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THE EMIRATES
A NATURAL HISTORY

- MAMMALS • BIRDS • MARINE LIFE
- REPTILES • AMPHIBIANS • INSECTS
- GEOLOGY • FOSSILS • HABITATS
- LIFE ON THE SEASHORE
- PLANTS • CONSERVATION

WILDLIFE OF THE UNITED ARAB EMIRATES

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THE EMIRATES – A NATURAL HISTORY

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The Environment Agency – Abu Dhabi is a government agency that was established in 1996 with the objective of protecting and conserving the environment as well as promoting sustainable development in the Emirate of Abu Dhabi.

The Agency's mission is to assist the Abu Dhabi Government in the conservation and management of the Emirate's natural environment, resources, wildlife and biological diversity through scientific research, proactive planning and co-ordination, environmental awareness promotion, policy formulation and enforcement that balances sustainable economic development with protection of the environment for this and future generations.

The Agency's vision is to become the Emirate's primary centre for information, co-ordinated scientific research and application, and policy guidance and enforcement regarding conservation and management of the Emirate's natural environment, resources, wildlife, and biological diversity. Also, to earn consideration by its government, private and public clients, stakeholders, and the international community as the Emirate's single credible, performance-oriented, innovative, and reliable resource in this regard.

Mubadala Development Company was established in 2002 through Emiri Decree as a wholly-owned investment vehicle of the Government of the Emirate of Abu Dhabi.

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The Bank offers financial services to three major groups.

Corporate Banking provides financial solutions to institutions and corporations through a highly qualified team of experts, focusing on customized services through its Relationship Managers.

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Dolphin Energy Limited is delighted to be a sponsor and supporter of this beautiful new study on the unusual flora, fauna and geology of the United Arab Emirates.

An unparalleled group of experts from all over the world, as well as UAE-based scholars, has been responsible for the research, study and editorial preparation that have gone into this work. It presents both a review of current knowledge – and a guide to what needs to be done in reviving and conserving the fragile ecosystem of the nation.

Dolphin Energy's major strategic initiative, the Dolphin Gas Project, involves the production and processing of natural gas from Qatar's North Field, and transportation of the dry gas by subsea pipeline across joint UAE-Qatari waters to the UAE and the Sultanate of Oman, beginning in late 2006.

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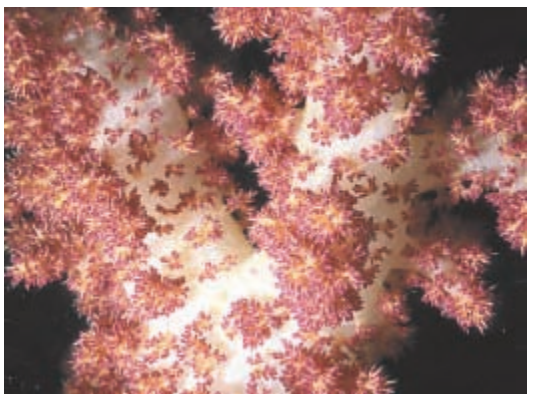

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MARINE FISH

Biogeographically, the waters of the United Arab Emirates belong to the Western Indian Ocean faunal province. Numerous factors govern the abundance and distribution of fish and marine species in the waters of the UAE. Perhaps the most important of these is the contrast between the two main water masses lapping the country. The relatively shallow (average depth 35 metres) and nearly enclosed Arabian Gulf is characterised by a stressful environment of high salinity (more than 40 parts per thousand (ppt), in summer), high summer temperatures, exceeding 35˚C at its peak, and wide temperature fluctuations between seasons. On the other hand, waters of the Gulf of Oman, which bathe the East Coast of the UAE, exhibit more oceanic properties with much lower salinity levels (around 37 ppt) and a more equable temperature regime.

Fish exhibit a strong tendency to inhabit certain habitats, thereby allowing categorisation of fish fauna by habitats. Furthermore, grouping fish in this way permits observers to appreciate the similarities and differences of the different species. The fish and marine fauna of the UAE may be broadly divided into two main categories: demersal, or bottom-dwelling, and pelagic species, 'off' the bottom. These two categories may be further subdivided into shallow, coastal and deep-water or oceanic species. Among the demersals, an additional category of coral reef species may also be added.

SHALLOW DEMERSAL

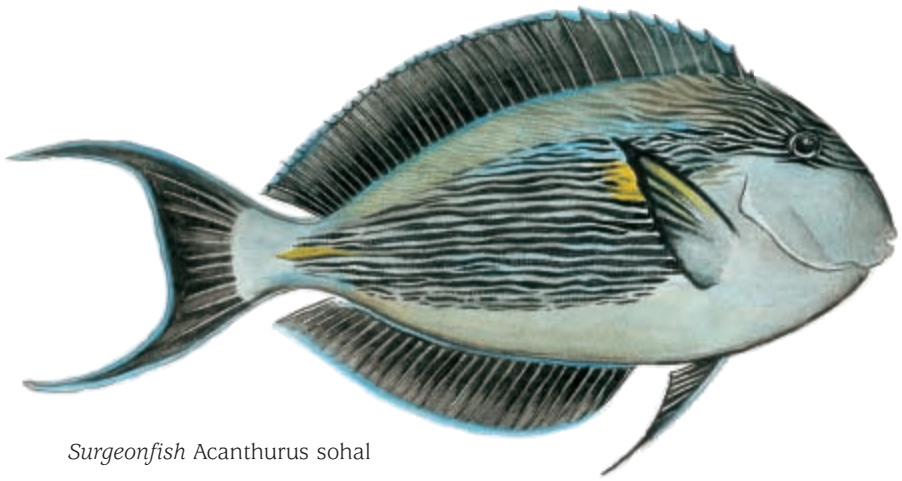
This category covers bottom-dwelling fish found in shallow water, less than 20 metres deep. The mojarras/silver-biddies (Gerreidae) are an important family of local shallow-water species, found on sandy and rocky bottoms as well as in lagoons, at depths of between 10 to 20 metres. They may, however, be encountered in waters as deep as 50 metres. Other significant shallow-water demersal species include the eel catfish (Plotosidae), sawfish (Pristidae), pipefish and seahorses (Syngnathidae), cornet fish (Fistulariidae), terapons (Teraponidae), sillagos (Sillaginidae), goatfish (Mullidae), sicklefish (Drepanidae) and batfish (Ephippidae).

Fish found at similar depths, but more restricted to coral reefs, include at least one member of the requiem sharks (Carcharhinidae), the blacktip reef shark *Carcharhinus melanopterus*, angelfish (Pomacanthidae), butterfly fish (Chaetodontidae), cardinal fish (Apogonidae), fusiliers (Caesionidae), damselfish (Pomacentridae), wrasses and tuskfish (Labridae), parrotfish (Scaridae), blennies (Blennidae), gobies (Gobiidae) and surgeonfish (Acanthuridae).

The shallow benthic habitat, especially when associated with seagrass beds, lagoons and mangroves, serves as an important nursery ground and shelter for many species, including those normally found further offshore, such as a number of rays and skates, snappers (Lutjanidae), grunts (Haemulidae), emperors (Lethrinidae) and seabream (Sparidae).

Seven species have been reported from shallow marine environments adjacent to sabkha-related habitats. These are the Sind sardinella *Sardinella sindensis*, the Arabian pupfish *Lebias dispar*, the kingsoldier bream *Argyrops spinifer*, the orange-spotted grouper *Epinephelus coioides*, the jarbua terapon *Terapon jarbua*, the common silver-biddy *Gerres oyena* and greenback mullet *Liza subviridis*. No fish are found exclusively in sabkha habitats. Species composition there depends on colonisation by marine species from the adjacent sea. These can therefore be classified ecologically as transients represented by tidal and seasonal visitors, or residents represented by true and partial residents (Zajonz *et al.* 2002).

BACKGROUND PHOTO: *A school of trevally* Carangoides bajad
BELOW: *Parrotfish (Scaridae) are among the species found in shallow water in the vicinity of coral reefs,*



Surgeonfish Acanthurus sohal

Indo-Pacific sergeant Abudefduf vaigiensis

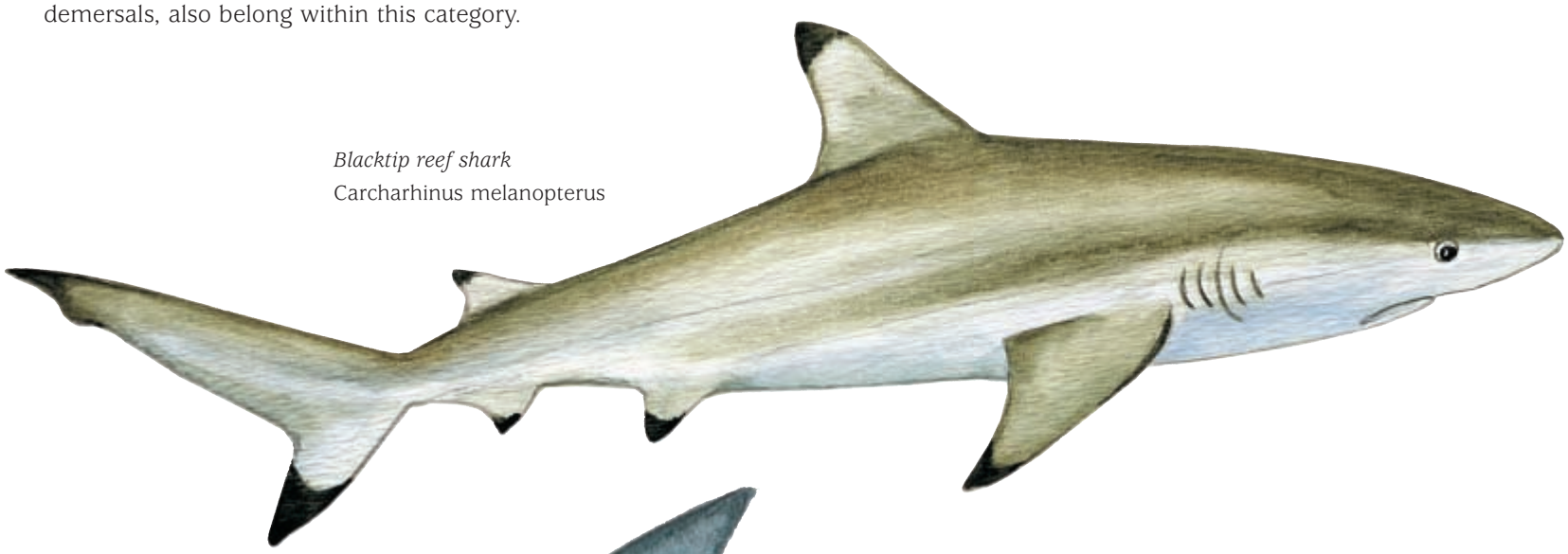
Orange-spotted grouper Epinephelus coioides

ABOVE: *Batfish* Platax orbicularis
ABOVE RIGHT: Gerres filamentosus
RIGHT: Terapon jarbua

SHALLOW PELAGIC

Among shallow pelagic species are ilishas (Pristigasteridae) and silversides (Atherinidae), which often frequent coastal lagoons. A number of species belonging to the hammerhead shark family (Sphyrnidae) can be added to this group: the winghead shark *Eusphyra blochii*, the great hammerhead *Sphyrna mokarran*, the smooth hammerhead *S. zygaena,* and juveniles of the scalloped hammerhead *S. lewini*. Again, the blacktip reef shark is included here. Mullet (Mugilidae) which spend some time at the bottom, although usually categorised as demersals, also belong within this category.

Blacktip reef shark
Carcharhinus melanopterus



Silverside (Atherinidae)

Greenback mullet Liza subviridis

Winghead shark Eusphyra blochii

ILLUSTRATIONS NOT TO SCALE

COASTAL DEMERSAL

The habitat of coastal demersal species extends from the nearshore from depths of around 20 down to 100 metres. In this category are a number of shark species, including the bamboo shark (Hemiscylliidae), the zebra shark *Segostoma varium*, the Arabian smoothhound *Mustelus mosis*, the bramble shark *Echinorhinus brucus*, the bull shark *Carcharhinus leucas* and some ray species including the electric ray (Torpedinidae), guitarfish (Rhinobatidae), the stingray (Dasyatidae) and the longtail butterfly ray *Gymnura poecilura*. Also included are the sea catfish (Ariidae), groupers (Serranidae), snappers, grunts, sea bream, emperors, threadfin breams (Nemipteridae) and rabbitfish (Siganidae). Some of the species in this group are among the most important commercial species throughout the region.

Silver grunt Pomadasys argenteus

Spangled emperor Lethrinus nebulosus

Zebra shark Segostoma varium

Bramble shark Echinorhinus brucus

Arabian smoothhound Mustelus mosis

COASTAL PELAGIC

Coastal pelagic species include some sharks, such as the nurse shark (Ginglymostomatidae) and the whale shark *Rhincodon typus*, and some members of the requiem shark family. Other species in this category include members of the order Elopiformes, such as tenpounders (Elopidae) and tarpons (Megalopidae), most of the members of the sardine, sardinella and shad family (Clupeidae), anchovies (Engraulidae), milkfish (Chanidae), cobias *Rachycentron canadum*, and most of the members of the jack/trevally family (Carangidae) which, although occupying near-bottom habitats, may be categorised as coastal pelagic.

Golden trevally Gnathanodon speciosus

Cobia Rachycentron canadum

Giant trevally Caranx ignobilis

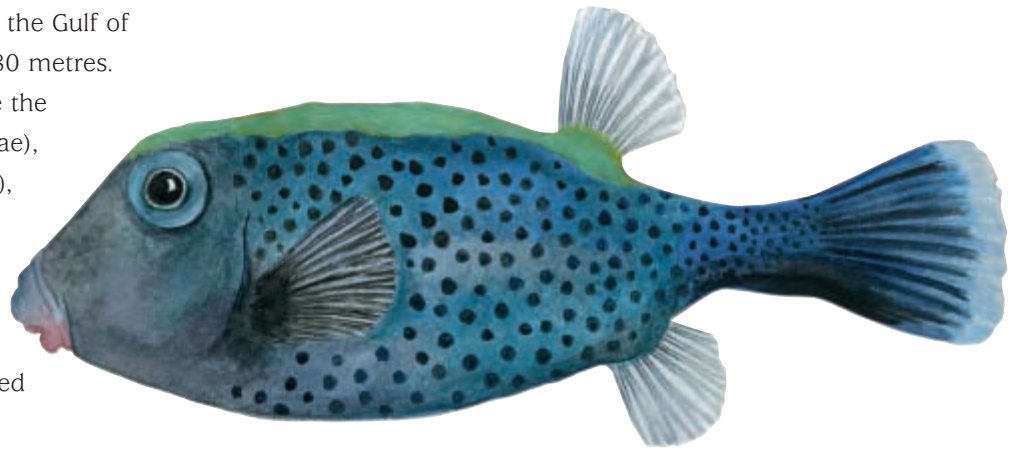
Orange-spotted trevally Carangoides bajad

Nurse shark (Ginglymostomatidae)

ILLUSTRATIONS NOT TO SCALE

DEEPWATER DEMERSAL

Most of the deepwater species in the UAE occur in the Gulf of Oman waters off the East Coast, at depths below 80 metres. Species which also occur in shallow waters include the morays (Muraenidae), pike congers (Muraenesocidae), lizardfish (Synodontidae), flatheads (Platycephalidae), bigeyes (Priacanthidae), croakers (Sciaenidae), armourheads (Pentacerotidae), cutlass fish (Trichiuridae), tripodfish (Triacanthidae), boxfish (Ostraciidae) and triggerfish (Balistidae). A new triggerfish species for the Gulf was recently procured (and eaten) in the UAE (Beech 1999).



Bluetail trunkfish Ostracio cyanurus

Shortnose tripodfish Triacanthus biaculeatus

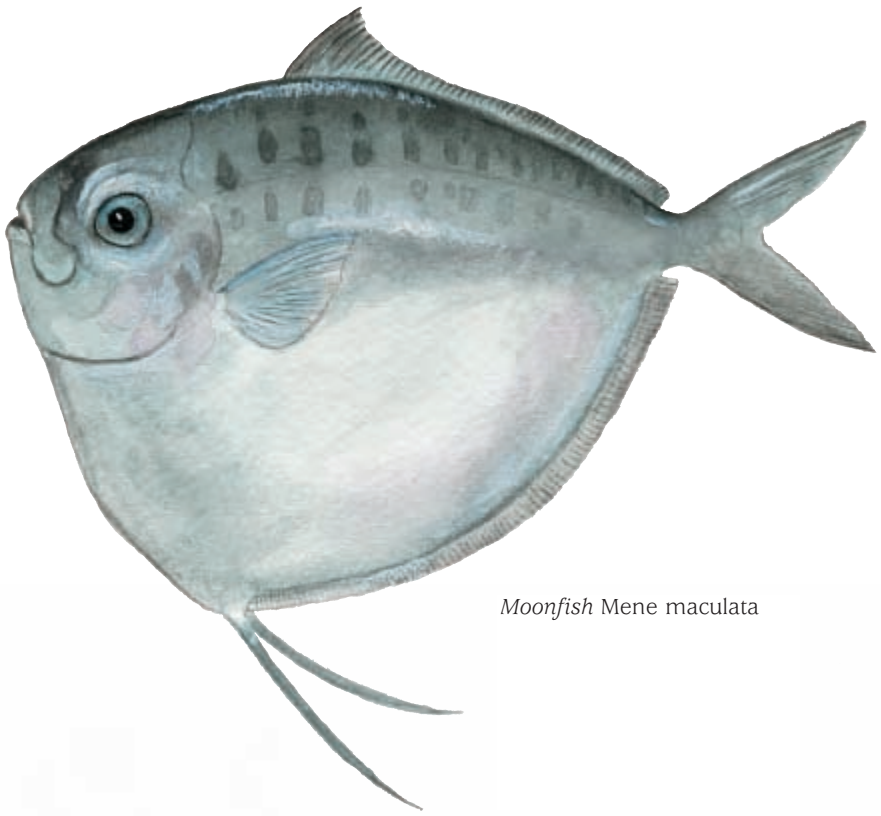
Picasso triggerfish Rhinecanthus assasi

Undulated moray Gymnothorax undulatus

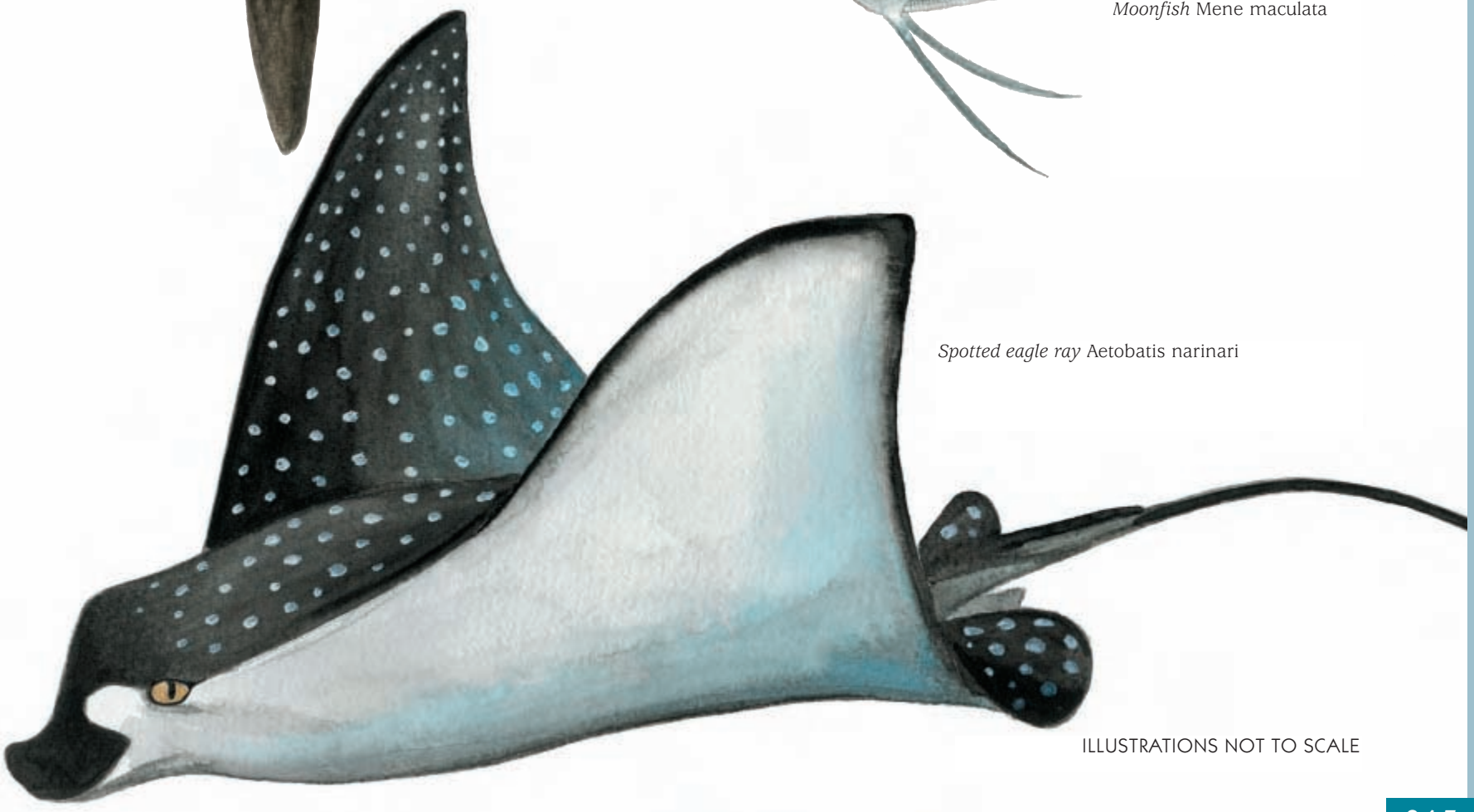
OCEANIC PELAGIC

Common pelagic oceanic species found in UAE waters include the narrow-barred Spanish mackerel *Scomberomorus commerson*, known locally as kingfish, and sailfish *Istiophorus platypterus*. Other fish in this category include devil rays (Mobulidae) and eagle rays (Myliobatidae), as well as several members of the requiem shark family, including the tiger shark *Galeocerdo cuvier*, the silky shark *Carcharhinus falciformis*, and the oceanic whitetip shark *C. longimanus*. Other pelagic oceanic species found in UAE waters include needlefish (Belonidae), sharksuckers *Echeneis naucrates*, dolphinfish *Coryphaena hippurus*, moonfish *Mene maculata*, barracuda (Sphyraenidae), several tuna species including the longtail tuna *Thunnus tonngol*, and the ocean sunfish (Molidae). Specimens of this latter group have been occasionally observed in UAE waters (Al-Ghais 1994; Iddison 2002).

Sunfish Mola mola



Moonfish Mene maculata



Spotted eagle ray Aetobatis narinari

ILLUSTRATIONS NOT TO SCALE

WHALE SHARKS

Whale shark Rhincodon typus

WHALE SHARKS, KNOWN LOCALLY IN ARABIC as *channaz*, are the largest living fish in the world. They are a pantropical species, occurring in tropical and warm-temperate waters of the Atlantic, Pacific and Indian Oceans. They can reportedly reach up to 16 metres in length. These extraordinary fish are a surface-dwelling, pelagic species that mainly feed on plankton, which they obtain by straining the water through their gill arches. Whale sharks are highly migratory. Movements of thousands of kilometres over periods of weeks or months have been recorded through satellite tracking in the eastern Pacific and south-east Asia. Their movement follows blooms of planktonic organisms. Sometimes they feed on fish and squids, and take advantage of schools of tuna that concentrate small and larval fish at the surface by rising vertically under the schools to feed (Compagno 1984; Randall 1995: 21).

Whale sharks are occasionally observed in the warm waters of a number of states surrounding the Arabian Gulf. Positive identifications have recently been noted off the coast of Kuwait (Bishop and Abdul-Ghaffar 1993), as well as in the Arabian Sea and off the Gulf of Oman coast of the Sultanate of Oman (Randall 1995; White and Barwani 1971). A number of records exist in UAE waters, which were summarised by the renowned naturalist, the late Bish Brown (Brown 1992).

On 8 October 1988, a small whale shark estimated to weigh 3 tonnes, was caught off the East Coast, 20 kilometres off Bidiya. On 17 December 1988, a 6-metre-long whale shark was caught off the coast of Sha'am in Ra's al-Khaimah. Its estimated weight was reported as being anything between half a tonne and 3.5 tonnes. On 13 September 1989, a dead whale shark was taken from a narrow channel near the watchtower at the entrance to Jebel Ali. This was lifted by crane, its weight being estimated as being 7 tonnes. On 21 April 1991, a juvenile less than 5 metres in length was caught off the breakwater near Abu Dhabi. On 31 December 1991, a 7-metre individual, with an estimated weight of up to 4 tonnes, was killed in a collision with a naval vessel a few kilometres offshore, and was subsequently brought into Abu Dhabi's Mina Zayed port. The largest whale shark reported to date in UAE waters was 10 metres long and had a reported weight of 50 tonnes. Whilst the latter figure is certainly exaggerated, the fisherman from Sha'am village who caught it, Abdullah Mohammed Abdullah, stated that: 'we normally catch up to six a year, but none as big as this one. It is probably the largest caught in the last 40 years.' (Brown 1992).

More recently, a whale shark, estimated to have been 8 metres in length, entered an Abu Dhabi marina and became trapped and subsequently died, despite efforts to usher it back through the narrow entrance. At the end of 2002, an adult accompanied by a juvenile passed along the Abu Dhabi Corniche towards the dead-end in front of the Hilton hotel. In this instance, they were successfully coerced into turning back and made their way out to open water (Hazim al Chalabi, pers. comm.).

The location of whale shark nurseries is unknown and remains one of the interesting mysteries of shark biology. It is worth noting here the presence of a number of juveniles captured in UAE waters. Gulf waters may play an important role in the life cycle of whale shark populations in the western Indian Ocean. The IUCN Red List records that data is deficient for this species and lists it as a 'species under threat'.

Mark Beech

ENDANGERED SPECIES

Although guidelines have been compiled to assist with the evaluation of the threatened status of marine fish using the Red List Categories and Criteria of the World Conservation Union, IUCN (IUCN 2003), it is not always a straightforward matter to compile such a list and an agreed 'Red List' for the fish of the UAE does not yet exist.

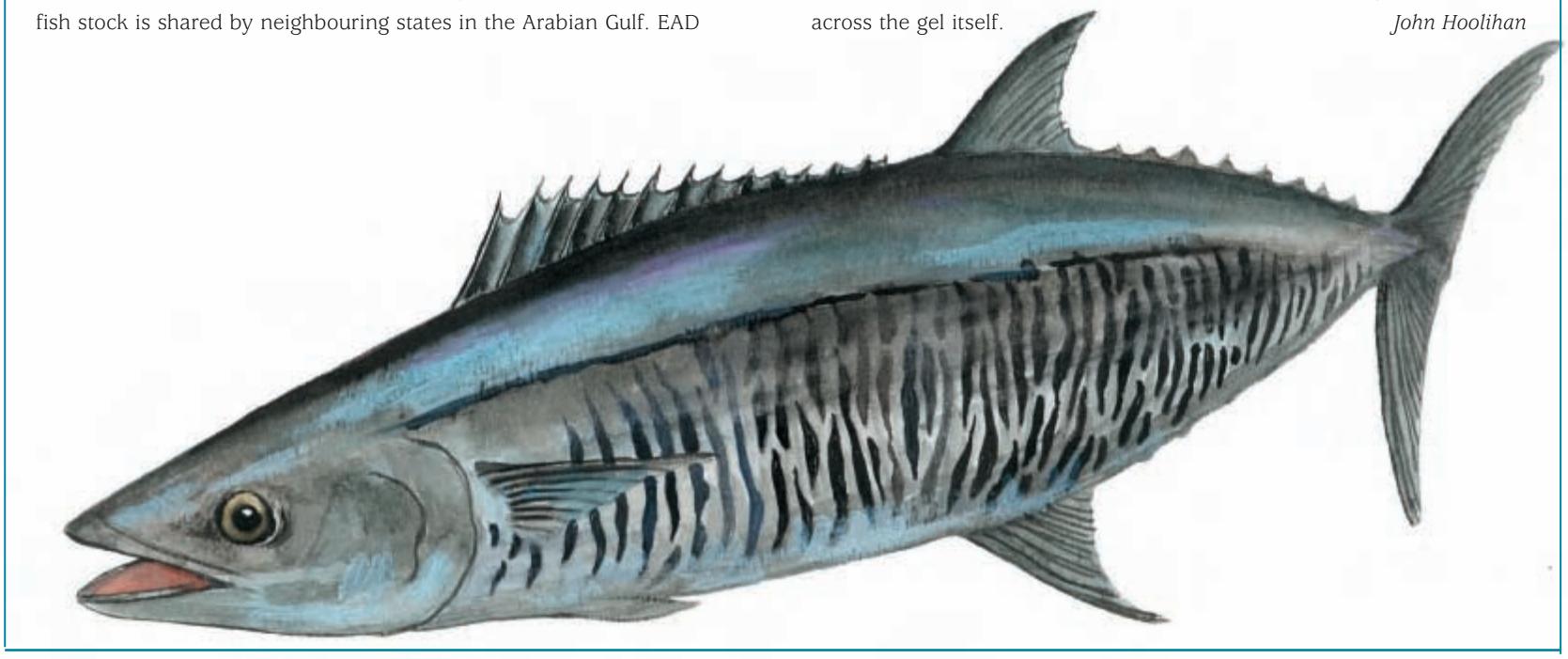
A salutary warning, however, is the fact that in a recent study of commercial fish caught in Abu Dhabi waters, it was demonstrated that a large proportion of the landed catch was immature fish, a direct result of the over-fishing of large adult individuals (Al Abdessalaam, in press). Old fishermen's tales of large 'hamoor' (groupers) which once prospered in the coastal waters, as well as stories of giant sharks caught in days gone by, further suggest that over-fishing has effected a change in the local marine ecosystem. It is not only the catching of immature fish which can affect the balance of fish populations. The trade to the Far East of shark fins has had a disastrous effect on shark populations worldwide, leading to a number of species now being considered as endangered.

KINGFISH DNA STUDY

The narrow-barred Spanish mackerel *Scomberomorus commerson* is perhaps the most important of the region's highly migratory species. Greatly prized for human consumption and known locally as the kingfish or by its Arabic name of *kanad*, it is pursued by both commercial and recreational fishermen. Widespread through the Indo-Pacific region, it is well known in Australia, South Africa and north to the Arabian Gulf. Kingfish are representative of a so-called 'straddling stock' in the Gulf, criss-crossing political boundaries and shared by many nations. The commercial importance of kingfish in the region requires that informed management decisions are implemented to ensure optimal sustainability. For this to occur, valid scientific data on biological requirements and stock structure are needed. Scientific studies are under way to determine just how this fish stock is shared by neighbouring states in the Arabian Gulf. EAD (formerly ERWDA) is spearheading regional co-operative research aimed at determining stock assessment and delineation of this species. In this research, fin clip samples are collected for mitochondrial DNA (mtDNA) analyses.

Results from this study should provide answers to such questions as whether kingfish being caught throughout the region originate from the same stock or represent various populations. Polymerase chain reaction (PCR) techniques are used to multiply the mtDNA to the required quantities. Targeted gene segments are then tested with specific primers to determine if there is variation in the sequencing. Using electrophoresis, whereby an electric current is run through a gel containing tissue samples, differences can be detected in the individual sample's migration patterns across the gel itself.

John Hoolihan



COMMERCIAL FISHERIES

The north-west Indian Ocean is designated by the FAO as 'statistical area 51'. It has a surface area of around 30 million square kilometres and encompasses regions with very different fishery resources characteristics. Fisheries have been important in the Arabian Gulf and Gulf of Oman since ancient times, and the pearl fishery of the Arabian Gulf was once a mainstay of the economy in the pre-oil era. Rising incomes and the traditional popularity of fish as a dietary item have resulted in virtually all resources of the area becoming fully exploited.

Marine and fisheries resources have always occupied an important place in the UAE and still do so today. Apart from supporting a traditional way of life that can be traced back to the earliest known archaeological sites in the region some 7,000 years ago (Beech 2001; 2003; 2004), these resources still provide an important source of income, food and recreational opportunity for many residents of the country. Typical of the global trend, and in response to a growing demand for fishery and marine products, the

Five-lined snapper Lutjanus quinquelineatus

ABOVE: *A pearling boat at Abu Dhabi in the 1950s*

last three decades have seen increased use of fisheries and marine resources in the UAE. During this period, the traditional commercial fishing sector has substantially invested in modern fishing fleets, while there has also been a significant increase in other uses of fisheries and marine resources. The advent of a modern way of life and a growing tourism industry has augmented the use of fisheries and marine resources for recreation. Furthermore, marine and coastal habitats are being subjected to the impacts of unprecedented urban and industrial development in the country.

All this has inevitably led to concern regarding the sustainability of the use of the fisheries resources. In particular, questions pertaining to depletion of the fish stocks, habitat degradation, and over-fishing have been raised (Carpenter *et al.* 1997). The recently completed report undertaken by the Environment Agency – Abu Dhabi (EAD), formerly ERWDA, in Abu Dhabi, in association with the UAE Ministry of Agriculture and Fisheries, and the Australian/New Zealand consultants, Bruce Shallard Ltd, has highlighted some of these issues. Since 1978 there has been a major decline in the stocks of both commercial and non-commercial fish. This cannot be simply explained by overfishing. The destruction of important marine habitats by activities such as dredging has had a major impact on fisheries within Gulf waters.

FISH ECOLOGY AND ECOSYSTEMS

It is undisputed that habitat exerts a major influence on which species are able to live in a particular place. Effective management of fisheries can only be achieved if a unified ecosystem-based approach is used. Future conservation strategies have to encompass the protection of ecosystems which play an important role in fisheries. An important point to bear in mind is that fish do not respect national or international boundaries. Almost all tropical fish have a pelagic larval dispersal phase. Larvae drift with the plankton for days or weeks before settling onto a reef (Sale 1980). Since many stocks are shared by several countries, this means that only through the co-ordination of regional, national and international bodies can effective measures be taken to protect fisheries resources.

Mangroves, shallow coastal waters, including lagoons and seagrass beds, represent some of the most important nursery grounds for many fish in the region. Unfortunately, it is precisely these habitats that, in many cases, are under threat due to modern coastal development.

Coral reefs are also an important ecosystem under threat. Fish play an important role in many reef processes. Herbivorous fish by defending their territories help to increase rates of carbon fixation. Heavy grazing by fish and echinoderms in areas outside these territories result in dominance by nitrogen fixing blue-green algae. Migrations by foraging fish help to form important pathways for nutrient transfer within and among reef habitats (Sheppard *et al*. 1992: 107).

The vertical distribution of abundance and diversity of fish on reefs is very uneven. Species richness generally increases down to a depth of about 10–15 metres before decreasing with increasing depth. A complex range of factors influence reef composition, including environmental stress such as wave action, turbidity, temperature fluctuations, salinity, food supply, and the structural complexity of the reef.

Knowledge of the Arabian pelagic system is very patchy, with much conflicting and incomplete data (Sheppard *et al*. 1992: 217). Many of the larger fish, such as kingfish and tuna disappear in the hot summer months, either retreating to the deeper, cooler waters on the Iranian Gulf coast, or perhaps even exiting the Gulf via Musandam into the Gulf of Oman. New research is currently being undertaken using satellite tagging and DNA analysis to test the seasonal movements of particular fish taxa and the relationship to different fish communities in neighbouring states (see page 269).

PELAGIC GAME FISHERIES

Recreational fishing is a popular and widespread pastime in the UAE, both in the Arabian Gulf and Gulf of Oman waters. A wide variety of fishing methods are employed, although handlines and rod and reel use are most prevalent. There are also fishermen (mostly UAE nationals) practicing traditional artisanal fishing methods at weekends, under the guise of recreational fishing, often using traps (*garagir*) as well as handlines. The recent implementation of UAE Federal Law No. 23 for 1999 relating to fishing practices has restricted recreational fishing to the use of attended handlines or rods and reels only, and require all users to possess a valid licence. Fishing from both shore and vessel are widely practiced. However, for pursuit of larger pelagic game species, fishing from vessels is the primary choice. Trolling is the most popular method of angling for larger pelagic game fish. Dead baits, live baits and artificial lures are all used.

Numerous species are found in local waters and readers are directed to available literature detailing the region (Al-Abdessalaam 1995; Carpenter *et al.* 1997; Randall 1995; Kuronuma and Abe 1986; Assadi and Dehghani 1997). Popular species pursued by recreational anglers include the pickhandle barracuda *Sphyraena jello*, cobia *Rachycentron canadum* and jacks/trevallies such as the Talang queenfish *Scomberoides commersonnianus*, orange-spotted trevally *Carangoides bajad*, golden trevally *Gnathanodon speciosus* and giant trevally *Caranx ignobilis*. By far the most favoured group is the tuna and tuna-like species. Within this group are members of the family Scombridae including kingfish *Scomberomorus commerson*, kawakawa *Euthynnus affinis*, longtail tuna *Thunnus tonggol* and, to a lesser extent, yellowfin tuna *T. albacares*. The sailfish *Istiophorus platypterus* is also included in this group. All of these species are classified as highly migratory by the Food and Agriculture Organisation (FAO) of the United Nations. For the most part, they are seasonally resident in the UAE during the winter months, October to April. Additionally, most of these species represent so-called straddling stocks, as they traverse political boundaries.

Management measures aimed at protecting fisheries are important for maintaining species diversity, sustainable fishing and ecosystem stability. The sailfish is the sole member of the billfish group (which also includes marlins, spearfish and swordfish) to be caught in the Arabian Gulf on a regular basis (Hoolihan 2001a), and plays an increasingly important role in recreational fishing and revenue generation in the tourism sector. While swordfish are present, they are rarely caught. Known for their speed and jumping ability, sailfish are a popular recreational game fish wherever they are found. The recent rapid development of tourism, particularly in Abu Dhabi and Dubai emirates, has resulted in rising demands for watersport activities, including recreational fishing. Foreign tourists already travel to the UAE solely for the pursuit of sailfish. Associated with this growth are tag and release tournaments, which are becoming increasingly popular (Hoolihan 2002).

Catch and release and tagging are widely practiced by private anglers and charter operators. Game fish anglers in Dubai have in fact voluntarily operated a sailfish tag and release programme since 1983, while more recently, the Environment Agency – Abu Dhabi (EA–AD) (formerly ERWDA), has started distributing tags to fishermen. This has permitted study of the migratory movements and growth patterns of Arabian Gulf sailfish. Each small plastic tag consists of a nylon dart that is implanted into the muscle of the sailfish. This is accomplished when the fish is brought alongside the vessel. Attached to the dart is a plastic streamer with printed information including: return address, phone number and tag serial number. Additionally, a tag data card with corresponding serial number is filled out by the fisherman. This card records information on the fisherman's name, date, location and estimated weight of fish and remarks. Tag recaptures have revealed a springtime spawning migration of this species from UAE Gulf waters leading north-north-west further into the Gulf (Hoolihan 2001b). Further details of movements by this species and its habitat preferences are being determined through deployment of satellite pop-up tags. Each tag can be pre-programmed to release from the sailfish on a chosen date. At release time, the tag contacts an Argos satellite. Data is then uploaded to the satellite and is re-routed back to EAD via e-mail. The data includes location as well as archive readings on water temperature and depth recorded during the sailfish's journey. Pop-up location data enable scientists to ascertain seasonal movements of this population during periods when no conventional tag data is available. Water temperature and depth data provides valuable information that is useful in understanding the preferential habitat and ecosystem requirements of this species.

John Hoolihan

FISHING METHODS

Fisheries in the UAE involve many species and species groups and employ different types of fishing equipment and methods, deployed from various types and sizes of fishing vessels. The methods used can broadly be divided into commercial fisheries, using wooden dhows locally known as *lansh* (from the English word 'launch'), fibreglass boats, traditional methods and recreational fishing.

A variety of fish are caught, including sharks and rays, seacatfish, lizardfish, flatheads, groupers, jacks, mojarras/silver-biddies, angelfish, grunts, parrotfish, wrasses, rabbitfish, barracudas, ponyfish (Leiognathidae), snappers, threadfin bream, emperors, seabream, goatfish, turbots (Psettodidae), flounders (Bothidae and Paralichthyidae) and tonguesoles (Cynoglossidae). A combination of over-exploitation resulting from inadequate fisheries management and degradation of the environment has been a major cause of the overall decline in fish stocks in the area. Environmental degradation includes the elimination of important nursery areas by land reclamation and dredging in coastal areas, and increased marine pollution by discharge of liquid and solid wastes into the marine environment (Chiffings 2000).

The dhow-based fishery, responsible for the majority of commercial fishing in UAE waters, comprises mostly small commercial operations. Wooden dhows are usually about 12–20 metres in length, powered by 150–300 horsepower inboard diesel engines. Dhows typically fish with baited basket traps, known locally as *gargoor,* (plural *garagir*), trawls, hook and line and trolling lines. Drift nets used to be a dominant fishing method, especially for large pelagic species. These nets, known as *al hayali*, are now banned by law, except in tightly-regulated circumstances.

Trap fishing using *garagir* is the most common fishing method. Formerly made from interwoven palm fronds, the traps are now manufactured from galvanised steel wire of 1 to 1.5 millimetres thickness, imported from the Far East. *Garagir* are usually made as dome-shaped traps with a base diameter of between 1–3 metres supported by reinforced steel bars and a funnel-like entrance.

Two types of *garagir* are operated – smaller traps (180 centimetres in diameter and 90 centimetres in height) are used in shallower waters, between 4 and 40 metres depth by fishermen mostly using fibreglass boats; larger traps (250 to 300 centimetres in diameter and 150 to 180 centimetres in height) are used by *lanshs*, larger dhows, in offshore deeper waters at depths ranging from 60 to 200 metres. Polystyrene or plastic marker buoys are generally used to mark their location. These traps are usually set in the afternoon and the fish are retrieved after three or four days in the early morning. A variety of baits are used inside the traps, including green algae (*Enteromorpha*), ground dry fish, dead fish and bread. The majority

of the catch (over 80 per cent) at the present time is caught using these traps. Large *garagir* target species such as groupers (known locally as *hamour)*, emperors (known locally as *shaeri*) and grunts. Other important species caught in *garagir* include jacks such as the black-banded trevally *Seriolina nigrofasciata*, snappers, sea bream, parrotfish and rabbitfish.

Another fishing method, also used from dhow-based fisheries, are gillnets, known locally as *al liekh*, often set on the bottom. These catch a variety of fish, including grunts, sea bream, emperors, goatfish, rabbitfish, pomfrets (Stromateidae) and others. A further type of gillnet, *al hayali,* which is a special drifting gillnet, was formerly used during the winter to capture, in particular, the narrow-barred Spanish mackerel, abundant at that time. Other fish generally captured by *al hayali* included cobias, jacks/trevallies, barracuda and tuna (Scombridae, mostly *Euthynnus affinis* and *Thunnus* spp.). The net was either allowed to drift freely or fixed on one end so that the other end was free to move with the tides. Fish were caught as they moved into the path of the moving net. As noted above, use of *al hayali* is now restricted

Inshore fisheries usually use fibreglass speedboats with twin outboard engines, these having been introduced since the early 1970s, replacing traditional wooden craft known as *houri*. Shore-based fishing is mostly carried out with *garagir* and hook and line along rocky shores and jetties or, more often along beaches or intertidal areas. Other shore-based fishing equipment used includes beach seines and barrier traps, known locally as *hadrah*.

Fishing by hook and line, known locally as *hadaq*, is specifically used for the capture of groupers, cobias, jacks/trevallies, grunts, emperors, sea bream and Spanish mackerel. Long-lines, known locally as *manshalla*, are sometimes used which may have 10–20 extra smaller lines and hooks. These are said to be good for catching requiem sharks and groupers. Another local variant is *shab*, a nylon line with 4–8 shorter lines and hooks which have lures (small feathers or pieces of coloured material) fastened to them. Another method used from moving boats is a trolling line, known locally as *lafah*, used particularly for the capture of larger fish like giant trevally *Caranx ignobilis*, barracuda, narrow-barred Spanish mackerel, tuna and occasionally sailfish *Istiophorus platypterus*.

Several other methods of fishing have become obsolete in recent years, including a kind of harpoon, known locally as *oumla*, and a wooden spear, *al katra*, including a sharp metal unit called *al jalala* inserted into another metal unit called *al kaber*. This latter section has a float attached to it. The *oumla* was specifically used for the spearing of large pelagic fish such as tuna, narrow-barred Spanish mackerel and was occasionally used to spear cetaceans.

Apart from gillnets, two other types of fishing nets are used. Beach seines, known locally as *yaroof*, can be up to 40 metres or more in length. One end of the seine is moved rapidly from the shore in a wide arc in an effort to surround fish both ends of the seine then being pulled to shore. Fishing by this method remains fairly common on the UAE's East Coast, and can be seen, for example, at Fujairah and Dibba, the fishermen often being accompanied by large flocks of feeding gulls and terns. Speedboats with outboard motors and four-wheel drive vehicles are used today to pull these seine nets to the shore, but traditionally this was done by a large group of men. This method was especially good at catching mojarras/silver-biddies, flathead mullets *Mugil cephalus* and rabbitfish. Many other fish are also caught, including small needlefish and jacks/trevallies.

Also sometimes used is the bell-shaped cast net, known locally as *salieya*, which has small weights around its base to make it sink. This is only used at times of year when fish such as the Indian oil sardine *Sardinella longiceps* and flathead mullets are abundant in shallow inshore waters.

Hadrah were traditionally built by driving a row of palm fronds and wooden stakes into the sediment supported by stones at their base. A frond fence was then placed between these stakes out towards the outer circular/pentagonal enclosure, which in turn surrounded an inner chamber. With the receding of the tide fish were thus channelled by the wings of the trap into first an outer, then an inner chamber. Such traps are typically used in shallow inshore waters throughout the Arabian Gulf. In some locations in the western coastal region of Abu Dhabi these barrier traps were made from rocks. Such examples could once be seen on the west coast of Dalma Island, and still exist on the islands of Qarnein, Ghagha' and the Yasats (Beech 2003). These stone traps take a variety of forms; some of them are semi-circular walls enclosing small bays, for example on the north-west coast of Ghagha'. A gap in the wall was blocked as the tide receded, trapping all the fish in the shallow water on the landward side of the wall. Sometimes the walls extend outwards from the coastline like giant pincers, to channel fish into restricted shallower waters, for example on the west coast of Dalma. Other traps consist of a stone wall running perpendicular to the shoreline, the seaward end terminating in a circular or oval-shaped enclosure; several examples are found off the small islands just to the west of Abu Dhabi Island.

Determining the age of these ancient fish traps is difficult, since there is rarely little, if any, archaeological material directly associated with them. As many are situated in the present intertidal zone it seems likely that the majority belong to the Islamic or recent pre-oil period. It is possible, however, that some of them may date from much earlier periods.

Modern *hadrah* are usually made with steel or iron poles and wire mesh or nylon netting. In the UAE, these traps are traditionally used, especially during the summer months, to catch the blackspot snapper *Lutjanus fulviflamma*. Other typical kinds of fish caught using this method include needlefish, jacks/trevallies, sea bream, mullets, barracuda and rabbitfish. Other bottom species may also be occasionally caught in these traps. Other variants of tidal barrier traps also exist in the UAE, such as a wide fence of nets linked by

wooden posts called *sakkar*. This may be stretched across narrow estuaries or gaps in lagoons. This is particularly used in the capture of mojarras/silver-biddies and gold-striped seabream *Rhabdosargus sarba*. Sometimes a second fence, the *dafaf*, is added behind the *sakkar*, and this may catch fish such as sea bream (in particular, *Acanthopagrus* spp.) and flathead mullets.

Recreational fishing in the region is growing rapidly, and is largely carried out from small motorboats operating relatively close to shore. A licensing system for all recreational fishing, whether from boats or from the shore, was introduced in the Emirate of Abu Dhabi in 2002, as a by-law under Federal Law No. 23 for 1999 on Exploitation, Protection and Development of Marine Bio-Resources. The licences for recreational fishing allow only two methods, handline and rod and reel. All fishermen over the age of 18 must obtain a licence, valid either for a year or for a week, although children can continue to fish in the company of a licence holder. Recently a new licence category, the traditional fishing licence to cater for national fishermen who do not fall under either commercial or recreational fishing categories was introduced. Competent authorities in each emirate are responsible for licensing. In Abu Dhabi, licences for both commercial and recreational fishing are issued by EAD, with an upper limit of 1,000 being set on commercial licences.

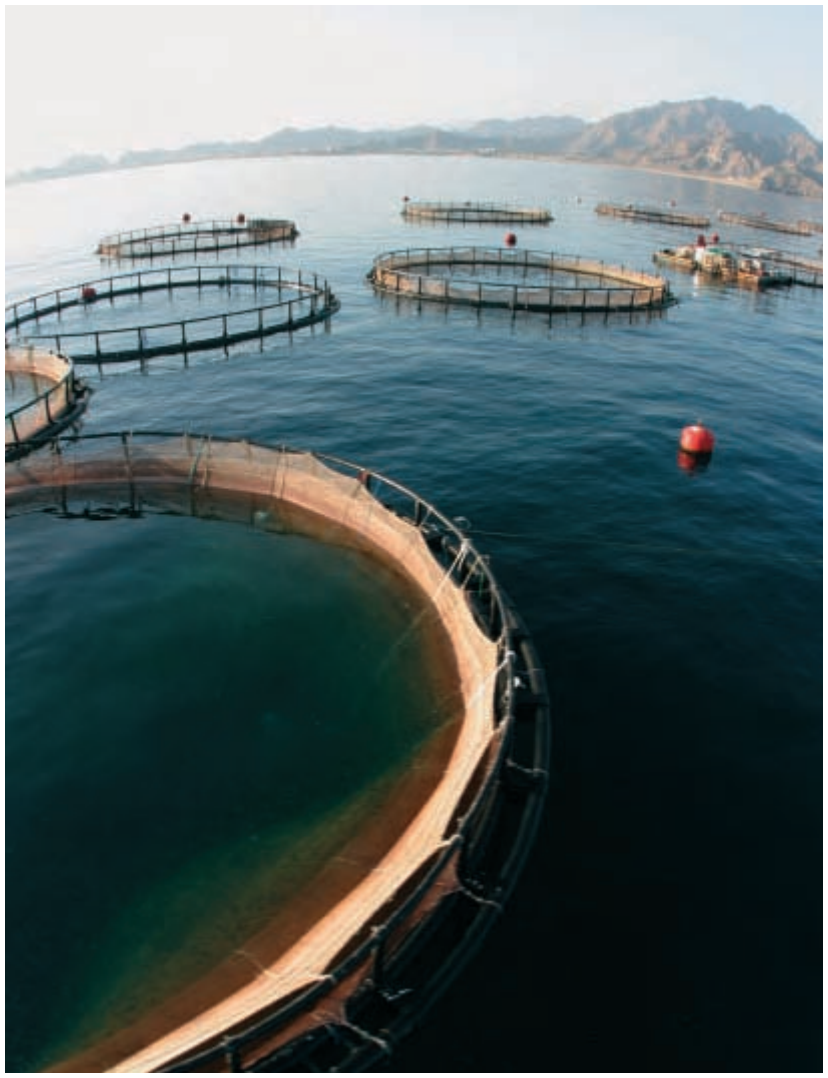
PROBLEMS, SOLUTIONS AND NEW LEGISLATION

One serious problem affecting fish stocks in the region is the loss of fishing traps and nets. Their accidental loss leads to 'ghost fishing', whereby they continue trapping fish on the seabed, but are not lifted and emptied. According to information provided from the fishermen's co-operatives, inshore fishermen may lose between 7 to 12 traps per month, whilst big dhows generally operate between 150 to 200 traps with a loss of 20 to 25 traps per month (Tawfik 2000a). Fishermen also sometimes do not link the traps to their buoys to avoid thefts and may subsequently fail to relocate them. The small traps may take anything between 5 to 7 months to corrode and deteriorate at depths of 4 to 40 metres, thus continuing to trap fish for some time after they are lost. One method that has been utilised in other parts of the world, is to develop fastenings for the doors to fish traps which naturally decompose after a certain period of time, thus allowing trapped fish to escape.

Another method now being used to try to stem the depletion of fish stocks has been the creation of artificial reefs, several of which have been established by decree of the Ruler of Fujairah on the UAE East Coast, following the original designation of three areas as marine reserves by the Ruler of Fujairah in 1995. The first, at Al Faqit near Dibba, was established in February 1998 in approximately 8 metres of water and the second at the Aqqa Marine Reserve, in around 4 metres of water, to protect coral from lost fishing nets. The third reef was created at the end of 2000 by

sinking 100 'caves' at the edge of the Aqqa Reserve (Tawfik 2000b). In February 2001, experiments were carried out using a new cheaper type of triangular-shaped cave made of palm leaves woven together and held in place by iron grids and rope (Shaghouri 2001). Although such reefs may appear to encourage the development of marine resources in the short term, however, they need to be established within protected areas which are themselves regularly patrolled, to prevent targeting by fishermen.

In April 2000, a regulation stipulating that no fishing boat is allowed to sail without the owner or a national captain on board, as provided for in Federal Law No. 23 of 1999, was introduced. Fishing boats are now only permitted to sail if their national owner or captain is aboard. The Frontier and Coast Guard patrols stop any boat that violates this rule. Article 26 of the law banned the use of fixed or drifting *hayali* fishing nets in Abu Dhabi waters. Each fishing boat formerly carried 20 to 50 drift nets, which often caught and drowned endangered species such as dugong *Dugong dugon*, dolphins and turtles. The nets also damaged commercial fish stocks, catching fish that were not brought to market or fish of no commercial use. Enforcement of the law is being undertaken by the Frontier and Coastguard patrols, the UAE Navy, police, the municipalities and other relevant agencies, including EAD, and heavy penalties have been prescribed for violators of the new legislation. Problems still remain, however, such as the removal of fins from sharks for lucrative trade with the Far East. This has decimated the shark population of the Arabian Gulf in recent years.



LEFT: *Fish farming*
BELOW: *White-spotted spinefoot* Siganus canaliculatus

AQUACULTURE

The focal point of aquaculture in the UAE is the Marine Resources Research Centre (MRRC) of the Ministry of Agriculture and Fisheries, based in Umm al-Qaiwain. Founded in 1978 under the terms of a technical cooperation programme between the UAE and Japan, it began operations in 1984, and has succeeded in developing a suitable technology for growing rabbitfish, *Siganus canaliculatus* and *S. javus*, from induced spawned eggs to marketable size fish (Department of Fisheries 1984). Work has also been carried out on shrimp farming, both at Umm al-Qaiwain and on Abu al-Abyadh Island in Abu Dhabi.

In 1999, the International Fish Farming Company, ASMAK, was set up under the UAE Offsets Programme, with a total capital of 300 million UAE dirhams. The company specialises in fish and shrimp farming and has 31,000 investors and shareholders from different emirates. Its projects include the Middle East's largest commercial hatchery for finfish, in Umm al-Qaiwain, and other facilities at Dibba in Fujairah, and in Ra's al-Khaimah, the latter two having a combined capacity of 3,200 tonnes of fish. One of the objectives of the company, which also operates in Oman and Kuwait, is to replace wild-caught fish, thus reducing the pressure on fish stocks.

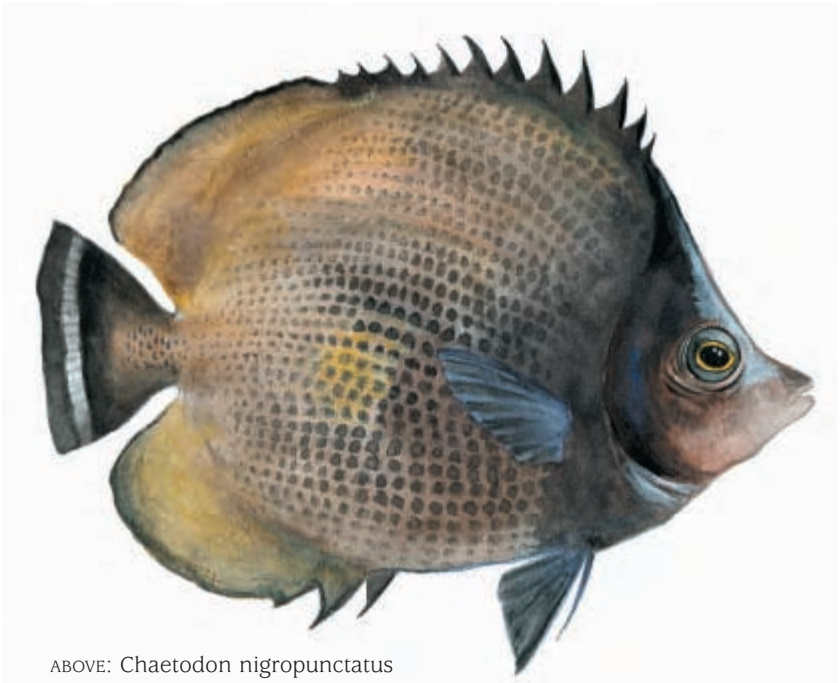
Fish farming is likely to be developed further in the future and both ASMAK and the MRRC at Umm al-Qaiwain are active in promoting the industry.

FISHERIES STUDIES – PREVIOUS WORK

The Arabian Gulf is a comparatively young sea which originated about 16,000 years BP (Sheppard *et al.* 1992). Sea level in the Gulf is generally believed to have not reached its present level until around 6,000 years BP, during the Holocene period. All fish species found in the Gulf originally penetrated from the Indian Ocean through the Gulf of Oman and Straits of Hormuz. Although high levels of endemism have been suggested, in fact, only a very low number of species exist solely within the Gulf. Kuronuma and Abe (1986: 298) report that only 7 (1.5 per cent) out of a total of 465 species, which they recorded as being present within the region, are endemic species. Most species present (89 per cent) are derived from both the Indian and Pacific Oceans, a smaller number (11 per cent) being restricted to the Indian Ocean, or the 1.5 per cent from the Gulf.

Despite the fact that marine ecological research in the region dates back as far as Forsskål on the Danish expedition of 1775, comparatively little is still known about the Arabian Gulf marine fauna. Although there have been a number of publications specifically concerning Gulf fish (e.g. Al-Baharna 1986; Al-Sedfy 1982; Kuronuma and Abe 1972, 1986; Relyea 1981; Sivasubramaniam and Ibrahim 1982; White and Barwani 1971) these have recently been criticised for including many records based on old literature rather than on actual specimens (Randall 1995). Although there has been some work on the identification of fish in the western Indian Ocean region (e.g. Randall *et al.* 1978; Fischer and Bianchi 1984), and some checklists have been published for the region (e.g. Jennings 1997a–g), there are no up-to-date accurate lists of taxa available for each of the Arabian Gulf states.

One problem with the available literature is the plethora of names and synonyms which exist for Arabian Gulf fish taxa, this being



ABOVE: Chaetodon nigropunctatus
BELOW: C. melapterus

further complicated by many misidentifications. The recent publication of Randall's *Coastal Fishes of Oman* (Randall 1995), along with the *FAO Field Identification Guide* by Carpenter *et al.* (1997), have fortunately summarised many of these and represent the most recent attempts to update the taxonomy and description of fish in the region. Various opinions exist concerning the precise number of fish species present within the Arabian Gulf and it is clear that many earlier records are questionable (Randall 1995). Also, many published accounts do not provide detailed distribution data and it is not possible to determine if a particular species occurs in the Arabian Gulf or in the Gulf of Oman or in both (e.g. Relyea 1981; White and Barwani 1971).

There does appear, however, to be some variation in species richness throughout the Gulf, the deeper waters of the northern Gulf and along the Iranian coastline being richer in species than the southern region, in which the Gulf waters of the UAE lie. Studies have shown that habitat area (MacArthur and Wilson 1967) and its differentiation into zones can affect species richness (Goldman and Talbot 1976; Roberts 1986). It has also been demonstrated that trends in butterfly fish species richness and abundance in the Red Sea correlate closely with reef development patterns (Roberts *et al.* 1988). The harshness of the environmental conditions in the Gulf, i.e. extreme temperatures and high salinity, certainly appear to inhibit reef growth (Downing 1985; Sheppard 1988), and it is likely that this has reduced species richness within the region. A further explanation is that the comparative youth of the Gulf has also meant that diversification has not had sufficient time to develop.

The few systematic fisheries surveys carried out in the Arabian Gulf using SCUBA-equipped observers have largely concentrated on reef fish assemblages. These appear to be far less diverse than elsewhere in the Indian Ocean, or even in the Red Sea at the same latitude. Downing (1987) counted only 85 species on Kuwaiti reefs. Basson *et al.* (1977), McCain *et al.* (1984) and Coles and Tarr (1990) only 70, 101 and 106 species respectively along the east (Arabian Gulf) coast of Saudi Arabia. Smith *et al.* (1987) found only 72 species in reefs off the coast of Bahrain. Roberts (quoted in Sheppard *et al.* 1992) observed only 35 species during a 10-hour observation of inshore reefs in Qatar. Unfortunately, comparatively little is known about the fish fauna of the UAE Gulf coastline. The few popular publications that exist suggest, however, that the number of species present is also low in number (Dipper and Woodward 1989).

Several fish landing surveys were carried out two decades ago by the UAE Ministry of Agriculture and Fisheries (Ali and Thomas 1979; Ali *et al.* 1980; Ali and Cherian 1983), consisting of landing data from Khor Fakkan and Kalba on the East Coast. However, many non-commercial fish species are not included, and no data are given for discarded by-catch. Furthermore, such landings data do not provide adequate samples from all coastal habitats and of all species for statistical analysis to be undertaken.

Fieldwork carried out by a group of fisheries scientists led by John Randall identified a number of fish hitherto unrecorded within the region (Randall *et al.* 1994), while a subsequent detailed study of fish in Oman identified 930 fish species within the whole region, with at least 95 families and 361 species being recorded as present within the Arabian Gulf (Randall 1995). Further work is clearly required.

One of the most comprehensive recent attempts to systematically update the taxonomy and list of fish occurring in the Arabian Gulf is the *FAO Species Identification Field Guide for Fishery Purposes for Kuwait, Eastern Saudi Arabia, Bahrain, Qatar, and the United Arab Emirates* (Carpenter *et al.* 1997). This includes 17 families of the Chondrichthyes, (sharks, rays and skates), including 46 species, and 101 families with 493 species of Osteichthyes (bony fish).

A survey by Iddison (1998) of the Al Ain fish market, well inland from both the Arabian Gulf and Gulf of Oman coasts, but supplied from both coasts, revealed that a wide variety of fish were sold.

More than 170 species are listed, although some of the unusual species may have been brought in, packed in ice, from Oman and further afield

A recent review of the demersal fisheries of the Arabian Sea, Gulf of Oman and Arabian Gulf has noted the presence of over 350 commercial fish species (Siddeek *et al.* 1999). Primary families represented were emperors, sea bream, groupers, rabbitfish, croakers (Sciaenidae), pomfrets, snappers, cutlassfish (Trichiuridae) and threadfin breams. Fishing effort in the Arabian Gulf was observed to be above the optimum level (i.e. over-fishing was considered to be taking place), and they suggest that reduced fishing effort, strictly enforced closed seasons and closed areas are urgently required.

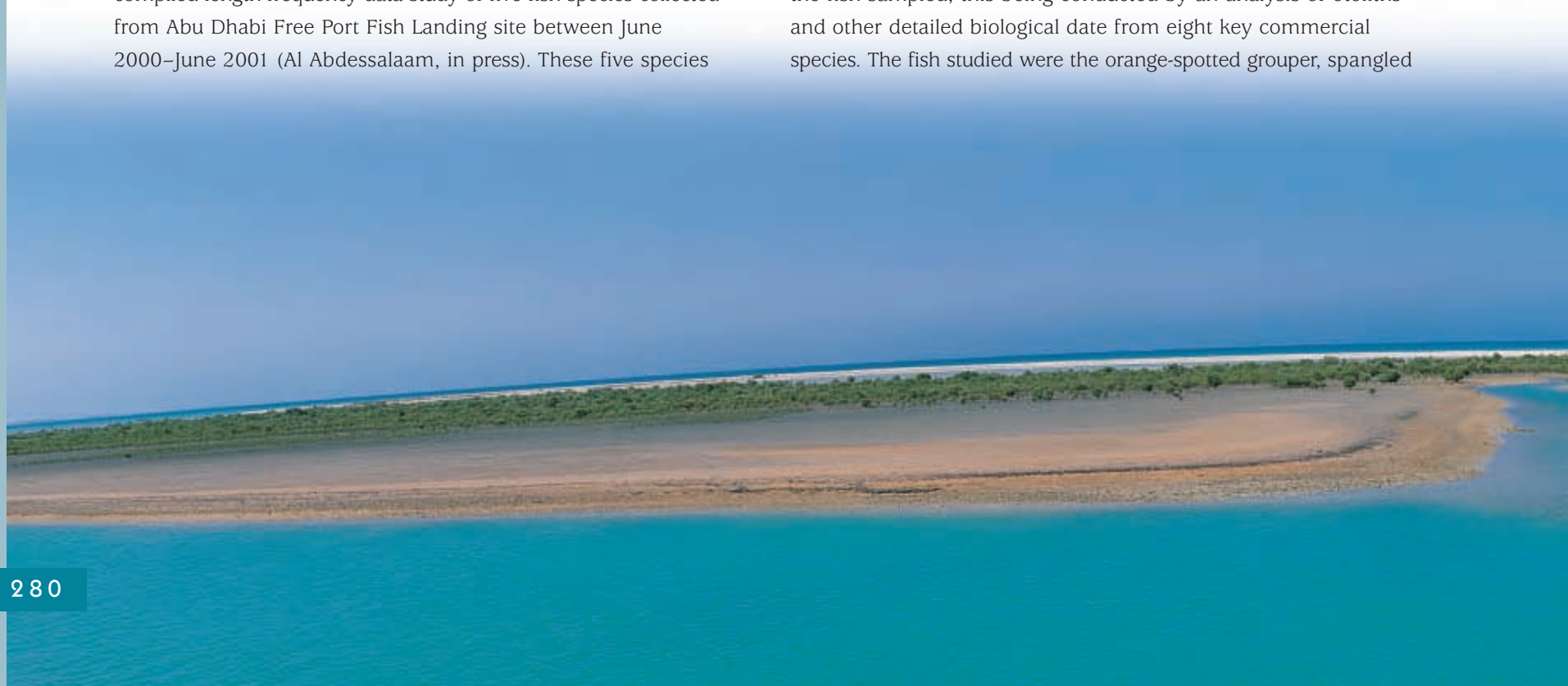
In 2000 there were 578 licensed fishing boats working in Abu Dhabi waters. These boats were owned by 486 nationals and were operated by 4,397 expatriate fishermen. Around 30,273 tons of fish was landed during 2000. The relative percentages of the main fish families landed at Abu Dhabi fishing port in 2000 are as follows: emperors were the most commonly exploited fish (34 per cent); followed by groupers (21 per cent); grunts (9 per cent); tuna/mackerel (9 per cent); and other fish (27 per cent).

FISHERIES STUDIES – NEW WORK

A major study has recently been carried out of major economic fish species in Abu Dhabi waters. Initiated by the Marine Environmental Research Centre (MERC), part of EAD (formerly ERWDA), this compiled length-frequency data study of five fish species collected from Abu Dhabi Free Port Fish Landing site between June 2000–June 2001 (Al Abdessalaam, in press). These five species were the orange-spotted grouper *Epinephelus coioides*, the orange-spotted jack *Carangoides bajad*, the spangled emperor *Lethrinus nebulosus*, the king soldierbream *Argyrops spinifer* and the double-bar seabream *A. bifasciatus*. The study showed that a large proportion of the landed catch included immature fish, suggesting over-exploitation of the fish stocks.

Implementation of new legislation and the ensuring of better fisheries management will require the provision of adequate and accurate information about the UAE's fisheries and marine resources. To this end, EAD (formerly ERWDA) launched a survey in February 2002 to assess the fish and marine resources of the UAE, this being undertaken in association with the Ministry of Agriculture and Fisheries, and the Australian/New Zealand consultants, Bruce Shallard Ltd. Some of the key outputs of this survey, completed early in 2003, include information on species identification, a catalogue of all species captured, and biological statistics such as length/frequency data for the key species. Catches and catch rates were also recorded for each documented species. This work was carried out from a research vessel that traversed the coastal waters of the UAE undertaking habitat mapping and sampling. By October 2002, a total of 587 small pelagic and demersal species from 78 families had been identified and documented.

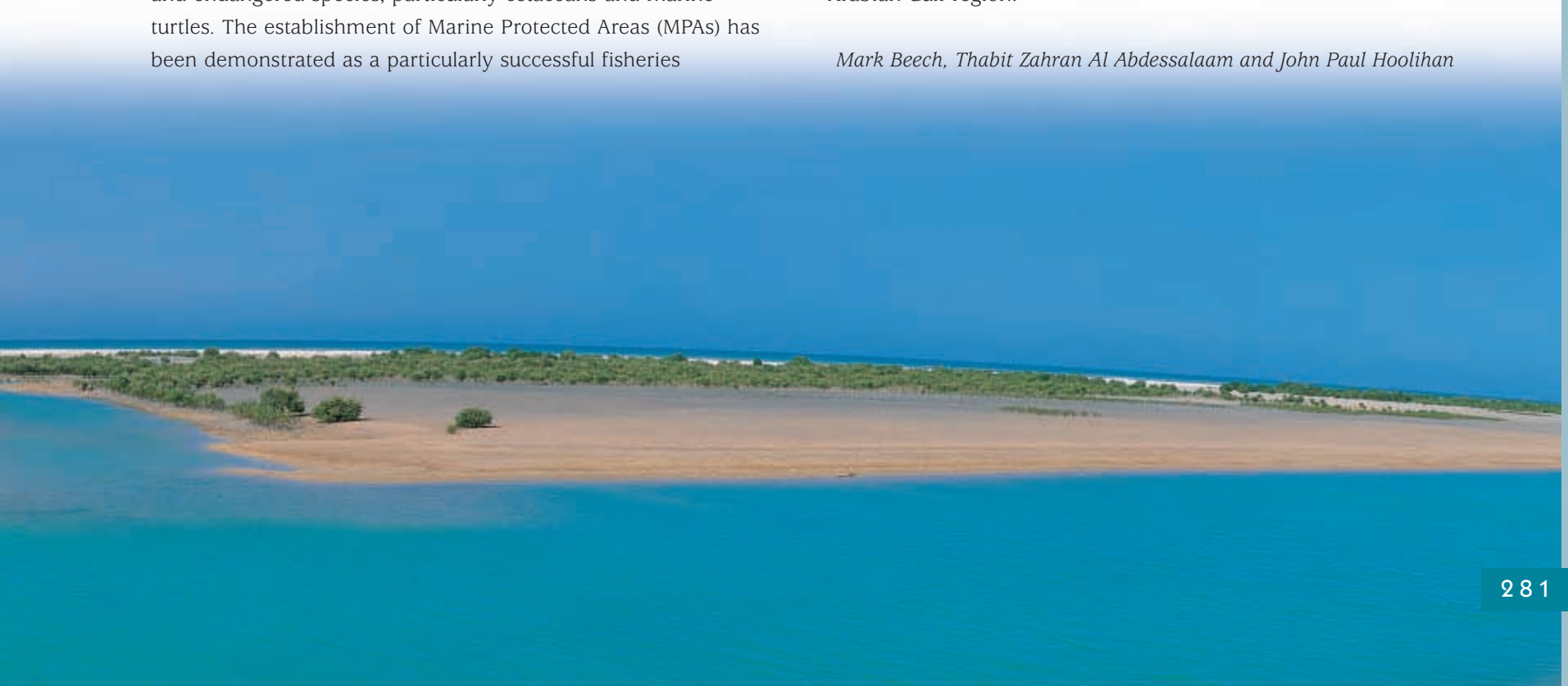
Part of the survey was concerned with determining the ages of the fish sampled, this being conducted by an analysis of otoliths and other detailed biological date from eight key commercial species. The fish studied were the orange-spotted grouper, spangled



emperor, pink-ear emperor *Lethrinus lentjan*, trout thicklip *Plectorhinchus pictus*, sordid sweetlip *P. sordidus*, king soldierbream, double-bar seabream, and yellowfin seabream *Acanthopagrus latus*. Biological and size frequency data were also collected from a further 12 species which either constitute potential commercial species or which made up a significant portion of the catch in the survey. These 12 species include the greater lizardfish *Saurida tumbil*, brushtooth lizardfish *S. undosquamis*, areolate grouper *E. areolatus*, orange-spotted jack, golden trevally *Gnathodon speciosus*, bigeye snapper *L. lutjanus*, mojarra *Gerres acinaces*, gold-lined seabream *Rhabdosargus sarba*, snubnose emperor *Lethrinus borbonicus*, blackstreak bream *Scolopsis taeniatus*, white-spotted rabbitfish/spinefoot *Siganus canaliculatus*, and backtail barracuda *Sphyraena qenie*.

Effective management of resources of such complexity invariably involves an array of objectives encompassing various management techniques. Recently, however, a number of measures have been taken to provide better management of the country's marine resources, one such key measure being the enactment of the 1999 Federal Law for the conservation, development and exploitation of fisheries and marine resources.

Since the Arabian Gulf is a complete biogeographic province, it is therefore an area of global importance. It has global status as a major conservation area for the dugong *D. dugon* and other rare and endangered species, particularly cetaceans and marine turtles. The establishment of Marine Protected Areas (MPAs) has been demonstrated as a particularly successful fisheries management tool. Protection should also be afforded to mangroves, lagoons, seagrass beds, reefs and islands along the coastline, which are important breeding grounds for fisheries. Without a network of such protected areas, there is little hope of protecting resources for future generations.

Four small marine reserves have so far been established on the UAE East Coast to enhance coral reef formation, these being managed by Dibba Al-Fujairah Municipality in co-ordination with the Ministry of Agriculture and Fisheries. The Marawah MPA was also established in 2002 in Abu Dhabi, covering an area of 4,255 square kilometres (including some islands and a stretch of mainland coastline) from the northern tip of the island of Abu al-Abyadh out to Bu Tinah shoals to an area west of the island of Bazm al-Gharbi. Plans are under way to include the island of Abu Al Abyadh and its surrounding waters as part of the MPA, which will increase the area to 5,561 square kilometres. An elaborate management plan is now in place for the Marawah MPA and consultations with potential partners are currently under way to develop a cooperative system of management for the area. The value of 'no-take' zones, where fishing is completely prohibited, has been much discussed, but it is clear from a number of studies that, even after just a few years without fishing, stocks can successfully replenish. There is, however, a need to establish integrated MPA networks for the Arabian Gulf region.

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