UNITED NATIONS ENVIRONMENT PROGRAMME

Management and conservation of renewable marine resources in the Kuwait Action Plan region

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PREFACE

The United Nations Conference on the Human Environment (Stockholm, 5-16 June 1972) adopted the Action Plan for the Human Environment, including the General Principles for Assessment and Control of Marine Pollution. In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" (General Assembly resolution 2997(XXVII) of 15 December 1972). The organisations of the United Nations system were invited "to adopt the measures that may be required to undertake concerted and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organisations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination". Subsequently, the Governing Council of UNEP chose "Oceans" as one of the priority areas in which it would focus efforts to fulfil its catalytic and organising role.

The Regional Seas Programme was initiated by UNEP in 1974. At present, it includes eleven regions[1/] and has over 120 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to controlling environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities[2/].

The Regional Seas Programme has always been recognised as a global programme implemented through regional components. Interregional co-operation among the various sea areas on common problems is an important element in assuming the compatibility of the different regional components.

1/ Mediterranean Region, Kuwait Action Plan Region, West and Central African Region, Wider Caribbean Region, East Asian Seas Region, South-East Pacific Region, South-West Pacific Region, Red Sea and Gulf of Aden Region, Eastern African Region, South-West Atlantic Region and South Asian Seas Region.

2/ UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1. UNEP, 1982.

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This document reviews past and on-going conservation activities relevant to the Kuwait Action Plan region at the regional and national levels, identifies priority concerns of the Governments bordering the region, and contains recommendations for interregional and regional projects to be undertaken to address these concerns. The assistance of A.R.G. Price in the preparation of this document is gratefully acknowledged. In addition, the sections concerned with fishery aspects of conservation have been prepared by J. Beddington and J.A. Gulland. The report has been compiled and edited by the Tropical Marine Research Unit, University of York, UK.

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INTRODUCTION

Area Covered

The Kuwait Action Plan (KAP) region comprises eight countries, namely: Iran, Iraq, Kuwait, Saudi Arabia, Bahrain, Qatar, the United Arab Emirates (UAE) and the Sultanate of Oman. The first seven countries border the Inner Gulf, while the shoreline of the Sultanate of Oman borders the Gulf of Oman and the Arabian Sea, both of which differ appreciably from the Inner Gulf. The southeastern geographical boundary of the KAP region is determined by rhumb lines from Ras Dharbat Ali (16°39'N,53°3.5'E) to a position 16°00'N,53°25'E; thence through the following positions: 17°00'N,56°30'E and 20°30'N,60°00'E to Ras Al-Fasteh (25°04'N,61°25'E). The northern boundary is the head of the Inner Gulf at latitude 30°30'N.

Long before the advent of the oil industry, the KAP region was important as a major artery of seafaring. It functioned as a trading route, which before the tenth century extended even as far as China. However, the wealth generated by the development of oil industry in the 1930's and 40's brought rapid changes and modernisation within these States.

Numerous accounts and reviews of the physical and general characteristics of the Inner Gulf region are available in the literature (e.g. Purser, 1973; Kuronuma, 1974; Unesco, 1976, 1984; Basson et al., 1977; UNEP, 1980a,b,c,d,e; 1984a; Price et al., 1982; Nelson-Smith, 1984), whereas the coastal region of Oman has received less attention. However, useful environmental information on Oman is given by UNEP (1980e), and the results of a recent ecological study are presented by Barratt (1984). A number of useful bibliographies covering the whole of the KAP region have also been compiled (Paldi, 1968; Rahim, 1979; Farmer & Docksey, 1983; UNEP, 1984b). The account below merely highlights the main physical and general features.

Since the Inner Gulf probably formed during the Miocene it is, geologically, a young sea. Following a world-wide lowering of sea level during the subsequent Pleistocene glacial periods, the basin dried up completely. The marine biota would therefore have been destroyed, an event which may well have influenced the present day distribution of marine life.

The Inner Gulf is now a semi-enclosed sea measuring c. 1000 km by 200-300 km. The average depth is only 35 m, and the maximum 100 m near the 111 km wide Strait of Hormuz; this constricted entrance provides the only connection with the outside Gulf of Oman and Arabian Sea. The basin in southern and western parts is covered with biogenic and evaporitic sediments derived from sea water, The northeastern area is deeper and the deposits are mostly of terrestrial origin carried by streams and rivers, e.g. the Tigris and Euphrates. Biological habitats in the region are represented by at least 3 critical marine habitats: intertidal flats/marshes, sometimes containing mangroves; coral reefs and seagrass beds. The paramount importance, but widespread demise, of these habitats in the area is well documented (see Basson et al., 1977; Price, 1982a; TMRU, 1982; Price et al., 1983). A great variety of other intertidal and sublittoral marine habitats are also available to marine biota.

The land movements which formed the Inner Gulf also created the physical environment of the Oman coastline. However, in contrast to the Inner Gulf, the coastal waters of Oman (i.e. Gulf of Oman & Arabian Sea) are much deeper, and the conditions prevailing resemble more closely those of the Indian Ocean. Intertidal habitats of Oman are represented by sandy and various types of rocky beaches, as well as mangrove-fringed bays. Of the sublittoral habitats coral

reefs are not widespread. However, of particular significance and interest are the dense sublittoral kelp beds, which appear to support unique biological communities (Barratt, 1984).

Climate

Knowledge of climate within the KAP region is of great significance, since it strongly influences oceanographic conditions within coastal waters of the various countries.

The Inner Gulf is a nearly enclosed, subtropical sea lying between the arid land masses of Iran and the Arabian peninsula. The climate of the bordering countries is therefore essentially continental rather than maritime. Summer months are characterised by searing heat (45-50°C), lack of rain and at times strong NW shamal winds. During this period humidity may be high, approaching 100% RH in autumn. In the winter months of December - February air temperatures may descend to nearly 0°C. Strong winds, some rain and thunderstorms, interrupted by milder weather, are characteristic features of this season. The combined effects of generally high temperatures, strong winds and limited freshwater input results in abnormally high salinities (see below).

The climate of Oman differs appreciably from that of the Inner Gulf, and the country is affected by two different climatic zones: a Mediterranean zone to the north, and a tropical zone from the Indian Ocean to the south. On the north coast, June temperatures average 38°C but may even reach 50°C, whereas at Salalah on the south coast the temperature is a modest 32°C during the hottest month (May). Winter temperatures typically descend to below 25°C on both the north and south coasts. The monsoon regime of the Arabian Sea strongly influences the climate of southern Oman. During November - April the NE monsoon prevails, whereas from April - October the system reverses and the SW monsoon predominates. The latter, in particular, is of great significance as it results in water movements that create cold-water upwelling and notably high productivity (see below). Rainfall within Oman is erratic and unevenly distributed. The annual average is 104.3 mm, though there are considerable regional differences (Whelan, 1981).

Oceanography

Oceanographic information for the Inner Gulf is available in a number of reports (e.g. Enomoto, 1971; Kuronuma, 1974; Unesco, 1976, 1984; Hughes & Hunter, 1979; Hunter, 1980; Price, 1982b). Less has been published on the oceanography of Omani waters, though basic data are provided by several authors (e.g Sewell, 1934; Wyrtki, 1971,1973; Currie et al., 1973; McGill, 1973). Oceanographic measurements have also been made recently (1983) from r/v DR FRIDTJOF NANSEN (unpublished data).

Surface and coastal waters of the Inner Gulf are subject to wide temperature changes in response to daily and seasonal climatic variations. In contrast to other seas, these fluctuations generally affect the entire water column and are not buffered by any deeper body of oceanic water. Actual surface water temperatures range from less than 15°C to more than 30°C. In the Gulf of Oman (at Mina al Fahal) surface temperatures range from 20-30°C (Edwards, 1984), whereas on the south coast they may fall to 16°C during periods of upwelling. However, there is considerable local variability.

Salinities within the Inner Gulf are high, averaging c. 40°/oo, but increasing to more than 70°/oo at the southern end of the Gulf of Salwah. In hypersaline lagoons, salinities exceeding 70°/oo have been recorded and still support more than 40 species of plants and animals (Basson et al., 1977). Salinities along the Oman coast are less severe than within the Inner Gulf. During February, the salinity is >37°/oo in the Gulf of Oman and 36-37°/oo on the south coast, whereas in August values are generally 36-37°/oo and 35-36°/oo respectively (Couper, 1983).

Data on nutrient levels in the area are given by various authors (e.g. Brettschneider et al., 1970; Rabsch, 1972; Unesco, 1976; Basson et al., 1977; Price, 1982b). In western areas of the KAP region, nutrient concentrations fluctuate considerably, but are generally higher in interior bays than in nearshore and offshore waters. Nutrient concentrations around Oman vary seasonally according to the monsoon system. For example, in areas of intensive upwelling during the SW monsoon inorganic phosphate levels may rise to >2.0 mic.g.at.l^{-1} (Currie et al., 1973).

Information on oxygen levels within the Inner Gulf is limited, although Unesco (1976) and Basson et al. (1977) provide some data. In general, oxygen seems not to act as a limiting factor to marine life except in certain localised areas. Little published information on oxygen levels is available for Oman, and the results from the survey of r/v DR FRIDTJOF NANSEN have yet to be fully evaluated. However, it appears that the waters of Oman are mostly well oxygenated, though critically low levels have been observed below 100 m off the Gulf of Oman (Unesco, 1976).

Primary (phytoplankton) and secondary (zooplankton) productivity in the Inner Gulf vary seasonally and spatially. Nevertheless, there is evidence that it is among the most productive water bodies in the world (see Couper, 1983). Recent studies also suggest that primary productivity from seagrass and shallow-water benthic algae may be of even greater importance than the contribution from phytoplankton (Basson et al., 1977; Price et al., 1983). In Oman, phytoplankton and zooplankton levels are influenced by the monsoon. Chlorophyll (phytoplankton) standing crop values within the Gulf of Oman range from 0.18 mg m^{-3} during August to 1.01 mg m^{-3} in May (Jones, 1984). A recent survey of southern Oman has also shown the importance of benthic algal (kelp) productivity to the coastal ecology of the area (Barratt, 1984). According to Rao (1973) the (southern) Arabian coast is the richest area for secondary production in the north Indian Ocean.

The tidal regime in the Inner Gulf as a whole is complex, with an overall counter-clockwise current. There is a general flow westwards into the water body along the Iranian coast of magnitude c. 0.1 m/sec (Unesco, 1984). Tides are diurnal, semi-diurnal and mixed - in which a large "diurnal inequality" exists between the two high tides and two low tides. In the north of Kuwait tidal range varies from 3.5-4.0 m, while south of Al Khobar in Saudi Arabia the range is less than 1 m. However, because of the gentle slope of the intertidal zone, the ebbing tide may expose an expanse of tidal flats several kilometres wide. It is of biological significance that in Kuwait most spring tides occur at night during the summer, and during the daytime in winter (Collins et al., 1984). Consequently, the whole intertidal zone is seldom exposed to strong insolation during summer months. In Saudi Arabia, by contrast, tidal flats are sometimes exposed during the summer in the daytime.

The water circulation around Oman is greatly affected by the reversing monsoons. From November - April the NE monsoon results in water movements from east to west at velocities up to 1 knot. In contrast, during the SW monsoon, particularly during July and August, the direction of water flow reverses,

creating net water movement in an easterly or north easterly direction. Details of wind patterns and water circulation are of great importance to all countries of the KAP region. The track of oil slicks, for example, is highly dependent on wind and water movement.

In summary, the Inner Gulf represents a highly stressful environment, characterised by large seasonal temperature variations, fluctuating nutrient levels and high salinities. This limits the variety of organisms compared to the adjacent Indian Ocean. Whilst the resulting rather impoverished fauna is commonly referred to as "restricted", recent studies have shown that it contains a richer biota than generally acknowledged. The shallow depth and modest rate of water exchange also make the area particularly vulnerable to damage from oil spills, dispersants and other pollution. In contrast, the marine environment of Oman provides conditions more favourable to marine life, although the cold-water upwelling limits the distribution of certain organisms such as corals.

CONSERVATION AND MANAGEMENT

Details of the main conservation activities and legislation are summarised below, both on a national and regional basis. However, specific details relating to particular habitats and species are given in subsequent sections.

National

Iran: (see Firouz, 1974; Anon, 1984; Gallagher et al., 1984; Keyvani, 1984)

Department of the Environment: Responsible for progressive environmental activities and policies since the 1960's, including administering the country's biotic reserves of which there are 4 categories: National Parks (formerly 'Wildlife Parks'); Protected Regions (sometimes known as 'Protected Areas'); National Nature Monuments, and Wildlife Refuges. The main law covering conservation within Iran (and under which biotic reserves are designated) is the Environmental Protection and Enhancement Act of 1974, which is reportedly still firm. Five reserves include sections of the coast and/or islands: (i) Shadegan Protected Region, (ii) Kharku Protected Region, (iii) Sheedvar Island Protected Region, (iv) Hara Protected Region, (v) Bahu Kalat Protected Region. Several other coastal areas (delta/tidal mud flats) are listed under the Wetlands Convention, and are in government ownership administered by the Department of the Environment. Additional laws and regulations (e.g. for protecting seabirds) have also been created, as well as detailed effluent and other standards. The Department of the Environment has an Environmental Research Centre, and in the past there was a large volume of data on water birds within the country. In addition, general marine science research and pollution monitoring and abatement are undertaken.

High Council for Agriculture and Rural Affairs: Ratified the establishment of a Commission for Evaluation of Wetlands in 1983 (under Department of the Environment), to investigate any economic and social development projects which are to be undertaken in wetlands throughout the country.

Iranian National Centre for Marine Science: Within this centre the Institute of Marine Science & Technology deals with applied marine research, whereas the College of Marine Science is concerned with higher education and research.

Iranian Ports & Shipping Organisation: Deals with oil pollution control under the Law of Marine Protection from Oil Spills.

Iraq: (see Anon, 1980)

Arab Gulf Study Centre: Publishes many books and studies as well as a scientific magazine, 'The Arabic Gulf,' in which some articles cover environmental issues. The Centre also collects scientific literature for the Gulf, and has held several international symposia.

Environmental Pollution Research Centre/The Organisation of Scientific Research: General pollution research.

Marine Science Centre, Basrah University: Studies in fish and coastal ecology and marine science in general.

Coastal Environmental Research Centre: Studies on biological and geological aspects of surface waters.

Natural History Museum: Projects studying bird migration and its relation to the environment, and a museum magazine is published annually.

Ministry of Transport/General Organisation of Iraqi Ports: Concerned with marine environmental protection, particularly oil pollution combat.

Kuwait: (see UNEP, 1980d; Farmer & Docksey, 1983; Gallagher et al., 1984)

Kuwait Institute for Scientific Research (KISR): Directly involved in conservation, projects with University of Kuwait, for proposals to establish the first National Park; it is expected to cover c. 300 km2 including the NW of Kuwait Bay, which contains bird feeding and nesting areas and noteworthy marine life in general. The institute also conducts heavy metal studies and formulates environmental and water quality standards.

University of Kuwait: Numerous studies on ecology of Kuwaiti shores.

Ahmadi Natural History & Field Studies Group: Sponsored by the Kuwait Oil Company (KSC), the group studies local fauna and flora. It is also recommending outlawing of shooting, which is currently prohibited only in urban areas, and establishment of reserves.

Saudi Arabia: (see UNEP, 1980c; Younes, 1982)

National Committee for the Co-ordination of Environmental Protection: The committeee includes various ministries (including the Ministry of Agriculture & Water) and MEPA, both of which are considered separately below, as well as the National Centre for Science and Technology (SANCST). The main objective of this committee is to provide a permanent liason between the ministries and other governmental activities concerned with environmental issues.

Meteorology & Environmental Protection Administration (MEPA): Established in 1980, this organisation is responsible for all activities to ensure compliance with the Kuwait Regional Agreement for the Protection of the Marine Environment. MEPA has additionally made resolutions for establishing the 6 offshore islands as marine protectorates, and has proposed a moratorium on further uncontrolled coastal infilling. These and other resolutions/recommendations are supervised by an inter-ministerial committee (EPCCOM). MEPA also formulates environmental standards, and has been preparing a National Oil Spill and Hazardous Substances Pollution Contingency Plan. The organisation has carried out several marine conservation projects in conjunction with ROPME/UNEP/IUCN (e.g. Price, 1982; TMRU, 1982). A book, Fauna of Saudi Arabia is produced annually by MEPA and deals with the faunistics and environmental studies within the kingdom.

Ministry of Agriculture and Water: Within the Department of National Parks, this ministry has responsibility for parks and reserve development.

Arabian American Oil Company (ARAMCO): The most extensive ecological survey in the Inner Gulf was undertaken by Aramco's Environmental Unit (Basson et al., 1977). The company has additionally supported more recent coastal surveys (e.g. McCain, in press), studies on birds, heavy metals and shrimp ecology. Aramco is directly involved with the combating of oil spills, and has developed oil spill contingency plans as well as a shoreline sensitivity map.

Research Institute, University of Petroleum & Minerals (UPM): A newly developed institute in Dhahran, which has considerable expertise in oceanographic surveillance and modelling, analytical chemistry, pollution monitoring and coastal resource evaluation. It also supports various taxonomic studies.

King Faisal University (KFU): Departments of the University at Dammam and Al-Hasa have carried out a number of fisheries and marine science studies.

The Saudi Arabian National Centre for Science and Technology (SANCST): A recently established centre coordinating and funding various environmental and scientific projects within the Kingdom.

Royal Commission: The Royal commission at Jubail has carried out baseline and environmental impact surveys in the area with various consultancy organisations such as Tetratech and Amartech.

Bahrain: (see UNEP, 1980c)

Directorate of Environmental Affairs/Ministry of Health. Responsible for marine and coastal environmental activities. In collaboration with ROPME/UNEP/IUCN, the organisation was involved in the recent marine ecological survey around Bahrain (Price et al., 1983), as well as an environmental evaluation of the coral reefs at Fasht Adham (Barratt & Ormond, 1985) and a study by IAEA on heavy metals.

Department of Fisheries: Compiles fisheries statistics and carries out various environmental studies.

University College of Bahrain: Conducts taxonomic and ecologcial studies along the coast.

Bahrain Natural History Society: Conducts floral and faunal surveys, and publishes 'Wildlife in Arabia' with government and oil company support.

Bahrain Petroleum Company (BAPCO): Involved with oil spill contingency and marine environmental affairs.

General Remarks: The southern part of the main island of Bahrain and most subsidiary islands (e.g. Howar islands) are out of bounds to most people, and this affords considerable protection to habitats and species in these areas.

Qatar: (see UNEP, 1984a)

University of Qatar (Centre for Science & Applied research and Marine Science Department: Studies on marine life as well as human impact on the environment. A seagoing oceanographic vessel has been provided with support from Unesco.

Qatar Natural History Society: Active in faunal and floral studies, and liases with government on conservation issues.

Qatar General Petroleum Corporation (QGPC): Environmental activities include combat of oil spills and oil spill contingency plans.

Environmental Protection Committee (EPC): With advice from various government organisations, this committee is responsible for environmental protection policies.

UAE: (see, UNEP, 1980a)

Abu Dhabi National Oil Company (ADNOC): Environmental departments within the company are involved with oil spill control and assist with environmental impact surveys.

Ministry of Agriculture: Previously dealt with conservation of the environment.

General Remarks: According to UNEP (1980), comprehensive environmental laws have not yet been developed.

Oman: (see Unep, 1980c; Gallagher et al., 1984)

Council for the Conservation of the Environment and Prevention of Pollution (CCEPP): This department is actively involved in marine and industrial pollution surveys, and in particular the recent marine ecological survey of Oman in collaboration with ROPME/UNEP/IUCN (Barratt, 1984). As a result of the survey, a number of additional protected areas and reserves were recommended. Proposals for the Muscat area have already been formulated, and a 18-month survey has commenced in a project assisted by IUCN. Heavy metal studies along the coast have been undertaken in association with IAEA.

Petroleum Development Oman (PDO): The company recently appointed an environmental advisor to management, and is increasingly involved with marine environmental affairs.

Ministry of the Environment: Newly formed Ministry which will be responsible for legislative procedure on conservational and environmental issues. The exact role of the ministry has not yet been revealed.

General Remarks: A series of laws have been issued by Royal Decree to control marine pollution (1974), establishment of national parks or national reserves (1979) and protection of marine biological wealth and regulation of sea fishing (1981). Three areas used by sea birds have also been given protected area status (see 15.14 & 15).

Regional

Kuwait Action Plan (KAP): This action plan is based on the Kuwait Regional Convention on the Protection of the Marine Environment from Pollution. All countries within the KAP region are signatories of the convention, which aims: to prevent and control pollution from ships and other causes; to establish national standards; and to develop national research and monitoring programmes relating to all types of pollution. However, the potential for severe environmental degradation from massive oil spills was recognised as the priority concern. Various national institutes and international organisations, such as UN/OETO, UNIDO, UNEP, UNDP, FAO, UNESCO, IOC, WHO, IMO, were involved with implementation of the Action Plan and some have actively participated in various projects. Further details of the Action Plan are available in various reports (e.g. Baker & Dicks, 1982; UNEP, 1983a,b, 1984c).

Marine Emergency Mutual Aid Centre (MEMAC): This centre, currently based in Bahrain, is one of two complementary regional oil spill response schemes. Equipment stockpiles are available to member countries, and the base may be utilised as a coordinating centre during major oil spills (e.g. Nowruz).

Gulf Area Oil Companies Mutual Aid Organisation (GAOCMAO): Oil companies in the KAP region formed GAOCMAO, the other regional oil spill response scheme, to pool the resources of all member companies for joint capability in cleaning up oil spills.

IMO Regulations: Several of the Gulf States have ratified the IMO regulations on marine pollution, in some cases only in relation to the coastal zone.

Convention for International Trade in Endangered Species (CITES): Iran and the UAE are the only States which are party to the convention in the KAP region. Kuwait has also signed the convention but has yet to ratify.

Other International Activities and Environmental Programmes: Various international activities and programmes have also been directly or indirectly responsible for conception of the above-mentioned conventions and organisations, and include the International Biological Programme (IBP), the UN Conference on the Human Environment (1972), UNEP and IUCN's World Conservation Strategy (WCS)(1980). Of particular significance is the Man and the Biosphere Programme (MAB). This was launched by Unesco in 1970 and aims to "develop within the natural and social sciences, a basis for the national use and conservation of the resources of the biosphere and for the improvement of the relationship between man and environment, to predict the consequences of today's action on tomorrow's world, and thereby to increase man's ability to manage efficiently the natural resources of the biosphere". Iran, Iraq, Kuwait and UAE all have national (MAB) committees, and Iran has several biosphere reserves, of which several are coastal. Also of importance are the World Heritage Convention, to which Saudi Arabia, Iran, Iraq, Oman and Qatar are all parties, but no national sites are currently inscribed; and the Wetlands Convention, adopted in 1971 in Iran, to which Iran is the only KAP country party to the convention.

RESOURCES, HABITATS AND SPECIES

Open Sea

Character

In the KAP region, open sea habitats comprise the water column (plankton & nekton), sublittoral sand, mud and rock, artificial structures and offshore islands. Of the water column inhabitants, only plankton will be considered as nekton (fish, turtles, dugongs etc) are treated separately. Similarly, although the islands are treated here in general terms, their particular habitats (open soft bottom habitats, coral reefs, beaches) and animals (birds, turtles) associated with islands are dealt with individually in other sections.

The plankton of the Inner Gulf has not been exhaustively studied, but seems to be more diverse in the lower area which receives a small contribution from the main Indian Ocean (see Nelson Smith, 1984). Studies have often centred on the population dynamics of shrimp larvae, particularly of commercial species (see e.g. Price, 1979, 1982b).

In the Inner Gulf, subtidal sand habitats have been shown to support 638+ species of plants and animals (Basson et al., 1977) and include species of sand dollars and heart urchins in abundance. Mud bottom habitats occur in environments of lower energy and also support a diverse biota (610+ species) with at least 2 distinct communities (Basson et al., 1977). Rock bottom habitats exhibit considerable variability, and altogether 194+ associated species have been recorded (Basson et al., 1977). Of special scientific interest are the shallow sublittoral rocky areas of southern Oman which support a unique annual kelp system (Barratt, 1983). The major components are dense brown (Fucalean) algae dominated by kelp (Ecklonia radiata), and another unknown seaweed associated with Sargassum that may be a species (or even genus) new to science. Among the animals associated with the kelp system is a large abalone (Haliotis mariae) which supports a local fishery.

Artificial structures, such as oil platforms, provide a substratum for many forms of marine life, acting as an "artificial reef". More than 170 species have been recorded from such habitats in the Inner Gulf (Basson et al., 1977).

Occurrence and extent

Plankton is naturally present in all open-water habitats, and may occur in "bloom" concentrations at certain times of the year.

Sublittoral mud habitats are predominant in northern and eastern parts of the Inner Gulf, with sand more common in southern and western areas. Sublittoral rock is present in localised areas such as the Straits of Hormuz and in conjunction with reefs and islands. A variety of sublittoral rocky habitats are also represented off the southern coast of Oman.

The most conspicuous artificial structures are oil platforms which are scattered in the area. Piers, jetties and other coastal installations have also been built in many areas, and represent additional "man-made" habitats. Special mention should be given to the recently completed Saudi-Bahrain causeway, which will support a 25-km highway linking the two countries (see Price et al., 1983; Vousden & Price, 1985).

Conservational status

Variable but largely indeterminate.

Human and economic value

Since plankton directly or indirectly supports water-column organisms (e.g. fish), as well as many other animals (e.g. benthic organisms, birds & turtles), the plankton is both biologically and economically very important. Sublittoral sand and mud habitats often represent important shrimping and fishing grounds. Sublittoral rock habitats provide habitat for many animals including the culturally and economically important pearl oysters (Pinctada spp.) and the abalone fishery of Oman.

Several islands in the KAP region are major rookeries for turtles. In addition, the islands provide breeding sanctuaries for various birds (e.g. terns, Socotra Cormorants) and are frequently surrounded by coral reefs. The latter also provide habitat and food for fisheries which are currently exploited.

In addition to the direct economic importance of oil platforms and other large man-made structures (e.g. Saudi-Bahrain Causeway), these objects provide solid substrates and attachment points for a whole variety of marine life and a refuge or food for large fish. As a result jetties, in particular, have become favoured spots for anglers.

Targeted exploitation

No truly oceanic fisheries occur in this area, although pelagic fisheries do exist for tuna, in small quantities, and for some smaller open water fish such as anchovies.

Trawling occurs throughout most of the soft-bottomed zones in the Arabian Sea and Inner Gulf. Although the target species is shrimp (principally Penaeus semisulcatus) a wide variety of other species are taken and landed. In some areas shrimp stocks have been over-exploited and management plans put into action to conserve stocks. However, unlike the demersal fishery in the Gulf of Thailand, so far no major shifts in the species composition of the fish catch have been recorded. The fact that the fishery is targeted mainly on one group, the shrimps, may mean that other groups, including all the fish are less heavily exploited than if the fishery was an indescriminate trawl fishery.

Incidental exploitation

During shrimp trawling significant quantities of trash fish as well as some 'prime' (commercial) fish are caught, details of which are available in the literature (Price & Jones, 1975). Various crustaceans (e.g. Thenus orientalis, Portunus pelagicus) are also taken incidentally.

From a conservation viewpoint, the most important incidental catches are those of rare or vulnerable species. In general, these include turtles and cetaceans, although other species (e.g. invertebrates) are also subject to incidental exploitations, but few details are available.

Incidental capture of turtles certainly does occur in these waters, although at what rate is unknown. In Kuwait, over a three year period, a fisheries research vessel is reported to have caught only one Green turtle. Yet in Qatar, turtles of all sizes are said to be caught in trawls, although most are returned to the sea alive (Ross & Barwani, 1981). It is likely that most of

these incidental captures are in seagrass beds rather than in open soft-bottomed habitats. Small cetaceans may also be taken in the waters of this Region, but there are no records of any incidental capture specifically in open soft-bottomed habitats.

The oil industry

Numerous reports have been written on the oil industry in this region (see e.g. Wennink & Nelson Smith, 1977; Baker & Dicks, 1982; Price, 1983; UNEP, 1984c), though the effects on sublittoral and other open sea biota have not been investigated in detail. Since several hundred thousand barrels of oil discharged into the sea following the Nowruz blow-out in 1983, a fair amount would have inevitably reached the sea bed, particularly since it was a heavy crude and relatively little was subsequently observed on shores. Sinking of the oil may also have been aided by airborne dust and sand becoming incorporated with the oil. Apart from the immediate concern for desalination intakes, there was also possibility of the shrimping and fishing grounds becoming oiled. Shortly after the Nowruz spill, large numbers of dead fish, turtles, seasnakes, dolphins and dugongs were found washed up along extensive stretches of the coastline, particularly in Saudi Arabia. However, the animal deaths could not definitely be attributed to the oil spill (see Price, 1983).

Waste discharge

Several studies on heavy metals in sublittoral organisms have been undertaken, including those of Anderlini (1979;1980) in Kuwait; Menzies et al., (1975) and Laseter (1982) in Saudi Arabia; Linden (1982) in Bahrain; and IAEA (1984) in Oman. These studies showed that heavy metal levels are often considerably elevated in sediments and biota around industrial outfalls.

Sedimentation

The occurrence and adverse effects of sedimentation are covered in detail under coral reefs and seagrass beds, and similar considerations apply to sublittoral sand, mud and rock communities in general.

Direct and habitat destruction

Coastal infilling and land reclamation is the overriding environmental problem and is discussed more fully further in the document.

Recreation and tourism

Offshore islands represent the main recreational attraction in the open-sea environment. Residents of the KAP region are increasingly visiting the offshore coral islands, particularly for scuba-diving. Such visits provide an opportunity of experiencing a relatively undisturbed tropical island. According to local residents, the islands' reefs of at least some countries (e.g. Saudi Arabia) are now subject to some anchor damage and shell collecting during visits. Disturbance of nesting turtles and birds can also be a problem. Divers occasionally visit the nearshore oil platform for spearfishing, while jetties and wharfs are favoured by anglers.

Existing management policy and practice

The islands within Iran's Marine Reserves are fully protected from development. The six Saudi offshore islands are expected to become Marine Protectorates, and proposals for creating a National Park on Kubbah island in

Kuwait have also been made. In some cases, military installations on certain offshore islands (e.g. Falakkah, Kuwait & Al-Arabiyah, Saudi Arabia) may create obstacles to the creation of marine parks.

Recent conservation projects

A number of plankton studies have been undertaken, some with emphasis on locating areas with abundant shrimp eggs and larvae (i.e. spawning grounds) for conservation and fishery purposes. Conservation projects which have included studies on sublittoral sand/mud/rock habitats have been undertaken in Bahrain (Price et al., 1983) and Oman (Barratt, 1984), and extensive information on the ecology of these (and other) habitats is provided by Basson et al. (1977).

Primary concerns and priority recommendations

The main concerns are loss/damage of these habitats by oil and other pollution, coastal infilling and sedimentation from dredging. Increasing disturbance to the offshore islands by recreational and military activities also represent a major threat, especially to the coral reefs and nesting turtles and birds. Recommendations focus on controlling the above, and more details are given elsewhere in the report.

Deep Sea

Character

Deep sea environments occur only around Oman, where depths greater than 4,000 m. can be found off the south coast. Apart from minor oceanographic and fisheries surveys, there is little knowledge of any deep sea habitats or species.

Targeted exploitation

Various survey cruises in the Arabian Sea found and confirmed that high densities of mesopelagic fish existed in the Gulf of Oman (Gjosaeter & Kaeaguchi, 1980). Highest concentrations were usually found along the edge of the continental shelf. An FAO acoustic survey gave biomass values of 4.6 million tonnes of fish in November 1977 and 2.75 million tonnes in May 1978. Night trawling by the Dr Fridtjof Nansen resulted in catch rates varying between 600 and 10,00 kg/hour of myctophids, which completely dominated the catch composition. Another FAO cruise in November 1978 reported dense concentrations of mesopelagic fish in the southern part of the Gulf of Oman, and very low concentrations in central and northern parts. The biomass found in the Gulf of Oman and off Pakistan is higher than in any other areas of the Arabian Sea.

The main species groups are Myctophidae and Gonostomatidae. The species Benthosema pterotum is dominant; other abundant ones include, B. fibulatum, Hygophuum proximum, Bolinichthys lengipes and Diaphus thiollieri.

No exploitation is at present taking place on this mesopelagic fish resource, and experimental fishing is only at an initial stage (IOFC, 1978). The mesopelagic fish stocks are estimated to be the largest fish resource within the north Arabian Sea area.

Open Soft Bottom Habitats

Character

Sandy beaches represent an important open soft bottom habitat in the KAP region. They typically occur along exposed shorelines, and in the Inner Gulf consist of relatively fine-grained sand compared to that normal in this kind of habitat. However, in southern Oman, where conditions are more exposed, the beaches are of moderately coarse grain size. More than 200 species of macrofauna have been collected from exposed sandy beaches in the area, with the ghost crab (Ocypode saratan) the most conspicuous invertebrate and gastropods the dominant group (Basson et al., 1977). The tall beach grass, Halopyrum mucronatum often occurs immediately behind the beach.

Occurrence and extent

Exposed sandy beaches are found along the shores of all KAP countries. In Saudi Arabia, they account for c. 350 km of the shoreline (Basson et al., 1977). They are also a significant habitat of the offshore islands. However exposed sandy beaches generally occupy much smaller areas that the intertidal mud/sand flats.

Conservational status

Becoming increasingly vulnerable to oil spillages, flotsam and refuse.

Human and economic value

Exposed sandy beaches have relatively low biological productivity and vulnerability to oil spill damage: probably 3-5 on the Gundlach & Hayes vulnerability index (Baker & Dicks, 1982). Nevertheless they are used for nesting, particularly on islands, by turtles and several tern species. In addition, they have high recreational value.

The oil industry

The quantity of tar reaching beaches has been estimated in several KAP countries including Kuwait (Anderlini & Al-Harmi, 1979), Bahrain (Price et al., 1983) and Oman (Burns et al., 1982). General environmental considerations of oil pollution are available in various reports (e.g. Wennink & Nelson Smith, 1977; Baker & Dicks, 1982; Price, 1983; UNEP, 1984c). The full ecological consequences have generally not been determined. However, heavy oiling on beaches of offshore islands in the area (e.g. Karan, Jurayd) following the recent (1983) Nowruz oil spill may well have impeded breeding activities of turtles and certain birds (e.g. lesser crested terns, white-cheeked terns) that nest on the beach. Sand beaches are sometimes used as "sacrificial beaches" or repositories for oil contained and collected from spills (Baker & Dicks, 1982).

Waste discharge

Exposed sandy beaches are inevitably subjected to sewage, desalination effluents and a whole variety of other waste products from industry, though the ecological consequences have not been determined.

Direct and habitat destruction

Compared to intertidal flats and shallow embayments, sand beaches have remained largely undisturbed from direct habitat destruction.

Recreation and tourism

Numerous amenity beaches have been established and maintained around industrial and other sites in the KAP region. During weekends, literally thousands of vehicles can be seen along small distances (e.g. 60 km), with their occupants picnicking, boating, swimming and angling (see TMRU. 1982). The numbers seeking recreation on beaches is naturally bound to increase following general industrial expansion within the region.

Other impacts

Accumulating driftwood on the offshore islands can potentially form a barricade to female turtles crawling up the beach to nest, (see TMRU, 1982, Pl. 4), and also to hatchlings crawling down the beach to the water.

Existing management policy and practice

There are no specific legislations dealing with sandy beaches. However, any sandy beaches within the National Parks of Iran will naturally receive full protection. If the resolutions for establishing the Saudi offshore islands as marine protectorates are adopted and enforced, their habitats (e.g. beaches & reefs) and nesting birds and turtles will also receive direct protection. (See also sections on birds and turtles).

Recent and current conservation projects

Since exposed sandy beaches are not recognised as a critical marine habitat, they have been studied less extensively than certain other habitats. Nevertheless, various surveys have been undertaken, e.g. in Kuwait (Jones, in press), Saudi Arabia (Basson et al., 1977), Bahrain (Price et al., 1977) and Oman (Barratt, 1984), and the resulting information has been useful for conservation purposes.

Priority concerns

The possible short- and long-term effects of oil spillages, industrial effluents and general refuse on sand beach biota are the main concerns, together with the increasing pressure from recreational use.

Priority recommendations

Refuse on beaches should be kept to a reasonable minimum, to avoid heavy metals and other contaminants from leaching into the marine environment. Driftwood should also be removed periodically from beaches used by nesting turtles. If sand beaches continue to be used as "sacrificial beaches" for oil collected from spills, relatively "non-critical" sites should preferably be chosen, rather than localities important to nesting turtles and birds.

Enclosed Soft Bottom Habitats

Character

Enclosed, shallow embayments (< 8 m depth) are a major coastal habitat in the KAP region. They mostly contain sandy or muddy substrates often in association with seagrass beds, and become hypersaline (> 55°/oo) in much of the SW region of the Inner Gulf. Also included in this category are intertidal sand/mud flats. Details of the ecology are available in the literature (e.g. Basson et al., 1977; McCain, in press).

Occurrence and extent

These habitats are particularly prevalent along the north and west sides of the Inner Gulf. Fine examples are found in Iraq, Kuwait (e.g. Kuwait Bay), Saudi Arabia (e.g. Tarut Bay, Musharihah & Mussallamiyah), NE Bahrain, and also along much of the coastline of Qatar and UAE. Much of the Iranian coastline is rocky, though there a number of well-developed bays to the south (e.g. Chah Bihar, Pizom, north of Qeshem Is and in Khoran Straits). A number of bays are also present on the north and south coasts of Oman.

Conservational status

In Kuwait, Saudi Arabia, Bahrain and other parts of the KAP region, these habitats are now acutely threatened, and some face total destruction from coastal infilling (see TMRU, 1982; Price, 1982a; Price et al., 1983).

Human and economic value

Apart from the very high "dollar value" to coastal developers, these habitats are of enormous biological importance, and the associated fauna are also of major economic value. For example, the highly productive tidal flats and shallow embayments of the area directly or indirectly support many important commercial fish (e.g. Siganus spp., Lutjanus spp.). Coastal embayments, particularly when covered with seagrass, also represent major nursery areas for commercial shrimp (P. semisulcatus) and pearl oysters (Pinctada spp.), as well as feeding areas for green turtles and dugong. Hypersaline bays are stressful environments and of particular scientific interest. Bays are utilised for boating and other recreational activities.

Targeted exploitation

The artisanal fishery has operated in enclosed bays from earliest history, using traps, beach seines and small vessels (dhows). In certain bays within Saudi Arabia shrimp catches from traps average less than 500 to more than 20,000 lbs per day; high shrimp catches (c. 200 lbs/day) in beach seines have also been reported (Price, 1976). In previous years the dhow fishermen caught only fish, by means of pots and handlines, but following the advent of the industrial shrimp fishery in the 1960's many crafts were rigged with shrimp nets and began shrimp fishing. Nowadays, dhow fishermen catch both shrimp and fish. Fish species caught include Siganus sp., Gerres oyena, Upeneus tragula, Lutjanus spp. and Lethrinus nebulosus.

Incidental exploitation

A whole variety of non-targeted 'trash fish', crustaceans and other invertebrates are caught incidentally during shrimp trawling in enclosed soft bottomed habitats. The quantities can often be substantial (see Price & Jones, 1975).

The oil industry

Enclosed soft bottom habitats, particularly tidal flats, are highly vulnerable to oil spill damage; the latter are rated as grade 9 on a 1-10 index, where 1 is least vulnerable and 10 most vulnerable (Gundlach & Hayes, 1978). Following a pipeline rupture in Tarut Bay (Saudi Arabia) in 1970, c. 16,000 tons of oil were spilled and extensive areas of the tidal flats became oiled (see Spooner, 1970a,b). Mortalities among shore plants and animals were low enough to permit fairly rapid recovery and, although local fisheries were

temporarily disrupted, the approximate synchrony of the spillage and drop in shrimp catch was apparently coincidental (see Nelson Smith, 1984). However, although long-term effects of the Tarut Bay accident were not monitored, many of the world's major oil spills are known to exhibit long-term consequences (Vandermeulen, 1982). Various reviews and reports on oil pollution in the KAP region are available in the literature (e.g. Wennink & Nelson Smith, 1977; Baker & Dicks, 1982; Price, 1983; UNEP. 1984c).

Waste discharge

Embayments in the KAP region have increasingly become sites for the discharge of various effluents (see TMRU. 1982; Price, 1982a; Price et al., 1983). The effects of heavy metals on local biota have been considered in a number of studies (see 1.7). Eutrophication is also a problem in a number of bays.

Sedimentation

This is one of the major environmental problems in the area. The adverse effects of sedimentation on shallow sublittoral communities, particularly seagrass habitats, is discussed further in the document. However, it can be stressed again that coastal embayments are frequently areas chosen for dredging and development, and therefore become susceptible to sedimentation.

Direct and habitat destruction

Land-fill contracts are now systematically eliminating many of these intertidal refuges and their salt marsh hinterland. This has been considered in some detail by TMRU (1982) who also give full pictoral documentation (Pls. 17-19). Coastal infilling and land reclamation is particularly prevalent along the western side, and in Kuwait it is possible that following large scale habitat loss species new to science are becoming extinct prior to their discovery (Jones, pers. comm.). Mangroves are often associated with shallow embayments, and their increasing wholesale destruction is considered further in in the text.

Recreation and tourism

Large embayments are increasingly becoming used for boating, fishing, picnicking and other recreational activities. In general, ecological effects are probably fairly minimal at present, though the accumulation of refuse is increasing and has an unattractive appearance.

Existing management policy and practice

See remarks under mangroves, which also apply to enclosed soft-bottomed habitats in general.

Recent and current conservation projects

In addition to the projects mentioned under mangroves, various surveys have been undertaken (e.g. Basson et al., 1977; Jones et al., 1978; McCain, in press) which provide information valuable for developing conservation and management strategies.

Priority concerns and recommendations

Habitat loss damage and sedimentation, as well as impact from oil spills and industrial effluents, are the main problems and desperately need to be controlled.

Mangroves

Character

Mangroves and associated intertidal flats/marshes represent one of several critical marine habitats in the KAP Region. Superficially appearing to be "worthless swamps", mangroves are actually extremely productive biologically, and their great ecological value is recognised both regionally (Price, 1982a; TMRU, 1982; Barratt, 1984; Price et al., 1983) and worldwide (IUCN, 1980, 1983; Por & Dor, 1984). A single species, Avicennia marina, is represented in the KAP region.

Occurrence and extent

In the KAP region, mangroves occur along the upper intertidal zone in certain embayments. However, they are poorly developed and patchily distributed, partly because of intensive human use in the past (Baker & Dicks, 1982) but largely due to present-day coastal infilling (TMRU, 1982; Price et al., 1983). Mangroves are absent from Iraq and Kuwait, perhaps due to climatic effects of latitude. In Iran, there is an estimated 8,900 ha, and the largest stand is in the Khoran Straits and is included within the 82,000 ha Hara Protected Region (see IUCN, 1976). In Saudi Arabia, mangroves are limited to a few stands in Tarut Bay and to the south of Abu Ali. Remaining stands of any significance in Bahrain are found at Sanad (Price et al., 1983). Mangroves also occur in southern parts of the region and the densest stands fringe the Gulf of Hormuz. Mangroves are also found around Oman, with particularly dense stands at Mahwt (Barratt, pers. comm.).

Conservational status

A. marina is acutely threatened in certain countries (e.g. Saudi Arabia, Bahrain), and the mangrove forests of Iran are also rapidly disappearing.

Human and economic value

The mangroves here have now largely been removed (MacNae, 1974), presumably for human use. The direct uses for mangroves are numerous (e.g. fuel, construction, fishing, textiles, food, drugs, beverages, household items). By functioning as a critical marine habitat to various animals (e.g. shrimps, fish, birds, mammals), they are of great economic and also scientific interest. Reviews on the ecology and value of mangroves are available in the literature (e.g. IUCN, 1983; Por & Dor, 1984).

Targeted exploitation

Nowadays, mangroves in the region are not exploited directly in large quantities, but frequently destroyed as a consequence of coastal infilling.

Incidental exploitation

Although widespread habitat loss is occurring as a result of coastal infilling, there appear to be no records of incidental intentional exploitation associated with mangroves of the area. The main shrimp stocks are of species which do not require mangroves, although various commercial fish species exploited may well associate with mangroves.

The oil industry

While mangroves and marshes have high biological productivity, they are also "oil traps" and rated by Gundlach & Hayes (1978) as the most vulnerable shoreline habitat. The shorelines of the KAP countries are inevitably subject to a certain amount of oiling, though the effects on mangroves specifically have not been considered in detail. However, studies have been undertaken in other parts of the world, and it appears that the final extent of impact may not be apparent immediately after a spill (see Baker, 1983). Ideally, mangroves should be protected from oil by booms or sorbent pads, as they are notoriously difficult to actually clean.

Waste discharge

Industrial effluents discharged into bays will inevitably reach mangroves, even if in low concentrations. However, the ecological consequences in the KAP region have not been studied but may well be appreciable.

Direct and habitat destruction

Mangrove clearance and coastal infilling of the tidal flats for land reclamation probably represent the most serious threat to marine life in the KAP region. The infilled area is rendered virtually useless as a biological habitat (see TMRU, 1982, Pls. 17-19). In Iran, the westernmost stand at Bandar Asalu has been cut severely and is rapidly disappearing. As already mentioned, extensive mangrove deforestation in the area also took place in the past.

Other impacts

Secondary effects also take place as a result of infilling. This results from fine, wind-blown sand being transported from coastal development areas and becoming deposited on terrestrial/intertidal vegetation such as mangroves. In some areas, the mangroves have been observed to be coated with fine silt (TMRU, 1982). This is not only undesirable aesthetically, but also reduces the amount of light available for photosynthesis

Existing management policy

In Iran, the largest stand of mangrove (c. 6,800 ha) is in the Khoran Straits and has been included within the 82,000 ha Hara Protected Region (Keyvani, 1984). Furthermore, c. 80% of the country's mangroves is contained within Protected Regions. In Saudi Arabia, resolutions have been proposed recently (1984) by EPCCOM to prevent any new coastal infilling without approval from the Ministry of Urban and Rural Affairs and Ministry of Agriculture and Water in collaboration with MEPA: if adopted, this will protect the acutely threatened mangroves and intertidal flats. In Bahrain, the Directorate of Environmental Affairs is also attempting to prevent dumping of infill on mangroves and coastal shallows.

Existing management practice

Although the majority of Iran's mangroves are within National Parks, and therefore protected, mangrove destruction still continues in many other parts of the region.

Recent and current conservation projects

Recent ROPME/UNEP/IUCN projects have considered in some detail the conservational status of mangroves in the KAP region. These include: Bahrain (Price et al., 1983), Saudi Arabia (Price, 1982a; TMRU, 1982) and Oman (Barratt, 1984). From these and other studies it appears that mangroves in Oman are less disturbed than in other KAP countries.

Priority concerns

Loss of mangroves through direct habitat destruction is of concern, and damage from oil spills and other industrial effluents can also be a potential problem.

Priority recommendations

These focus principally on reducing further mangrove loss and, in particular, enforcing moratoria on coastal infilling. At present, there are some difficulties which need to be overcome before coastal infilling ceases.

Seagrasses

Character

Seagrasses may be regarded as underwater meadows or pastures, characterised by high biological productivity. Three particularly euryhaline species are represented in the Inner Gulf: Halodule uninervis, Halophila ovalis and Halophila stipulacea. In Oman, additional species (e.g. Syringodium isoetifolium & Cymodocea serrulata) are also present. Seagrass ecosystems represent one of several critical marine habitats and provide food or shelter to more than 500 species of plants and animals (Basson et al., 1977).

Occurrence and extent

Large areas of subtidal shallows (0.5-6 m) contain seagrass, and dense grassbeds have been reported down to depths of 15 m (Basson et al., 1977). Seagrass occurs along the coasts of all KAP countries, including the south coast of Oman, but may be of only limited distribution in Kuwait. In Saudi Arabia, the approximate locations of some of the major grassbeds have been mapped (TMRU, 1982; Tetratech, unpublished), though in most countries the extent and distribution have not yet been determined.

Conservational status

Variable, though acutely threatened in certain areas (e.g. Saudi Arabia, Bahrain) following coastal dredging and infilling.

Human and economic value

In the KAP region, seagrasses play a key role in maintaining the productivity of local fisheries and coastal waters in general. Turtles and dugong feed directly on the growing plant, as do certain commercial and other fish (e.g. Siganus spp.). Also associated with seagrass are many animals which rely on this habitat for larval settlement and growth. These include species of great economic and cultural importance such as commercial shrimp (P. semisulcatus) and pearl oysters (Pinctada spp.).

The approximate "dollar value" of a bay 410 km^2 in Saudi Arabia (Tarut Bay) has been calculated (Basson et al., 1977). If seagrass in the bay is incorporated into food chains, the estimated value of the fish yield was $8 million. If instead, grass was converted at the same efficiency (1 % overall) into shrimps, the calculated value was nearly $12 million. On the other hand, if the seagrass was grazed directly by green turtles, at an efficiency of 10 %, the turtle yield was estimated to be $46 million. The value of these natural resources is based on 1977 prices, and the calculations are very approximate and largely theoretical. Nevertheless, they demonstrate the considerable value of local biological resources which, if managed correctly, are renewable.

Targeted exploitation

Seagrass beds are of great importance for the main fishing industry of the area, that for the shrimp Penaeus semisulcatus. Seagrass beds are not generally subject to trawling by the industrial fleets, but smaller traditional fishing boats have been adapted to trawl on seagrass beds in inshore areas (Basson et al., 1977). The shrimp Penaeus semisulcatus makes use of seagrass beds during part of the larval and juvenile stages, and migrates to deeper waters as adults (Basson et al., 1977). Some evidently remain in the seagrass beds as adults also. Seagrass beds are enormously productive, and a wide variety of other species are also taken in trawl nets. There are no records of direct use of the seagrasses themselves.

Incidental exploitation

Both dugongs and Green turtles feed almost exclusively in seagrass beds, and therefore face the danger of being caught in trawl nets. Although dugongs are known to be caught incidentally throughout their range, specific examples of dugong capture in this area are lacking. The population is probably not very large and any mortality due to net entanglement would be significant.

Green turtles are evidently caught, but the numbers involved are not known. Ross and Barwani (1981) suggest that a few hundred may be taken in trawl nets in Qatar annually. Most are said to be returned alive. Similarly, in Oman there is reported to be some capture, but as c. 100 may be exported to the United Arab Emirates every year (Ross & Barwani, 1981) it is not clear if this is an incidental or a deliberate take.

The oil industry

Little published information is available on the effects of oil pollution on seagrass beds (Baker & Dicks, 1982), and no studies in the KAP area have addressed the problem directly. However, oiling of seagrass beds is bound to occur, particularly following major disasters such as the recent Nowruz (1983) oil spill and the earlier (1970) Tarut Bay spill.

Waste discharge

Since sewage and various industrial effluents are frequently discharged into bays, any seagrass beds will inevitably be subject to some impact. However, details of the ecological consequences have not been determined.

Sedimentation

This is a serious environmental problem throughout much of the area and results largely from dredging, shipping and various industrial construction operations now taking place along the coast. In severe cases (e.g. Bahrain), certain seagrass have become completely smothered as a result of sedimentation

(Price et al., 1983). Sedimentation also has the effect of reducing the depth of light penetration and thereby limiting photosynthesis of seagrass and other primary producers.

Direct and habitat destruction

Since vast expanses of the sublittoral are shallow (< 6 m), infilling of these areas is not a problem from an engineering point of view. Consequently, coastal infilling is now prevalent in many parts of the region, and the adverse effects are considered in more detail elsewhere in this report, as well as in earlier studies (TMRU, 1982; Price et al., 1983). The extent of the damage is now such that the size of shrimp and fish stocks associated with grassbeds has probably become reduced (Price et al., 1983).

Other impacts

In addition to direct habitat destruction (above), seagrass beds are locally damaged by the action of trawl nets over the seabed (see Basson et al., 1977, Fig. 81). Damage results from physical disruption due to scouring, and also from general disturbance of biological communities within the seagrass habitat.

Existing management policy and practice

The management policies aimed at preventing unlicensed infilling (see 5.15) should help limit the loss of shallow sublittoral communities. However, dredging is also a major problem and although guidelines for minimising damage from dredging have already been put forward (Price et al., 1983), they appear not to be mandatory.

Recent and current conservation projects

The conservational status of seagrass habitats has been considered in some detail during recent studies in Bahrain (Price et al., 1983) and Saudi Arabia (Basson et al., 1977; TMRU, 1982). However, seagrass ecology and conservation has not been considered in such detail in other KAP countries.

Priority concerns

The major concern is the current extensive loss or severe degradation of seagrass habitats, and probable reduction in natural resources associated with this habitat, such as shrimp and fin fisheries, turtles, dugong and other marine life. Accumulation and incorporation of heavy metals and other pollutants into food chains may well also become a severe environmental problem.

Priority recommendations

Detailed recommendations for conserving seagrass beds in this area are available in several reports (Price, 1982a; TMRU, 1982; Price et al., 1983) and should be consulted. These focus largely on preventing further uncontrolled habitat destruction and widespread pollution. Any legislation aimed to prevent impact must be enforced, if it is to be effective. In addition, the distribution and rate of seagrass loss needs to be determined in the various KAP countries.

Rocky Substrates and Shores

Character

In the Inner Gulf, this habitat is represented by exposed rock beaches and, more commonly, intertidal rock flats which are more productive biologically. Exposed rocky beaches support at least 130 species of plants and animals (Basson et al., 1977) with barnacles (Cthamalus sp., Balanus amphitrite), crabs (Petrolisthes carnipes) and urchins (Echinometra mathaei) prevalent (Jones, in press). Intertidal rock flats are often made up of a soft grey limestone known locally as "faroush", and support more than 300 species of plants and animals (Basson et al., 1977); dominant groups within this habitat include polychaetes, gastropods, bivalves and decapods.

In southern Oman, much of the coastline is exposed and a whole variety of rocky shore habitats are found, e.g. boulder beaches, sedimentary rocky shores, metamorphic cliffs and rocky shores and limestone cliffs; the latter are dominated by mussels (Mytilus viridis), barnacles, oysters and serpulid worms (Barratt, 1984).

Occurrence and extent

The coast of Iran and the eastern shores of UAE are rocky. However, along the western part of the region these give way largely to sandy and muddy shores. In southern Oman, rocky shores of various kinds predominate.

Conservational status

Variable, but impacted in certain areas by stranded oil and mining (see Basson et al., 1977; TMRU, 1982; UNEP, 1984c).

Human and economic value

Although biological productivity of rocky shores in the Inner Gulf is not exceptional, the species diversity (314+ species) on rocky tidal flats is nevertheless quite impressive. One type of rock "faroush" has been systematically harvested from intertidal rock flats for centuries as building stone (Basson et al., 1977), and was/is undoubtedly of value locally.

Targeted exploitation

No specific information is available for exploitation of these habitats. Traditionally, fishing gear in this region has consisted mostly of pots and lines, which are both suitable for fishing on rocky substrates. Groupers and other large predatory fish are the favoured species but no catch statistics are available for this type of fishery. It seems likely that fishing is restricted to traditional gear types. Abalones and crayfish are caught locally in southern Oman, and the catch is distributed internationally.

Incidental exploitation

There appears to be no documentation of any incidental exploitation of rocky substrates, though in Oman and Bahrain algae is collected and used as bait in fish traps. In some parts of southern Oman, gastropods are collected for food for local consumption.

The oil industry

Despite the frequent occurrence of oil spills reaching shores of the KAP region, the ecological consequences have not been considered in detail. However, the effects from studies elsewhere are well documented (see e.g. Nelson Smith, 1972; Baker, 1983). In general, fresh crude or light products tend to penetrate well and have toxic internal effects, whereas weathered or heavy oils tend to cause external, mechanical effects through smothering. Exposed rocky shores have relatively low vulnerability to oil spill damage - probably 3-5 on the Gundlach & Hayes (1978) vulnerability index (see Baker & Dicks, 1982).

Waste discharge

Effects on rocky shore biota not known in detail.

Direct and habitat destruction

This is a relatively minor problem at present. However, some areas of intertidal rock flats are inevitably being infilled, together with the more extensive sand/mud flats. "Faroush" mining has also removed unknown quantities of this substrate/habitat.

Other impacts

Extensive refuse and driftwood can be a problem. It is not only unattractive but also represents a hazard to marine life (see TMRU, 1982).

Existing management policy and practice

Rocky shores are protected directly within the National Parks of Iran. Resolutions to prevent uncontrolled infilling in Saudi Arabia should provide some protection in this part of the KAP region if the resolutions are adopted and enforced.

Recent and current conservation projects

Recent studies considering rocky shore ecology have been undertaken in Kuwait (Jones, in press), Saudi Arabia (Basson et al., 1977) and Oman (Barratt, 1984), and have provided useful conservational information.

Priority concerns

The main concerns are possible increased loss of habitat, particularly intertidal rock flats, from coastal infilling, as well as the short-term and long-term effects oil spills.

Priority recommendations

Coastal infilling on rocky habitats needs to be regulated, particularly over intertidal flats. Determination of the distribution of rocky habitats of all KAP countries is also a priority.

Coral Reefs

Character

Reef building corals in the KAP region represent one of several critical marine habitats. Although less well developed than those in the Red Sea, coral reefs of the Inner Gulf are more spectacular than generally acknowledged, and support at least 500 species of plants and animals (Basson et al., 1977). Acropora is the principal reef builder, and Porites and brain corals are also common. However, coral diversity is low: 24 genera according to Burchard (1979), as compared with 64 genera in the Red Sea (Scheer & Pillai, 1983). Diversity in the Arabian Sea (i.e. southern Oman/Arabia) is similarly low, largely due to the limiting effects of cold-water upwelling. Coral reefs in the region occur principally as fringing reefs, patch or platform reefs and submerged "coral banks".

Occurrence and extent

Coral formations are absent in the northern part of the KAP region, due to fresh-water inflow and sedimentation. Particularly well-developed fringing reefs surround the six offshore Saudi islands, Kubbar island (Kuwait) and several islands between the Straits of Hormuz and Bandar Asalu (Iran). Coral reefs are also present in coastal waters of UAE and along the eastern coasts of Bahrain and Qatar as well as in Oman. Since reef corals are unable to tolerate salinities much greater than 45°/oo (Kinsman, 1964), they are absent from the entire Gulf of Bahrain and Gulf of Salwah.

Conservational status

Coral reefs are rapidly becoming threatened in some areas, largely because of increasing sedimentation and probably also as a result of oil spillages.

Human and economic value

The outstanding biological productivity of coral reefs is well documented (see Salm & Clark, 1984). In the KAP region, they provide food and shelter for a multitude of plants and animals, and a refuge for several large commercial fish species (e.g. Gnathanodon speciosus & Epinephelus tauvina). Corals found in the Inner Gulf are of particular interest to scientists because they are existing in environments of high salinity and fluctuating temperatures near the limit of their tolerance. Because of their low diversity, they also provide reef ecologists with an opportunity to study an otherwise complex community in a relatively simple form. Coral reefs in the KAP region are now also becoming increasingly valued for their enormous recreational potential.

Targeted exploitation

Information on reef fisheries in this area is sparse. Handlining and potting are both methods which are employed, and groupers and snappers in particular are taken. The fisheries do not appear to be intensive anywhere. There are no indications of any fishing for ornamental fish or other exotic reef species.

The oil industry

The detailed effects of oiling on corals in the area have not been determined. However, the effects of exposing oil, dispersant and dispersant plus oil to a coral reef in Saudi Arabia (Jurayd Island) has been investigated by field experiment (LeGore et al., 1983), though the results are not

conclusive. Following the recent (1983) Nowruz oil spill, quantities of oil apparently reached several offshore islands. The increase in algal cover and apparent reduction of certain invertebrates on these reefs may be at least partly attributed to oiling.

Sedimentation

Sedimentation on coral reefs is becoming a major problem in many tropical areas, particularly where dredging is prevalent. The primary effect of sedimentation is complete or partial smothering of the coral polyps; the secondary effects are reduced light penetration and impaired photosynthesis by reef corals' symbiotic zooxanthellae following increased water turbidity.

A brief survey of the reefs at Fasht Adhm in Bahrain recently showed that well over 50 % of the coral in some areas was dead as a result of sedimentation (Price et al., 1983). Most of this appeared to have died within the last 1-3 years, since the coral skeletons were generally still standing and intact. Very heavy sedimentation, enhanced by dredging activity, was also observed during a very recent (1985) survey in Bahrain (Barratt & Ormond, 1985).

Direct and habitat destruction

In addition to the smothering effects of sedimentation, there is some direct habitat destruction locally as a result of channels being blasted through coral reefs to provide access for shipping. Ships and boats anchoring on reefs also break and kill considerable amounts of coral.

Recreation and tourism

Apart from some coral and shell collecting, spearfishing and anchor damage from visiting boats, disturbance to most coral reefs from recreational activities is probably only moderate at present. This contrasts with the situation in the Red Sea (Ormond, 1975, Ormond et al., 1983) and other parts of the world (Wells, 1981a,b), where collection of reef coral and other souvenir species is having harmful effects in some areas.

Other impacts

High numbers of urchins have increasingly been found on impacted and deteriorating reefs in several parts of the world (e.g. Lewis, 1974; Ormond, 1980). In Bahrain, very high numbers (>250 in 15 m^2) of the urchin Echinometra mathaei have been found on some reefs (Price et al., 1983), and dense aggregations have also been observed in other parts of the KAP region (Basson et al., 1977).

Existing management policy and practice

In Iran, Sheedvar island off the western end of Lavan island, an area of excellent coral reefs and other noteworthy fauna, has been fully protected since 1972. Proposals have also been made for the creation of additional reserves, to protect the reefs and other important marine life (see IUCN, 1976). In Saudi Arabia, designation of the six offshore islands (Karan, Jana, Jurayd, Harqus, Al-Arabiyah, Kurayn) as marine protectorates is also imminent. In Kuwait, similar proposals are underway for establishing Kubbar island as a protected area, on account of its spectacular reefs and other noteworthy biota.

Recent and current conservation projects

The most detailed studies on the corals and associated fauna have been undertaken in Saudi Arabia (Basson et al., 1977; Burchard, 1979; McCain, in press). Surveys have also been undertaken in Bahrain (Price et al., 1983; Barratt & Ormond, 1985) and Oman (Barratt, 1984; Green, 1983) as well as in other KAP countries.

Priority concerns

The major concerns are coral reef degradation following sedimentation caused by dredging, as well as direct habitat loss caused by channel blasting. Impacts from oil and various industrial effluents may well also be significant, though details are not known.

Priority recommendations

Detailed recommendations and guidelines for conserving coral reefs within the KAP region are already available (Price, 1982a; TMRU, 1982; Price et al., 1983; Barratt & Ormond, 1985). These centre principally on controlling and minimising sedimentation, mapping the distribution and rate of recession of reefs, and establishing permanent monitoring stations.

Pelagic and Demersal Fisheries

Character

In general, with the exception of the relatively modern shrimp fisheries, the fishing industry in this region is at an early stage of development. However, a high proportion of the boats of the predominant artisanal sector are now motorized. On the coast of Saudi Arabia, the main fishing effort is concentrated at Jubail, Tarut Island and Qatif (World Fishing, July 1977). Most of the boats (about 200 in 1981) are 10 - 18 m.dhows, using mainly traditional gear: hand-lines, gill-nets, traps, simple trawls and fish nets. The dhows operating out of Jubail, the most important port, fish mainly around the nearby coral islands. The principal fishing method is gill-netting for the migrating King Mackerel (Scomberomorus commerson) (FAO, 1981b).

In the United Arab Emirates, there were about 2400 vessels in 1977, most of which were motorized, (World Fishing, September 1977). The sea bottom off this region is mostly unsuitable for trawling, so there is very little of this activity. Purse-seine fishing is carried on, mainly for fish meal reduction, exploiting the abundant sardine and anchovy resources.

The main fisheries centres in Iran are in the south at Bandar Busher and Bandar Abbas, where pelagic fish shoals are concentrated near the strait of Hormuz (World Fishing, Nov. 1983). In 1978, the fishery fleet, apart from shrimpers, consisted of 2000 mechanised, 2000 unpowered artisanal boats, and three multi-purpose stern trawlers (FAO, 1978). Trawls, beach seines, traps, drift nets and gill-nets are used. Polish and North Korean boats are fishing in the Inner Gulf in an agreement with Iran (World Fishing, Nov. 1983).

The Omani traditional fishery numbered about 4500 boats in 1979 (FAO, 1979b). These consist of "houris" with outboard motors, shashas, wooden sambuks with inboard motors and large wooden canoes (badans) for beach seining, trolling, handlining and traps. The houris are being replaced by 5 m. aluminium skiffs. In the Gulf of Hormuz Province of Musandam, the fisheries are mainly at

a subsistence level, using hooks and lines and gillnets (Vidal-Junemann, 1981). The whole coastal area of the Gulf of Oman, which has a very narrow continental shelf, is fished heavily for demersal resources by artisanal fishermen with a wide variety of gears. There is a small fleet of trawlers fishing off Sahu, Suwaidi, As Sib and Sur. Beach seining for small pelagic fish has been decreasing, which is attributed to a decline in abundance of these fish. Exploitation of large pelagic fish is also on the artisanal level, with gillnets, drift nets, pen-nets, longlines and handlines. The largest catches are found on the Batina coast.

Apart from the industrial shrimp fishery, which sometimes lands high priced fish from their by-catch, the traditional coastal fishery of Kuwait supplies the bulk of the local market requirements (FAO, 1979b). The artisanal dhow fleet fishing in Kuwaiti waters comprised about 50 vessels in 1979, rotating with 250 other boats also fishing in Iranian and Saudi Arabian waters. All boats are motorized. The main gears are trawls, fish traps, drift and set nets. There is a small fishery with speed boats using trapnets that provide fish for the small live-fish market.

Status - PELAGIC FISHERIES

Small pelagic fishes including species like sardines, anchovies, and horse mackerels, have an estimated potential yield of around 375,000 tonnes per year: 110,000 tons for the northeastern area, 250,000 t for the south and 15,000 t for the Gulf of Oman (IOFC, 1979). Of the total potential yield, nearly 60% would be sardines. In the case of the large pelagic fishes, (tunas, mackerels and sharks) the present level of exploitation of about 20,000 t could be doubled (IOFC, 1979).

The total production of small pelagics by existing artisanal and large-scale fisheries in the area is estimated to be approximately 10,000 tonnes/year (FAO, 1981b). The scads, horse mackerels and Indian mackerel are the main species groups landed, whereas sardines caught by large trawlers are generally discarded at sea. There thus appears to be a wide scope for pelagic fisheries development in the whole area. During the surveys there was a large variation in the species composition by area and season, with wide and reversible differences between the Iranian and Arabian sides (FAO, 1981b). The Arabian side showed a very high proportion of sardines.

The main species groups identified were Sardinella spp., Stolephorus spp. (anchovies) and small Carangidae (scads and horse mackerels). Other important groups were rainbow sardines, ilishas, round herring and gizzard shad (FAO, 1981b; Vidal Junemann, 1981).

Catch levels for pelagic and demersal fisheries have been fairly stable in the 1976 - 1981 period, according to the FAO yearbook of Fisheries statistics (1983). Only in Bahrain did the landings increase slowly from around 4000 metric tons (MT) in 1976 to over 6000 MT in 1981. The Iranian catches appear to have decreased from 58000 MT in 1979 to 38000 MT in 1979; however, this is a sum total and is not broken down into species groups. The total estimated catch level for the region, excluding shrimp, is about 78,000 tonnes (FAO, 1981b).

The narrow-barred king mackerel was found to be the most widely distributed large pelagic species. The long tail tuna is found more in the Gulf of Oman than in the Inner Gulf, where its distribution is restricted close to the Strait of Hormuz. Eastern little tuna also has a wide occurrence, although it is most abundant on the south eastern part of the area including the Strait

of Hormuz. Indo-Pacific King mackerel has been observed mostly along the Iranian side (FAO, 1981b). Frigate tuna, queenfishes, jacks, dolphinfish, barracuda, and grey mullet are also important species in the area.

Status - DEMERSAL FISHERIES

The expected maximum potential yield in the Project area for commercial demersal resources has been estimated at about 216,000 tonnes per year, including species like groupers, snappers, grunts, breams, scads, etc, (IOFC, 1979); of this amount, 180,000 t is from the Inner Gulf and 36,000 t from the Gulf of Oman. It appears that because of the high diversity of fishes found in the two water bodies Gulfs very few are under intense exploitation, and that greater sustainable catches could be taken from these stocks (Morgan, 1980). However such an assessment is problematic in a multi-species fishery.

Stock assessment of the most important species in Kuwait started in 1978 (Mathews, 1984). Of these, the silver croaker (4% of 1984 landings) is near its maximum sustainable yield level; the reef-living orange spotted grouper and crimson snapper (each 18% of 1983 landings) are both at a suitable exploitation level. One of the most abundant demersal fish found in the catches of the RV Olamn 1978-83 exploratory cruises is the presently non-marketed giant sea catfish (Siluriformes); this highly seasonal species could sustain an estimated catch level of 1,500-2,000 t per year and be introduced for human consumption. Assessments of other important species such as the silvery grunt (10% of 1983 landings) and the yellow-finned black porgy (2% of 1983 landings) are not yet completed.

From trawl surveys conducted in the region from 1976 to 1978, catch rates of demersal fish have been calculated. The average catch rates by type of bottom substratum varied between 101 kg/h in shallow waters of the bay south of Qatar, and 1,034 kg/hr in deep (100-200m) waters on the Gulf of Oman coast of Iran (FAO, 1981c). Relatively high average catch rates were obtained in shallow waters along the Iranian coast, ranging from over 400 to 800 kg/h. Along the Arabian coast, the average catch rates in the 25-50 m zone varied between 300 to over 500 kg/h, the best area being close to the Strait of Hormuz. In the Gulf of Oman catch rates were over 500 kg/hr near the Strait of Hormuz. However, wide areas were considered untrawlable, although they can be assumed to be of equal productivity as the trawlable grounds. For the development of fisheries in those areas, other less efficient gears will probably have to be used.

Human and economic value

Most fish landed in this region are sold fresh to the local population, either directly or through town markets. In Saudi Arabia, about 1,000 fishermen are estimated to be employed (FAO, 1981b). Almost all the catch is sold within a few miles of the coast. However, imported canned fish, especially mackerel, now exceeds local production by a substantial margin, and is being distributed throughout the kingdom. This might in the long term open new inland markets for locally caught and processed fish.

In Kuwait, the fresh fish component of domestic supply, has declined steadily as expanding import markets for canned and frozen fish products make up for the under-supply of fresh fish (Morgan, 1980). Fish prices have increased and for the more popular species this increase has been more than 500% in the past six years. The number of fishermen employed in Kuwait was estimated at 843 in 1979 (FAO, 1979a). In respect of the total Kuwaiti economy, the contribution by fisheries is small, but its significance is heightened by the shortage of land and the difficulties of expanding agricultural production.

The fishing sector is considered third in importance in the Omani economy (FAO, 1979b). It is estimated that 15% of Oman's labour force is engaged in this sector, totalling in 1978, 100,000 fishermen and 26,800 employed in the secondary sector. Except for fish caught by Korean vessels under a joint venture agreement, which is frozen at sea, catches are sold fresh for human consumption, substantial quantities of fish are sold on ice to neighbouring countries. Some of the small pelagic fish are dried or salted for sale inland, and most of the sardines caught in the south of the country are dried and used as cattle feed.

Targeted exploitation

The estimated annual catch levels for pelagic and demersal fisheries by country, are listed in Table I.

Kuronuma (1974) gave an account of species composition from a trawling survey, which provides comparative percentage values for Kuwaiti, Qatar and UAE waters. The main species groups in Kuwait were Nemipteridae (threadfin breams) (31.5% of total weight), Mullidae (17.8%), sharks and rays (16.0%), Synodontidae (lizard fish) (7.3%), Leiognathidae (slipmouths) (4.9%) and sciaenidae (croakers) (4.1%). The order and proportions in Qatar and UAE were quite different: Carangidae (19.6%), Leiognathidae (3.7%), and Pomadsyidae (grunts), (3.6%). Sea catfish were abundant in all areas. There are wide seasonal variations, especially for the pelagic groups.

Despite the high diversity of fish species, the present fishery in Kuwait is targeted on about 10 species (Morgan 1982). Most of the highly prized ones are demersal real fishes: the orange spotted groupers accounted for 18.1% of the 1983 landings, the crimson snapper 18%, the silvery grunt (Mathews, 1984). From mainly trawls, gillnets and set nets, the silver croaker (4%), the yellow-finned black porgy (2%) and the silvery black porgy (<1%) are also popular. One of the preferred fish is the silver pomfret (7.7% of 1984 landings), a pelagic species. The ubiquitous sea catfish is presently considered a trash species, but could be fished for human consumption (Mathews, 1984).

On the coast of Saudi Arabia, the principal fishing activity is gill netting for King mackerel (Scomberomorus commerson) (FAO, 1981a). This fishery is seasonal, between November and April, as the mackerel migrates out of coastal waters. There is also a small fishery for groupers and snappers.

In Bahrain and Qatar the demersal fishery is the most important, targeting on groupers (about 1900 MT for Bahrain in 1981), rabbit fishes (Siganus sp.) (854 MT), snappers (353 MT), seabreams (121 MT) and grunts (99MT) (FAO Yearbook, 1983). The pelagic fishery concentrates mainly on mullets and jacks.

The fishery in the UAE is concentrated on small pelagic species, namely the Indian oil-sardine, other sardine species, anchovies and Indian mackerel. The main demersal species landed are the ponyfishes (Leiognathidae), threadfin breams, groupers and emperors.

Anchovies and sardines account for at least half the catch of the artisanal sector in Oman (FAO, 1979b). Important large pelagic species include tunas, king mackerel and barracudas. Other common groups are the seabreams, jacks, scavengers, grunts, porgies, snappers and sharks. The catches of large pelagic species vary seasonally, with tunas being more abundant during the southwest monsoon, accounting then for almost one third of the landings. Barracuda are caught only during northeast monsoon (World Fishing, September 1977).

Oil industry

The KAP waters are regularly the recipient of oil spills, either on a small scale from the illegal discharge of ballast waters from tankers, from natural seeps, or from accidental spills (Al Hanui & Anderlini, 1979). The effect of oil pollution on the fish resource cannot at present be evaluated, due to insufficient data.

Waste discharge

The KAP region has the world's greatest concentration of desalination plants, which are used to produce drinking water and to irrigate agricultural land with fresh water; however, the highly saline water resulting as a by-product is redirected to the sea (Walgate, 1978). These and other effluents, together with increasing concentrations of pesticides and agricultural fertilizers in the river waters, are likely to pose a significant threat to the commercial fish stocks of the area.

Existing management policy

In Oman it is government policy that industrial and commercial activities should be undertaken mainly by private enterprises (FAO, 1979b). However, it is providing aid to the artisanal sector by a mechanization programme and by encouraging the establishment of maintenance workshops, ice-producing plants, and the adoption of man-made fibres. In 1979, there was an agreement for a joint venture with Korea.

Government efforts to develop the fishery in Saudi Arabia include the construction of new fishing harbours at Dammam and Jubail (FAO, 1981a). However, the industry is affected by high labour costs, and costs of repairs.

The government of Kuwait is giving substantial support to fisheries research and training. Assessment of specific fish stocks began a few years ago. The main effort in development is however concentrated toward the shrimp fishery.

In 1983 Iran was considering a five year US$620 million development plan to step up fisheries production in order to compensate for reduced imports (World Fishery, November 1983). The plan is to increase the present annual catch to over 200,000 tonnes by 1989. The project includes the establishment of six new small fishing centres, as well as research and training facilities. The Directorate of Fisheries in Bahrain has recently encouraged the use of hydraulic haulers for fish traps used in the demersal fishery. These haulers enable a considerable increase in production in the small-scale sector.

In the UAE, a fish meal plant has been constructed, supplied by a fleet of purse-seiners which exploits the abundant small pelagic resource. There is at present a considerable effort being put in co-operation between the countries of the region, especially in resource survey research. Several reports have already been published (see FAO, 1981b,c). Representatives of the countries meet regularly to discuss development plans and projects.

Priority concerns

The main concern in this area is the effect of human activities (oil industry, reclamation of wetlands, input of highly saline water, etc.) on the exploitable marine resources of the region. These changes may be irreversible, but knowledge of their influence on the fisheries could provide a basis for management action to further protect the fish resources. The other concern in

this region is the development of fisheries production according to the constraints of limited portential yield, untrawlability of a large area of the Gulf and high seasonality in the availability of the pelagic stocks. It is important that an evaluation of the potential yields be conducted for the specific areas where increased effort is planned.

Priority recommendations

The active development of small-scale fisheries should be carried on to exploit fully the large untrawlable shallow areas of the KAP region. Also, the creation of small pilot trawl units should be attempted. In the areas where such development would be indicated, a survry of the exploited resources should be undertaken to enable proper management action at the local level. Considerable emphasis should be put on the strengthening of infrastructure required for these fisheries (IOFC, 1979).

The wide variations in abundance, especially in the case of pelagic stocks, requires further investigations at the regional level. The regional collaboration already existing could usefully continue, with research on migrations and seasonal behaviour of pelagic species and management and conservation of shared stocks.

Shrimp Fisheries

Character

The shrimp fishery has two sectors: the industrial one that first started to exploit shrimp on a large scale, and a more recently developed artisanal one. All vessels are fitted with Gulf of Mexico type double rig trawls, and use flat trawls, semi-balloon and balloon trawls (van Zalinge, 1984). In the artisanal fishery, intensive exploitation of shrimp started around 1970 when stern trawl nets were adapted for use on motorized dhows. According to the latest figures (van Zalinge, 1984), 123 shrimp dhows were counted in Kuwait, about 26 in Bahrain, over a thousand artisanal boats in Iran, 300 on the Gulf coast of Saudi Arabia, 35 in Qatar, 48 in Iraq and between 10 - 25 shrimp dhows in Abu Dhabi. The artisanal shrimp fishing fleet, totalling over a thousand boats, probably has the same affect as a fleet of about 250 industrial trawlers. This exceeds the size of the industrial fleet even at its maximum level in 1969.

Both industrial and artisanal fisheries use very small mesh sizes and double-layered cod ends; these retain substantial amounts of small shrimps which are subsequently discarded (van Zalinge *et al.*, 1981).

The main fishing areas are concentrated in the northern areas. *Penaeus semisulcatus* occurs in both muddy and sandy grounds, whereas in general the other penaeids are limited to specific areas, such as Tarut Bay in Saudi Arabia, Shatt-al-Arab in Kuwait and Bandar Abbas in the Iranian waters (FAO, 1982). However these distributions may vary seasonally.

The richest shrimp resources are found on the Iranian coast, on the Bandar Abbas grounds (Strait of Hormuz) and the more northern grounds of Bushehr-Ras Al Motaf. Other fishing areas are the Kuwait Bay, and grounds off Bubiyan, Rixa, South Failaka and Kubbar (FAO, 1982; van Zalinge et al, 1981). Spawning and nursery grounds of important shrimp species are known to exist all along both the western and eastern coasts, in more or less independent population units. Kuwait Bay is one of the important nursery areas on the west coast (van Zalinge, 1984), and the seaweed beds (*Sargassum*) are reported to be important habitats for juvenile shrimp, mainly *Penaeus semisulcatus*. Similarly, in Tarut Bay,

Saudi Arabia, young stages of that species are dependent on algae and seagrass bed productivity (Basson et al., 1977). These seagrass beds are used as fishing grounds by the dhows, whereas a two-mile inshore exclusion zone has been declared for the industrial fleet. Due to life cycle patterns, availability of shrimp has a seasonal nature, and consequently no or little industrial fishing occurs during the low catch months of May and June (FAO, 1982).

Status

Industrial shrimp fishing started in 1961, and total catches for the area increased rapidly to a peak of 17,200 tonnes in 1967/68. Thereafter the catches declined considerably to about 60% of the peak level in the early 1970's (FAO, 1982). During the latter period, artisanal fisheries were developing, and a peak in landings in 1973/4 was partially caused by an increase in the dhow fishing effort. In the later years the artisanal levels of effort and landing were comparable to those of the industrial sector (van Zalinge, 1984).

In Kuwait, available data suggest that during the last decade the effort has remained fairly stable and this effort produced the highest catch rates obtained from the area (FAO, 1982). However the analysis of catch and effort data is complicated by movements of the Kuwaiti fleet between different fishing grounds, which include both national waters and Saudi Arabia/Bahrain waters. These movements depend on catch rates and species composition in each area (FAO, 1982; van Zalinge et al, 1981).

A workshop on the assessment of the shrimp stocks in the area held in 1981 concluded that there was no apparent evidence of overfishing of the stock fished in the Kuwait area (FAO, 1982). The fluctuations in size of the shrimp stock were thought to be due in part to the imprecision of effort and landing data, and to environmental changes, including human activities around the KAP region.

For the Saudi Arabia/Bahrain/Qatar region, data are mainly available from the major commercial fishing companies. The analysis suggests that the fishery was heavily exploited until 1979, at a catch level of at least 6000 tonnes (FAO, 1982); van Zalinge, 1984). In 1979, Saudi Arabia banned foreign fleets from its territorial waters, which reduced considerably the effort level.

The Iranian situation is difficult to evaluate due to the absence of artisanal fishing data, and to the paucity of information on the commercial effort. The pattern of fluctuations is similar to the one found on the west coast (van Zalinge 1984). Catch rates after the 1980 closed season were higher than in 1978 and 1979, as was the average weight of individual shrimps (FAO, 1981a).

There was a sharp drop in landings of shrimp in the 1978/79 season. In the early season of 1979/80 this was repeated and most of the industrial fisheries became uneconomic and had to cease operations (FAO, 1980, 1981a). For the west coast stocks, the decline was felt as much in the artisanal as in the industrial sector. The decline is thought to have been caused by a recruitment failure. Management measures such as a six month per year closure of the fishery and a ceiling on the number of fishing boats were then recommended. A closed season for shrimp fishing has since been implemented, although the length of time varies between countries (FAO, 1981a, 1982).

A Kuwaiti Shrimp Culture Project was established in the mid-1970's to investigate stock depletion problems and to whether large-scale releasing might be profitable (Farmer, 1981). Experimentation and trial fishing is also under

way to find the optimum mesh sizes appropriate for commercial and for artisanal fisheries (van Zalinge et al, 1981).

Human and economic value

Nearly all the industrial shrimp production in Kuwait is exported (FAO, 1979a). Although information about other countries is scarce, it is probably the case for these as well. However, in Saudi Arabia, considerable quantities of shrimp are used for local comsumption. Shrimp caught by the artisanal fleet are sold fresh to the public, either directly or through the town markets. Industrial shrimping fleets are owned by companies from the countries of the region. Many artisanal shrimp fishermen are subsidised (FAO, 1981a).

Targeted exploitation

Depending on the fishing ground, dominance in the catches alternates between Penaeus semisulcatus and Metapenaeus affinis. From Kubbar southward along the Kuwaiti coast and into Saudi Arabia, shrimp commercial landings always contain more than 90% P. semisulcatus (FAO, 1982, van Zalinge et al, 1981). Metapenaeus affinis inhabits the shallow water areas, notably Kuwait Bay and around Mischen and Bubiyan Islands. (Anon., 1979). In the 1977 Kuwait artisanal landings this last species accounted for 53% of the shrimp portion of the catch, P. semisulcatus, 37%, P. stylifera, 7% and M. stebbingi, 3% (van Zalinge et al, 1981). A peak density of M. affinis occurs in February, followed by a sudden increase of P. semisulcatus in May, peaking in June.

According to the FAO yearbook of fisheries (1983), total shrimp catches were rather stable in the last years before 1981. Catch levels in 1981 were 503 metric tons in Bahrain, 2000 Mt in Iran, 286 Mt in Kuwait, 240 Mt in the United Arab Emirates, and 1650 Mt in Saudi Arabia. In the last years, total catches from industrial and artisanal sectors were approximately equal at least for the countries on the west coast (FAO, 1982).

Commercial sized shrimp species usually account for only a small proportion of the total shrimp trawling catch. Diverse studies report from 9% to 23% of shrimp in hauls from different regions (van Zalinge, 1984). In addition, the nets used by both commercial and artisanal boats retain a substantial amount of shrimps too small to be marketable and which are discarded at sea (van Zalinge et al, 1981). This is especially true for the artisanal boats, which discard non-commercial species such as Melapenaeopsis and Trachypenaeus sp., as well as juveniles of commercial species (van Zalinge, 1984, 1984).

Incidental exploitation

The usual policy, in the industrial as well as the artisanal sector, is to use the maximum of ice and storage space in the boats for the shrimp fraction of the catch, since it is much more valuable. Fin fish landings of the commercial fisheries are extremely low although most of the catch consists of fish. In Kuwait, industrial shrimp trawlers discard about 30,000 t of fish annually (Morgan, 1980). Data available indicate that the by-catch of fish as a proportion of total catch is around 90% in the Bandar Abbas region, 91% in Kuwait waters and 77% in Northern Iran (van Zalinge, 1984). The most important species groups, by weight, of the catch are the majarras (Gerres sp.), ponyfishes (Leiognathidae), tripod fishes (Pseudotriacanthus sp.), goat fishes (Mullidae), sharks and rays, all of which have a low commercial value at present (Gran, 1980). The predominant marketable species from the Iranian coast, accounting for about 10% of the fish by-catch, were thread-fin breams (Nemipterus sp.), lizard fish (Saurida sp.), catfish (Arius thalassinus),

croakers (Otolithes), scads (Decapterus & Selar) and scavengers (Lethrinidae) (van Zalinge, 1984).

Proportions of the fish by-catch in the artisanal shrimp fisheries are not known. The percentage of fish caught that is landed varies depending on the species composition of the catch, being around 10% in summer, and higher in winter. In summer 1978, fish landed by shrimp boats were usually croakers, tongesoles (Cynoglossus), flounders (Pseudorhombus), flatheads (Platycephalus), threadfin breams (Nemipterus), crabs and squids (van Zalinge, 1984).

The oil industry

The "oil industry" section of the chapter on pelagic fisheries applies also to the shrimp fishery.

Shrimps living in enclosed areas are particularly susceptable to high hydrocarbon and heavy metal levels, at different points of their degredation process. Although no data are available on the impact of oil pollution on local shrimp populations, these are probably affected by environmental changes brought about by the oil industry in area.

Sedimentation

In Kuwait Bay, it has been estimated that in recent years human pollution from Kuwait City sewage system supplied a greater share of organic matter than the natural organic production itself (Mohamed and Al-Shamlan, 1977). Kuwait Bay is thought to be a main nursery area for P. semisulcatus (van Zalinge, 1984), and is also a productive fishing area for penaeid shrimps (FAO, 1982), though effects of increased organic matter are not known.

Direct destruction

Land reclamation, filling and dredging is carried out for agricultural and industrial purposes in most countries in the KAP region (van Zalinge, 1984). Shallow water post-larval and juvenile shrimp habitats are particularly affected by those activities. It has been estimated that land reclamation has transformed about 15% of Kuwait's coastline and 35% of Kuwait Bay (van Zalinge, 1984).

Existing management policy

The main existing management policy in the shrimp fishery of all countries of the KAP region is a closed season of variable length; from two and a half months in Iran to five months in Kuwait (FAO, 1981a; van Zalinge, 1984). This period corresponds approximately to the spawning season of the main species. In Saudi Arabia, fishing rights of foreign companies were withdrawn in 1979. In 1977 temporary regulations were formulated in Iran prohibiting shrimp fishing in spawning and nursery areas (van Zalinge, 1984). In the case of Qatar and the United Arab Emirates (UAE), there is presently a five month closed season period; however, the shrimp stocks there are small and might not tolerate the high levels of exploitation associated with an industrialised fishery. In the UAE, there are a few instances in which a form of franchise system operates, either under government charter or through traditional practices (FAO, 1981a). A legislation adopted by Kuwait provides for licencing of all fishing vessels; however, there is no limit on the number of licences, although this has been a proposed management measure.

Many shrimp fishermen are subsidised, a practice that leads to an artificially high fishing effort (FAO, 1981a).

Table 1

Estimates of the general annual production level (tonnes) of major groups of fish in the Inner Gulf and Gulf of Oman (from FAO, 1981a and FAO Yearbook of Fisheries Statistics, 1983)

Country	Small Pelagics	Large Pelagics	Demersals	Total
Bahrain (1983)	600	425	3,400	4,425
Iran (1981)	3,000	6,000	24,000	33,000
Iraq (1981)	100	100	800	10,000
Kuwait (1981)	650	500	3,600	4,750
Oman (1983)	21,500?	40,000?	8,500	70,000
Qatar (1981)	100	500	1,000	1,600
Saudi Arabia (1981)	150	1,000	3,850	5,000
UAE (1983)	12,390	4,100	14,100	54,000
TOTAL	38,490	52,625	59,250	150,365

Priority concerns

The main problem of the shrimp fishery here is the need to formulate a management policy that will be applied by all countries of this region (FAO, 1979a). It is also important that more research should be done, especially on stock identification, population dynamics and on the effects of land reclamation on nursery areas (van Zalinge, 1984). This will imply acceleration or creation of research training programmes. Another important objective is the improvement of the utilization of the by-catch of the shrimp fisheries, presently almost unutilized. However, there has also been some real concern with the drop in catch and recruitment. This could be due to recruitment over-fishing or to damage to the nursery grounds or it may be a natural cycle.

Priority recommendations

More intensive collaboration is needed from all countries in the region to formulate a unified management policy for protection of the shrimp resources. This also includes improving the exchange of scientific information throughout the region.

Research on shrimp dynamics, especially the use of seagrass beds and other shallow nursery habitats, could be integrated with studies on the conservation of these habitats.

An effort should be made to develop techniques to utilise the large discarded by-catch. Information about by-catch separating devices developed for trawl nets should be made available and the technique tested in the region.

Other Crustaceans

Targeted exploitation

In Oman, spiny lobsters (Panulirus homarus) are found in inshore waters; they are abundant on the Dhofar coast and around Masirah Island (World Fishing, September 1977). In 1976 10,772 lobsters were sold to an RAF base. The present catch level is not available. There is a ministerial decree to forbid fishing of lobster during the hatching period and the early stages of growth. Fishing of egg-bearing females is forbidden.

In Bahrain there is a substantial fishery for crabs (123 MT in 1981) and catches of slipper lobsters (Scyllaridae) are also reported (7MT in 1981) (FAO Yearbook, 1983).

For all countries, mud and slipper lobsters (Thenus orientalis) are caught as a by-catch of the shrimp fishing industry. However, catch and utilization levels of these species are not available.

Priority concerns

Lobster populations are particularly vulnerable to intense exploitation. Data on catch and effort levels for this resource are needed for an assessment of its present status.

Priority recommendations

In each country concerned, a programme for gathering catch statistics could be set up or extended, covering shallow water species collected by small-scale fishermen, and the lobster by-catch of the shrimp trawling fishery.

Marine Mammals

Character

The marine mammal fauna of the KAP region has not been studied in great detail. Presumably many of the same species occur in this area as are found in the warmer waters of the Indian Ocean in general.

Baleen whales are known on occasion to have become stranded on beaches or in shallow bays in the area (Basson et al., 1977). Positive records include Bryde's whale (Belaenoptera edeni) and the Humpback whale (Megaptera novaeanglia)(see Brown, 1980). Yukov's (1969) record of blue whales in the Gulf of Aden suggests the possibility of their occurrence in the KAP region also.

Townsend's (1935) whaling maps indicate the presence of a significant sperm whaling ground in the Arabian Sea, south of Oman and presumably sperm whales still occur in this region, which is highly productive.

The distribution of many of the smaller cetaceans is less well known, as there have never been any large scale fisheries for them. Longman's beaked whale, Blainville's, the Gingko-toothed and Cuvier's beaked whales might all be expected in the Arabian Sea, but are less likely in the shallower waters of the KAP region. Of the dolphins and porpoises, there are records of Tursiops truncatus (=aduncus), the bottlenose dolphin, and Sousa chinensis, the Indo-Pacific humpbacked dolphin, from this area (Al-Robaae, 1974).

Pygmy and dwarf sperm whales (Kogia spp.), rough toothed dolphins (Steno bredanensis), melonheaded whales, (Peponocephala electra), false killer whales (Pseudorca crassidens), Pygmy killer whales (Feresa attenuata), killer whales (Orcinus orca) short finned pilot whales (Globicephala macrorhynchus) and Fraser's dolphin (Lagenodelphis hosei) might all be expected to occur at least in small numbers in the Arabian Sea if not in the Inner Gulf.

More numerous species which might also be expected include Risso's dolphin (Grampus griseus), spotted, striped and spinner dolphins (Stenella attenuata) S. coeruleoalba, S. longirostris) and common dolphins (Delphinus delphis). The finless porpoise (Neophocaena phocaenoides) may also extend its range from the coastal waters of Pakistan into this area.

Finally, the Dugong (Dugong dugon) is present in reduced numbers throughout this area, in shallow coastal waters.

Status

Nothing is known of the status of any of the cetaceans in this area. There has been little exploitation, except for sperm whales in the last century, so that there should be no cause for concern. The baleen whales in this area may well be part of the same stocks which have been decimated in the Antarctic, but stock migrations are poorly understood, so that the status of the baleen whales in the northern Indian Ocean is unknown. After the Nowruz oil spill significant numbers of dolphins and dugongs were washed up in Saudi Arabia, and this may well have resulted in a decline in local populations

The dugong is classified as vulnerable, and here in the western part of its range, this is particularly the case. The numbers of dugongs are unknown, but thought to be declining. In eastern Bahrain there may be a population of 70-100 (Vousden, 1985), and in the UAE fishermen report that dugongs have become rare (Price, 1982a).

Human and economic value

Marine mammals probably have minimal economic value in this region. Sousa chinensis is reportedly taken in small numbers for human consumption, (NCC, 1980) and this may presumably also be the case for Tursiops.In Kuwait, dolphin oil is also reported to have been used for waterproofing the decks and hulls of "dhows" (Bruyns, 1960) but whether this practice continues is unknown.

Targeted exploitation

Beyond the small numbers of dolphins reportedly taken for human consumption and for treating boat timbers, there are no indications that marine mammals are actively sought. Even these uses are more likely to be supplied by incidental catches.

Incidental exploitation

There is at least one record of Sousa chinensis having been taken in a fishing net (Al-Robaae, 1970). It seems reasonable that here, as elsewhere in the world gill nets, and other nets, take small cetaceans. However the extent of this is entirely unknown. Dugongs are likely to be caught far more often as they are relatively slow moving and are generally confined to shallow water areas such as seagrass beds.

The oil industry

There is no information on the effects of the oil industry on cetaceans. Oil spills and tar may have had an adverse effect on the dugong population, but this has not been quantified. Following the recent Nowruz oil spill significant numbers of dolphins and dugongs have been reported dead, but the exact cause of these deaths remain unknown. This latest incidence of dugong mortality may have had a major impact on the Gulf population.

Sedimentation

The effects of sedimentation on the dugong populations are likely to be apparent only where seagrass beds are affected.

Existing management policy

The International Whaling Commission (IWC) has designated the Indian Ocean as a whale sanctuary, which is supposed to prohibit all commercial exploitation of cetaceans. Of the coastal states in this area, only Oman is a member of the IWC. There are not known to be any specific management or conservation policies concerning marine mammals in any of the other countries.

In Iran there are several nature reserves, which include coastal areas/islands including the Hara National Park, where there is total legal protection for the marine fauna, including porpoises.

Existing management practice

As most of the population in the area is Muslim, it may be presumed that religious prohibitions on the consumption of marine mammals has some effect on limiting the numbers which are eaten. However, this may not have any effect at all on the numbers which are taken in fishing nets.

Priority concerns

As in other regions, the dugong is probably the most vulnerable marine mammal species, and it is clear that, with increasing coastal development, dugong protection must be the priority concern for this region. Not enough is known about the cetaceans for any other concerns to be formulated.

Priority recommendations

Clearly, the establishment of dugong reserves, or areas of undisturbed seagrass habitat away from oil and other industrial installations should be of high priority. As so little is known about the status of other marine mammal, surveys to determine the size of theior populations would also be useful.

Turtles

Character

Two species of turtle occur frequently in the Inner Gulf. The green turtle (Chelonia mydas) is the most common whereas the hawksbill (Eretmochelys imbricata), which is smaller in size, is less abundant (see Basson et al., 1977; Ross & Barwani, 1981). Loggerheads (Caretta caretta) and leathery turtles (Dermochelys coriacea) also occur. In addition to the above species, olive .pa

Olive ridley turtles (Lepidochelys olivacea) are found in Oman. More detailed accounts are available in the literature (Basson et al., 1977; Ross & Barwani, 1981).

Occurrence and extent

The Inner Gulf and Gulf of Oman represent extensive feeding grounds for green turtles, which feed directly on seagrass. Large nesting grounds occur at Karan and Jana islands (Saudi Arabia; >3,000 females annually) and Ras al Hadd (Oman; 6,000 females annually). Hawksbill generally occur in smaller numbers, though major rookeries are found on Hormuz, Shedvar and Lavan islands (Iran) and also Masirah island (Oman); these populations are very important in a world perspective. In addition, single or small nesting groups often occur. Loggerheads are not common except at Masirah island, where an estimated 30,000 females nest annually; this is by far the largest single nesting site for the species in the world. Olive ridley turtles favour areas with mangroves and low salinity and, consequently, their distribution may be limited. However, small numbers (150 females annually) nest on Masirah.

Conservational status

According to the Red Data Book (IUCN, 1975), turtles occurring within the KAP region have conservational status as follows: Green turtle - threatened; Hawksbill - threatened; Leatherback - threatened; Loggerhead - vulnerable; Olive Ridley - threatened. According to Ross & Barwani (1981), turtle populations of all species within the KAP region are threatened by increasing subsistence exploitation and general coastal development.

Human and economic value

Turtles within the KAP region represent a biological resource of considerable biological, scientific and economic significance. Many turtle populations in the area remain large, partly because most people in the region are muslims with religious prohibitions against eating turtle meat. However, in certain localities a certain amount of turtle consumption is found. Throughout the region, turtle eggs are frequently taken for subsistence use.

Targeted exploitation

Throughout this region, coastal people are said to take eggs at a subsistence level. This refers mainly to the Green and Hawksbill turtles. However, at Masirah, Loggerhead turtle eggs are also taken, though only a small proportion of them. In Saudi Arabia turtle nesting on the mainland is thought to be discouraged by nest predation by people, and in Iran, people are also known to take turtle eggs. In the Iranian Islands of Sheedvar and Lavan both Green and Hawksbill turtles are harvested for their shells, and in neighbouring Larak, and possibly throughout the region, Leatherback turtles are rendered to oil for boat timbers when they are found (Ross & Barwani, 1981; Frazier, 1981).

In some areas, muslim prohibitions seem to have been eroded, and turtle meat is eaten. In Qatar, green turtles have been seen in the market; it is estimated that no more than a few hundred are taken annually. In Oman, there is some exploitation of green turtles at Ras el Hadd, where about a hundred a year may be exported to the neighbouring United Arab Emirates. Hawksbills and their eggs are also said to be eaten whenever they are found.

At Masirah, which is probably the most important nesting area in this region, the killing of nesting turtles is prohibited. However, at least 1000 green turtles are caught in the feeding grounds, and eaten in Masirah and the villages of the south coast of Oman (Ross & Barwani, 1981; Frazier, 1981).

Incidental exploitation

There are no statistics available on incidental turtle captures, except the one record from Kuwait which states that in three years only one green turtle was caught by fishery research vessels (Ross & Barwani, 1981). Turtles are known to be caught in large pen nets for pelagic fish, as well as in shrimp trawls. However, the numbers killed in this way may be small, although it has not been quantified, and in Qatar, most such catches are said to be returned to the sea alive.

The oil industry

Heavy oil is a serious threat to turtles in the region: swimming turtles can become directly coated, or their major food source (e.g. seagrass) can become coated or contaminated. Heavily oiled beaches (see TMRU, 1982) can also impede the movements of young and nesting female turtles. Following the recent (1983) Nowruz oil spill at least two significant turtle rookeries Karan and Jurayd islands were reported to have become oiled (see Price, 1983).

Direct and habitat destruction

Seagrass beds along the western coast of the Inner Gulf represent major feeding grounds for turtles, particularly the Green turtle. Habitat destruction in these areas by coastal infilling and dredging is now extensive, and will inevitably put additional pressure on the remaining feeding grounds.

Recreation and tourism

Local residents of the KAP countries increasingly visit offshore islands for recreational purposes. Unless controlled, this will probably lead to additional disturbance of nesting female turtles.

Other impacts

Driftwood and refuse on nesting beaches form a potential barricade to newly hatched turtles and also to the nesting females (TMRU, 1982). Human activity in general also tends to disturb breeding females. In addition to the natural predators of baby turtles (e.g. birds, crabs, foxes, dogs), significant numbers are lost to house mice (Mus musculus) which were probably introduced onto islands by local fishing boats. On Masirah island, c. 40 % of loggerhead eggs are washed into the sea (Ross & Barwani, 1981).

Existing management policy and practice

Sheedvar island is a major turtle rookery in Iran, though beaches along the Iranian coast are not protected from turtle exploitation. It is expected that the six offshore islands in Saudi Arabia will shortly become marine protectorates, in which case breeding turtles and other marine life will become directly protected. In Oman, killing of nesting turtles on Masirah has been banned, and there are proposal for protecting nesting beaches in national parks or marine reserves. In Bahrain and Qatar, there are no regulations on turtle exploitation, while in Kuwait, Iraq and UAE turtles are either uncommon or their status is unknown (Ross & Barwani, 1981).

Recent and current conservation projects

Several studies have provided information on turtles in the region, including those of Basson et al.(1977) in Saudi Arabia, and WWF/IUCN supported projects carried out by Ross & Barwani (1981) in the KAP region as a whole.

Priority concerns

Uncontrolled exploitation of adults, young and eggs, as well as disturbance of nesting females, are the main concerns. Increasing dredging within coastal seagrass areas (i.e. turtle feeding grounds) is also a serious problem. Additional trawling activity may well also increase turtle mortality significantly.

Priority recommendations

Active steps need to be taken to control the above-mentioned factors. Establishment of additional protected areas would help protect nesting females. Educational programmes showing the benefits of conserving turtle populations should also be included in school and college curricula.

Birds

Character

Coastal environments within the KAP region support a large variety of sea- and shore birds. Altogether more than 350 species of birds occur in these States (Jennings, 1981). These include residents, migrants, and winter visitors, and a number of islands are particularly significant nesting sites. An extensive review of breeding seabirds in the region is given by Gallagher et al. (1984) from which much of the information below was extracted.

Occurrence and extent

Of the shore birds are many species which visit the shores in winter such as ducks and herons, flamingoes, plovers, snipe and curlew; several of these remain throughout the year and some actually breed. Coastal birds include winter visitors such as ducks and grebes, as well as permanent residents and/or breeders such as cormorants, gulls and terns. Favoured sites for nesting are islands and shifting sand bars within shallow coastal embayments. Breeding birds are particularly susceptable to disturbance, and knowledge of the species and breeding sites is therefore of considerable conservational significance. A list of seabird species breeding in the KAP region are given below together with notes on their breeding sites.

1. Jouanin's Petrel (Bulweria fallax): ? upwelling areas of Oman; endemic to NW Indian Ocean.

2. Audoubon's Shearwater (Puffinus lherminieri persicus): Al Hallaniyah, Kuria Muria group (Oman).

3. Red-billed tropicbird (Phaeton aethereus indicus): Halul island eastwards in around Oman including Kuria Muria group; race endemic to Arabian peninsula area.

4. Masked Booby (Sula dactylactra melanops): Kuria Muria group (Oman); race endemic to Western Indian Ocean.

5. Socotra Cormorant (Phalacrocorax nigrogularis): several localities, e.g. al-Uqayr bay (Saudi Arabia), and particularly in Zirkuh island (UAE) and also in Kuria Muria group (Oman); endemic to region & Gulf of Aden. This is a candidate for future Red Data Book treatment (see Collar & Stuart, 1985: Appendix D).

6. Sooty Gull (Larus hemprichii): From Qarnayn island (UAE) east to Astola and several localities in Oman; endemic to NW Indian Ocean.

7. Caspian Tern (Sterna caspia): On islands, sometimes in marshes of islands.

8. Greater Crested Tern (Sterna bergii velox): Islands of Inner Gulf and southern Oman.

9. Lesser Crested Tern (Sterna bengalensis): In small numbers on islands in Inner Gulf.

10. Roseate Tern (Sterna dougallii): Some islands of Oman.

11. Common Tern (Sterna hirundo hirundo): Wetlands of Iran south to marshes in northern region, and probably nested at Kubbar is. (Kuwait).

12. White Cheeked Tern (Sterna repressa): Many islands and sand bars of Inner Gulf and several localities around Oman.

13. Bridled Tern (Sterna anaethetus): Commonly on islands of Inner Gulf and off eastern and southern Arabia.

14. Sooty Tern (Sterna fuscata): Uncommonly in Oman, at ?2 localities.

15. Saunder's Little Tern (Sterna saundersi): Some islands and coasts off Iran, eastern Saudi Arabia, Bahrain and Howar islands, and Masirah and west of Ras al Madrakha (Oman).

16. Little Tern (Sterna albifrons): Inland wetlands and delta marshes (Iran), but not observed to nest on coast of Inner Gulf.

17. Brown Noddy (Anous stolidus plumbeigularis): Several localities in Oman including Kuria Muria group.

Various other bird species sometimes also occur in large colonies in the KAP region, or are noteworthy for other reasons. For example, the sooty falcon (Falcon concolor) has major colonies on islands in the Inner Gulf, and is known to breed in areas such as the Hawar Islands (Hill & Webb, 1983). The crab plover (Dromes ardeola) has major colonies on the Iranian coast, one on Masirah Island (Oman) and is also a common winter visitor to Kuwait. Other colonies possibly occur in Iraq. Otherwise it is known to breed only in the Red Sea region, so this is a very important species.

The red-necked phalarope (Phalaropus lobatus) is also important. The species has a major wintering area at sea off the southeast coast of the Arabian peninsula. A new race and extremely isolated (most westerly) population (? c.

20 individuals) of the collared kingfisher (Halcyon chlorus halbaensis) is restricted to mangroves at Khor Kalba, on the east coast of the UAE. Further details of these birds are available in the literature (Cramp & Simmons, 1980, 1983; Jennings, 1981).

Conservational status

Variable, though there is a fundamental threat to (particularly breeding) seabirds from industrial and other human activities. Several of the species are endemic to the region and therefore of special conservational significance.

Human and economic value

Eggs of seabirds were an important addition to the diet of Arab fishermen and coastal people. Nowadays, eggs, chicks and adults of various seabirds are taken, sometimes in great quantities (see Gallagher et al., 1984). Falcons (e.g. peregrines) are of great cultural and economic value and are sometimes trapped and used for falconry.

Targeted exploitation

There are no reports of sea bird exploitation.

Incidental exploitation

Although some birds may become entangled in fishing gear, particularly the diving birds, there is no documentation of this.

The oil industry

A major threat to seabirds comes from oil spillages, particularly from offshore oil operations. Many species (e.g. ducks, grebes, cormorants & flamingoes) are particularly vulnerable since they use the water-air interface. Birds that come into contact with oil often die, though quite successful cleaning methods are now available. Approximately 1000 birds, mostly Socotra cormorants and also some white-cheeked terns, were killed on NE Bahrain following a spill of c. 20,000 barrels of light crude. There have been other similar unfortunate incidents (see Gallagher et al., 1984).

Waste discharge

Elevated concentrations of toxic heavy metals are now being recorded here, and are likely to enter food chains and contaminate birds; a PCB problem can apparently also be expected (Burchard, 1983). Shortly after the Nowruz oil spill large numbers of dead birds and other animals were found washed up on beaches. The deaths may have been due to toxicants related or unrelated to the spill (see Price, 1983).

Direct and habitat destruction

This occurs mostly as a result of coastal infilling and industrial development. In addition to destruction/disturbance of breeding sites, impact on critical marine habitats such as seagrass beds and coral reefs may lead to a reduction of food supply (e.g. fish stocks) of various bird species. Breeding grounds of the following seabirds have been or are likely to be affected by encroachment of human settlements: Al Arabiyah - Socotra Cormorant, L. Cr. Tern; Halul - Socotra Cormorant, L. Cr. Tern, W. Ch. Tern, Bridled Tern; Zarka - Socotra Cormorant. Further details are given by Gallagher et al. (1984).

Recreation and tourism

Increasing visits to the mainland and islands are likely to disturb bird breeding. In some areas, seabirds are harassed deliberately as a sport.

Other impacts

Nesting seabirds are preyed upon by humans, other birds (e.g. herring gulls) and various other animals (e.g. cats, goats & rats). Helicopters and hovercraft, used principally by coastguards, customs and police, can also disturb nesting colonies.

Existing management policy and practice

This is considered in detail by Gallagher et al. (1984) and should be consulted. In Iran, five of the protected reserves include sections of the Gulf and provides protection to seabirds. However, egg collecting still continues in certain areas. In Kuwait, the proposed National Park covers 300 km2 including parts of Kuwait Bay, an important bird feeding and nesting area. In Saudi Arabia, the expected moratorium on further coastal infilling, and the creation of the offshore islands as marine protectorates would also afford some protection to breeding birds and other marine life. In Bahrain, the south of the main island and the Howar Islands are out of bounds to most people, and this of course greatly reduces human disturbance. In Qatar, attempts are being made to control wild-life shooting.

In Oman three localities used by seabirds have been granted protected area status: Khawr-Salalah bird sanctuary in Dhofar; Sultan Qaboos Public Park & Nature Reserve at Qum, near Muscat; Khor Kashmir Bird Sanctuary near Sohar. Plans for establishing additional protected areas are also in progress (Gallagher et al., 1984).

Recent and current conservation projects

A number of projects have been undertaken and include studies by Hill & Webb (1981) and Bahrain Natural History Society [Bahrain]; Basson al al. (1977) [Saudi Arabia]; Qatar Natural History Society, Centre for Science & Applied Research and University of Qatar [Qatar]; Gallagher & Woodcock (1980) [Oman]. The general overviews by Jennings et al., (1981) and Gallagher et al., (1984) are particularly informative.

Priority concerns

The main concerns are disturbance of breeding birds, particularly as a result of encroachment of nesting sites by industrial activities. Oiling and possible contamination by heavy metals, PCB's and other pollutants passing through the food chains also represent major environmental problems.

Priority recommendations

Efforts to minimise the above should be of highest priority, together with establishment of additional protected areas. Much more information on seabirds in the region is needed, particularly the ecology of certain species (e.g. Socotra Cormorant, boobies & various terns). Environmental awareness programmes would also be of great benefit.

Other Resource Species

In addition to resources currently exploited in the KAP region, there are species such as certain shrimp (e.g. P. latisulcatus) which may become more important in future years (see Price, 1982a). Similarly, various holothurians occur in the region including Stichopus variegatus and Holothuria atra ,which are not currently utilised locally but in other parts of the world are recognised as important food species. In addition, a great variety of marine species throughout the world are now becoming important on account of the useful natural products they contain.

Targeted exploitation

The exploitation of resources other than fish and crustaceans in this region is very limited. There has been a joint venture fishery between Japan and Oman off the coast of Oman for cuttlefish, but this did not last for long, possibly due to low catch rates.

CONCLUSIONS AND RECOMMENDATIONS

Priority Concerns

The massive industrial development programmes in the KAP region are bringing increased pressure on coastal and marine resources. The most serious environmental problems are highlighted below. These have also been considered in detail in earlier reports (e.g. Baker & Dicks, 1982; Price, 1982a; TMRU, 1982; Price et al.,1983) which can be consulted.

1. Coastal infilling. Mangroves and associated intertidal flats represent critical marine habitats, but are currently becoming degraded and destroyed by coastal infilling and other human activities. Once reclaimed, the habitat loses its former high biological productivity and becomes virtually barren. Coastal infilling also extends to the shallow sublittoral, and has already degraded extensive areas of seagrass which represents another critical habitat. Activities associated with construction of the recent Saudi-Bahrain causeway highlight these concerns. Continued habitat degradation and destruction is likely to lead to significant loss of the natural resources (e.g. shrimp- & fin-fisheries) reliant on these habitats.

2. Dredging and sedimentation. Extensive dredging along the coast has greatly increased sedimentation. The primary effects are direct smothering or clogging of organisms such as corals and seagrass. Serious damage, or even complete loss, of these habitats has now been observed in many areas, but is particularly well documented for Bahrain. Sedimentation also increases the water turbidity, which in turn impairs photosynthesis and hence productivity of seagrass, reef corals' symbiotic zooxanthellae and other marine plants.

3. Oil pollution and industrial effluents. In a region so heavily committed to the extraction and production of crude oil, accidental spillages are probably inevitable. Beach oil and floating oil are frequently encountered, and oiling of coral reefs has also occurred. However, the ecological consequences of oil spills have seldom been determined locally. High concentrations of heavy metals are also being recorded in biota and sediments, particularly in areas where effluents are discharged. The environmental consequences which have been observed in other parts of the world can probably be expected in the KAP region.

4. Recreational activities. An increasing number of residents are now visiting offshore islands in the region, principally to dive on the reefs and to enjoy a relatively undisturbed tropical island. Unless controlled, recreational visits are likely to disturb turtles and birds nesting on the islands and impair their breeding. Reef deterioration may also result from increasing pressure from diving.

Recommendations for Action

1. An immediate moratorium be imposed on current coastal infilling over intertidal flats and mangroves. The moratorium should also cover any future coastal infilling plans (e.g. for the extensive tidal bay systems of Musharrihah & Musallamiyah north of Abu Ali in Saudi Arabia). Creation of new National Parks, Marine Reserves and other protected areas is expected and that should provide further protection of habitat and species. Coastal zone management schemes should also be encouraged and adopted.

2. Legislation to prevent widespread pollution should continue to be developed through existing schemes (e.g. KAP) and actually enforced. The enclosed position of the area makes this more important than for oceanic areas.

3. Dredging needs to be severely curtailed, particularly around seagrass beds and coral reefs, and all operations should comply with standards set to minimise environmental damage.

4. Regular appraisal of fisheries (i.e. shrimp & fish), and enforcement of fishery regulations when necessary.

5. Other species of commercial, scientific or cultural interest (e.g. pearl oysters, turtles, whale sharks, dugongs) should also be appraised and protected if necessary. These represent a major element of the KAP's genetic resource base.

Project Proposals

1. Patch reefs, seagrass beds and intertidal flats/mangroves should be regularly mapped to estimate damage and recession.

2. Detailed monitoring sites need to be established in several KAP countries, to assess the increasing problem of sedimentation. In a number of countries (e.g. Bahrain, Oman), such studies have already been initiated, and a variety of other parameters are also monitored. Of special importance is the continued monitoring around the Saudi-Bahrain causeway and various industrial complexes, together with surveys at coastal and offshore control sites.

3. An inventory of rare, endemic, threatened and vulnerable species of marine flora and fauna should be established, and the status of the species should be monitored and reappraised regularly. For example, knowledge of the apparently important turtle populations in Iran is based largely on surveys over a decade old.. The status of species taken for ornamental purposes (e.g. corals, shells) should be similarly monitored.

4. Environmental education and encouragement of measures to minimise degradation of marine ecosystems throughout the region is needed.

5. Oceanographic and marine biological data from all the countries in the area should continue to be integrated by ROPME/KAP and other regional organisations, to consider the overall integrity of the ecosystem. Since natural resources frequently cross national boundaries, conservation needs to be a joint venture between all the KAP countries.

APPENDIX

Dugong Survey

Main interested areas: Red Sea; Kuwait Action Plan (KAP) region;
Other interested areas: Eastern Africa;

Background

The dugong is a vulnerable species, and has become very rare over all of its range outside eastern Indonesia, Papua New Guinea and northern Australia. It is difficult to determine appropriate management measures because of the very poor information on how many dugongs are left, and where the main concentrations are.

The Project

The survey would be carried out in selected areas, using a small aircraft flying according to a carefully designed grid, using standard wild-life censusing procedures. The two main priority areas will be parts of the Red Sea, because this is believed to contain the largest population of surviving dugongs outside its eastern stronghold, and the KAP region, because the stock here may have been severely affected by recent oil spills. The possibility also exists of carrying out similar surveys in other regions.

Staff and Other Costs

Hire of aircraft/helcicopter (including pilot) - 2 months
1 senior scientist - 2 months
1 observer/research assistant - 2 months.

Output

Maps showing the distribution of dugongs, and estimates of the total numbers in the survey area.

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