already led to a major reduction in mangrove coverage as salinity has increased. Remnant areas are reportedly mainly sparse, small *Avicennia* lining the banks of the better tidally flushed channels. Further declines are anticipated and additional information is given in Ansari(1986). In Baluchistan, the environmental conditions for mangroves are marginal and so additional human pressure is placing them under increased threat, as in Miani Khor.

Work on the impact of industrial pollution on mangroves is described in Siddiquie & Ilyas (1983), but this source of degradation is less important that the other threats.

4.1.2. Marshes and wetlands

Threats to coastal and other wetlands are described in detail in Scott (1989) as follows:

1. Drainage to provide more land for agriculture, industry and housing.
2. The construction of dams and large-scale agricultural improvement works, which have reduced the flow of water to many natural wetlands and resulted in some former rice-growing areas drying out.
3. Pollution, particularly the release of industrial waste into rivers and lakes.
4. Intensive development for fisheries production and large-scale introduction of herbivorous fishes, resulting in changes in the ecology of the wetlands.
5. Changes in land use practices in areas around wetlands, causing a change in the water quality and water regime.
6. Forestry projects, range management and quarrying activities in the water catchment areas of wetlands.
7. Increased sedimentation caused by serious erosion in the water catchment areas.
8. Eutrophication and the resulting spread of aquatic vegetation leading to the disappearance of open water areas.

9. Heavy hunting pressure outside protected areas and illegal hunting in the reserves, particularly in the northern and tribal areas.
10. Deliberate poisoning and scaring of waterfowl on agricultural land.
11. Excessive recreational use.

4.1.3. Sea level rise and erosion

The main area of concern is the Indus Delta. Milliman *et al.* (1984) and Schubel (1984) provide estimates of the reduction in sediment reaching the Indus Delta as a result of upstream barrages and water diversion, and discuss the likely effects of this on the delta and estuary. It has been estimated that less than one fifth of the sediment flow of the 1940s now reaches the estuary and that future construction along the Indus may completely cut off sediment supplies. The estuary is now only functional in the monsoon season, and represents only 10% of the original size of the active delta area. Reducing the sediment load reaching the estuary on such a high energy coastline and continental shelf may result in extensive coastal erosion. Flushing of ports and harbours will be less effective and may lead to increased concentrations of some contaminants.

4.1.4. Overfishing

Schatz *et al.* (1987) report on major problems in the fisheries sector, such as degradation of the Indus Delta, lack of good statistics on fish stocks and of long-term studies and suggest that reduced sediment discharge is probably depressing the productivity of the coastal zone with consequent reduction in fish production. The decreased influx of nutrient rich, river water through the Indus may affect offshore fisheries and has already caused a decline in fish stocks in some areas. Several of the references cited in the fisheries section above also refer to this and related problems.

4.1.5. Pollution

The main pollution problem is domestic sewage in the Karachi area, which is discussed in some detail in UNEP (1982; 1986). There is a great deal of pollution oriented research underway and Burbridge (1989) provides an extensive list of references. Korangi, Phitti and Gharo creeks all receive sewage effluent and have been the subject of numerous studies (Burbridge, 1989). It is thought that sewage pollution may have caused the decrease in biomass of economically important marine fauna on the Sind coast (Hunda and Munir, 1988). The impact of industrial pollution on mangroves has been studied by Siddiqui & Ilyas (1983).

UNEP (1986) discusses the potential for oil pollution of the coast in great detail although exploration on the Sind coast has just started. At present the only ports are Karachi and Port Mohammad Bin Qasim where pollution is a problem the most badly affected locality being Manora channel. Pollution could potentially be more serious on the Sind coast as the creeks and backwaters are less well flushed than the coastline of Baluchistan which is subject to greater wave action and open oceanic conditions.

4.2. Species of conservation concern

In the following paragraphs species listed by IUCN (1990) as globally threatened are considered individually. Other species, including those considered threatened regionally or nationally are discussed in the general paragraphs. Status categories follow the IUCN definitions namely: endangered (E); vulnerable (V); rare (R); indeterminate (I); insufficiently known (K); threatened (T) and commercially threatened (CT).

4.2.1. Mammals

Platanista minor, the Indus dolphin, (E)
This species used to occur in the Indus Delta and throughout the Indus drainage system. It is now restricted to small areas of river inland and must be locally considered extinct in coastal areas (Khan & Niazi, 1986; Perrin & Brownell, 1989; Perrin, 1989).

Balaenoptera physalus, the fin whale (V)
Recorded in Pakistan waters but no further information on its status is available (Groombridge, 1983; Klinowska, 1992).

Balaenoptera musculus, the blue whale (E)
Recorded in Pakistan waters but no further information on its status is available (Groombridge, 1983; Klinowska, 1992).

Megaptera novaeangliae, the humpback whale (E)
No information on Pakistan sightings is available.

Other cetaceans:
Silva (1987) records a total of 17 species having been sighted or landed in Pakistan waters, but there may be more. The plumbeous dolphin *Sousa chinensis (plumbea)* is recorded regularly in the Indus Delta and is more numerous than the finless porpoise; it may occur up to 15 km inland and favours mangrove areas (Groombridge, 1983). It may be taken accidentally in fishing nets and populations are considered to be at risk.

Sightings of the finless porpoise, *Neophocaena phocaenoides* in the Indus Delta (Kudi, Mull, Khai and Dubla creeks) have been not uncommon in recent years, but the species is thought to occur less frequently than in the past, owing to increased human activities. It formerly ranged up to 65 km up the river Indus, but is now restricted to the delta. It is normally observed from October-April, a timing which is presumably related to seasonal spawning migrations of prawns, the porpoises' preferred food items. Boat traffic may also have affected the population around the Indus mouth and there is some accidental capture.

The bottle-nosed dolphin, *Tursiops truncatus* occurs in the larger more open creek mouths of the delta and further offshore although there is no further detailed information (Groombridge, 1983). The tropical dolphin, *Delphinus delphis tropicalis* is considered by Ahmed *et al.* (1987) to be rare, but is not of global concern according to Klinowska (1992).

Canis lupus, the wolf (V),
The wolf is rare in Sind and the lower Indus plains (Groombridge, 1983) and is unlikely to occur in coastal areas.

Cuon alpinus, the dhole (V)
Felis margarita scheffeli, the Pakistan sand cat (E),
Panthera pardus, the leopard (T)
Data is needed on the status and coastal distribution of these species.

Lutra perspicillata, the smooth-coated otter (K)
Known to occur in Indus Delta its status is not known (Groombridge, 1983).

Dugong dugon, the dugong (V)
Habitat not considered suitable but individuals may stray into Pakistan waters from the Gulf of Kutch and populations of this species may constitute a straddling stock (Thornback & Jenkins, 1982).

Equus hemionus khur, the Indian wild ass (E)
Data needed on occurrence and status on coast, but it is unlikely that it occurs here (Groombridge, 1983).

Gazella dorcas bennetti, the Indian gazelle or, chinkara (V)
Dasht Kaur (Scott, 1989); further information on coastal distribution needed.

4.2.2. Birds

Pelecanus crispus, the Dalmatian pelican (E)
Winters in Pakistan (Collar & Andrew, 1988); occurs in Badin and Kadhan Lagoons, Miani Khor, Indus Delta, Dasht Kaur, Pasni (Scott, 1989). 2,600 individuals were recorded in Kur, 300 in Shaikh Kerio Peer in 1988. (*P. philippensis* is recorded by Groombridge (1983) as being frequent in the Indus Delta, but this is confusion with *P. crispus*).

Marmaronetta angustirostris, marbled teal (V)
Breeds and winters (Collar & Andrew, 1988; Savage 1965).

Oxyura leucocephala, the white-headed duck (V)
Some of largest wintering concentrations of this species are found in Pakistan (Collar and Andrew, 1988); information on coastal status needed.

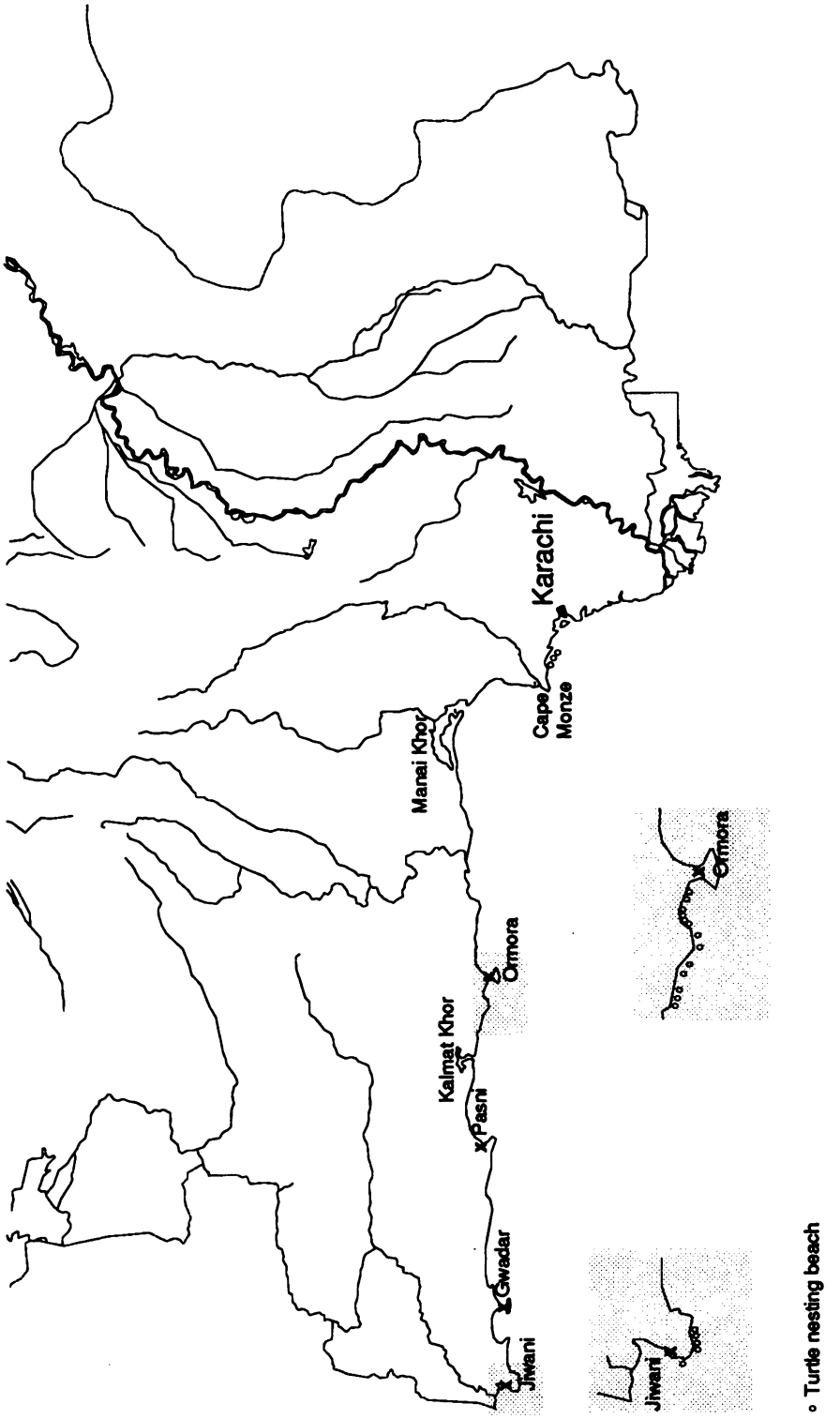
Haliaeetus leucoryphus, Pallas's fish eagle (R)
Recorded as occurring (Collar & Andrew, 1988) but no further information is available on its status.

Chettusia gregaria, sociable plover (R)
Winters in Pakistan (Collar & Andrew, 1988).

to be abundant in Manora Channel and Korangi Creek; it is now much rarer and is thought to be threatened by oil pollution (Ahmed, 1977). Other marine invertebrates which might be similarly affected include the lugworm *Arenicola brasiliensis* and the crinoid *Commanthus samoanus* (UNEP, 1986).

There are no listed fish or amphibian species.

Figure 2.
Location of turtle nesting beaches and important wetlands along the Makran coast of Baluchistan (After Groombridge, 1987a)



Important sites for waterfowl and waders include Badin and Kadhan Lagoon, Miani Hor, Clifton Beach, Korangi and Gharo Creeks, Dasht Kaur, Pasni Bay, Hawksbay and Sandspit Wildlife Sanctuary and Korangi Protected Forest (Ahmad, 1986a; 1987; IUCN, 1987; Karpowizc, 1985; Kermani, 1976; Khan, 1984; Koning & Dijksen, 1971; 1974; Koning & Koning-Raat, 1975; 1976; Koning & Walmsley, 1972; 1973). The Makran coast is used largely as a wintering area by Palearctic breeding waterbirds and is important for a small number of Indian Ocean species which either winter, such as the crab plover, *Dromas ardeola* or breed, such as seabirds, in this area (Groombridge, 1989).

There appear to be few large concentrations of seabirds on the Pakistan coast, perhaps due to the low productivity of coastal waters (UNEP, 1986), but Haft Talar has major breeding colonies of sooty gull *Larus hemprichii* and large crested tern *Sterna bergii* (Scott, 1989).

4.1.3. Reptiles

Caretta caretta, the loggerhead turtle (V)
Recorded but status unknown (Groombridge, 1987a).

Chelonia mydas, the green turtle (E)
Pakistan is one of the most important nesting areas for this species in the Indian Ocean and even the world. In Sind, nesting is known or suspected to occur on most beaches and sand coves between Manora Lighthouse (entrance to Karachi Harbour) and Cape Monze, 40 km to the west. Most nesting is on the 5 km beach at Hawkes Bay with an annual total of 1,500 nests, and on the Sandspit beaches with a total of between 2,000-3,000 or a maximum of 6,000 (Kabraji & Firdous, 1984). The coast around Cape Monze is rocky and mainly unsuitable for nesting. Foraging *C. mydas* are encountered off the Sind coast throughout much of the year except in the monsoon (April-Aug) when rough seas prevent investigation (Kabraji & Firdous, 1984).

Nesting on the Baluchistan coast may be comparable or even more important than in the Karachi area. The main sites are Ormara with nesting occurring along 32 km of coast from midway along the northern margin of Ormara West Bay, westward past the Kamgar Hills and Ras Sakanni (Sikani) to Ras Basol. Nesting is most dense around Tak with 100-200 nests annually on the 8-10 km 'Lighthouse' Beach and on the 2km beach at Haft Talar. Gwadar and Pasni are both minor sites. (Kabraji & Firdous, 1984; Groombridge, 1987a; 1987b; 1989; Groombridge *et al.*, 1988). Other references include Firdous (1986) and Kabraji & Firdous (1984).

Lepidochelys olivacea, the olive ridley turtle (E)
About 12 known nesting beaches including Hawkes Bay/Sandspit, and possibly also in Baluchistan (Groombridge, 1982).

Eretmochelys imbricata, the hawksbill turtle (E)
Not known to occur in Pakistan although at one time it was thought that it might nest on Haft Talar (Scott, 1989), but it seems this population is of green turtles.

Turtles are not traditionally hunted but exploitation has been intense at times, mainly in Baluchistan. Small numbers of eggs are taken for feeding to ailing stock and adults are

irregularly killed but sometimes intensively for export of shell, oil and skin. Hunters have been active in recent years at Jiwani, Haft Talar and Ormara. The Hawkes Bay/Sandspit beaches are much frequented by Karachi residents and are backed by a continuous line of beach houses. Adults are occasionally lured inland by lights and hatchlings are often found on the road. Large volumes of sand were recently removed by the Karachi Development Authority (KDA) for construction but this has now ceased. The KDA is developing tourist facilities west of the main nesting area and is upgrading the access road and this could have a major adverse impact (Groombridge & Luxmoore, 1989; Groombridge, 1989), Further information is provided by Khan & Mirza (1976). Major nesting beaches are illustrated in Figure 2.

Crocodylus palustris, the mugger (V)
Very rare, possibly only 100 individuals in Sind (Groombridge, 1982); status on coast not known but reported to occur in Dasht Kaur (Scott, 1989).

Gavialis gangeticus, the gharial (E)
Fewer than 20 individuals are estimated to occur in the country (Groombridge, 1983) and the species probably does not occur on the coast.

Python molurus Indian python (V)
Found at scattered localities throughout the Indus delta (Groombridge, 1983) this species is threatened by the skin trade.

Other reptiles:
Three species of monitor lizards occur in Pakistan. *Varanus flavescens* is not known to be coastal. *Varanus bengalensis* is occasionally found in tidal creeks and dunes on the coast and is depleted locally through over-exploitation (Scott, 1989) as is *Varanus monitor* from Badin and Kadhan Lagoons. *Varanus griseus koniecznyi* is known from coastal Baluchistan but *Varanus griseus caspius*, the Central Asian monitor (V) may not be coastal in distribution. All the varanids are protected in Pakistan but there is a large illegal trade (Luxmoore & Groombridge in prep.; Auffenberg, 1989).

Sea snakes from Pakistan are described in Iffat (1988) and Rahman (1986) and *Enhydra schistosa, Hydrophis cyanocinctus* and *Microphalophus gracius* are found in the outer Indus Delta (Scott, 1989) as is the saw-scaled viper *Echis carinatus*. Additional herpetological references include Minton (1962; 1966).

4.1.4. Invertebrates

Palinurus spp., Spiny lobsters (CT)
Three species *P. polyphagous, P. homarus* and *P. versicolor* have been recorded and may be subject to high levels of exploitation in some areas.

Other invertebrates:
The marine invertebrate fauna of Pakistan has been fairly extensively documented. Although the intertidal fauna is diverse, abundance is generally low as is the size of individuals in many populations. The brachiopod *Lingula anatina* occurs on mud and sand beaches in Sind and used

5. Environmental and Conservation Legislation

According to Scott (1989), rules and regulations relating to wildlife and protected areas have been made more stringent, and the penalties for infringement have been increased. Magistrates have been given greater powers to deal with wildlife offenses; more wardens have been employed and given greater mobility, and a network of check-points has been established in order to achieve more effective control of illegal hunting and undesirable hunting practices. However, because of Pakistan's economic situation, the limited resources available have not been adequate to match the magnitude of the threats. Legislation concerned with tradein species includes the Export Trade Control Order of 1978 and the Export and Control Order of 1982.

Draft legislation prepared by the Wildlife Enquiry Committee, set up in 1968, has been adopted, with minor modifications, at provincial level.

Baluchistan Wildlife Protection Act 1974
Protects *C. caretta, C. mydas, E. imbricata, D. coriacea.*

Sind Wildlife Protection Ordinance 1972
Protects *C. caretta, C. mydas, E. imbricata, D. coriacea, P. minor.*

Pakistan Environmental Protection Ordinance 1983
Provides for enforcement of the National Environmental Policy and for control of pollution of harbours and marine waters (UNEP, 1986); requires submission of EIA for every project likely to adversely affect the environment.

Baluchistan Sea Fisheries Ordinance 1971

Territorial Waters and Maritime Zones Act 1979

6. Institutional Infrastructure

6.1.1. Governmental Organizations

National Council for Conservation of Wildlife, Department of Food, Agriculture and Co-operatives, Islamabad.
The Council was established in 1974 to coordinate government efforts in the formulation and implementation of wildlife policies. It is responsible for the administration of the Ramsar Convention in Pakistan, and assists in the identification of wetlands of national and international importance and achieving appropriate designation for their protection.

Provincial Forest and Wildlife Departments: Sind Wildlife Management Board, Karachi, and Baluchistan Forestry and Wildlife Department, Quetta.
Responsible for the enforcement of legislation and management of wildlife and protected areas. Sind has a separate wildlife department but in Baluchistan, wildlife is administered by a branch of the forest department. In general, forest staff look after wildlife in reserved or protected forests while wildlife staff are concerned with protecting wildlife in other protected areas and elsewhere. Legal provision has also been made for the creation of wildlife management boards to approve wildlife policies and monitor development activities. The Sind Wildlife Management Board is particularly active and effective in the creation of protected areas and management of wildlife; that in Baluchistan performs only an advisory role.

Zoological Survey Department, Karachi.
The Department has regional offices in Multan, Peshawar and Quetta, and conducts nationwide mid-winter waterfowl counts in collaboration with the National Council for Conservation of Wildlife, the Pakistan Forest Institute and the Provincial Forest and Wildlife Departments.

Pakistan Science Foundation.
The national centre for research information.

Pakistan Environmental Protection Council.

Hydrographic Department, Pakistan Navy
Carries out hydrographic surveys for charts, etc.

Division of Environment and Urban Affairs
Within the Ministry of Housing and Works; developing legal instruments of marine pollution control.

National Institute of Oceanography
Involved in a wide range of coastal and marine research projects.

Pakistan Agricultural Research Council

6.1.2. Non-governmental Organizations

World Wide Fund for Nature - Pakistan

Pakistan Wildlife Conservation Foundation, Karachi

6.1.3. Universities

University of Karachi
Department of Zoology and Centre of Excellence for Marine Biology. The Coordinator of the National Mangrove Committee is based at the University.

University of Baluchistan, Quetta
Department of Zoology.

7. Conservation and Environmental Management Activities

7.1. Current research

Details concerning current research on waterfowl and wetlands are provided by Scott (1989). The history of scientific research in the North Arabian Sea is described in Ataur-Rahim (1986b), and an extensive bibliography is provided in Ataur-Rahim (1986a). There has been a significant amount of work on a number of marine and coastal ecosystems.

In 1978, an Indus Flyway Committee was set up to coordinate the collection of information on waterfowl populations using the Indus flyway; to monitor hunting pressure; and, to supervise research programmes. The committee included representatives of most governmental and non-governmental bodies concerned with wildlife conservation and research.

Annual mid-winter waterfowl censuses have been carried out at many of the major wetlands of the Indus plains since the early 1970s. In recent years, the censuses have been conducted by the Zoological Survey Department, Pakistan Forest Institute and Provincial Wildlife Departments under the coordination of the National Council for Conservation of Wildlife. A large amount of data has been collected; in the winter of 1986/87 alone, 65 wetlands were visited and over 850,000 ducks and coots, 10,000 herons and egrets, and 50,000 shorebirds were counted (Van der Ven, 1987). The data have not, however, been fully analysed, and little information is available on population trends.

The extensive mangrove swamps and intertidal mudflats in the Indus Delta have received relatively little attention in the past, but the importance of these areas has now been recognized, and studies on the mangrove and mudflat ecosystem have recently been initiated. Ansari (1987) has recently reviewed the status and distribution of the mangrove ecosystem in Pakistan, and has discussed the development of a national mangrove management plan. The University of Washington (Seattle, USA) and the NIO are cooperating on a National Science Foundation research project focussing on the Indus Delta which will include an analysis of primary production, the role of mangroves in support of fishery resources, and the impact of sea level rise etc. (Burbridge, 1989). Wetlands on the coast of Sind and Baluchistan have also been investigated in recent years, and have been found to support large numbers of migratory birds.

The Pakistan Forest Institute and the Punjab Wildlife Department are currently undertaking a co-operative project to study the wetland ecosystems and waterfowl of Pakistan (Anon, 1979; 1980; 1981; 1982; 1984; 1987a; 1987b) and a research institute has recently been established at Lahore to conduct research on inland fisheries. It is to be hoped that the projects of this institute will include a study of the impact of introduced herbivorous fishes on the ecology of wetlands.

Plans for future research include a continuation of work on the national wetlands inventory, detailed studies of particular wetland ecosystems, the analysis of waterfowl census data to determine population trends, and a study of waterfowl migration routes. Much information is still lacking on the geographical and hydrological characteristics of the wetlands. The mid-winter waterfowl counts have only served to establish the importance of the wetlands as wintering habitat for waterfowl. Additional surveys are required at other times of the year to determine the importance of the sites for resident species and passage migrants, and much more work has to be carried out on other aquatic fauna and flora. Many wetlands have recently been located using aerial photography and Landsat imagery, and these must now be surveyed in detail so that their importance can be determined. Waterfowl censuses on the coast of Sind and in the Indus Delta are ongoing with the Zoological Survey of Pakistan (Hasnain & Perveen, 1988); there is a long-term survey of the waders of the Karachi coast and of the birds of prey of Sind; and the macro-benthic fauna of the coastal wetlands of Karachi is being studied to assess the benthic potential of the intertidal flats of Clifton Beach for waders (Burbridge, 1989).

Some pollution monitoring has been carried out in Baluchistan coastal lagoons using remote sensing (Alizai *et al.*, 1986).

7.1.2. Coastal zone management

A Coastal Environmental Management Plan for Pakistan has been drawn up by UN-ESCAP-NIO (1989). According to Burbridge (1989), this report was to have been published at the end of 1989. The Ministry of Environment and Urban Affairs is the lead agency for the Plan, in cooperation with the United Nations Economic Commission for Asia and the Pacific. Background studies are being carried out by NIO. A project to develop a coastal zone management programme for the Karachi area is underway, and an environmental survey of this part of the coastline has been carried out (NIO, 1989).

Fishery management is still largely sectoral and the government's priority has been largely to mechanise the fishing fleet. Karachi harbour is being expanded and a new fishing harbour built at Karangi. There have been some inshore water surveys for resource assessment (UNEP, 1985).

Management plans have been prepared for some of the wetland reserves, but the Provincial Forest and Wildlife Departments have so far been unsuccessful in convincing land-use planners of the importance of wetlands, and no legal steps have been taken to check the destruction and drainage of wetlands in Pakistan (Scott, 1989).

The government of Baluchistan and IUCN are currently developing a turtle project for this province to include long-term research and a coastal zone management programme. A National Conservation Strategy is in preparation. A major campaign has been launched to focus the attention of the general public on conservation issues, and has included television and radio programmes, newspaper articles, road-side advertisements, lectures in schools and universities, wildlife posters, wildlife films and a variety of booklets and brochures (Scott, 1989).

7.1.3. Existing protected areas

1. Hawkes Bay/Sandspit Wildlife Sanctuary: Southwest of Karachi; important for turtles, shorebirds, some mangrove; recreation and fishing; turtle project underway since 1980; threatened by increased settlement and pollution, damage to mangroves; site account in Scott (1989).

2. Keti Bundar North Wildlife Sanctuary: 8,948 ha, established 1977; area of Protected Forest is 80,489 ha (Ahmed, 1983).

3. Keti Bundar South Wildlife Sanctuary: 23,046 ha, established 1977; area of Protected Forest is 183,617 ha (Ahmed, 1983).

4. Korangi Protected Forest: 80,744 ha (see below under proposed protected area for Korangi-Gharo Creek).

In July 1976, Pakistan became a Contracting Party to the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention). Nine wetlands were designated for the List of Wetlands of International Importance, none of which were coastal. It has now become apparent that a review and adjustment of these sites is required, and a revised list is being prepared on the basis of the criteria established at the Third Conference of the Contracting Parties held in Regina, Canada, in 1987 (see Karpowizc, 1985; IUCN, 1987).

There are no coastal biosphere reserves but there is a national committee for the UNESCO Man and the Biosphere programme.

7.1.4. Mangrove management and protection

About 70% of the mangroves in Sind are under the control of the Sind Province Forestry Department and the remainder are administered by the Sind Board of Revenue and Muhammad Bin Qasim Port Authority. According to Hamilton & Snedaker (1984) and Davie, (In prep.) the control of overgrazing by camels is the responsibility of the Department of Wildlife and Forests, Regulation of mangrove timber exploitation was introduced in 1958 and consolidated in 1963 when a 'Working Plan (management plan) of Coastal Forests' was implemented. This designated the largest forest areas (306,299 ha) as protected forest under the Forest Act 1957 and required that no cutting or removal of forest trees or other vegetation,cultivation or grazing or other works within the area were permitted without a permit. Boats must be licensed to carry produce from the forest areas to markets in Karachi (Davie, In prep.). Management is described in Ahmad (1983a). Mangrove rehabilitation is described by Qureshi & Khan (1988), and Khan (1961) describes regeneration of *Avicennia officinalis*.

8. Recommendations for Future Action

8.1.1. Proposed protected areas

1. Haft Talar (Astola I.): Baluchistan, off Pasni; seabirds; only significant island in the region; little information (Scott, 1989); turtle nesting beaches and adjacent waters should be protected (Groombridge, 1989).

2. Jiwani: protection of turtle beaches and adjacent waters as Wildlife Sanctuary (Groombridge, 1989).

3. Pasni: has greatest diversity (cliffed river valley, estuarine mudflats, sandy shore with lagoons, rocky shore, sheltered bay and rocky cliffs) of all Baluchistan wetland sites and probably greatest diversity of birds, including terns Crab Plovers and flamingoes; threatened by withdrawal of water from Shadi river, and potential threat from plans for new fishery storage and port facilities at Pasni. There are two important sites for water birds, both recommended for protection as wildlife sanctuaries; a) Shadi estuary to north of Pasni town including the brackish lower reaches of the Shadi and estuarine mudflats; b) the sandy coast with lagoons south from Pasni to rocky foreshore at Ras jaddi and Jebal zarain (Scott, 1989; Groombridge, 1989).

4. Ormara: protection of turtle beaches and adjacent waters as wildlife sanctuary (Groombridge, 1989).

5. Proposed national park at mouth of Hingol River with mud volcanoes and Hindu shrine (Groombridge, 1989).

6. Korangi-Gharo Creek: southeast outskirts of Karachi; original creek system once part of Indus Delta but no longer hydrologically connected; important for mangroves, birds, fisheries; IUCN/UNEP project under development for an integrated management plan for the area (see Burbridge, 1989) for references; also Ahmed & Rizvi (1982)); includes Korangi Protected Forest; main problems are pollution from industry and rivers, over-exploitation of mangroves, overfishing; shrimp fishing banned (Scott, 1989). There is a large amount of data, reports, consultancy material relating to this - some information is given in Burbridge (1989); a summary of the situation to date is required. Early consultancies/recommendations/proposals included a master plan by Doxiodes Associates in 1959 to use part of the area as a parkland and recreation area; a report on the natural resources of the area was being prepared in 1989; a pollution survey has been carried out, and an environmental management plan proposed (Anon, 1985).

7. Outer Indus Delta - southeast from Karachi to Indian border; management plans being proposed in association with Korangi project; recent survey work carried out by Zoological Survey Department; site accounts in Scott (1989) and Groombridge (1983).

Other important sites:

1. Dasht Kaur: on Iran border; little information (Scott, 1989); extensive tidal lowlands with some mangrove (Groombridge, 1989; Mirza *et al.*, 1986).

2. Kalmat Khor - extensive tidal lagoon system with some mangrove; important for birds; important for artisanal fisheries of Pasni and Sonmiani, particularly in monsoon when open sea is too rough; prawn fishery very valuable; management requirements need investigation (Groombridge, 1989; Scott, 1989).

3. Miani Hor - extensive tidal lagoon system with some mangrove; important for birds; separated from Sonmiani Bay by broad peninsula of sand dunes but connected at eastern end; surrounded by sand dune desert; little information (Scott, 1989); important for artisanal fisheries of Pasni and Sonmiani, particularly in monsoon when open sea is too rough; management requirements need investigation (Groombridge, 1989).

4. Siranda Lake - shallow brackish lagoon near coast, separated from Sonmiani Bay to the west by a series of sand dunes; fed by local run-off and possibly seepage of seawater through dunes; water levels fluctuates widely and lagoon often dries out, especially recently due to diversion of streams; important for overwintering birds (Scott, 1989).

5. Clifton Beach - south of Karachi; backed by sand dunes; important for turtles and recreation; little information (Scott, 1989).

6. Badin and Kadhan Lagoons - near Indian border on edge of Great Rann of Kutch; important for birds but little other information (Scott, 1989); possibly not considered coastal.

Scott & Poole (in press) consider Badin and Kadhan Lagoons, Hawkes Bay and Sandspit Beaches and adjacent creeks, Clifton Beach, Korangi and Gharo Creeks and the Outer Indus Delta to be the coastal wetland sites of highest priority for protection and improved management.

8.1.2. Species protection

Scott & Poole (1989) consider the following to be priority species for action: *Platanista minor, Pelecanus crispus, Marmaronetta angustirostris, Oxyura leucocephala*, and marine turtles. A government plan to breed crocodiles and gavials was being considered in 1984 (Luxmoore *et al.*, 1985) and a marine turtle programme has been drafted (Groombridge, 1989). Groombridge (1989) recommends:

1. Initiate a long-term turtle research and conservation programme at Jiwani, Haft Talar and Ormara in Baluchistan.
2. Stop all turtle exploitation in Baluchistan and investigate past and recent exploitation.

Populations of the plumbeous dolphin, *Sousa chinensis plumbea* are in need of monitoring

given the species preference for mangrove habitat and its vulnerability to incidental capture (Perrin, 1989). Populations of the finless porpoise, *Neophocaena phocaenoides* are in need of monitoring (Groombridge, 1983; Klinowska, 1992; Perrin, 1989) in the light of its apparent recent decline.

8.1.3. Mangrove conservation and management

Recommendations for mangrove management and rehabilitation have been made by a CIDA-Canada Pakistan Forest Development Project. At present this project is to focus on the rehabilitation of riverine forest which is considered a higher priority for practical administrative reasons; mangrove rehabilitation will be undertaken Burbridge, 1989). Kogo (1985) made recommendations for mangrove management which include protection of existing areas, promotion of regeneration and the planting of *Rhizophora spp.* for the commercial production of poles and charcoal. Recommendations for the Sind mangroves are given in Ansari (1986).

8.1.4. Other recommendations

Zalinge *et al.* (1986a) provide recommendations for research to improve fisheries management on the Indus Delta. It is suggested that a survey of fish and shrimp is carried out in the entire delta; the influx of shrimp postlarvae from the sea and the migration of the juvenile/pre adult shrimp out the estuary is monitored; and, management options for the commercial shrimp fishery are formulated. These options could include flexible closing and opening dates for the fishery and management strategy for conservation of the delta area for shrimp and fish. Further recommendations are made in Schatz *et al.* (1987) and Ahmed (n.d.).

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