

The Regional Organization for the
Conservation of the Environment of
the Red Sea and Gulf of Aden

(PERSGA)

*Dungonab Bay–Mukawwar Island
Proposed Marine Protected Area*

*Site-Specific Master Plan with
Management Guidelines*

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PERSGA

June 2004

PERSGA-‘The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden’ is an intergovernmental authority dedicated to the conservation of the coastal and marine environments in the region and the wise and sustainable use of their natural resources.

The Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (Jeddah Convention) 1982 provides the legal foundation for PERSGA. The Secretariat of the Organization was formally established in Jeddah following the Cairo Declaration of September 1995. The PERSGA member states are Djibouti, Egypt, Jordan, Saudi Arabia, Somalia, Sudan, and Yemen.

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All satellite photographs are Landsat 7ETM+ true colour composites ETM1,2,3.

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LIST OF ABBREVIATIONS

ACORD	Agency for Co-operation and Research in Development
AEWA	African Eurasian Migratory Waterbird Agreement
AIMS	Australian Institute of Marine Science
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
COT	Crown of thorns
EIA	Environmental Impact Assessment
GEF	Global Environment Facility
GIS	Geographical Information System
GPS	Global Positioning System
HCENR	Higher Council for Environment and Natural Resources
IBA	Important Bird Area
IUCN	The World Conservation Union
MPA	Marine Protected Area
NEB	Net Environmental Benefit
NGO	Non-Governmental Organisation
OVI	Objectively Verifiable Indicator
PERSGA	The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
RIB	Rigid Inflatable Boat
ROPME	Regional Organization for the Protection of the Marine Environment
SAP	Strategic Action Programme
SCUBA	Self Contained Underwater Breathing Apparatus
SNP	Sanganeb National Park
SPA	Special Protected Area
TOR	Terms of Reference
TPH	Total Petroleum Hydrocarbon
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN	United Nations
WWF	World Wild Fund for Nature

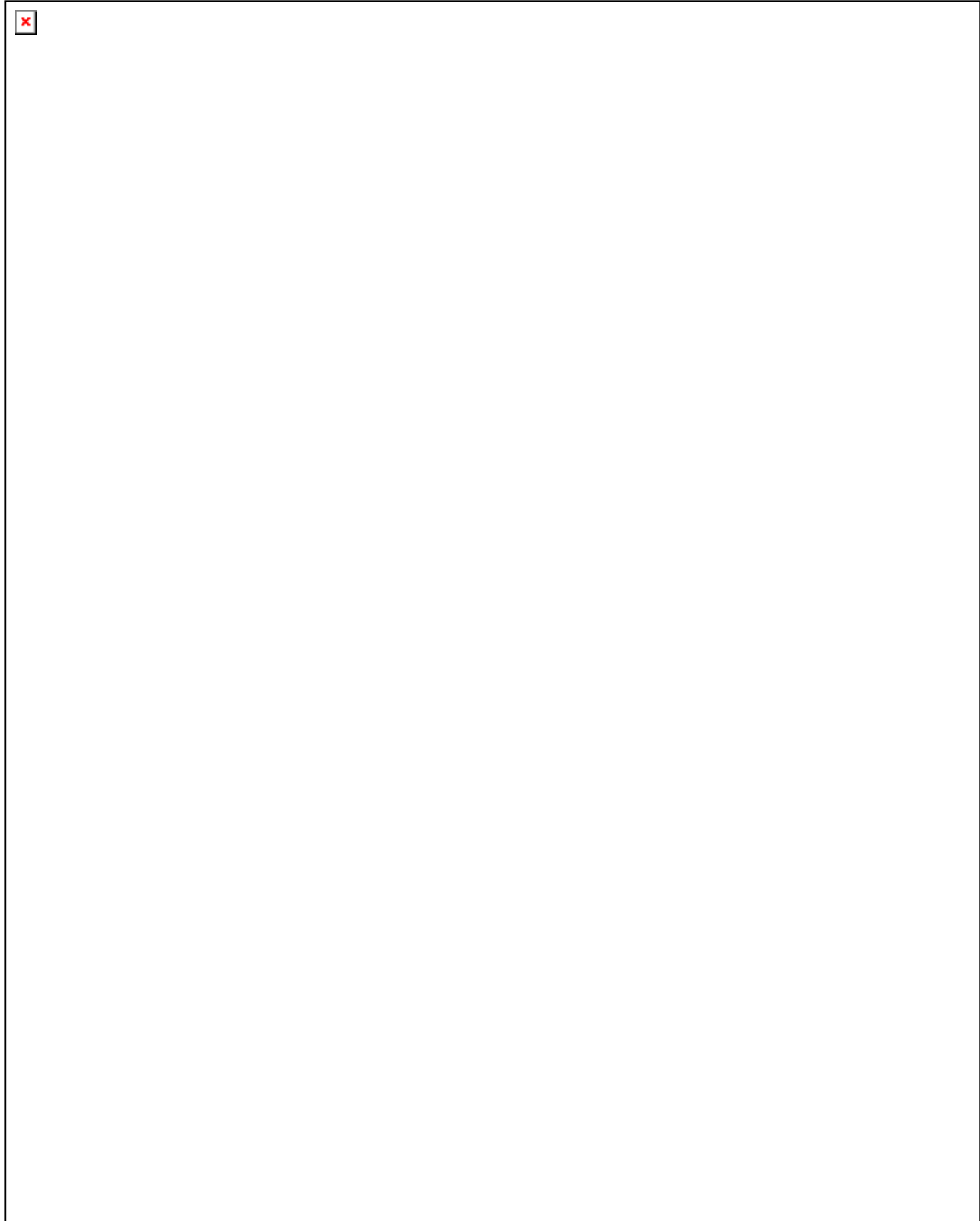


Figure 1. True colour satellite image of the Dungonab Bay–Mukawwar Island area.
Landsat 7ETM+ true colour composites ETM1,2,3.

1. EXECUTIVE SUMMARY

This Master Plan has been prepared for the proposed marine protected area (MPA) at Dungonab Bay–Mukawwar Island, one of twelve MPAs within the Red Sea and Gulf of Aden regional network. The primary goal is the conservation of the biological diversity of this unique location, while allowing and facilitating sustainable resource use through the application of ecosystem-based management. The PERSGA Strategic Action Programme (SAP), through which this Master Plan was developed, supports and facilitates these goals at the regional level.

MPAs act as tools to provide for sustainable use of natural resources, economic development, and biodiversity and habitat conservation. The regional network of MPAs, of which Dungonab Bay is an important part, will constitute a regionally and globally important tool for *in-situ* conservation of species and habitats within the unique Red Sea and Gulf of Aden region.

The Red Sea and Gulf of Aden contain some of the world's most diverse and varied tropical marine habitats and communities. The combination of broad diversity, great biogeographic complexity, and high levels of endemism make the region of global importance for marine biodiversity conservation (CHIFFINGS 1995; PERSGA/GEF 2001).

The Dungonab–Mukawwar area lies on the western shore of the north-central Red Sea. The southern boundary of the proposed MPA is located approximately 120km north of Port Sudan; it extends almost 70km northwards and includes reefs, islands and all other marine habitats along this stretch of coast. The MPA contains an enormous diversity of habitats, many still in very good condition, and a diversity of species including populations of several globally threatened or endangered flagship species.

A number of ecological and socio-economic characteristics of the area mean that the Dungonab Bay MPA is of national, regional and international importance for biodiversity conservation, and for sustainable use of living marine resources. These characteristics include:

- A spectacular diversity of marine habitats and communities, including some extremely unusual coral and reef fish communities;
- Extensive and diverse coral and reef fish communities;
- Extensive seagrass beds of regional importance;
- Spectacular, unspoiled coastal landscapes;
- A large population of the globally endangered dugong;
- Regionally or globally important nesting areas for marine turtles and seabirds;
- Seasonal aggregations of whale sharks and manta rays that are unique in the entire western Indian Ocean region;
- A possible refuge for corals in the face of climatic and oceanographic changes attributable to global climate change;
- Potential for implementation of an ecosystem-based approach to fisheries management that will be important for sustainability of fisheries both within the MPA boundaries, and beyond;

- A significant resident human population that is almost entirely dependent upon extractive resource uses;
- Other important economic activities including aquaculture and salt production;
- Considerable potential for the development of sustainable high-value tourism.

The exceptional significance of the area is such that the designation of Dungonab Bay-Mukawwar Island MPA should become a conspicuous flagship project for conservation in Sudan and the Red Sea, and the regional network of which it is a part.

The area is currently relatively pristine but there are already indications that ecosystem-based management and MPA-based conservation are becoming an urgent necessity. For example:

- Over-exploitation of fisheries resources is already apparent in some important groups.
- There are real and immediate threats to a number of endangered and flagship species within the MPA. For example, the population of globally endangered dugong in the area is rapidly declining due to use of inappropriate fishing methods in sensitive areas.
- Extensive areas of coral damaged in the 1998 global coral bleaching event require management of further impacts to enable recovery.

1.1 OBJECTIVES AND GOALS

The objectives for the Dungonab Bay – Mukawwar Island MPA are based upon those set out in the Regional Master Plan, and can be summarised as:

- 1) To conserve representative and prime examples of the biodiversity of the Red Sea and Gulf of Aden.
- 2) To provide for the sustainable use of living marine resources both within and beyond the MPA boundaries, by:
- 3) The development of a network of seasonal and permanent Fisheries Reserves that will provide for the conservation and replenishment of breeding stocks, and biomass; and
- 4) The promotion of sustainable and non-destructive fishing methods.
- 5) To support local and national economic and social development.
- 6) To protect the unique cultural heritage of the marine and coastal environments of the Red Sea and Gulf of Aden.
- 7) To develop regional capacity in all aspects of MPA planning and management.
- 8) To involve local communities and stakeholders as partners in MPA management.
- 9) To conduct research and monitoring programmes to inform MPA management.
- 10) To enhance public awareness of the marine resources and biodiversity of the Red Sea and Gulf of Aden, and the principles of sustainable use.
- 11) To implement a regional legal framework for protected areas and biodiversity (through Dungonab Bay and the other MPAs within the regional network).

Each of these primary objectives has a series of goals, as well as specific policies and strategies for achieving them.

1.2 MANAGEMENT POLICIES AND STRATEGIES

Management policies and strategies in this Master Plan provide a mechanism for ensuring that issues relevant to the management of the proposed MPA are dealt with. These policies and strategies cover: biodiversity; resource uses; zoning for management; cultural heritage; capacity building and technology transfer; community consultation and participation; research and monitoring; public awareness and education; infrastructure; defence; oil spill contingency planning; and sustainable financing mechanisms.

Central to the management approach is the adoption, as far as possible, of a collaborative and community-based approach. This requires that residents of the MPA are kept fully informed of management policies and approaches, and that effective consultation mechanisms are put in place and utilised from the earliest stages of implementation. The adoption of this approach will simplify management, reduce operating costs, encourage and increase the support and involvement of the local community, foster a ‘self-policing and self-enforcement’ approach, and greatly increase the medium to long-term success of the MPA in achieving its objectives.

The existence and further development of the Sanganeb National Park provides opportunities for co-operation and collaboration that will improve the management effectiveness of both areas, and has the potential to provide a very strong foundation upon which to build the Sudan national MPA network.

1.3 THE MANAGEMENT PLAN

This section of the Master Plan outlines specific activities to be implemented for management of the MPA. Issues and matters addressed match closely those addressed by the policies and strategies.

The use of zoning is central to the Management Plan. Zoning provides a powerful mechanism for reducing or eliminating conflicts and for combining compatible uses, often for mutual benefit. Within the proposed area a number of different zone types will be used, although changes to these may occur as the MPA develops. For each of the different zone types, the main purpose is described, together with the activities which are permitted and prohibited. The different zone types can be summarised as:

- Nature Sanctuaries: for strict protection and conservation of critical sites, and endangered or particularly vulnerable habitats and species.
- Fisheries Reserves (i.e. ‘no-take’ fishing areas): to allow maintenance and/or regeneration of fish and other marine populations, and to increase sustainability of fisheries within and outside the MPA by export of eggs and larvae, and emigration of adults.
- Nature Reserves: for non-extractive and non-destructive resource uses compatible with biodiversity, habitat and species conservation. In addition to conservation these areas will be made available for sustainable tourism uses that do not conflict with conservation.

- Resource Use Zones: for sustainable and non-destructive fisheries, and other fully sustainable uses (where these do not clash with fisheries) such as carefully controlled tourism.
- General Use Zones: for sustainable and carefully controlled infrastructure development.

This Master Plan provides an indicative preliminary zoning plan to be implemented, developed and extended throughout the first two to three years of implementation (Appendix 3). A number of general and specific requirements for zoning are provided to support this process.

It is essential that the residents are fully consulted about and involved in the full development and implementation of the zoning plans, as well as other aspects of the Management Plan.

2. INTRODUCTION

The primary goal of the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) is the conservation of the environment and biological diversity of this unique region. From 1999 to 2004 PERSGA was the executing agency for the Strategic Action Programme for the Red Sea and Gulf of Aden (SAP). The SAP was funded by the Global Environment Facility (GEF) implementing agencies (UNDP, UNEP and the World Bank) with supplementary support from the Islamic Development Bank. The SAP included several components, one of which (Component 5) was titled *Development of a Regional Network of Marine Protected Areas* (PERSGA/GEF 1999).

One of the twelve marine protected areas (MPAs) proposed for the regional network is the Dungonab Bay–Mukawwar Island MPA. This MPA is designed to enable the conservation of the regionally and globally significant marine biodiversity of the area with sustainable use. As such, although it includes a substantial area of coastal land as an essential buffer zone, it can be termed a marine protected area.

The location of Dungonab Bay and Mukawwar Island are shown in Figure 2 along with the approximate locations of the other MPAs proposed in the network.

Marine protected areas (MPAs) are an important component of the armoury of methods and approaches available for sustainable use of marine natural resources, economic development, and biodiversity and habitat conservation. The regional network of MPAs will form an important tool for *in-situ* conservation of species and habitats in the Red Sea and Gulf of Aden.

A marine protected area may be defined as:

An area managed to protect and conserve marine and coastal biodiversity, and related ecosystems, ecotones and ecological processes, for posterity.

This is achieved by managing human activities in order to maintain (or in damaged areas to enhance) the ecological integrity of the mangroves, coral reefs, seagrass beds, beaches, coastal vegetation, intertidal areas and other key habitats and species within the MPA.

MPAs can provide a range of benefits to local communities and national development, including:

- Sustainable use of resources, helping to secure the future of coastal communities dependent upon extractive resource and the health of marine systems;
- Conservation of biological diversity;
- The maintenance of ecological processes essential to ecosystem function;
- Recovery of degraded environments or overexploited populations;
- Provision of areas for education and research;
- Protection of cultural heritage;
- Support for development goals.

(See PERSGA/GEF 2002 for detailed summary.)

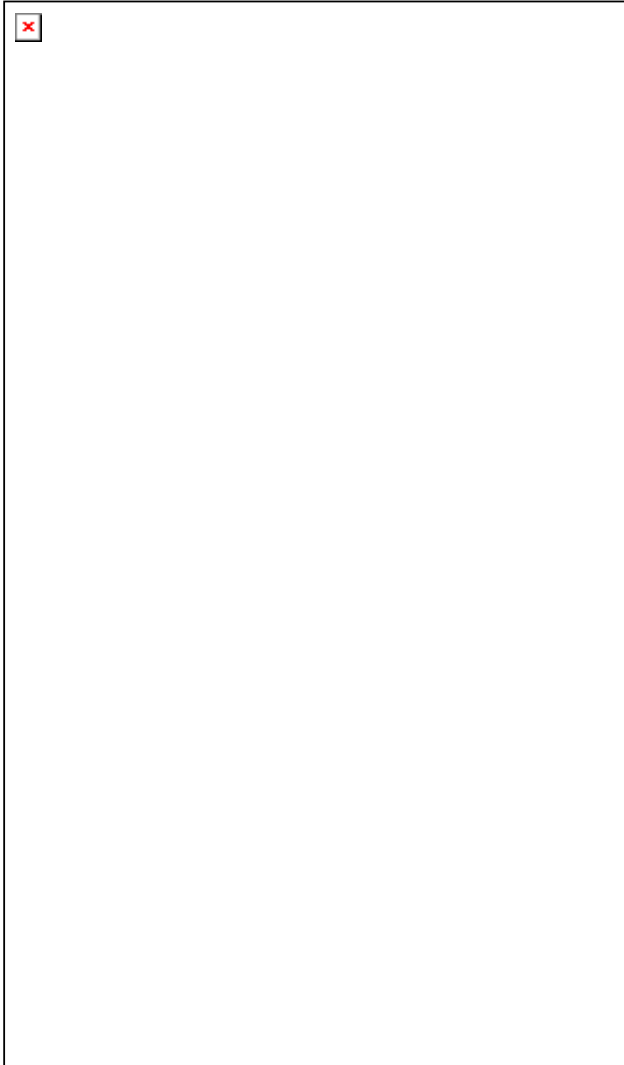


Figure 2. Map of the Red Sea and Gulf of Aden showing the location of Dungonab Bay and Mukawwar Island in the north-central Red Sea and Sanganeb National Park to the south.

The proposed regional network of marine protected areas will include the following sites:

- 1) Aqaba Marine Park (Jordan)
- 2) Straits of Tiran (Egypt and Saudi Arabia)
- 3) Ras Mohammed National Park (Egypt)
- 4) Red Sea Islands (Egypt)
- 5) Wajh Bank, Sharm Habban and Sharm Munaybirah (Saudi Arabia)
- 6) Mukawwar Island and Dungonab Bay (Sudan)
- 7) Sanganeb National Park (Sudan)
- 8) Farasan Islands (Saudi Arabia)
- 9) Iles des Sept Frères and Ras Siyyan (Djibouti)
- 10) Aibat and Saad ad-Din Islands, Saba Wanak (Somalia)
- 11) Belhaf and Bir Ali area (Yemen), and
- 12) Socotra Islands (Yemen)

This Site-Specific Master Plan has been produced following guidelines in the *Red Sea and Gulf of Aden Regional Network of Marine Protected Areas: Regional Master Plan* (PERSGA/GEF 2002). The regional network of MPAs, and individual MPAs established under that programme, will: promote and support the establishment of other MPAs in the region; facilitate the development of information sharing and linkages; develop a strong national and regional human resource base; and contribute to the conservation and sustainable use of the marine wealth of regional nations.



An ecological and resource use survey of the Dungonab Bay–Mukawwar Island area was carried out in 2002 by PERSGA and the Sudan Wildlife Conservation Administration, to provide the information base upon which to build the Site-Specific Master Plan presented here. Full details of the survey findings are provided in the survey report (KEMP et al. 2002, in printing as PERSGA/GEF 2004). The findings of that survey are summarised in this Master Plan and the report should be available to MPA management for further reference, as required.

Figure 3. Geographical location of the Dungonab Bay–Mukawwar Island proposed MPA in relation to Sanganeb National Park.

3. DESCRIPTION OF THE AREA

3.1 LOCATION AND SIZE

The Dungonab Bay–Mukawwar Island proposed marine protected area (hereinafter referred to as ‘the Dungonab Bay MPA’) lies on the central Sudanese Red Sea coast (Figure 3). The southern boundary of the MPA lies close to and slightly south of Sheikh Okod, approximately 125km north of Port Sudan (Figures 4 and 5). The northern boundary lies to the north of Khor Shanaab, 195km north of Port Sudan. On its western (landward) side the Dungonab Bay MPA includes a substantial ‘buffer zone’ of coastal land between 5km and 10km wide. This buffer zone includes the two principal villages of the area, Mohammed Qol and Dungonab.

The terrestrial buffer zone will enable the management of impacts from terrestrial sources, which may otherwise render the MPA ineffective. Protection of subtidal areas is likely to be wholly or partially ineffective if activities on the adjacent shores are not carefully controlled. Direct and indirect impacts on marine communities by shore-based activities are a common reason for failure of both short and long-term protection programmes aimed at coastal and marine communities.

On its eastern (seaward) side the MPA extends between 6km offshore at its northern end, and 30km offshore in the area of Mukawwar Island and the large complex of reefs to the south of the Dungonab Peninsula.

The MPA extends a straight-line distance of approximately 70km north-south, and slightly over 40km east-west at its widest point. The total length of coastline in the MPA, including Dungonab Bay and Peninsula and the major islands, is over 200km. A detailed legal description of the boundaries of the MPA and how they should be marked is provided in Appendix 1.

3.2 TOPOGRAPHY AND BATHYMETRY

Topography

The mainland shore throughout the MPA is for the most part backed by a gently sloping coastal plain varying in width from 5km, to the south of Mohammed Qol, to over 30km to the north of Dungonab Bay and towards Khor Shanaab. The coastal plain is composed of sandy and gravel deposits, in many places overlying fossil reefs, and backed by the Red Sea Hills, rising to over 1500m. In some areas, particularly south of Mohammed Qol, low raised areas of fossil reef, up to 15m high, extend to the water’s edge. These form the edges of some significant features, such as Mersa Inkefal.

At the western end of Khor Shanaab the hills approach the coast, and limit easy access to the shore along the north-western side of Khor Shanaab. However, between Khor Shanaab and the northern MPA boundary, the coastal plain once again reaches 20km or more in width.

The western edge of Dungonab Bay is formed by the Ras Rawaya Peninsula (referred to in this management plan as the Dungonab Peninsula). This is a low-lying sand and gravel peninsula primarily composed of extensive areas of fossil reef. The low hills of Jebel Abu Shagrab and Jebel Tetwaib (important for terrestrial wildlife including Eritrean gazelle – *Gazella dorcas littoralis*) are located at the southern end of the peninsula.

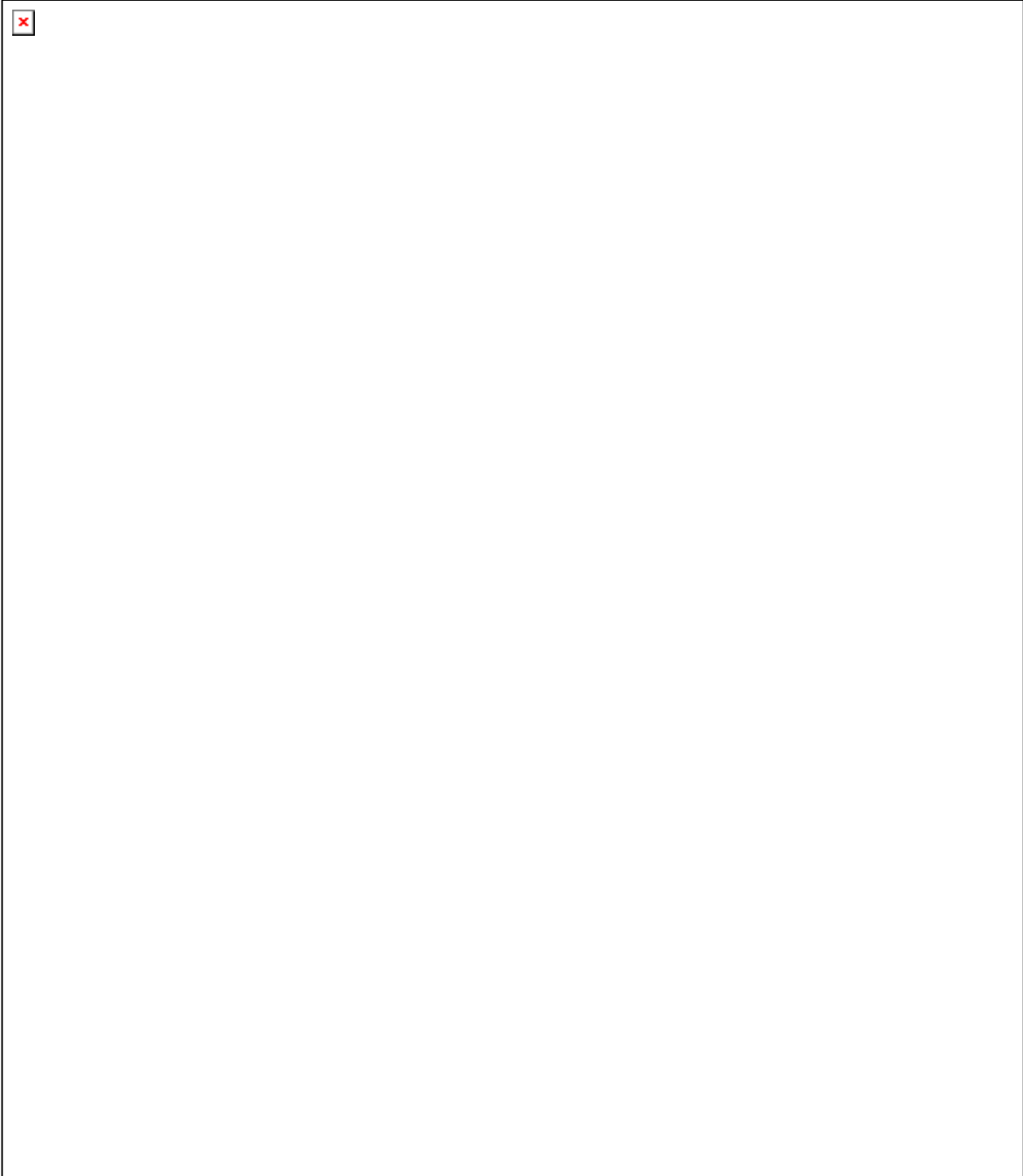


Figure 4. Map of the Dungonab Bay Marine Protected Area, showing the location of principal features and areas mentioned in the text of this Master Plan.

Management issues related to location and size

The area at Dunganab proposed for the MPA is both relatively remote and large. Both of these characteristics have implications for management.

Location:

Until transport links (i.e. the coastal road) between Port Sudan and the MPA are improved, levels of impact due to coastal development are likely to be relatively slow to arise. However, it is essential to control development from the earliest stages of implementation as inappropriate development may render parts of the management plan unworkable.

Poor transport links (difficult, expensive and time-consuming transportation) will limit the accessibility of the MPA to tourists, and so will have a negative impact on the income of the MPA.

Communication for management purposes between the MPA, and offices, authorities, emergency services, etc. in Port Sudan will be relatively expensive and time-consuming until transport links are improved. Currently a full day (12–16 hours travel) is required for the round trip to Port Sudan. Offices within the MPA will need to be relatively self-sufficient, extra vehicles will need to be made available for re-supply and emergency use, in addition to the number required solely for patrolling and other work within the MPA. Radio communication must be established very early, and arrangements put in place with emergency services (particularly medical services) in Port Sudan.

Plans are apparently already being developed for improvement to the coastal road from Port Sudan to Egypt. Currently the coast road passes through the MPA, in many places within a few metres of the shore. It is essential that the new coast road is set back from the shore. This will ideally be outside the coastal buffer zone (i.e. between 5km and 10km behind the shore). Where this is not possible, set-back should be a minimum of 1km. In such locations management efforts related to the road should focus on controlling or preventing access to the shore except via designated routes, leading to carefully selected sites.

Size:

A minimum of three well-serviced vehicles, and two seaworthy boats (6.5m RIBs) will be required for routine and non-routine patrolling and enforcement within the MPA boundaries. For day to day management the MPA will eventually need two separate offices: a main office and a sub-office, one to be located in each of Dunganab village and Mohammed Qol.

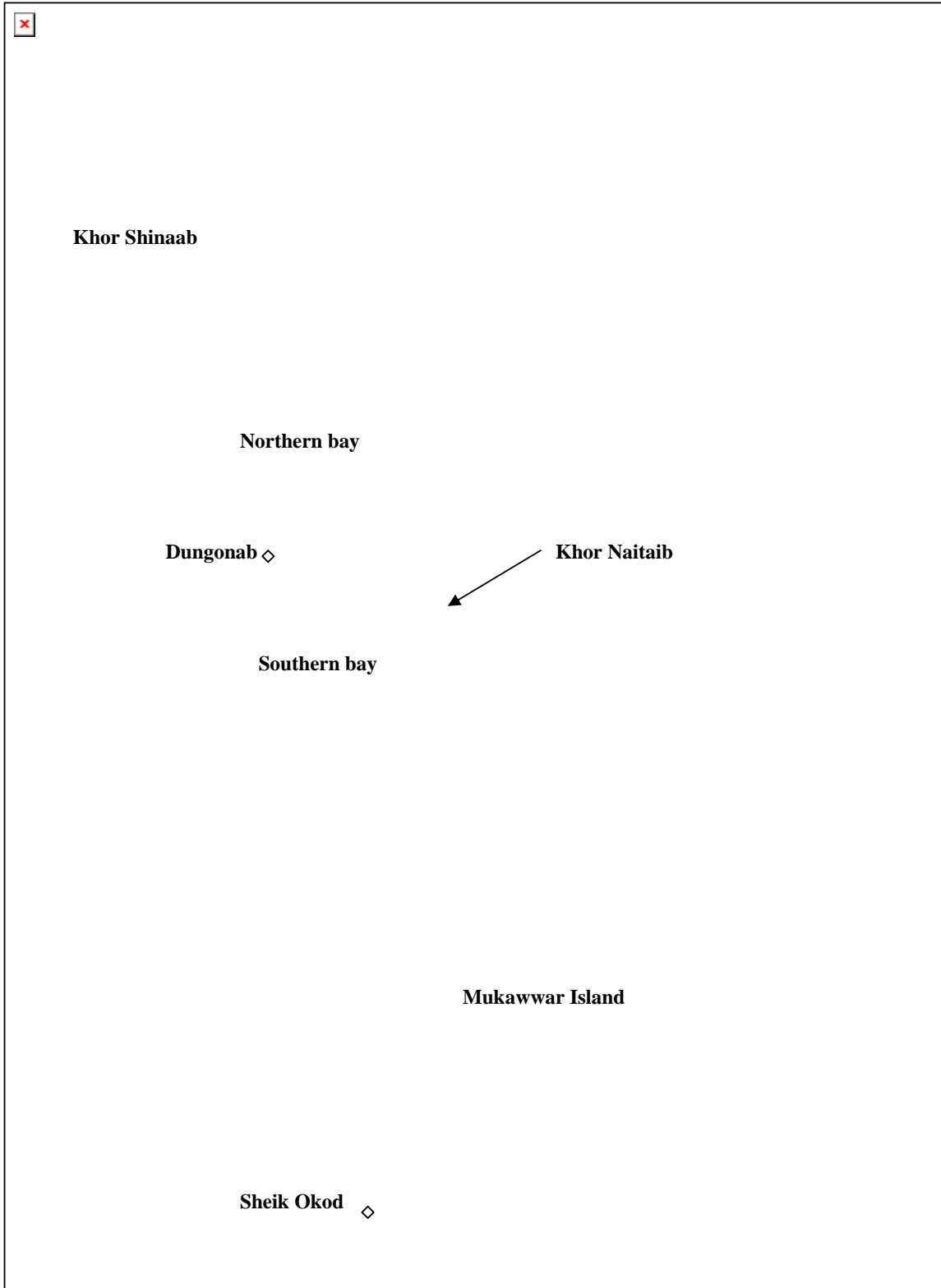


Figure 5. The external boundaries of the proposed marine protected area.
(See Appendix 1 for details.)

Islands

There are numerous small islands at the southern end of Dungonab Bay, and to the south of the bay towards Mukawwar. The islands within the MPA are either:

- 1) Very low-lying (generally less than 1m elevation) with halophytic vegetation on sand, overlying fossil reef rock. These islands tend to be small, some being less than 100m across; or
- 2) Slightly uplifted (1–2m) flat-topped fossil coral, demonstrating the classic central Red Sea undercut profile at the waters edge; or
- 3) In two cases (Mukawwar and Mayteb Kebir) high rocky islands composed of uplifted sedimentary rocks and fossil reef.

Bathymetry

Dungonab Bay

Dungonab Bay is approximately 13km across at its southern end, and extends 31km from north to south. The total area of the bay is 284.5km². The maximum depth of the bay is 42.5m, with an average of 15.9m (FARAH 1982).

The bay has three main features:

1. A wide shallow sill (approximately 5m deep) at its southern end, separating a large southern basin within the bay from the deeper water outside. Maximum depth here is 42.5m, with an average of 34.1m.
2. An almost circular northern basin partially isolated from the southern basin by islands and another shallow sill. This northern part of the bay reaches depths of 15m, with an average of 7.2m.
3. The long narrow basin of Khor Naitaib (13km long and 1.5km wide along most of its length, reaching 22.5m depth and averaging 6.6m), almost enclosed within the Dungonab Peninsula.

These will be referred to in this Management Plan as the Southern Bay, the Northern Bay, and Khor Naitaib, respectively (Figure 5).

Other areas

Immediately to the south and south-east of Dungonab Bay is a large complex of shallow reefs and islands, rising from a seafloor varying in depth from less than 20m (immediately to the south of the Dungonab Peninsula) to over 100m, and as deep as 400m or more (offshore reefs and islands including Mayteb Kebir, Shambaya, Merlot, Angarush and Abington). The channel between Mukawwar Island and the mainland is devoid of reefs or shoals except close inshore, where broken or patchy fringing reefs and rocky outcrops on a shelving sandy sea floor are found along both sides. To the south of Khor Inkefal and towards Sheikh Okod extensive inshore shallow areas host complexes of seagrass beds and reefs.

The eastern, seaward side of the Dungonab Peninsula, and the coast from there northwards to the northern boundary of the MPA, is bordered by continuous fringing reef broken only by the mouth of Khor Shanaab. This reef is backed along much of its length by a lagoon up to 500m wide, and up to 15m or more in depth. Here the reef face drops away rapidly in stages to over

400m. Two important reefs lie within the MPA boundaries off this coast, rising to the surface from deep water.

Management issues relating to topography and bathymetry

Limited exchange of water between Dungenab Bay and the open sea means the whole of the bay is particularly vulnerable to pollution. This limited circulation also gives rise to unique ecology within the bay.

The extensive lagoon behind the coastal fringing reef to the south of Khor Shanaab is also vulnerable to pollution, which may be retained within the relatively small body of water in the lagoon by limited exchange with the open sea.

Very different sea conditions occur in different parts of the MPA in severe weather. Most of the bay itself is relatively easily navigable by small boats with outboard motors even in the worst weather. Outside the bay it is regularly unsafe to travel by small boat, even between Mukawwar and the mainland, due to high winds and heavy swells.

Safe anchorages are very limited in areas outside the bay. Such locations should be identified and clearly marked, and mooring buoys provided to avoid anchor damage to reefs. This is made more important by the fact that the most attractive SCUBA diving sites tend to be among the exposed outer reefs and islands.

3.3 CLIMATE AND OCEANOGRAPHY

Sudan lies within the semi-desert and desert zone of North Africa. The coastal plain is hot and very dry, with only occasional and brief freshwater run-off into the sea during the rainy season in November–December (there are no natural perennial inputs of freshwater on the Red Sea coast). A consequence of this is low nutrient levels throughout much of the Red Sea, with resultant low levels of turbidity in many areas. Seawater clarity in the region is thus generally very high, particularly in deeper water areas and around offshore reefs where visibility of up to 70m has been recorded (PERSGA/GEF 2001). However, poor weather conditions and rough seas can reduce visibility in some shallow inshore areas of the Dungenab Bay MPA to almost zero.

During the winter air temperatures may fall as low as 15°C (FARAH 1982), while summer temperatures regularly reach the mid 40s (°C) or higher (FARAH 1982; SHEPPARD et al. 1992).

Surface water temperatures throughout most of the Sudanese Red Sea range from approximately 26°C to 31°C. The semi-enclosed and shallow waters of Dungenab Bay are highly unusual in this respect exhibiting what is possibly the greatest range of temperatures for any moderately large body of water in the entire Red Sea basin. Water temperature here ranges from a low of 19°C in winter to approximately 35°C in summer (FARAH 1982).

At greater depths the Red Sea is globally unique in that its deep waters maintain temperatures of approximately 21°C even in the deepest parts, due to the semi-enclosed nature of the sea, and the circulation patterns this creates. For comparison, the deep waters of the global ocean have a temperature of approximately 4°C. As a consequence, water temperature at 150m depth in the Port Sudan area is in the region of 23°C–26°C (SHEPPARD & WELLS 1988). Similar conditions can be expected in deeper areas of the MPA.

The unusual oceanography of the Red Sea means that it is particularly saline. In the area of Sudan and the MPA, salinity in the open sea at approximately 40ppt (parts per thousand) is significantly higher than that of the global ocean (37ppt). Within Dungonab Bay the salinity increases steadily from south to north, where it can reach levels of up to 43ppt. At the southern end of Khor Naitaib salinities of 45ppt have been recorded (FARAH 1982). In combination with the broad temperature ranges found in the bay this further emphasises the highly characteristic nature of the bay, and probably explains the unusual or even unique ecology found within it.

Tidal range throughout the central Red Sea is typically in the region of 55cm in non-enclosed areas. By contrast, although the restricted water exchange between the bay and the open sea means that the true tidal range inside the bay is probably only a few centimetres. Tides within Dungonab Bay are highly variable, being dependent upon wind strength and direction, and associated local forcing of surface water movements. The overall result is irregular and unpredictable tidal patterns (CROSSLAND 1911), where the tidal range never exceeds 50cm.

Management issues relating to climate and oceanography

Dungonab Bay as a northern/central Red Sea refuge from coral bleaching events. The global coral reef bleaching event of 1998 impacted the coral communities within the MPA to differing degrees, almost certainly due to the complex oceanography of the area. In particular, corals within the bay, inside Khor Shanaab, and at the offshore reefs in deep water were largely unaffected. In contrast those of fringing reefs outside the bay or Khor Shanaab, and around Mukawwar, Mayteb Kebir and Sarir were heavily, although patchily, affected. Environmental parameters monitored within the MPA should thus include weather conditions (through the installation of a semi-professional weather station, in co-ordination with similar monitoring at Sanganeb National Park) and continuous monitoring of seawater temperatures through the positioning of data loggers at various points throughout the MPA.

The exceptionally hot and humid summer weather of the region will limit the attractiveness of the MPA to tourists during this season. This will have to be taken into consideration when planning the detailed management of both finances and tourist facilities.

Sudan is already world-renowned among the sport SCUBA diving community, at least in part due to warm water and exceptional underwater visibility. This fame should be fully exploited when promoting the MPA internationally.

3.4 BIODIVERSITY

The Red Sea and Gulf of Aden contain some of the worlds most diverse and varied tropical marine habitats and communities. The combination of high levels of diversity, biogeographic complexity and endemism found in these bodies of water make this a region of global importance for marine biodiversity conservation (CHIFFINGS 1995; PERSGA/GEF 2001).

Habitats

The wide range and complex distributions of habitats within the MPA are described in some detail in KEMP et al. (2002). A summary is provided here.

Corals and coral reefs

Corals and coral reefs are the dominant shallow marine communities on hard substrates throughout the MPA. SHEPPARD & WELLS (1988) provide a brief summary of previous biological survey work within the area. This was dominated by the work of CROSSLAND (1907, 1911, 1913), VINE & VINE (1980) and MOORE (1985). VINE & VINE (1980) described coral communities at a number of sites inside and outside the bay. They recorded a number of highly unusual monospecific areas of *Galaxea*.

Corals are widespread and healthy along all shores of the bay, including those to the west, east and north, and around the islands. The exception to this is those of the southern sill, separating the bay from the open sea. Corals at this site, in early 2002, were heavily impacted by the 1998 bleaching, with over 90% mortality in places.

The impact of the global coral bleaching mortality event of 1998 is evident throughout most of the area, but levels of impact are highly variable. At the largest scale there is a significant difference between the corals inside and outside the bay. Those within the bay are almost entirely unaffected by the bleaching event, but many areas outside the bay have been severely impacted. The main exceptions to this are the corals of some, but not all, of the furthest offshore reefs, and those of Khor Shanaab. Corals at these locations are generally in very good condition. There are also scattered pockets of healthy corals throughout the rest of the survey area.

The distribution of healthy and impacted coral communities outside the bay is very patchy, with many areas remaining in good condition. Many impacted areas show good levels of recruitment of new corals, but others show no recovery at all. Management measures can aid the recovery of damaged reefs.

The MPA outside Dungonab Bay is dominated by well-developed coral reefs fringing both the mainland and islands, with extensive offshore patch reefs and barrier reefs extending to approximately 30km from shore. These coral communities are more typical of the northern and central Red Sea, and are different to the coral communities inside the bay.

Seagrasses

The total area of seagrass estimated using remote sensing from LANDSAT images is almost 12km² – a substantial area. The extensive seagrass beds are a nationally and regionally important feature of the MPA. This is especially true given the population of globally endangered dugong (*Dugong dugon*) found here. Most of these seagrass areas are known to be important feeding areas for dugong.

The main concentrations of seagrasses so far identified are:

- Shallow areas of the mainland coast to the south of Mohammed Qol and extensive seagrass beds towards Sheikh Okod;
- The western and southern shores of Mukawwar Island, particularly in and around the southern lagoons;
- The northern and western parts of Dungonab Bay;
- The western one third of Khor Shanaab;
- Around mangroves at the southern end of the Dungonab Peninsula.

Mangroves

Mangroves (*Avicennia marina*) occur at a number of sites throughout the MPA. Three or four sites are particularly important (southern Mukawwar; southern Dungonab Peninsula and Mersa Inkefal). A significant mangrove stand is also reported inside Dungonab Bay, on the north-western section of the peninsula.

The mangroves of the proposed MPA are generally in good condition with little evidence of recent human impact, other than at one site. However, camel grazing is a factor at all the mainland mangrove sites, and may be limiting the further expansion of these mangrove areas.

Mangrove stands near Mersa Inkefal to the south of Mohammed Qol appear to have suffered heavy woodcutting in the past, but may now be regenerating. At the southern end of the Dungonab peninsula, mangroves are subject to cutting, probably for animal fodder and/or firewood for the salt works on the peninsula. This activity is moderately severe in some parts of the mangrove and should be addressed by management.

Intertidal sand and mudflats

Extensive areas of intertidal sand and mud are found, including inside the bay and at the western end of Khor Shanaab. These areas are highly productive; they probably contribute significantly to the total biological productivity and biodiversity of the MPA, and are of national or regional significance as feeding sites for resident and migratory birds. These frequently neglected habitats are often the first to fall victim to destruction through landfill schemes, pollution, and development and, therefore, merit strong protection.

Other habitats

Subtidal sediments and deep water areas are also important components of the MPA. They have distinctive species assemblages, and contribute significantly to biodiversity, ecosystem function, and productivity of the area. Deeper areas in particular are important to whale sharks (*Rhincodon typus*), manta rays (*Manta birostris*), cetaceans and other charismatic megafauna.

Management issues relating to habitats

The wide range of habitats present within the proposed area presents a challenge to management in a number of ways:

All habitat types are important for general biodiversity management and conservation throughout the MPA. All of the more sensitive habitats (coral reefs, seagrasses and mangroves) must be included in monitoring programmes, ideally with representation from throughout their range.

Zoning of the MPA (i.e. differing levels of protection and matching sensitivities of different habitats to different types and intensities of use) must take into account the full range of habitats and their distributions. The objective should be to ensure the conservation of all habitats.

Some of these habitats, such as seagrasses and certain areas of beach, have additional significance as key habitats for globally endangered flagship species (e.g. dugong in the case of seagrasses, and turtles in the case of beaches).

Mainland mangrove stands need protection from cutting and camel grazing.

Detailed habitat-specific management policies should be drawn up early in the implementation of the MPA.

Fauna and flora

To date, limited studies of the fauna of the MPA have been carried out and no comprehensive species lists have been developed for any group. However, those studies which have been undertaken have revealed pronounced patterns in the distribution of indicator groups.

Invertebrates

Hard corals are extremely valuable, providing the most important cover of hard substrates, and creating the majority of reef structures within the MPA boundaries. Although no detailed studies of coral communities in the area as a whole have been carried out, the limited studies available show distinct distribution patterns of coral community types, probably due to the differing environmental conditions. These patterns fall into two categories:

1. *Differences in coral community types inside and outside Dungonab Bay.* Extensive coral communities occur inside the bay, particularly around islands to the west that may be termed 'non-reefal', being on level rocky or gravelly substrates, and apparently giving rise to no biogenic accumulations of rock. In this respect these communities resemble those of Oman and the Gulf of Aden. The exception to this is Khor Naitaib, where well developed fringing reefs occur along most of the eastern shore. Coral communities within Dungonab Bay appear to be very unusual, and possibly of lower diversity than those outside the bay. Low diversity communities such as monospecific *Galaxea*, and other communities dominated by just two or three species, in particular *Stylophora pistillata* are found in several areas, particularly at the northern end of the bay and in Khor Naitaib.

Outside Dungonab Bay coral communities appear to be more diverse, and conform much more to the 'normal' central Red Sea morphology of fringing, patch or barrier reefs with 'classic' profiles including reef slope, crest, backreef and lagoon.

2. *Differences in coral health* (also see section on habitats above). Coral communities inside Dungonab Bay are in very good condition with minimal recent mortality. The coral bleaching event of 1998 does not appear to have caused a significant impact inside the bay. This may be for one or both of two reasons:

Firstly, corals within the bay are likely to be pre-adapted to periodically higher water temperatures than those corals outside the bay. This pre-adaptation is a well known feature of corals in other similarly stressed environments such as the Arabian Gulf (SHEPPARD et al. 1992), and may have enabled the corals of the bay to remain unaffected by the bleaching event.

Secondly, water within the bay itself may have escaped the high temperature anomaly due to its relative isolation from the main body of Red Sea water. The particularly severe impact suffered by the exposed seaward reefs of Mayteb, and other areas including the shallow corals of seaward fringing reefs on and to the north of the Dungonab Peninsula, suggests that the degree of exposure to the open sea was a factor. Both of these factors (pre-adaptation and degree of exposure) may have played an important role in creating the observed distributions of coral health indices in the survey area (KEMP et al. 2002).

Outside the bay coral health is very variable. Some areas (such as the seaward reefs of Mayteb Kebir, of Mukawwar, and of much of the mainland coast to the south of Mohammed Qol) have suffered extensive and high levels of mortality to depths of 10–15m or more. Others, including Khor Shanaab, the deep-water offshore reefs such as Merlot Reef and Abington, and some areas at the southern end of the Dungonab Peninsula, appear to have escaped completely.

Management issues relating to marine invertebrates

Many invertebrate fisheries within the MPA show signs of unsustainable exploitation. As with other fisheries (see below) appropriate management tools should be introduced as a matter of urgency to improve sustainability, and protect the spawning stocks of these animals.

With appropriate ecosystem-based management, adequate and appropriate fisheries reserves to protect the spawning stock, and some areas of undisturbed populations, these fisheries may provide a long-term and sustainable form of extractive use for the peoples of the area.

Increasing commercial value with increasing rarity. It should be noted that, with many of these species becoming increasingly rare worldwide an increase in value is already occurring for some groups. This phenomenon is likely to be seen for other rare species. As a consequence there will be increased incentive to unscrupulous fishermen, particularly poachers from outside the MPA with no interest in the long-term sustainability of stocks, to both overfish legally harvestable stocks, and collect from protected populations/sites. Protection of fishery species will thus be, and remain, a major challenge for the MPA.

Other invertebrates

Other groups of invertebrates are conspicuous throughout the MPA, to varying degrees, with some groups clearly subjected to very high levels of fishing pressure (see section on fisheries below).

Outbreaks of crown of thorns starfish (CoT, *Acanthaster planci*) were reported to have caused extensive damage to corals of the area in the 1970s, particularly inside Dugonab Bay. CoT and other significant threats such as coral diseases were not present in large concentrations in the Dugonab Bay area in early 2002.

Management issues relating to coral predators and coral diseases

1. Crown of thorns starfish

The crown of thorns starfish (*Acanthaster planci*) was a conspicuous component of the coral reef community in the Dugonab Bay area in the 1970s and 1980s (MOORE 1985), and unusually was recorded as feeding on soft corals (*Xenia* spp.) inside the bay. Abundance of crown of thorns (CoT) was so high in the early to mid 1970s that a decline in abundance of soft corals in the mid to late 1970s was attributed to CoT-related loss of corals in the bay.

Abundance of CoT was very low throughout the entire area during the 2002 survey, with animals only recorded at four sites, and no evidence of recent outbreaks (the patterns of damage to coral communities apparent outside the bay indicate that the damage is not due to outbreaks of CoT but to a bleaching-related mortality event).

Crown of thorns starfish are currently not causing problems for the coral communities of the proposed MPA. However, CoT has caused severe problems in several other areas of the Red Sea in recent years, including Yemen and Egypt.

Monitoring of CoT numbers throughout the MPA and adjacent areas should be included within the Management Plan as a routine component of the monitoring programme.

2. *Drupella*

Drupella, a corallivorous gastropod that occasionally occurs in outbreak proportions, has not been recorded causing problems in the MPA (although it has done so further north, in parks in the Egyptian Red Sea). *Drupella* was not observed in significant numbers at any survey site in 2002. However it should be included in routine monitoring programmes for the MPA.

3. Coral diseases

A wide range of coral diseases, including the generic disease groups 'black band disease' and 'white band disease', have caused occasional concerns in other parts of the Red Sea, although never at levels similar to those experienced in other parts of the world such as the Caribbean. Coral diseases should be included in routine monitoring for the MPA.

Fishes

The fish communities of the MPA are diverse and varied. Detailed surveys of the fishes of the area have not been carried out and so species lists are not currently available. However, the relatively rapid surveys, both of the 2002 and previous studies, provide an indication of the nature of the fish communities.

A striking large-scale pattern is apparent in the distribution of fish communities inside and outside the bay, similar to the geographical pattern displayed by different coral communities. This pattern in fish species assemblages resembles biogeographic differences more usually associated with distances of several hundred kilometres. Fish communities inside the bay resemble those of the southern Red Sea (Eritrea/Yemen), while those outside the bay are characteristically northern-central Red Sea.

An implication of this is that studies and monitoring of fish communities should be designed to provide sufficient replication for communities inside and outside the bay. Separate species lists for different sites and areas within the MPA should be developed for monitoring purposes, in addition to an overall list.

This characteristic of the proposed MPA emphasises the importance of the area for marine biodiversity conservation: the Dugonab Bay–Mukawwar area encompasses a variety of fish communities and coral communities more usually separated by several hundred kilometres.

Indications of heavy fishing pressure

In some cases the striking variation in fish communities is likely to be an indication of heavy fishing pressure selectively removing some groups. In particular:

- Large groupers were conspicuous by their absence throughout the entire survey area;
- Very few nagil (*Plectropomus* sp.) over 30cm in length were seen in the water during the field survey, indicating very heavy exploitation pressure on this species;
- A lack of some fisheries groups such as snappers was notable at sites fringing the mainland shore near Mohammed Qol. This is unlikely to have been a habitat effect.

Sharks and rays

Little is known of the sharks and rays of the proposed area. Very few sharks were observed during the survey. A number of small reef sharks (reef black tips, *Carcharinus melanopterus*, and occasional reef white tips *Triaenodon obesus*) were seen at several sites, most notably on the

western side of Mukawwar Island and at one of the western islands inside Dungonab Bay. Hammerhead sharks (*Sphyrna* sp.) were seen at Merlot reef, where they are apparently common. Such sites have great potential for scuba diving tourism, although carrying capacities must be set at realistic levels (heavily dived sites tend to lose their sharks – driven away by excessive disturbance).

The Dungonab Bay–Mukawwar area is well known as a place where whale sharks (*Rhincodon typus*) and manta rays (*Manta birostris*) aggregate (SHEPPARD & WELLS 1988), although none were observed during the 2002 survey. This is probably because the survey did not coincide with the aggregation period, reported to be over the summer months (personal communication, Mr Andrea Bari).

Management issues relating to fishes

Fishing is the major economic activity within the MPA. There are numerous management issues related to fisheries. These are addressed in section 3.5. Resource Uses, below.

Management issues relating specifically to sharks and rays

Shark fishing is currently a common occurrence in the MPA, usually carried out by fishermen from Port Sudan, or illegally from outside Sudan. Sharks were observed within the catch landed at Mohammed Qol and evidence of shark fishing was also observed in a number of locations, including the sheltered anchorage of Mersa Inkefal.

Sharks worldwide are heavily overfished. Large size, rarity, slow reproduction rates, late maturity and high demand for shark products from the Far Eastern market all mean that this ecologically important group is under unsustainable pressure worldwide.

Management should ultimately aim to halt all shark fisheries within the MPA. The wide-ranging nature of many sharks means that many will still be vulnerable to capture when they move outside the park's boundaries.

Sharks are one of the most noteworthy attractions for high-value international scuba diving tourism, adding to the already considerable potential that the deep-water reefs of Sudan have for development of scuba diving tourism. Any shark fishing effort will rapidly remove sharks from potential dive sites, with significant negative consequences for dive tourism (just a few days of fishing can severely deplete the shark populations of such sites).

Advice and input regarding management of shark and ray populations inside and outside the MPA should be sought from expert groups, including the IUCN Shark Specialist Group.

The Dungonab Bay–Mukawwar Island area is well known for its whale sharks and manta rays during the summer months. These are likely to become a major attraction for both diving and non-diving tourists. Careful management of tourism and other activities is essential as excessive or intrusive activities may drive these animals away altogether.

The areas where these aggregations occur must be clearly identified and protected. Approaching or interfering with whale sharks should be prohibited, except for carefully controlled licensed 'shark viewing' tourist activities. These activities should be used to bring

revenue to the MPA through a licensing system, and may provide additional alternative livelihoods to local communities, who should be given preference over non-local applicants.

It is strongly recommended that expert advice is obtained on how best to develop and control tourism and other activities related to shark watching. Unlike whale watching, this is a form of tourism not yet widely practised, but valuable experience has been gained in north-western Australia, and to a lesser extent in Belize. This experience and expertise should be accessed early in the implementation of the MPA, and incorporated into the management programme for the Dungonab sharks.

These annual aggregations of whale sharks and manta rays are unique in the western Indian Ocean region, and have the potential to create a world-wide interest in the Dungonab Bay MPA, with consequent local and national benefits, particularly from ecotourism.

Turtles

Both green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) are common throughout the survey area. Green turtles are particularly widespread. The extensive shallow areas of reef flat and sand at the northern end of Mukawwar Island may be an area where green turtles gather during the day in the breeding season. Nesting then takes place at nightfall on the beaches of the island immediately to the south. Hawksbill turtles are common at the extreme northern end of Dungonab Bay, where the areas of shallow *Stylophora* corals may form an important feeding ground.

Beaches throughout the MPA, but particularly the islands and Dungonab Peninsula, constitute a nationally and regionally significant turtle nesting area. The range of different egg sizes (assessed on the basis of old empty shells) indicates that at least three species of turtle nest within the survey area.

The extensive sandy beaches on the eastern side of Mukawwar are a mass turtle nesting site of regional or global significance, whose importance has not previously been recognised. At site SUD/04/11 a total of 409 nest pits were counted along 800m of beach (Figure 6). This constituted less than half the total length of that single beach, which is only one of several along that shore of the island. A cursory examination indicated that all or most beaches on this side of the island are likely to be similarly important for turtle nesting, with perhaps several thousands of nest pits along this 8–10km stretch of shore. Identification of all such sites in the area should have a high priority during the first two years of management. Stringent protection of this extremely important site is essential.

Management issues relating to turtles

The turtle nesting beaches of the MPA are one of the most important features of the area. Implementation of stringent protection, and monitoring programmes, should be among the highest priorities.

The importance of many of the islands for turtle nesting emphasises the need for protection, and exclusion of all development at these sites.

Attitudes to living adult turtles among the people of the MPA is generally good with no deliberate capture occurring. Turtles caught accidentally in fishing nets are generally released unharmed as it is believed that this will bring good luck to the fisherman concerned.

Turtle eggs are occasionally taken as food by local people. This is a small scale activity at subsistence or opportunistic levels and little or no trade or exchange in eggs takes place. This activity should be strongly discouraged, and awareness of the conservation issues related to this activity should be included in local public awareness programmes.

The generally positive attitude of the local fishermen towards turtles may be conducive to the adoption of a community-based monitoring and management programme. Participation of local people in any such scheme should be strongly encouraged.

The turtle nesting sites have potential for ecotourism. Carefully controlled visits by tourists to selected beaches to observe nesting turtles may be implemented without compromising the conservation of these sites. It is, however, essential that this is very carefully regulated, and any such activities should only be developed with expert input.

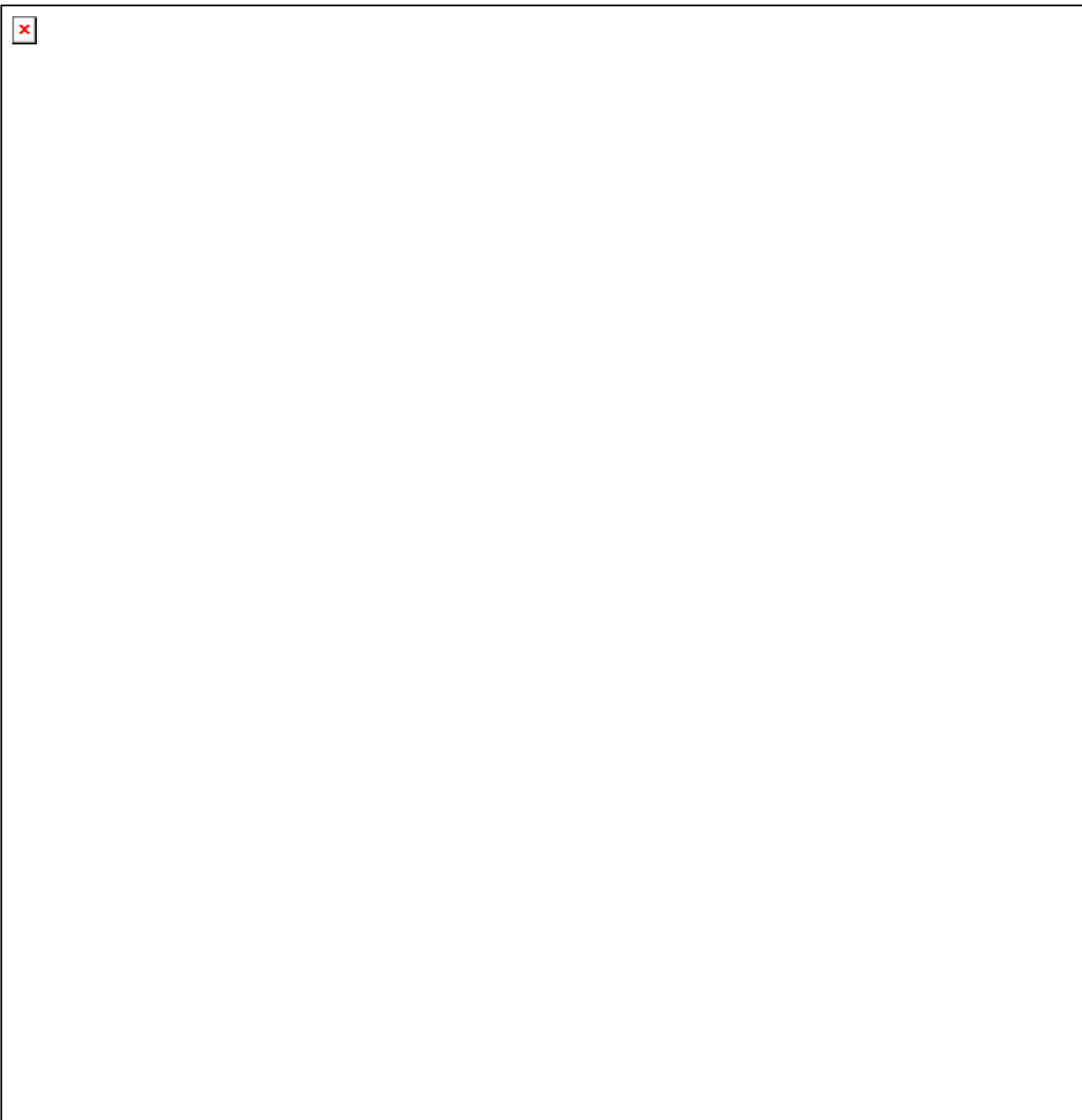


Figure 6. The principal turtle nesting sites identified during the 2002 survey.

Birds

The entire area is significant for birds, and internationally recognised as an Important Bird Area, or IBA (FISHPOOL & EVANS 2001). Every island visited during the 2002 survey, from the largest to the smallest, was a nesting site for one, two, or more species of birds. Dozens of occupied osprey nests were recorded, with up to ten osprey nests (about 25-30% occupied) even on some of the smaller islands. The occurrence of occupied osprey nests on flat and easily accessible areas of the mainland shore within 500m of the larger villages provides an indication of the positive attitude of the local communities towards the environment. The density of osprey nests in the MPA is exceptional.

A previously unrecorded nesting site for the crab plover (*Dromas ardeola*) was found on one of the islands (Brasit Island) within the Northern Bay.

Apart from pigeons and crows in the vicinity of the major villages, and a single observation of a number of vultures at a camel carcass, birds other than seabirds (principally terns, gulls, plovers, egrets and herons) and osprey were rarely observed during the survey.

Management issues relating to birds

The collection of birds' eggs occurs throughout the proposed area at a relatively low level. This activity should be discouraged, and awareness of the conservation issues related to this activity should be included in public awareness programmes.

The importance of all islands within the area for bird nesting emphasises the need for protection and exclusion of all development from island sites. Carefully regulated visits by tourists need not be a problem, but the more important bird nesting islands should be closed to visitors during the nesting season. Agreement on this issue should be sought with the local communities through consultations, although it must also be recognised that the current low levels of visits by fishermen appears to have had very low levels of impact. As long as these visits do not change in nature, or increase significantly in frequency, they are likely to be compatible with conservation objectives. As with turtles, participation of local people in management and monitoring programmes should be encouraged.

A comprehensive survey of the bird nesting localities of the area should be undertaken as a matter of priority, and the results incorporated into the management plan and practices for the proposed MPA.

Monitoring programmes to assess the nesting and abundance of the more important, rarer or indicator species of birds should be established.

Dugong

The dugong (*Dugong dugon*) is a globally threatened species, with the Red Sea and Arabian Gulf being home to the last remaining healthy populations in the western Indian Ocean. Three dugong sightings were made during the 2002 field survey, in northern Dugonab Bay, on the mainland coast to the north of Sheikh Okod, and in the lagoons of southern Mukawwar Island.

Given the extremely shy nature of dugongs this is a very large number of sightings for the survey duration. The common occurrence of dugong throughout the proposed area, including Khor Shanaab, as well as outside the MPA to both the north and south, is confirmed by local

fishermen. The Dungonab Bay MPA appears to be home to a globally significant dugong population. The extensive areas of seagrass present will be a crucial factor in this: dugong being herbivores depend upon seagrasses for their food.

Regular sightings by fishermen occur throughout Dungonab Bay, along the mainland shore to the north and south of the bay (but more frequently to the south), at Mukawwar, and in extensive shallow areas around the offshore reefs. Concentrations of dugong occur in the Northern Bay, in the area to the north and south of Sheikh Okod, and around Mukawwar.

The fishing communities of both Mohammed Qol and Dungonab have confirmed that numbers of dugong are falling rapidly. The fishermen blame this on the regular but accidental capture and consequent drowning of dugong in fixed fishing nets.

Management issues relating to dugong

The importance of the dugong population within the MPA indicates that management measures should be implemented as a matter of urgency. Measures should include:

A ban on the use of fixed nets in areas where dugong are most frequently observed, and in areas where they are most often accidentally caught. Such a ban should be discussed with and agreed by the majority of local fishermen. The replacement of fixed nets by other methods which do not threaten the dugong population should be strongly facilitated and supported by the MPA. Examples include the use of cast nets, or suitable traps (traps are currently not used in the survey area).

Any fish traps, if that option is implemented, should be carefully designed and constructed to be biodegradable in case of loss (either made entirely of biodegradable materials, or with large biodegradable panels), to prevent ghost-fishing. Rules for the use of traps or any other fishing methods should be agreed with the local fishermen, and they should be provided with the means to police and enforce any such agreements themselves, in order to maximise sustainability of the method.

A dedicated study of dugong within the entire area, both inside and outside the proposed MPA is strongly recommended. The disastrous recent history of loss and destruction of dugong populations in East Africa means that this population may be among the most important remaining on the coast of Africa. Conservation of this population, and the habitats they require for their continued survival, will be a high priority. Dugong will suffer considerably if large numbers of tourists invade their most important areas.

Speedboats, jet-skis and other similar leisure activities will seriously threaten this population. Speedboats and jet-skis should be prohibited throughout the area. MPA management should also press for wider protection of dugong outside its boundaries.

Cetaceans

There is very little information on the cetaceans in the Sudanese Red Sea. However, the survey area is home to at least two species of dolphin, bottlenose dolphins (*Tursiops truncatus*) and common dolphins (*Delphinus delphis*). Both species are seen most frequently outside the bay (a large group of common dolphins is reputedly resident at Shambaya reef). Dolphins are only rarely seen inside Dungonab Bay. There is apparently no deliberate fishing of dolphins, although they are occasionally caught accidentally.

Terrestrial fauna

The terrestrial fauna of the MPA is most notable for the presence of a significant local population of Eritrean gazelle. This species was considered by NIMIR (1983) to be threatened. The population appears to be principally confined to the Dungonab Peninsula, although it is occasionally more wide-ranging.

Management issues relating to terrestrial fauna

Eritrean gazelles are a favoured target for hunters from the Arabian mainland, who regularly travel through the proposed protected area. The entire area must be placed off-limits to all hunting in order to protect this threatened species.

The workers at the salt works on Dungonab Peninsula are known to kill gazelle occasionally, to supplement their food supply. This practice should be actively discouraged through both education and, if possible, incentives such as assistance to develop sustainable alternatives.

The introduction of goats or sheep to the peninsula should not be permitted. These animals are extremely destructive of local indigenous vegetation, and may compete with the gazelles for the scarce food resources.

A full survey of the terrestrial fauna including gazelle, other mammals, birds and reptiles, should be carried out, and management plans for the terrestrial biodiversity prepared.

Non-indigenous and genetically modified species

Introduced species

Introduced species are not currently known to pose a problem within the boundaries of the proposed MPA. However, introduced mesquite (*Prosopis* spp) poses a local, national and regional environmental threat. *Prosopis* is known to be present at the southern edge of the proposed area, particularly in the region of Sheikh Okod.

Genetically modified organisms

No genetically modified species are known to have been introduced into the proposed MPA, or surrounding areas.

Management issues related to non-indigenous and genetically modified species

Prosopis

The spread of *Prosopis* towards the MPA should be carefully monitored and a control programme instituted before it becomes a nuisance. This species is already out of control over large areas to the north of Port Sudan, and this situation must not be allowed to spread to the MPA.

Aquaculture as a source of exotic species

A common source of aquatic alien species introductions is aquaculture (e.g. the tilapia species *Oreochromis mosambicus*, widely used in marine aquaculture, and known to survive in

salinities well over 40ppt, is one of the 100 most invasive species in the world). At present the aquaculture operations do not involve any introduced species.

Invasive alien species, particularly in the marine environment, are almost impossible to control or eradicate once established. Aquatic invasive species tend to spread rapidly over long distances. For this reason any deliberate exotic species introductions into any part of the Sudanese Red Sea must be rigorously assessed through environmental impact assessment procedures prior to introduction. The institution of ballast water controls (e.g. the measures proposed and supported by the Globallast Programme of the International Maritime Organization) throughout Sudan and the Red Sea is also essential for the control of exotics travelling in ballast water.

Ultimately, control of non-indigenous species is a national and regional issue, crossing the boundaries of management units such as MPAs, and nations.

3.5 RESOURCE USES

The type and quantity of socio-economic information gathered during the field survey in 2002 was limited. There is an urgent need for the completion of a more detailed socio-economic survey to complement the information already gathered. It is essential that this study be carried out by an expert in the socio-economics of sustainable resource use, with experience of environmental management and conservation projects. Recommended approaches for tropical coastal socio-economic surveys are outlined in BUNCE et al. (2000).

Specific details are lacking in some parts of this Management Plan because of insufficient recent information.

Settlement

Dungonab Bay MPA is home to a resident human population of approximately 2000 individuals. There are two main centres of population within the area, at Dungonab village on the western shore of Dungonab Bay, and at Mohammed Qol on the mainland shore approximately 10km south of Dungonab Bay. A number of other small settlements are scattered throughout the survey area, and with only one exception these communities are based largely upon subsistence level artisanal fishing. The exception is the workers at the Dungonab salt works on the southern Dungonab Peninsula.

The distribution and relative size of the fishing communities, including the two main villages and the widely spread much smaller communities, is reflected in the distribution of fishing boats illustrated in Figure 7. Fisheries are the principal economic activity at all settlements. The development of fisheries as a coastal activity is, however, only a few decades old. The older traditions of seasonal and semi-nomadic agriculture and pastoralism have been replaced in the past 20-30 years.

Mohammed Qol is the location of the local headquarters of the principality and has a population of approximately 750, in about 115 families. Approximately 40 people are full-time fishermen, although others take part in the fisheries on a part-time, seasonal, or casual basis. In 2002 there were a total of 14 shops and restaurants, many of which gain a significant proportion of their income from traffic passing along the coast road through the village. Two carpenters are involved in making and repairing wooden boats.

At the time of the survey Dugonab village had a population of approximately 430, in about 70 families. About 30 people are full-time fishermen; only 16 of these were engaged in fishing at the time. The village had 14 small shops, including 4 tea shops. Four villagers worked for the private oyster farm, and one for the Marine Fisheries Department.



Figure 7. Map showing the distribution of settlements within the marine protected area, as revealed by fishing boat landing sites. The abundance of boats provides a proxy measure for the size of settlements.

Management issues relating to settlement

A number of smaller settlements are located within the terrestrial reserve areas. These settlements should be allowed to continue in their present locations, with careful regulation of growth and development. Excellent models for how these communities should be managed can be found within the Gulf of Aqaba Protectorates in Sinai, Egypt (a specific example is the fishing village located within the Nabq Managed Resource Protected Area). Study tours and placements of Sudanese MPA rangers and managers, and representatives of the local community with the Sinai protected areas should be developed *specifically* to include this site.

The existence of two main settlements in the area reflects the fact that there are two principal tribal groups present. It is essential that the MPA management makes strenuous efforts to avoid being, or perceived as being, biased towards one group over another.

The very different locations of the two main settlements (Dungonab village inside the bay, Mohammed Qol outside) gives rise to slightly different management issues. In particular, the marine environments inside the bay are in better condition than those outside the bay, but paradoxically the fact that they are inside the bay means that they are more vulnerable to pollution and inappropriate development.

Community Services and Infrastructure

Low population density, budgetary limitations and poor transportation to and from the area have limited the level of public service provision in the Dungonab Bay MPA. Although some significant efforts have been made both by government and NGOs, basic services in the MPA are generally inadequate. The administrative centre is Mohammed Qol, where the regional headquarters of the principality are located. There is no administrative centre in Dungonab.

Health services are limited to two inadequately stocked and staffed dispensaries, one in each of Mohammed Qol and Dungonab. No doctor is resident within the area, with dispensaries being staffed by health assistants, and facilities lacking most basic equipment.

There are two schools within the area, one at each of Mohammed Qol and Dungonab. At the time of the survey the school in Mohammed Qol had 8 classes and about 130 pupils. The school in Dungonab also had 8 co-educational classes, and a total of about 65 students. The Mohammed Qol school services smaller outlying settlements, and a student residence is provided free to pupils from outside the town. At Dungonab, very few of the students at the school are from outside the village, and there is no student residence provided.

Water is supplied to Mohammed Qol and Dungonab by tanker truck. Electricity is supplied to the mosque, school, market area and a few of the houses in Mohammed Qol by a generator.

The principal concerns expressed by the villagers of both Mohammed Qol and Dungonab about services and infrastructure were:

- Low quality of drinking water;
- Poor health services;
- A lack of employment opportunities provided by the outside investors involved in the area, including the privately owned pearl farm, the sea-cucumber fishery, and the salt

works on Dungonab Peninsula. All of these businesses were perceived as employing people from outside the area, as being users of local resources, without any concern for the local people, and without adequately contributing to the welfare of those people.

Transport within the MPA

There are currently no paved roads within the MPA, or between the MPA and Port Sudan. This factor, in combination with the distance from Port Sudan, is probably a major reason for the relatively good condition of the area at present. However, it is also without doubt a contributory factor in the poor facilities and infrastructure available for the local people.

There are, apparently, already plans for the development and improvement of the coast road from Port Sudan to Egypt. A significantly improved coast road, particularly if it is paved, will result in improved access to the MPA from major population centres by at least an order of magnitude. Currently it takes between five and ten hours to reach the area by road from Port Sudan. A paved road would potentially reduce this journey time to little more than an hour, vastly increasing the potential for unsustainable use and destruction of natural resources in the area.

The route of the coast road currently runs close to the shore throughout much of the MPA, and in a number of places within a few metres of beaches, mangroves and coral reefs. The road to the salt works on Dungonab Peninsula is the only access route to the whole of the peninsula, eastern Dungonab Bay and Khor Naitaib.

Management issues relating to transport within the MPA

Control of access to all areas by land will be essential for successful management, particularly once the coast road is improved, although the degree of control of access will vary between different areas. Development and full implementation of detailed plans and policies to address this issue by the MPA management will be a high priority during the first one or two years of park implementation (see also sections 4.4. and 5.2).

Land ownership

There are two main tribal groups in the survey area: the Korbeeb, which are more numerous in Mohammed Qol and the south of the area, and the Beshareen, which are more numerous in Dungonab village and the north of the area. Relations between these groups are generally good, although rivalry can sometimes be intense. Intertribal relations, including the distribution of land rights between tribes, are governed by agreements between the tribal leaders.

Management issues relating to land ownership and custodianship

The protection of the rights of the local peoples is of crucial importance. This is particularly relevant to land tenure and ownership. The current methods of traditional land ownership and allocation are effective, in the existing situation. Adaptation (not removal or replacement) is needed to meet the needs of local peoples in the changing situation of MPA designation and the subsequent implementation of management, and of changes that are likely to ensue.

The needs of the local peoples should be considered to be inseparable from those of the MPA, but the requirements of long-term conservation and sustainable use should not be subordinate to issues of land ownership.

Ownership of little or possibly none of the land in the area is presently centrally registered. The reason for this was repeatedly cited by the people in the area as being the cost and the bureaucracy involved, coupled with the fact that the present largely successful management regime reduced the urgency of the need for registration. As indicated above, the changing situation increases this urgency considerably.

In order to protect the interests of the local inhabitants it is essential that this situation (the lack of registration of ownership) is rectified as soon as possible. The help and support of the Sudanese government will be needed for this, and possible roles of donors and NGOs in helping to facilitate this should be investigated as a matter of priority.

There are currently several unresolved disagreements between the groups within the proposed MPA. However, the generally good relations between the different groups within the area mean that successful interim solutions appear to have been reached. Of particular significance to the MPA is the lack of agreement about the ownership of some coastal land between Mohammed Qol and Dunganab. This lack of agreement has been resolved to date by a mutual understanding that this land will not be developed, or exclusively used, by either group. The accessibility, fragility and good condition of coral communities along the coast between the villages means that any coastal development here should be disallowed. The current status of the agreement between the villages should facilitate this objective.

Fishing

Key Points:

- There is a pronounced lack of effective fisheries management in the area at present.
- Some high-value species, particularly nagil (*Plectropomus* spp) appear to be heavily overfished.
- There are signs of overfishing in a number of the invertebrate fisheries, particularly for *Trochus* (kokian) and sea-cucumber.
- Commercial trawling appears to have already resulted in the loss (long-term or possibly permanent) of some populations, probably through removal of spawning aggregations.
- The impacts of the local artisanal fishery on dugong are a major cause for concern. Fishing methods causing the steep decline in dugong populations (fixed nets) should be phased out (see section on dugong above).
- The introduction of ecosystem-based fishery management (including the development of a network of permanent and seasonal fishery reserves) is required within the MPA to provide refuges from direct and indirect fishing impacts on habitats and non-target species, and to safeguard the reproductive potential of target species.

All or most fishing activity is artisanal and shore-based, or uses small wooden or fibreglass boats. Industrial trawling and experimental trawling has occurred in the area in the past, but is now rare or non-existent.

Fishing was not traditionally an important activity for the communities of the area until the past 30–40 years. The main activity of the people was previously pastoralism. The change from pastoralism to fisheries happened in the 1960s and 1970s due to the development of fishing co-operatives, encouraged by government policy.

Prior to this development, alternative livelihoods to fishing were available for the local communities, e.g. pastoralism, seasonal agriculture, and work for oil and other companies active in the area. The emphasis on fishing in recent decades has removed these alternatives. The lack of alternative sources of income and the resultant dependence on a single area of activity, is repeatedly cited as a profound concern by the local communities. Observed declines in local catches of some important groups, probably due to overfishing, add urgency to this concern.

Fin fisheries

Fin fisheries of the area are typical of tropical reef fisheries in that they are multi-species in the extreme, although there are favoured or more highly valued species which are preferentially targeted. The section on fisheries in KEMP et al. 2002 provides a list of 25 species or species groups (from over 20 families) that are of high importance to the local fishery. Highly multi-species fisheries such as this are notoriously difficult to manage for long-term sustainability and maintenance of biodiversity, unless ecosystem approaches are adopted. Additional issues relate to unsustainable practices targeted at single species or species groups.

One of the most valued species in the area is nagil (*Plectropomus* sp.). This has historically been a favoured fishery species, as it is throughout much of the Red Sea. The deliberate fishing of spawning aggregations of this species began in about 1996, with the chance discovery of the main aggregation area at the southern end of Mukawwar. This fishing of spawning aggregations has since developed into a major fishing activity for the local communities, even though there are economic and ecological disincentives for this.

- The price of the fish falls briefly but dramatically during the spawning season, due to the temporarily increased supply. These fish are thus removed from the water in a concentrated but relatively low-value ‘burst’, rather than over a longer period at a higher value.
- The continued fishing of these spawning aggregations is likely to lead to the collapse of the resource not only at spawning time but throughout the year and over a considerable area, due to the destruction of reproductive capacity and resultant loss of recruitment and replenishment. Local fishermen have already observed a general reduction in the abundance of nagil throughout the area. This suggests that collapse of the local stock may be imminent. The extremely low abundance of nagil seen during the ecological survey (only a tiny percentage of the numbers that would normally be expected), and the small size of those that were seen, also indicates that this is likely to be the case.

Industrial trawling in the area is known to have caused damage to habitats and fish stocks, and is a source of great resentment and concern to the local fishing communities. At least one spawning aggregation (probably of snappers, *Lutjanus* sp.) is reported by local fishing

communities to have been trawled several years ago. As is typical of such events, that aggregation has shown no return, and the species is now uncommon in the area. As mentioned above, the often permanent nature of such depletions is an increasingly well-known phenomenon in tropical coastal fisheries worldwide.

Invertebrate fisheries

Invertebrate fisheries are an important source of secondary and/or seasonal income for the coastal communities of the area. The most important fisheries are those for: sea-cucumbers (also termed *bêche-de-mer*) particularly in their processed state; the gastropods *Trochus* and *Strombus*; and, to a lesser extent *Lambis*, *Murex* and *Tridacna*. A fishery for wild *Pinctada* is also reported to exist, although this appears to be at a very low level of intensity.

These invertebrate fisheries are largely seasonal, taking place mostly over the summer months and are entirely or almost entirely cash fisheries for export. Buyers for the products of these fisheries are either from Port Sudan or from outside Sudan altogether. Almost all of the products are exported, with the possible exception of meat from some of the gastropods. The sea-cucumber fishery in particular is carried out by non-local fishermen for a non-local company, and little or no benefit from this fishery accrues to the people in the MPA area.

The huge numbers of *Strombus*, *Lambis* and *Murex* shells found on the shore at every survey site throughout the entire area testify to both the widespread nature and importance of these fisheries. However, there are indications of overfishing in these and the *Trochus* and sea-cucumber fisheries. The small size and scarcity of individuals seen from all of these groups suggests that the area is likely to be a sink for larvae, and as a result of over-collection is probably not capable of restocking itself.

The only one of these groups with clearly healthy local populations is *Tridacna*. Development of any commercial exploitation of these will result in rapid loss of these conspicuous and vulnerable animals.

The sea-cucumber fishermen of Dunganab village are supplied with scuba equipment by a fisheries company based in Port Sudan (no scuba equipment is supplied to the fishermen at Mohammed Qol). Without prompting, the local fishermen volunteered the information that many shallow areas are now fished out and they have to move further from the village into deeper waters in order to find economically viable numbers of sea-cucumbers. This is a strikingly close parallel to the pattern of extreme overfishing of sea-cucumbers that has occurred throughout many areas of the Indian Ocean coast of East Africa. It is an indication that there is an urgent need for effective management of this resource, including the designation of fisheries reserves in order to protect reproductive potential.

The use of scuba equipment in sea-cucumber fisheries should be phased out very rapidly.

The health and safety of the scuba diving sea-cucumber fishermen is of real concern. Questions posed to the fishermen during the reconnaissance phase of the survey revealed that they are inadequately trained, and ignorant of the nature and causes of decompression sickness. They reported a number of symptoms of decompression sickness, and in some cases these symptoms have proved debilitating.

Aquarium fish collecting

Aquarium fish collecting does not appear to take place within the area at present, although there are aquarium fish collecting operations based in Port Sudan. Little information is available about their activities.

The need for ecosystem-based management of fisheries within the MPA

There is an urgent need for the development of effective ecosystem-based fisheries management for sustainability.

The results of the recent ecological and fisheries survey indicate that many of the current fisheries practices in the area are, in the long-term, likely to be unsustainable. Some of the practices (such as the deliberate targeting of spawning areas) will destroy many of the more important resources of the area unless rapidly brought under control. Others, such as the use of scuba for sea-cucumber fisheries, threaten both the sustainability of the fishery and the health and safety of the workers involved.

More widely, there are serious concerns about conflicts between certain fisheries and significant biodiversity conservation requirements. This is particularly the case with the use of fixed nets in areas important for dugong. Use of fixed nets in these areas should be phased out, and carefully chosen alternative sustainable practices introduced in their place.

The attitude of the fishing communities of the MPA towards sustainable fishing practices is generally very positive. It is hoped that through explanation and discussion, a relationship based upon trust and mutual respect may develop between the fishermen and the MPA. Such management will be fully acceptable to the local communities, and provide an example that may be adopted elsewhere in Sudan.

Fisheries reserves

Fisheries management measures should include permanent and seasonal fisheries reserves (ROBERTS & HAWKINS 2001). These need not cause loss of fisheries productivity (and may in time increase total productivity of the area) ensuring the long-term sustainability of fishery resources.

Gradual introduction of permanent fisheries reserves on a trial basis, to convince the fishing communities of their effectiveness, is recommended.

Seasonal bans on fishing in the areas of spawning aggregations are essential; strong arguments and unequivocal proposals must be made for them. An increasing degree of acceptance for such ideas on the part of the local fishing community, as a result of discussions during the 2002 survey, suggests that the underlying principles are generally well understood by the fishermen and that such recommendations will ultimately be accepted.

Indeed, the main objection to their implementation was the urgent need for short-term income to service debts on boats and engines. These debts are owed to a fish exporting concern based outside the MPA, and are a major issue for sustainability of the local fisheries. The proposed MPA should investigate and facilitate the resolution of this issue as a high priority.

Management issues relating to extractive use of living marine resources

In an area such as the MPA, trawling is inimical to biodiversity conservation and sustainable use, being directly destructive of non-target habitats and species (including globally endangered species such as marine turtles). As already experienced in the MPA, trawling has the potential to unsustainably harvest or even completely remove vulnerable target species. Trawling should, therefore, be permanently prohibited throughout the MPA.

Shark fishing is currently widespread in the MPA; sharks, including small juveniles, are regularly landed. Unlike reef fishes and other demersal fisheries, sharks, because of their wide-ranging nature, are seldom afforded any protection or effective management by the designation of relatively small fishery reserves. Shark fishing should therefore be prohibited throughout the proposed area.

The seasonal nagil fishery must be effectively managed if nagil are to remain part of the catch in the MPA. For this reason a fishery reserve (permanent or seasonal) is strongly recommended around the southern part of Mukawwar. This must be discussed and agreed with the local fishing communities, but it is stressed here that the nagil fishery, unless effectively managed, is likely to rapidly decline and possibly disappear altogether. There was a strong reluctance on the part of the fishermen to reveal the locations of the nagil spawning grounds and so other sites may also exist. These must also, eventually, be closed during the spawning season.

Shipping and navigation

The MPA is not directly on any major routes for shipping or navigation. Port Sudan is approximately 120km from the southern boundary and most maritime traffic from there passes some considerable distance offshore, outside the outermost boundaries of the MPA. Small coastal vessels (mostly coastal trading dhows) may visit or pass through the waters of the MPA.

Management issues relating to maritime transport

Principal issues are those related to pollution, both solid wastes (litter) and oil. Litter is extremely conspicuous in parts of the MPA, particularly along the shores most exposed to the open sea.

Oil pollution is very limited throughout the area at present. The only sites where this was recorded were, as with the most serious littering, those most open to the sea.

Cultural uses

Sheikh Okod is a very significant site for cultural heritage, being the location of a religious festival that attracts thousands of visitors every year from Port Sudan and further away. The character and use of this site should be fully respected and preserved. It is placed within a protected coastline area to allow the continued use of the site for its cultural purposes and to prevent any other uses that may interfere with or otherwise affect the cultural integrity of the site.

Tourism

Tourism within the Dungonab Bay MPA is currently almost non-existent. A few tourists have briefly visited the area by land over the past several years, but numbers are not known. Those who have visited have generally passed through without staying or only stayed for one or two days.

Negative impacts of these visits are already apparent: The survey team in 2002 were offered a number of shells (mainly Triton, *Charonia tritonis*) by local people, with an asking price of \$10 each. These shells had been collected by local fishermen specifically to be offered for sale to visitors, because previous visitors to the area have on a number of occasions bought shells and corals.

In terms of value, the only significant tourism in the area is probably dive tourism, although again no figures were available. With the exception of a few groups that used a boat based at the commercial pearl farm in the period 2000–2001, this activity is entirely based upon boats out of Port Sudan. The boat from the pearl farm no longer operates in the area.

Figures for boat-based visitors to the area were not available at the time of the 2002 survey, but are believed to be very low (at most a few dozen each year), with most live-aboard dive boats tending to visit areas closer to Port Sudan. Those dive boats that have visited the MPA have tended only to visit outer reefs, where the most spectacular diving is to be found. No economic or other benefits accrue to the inhabitants of the proposed area from such visits.

The Dungonab salt works

The salt works on the southern part of the Dungonab Peninsula has been active since at least the early part of the 20th century. The salt pans cover a large area, but with a very low density of human population to work them. The total number of workers at the plant never exceeds a hundred, and is usually considerably smaller than this.

Salt is exported from the area by truck to Port Sudan. These trucks make up a large proportion of the road traffic.

Overall the environmental impact of the salt works beyond its own boundaries appears to be minimal, and given that the activity has been carried out for almost a century it is clearly environmentally sustainable in its present form. Any changes in methods or expansion of its size will, however, have to be closely monitored and will need approval from and integration with the MPA management before implementation.

Improvement of transport links between the salt works and Port Sudan will need careful management and control within a protected area system. Improvements will open up the entire area, including the extremely important and sensitive habitats of north and south Dungonab Bay, the Dungonab Peninsula, and Khor Naitaib to easy and possibly very damaging access. These areas will be particularly sensitive to increased or inappropriate use and will be one of the key areas of concern for sustainable management and protection.

Management issues relating to Dungonab salt works

Communication must be established and maintained between the salt works management and the MPA.

Transport to and from the salt works, principally by trucks travelling to and from Port Sudan is currently the only significant use of the road around the north of Dungonab Bay and down the peninsula. Currently this road and the traffic along it have minimal impact. However, this road will become a management issue as numbers of visitors increase, and when the main coast road is improved. Control of access to this road will regulate access to the peninsula.

The employees at the salt works currently create management problems related to two important features of the peninsula: the gazelles (salt workers occasionally take animals to supplement their diet), and the mangroves, which show signs of severe cutting in places. These issues must be carefully addressed, and ways found to prevent their recurrence.

Although the area of the salt works is designated a General Use Zone, this zone is only designated to enable the salt work activities to continue. Other development activities should be prohibited within the zone.

Aquaculture

There is a long history of aquaculture within the MPA. This has historically been for oysters and started in the early years of the 20th century. There have, however, been two more recent aquaculture initiatives within the MPA:

- A government-sponsored oyster farm to provide employment and income to the inhabitants of Dungonab village,
- A privately sponsored farm with headquarters based to the south of Dungonab, and operations spread across large areas of the bay.

The government sponsored farm

This had recently ceased working at the time of the 2002 survey due to outbreaks of disease that repeatedly destroyed the oyster stocks. These outbreaks have been a recurring feature of oyster culture attempts in the bay since the early 20th century.

The private pearl oyster farm

At the time of the survey the private oyster farm was experiencing severe problems with the mass die-off of oysters which resulted in the closure of the government sponsored project. As a result in early 2002 it was uncertain whether the farm would continue to operate inside the bay, move out of the bay into waters near Mukawwar, or cease operations altogether.

The activities of the oyster farms need not conflict with the design, implementation or management of an MPA, and it should be possible for this activity to remain in the long-term, provided that it stays the environmentally innocuous activity that it presently appears to be.

The exception to this is the large amount of plastic litter throughout the area that originates from the oyster farm. This plastic, used as part of the spat-collecting activities of the farm, is

conspicuous along the shoreline almost everywhere in the MPA, even at the southern end of Mukawwar Island and as far south as Sheikh Okod. This issue must be addressed by the oyster farm, either by preventing the loss of this material in the first place, or by organising and funding regular park-wide cleanup operations to remove, and dispose of it properly.

Egg collecting: seabirds and turtles

Both seabird and turtle eggs are collected for local consumption. In both cases this activity currently occurs at a low subsistence or opportunistic level, and little or no trade or exchange in eggs takes place. All egg collecting should be strongly discouraged, and awareness of the conservation issues related to this activity should be included in local public awareness programmes.

Hunting

Parties of non-Sudanese hunters from Arabia frequently pass through the MPA. These parties are occasionally quite large, and tend to be well equipped for extended hunting expeditions. Hunting by these parties, particularly of gazelles, within the park boundaries is known to have occurred in the past.

All hunting activities by these and any other parties within the boundaries of the MPA must be prohibited. Entry of these parties to any part of the protected area should only be permitted if they leave all hunting equipment, including rifles, dogs and falcons, outside the park's boundaries.

Penalties for illegal hunting within the park boundaries should be regularised with penalties for hunting within other parks in Sudan.

4. GENERAL POLICIES AND STRATEGIES

This section lists the general policies and management strategies that apply throughout the MPA, for the various topics in the previous section (i.e. habitats, flora and fauna and resource uses). It also describes the content of the specific management strategies to be implemented.

The Dungonab Bay MPA is a multiple-use protected area. Within the outer boundaries the protected area is divided into a number of zones for different uses, with different levels and types of protection. The range of different zones allows for the full range of uses (including extractive resource uses, appropriate development, and sustainable tourism) compatible with sustainable development and biodiversity conservation.

The Dungonab Bay MPA differs significantly in several ways from Sanganeb Atoll, the other MPA currently under development in Sudan.

- Dungonab is very much larger than Sanganeb.
- Dungonab is more geographically and socio-economically complex than Sanganeb.
- Dungonab has a significant resident human population of long historical standing. This population is currently almost entirely dependent upon the extractive use of marine resources.
- Dungonab currently has no measurable tourist income, and it will take several years for any significant income from tourism to be generated. This point has important implications for funding, and is thus a central consideration in the earlier stages of implementation.

These differences are reflected to varying extents in the Site-Specific Master Plans for these two MPAs but, in spite of these differences, the similarities between the broad objectives and methods of the two parks are considerable. Between them, implementation of these two marine protected areas will provide Sudan with an array of techniques and approaches to marine environmental protection and conservation. These will provide an exceptionally strong basis for the successful development of a national network of MPAs, and consequently the successful management of marine and coastal biodiversity for long-term sustainability.

4.1 GUIDING PRINCIPLES FOR MARINE PROTECTED AREA MANAGEMENT

A number of guiding principles can help ensure that the concept of sustainability becomes embedded in decision-making processes that affect the Dungonab Bay MPA. These general measures (see box) serve as cornerstones for biodiversity conservation and sustainable resource use.

Guiding principles for successful MPA management

- 1) Understand that **management of renewable coastal and marine resources** is of *strategic importance* for social and economic development and is cost-effective in the long-term.
- 2) Recognise that **sustainability** requires the maintenance of the integrity of coastal systems, and that this implies limits to the use of resources generated by these systems.
- 3) Understand that the **carrying capacity** of coastal systems to support tourism, recreation and other human use is variable, and is not infinite.
- 4) Develop **integrated management actions** that allow **multiple uses** of natural resources, in which **complementary activities are integrated** and **conflicting activities are avoided or segregated** (i.e. undertaken in different areas).
- 5) Ensure good **co-ordination** in coastal management activities and involve local people. This is essential to ensure **effective management** and **equitable socio-economic development**.
- 6) Recognise that inadequate or lack of **implementation** and **enforcement** are often more of an obstacle to effective management than deficiencies in environmental legislation or scientific information.
- 7) Accept that **MPA management** should not be fixed, but is an **ongoing and adaptive process**, with adaptation and modification in the light of changed environmental conditions, updated information, and changing human needs.

4.2 BIODIVERSITY

Sudan is a signatory to the Convention on Biological Diversity (CBD), and ratified the convention in October 1995. To fulfil obligations of the CBD a National Biodiversity Strategy and Action Plan was developed by the Higher Council for Environment and Natural Resources (HCENR), providing an overarching national framework for biodiversity conservation within Sudan.

Other key international treaties or conventions relevant to marine biodiversity conservation and management that Sudan is party to are, the:

- African Eurasian Migratory Waterbird Agreement (AEWA), and the
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Important or unique characteristics

Sudan lies in the central-northern Red Sea biogeographic zone, an area of high endemism and high overall biodiversity within the marine realm, making this park of great significance for marine biodiversity conservation. However, a number of other characteristics further enhance the value of Dungonab Bay MPA, making it globally important:

- Unusual coral communities;
- Unique ‘biogeographically displaced’ fish communities (i.e. fish communities characteristic of the southern Red Sea, here found in the north due to unusual environmental conditions);
- A high diversity of broad habitat types;
- Regionally or globally important concentrations of turtle nesting sites;
- Regionally or globally important sites for birds;
- Globally unusual and regionally unique aggregations of whale sharks and manta rays;
- The bay itself may constitute a regionally important refuge for coral communities, from global-warming induced coral bleaching.

Maintenance of process and populations

The primary objective of the proposed MPA is to ensure the conservation and sustainable use of the biodiversity of this nationally and regionally important area. The size, location and ecological diversity of the area mean that the ecological significance of the MPA extends well beyond its own boundaries. Both internally and more widely the protected area will help to maintain both ecological processes and populations in a number of ways, providing:

Refuges for endangered species. In particular these include marine turtles and dugong, both of which are found in large numbers and reproduce within the MPA boundaries. Although these groups, along with others such as sharks, will only spend a portion of their life history within the park, protection of critical areas and sites (such as turtle nesting beaches), and of such a large area, will make a significant regional contribution to the maintenance of viable populations.

Protection for both representative (‘typical’) and highly unusual habitats and communities. The wide range of habitats and associated plant and animal communities present will ensure long-term protection of a wide variety of biodiversity.

Reproductive refuges for marine species (including fisheries species), that will benefit areas both within and far beyond the MPA boundaries. The inclusion of zones for protection and maintenance of reproductive capacity will provide an insurance policy and a buffer to ensure the long-term security of the reproductive potential for ecologically and economically important species. In particular, the use of Fisheries Reserves (areas closed to all fishing) is now recognised to be a highly effective and valuable way to ensure the continued existence of viable fisheries (ROBERTS & HAWKINS 2001). Export of larvae from such reserves, as well as the emigration of adults, will benefit fisheries both close to the boundaries of such reserves, and much further afield.

4.3 RESOURCE USES

Tourism

The current lack of tourism within the park boundaries is important. As mentioned above, this has very considerable implications for the early stages of implementation of any Management Plan.

Tourism plays a significant role in the development and funding of many conservation areas or MPAs, and promotion of wider ecotourism within Dungonab Bay MPA, especially scuba diving, should be a high priority for management.

There are numerous excellent sites for scuba diving throughout the area, but these have yet to be fully identified and described. This makes the realistic determination of carrying capacity for dive tourism within the MPA impossible at the present time.

A tourism development plan should be drawn up by the park management, in consultation with major stakeholders under the guidance of the MPA management committee, and fully taking into account the wishes of the MPA's inhabitants.

The objectives of the tourism plan will be:

- To develop of sustainable tourism, in line with the overall objectives of biodiversity conservation and sustainable use, and strictly following all zoning and other regulations of the MPA. Compromising the conservation regulations of the MPA to maximise tourism (or other income generating uses) will undermine the MPA and ultimately lead to failure.
- To develop mechanisms that will increase the ability of the MPA to be self-financing, through the collection of tourism revenues. Mechanisms for revenue generation, and prices levied, should be based upon examples from elsewhere in the region (Ras Mohammed National Park in Egypt being a good example), and should be co-ordinated with other MPAs in Sudan.
- To develop alternative livelihoods for the inhabitants of the region through tourism. This should include:
 - All tourism developments must undertake to employ a minimum proportion of their staff from among the MPAs inhabitants. A minimum of 30% for small operations (up to 10 employees), and 20% for large operations (more than 10 employees), should be the minimum initially enforced, although this may be revised upwards).
 - Development of other, entirely locally generated, businesses to service tourism. For example, fishermen and others with good local knowledge who may want to become involved in ecotourism activities should be encouraged and supported.
 - Encouragement for the development of traditional handicraft skills by the local communities, especially women, for souvenir sales to tourists.

Carrying capacity

Many intense human activities, such as mass tourism, are known to be incompatible with conserving the diversity, productivity and beauty of important coastal areas. Sudan has so far avoided the perils of mass tourism.

To ensure that management does not fail due to excessive non-extractive uses, it is vital that carrying capacity is determined now. Cautious (precautionary) long-term limits to growth should be established and incorporated into the long-term management strategy for the MPA. In this way both natural resources and people will continue to coexist side by side.

A critical challenge will be ensuring that economic development does not deny to later or even present generations important future resource-use options that may currently be unknown. Loss of opportunity can happen unexpectedly following incremental and often unperceived environmental deterioration.

Fisheries

Dungonab Bay MPA policy towards fisheries and other extractive resource uses:

Dungonab Bay MPA recognises the importance of extractive resource uses within its boundaries to the resident population and to user groups based outside the MPA.

The overall policy of the Dungonab Bay MPA towards extractive resource uses is:

To ensure that the needs and requirements of the residents of the proposed MPA are met with regard to fisheries, but to ensure that fishing and other extractive activities are carried out in a fully equitable and sustainable manner, safeguarding those resources for future generations.

This will be achieved by adopting an ecosystem-based approach to fishery management. An ecosystem approach will ensure that extractive resource uses:

- 1) Do not damage or destroy habitats within the MPA.
- 2) Do not endanger or otherwise threaten non-target species within the MPA, including endangered or ecologically 'key' species such as dugong, turtles or sharks.
- 3) Do not reduce the abundance of any target or non-target species or groups to a level where that species or group faces ecological extinction (i.e. is reduced in numbers to a point where, although perhaps not threatened with complete local extinction, they are no longer capable of fulfilling their ecological role in the local ecosystem).
- 4) Do not unsustainably harvest any target species.

A number of measures will be used, all of which will be fully developed and implemented in co-operation with the resident communities of the MPA. These measures will include, but not be restricted to:

- The designation of permanent Fisheries Reserves, closed to all extractive uses, to serve as biomass and reproductive reserves for key fisheries species.
 - i) These reserves should be fully explained and discussed with the fishing communities of the MPA before implementation.
 - ii) The assistance and support of the fishermen should be actively sought to identify, designate and police such areas.
 - iii) It is recommended that a small number of fishery reserves (minimum of five) be introduced initially, to illustrate to the fishing communities the benefits of such reserves and to help gain acceptance for this management approach.
 - iv) Fishery reserves should initially be relatively small (each one covering a maximum of 1km of coast or reef).
 - v) Fishery Reserves should preferentially include areas where critical processes take place, and areas where habitats are very fragile.
 - vi) Fishery Reserves should be placed within existing reef fishing areas, including areas of recent or historic decline in catch. This will provide, within two or three years, a practical demonstration of how fish stocks can recover within such reserves, and how those reserves can then provide considerable ‘overspill’ benefits to adjacent areas, even while the Fisheries Reserves themselves remain closed.
 - vii) The ultimate objective should be to include a minimum of 20% of the MPA area within a network of Fisheries Reserves. This may seem a large figure, but extensive evidence shows that complete closure of 20% or more of an area to fisheries will provide a net benefit to fishermen in the medium and long-term.
 - viii) Careful reference to the extensive literature on the design and management of fisheries reserves should be made throughout the discussion, design and implementation phases. A key text will be ROBERTS & HAWKINS (2001): *Fully Protected Marine Reserves: A Guide*. Translation of this text into Arabic (with the full permission of the publishers) should be considered for use throughout Sudan and further afield in the PERSGA region.
- Seasonal reserves should be designated to protect spawning sites, spawning aggregations, or similar transitory critical features.
- Fishing methods that threaten a species survival should be phased out. For example, the use of fixed nets threatens the regionally important local population of dugong. The introduction of alternative non-destructive methods should be encouraged and as far as possible facilitated by the MPA. For example, an acceptable alternative for dugong may be the use of biodegradable traps in important areas instead of fixed nets.
- The prohibition of recreational fishing (e.g. fishing by non-park residents, including tourists).
- Trawling should be prohibited throughout the entire park area, including deep-water areas.
- Spear fishing is prohibited in Sudan. This ban is widely ignored, particularly by expatriates, tourists, and visiting yachtsmen. The ban must be rigorously enforced throughout the area and penalties must be severe enough to operate as a genuine

deterrent (minimum fine suggested to be in the region of US\$250 for non-Sudanese residents, with a lower figure, in the region of US\$50, for Sudanese residents).

- i) Visiting yachts should be required to deposit spear guns with the MPA office on arrival, to be reclaimed upon departure.
 - ii) Any spear guns in the possession of visitors based on land (who have no excuse for possession of spear guns in Sudan) should be permanently confiscated, in compliance with Sudanese laws on spear fishing.
- The use of scuba diving for sea-cucumber fisheries should be prohibited. Use of such equipment is a central factor in rapidly making such fisheries unsustainable.

Particular reference here is made to the fisheries and other coastal/marine plans and activities of ACORD, an NGO that has been active throughout the area since 1986, primarily through a pastoralist programme. The role of ACORD has grown to include three main elements (water, livestock and capacity building). ACORD has extensive experience of working with local communities in the rural areas of coastal Sudan, including the MPA, and has recently proposed extending its activities into the area of facilitating the exploitation of living marine resources in the Dungonab area. The close assistance and co-operation of ACORD should be sought by the MPA in these activities.

Aquaculture

Aquaculture carried out in the area to date (i.e. low impact oyster culture) need not conflict with the objectives of the MPA, and may provide sustainable livelihoods to park inhabitants.

If oyster farming remains an activity within the MPA it is recommended that:

- a) Close and regular communication, both formal and informal, is maintained between the MPA management and oyster farm management. The park's management should be consulted before any changes in aquaculture activities are implemented, and will have powers of veto over any potentially damaging activities.
- b) If the activities of the farm have moved, these must be incorporated into the zoning plan for the MPA, after assessment to ensure that they are not conflicting with other significant permitted activities or with the zoning plan.
- c) A monitoring programme to include water quality, substrate (coral, algae and invertebrates) and fish community monitoring be put in place around the farm to identify any adverse impacts. This should be funded by the oyster farm, following the 'polluter pays' principle, but should be incorporated within the wider park monitoring programme, and overseen by MPA management.
- d) The importation, introduction, or use of any non-native species must be strictly prohibited.
- e) The local communities should be provided with greater opportunities to benefit from such activities, i.e. recruitment of oyster farm workers should preferentially be from the local population rather than outside the MPA.

4.4 ZONING

Zoning provides a powerful mechanism for separating conflicting activities and combining compatible ones. Dungonab Bay MPA is a multiple use MPA and as such, zoning is central to its design, successful implementation and management.

The objectives of zoning within the Dungonab Bay MPA are:

- To enable the full range of user groups within the MPA to carry out their activities in a manner which is compatible with biodiversity conservation and sustainable use;
- To minimise conflicts between different user groups;
- To provide an overall spatial framework for planning and development within the MPA which is compatible with the long-term sustainable use and conservation of the biodiversity of the area;

This is to be achieved by:

- Physically separating mutually incompatible uses from each other;
- Providing areas within which essential natural processes (e.g. breeding of commercially/ecologically important or threatened/endangered species) can continue to take place undisturbed;
- Providing areas where endangered, vulnerable or critical species and habitats can exist undisturbed.

The preliminary zoning of the MPA has been kept relatively simple. Zoning of both terrestrial and marine components will become more complex as the MPA matures. It will be developed in consultation with the inhabitants and major stakeholders of the area through an iterative process. This plan describes initial zoning, and sets broad objectives for the further development of zoning schemes.

It is important to note that within the proposed area different zones will conform to different IUCN categories, particularly IUCN Categories I and II in the marine environment, and IUCN Categories II and V in the terrestrial environment.

The zones are defined and described in detail, and the zoning plan presented in section 5.2. Zoning maps for the MPA are given in Appendix 3.

Table 1. IUCN protected area categories relevant to Dungonab Bay protected area (KELLEHER 1999).

IUCN Category name	IUCN definition
Category I	Protected area managed mainly for science or wilderness protection.
Category II	Protected area managed mainly for ecosystem protection and recreation.
Category V	Protected area managed mainly for landscape/seascape conservation and recreation
Category VI	Protected area managed mainly for sustainable use of natural resources.

4.5 CULTURAL HERITAGE

Sheikh Okod

The shrine at Sheikh Okod has great cultural importance throughout the northern coast of Sudan and beyond. The policy of the MPA with respect to Sheikh Okod will be to safeguard this site and its cultural significance in the long-term through the protection of the site, the continuation of festivals, and protection of the surrounding environment. This is the only site in the MPA where encroachment of *Prosopis* (mesquite) was observed during the survey phase. The possibility of removing or controlling this invasive species should be fully investigated, and agreement reached with the relevant stakeholders about the best way to address this issue at this site.

Shipwrecks

Currently no historic shipwrecks have been identified within the MPA boundaries, although it is likely that such wrecks do exist. With the probable future importance of scuba diving in the MPA any wrecks discovered must be fully protected from plunder and souvenir hunting by divers. It is recommended that all except very recent (post-1945) shipwrecks be placed off limits to divers once they are discovered, until they can be fully assessed and, if necessary, properly excavated.

Other sites

There has been human activity within the MPA area for thousands of years, and it is likely that historic and/or prehistoric sites exist in the area. All such sites should be protected from looting and destruction, and incorporated within the Management Plan, as the managers become aware of their existence.

4.6 CAPACITY BUILDING AND TECHNOLOGY TRANSFER

Protection of Dungonab Bay MPA is, along with Sanganeb to the south, the first step towards the development of a national network of MPAs, and will constitute an important part of the foundation upon which marine conservation and management in Sudan is based. Currently, capacity within Sudan for management of marine protected areas is very low – as opposed to terrestrial protected areas, where Sudan has a long history and considerable experience.

A number of the fundamental aspects of the marine environment, and of the skills and processes necessary to protect that environment and the biodiversity that exists within it, are very different from those on land.

Recognising this, capacity building will be a central aspect of the initial implementation of park management for several years, at least to the end of Phase II and beyond. Indeed, capacity-building and training will be an ongoing activity to varying degrees, and for varying purposes, throughout the lifetime of the MPA. A model of this may be found within the Gulf of Aqaba Protectorates in Egypt.

Expert technical assistance will be essential to the successful development and management of the MPA throughout the early stages of implementation. To this end it is recommended that:

- An experienced park manager of international standing be recruited to lead the implementation, and to provide on-the-job training to a counterpart (the assistant park manager).
- An experienced and fully qualified scuba diving and marine safety trainer be recruited to provide all necessary swimming, snorkelling, scuba diving, boat handling and other marine safety and survival skills to park staff. This individual should be required to train selected staff in the effective maintenance and basic servicing of scuba equipment, boats and engines.

An early task will be, in consultation with the management of Sanganeb National Park, the development and implementation of a training policy and programme for MPA managers and rangers in Sudan. The careful co-ordination of this programme with that of Sanganeb (i.e. the development of a joint training programme) will provide considerable savings of time, money and other resources, and will also facilitate the development of the links necessary for an effective national network of MPAs.

Long-term successful park management will require access not only to practical skills, but also to scientific expertise. For this reason, a medium to long-term objective of capacity building should be the development of specialist academic training for park staff in marine biology, management and conservation.

The development and maintenance of links with other MPAs in the regional network

Dungonab Bay MPA and Sanganeb National Park will form part of the regional network of MPAs. This should provide an opportunity to benefit from the experience and skills already present in the region. The most important of these regional centres is currently Egypt, where the Gulf of Aqaba Protectorates in particular now have almost 20 years of experience of the implementation of all aspects of marine and coastal protected areas. Other member states of PERSGA also have active MPAs, or are developing them through the PERSGA executed Strategic Action Programme.

Links with the Egyptian parks have already been initiated, with three staff from Ras Mohammed National Park taking part in the initial ecological and resource use survey of the MPA in early 2002. These and other links should be developed and maintained. This may be achieved chiefly through:

- Exchange visits and placements, for both managers and rangers;
- Initiation of and participation in regional and international workshops, seminars and other forums, for the exchange of information, experience and ideas.

4.7 COMMUNITY CONSULTATION AND PARTICIPATION

The involvement of local people in all stages of management is critical to the success of the Dungonab Bay MPA. This includes planning and consultation at all stages, as well as operational activities. The views of the resident population on development concerns should take precedence over those of migrant fishermen or external fisheries (although those wishes should not be allowed to exclude other user groups unreasonably).

To this end the institution of formal communication and consultation mechanisms should be central to management, and local communities should be a focal point of the public awareness plan.

Community consultation should be formally incorporated into the finalisation of major design and implementation decisions. Practical steps taken to develop public understanding and acceptance of, and involvement in, the initial design process may include:

- The employment of extension officers, village meetings, an environmental education and awareness campaign, and regular meetings with local authorities;
- Development of a preliminary draft zoning plan (preliminary guidance is provided by this Management Plan) by the MPA management team. This plan should be based in the first instance on the results of the PERSGA survey;
- The draft zoning plan should be reviewed at a technical workshop attended by community and government representatives, international experts and the management team;
- Review of the draft zoning plan through public meetings held throughout the proposed area, open to all permanent park residents, and attended by local *omda*, fishermen's leaders, technical specialists, and government representatives;
- Subsequent amendment to the draft zoning plan to reflect concerns raised during the meetings.

Collaborative and community based management

The Dungonab Bay MPA has several characteristics that make it particularly suited to the adoption of a collaborative, community-based approach to management, particularly for fisheries. These characteristics include:

1. A significant resident human population spread throughout the area of the MPA

This resident population is, until alternative livelihoods can be identified and put in place, almost entirely dependent upon extractive resource uses within the MPA. The agreement and support of the residents will therefore be a major factor determining whether the MPA is a success in the medium to long-term.

2. Size

The size of the MPA means that effective enforcement implemented entirely by MPA 'authorities' will be impractical, and possibly prohibitively expensive. Adoption of this authoritarian approach may also arouse the resentment and defiance of local residents, which may in itself lead to failure of MPA management.

In contrast, the active participation of the residents in the design and implementation phases, and the development of self-policing and self-enforcement approaches (so long as these are effective), will greatly simplify the management of the area in general and of fisheries in particular.

3. Complexity

The MPA will ultimately be a relatively complex one, with a range of different zone types throughout the terrestrial and marine areas. As described above, and elsewhere, successful development and implementation of the zoning plans will require input from, and ultimately the agreement of, the majority of the residents.

Collaborative management (also called co-management) is based on the participation of all groups with a stake in the resources being managed. The following are key elements in this approach (from WHITE et al. 1994):

- All stakeholders within a park have a say in the management of the resource upon which they depend. This guarantees their commitment and participation, and permits the incorporation of their knowledge, aspirations and experience.
- The sharing of management responsibility varies according to the specific conditions. In some cases, much of the authority is in the hands of a government agency; in others a larger proportion may be in the hands of local community organisations. In virtually all cases, however, a level of government continues to assume responsibility for overall policy and co-ordination of functions.
- Social, cultural and economic objectives are an integral part of the management framework. Particular attention is paid to the needs of those who depend on the resource, and to equity and participation.

The form that collaborative management eventually takes within the MPA will be determined as part of the implementation process.

4.8 RESEARCH AND MONITORING

Institutions and individuals responsible for management need to recognise that the Convention on Biological Diversity (CBD), and other international agreements to which Sudan is a signatory, carry obligations for research and monitoring. These are not options or ‘luxuries’, but legally binding contractual requirements.

Research is carried out to answer specific questions, or resolve particular issues. In the present context, research will support ongoing management of the Dungonab Bay MPA through both proactive and reactive studies.

Research is undertaken to address issues such as:

- 1) The socio-economic significance of the area for local inhabitants, and the national economy;
- 2) Water movements and other hydrographic conditions;
- 3) Life history and population dynamics of exploited species, and in particular their use of specific habitats at different stages of their life cycle;
- 4) Life history and population dynamics of species that form important components of benthic habitats, especially corals and seagrasses;
- 5) Life history and population dynamics of species that may pose a threat to components of park diversity or ecosystems, such as crown of thorns starfish or *Drupella*;
- 6) Biodiversity inventories;
- 7) Community structure of key groups such as fish and corals, and factors affecting those communities.

Research programmes will for some time be beyond the capacity of park staff and management to implement. The full range of productive research opportunities, both applied and academic, presented by the MPA has the potential to attract researchers from throughout the PERSGA region and around the world.

A research policy for the MPA should be drawn up that will define priority research areas. Research programmes conducted within the proposed MPA should, where possible, contribute to the management of the area. Research may contribute to the sustainable financing of the park (see section on sustainable financing below).

Monitoring is undertaken in MPAs for a variety of reasons:

- 1) As part of the management evaluation process; monitoring will determine the baseline conditions at the time the MPA is established so that management performance can be assessed. The data from the 2002 survey will contribute to that baseline, with dedicated monitoring programmes developed during implementation of the MPA;
- 2) To understand the natural variations in the ecosystem so that impacts from human activities can be distinguished from normal, background variation;
- 3) To assess the impacts of particular activities (e.g. establishment of a tourist operation or port).

Monitoring should, from the earliest stages, be clearly and explicitly linked to management rather than merely being a routine, undirected activity. For example, any monitoring programme to sample/measure oil concentrations in the marine environment should be an integrated part of oil spill cleanup. This requires determination and setting of threshold criteria (e.g. not necessarily only minimum oil concentrations) before monitoring commences. In this way, it is known at what point oil spill cleanup should begin. Similarly, but often overlooked, the setting of 'endpoint' criteria is equally important, to determine at what point cleanup operations should cease.

Basic requirements of research and monitoring are set out in the Regional Master Plan.

4.9 PUBLIC AWARENESS AND EDUCATION

Public awareness is essential to the success of many conservation and environmental management activities. It helps to achieve a number of complementary objectives:

- 1) To increase support for and understanding of conservation and management for sustainable use, through increased awareness of the need for, and benefits from, all aspects of biodiversity;
- 2) To gain support for management activities that may otherwise be perceived by stakeholder groups as unnecessary, counterproductive or simply not clear;
- 3) To mitigate or prevent damaging human activities which result from misunderstanding, or a lack of understanding, of vulnerability or other characteristics of species, habitats, or the physical environment.

Achieving the goals and objectives of management requires the support and co-operation of a diverse range of people, including the people whose activities are being managed and key decision-makers in government agencies.

A public awareness programme is an integral component of the Management Plan. The objective of the public awareness programme is:

To achieve the support and co-operation of stakeholders for the goals of the Dungonab Bay MPA, by providing the information to:

- i) support the concept of the MPA,
- ii) comply with MPA regulations, and
- iii) understand why those regulations are there in the first place.

The Regional Master Plan provides guidance on information needs, strategies for public awareness, and guidelines for planning a public awareness programme. The Regional Master Plan should be consulted during the development of the public awareness plan. Topics for public awareness should include, but not be limited to, the following:

- The concept of sustainable development,
- The benefits to be derived from MPAs and their importance in conservation,
- The nature of the major coastal ecosystems (coral reefs, seagrasses, mangroves, etc) and links between the health of the ecosystems and human activities (e.g. heavy fishing and poorly planned tourism),
- The link between long-term conservation of marine and coastal systems, and their value in generating income for developers,
- The value of biodiversity, and of rare and endangered species,
- Regulations relating to the MPA.

Design and implementation of a far-reaching and comprehensive public awareness programme should be a priority in the first full year of implementation.

Co-operation with Sanganeb National Park

Considerable advantages of time, cost, training, production, distribution, etc, may be gained by developing and implementing this programme in co-operation with Sanganeb National Park, in the form a national awareness programme. Much of the more generalised material needed can be utilised by both parks (and by any further parks designated in the future).

4.10 INFRASTRUCTURE

Infrastructure required for management of the Dungonab Bay MPA, and the locations where it will be required, need to be determined. An office, vehicles, boats, communication facilities, accommodation, and personnel will be among the initial priority requirements.

Later on in implementation there will be varied and complex requirements including but not limited to – visitor centres, roads, fencing, mooring buoys, information sources including panels and displays, rubbish collection and disposal facilities, toilet facilities, ranger stations, scuba

equipment (including a dedicated store and workshop) and a range of technical and scientific equipment.

A full assessment of infrastructure needs is a high priority. An indicative list is provided in section 5.6. The needs and experiences of other MPAs in the regional network, particularly Ras Mohammed and the Gulf of Aqaba protectorates may also be studied to provide further insights in advance of full implementation.

4.11 DEFENCE

The Dugonab Bay MPA covers a large area of coastal land and sea. Security services are present in the area and there is great potential for harnessing the knowledge and logistics/skills of the coastguard and other security services to achieve management objectives within the park. This was very clear during the survey phase when security services provided invaluable help and support. Effective public awareness programmes should include these important groups and should help develop and strengthen relationships between the services and the proposed MPA. Development of strategies for liaising with defence authorities, and any requirements for management of defence activities within the MPA (e.g. timing of exercises in relation to nesting by sensitive species) should be a priority.

4.12 OIL SPILL CONTINGENCY

Oil pollution is a widespread threat to coastal and marine biodiversity, fisheries and tourism. The Dugonab Bay MPA, located on the coast of one of the world's major oil transport routes, is no exception. A major oil spill in the area will have the potential to cause extensive damage to the habitats, biodiversity and fisheries of the proposed MPA.

An oil spill contingency plan should be developed as part of the finalisation of the draft Management Plan. This contingency plan should be based upon, and fully compatible with the Sudan National Oil Contingency Plan (PERSGA/UNEP 2003). The Dugonab MPA will not have its own resources and facilities for combating oil, at least initially. In the event of a significant spillage in or near the MPA, management will need to draw on equipment and personnel from Port Sudan.

Assessment of the vulnerability (probability of an oiling event) and sensitivity (ecological/economic consequences of oiling) of different biological components within the proposed MPA is an important aspect of oil spill contingency planning. This helps determine priorities for protection in the event of an oil spill entering the MPA and threatening its biological features and resources.

4.13 SUSTAINABLE FINANCING

Implementation of the Dugonab Bay MPA will incur considerable costs, just as failure to conserve it will carry economic costs/losses. Costs will fall into two categories:

- 1) Initial set-up costs
- 2) Recurrent operating costs

Sustainable financing is a new field in the Red Sea and Gulf of Aden because, to date, there are few operational MPAs and costs associated with running them have tended to come from government operations or international donor agencies.

Tourism as a source of revenue for MPA operations has, after considerable development and investment, been successfully applied in Egypt at the Ras Mohammed National Park, where entrance fees to the National Park have allowed the Gulf of Aqaba Protectorates to be financially self-sustainable (at least nationally, as final mechanisms for returning revenues generated by the MPA to the MPA management have not yet been established) and not to require subsidy from central government.

The development of tourism as a source of sustainable financing on the Ras Mohammed model should be a point of policy for the MPA management. However, Ras Mohammed National Park required donor support throughout the early years of implementation before it reached the stage of being self-financing. With limited infrastructure it is unlikely that sustainable financing based upon tourism will be an option for Dugonab Bay MPA in the near future.

Since the financial requirements of the Dugonab Bay MPA still need to be determined this section provides recommendations on the principles to be applied:

Recommended Financing Principles:

- 1) Financial transparency in collection, auditing and distribution is essential, with revenues raised for the proposed MPA clearly seen to be recycling back to the budgets of the organisations providing services.
- 2) Users should, where possible, pay in full for all physical resources they use, including the costs of the management of these resources.
- 3) Prices of services and supplies (e.g. water and utilities) should reflect true economic costs, including costs of sustainable environmental management where appropriate (polluter pays).
- 4) Users, including recreational divers, should carry a good proportion of the financing burden for marine protected areas.
- 5) All tourists entering the area, even if they do not dive or snorkel, impose costs on management. As a matter of principle they too should make a contribution to maintaining the overall quality of the environment in the coastal zone. A lower level of entry costs may be applied to Sudanese nationals, and a higher (but still modest) rate to non-Sudanese visitors.
- 6) Traditional uses of the MPA, such as the festival at Sheikh Okod should, while being required to conform to the broader requirements of sustainable use and conservation, be exempted from standard entry fees.

To these broad principles may be added the following potential financing mechanisms. These are derived from findings of the recent GEF Red Sea Coastal and Marine Resource Management Project in Egypt and other international tourism projects:

- Yachting (the numbers are forecast to increase substantially in the PERSGA region, and they can contribute through harbour charges, and charges for (mandatory) use of identified mooring buoys);
- Cruise ships (few at present, but it is customary to impose a charge, typically per person on the ship's manifest, as a contribution to associated infrastructure and other costs imposed);
- Medical (revenue from use of their recompression chamber is a significant income source in areas such as the Sabah Marine Park, Malaysia). This is an example of lessons that might be learned from outside the region; and similarly,
- Research (research teams contribute in Malaysia to the costs of the Sabah Marine Park when they are working there. They also provide research students with an opportunity to work on a cost-free basis).

5. THE MANAGEMENT PLAN

The Management Plan is a specific document that outlines strategies for implementing the objectives, goals, and general policies in the Master Plan. The Management Plan has a life of around five years and is evaluated and amended following the results of the monitoring programme. The Management Plan includes the following contents:

- Management of natural resources
- Zoning
- Research and monitoring
- Public awareness
- Oil spill contingency
- Infrastructure

5.1 MANAGEMENT OF NATURAL RESOURCES

Biodiversity

For the purposes of management, biodiversity may be defined as the full range of biological communities, species, and variation within species occurring at a site, in a locality or within a region.

This range of biological diversity provides the basis for the food chain and productivity, and also influences the capacity of ecosystems to perform these and other services. Biodiversity, in both type and quantity, is affected by fishing and a wide range of other human activities. Hence management measures for the conservation of biodiversity underpin and support actions directed at the harvesting of natural resources.

Key issues relating to biodiversity identified within the Dungonab Bay MPA are summarised in Table 1, but the list is not exhaustive. Further issues will be identified during the implementation of the MPA, and subsequently. Table 1 also highlights and prioritises conservation measures needed to address these issues.

Careful attention will be necessary to ensure compliance with international obligations (e.g. CBD) and regional agreements concerning the monitoring of biodiversity.

Special policies and guidelines to be developed for managing key habitats and species of conservational importance will need to be comprehensive. Habitats to be covered include:

- Coral reefs and coral communities
- Mangroves
- Seagrasses
- Algae
- Sabkha
- Beaches and intertidal areas
- Terrestrial habitats

Important species to be covered include (but may not be limited to):

- Turtles
- Dugong
- Birds
- Cetaceans (dolphins, whales)
- Elasmobranchs (sharks and rays)

Until these guidelines have been developed, ‘broad-brush’ conservation measures will be needed (e.g. avoiding/preventing disturbance or development in known feeding or breeding areas, and tackling clear and obvious existing threats). Conservation measures for habitats and species already developed in the PERSGA region (e.g. Egypt and Saudi Arabia), as well as further afield (e.g. turtle conservation guidelines from East Africa) will be helpful.

Table 2. Key issues and proposed activities relating to biodiversity.

Key Issues	
<ol style="list-style-type: none"> 1. Knowledge of habitats and biodiversity in the MPA is adequate for initial implementation and management, but inadequate for long-term management. Details of species associated with habitats are generally insufficient. 2. Biodiversity of terrestrial habitats and associated flora and fauna is inadequately documented. 3. The MPA’s habitats and species assemblages are however well-enough known to indicate that they are significant both nationally and internationally. 4. The marine and coastal ecosystems of the entire area are varied and diverse, with a number of the most important areas remaining in good or very good condition. 5. The area is of national and regional (possibly global) importance for a number of threatened, endangered and flagship species. 6. Recent impacts in the area include the 1998 coral bleaching event. There have also been sharp declines, due to fishing activities, in the abundance of some important fisheries species, and the globally threatened dugong. 	
Proposed Activities	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Compilation of existing biodiversity/species data for key marine (coral reefs, seagrasses, algae and mangroves) and terrestrial habitats. 2. Identify, in detail, key species groups and habitats for priority study. These should include all vulnerable and threatened species. 3. Immediately implement protection and management of key critical sites (e.g. turtle nesting beaches of Mukawwar Island). 4. Assess the extent and possible impact of bird and turtle egg collecting activities, and implement management if necessary, including directed public awareness programmes.
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. Focused survey work on species of conservation importance (e.g. turtles, birds, cetaceans, corals and sharks), including naturally occurring but potentially damaging species such as crown of thorns starfish. 2. Undertake biodiversity surveys/inventories to augment information derived above. 3. Identify and initiate management processes that will incorporate new information about biodiversity and processes within the MPA into management actions (e.g. to adjust zoning plans, regulations within zones etc. and accommodate new information about environmental sensitivity).
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Develop and implement detailed policies and guidelines for managing key habitats and species of conservational importance. 2. Develop information systems (GIS and databases, and human capacity to fully utilise them) to facilitate management. This should be done as a joint Dugonab–Sanganab project.

Coral bleaching

A further point relevant to biodiversity conservation is coral bleaching. This is of considerable concern in the PERSGA region where it has caused extensive coral mortality for several years. Most notable was the bleaching event of 1998 – although large areas of coral on the eastern shore of the southern Red Sea (both Yemen and Saudi Arabia) were killed in a more localised event that probably occurred in 1995 or 1996. Climate change is probably a major factor behind the increasing frequency and severity of coral bleaching events. Individual developing countries like Sudan can probably do little to influence the western nations largely responsible for the increasing emissions of greenhouse gases, climate change and sea level rise. However, national and local efforts can help to combat the more local impacts of global climate change because:

- Healthy coral reefs have the capacity for vertical growth to keep pace with sea level changes. The same is to some extent true of other key habitats including mangroves and seagrasses. Healthy communities tend to be more resilient than damaged ones.
- Healthy coral reefs and other communities/habitats have a greater capacity to respond to sea level rise and other impacts than degraded communities (although this will not provide immunity against instances of heavy bleaching).
- Maintenance of coral reefs, mangroves, seagrasses and other biological communities may help to mitigate the consequences of climate change locally by protecting shorelines and reducing erosion.

Resource Use

Extensive fishing pressure within the proposed MPA, impacting both target and non-target species to a possibly unsustainable degree, means that development and implementation of effective resource use strategies and guidelines are fundamental to management.

Key issues relating to resource use are summarised in Table 3, which also highlights and prioritises conservation measures needed. The early identification of the agency/agencies that will implement these measures is important. With commitment and sufficient resources, the fisheries within and around the proposed MPA can be successfully managed for sustainability in the long-term.

Other resource uses

Resource-use management guidelines are considered separately from fishery regulations, and need to address in particular the following aspects of development:

- The exact location (site) and other planning requirements of development including, but not restricted to: tourism facilities including recreational facilities of all kinds; residential, fishing and other accommodation; and any other infrastructure including roads. The issue of siting is broadly addressed in the terrestrial zoning plan presented in this Management Plan, but more detailed planning is required within those zones.
- Construction (choice of materials; avoiding loss/degradation of critical marine habitats for fishery species and fauna of conservational importance; control of sedimentation etc.).
- Operations (control of nutrient, sewage and effluents).

- The present position of the coast road allows easy access to extensive areas of mainland coast, including fragile and vulnerable fringing coral reefs, khors, sabkha and mangroves. The opportunity for uncontrolled access to the shore from the main road should be limited as much as possible to specifically designated areas of low sensitivity, which are easy to patrol/maintain. It is essential that when the new coast road is constructed it is set back from the shore outside the terrestrial buffer zone, or otherwise as far back as is practical from an engineering point of view. Off-road driving by non-residents should be prohibited. In this way access to the coast, particularly by non-resident visitors from outside the MPA can be managed.

Table 3. Key issues and proposed activities relating to extractive resource uses.

Key Issues	
<ol style="list-style-type: none"> 1. Widespread and seemingly escalating fishery problems, including a combination of overfishing, and unsustainable fishing methods that may threaten the fishery's sustainability, and species affected by it (e.g. dugong). 2. Damage to corals and other benthic habitats by nets, including lost nets continuing to ghost fish, causing turtle mortality and/or damage to corals. 3. Anchor damage from fishing boats on corals. 	
Proposed Activities	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Undertake outreach activities and socio-economic studies to enable a full understanding of the nature, extent and importance of extractive resource uses, and begin to identify alternative livelihoods. 2. Prohibit trawling and other industrial fishing within the proposed MPA boundaries. 3. Initiate collaborative, community-based fisheries management for issues that can be addressed directly by the local communities. 4. Urgently implement management to protect endangered species (e.g. dugong) threatened by specific fisheries methods (in the case of dugongs, the use of fixed nets in or near areas of seagrasses, khor mouths etc). 5. Prohibit the use of scuba equipment for sea-cucumber fisheries.
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. Fully develop collaborative and community-based fisheries management structures and approaches. 2. Urgently designate 'no-take' fisheries reserves, both permanent and seasonal. 3. Institute measures to monitor and if necessary regulate the numbers of fishermen, traps, boats and nets, particularly of non-local fishermen. 4. Initiate management measures to protect vulnerable target species, including nagil, sharks, kokian, sea-cucumbers etc. 5. Prohibit unsustainable or damaging methods. 6. Prohibit use of nets in coral areas.
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Ongoing monitoring of fishing practices, fish catch and effort, and modification of regulations as necessary. 2. Ongoing monitoring of the impacts on the status of populations or species vulnerable to incidental fishing (e.g. as by-catch, including dugong and turtles). 3. Monitoring of the effectiveness of fishery reserves, with extension of Fisheries Reserves to at least 20% of the area (and including at least 20% of the reefs). 4. Develop more knowledge of critical life cycle phases (spawning and nursery areas) of important fishery species, and of the susceptibility of these to pollution and development pressures. 5. Formulate and apply guidelines/policies to manage coastal and marine uses (e.g. construction, development and tourism).

NOTE: There is considerable potential in the proposed MPA for inappropriate coastal development and coastal use. This has not yet happened to any appreciable extent, but unsustainable practices need to be prevented before they occur, rather than cured later. This is done through resource-use guidelines, zoning, and related measures.

General regulations within the MPA boundaries

This section provides an indicative list of general regulations that should be applied within the MPA. This list should be further developed and finalised during the first year of implementation.

- All extractive uses require a licence (see comments elsewhere about relative levels of charging, and eligibility of park residents for free licences).
- Removal of corals, shells, and other curios and souvenirs, whether living or dead, to be prohibited.
- All destructive fishing practices to be prohibited.
- All industrial fishing and trawling within the park boundaries to be prohibited.
- All bird and turtle nesting sites, nests and eggs to be fully protected.
- All juvenile and adult birds and turtles to be fully protected.
- All dugong to be fully protected.
- All mangroves to be fully protected.
- All elasmobranchs (sharks and rays) within the area to be fully protected.
- Anchoring or poling craft, or walking over corals and reefs to be prohibited.
- Driving anywhere except on designated routes and roads, to be prohibited (see more detailed comments elsewhere).
- Littering anywhere is prohibited.
- Feeding of fish within the MPA is prohibited.
- It is forbidden to possess fish poisons, nets, hooks and lines, traps, or any other fishing equipment without a licence.
- Possession of spear guns anywhere in the park at any time is prohibited.
- It is forbidden to use jet skis. Use of other fast moving or noisy craft within the MPA will be limited to permitted areas in order to protect vulnerable species including dugong, turtles and whale sharks.
- Building within 50m of the high tide line is prohibited.
- Landfill is prohibited.
- The building of residences, catering facilities and other shelters or structures whether temporary or permanent shall be restricted to the General Use Zones unless by prior written amendment to the Management Plan by the management committee, following the full completion, review and acceptance of appropriate EIA studies.

- The building of piers, groynes, breakwaters, seawalls or other structures on, across or seawards of the shore is prohibited unless by prior written amendment to the Management Plan by the management committee, following the full completion, review and acceptance of appropriate EIA studies.
- Digging, blasting or dredging on or seawards of the shore is forbidden, unless by prior written amendment to the Management Plan by the management committee following the full completion, review and acceptance of appropriate EIA studies.

5.2 ZONING

The proposed MPA, taken as a whole, is a multiple-use protected area. A preliminary zoning scheme has been developed (Tables 4 & 5). For each zone, the main purpose of the zone is given, together with a summary of the main areas/features represented. Activities which are permitted and forbidden are also given. In many cases, additional details of activities will need to be developed further. Preliminary maps showing the extent of the zones proposed are shown in zoning maps 1–4 in Appendix 3.

The zoning plan presented here is preliminary. Prior to implementation this plan is to be presented and discussed as part of a consultative process with the MPA residents. To be fully effective the zoning plan requires the support of the residents, and may be modified accordingly.

However, it must be stressed that a number of general and specific requirements for the ‘final’ zoning plan should be met, including:

General zoning requirements include but are not limited to:

- Implementation: the implementation of zoning will be:
 - Gradual over the first one to four years of implementation; and
 - Flexible, in order to respond to emerging conservation and management needs. Park management must be careful to ensure that flexibility does not allow zoning plans and objectives to be incrementally eroded to the detriment of conservation.
- Conflicting uses are to be, as far as possible, separated by the zoning plan;
- Where feasible Nature Sanctuaries should be nested within Nature Reserves, to provide a surrounding buffer zone of protection greater than that within General Use or Resource Use Zones;
- Zones within which extractive resource uses are disallowed (all Nature Sanctuaries, many Nature Reserves, and all Fishery Reserves) should:
 - Eventually encompass a minimum of 20% of the area of the MPA, including a minimum of 20% of the reef areas;
 - Include all significant spawning sites and other locations key to reproductive survival of target species; and
 - Form a network that will support fisheries throughout all other areas of the MPA by both dispersal of eggs and larvae, and by emigration or ‘leakage’ of adults. For detailed guidance on fishery reserve function and design see ROBERTS & HAWKINS (2001).

- The resident fishing community should be closely consulted about all aspects of fishery reserve location, size and function, and reassured about the motives of the MPA in designating such zones, and the medium to long-term benefits that should accrue to the residents as a result. This should be the focus of a carefully developed and highly targeted component of the public awareness programme. As described elsewhere in this plan, the network of Fisheries Reserves and of other restrictions on where fishing can be undertaken should be developed incrementally with the agreement of the park's residents.
- Marine and terrestrial Nature Reserves provide a basis for flexible levels and types of protection or management beyond the relatively simple designation of major zone types. Nature Reserve regulations and objectives should vary according to the specific objectives of each reserve. For example, it may prove necessary to designate a Nature Reserve area within the proposed MPA specifically to protect major dugong aggregations. Regulations applicable to that Nature Reserve will be tailored to that objective, and will thus be different from regulations in a different reserve zone designated for, for example, management of fragile coral communities.

Specific zoning requirements include but are not limited to:

- The turtle nesting beaches on Mukawwar should be within a Nature Sanctuary, but with the possibility of carefully controlled ecotourism specifically to see nesting turtles. All turtle nesting sites should be subject to protection from disturbance.
- The aggregations of whale sharks and manta rays are likely to need protection from harassment if and when tourism begins to take off in the MPA. Depending upon the spatial nature of those aggregations this may be suitable for application of seasonal zoning. However, general regulations about approaching or disturbing these animals will still be required.
- The possibility of including all or part of Khor Shanaab in a Nature Sanctuary (marine and terrestrial) or a Marine Reserve should be considered.
- The possibility of including all mangroves within Nature Reserves with appropriate regulations should be fully investigated. Detailed justification should be provided for not doing so.
- The possibility of creating a Nature Reserve for Mersa Inkefal and the inlets, reefs, mangroves, intertidal areas and shorelines associated with it should be considered.
- The mangroves, lagoons, reefs and seagrass beds at the southern end of Mukawwar merit a high level of protection.

Zoning definitions

The zones described here (Tables 4 & 5 below) are largely but not entirely based upon the IUCN definitions for protected area categories, with the addition of Fisheries Reserves, which are not easily included in any IUCN category (KELLEHER, 1999). Although the IUCN categories are intended to be applied to the overall objective or uses of entire protected areas rather than to zones within those protected areas, they may also be usefully adapted, and applied to different zone types within multiple-use protected areas such as Dungonab Bay MPA. With the addition of Fisheries Reserves, that is the approach adopted here.

Between them these zone types allow for the full range of activity types and levels of protection required for a multiple-use protected area of the size and complexity of the proposed MPA.

Table 4. Summary of proposed zoning categories for the Dungonab Bay–Mukawwar Island MPA.

Dungonab Bay–Mukawwar Island Proposed MPA Zone Types: Summary			
Dungonab MPA Category	Terrestrial or Marine	Equivalent IUCN Category	Summary Description
Nature Sanctuary	Both	Category I	Area with very strictly controlled access. Within the MPA this will include areas for species protection (e.g. marine turtles). Such sites will be off-limits for all human activities except patrolling and non-destructive monitoring by park staff, and strictly controlled non-destructive scientific research.
Nature Reserve	Both	Category II	Areas for non-extractive and non-destructive use, in which development is not permitted. This will be primarily recreational.
General Use Zone	Terrestrial	Category VI	Area providing for infrastructure and economic development under strict control.
Resource Use Zone	Marine	Category VI	Area providing for sustainable extractive resource use.
Fishery Reserve	Marine	None	Area permanently or seasonally closed to all extractive resource use, over and above those areas already included in marine Nature Sanctuaries and marine Nature Reserves. These are designated to provide reproductive refuges for vulnerable target species, and to ensure long-term security of fishery stocks.

Table 5. Key features of the zone types within the Dungonab Bay MPA.

Zone	Areas/Features Represented	Main Purpose	Activities Permitted	Activities Prohibited
Nature Sanctuary	<p><u>Mukawwar Island (south and east)</u>: internationally important turtle nesting beaches; mangroves, lagoons, seagrasses and coral reefs.</p> <p><u>Southern end Khor Naitaib</u>: pristine and highly unusual coral and fish communities in highly stressed environment, semi-enclosed or isolated.</p> <p><u>Western islands in Dungonab Bay</u>: fragile but very healthy coral communities, diverse fish communities and nesting birds.</p> <p><u>One of the further offshore reefs (provisionally Abington)</u>: representative deep-water reef with communities of corals, reef fishes, and large pelagic fishes. Easily disturbed by visitors or low levels of fishing.</p>	Preservation of key biological features of national/international significance, and protection of endangered species.	Patrolling by park staff. Non-destructive scientific research and monitoring.	Coastal development; all extractive resource uses; tourist activities ¹ ; anchoring over corals (further details to be determined).
Nature Reserve (Terrestrial)	<p><u>All terrestrial areas outside General Use Zones</u>: exceptional landscapes; representative coastal habitats and biodiversity; charismatic and threatened species.</p> <p><u>All islands not included in Nature Sanctuaries</u>.</p>	<p>Safeguarding of important resources/features.</p> <p>Buffer zone for management of marine areas and shorelines.</p> <p>Protection of all vulnerable island sites.</p>	Regulated, non-destructive activities, (except coastal development) further details to be determined.	Coastal development. Destructive resource uses (further details to be determined).
Nature Reserve (Marine)	<p><u>Offshore reefs including Shambaya, Merlot and Angarush</u>.</p> <p><u>Northern part of Khor Naitaib</u>.</p> <p>Areas for non-destructive and non-extractive recreational use.</p>	Providing buffer zones for Nature Sanctuaries, and/or providing an added level of protection above that within Resource Use Zones.	Regulated, non-destructive activities; diving may be allowed, but following guidelines (further details to be determined).	Extractive or destructive resource uses (further details to be determined).

¹ Eastern Mukawwar is the only exception. Turtle nesting beaches here may provide an important tourist attraction. All tourism here should be very strictly controlled, with no unsupervised access.

General Use Zone	<p><u>Dungonab village and Mohammed Ool</u>: principal centres of population in the proposed MPA.</p> <p><u>Sheikh Okod</u>: principal cultural site.</p> <p><u>The Dungonab salt works</u>. NOTE: this General Use Zone is only for activities related to the salt works. Any development within the salt works for any other purpose is prohibited, and any alterations in practices at the salt works will have to be notified to and cleared by the MPA management committee</p>	Multiple human use in accordance with principles of environmental sustainability; conservation of traditional features and landscapes.	Regulated development. (further details to be determined).	Building within 50m of the high tide line; landfill; discharge of sewage (further details to be determined).
Resource Use Zone	<u>All marine areas not included in other zone types</u>	Management for sustainability and biodiversity conservation including protection of vulnerable, threatened or endangered species, and key or fragile habitats.	Sustainable and non-destructive fisheries; diving allowed but following guidelines (further details to be determined).	Destructive or unsustainable resource use; trawling; curio or souvenir collection; damage or disturbance to key habitats and species (further details to be determined).
Fishery (No-Take) Reserves	<p><u>Southern Mukawwar Island</u>: spawning area for nagil.</p> <p><u>Other reef areas</u> (minimum five recommended initially): placed within reef fishing areas, including at least two or three with declining catch of one or more key species.</p>	Maintenance and build-up of fish biomass, diversity and spawning capacity, facilitating dispersal of raised concentrations of fish eggs and larvae to fishing areas, and leakage/migration of adults to adjacent fishing areas. Protection of spawning areas and aggregations.	Non-extractive resource-use activities. May be seasonal or permanent; (further details to be determined).	All forms of extractive, destructive and non-sustainable resource use (further details to be determined).

Further aspects of zoning are considered in Table 6. This highlights conservation measures needed for key issues.

Table 6. Key issues and proposed activities related to zoning.

Key Issues	
<ol style="list-style-type: none"> 1. Dungonab Bay MPA has outstanding landscapes and seascapes, and some of its biological features (coral reefs, seagrasses, mangroves, birds, turtles, dugong and sharks) are of major national and international significance. 2. The marine and coastal ecosystems of the entire area are varied and diverse. 3. Although some damage has occurred (largely due to coral bleaching) many important areas remain in good or very good condition. 4. The need to balance sustainable use with conservation is made imperative by the resident population who are almost entirely dependent upon extractive resource uses. 5. The need for zoning is central to management in order to safeguard the proposed MPA's natural resources, while allowing activities that do not threaten the sustainability or functioning of the MPA. 	
Proposed Activities or Action	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Refinement of present (preliminary) zoning scheme through consultation and review by stakeholders and others (to include specialist experts/advisors with extensive experience of multiple-use MPAs, including fishery reserves).
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. Finalisation of primary zoning scheme (if necessary following further rounds of consultation). 2. Development of comprehensive guidelines on permitted and prohibited uses in Nature Sanctuaries, Nature Reserves, General Use Zones, Resource Use Zones and Fishery Reserves. 3. Implementation of the primary zoning scheme and application of the guidelines for each. 4. Development and implementation of regulations and policies about access routes into the MPA as a whole, and within and between different zones. Implement regulations on driving by designated and marked routes only.
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Refinement of primary zoning scheme, and extension of network of Fishery Reserves to cover at least 20% of the marine area, including at least 20% of the coral reef area. 2. Ongoing monitoring of activities and environmental health within each of the zoning categories. 3. Periodic review of zoning schemes and their boundaries, modifications where necessary.

5.3 RESEARCH AND MONITORING

Research and monitoring programmes are essential to successful medium to long-term management of marine protected areas. Implementation of monitoring and applied research programmes will provide information to support improved planning and decision-making.

Links between research programmes and monitoring programmes are in many cases very close. Monitoring programmes can provide the basis for informative and useful applied research. Research programmes can, in turn, provide explanations and help to identify possible management actions for changes identified, but not explained, by monitoring.

Research

Key issues relating to research are summarised in Table 7, which also highlights and prioritises conservation measures needed.

Table 7. Key issues and proposed activities relating to research.

Key Issues	
<ol style="list-style-type: none"> 1. The abundance, distribution and local ecology of key species groups (sharks and rays including whale sharks and manta rays; turtles; dugong; birds; key fisheries species; etc) are largely unknown. 2. Understanding of ecosystems and processes central to functioning of the Dungonab Bay MPA (and links to its surrounding marine ecosystems) is currently rudimentary. 3. There is very little available information on terrestrial habitats and species. 4. Uncertainties remain about marine habitat categories and their distribution. 	
Proposed Activities	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Acquire spatially and taxonomically more comprehensive biodiversity information using several measures and explore the suitability of indicator species (e.g. corals, coral fishes, seagrasses, echinoderms) and possible threat species (crown of thorns starfish, <i>Drupella</i>, etc). 2. Undertake terrestrial surveys to extend knowledge of species of socio-cultural and ecological significance. 3. Carry out baseline surveys of fishery reserve sites (pre-implementation).
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. Verify satellite/other maps and charts for habitat types and boundaries, then decide which categories should be adopted for management purposes. To include considerations of species assemblages (e.g. inside/outside Dungonab Bay). 2. Initiate long-term studies of effectiveness of fishery reserves, and factors supporting or undermining that effectiveness.
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Conduct studies of ecosystem resilience and robustness against natural events and human activities (coral bleaching/disease and fishing).

Monitoring

Monitoring of the biological and environmental parameters within and immediately adjacent to the MPA, and of the socio-economic activities taking place in the proposed MPA, or in association with it, is essential. Ecological/socio-economic monitoring will include a number of components or factors:

- 1) Definition of initial status (baseline),
- 2) Identification of environmental or socio-economic changes (from natural events or human activities),
- 3) The need for remedial action,
- 4) The effectiveness of any management measures implemented.

Key issues relating to monitoring are summarised in Table 8, which also highlights and prioritises conservation measures needed. The details of monitoring programmes, including aspects of design, will need to be developed during implementation of the MPA.

Table 8 Key issues/findings and proposed activities or actions relating to monitoring.

Key Issues	
<ol style="list-style-type: none"> 1. Lack of detailed baseline data on habitats and species, and human activities. 2. Lack of fisheries catch and effort data, particularly uncertainties surrounding the fate of fish caught within the MPA but landed elsewhere. 3. No information on by-catch, or on indirect effects of fisheries on habitats and non-target species. 4. No implementation of EIA requirements for new developments, activities or infrastructures and their operations (including tourism). 5. No recent or detailed information on outbreaks of diseases or other biological threats in the MPA (e.g. crown of thorns starfish and <i>Drupella</i>). 	
Proposed Activities	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Develop preliminary plans for all monitoring programmes (e.g. methods, equipment and sampling frequency). 2. Implement the routine collection of detailed fisheries data, including by-catch, methods used, areas fished, etc. 3. Implement and fully enforce policy that fish caught in the MPA should be landed only in the MPA (not elsewhere), to facilitate monitoring of population/stocks and status. 4. Initiate baseline surveys (including but not limited to Fishery Reserves, nesting of turtles and birds, and key species/habitats).
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. Finalise design of all primary monitoring programmes, and fully implement those programmes. 2. Complete baseline surveys. 3. Formulation and implementation of detailed EIA guidelines for all new infrastructure and developments, prior to construction, i.e. pro-actively. 4. Monitoring of CoT starfish and its natural predators (e.g. triton) to help track CoT outbreaks (links with Ras Mohammed will be useful in this respect).
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Monitoring of human uses and their effects on the MPA's status and health. 2. Monitoring of the effectiveness of significant management interventions put in place (through use of success indicators and other project milestones, drawing on experiences elsewhere e.g. Ras Mohammed). 3. Initiate other monitoring as need arises, i.e. adopt a flexible approach.

Evaluation of success or failure of the proposed MPA

This Master Plan recognises the importance of tracking progress in a systematic and verifiable manner, to assess:

- The success of activities and expected outputs associated with the Dungonab Bay MPA.
- The extent to which overall objectives and requirements are met.

It is important that a monitoring system is established to provide a process for evaluation. Minimum requirements should include:

(1) Activities and outputs:

Summary of major project tasks as set out in the Master Plan, broken down into sub-tasks, activities and outputs.

(2) Operational history:

Brief historical review of task implementation and milestone achievements.

(3) Verifiable indicators:

Objectively Verifiable Indicators (OVIs) are direct and indirect indicators of outputs and action generated by the project, which can be validated. The sources of verification are documents, reports and other sources providing information that make it possible to gauge actual progress towards planned results and project purpose.

(4) Results:

Brief summary of main outputs and achievements in terms of tangible products (survey reports, electronic archives, reports, physical structures etc.).

(5) Extent of Achievement:

Ranked scale of the overall extent of success or achievement in respect of activities and outputs. A simple assessment can be based on a 3-point scale (+++ substantial; ++ partial; + negligible).

5.4 PUBLIC AWARENESS

The objectives of education and awareness programmes are to provide stakeholders with information about: the benefits of – and need for – marine and coastal biodiversity; the management arrangements of the proposed MPA; and to enhance their enjoyment and understanding of the marine environment. Successful achievement of these objectives will increase overall public and stakeholder support, and thus improve self-policing and voluntary compliance.

Linkages between all components of park management are important, and public awareness in particular can and should be built into many other areas of activity within the proposed MPA.

Key issues relating to public awareness are summarised in Table 9, which also highlights and prioritises conservation measures needed.

Table 9. Key issues and proposed activities relating to public awareness.

Key Issues	
<ol style="list-style-type: none"> 1. Very limited awareness among many stakeholders of the benefits of MPAs, including the benefits to fisheries. 2. Variable but generally limited understanding among different users and beneficiaries of the values and vulnerability of resources within the MPA. 3. Absence of other fully implemented MPAs in Sudan, hence no national examples for drawing on past experiences (links with Sanganeb National Park to be fully developed). 	
Key activities	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Assessment of environmental education needs at all levels (school curricula and media options including press articles, radio, TV, leaflets and audiovisuals). 2. Assessment of information-related professional skills for environmental officers and others involved in information collation and dissemination. 3. Assessment of stakeholder needs (e.g. to ensure inclusion of their view in all stages of planning and management). 4. Assessment of feasibility of visitor centre for both national and international visitors, including possible sources of funding, as showcase for the proposed MPA and centre for on-site information dissemination. 5. Determine need for environmental workshops and consultative meetings, for exchange of ideas and information (to be linked with and facilitate/develop wider consultative aspects of collaborative management).
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. In close consultation with Sanganeb National Park, and based on results of needs assessment above, develop a detailed public awareness plan for marine and coastal conservation and sustainable use (This may be one comprehensive master plan for both parks, or two plans closely linked and with common themes). 2. On the basis of the public Awareness plan, develop public awareness materials, programmes, infrastructures and facilities,. 3. Develop promotional materials on sustainable fishing practices, including benefits of buoys to prevent anchor damage to corals (One key reference will be ROBERTS & HAWKINS 2001). 4. Arrange environmental workshops and consultative meetings (e.g. to promote representation of all major stakeholders) based on results of needs assessment above.
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Demonstrate value of Fishery Reserves for safeguarding harvested species and/or enhancing heavily exploited populations. 2. Maintain and enhance public awareness capacity for sustainability.

5.5 OIL SPILL CONTINGENCY

Key issues relating to oil spill contingency planning are summarised in Table 10, which also highlights and prioritises conservation measures needed. There is very considerable regional expertise in oil spill planning. The contingency plan for the MPA should be based upon and fully compatible with the Sudan National Oil Contingency Plan (PERSGA/UNEP 2003). The oil contingency planning for Ras Mohammed National Parks Sector should be assessed for relevance to the proposed MPA.

Table 10. Key issues and proposed activities relating to oil spill contingency planning.

Key Issues/Findings	
<p>Limited awareness of the threats of oil spills and of approaches to combat oil spills. Absence of information on risks (probability of oiling event) and sensitivity of ecosystems/species/resources/features vulnerable. Lack of resources (human and physical) for dealing with oil spills in the proposed MPA.</p>	
Short-term (<12 months)	<p>Assess risks of oil spills and sensitivity of vulnerable ecosystems/species/resources and features. Determine oil spill cleanup equipment needs, considering availability and accessibility of national resources (e.g. Port Sudan) and regional resources (Saudi Arabia and Egypt), and consistent with best international practice to ensure net environmental benefit (NEB). Evaluate human capacity requirements for combating oil spills.</p>
Medium-term (1-3 years)	<p>Develop oil spill cleanup guidelines, based on outcome of needs assessment above. Procure and/or ensure availability of oil spill cleanup equipment in event of oil spill in the MPA, based on outcome of needs assessment above. Ensure adequate capacity to deal with oil spill emergencies and cleanup, based on outcome of needs assessment above.</p>
Long-term (3-5 years)	<p>Develop threshold criteria (e.g. Total Petroleum Hydrocarbon (TPH) concentrations) to determine when oil spill cleanup should commence, and endpoint criteria to determine when oil spill cleanup should cease.</p>

5.6 INFRASTRUCTURE

Little in the way of facilities, infrastructures and supporting staff is currently available in the Dungonab Bay MPA. Insights and lessons from Ras Mohammed and similar regional initiatives should provide helpful guidance on infrastructure requirements. Key issues relating to infrastructure are summarised in Table 11, which also highlights and prioritises conservation measures needed.

Table 11. Key issues and proposed activities relating to infrastructure.

Key Issues/Findings	
<ol style="list-style-type: none"> 1. Virtual absence of office infrastructures and management capacity within the MPA. 2. Absence of required vehicles, boats, radio and other equipment. 	
Short-term (<12 months)	<ol style="list-style-type: none"> 1. Complete detailed needs assessment for office infrastructure and project management facilities, transport and other equipment. 2. Develop system for acquisition and analysis of fish catch data for the proposed MPA.
Medium-term (1-3 years)	<ol style="list-style-type: none"> 1. Acquisition of office infrastructure and project management facilities. 2. Acquisition of vehicles, boats and ancillary MPA equipment.
Long-term (3-5 years)	<ol style="list-style-type: none"> 1. Encourage community based operation of MPA facilities and infrastructure as far as possible (with appropriate oversight and control), within the context of national institutions and international agreements.

The provision of an exhaustive project list of equipment needs at this stage is premature. However, an indicative list is provided below to give an indication of likely requirements (this is based on preliminary equipment needs identified for projects in Yemen and other regional countries).

Expendable equipment:

- Audio-visual materials
- Binoculars
- Charts and maps
- Equipment, spares and maintenance for laboratory equipment
- Equipment, spares and maintenance for vehicles
- Equipment, spares and maintenance for inflatables and outboards
- Stationery, data sheets and miscellaneous office supplies
- Tape recorders
- Thermometers

Non-expendable equipment:

- Analytical laboratory equipment and field equipment
- Boats (inflatable boats for close inshore work, and 6m Rigid Inflatable Boats (RIBs) for work and patrolling further offshore). Eventually the MPA is likely to need a substantial hard-hulled boat with capacity to work and patrol for more extended periods (overnight or longer) offshore.
- Communications equipment
- Diving equipment, plus spares and maintenance facilities
- Fax machines
- GIS equipment, including computers, plotters and hand-held GPS units
- Hand-held salinity refractometers
- Off-road vehicles
- Office equipment and furnishings
- Outboard motors
- Overhead projectors
- Personal computers/printers and software
- Photocopiers
- Slide projectors
- Telephones
- Video and stills (digital) cameras
- Video recorders/players
- Video monitors

Infrastructure:

- Park office buildings (on-site offices in the MPA, and office space in Port Sudan shared with Sanganeb National Park);
- Laboratory space (may be based in Port Sudan, and shared with Sanganeb National Park);
- Scuba and field equipment storage and basic maintenance facilities (more substantial maintenance facilities may be based in Port Sudan, and shared with Sanganeb National Park);
- Park accommodation for managers and rangers.

Constraints, issues and uncertainties

Constraints and uncertainties of immediate or particular concern for the Dungonab Bay MPA can be summarised as follows:

- **Information gaps** e.g. for species, habitats and biodiversity, including uncertainties about detailed distributions of marine communities derived from satellite imagery; however, enough is already known to implement MPA management;
- **Governance issues** e.g. lack of official recognition or registration of traditional land ownership patterns and local agreements; need to change prevailing ethos from 'maximise for short-term' to 'optimise for long-term sustainability' (creation of Fisheries Reserves will facilitate this);
- **Artisanal overfishing, particularly of nagil and some invertebrate groups;** largely due to external pressures;
- **Commercial/industrial fishing** i.e. trawling has probably caused significant damage to habitats and removal of some target species in the past. This should be prohibited throughout the MPA;
- **Improvement of the coast road** is likely to encourage/facilitate open access (unregulated) extractive and non-extractive resource use, and unplanned or inappropriate development; hence road should be set back from the coast, preferably to the west of the MPA's outer boundaries, and in all cases by a minimum of 2km. Off-road access should be banned except at prescribed locations.

6. PERSONNEL AND FINANCES

6.1 PERSONNEL

The Dungonab Bay MPA is to be implemented as a collaborative project, combining community-based approaches with more interventionist techniques. However, adoption of a fully flexible overall approach for identifying and dealing with problems as they arise is essential. This flexible collaborative approach and other factors, such as staffing policy, may change or develop as the MPA grows and strengthens.

Input and advice from technical and other steering committees will be important throughout implementation. These will include representation from local universities and research institutes as well as the fisheries sector, and tourism. However, the steering committees will be required to provide guidance that does not contradict the overall objective of the MPA – to conserve and sustainably manage coastal and marine biodiversity. As such, this management plan recognises that the advisory and learning process will be in both directions.

While non-local staff may be hired for some positions, local people should staff the project wherever possible, and required minimum levels of local recruitment should be established early in the implementation of the project. Among the many advantages of this approach are:

- Increased ‘ownership’ of and support for the project by local people.
- Immediate access to the detailed local knowledge held by local people of natural and socio-economic characteristics and processes in the MPA.

The need for flexibility means that it may be premature to provide precise descriptions of job requirements in this Management Plan. However, minimum staff requirements, at least during initial phases of MPA implementation include:

- Managers
- Field staff (technical, computer work, GIS, data analysis and interpretation, and report writing)
- Field staff: rangers (logistics, boat skills e.g. diving, placing of mooring buoys)
- Office/secretarial

It is likely that staffing experiences for other MPAs within the Red Sea and Gulf of Aden Regional Network will be valuable for the Dungonab Bay MPA. In particular, the experience of Ras Mohammed National Park in south Sinai (a park of comparable size and complexity to Dungonab Bay MPA) may be invaluable. Additional (tentative) staffing requirements, drawn largely from plans for Sanganeb National Park (SNP) in Sudan and Bir Ali-Belhaf in Yemen, are summarised below.

The overall management will be implemented by a park manager, who will be advised and informed by a management committee. During initial phases of the Management Plan, the minimum number of staff for Dungonab Bay might be around eight, consisting of:

- A senior park manager
- An assistant park manager

- A park administrator (this post may be shared with Sanganeb National Park, and based in Port Sudan, initially)
- Five rangers

This level of staffing should represent adequate human resources to manage the MPA effectively in the early phases of implementation. It also builds in the necessary flexibility to accommodate initial staff training/capacity building, annual and sick leave, as well as exchanges with other marine protected areas in Sudan and regionally (e.g. Sanganeb and Ras Mohammed).

Details of the broad range of activities that staff may be required to undertake and the skills that will need to be represented in the staff are provided in the Appendices (see indicative outline Terms of Reference).

6.2 CAPACITY BUILDING

Capacity building for marine environmental management/conservation must be recognised as a long-term investment. The Dugonab Bay MPA is proposed as the second MPA in Sudan (Sanganeb National Park was the first) and will be the only multiple-use coastal MPA in the country. Sanganeb National Park management plan is only now in the process of being implemented. There is a shortage of experience in Sudan covering many of the important aspects of MPA management and the use of collaborative approaches.

Given these factors, the availability of technical assistance will be extremely important during implementation of the MPA management plan, and for successful establishment of all aspects of management policies, structures and activities.

An experienced marine park manager should be recruited (perhaps from overseas) to oversee and advise on implementation, to provide guidance on all aspects of capacity building, and to provide on-the-job training in MPA management to counterpart(s). Since this job has both training and park management elements it will be important that the selected candidate has teaching and capacity building skills and experience, as well as practical fieldwork skills, particularly in an MPA context.

Training for rangers falls into a number of broad categories including practical field skills, ecological/wildlife management skills, and public awareness/public relations. An indicative list of the wide range of practical training for park rangers includes but is not limited to:

- Basic ecology and wildlife management skills;
- Basic fisheries monitoring, surveillance and control (to be supported and guided by expert fisheries monitoring personnel from relevant agencies);
- Scuba diving, snorkelling and small boat handling;
- Search and rescue, and safety;
- English language;
- Public relations, teaching, and tour guiding.

A detailed training and capacity building programme should be developed and implemented following a comprehensive training needs assessment. This provides an ideal opportunity for co-operation and collaboration with Sanganeb National Park, and this training programme should be a joint venture between the two parks.

It is recommended that a full-time expert scuba trainer be recruited during the first year of implementation, and retained for two years to design, implement and oversee all aspects of scuba training, boat handling and marine safety training for all rangers. This person will need to be a fully qualified scuba instructor with long-standing experience in the Arabian region, fluent in Arabic and preferably also in English.

Initial training must be targeted at achieving a level that enables effective management of the MPA during its early implementation. However, training and capacity building will be an ongoing process beyond initial implementation, and investment in skills maintenance and development will continue. This should include workshops and specialist training courses both in-country and overseas for all rangers, and academic training of selected senior rangers and managers to postgraduate level both nationally and in centres of excellence overseas.

The development and implementation of exchange programmes with other protected areas in the region, including the marine and coastal protected areas of the Egyptian Environmental Affairs Agency will provide invaluable lessons, examples, and experience to park staff. This will simultaneously allow less experienced staff to gain valuable exposure to the more established parks and park staff in the region, and will bring experienced overseas park staff to Dugonab. Full use should be made of the PERSGA regional network of MPAs for this purpose.

A tentative outline of schemes to expand capacity to manage the Dugonab Bay MPA is outlined below. These encompass marine environmental management, particularly in information collection and analysis, EIA and monitoring, and public awareness, through appropriate professional development of counterparts during on-the-job training and by designing and delivering in-service marine environmental training.

The full exploitation of linkages and support available via the regional network, or that can be developed within the framework of the regional network, should be a high priority for both park management, and senior management at the marine branch of the Sudan Wildlife Administration. Maintenance of links with PERSGA should, for this reason, be a high priority.

Target groups

In order to obtain a broad spectrum of expertise in MPA management, at least one staff member from each of the following will be selected for long-term study abroad and/or in-country training:

- Dugonab Bay area (as appropriate: taking care to avoid the appearance of favouritism between villages/tribal groups),
- Wildlife Administration
- Ministry of Fisheries
- Red Sea University
- Societies/NGOs

Further details of target groups and individuals will depend on qualifications including language skills, prior levels of academic training, and requirements of the various government agencies and other organisations, as determined by the technical steering committee.

A more detailed overview of recommended training is provided in Appendix 5.

Co-ordination between Dungonab Bay MPA and Sanganeb National Park

Development and implementation of a policy of co-ordination and co-operation between the MPAs of Sudan (initially Dungonab Bay MPA and Sanganeb National Park) will provide invaluable opportunities to benefit from economies of scale, shared objectives, and shared experience.

In the early stages of implementation of both MPAs these benefits will be most clearly felt in the field of training and capacity building. There will also be opportunities to economise from the development of shared facilities, in particular of a shared marine parks office in Port Sudan.

The Inter-Park Co-ordinating Committee will initially consist of:

- Marine parks officer (Wildlife Administration)
- Representative of the Red Sea University
- Park managers: Dungonab & Sanganeb
- Park administrators: Dungonab & Sanganeb
- Marine parks trainer (Years 1 & 2)

6.3 FINANCES

Possible financing options were outlined in section 4.13. It is critical that the Dungonab Bay MPA is conceived and implemented, at least initially, as a collaborative, community-based project. Tourism in and around the MPA are minimal at present and so (unlike Sanganeb National Park) little funding may be available from this sector early on. There will probably be a heavy reliance on external funding, at least in early years. However, successful use of the collaborative and community-based approach may mean that only modest levels of funding are necessary.

Later, the MPA may be able to draw on and operate using a mixture of funding sources. These might be acquired largely from industry (particularly tourism) and government sources, with donor agencies then making up a smaller and shrinking proportion of funds.

A further assessment of the financing needs is required (set-up costs and recurrent expenses), together with projections of the balance between income and expenditure, and the development of plans and targets/markers to be aimed for. Insufficient information is presently available to undertake these, even in a rudimentary manner. However, a brief outline of costs that will need to be financed can be provided. These include:

Capital costs and major expenditure:

- Park staff
- Infrastructure (offices and associated facilities, visitor centre, workshops and equipment stores, staff accommodation, etc.)
- Mooring buoy costs and installation
- Expendable equipment (as outlined above)
- Non-expendable equipment (as outlined above)
- Training, linkages, and other capacity building initiatives.

Other capital costs:

- Recruitment of staff
- Ancillary equipment for boats and outboards (fuel cells and jerry cans, washing facilities, oars, life jackets, first aid kit, tools etc.)
- Reference materials etc.
- Miscellaneous labour
- Installation of office equipment
- Lawyer's fees
- Infrastructure, boat and diving gear maintenance
- Establishment of monitoring transects and systems
- Public awareness and publicity (leaflets, posters, MPA logo, website, etc.)
- Toilet, rubbish disposal and other public facilities.

Possible initial operating costs:

- Maintenance, fuel and oil for boats and vehicles
- Incentives and bonuses
- Office operating costs (including consumables)
- Accounting and auditing
- Maintenance of infrastructure
- Reporting costs
- Committee costs (e.g. refreshments and local travel costs)
- Capacity building
- Contingency fund

Further considerations include:

- Licences for extractive uses will be issued to park residents in order to monitor and control levels of resource use within the MPA. Such licences to residents will be

issued free, but obviously will be contingent upon adherence to park rules, as drawn up in agreement with residents' representatives.

- Licensing of extractive uses for non-park residents will be set at levels commensurate to the level of use (contingent upon adherence to park rules and regulations).
- Licensing of non-extractive uses (e.g. tourism operations) will be applied to both residents and non-residents. Park residents will be charged only a small percentage of the charge levied on non-residents.

7. IMPLEMENTATION

As is implied in the tables of priority actions in section 5, the implementation of the plan is organised into three phases:

Table 12. Summary of implementation phases.

Phase	Summary	Timing
Phase I	Getting started: <ul style="list-style-type: none"> • Development of primary infrastructure • Recruitment • Initiation of priority management practices • Initiation of national and international publicity and awareness 	Year 1
Phase II	Full implementation of priority management practices: <ul style="list-style-type: none"> • Completion of initial capacity building • Development of community-based management for selected areas and resource uses • Extension of active management and enforcement throughout the MPA • Finalisation of Management Plan 	Years 2-5
Phase III	Achievement of self-sustaining management, and expansion into a functional and integral part of a co-ordinated national, regional and international network.	Begin year 5

Implementation of the objectives and activities of different phases may, in practice, overlap. Activities of one phase should not be unnecessarily delayed in order to wait for full achievement of the objectives of the previous phase, if those earlier objectives are not a prerequisite for specific activities of the later phase(s).

The Inter-Park Co-ordinating Committee (to be initiated in Year 1) and the links between Dungenab Bay MPA and Sanganeb National Park for training and capacity will, in effect, ensure that the development of a national network of MPAs will begin almost immediately.

Overall objectives of the Phases:

Phase I: To establish a management capacity that makes Dungenab Bay MPA functional.

Phase II: To consolidate on the early achievements of the MPA through:

- Full development of the infrastructure necessary to successfully manage the MPA;
- Development of the minimum necessary capacity to manage the MPA through full implementation of training programmes;
- Widely promote the MPA nationally and internationally;

Phase III: To consolidate the MPA as a self-sustaining entity through:

- Diversifying the income generating strategy to such an extent that it becomes self-financing for its operating and future capital investment costs;

- Full development of the capacity of the Dungonab Bay MPA, along with Sanganeb National Park, to fully support the development and implementation of the national network of MPAs.

REFERENCES

- BUNCE, L., TOWNLEY, P., POMEROY, R. & POLLNAC, R. 2000. *Socio-economic Manual for Coral Reef Management*. IUCN/Global Coral Reef Monitoring Network/AIMS. 251 pp.
- CHIFFINGS, A.W. 1995. *Arabian Seas. A Global Representative System of Marine Protected Areas*. Volume 3. Central Indian Ocean, Arabian Seas, East Africa and East Asian Seas. (G. Kelleher, C. Bleakley, & Wells, S. eds): 39-70. Great Barrier Reef Marine Park Authority/International Union for the Conservation of Nature/World Bank.
- CROSSLAND, C. 1907. Reports on the marine biology of the Sudanese Red Sea. 4. The recent history of the coral reefs of the mid-west shores of the Red Sea. *Journal of the Linnaean Society of London* **31**: 14-30.
- CROSSLAND, C. 1911. Reports on the marine biology of the Sudanese Red Sea. A physical description of Khor Dungonab. *Journal of the Linnaean Society of London* **31**: 265-286.
- CROSSLAND, C. 1913. *Desert and Water Gardens of the Red Sea*. London.
- FARAH, O.M. 1982. *The Bathymetry, Oceanography and Bottom Sediments of Dungonab Bay (Red Sea), Sudan*. Ph.D. Thesis, University of Delaware. 148 pp.
- FISHPOOL, L.D.C. & EVANS, M.I. (eds.) 2001. *Important Bird Areas in Africa and Associated Islands: Priority Sites for Conservation*. Newbury and Cambridge, UK: Pisces Publications and BirdLife International (BirdLife Conservation Series No 11).
- KELLEHER, G. 1999. *Guidelines for Marine Protected Areas*. WCPA Best Practice Protected Area Guidelines No. 3. IUCN, Gland, Switzerland. 107 pp.
- KEMP, J.M., KLAUS, R. & SALEM, M. 2002. *Survey of the Proposed Marine Protected Area at Dungonab Bay and Mukawwar Island, Sudan*. Draft Survey Report. 164 pp. (to be printed as PERSGA/GEF 2004).
- PERSGA/GEF. 1999. Strategic Action Programme for the Red Sea and Gulf of Aden: Project Implementation Plan. PERSGA/UNDP/UNEP/World Bank. 107 pp.
- PERSGA/GEF. 2001. Strategic Action Programme for the Red Sea and Gulf of Aden: Volume 2. Country Reports. The World Bank, Washington, DC. 205 pp.
- PERSGA/GEF. 2002. The Red Sea and Gulf of Aden Network of Marine Protected Areas: Regional Master Plan. PERSGA Technical Series No. 1. PERSGA Jeddah. 82 pp.
- PERSGA/UNEP. 2003. National Oil Spill Contingency Plan for Sudan. PERSGA Technical Series No. 6. PERSGA, Jeddah.
- ROBERTS, C.M. & HAWKINS, J.P. 2001. *Fully Protected Marine Reserves: A Guide*. WWF, Washington DC, and Environment Dept, University of York, UK. 137 pp.
- SHEPPARD, C.R.C., PRICE, A.R.G. & ROBERTS, C.M. 1992. *Marine Ecology of the Arabian Region*. Academic Press, London and San Diego. 359 pp.
- SHEPPARD, C.R.C. & WELLS, S.M. (eds.) 1988. *Coral Reefs of the World. Volume II. Indian Ocean, Red Sea and Gulf*. UNEP Regional Seas Directories and Bibliographies No. 27. WCMC Cambridge, IUCN Gland, and UNEP Nairobi. 389 pp.

VINE, P.J. & VINE, M.P. 1980. Ecology of Sudanese coral reefs with particular reference to reef morphology and distribution of fish. In: *Proceedings of Symposium on the Coastal and Marine Environment of the Red Sea, Gulf of Aden and Tropical Western Indian Ocean*; Khartoum, 9-14 Jan. 1980. Vol. I: 89-140. Red Sea and Gulf of Aden Environment Programme (ALECSO) & Division of Marine Sciences (UNESCO) with University of Khartoum, Sudan.

APPENDICES

APPENDIX 1. LEGAL DESCRIPTION OF BOUNDARIES

The external boundaries of the MPA

Figure 5 shows the external boundaries of the MPA. For ease of management all the boundaries on land should be marked with a man-made marker such as conspicuous painted concrete posts.

Northern coastal boundary point (Marker 1)

At the centre of the mouth of the khor to the north of Khor Shanaab (i.e. midway between the seaward edges of the coral reef fringing the coast either side of the khor mouth).

Northern landward boundary line (from Marker 1 to Marker 2)

From Point 1, running approximately southwest along the centre of the khor to the southwest end of the khor. From the end of the khor the boundary extends southwest to a point 10km straight-line distance from Point 1, or to a conspicuous landmark at approximately² at this point (Marker 2).

The extension of the northern terrestrial boundary of the MPA to this northern khor makes use of a natural barrier and in so doing also protects both shores of Khor Shanaab. This is essential for effective management of Khor Shanaab, and this location for the boundary will make demarcation and enforcement of that boundary easier and more effective.

Western landward boundary line (from Marker 2 to Marker 7)

From Marker 2 following a line parallel to the coast but 10km inland (measured at right angles to the approximately northwest-southeast line of the coast), to the 21°15'N line of latitude, or to a conspicuous landmark at approximately this point (Marker 3).

From Marker 3 directly eastwards along the 21°15.00'N line of latitude to 37°02.50'E, or to a conspicuous landmark at approximately this point (Marker 4).

From Marker 4 directly southwards to 20°55.00'N line of latitude (Marker 5).

From Marker 5 directly eastwards to a point 5km inland from the mainland coast; distance to be measured perpendicular to the general north-south line of the coast at this point (Marker 6).

From Marker 6, following the line of the coast but set back 5km from the coast, to the 20°39.00'N line of latitude (Marker 7).

The inclusion of a 10km buffer zone to the north and west of Dungonab Bay, wider than the 5km buffer zone to the south, is for two reasons:

1. The coastal (terrestrial) landscape here is particularly remarkable and pristine, and is also very vulnerable to anthropogenic alteration. In addition, this area is important for terrestrial wild mammals.

² 'Approximately' in descriptions of both internal and external boundaries of the MPA means within one or two hundred metres. If no prominent landmark is found within that distance of boundary points on land then the latitude/longitude and bearing description should be used to find the boundary marker point. For practical demarcation the boundary should then be marked with a conspicuous manmade marker such as a strong and conspicuously painted concrete post.

2. The coastlines and marine habitats of Dungenab Bay, Khor Shanaab and the Dungenab Peninsula are particularly important within the proposed MPA. A wider buffer zone here will give these areas the level of protection necessary for their long-term conservation and sustainable use.

Southern landward boundary (Marker 7 to Marker 8).

From Point 7 directly eastwards to intersect the coast just south of Sheikh Okod (Marker 8).

Southern coastal boundary (Marker 8).

Marker 8, as above.

The extension of the proposed MPA boundary to south of Sheikh Okod provides an easily identified boundary that is well known to both local communities and those from as far away as Port Sudan. It also includes this culturally significant site within the management area, providing for long-term protection of this important aspect of local cultural heritage.

Southern seaward boundary (Marker 8 to Marker 9).

From Marker 8 directly eastwards to the 37°15.00'E line of longitude (almost directly south of the southern tip of Mukawwar Island) (Marker 9).

Eastern seaward boundary (Marker 9 to Marker 11).

From Marker 9 directly north-eastwards to the 37°30.00'E line of longitude (Marker 10).

From Marker 10 directly northwards to the 21°00.00'N line of latitude (Marker 11)

From Marker 11 directly north-westwards to a point directly east of Marker 1 (Marker 12)

Northern seaward boundary.

From Marker 12 directly westwards to Marker 1.

Gazetteer of latitudes and longitudes for boundary marker points

Marker number	Latitude	Longitude
1	21°25.506'N	37°01.13'E
2	21°22.53'N	36°56.32'E
3	21°15.00'N	37°00.00'E
4	21°15.00'N	37°02.50'E
5	20°55.00'N	37°02.50'E
6	20°55.00'N	37°06.80'E
7	20°39.00'N	37°08.85'E
8	20°39.00'N	37°12.05'E
9	20°39.00'N	37°15.00'E
10	20°50.00'N	37°30.00'E
11	21°00.00'N	37°30.00'E
12	21°27.84'N	37°04.926'E

APPENDIX 2. PROTOCOL CONCERNING THE CONSERVATION OF BIOLOGICAL DIVERSITY AND THE ESTABLISHMENT OF PROTECTED AREAS (UNDER PREPARATION BY PERSGA)

(SUMMARY OF MAIN PROVISIONS)

Part II: Protection and Conservation of Species

This part of the Protocol includes requirements for contracting states/parties to draw up a list of threatened species (Article 5) and a list of species whose exploitation is regulated (Article 6). These are to be determined by common criteria and annexed to the Protocol. Article 7 prohibits the damage to and destruction of the habitats of threatened species and species of economic/cultural importance. Adopting principles of sustainable mariculture are requirements set out in Article 8. Part II of the Protocol concludes with Article 9. This sets out requirements for regulating the introduction of non-indigenous or genetically modified species to the wild and prohibiting those that may have harmful impacts on ecosystems, habitats or species; and eradicating those already introduced which appear likely to cause damage.

Part III: Protection of Selected Marine and Coastal Areas

Article 10 sets out requirements for contracting states/parties to establish a list of Specially Protected Areas (SPAs) of regional importance in accordance with guidelines and common criteria. Article 11 gives procedures for the establishment and listing of Specially Protected Areas. Guidelines for the management of protected areas are included in Article 12. Under Article 13, contracting states/parties are required to provide inventories for areas of special importance, in particular fragile ecosystems, reservoirs of biological diversity and important habitats for endangered species. The following guidelines should enhance the value of surveys undertaken for this purpose: (1) Assessments should be undertaken at different spatial scales according to common criteria such as point, sample, large area and bio-geographical province, the last three scales equating approximately to alpha, gamma and epsilon diversity as used in earlier scientific literature; and (2) In addition to conventional measures of biodiversity, such as species richness and endemism, other facets of biodiversity should also be assessed. These include taxonomic distinctness and other measures of relatedness, as well as beta-diversity. Article 14 gives requirements for the management of special habitats.

Part IV: Provisions Common to Protected Areas and Species

Article 15 of the Protocol gives guidelines for integrated coastal area management. Article 16 sets out requirements for more comprehensive EIA, to improve understanding of the costs and benefits of coastal development projects. Provisions are given for EIAs also to be used in the assessment of projects in river basins and other inland areas, to minimise possible adverse effects on coastal systems. Contracting states/parties shall require an assessment of the potential environmental impacts of industrial and other development projects that are likely to have significant adverse effects on biological diversity in the Protocol area. Also under Article 16, contracting states/parties should exchange information and undertake consultation with other states where proposed national projects are likely to have adverse effects on biological diversity in other states. Article 17 provides guidelines for the restoration of ecosystems and populations of species. Part IV concludes with Article 18, which provides guidelines for the

establishment/management of Specially Protected Areas and special habitats, and also for the use of common criteria in assessment of species, habitats and ecosystems.

Part VI: Other Provisions

This part of the Protocol contains a series of provisions concerning access to genetic resources (Article 19); transfer of technology (Article 20); scientific and technical co-operation and assistance (Article 21); research and exchange of information (Article 22); environmental awareness (Article 23); amendments of Annexes (Article 24); and reporting (Article 25).

Part V: Institutional Provisions

Requirements of ROPME and PERSGA as the regional organisations are set out in Article 26 of the Protocols. These are intended to ensure good co-ordination and consistency of approach among member states in respect of activities undertaken to assess and conserve biodiversity through marine protected areas and other measures. The need for designated institutions acting as a national focal point for implementing the provisions of this Protocol is addressed in Article 27. This Article also considers regional and international co-ordination, for example with the Ramsar Convention, IUCN, WWF, UNEP, CBD and CITES.

Part VII: Final Provisions

The final part of the Protocol contains provisions dealing with the effect of the Protocol on domestic legislation (Article 28), signature (Article 29), ratification, acceptance and approval (Article 30) and entry of the Protocol into force (Article 31).

APPENDIX 3. ZONING MAPS



The Dungonab Bay–Mukawwar Island MPA and Resource Use Reserve.

Landsat 7ETM+ true colour composites ETM1,2,3.



Terrestrial zoning including islands, and the location of the salt works.

Landsat 7ETM+ true colour composites ETM1,2,3.



Indicative map of preliminary network of Fishery Reserves.

Landsat 7ETM+ true colour composites ETM1,2,3.



Nature Sanctuaries including Mukawwar Island, and Fisheries Reserves.

Landsat 7ETM+ true colour composites ETM1,2,3.



Composite map with all proposed zoning.

Landsat 7ETM+ true colour composites ETM1,2,3.

APPENDIX 4. OUTLINE TERMS OF REFERENCE FOR STAFF

Adapted from terms of reference for Sanganeb National Park staff.

Park Manager

The MPA manager is responsible for overseeing the effective implementation of the MPA Management Plan and for liaison with national agencies and authorities. The MPA manager has responsibility:

- To implement and develop the MPA's Management Plan;
- To ensure the effective operation of Dungonab Bay MPA by co-ordinating and liaising with user groups and stakeholders;
- To train the assistant park manager(s) in all aspects of the MPA's operation;
- To oversee the development and implementation of training and capacity building for other park staff, and to provide guidance on similar issues for major stakeholders;
- To be responsible for the overall smooth management of park staff;
- Develop indicators as a means of tracking the effectiveness of the MPA's management;
- To develop measures for greater self-financing of the Dungonab Bay MPA.

The Assistant Park Manager

The assistant park manager is initially to be a counterpart to the MPA manager. With increasing experience and competence the assistant manager will be responsible for the implementation of the management plan, and will be the MPA rangers' operations manager.

He should be a graduate in marine science, or have more than 10 years experience of working with the marine environment and managing a small team. Under the guidance and supervision of the MPA manager, the assistant manager will:

- Assist the MPA manager to implement the MPA Management Plan;
- Co-ordinate and implement the training of the ranger team in the necessary aspects of MPA management;
- Develop and maintain good relations with resident groups, tour operators and the other main user groups;
- Assist with development and implementation of the public awareness plan;
- Co-ordinate implementation of the research and monitoring strategy.

The MPA Administrator

The MPA administrator may, at least initially, be a shared post with Sanganeb National Park. However, as full implementation of both parks gets under way the workload may be too great for one person, in which case each park should have its own administrator.

The overall responsibility of the administrator is to support the MPA managers in the areas of:

- General office management
- Accounting and book keeping
- Acting as the personal assistant to the MPA managers,
- Organising banking and salaries for park staff
- Co-ordinating purchasing
- Co-ordinating the maintenance schedules of the MPA's resources (boats, vehicles etc.)
- Co-ordinating the supply of food and water to the MPAs.

A background in office administration with additional experience in graphic design, accounting, law, and information technology would be an advantage.

The administrator's main duties should include:

- Day to day management of park administration
- Answering telephone enquiries and email from the general public about the MPAs
- Assisting the MPA manager with procurement and contracting requirements
- Assisting the MPA manager in organising legal aspects of park management
- Assisting the MPA manager in developing a range of Dungonab Bay MPA branded merchandise (this may be more general, or include more general, Sudanese marine parks or Sudanese marine environmental merchandise).

Park Rangers

Rangers are the major on-the-ground implementers of the Management Plan, and the principal point of contact park users will have with the MPA's management. It is therefore imperative that rangers can communicate well with the different categories of park users, from residents to school children, to foreign tourists. Rangers should therefore either have a background where public relations was a part of their work, or have an aptitude for communication and negotiation. Rangers should ideally have reasonable English language skills or be prepared to put considerable effort into learning early in their employment. They should be comfortable spending many hours at sea in a small boat. For reasons of both safety and management, all rangers should be comfortable with working in as well as on the water, and will be required to be, or become, good swimmers, and gain skills in snorkelling and scuba diving.

Secondary skills should be related to enforcement/surveillance, and to making sure that all park users abide by the regulations laid down by park management. The MPA manager will develop a detailed work plan for the rangers, to include:

- Enforcing the MPA's regulations on a day to day basis
- Assisting with the logistics of monitoring and research being carried out in the MPA
- Providing information about Dugonab Bay MPA to visitors and tour operators, both verbally and by distributing information leaflets
- Making general observations of the ecology around the MPA using feedback from park visitors, direct observations, etc. using GPS where possible.

The Dugonab Bay MPA Management Committee

The Dugonab Bay MPA management committee will consist of senior staff drawn from the main stakeholder groups who can support the MPA's management. Committee meetings should be held at least twice a year. It is recommended that the following staff sit on the committee:

Representative from the **Wildlife Administration** Headquarters; his responsibilities will include:

- Liaison with national policy makers and new national legislation relating to protected areas, management of biodiversity etc.
- Co-ordination with other protected areas in Sudan (although co-ordination with Sanganeb should be carried out directly, rather than going through an intermediary) including disseminating lessons-learned in other areas such as Dindir National Park.
- Co-ordination with national tourism authority and the relevant airlines to ensure that developments in tourism policy and the expansion of the sector are incorporated into the ongoing evolution of this management plan.
- Securing and increasing the allocation of funds to Dugonab Bay MPA from the central government budget.

Representative from the **Sea Ports Corporation**; his responsibilities will include:

- Co-ordination over issues relating to oil spill contingency planning and all other pollution arising from shipping.
- Co-ordination over all issues arising from navigation, including any issues relating to the use of lighthouses, buoys, or the installation of radar and beacons in the vicinity of Dugonab Bay MPA.
- Disseminating relevant information to mariners including notices to mariners, changes to navigation charts etc.
- Co-ordination with the Navy over all issues relating to national security, coastguard activities, fishing surveillance, anti-poaching and smuggling operations etc.

Representative from **The Red Sea University**; his responsibilities will include:

- Providing co-ordination and a first contact point with researchers around the world with an interest in Dungonab Bay and its ecology.
- Ensuring that data and sample repatriation mechanisms and agreements are in place with all researchers, and interpreting (with the MPA manager) the results of scientific monitoring and research conducted at Dungonab Bay MPA for wider dissemination within Sudan.
- Co-ordination, under the leadership of the MPA manager, of research activities in Dungonab Bay MPA.

A representative from the **Tourism Sector**, preferably a dive tour operator; his responsibilities should be:

- To assist the Wildlife Administration representative in the task of liaising with the tourism department.
- To maintain links with other dive tour operators using Dungonab Bay MPA to ensure that feedback is obtained from the users (operators as well as visitors). He will be the main point of contact between the MPA and the MPA's recreational user base.
- To support the MPA manager on all dive-related issues pertaining to the MPA.
- To liaise with the Dungonab Bay MPA management on matters relating to the moorings within the MPA.

A representative from the **Environmental NGO Sector**. His responsibilities should be:

- To liaise with national and international environmental NGOs with an interest in protected areas management and coastal zone management, in close consultation with the MPA manager.
- To assist the MPA manager and the representative from The Red Sea University in the design and preparation of grant applications in support of the management of Dungonab Bay MPA.
- To maintain links with the international marine environmental NGO sector (particularly IUCN) and, with the MPA manager, to disseminate information relating to the management of marine protected areas and marine natural resources to the management committee.
- To lobby the necessary government departments and ministries to amend their policies in favour of the conservation of marine resources in general, and Sudanese marine protected areas in particular.

APPENDIX 5. OUTLINE OF RECOMMENDED ACTIVITIES FOR CAPACITY BUILDING

(Adapted from the PERSGA Bir Ali – Belhaf MPA Site-Specific Master Plan)

In-service training courses

The purpose of these courses is to enhance national capacity in MPA management, through:

- Counterpart training gained during fieldwork and other project activities, particularly in environmental information collection and analysis, EIA and monitoring, protected area management, and public awareness.
- Design and delivery of in-service marine environmental training to augment the on-the-job training (above): each course will be made up of lectures, seminars, exercises, case studies and field training, although the exact choice of topics and format will be determined by training consultants.

The courses indicated here are indicative only, and a minimum of the training required. These courses, or an equivalent range and depth of capacity building, will provide a bare minimum of MPA design, implementation and management capacity necessary for Sudan to manage its own network of MPAs in the medium to long-term.

It must be recognised that training and capacity building will be an on-going process, well beyond the early years of implementation of this and other marine national parks. This is because:

- Staff recruited at later stages in park implementation will always require basic, intermediate and advanced levels of training.
- Training of selected MPA staff to high levels (PhD and equivalent) will be required for full and successful sustainability of capacity within Sudan. For example:
 - A minimum of relevant MSc qualifications will be required in the medium to long-term for leadership of the MPA biological, ecological and socio-economic survey and monitoring work.
 - A very broad understanding of ecological principles is required for fully effective application of EIA procedures in a conservation context.
- The science and practice of MPA design and management worldwide will itself progress, and advances will need to be learned and applied within Sudan.

Protected area management course

Course duration: 4 weeks.

- Introduction to protected areas management
- Integrated marine resources management
- Protected areas and sustainable development

- Protected areas and management of the Exclusive Economic Zone (EEZ)
- Global and regional extent of networks
- Role and values of protected areas
- Categories of protected areas
- Fisheries and protected areas
- Designing a protected areas network
- Critique and assessment of protected area management
- Economics of protected areas
- Developing management plans

Environmental information collection and interpretation course

Course duration: 4 weeks.

- Principles of marine planning and management
- The role of information in the planning process
- Techniques for acquiring information by field survey, interviews and censuses, and using existing information
- Scientific, socio-economic and other information needs
- Survey design
- Position fixing
- Numerical analysis, statistics and modelling

EIA and monitoring course

Course duration: 4 weeks.

- Introduction to EIA
- Nature of coastal developments and associated problems
- Role of EIA in marine planning and management
- Usefulness and limitations
- The EIA process
- Review of EIA parameters and their quantification
- EIAs in practice
- Broadscale *ex-situ* assessment
- Rapid *in-situ* assessment
- Detailed *in-situ* assessment
- Databases, GIS and other forms of data compilation
- Map and graphic (e.g. overlay) analysis

- Issue analysis
- Conflict avoidance and resolution

Public awareness enhancement

Course duration: 4 weeks.

- Introduction to public awareness
- The role of public awareness in marine resources management
- Brochures and guides
- School and college curriculum materials
- Audiovisual materials
- Marine aquaria and museums
- Educational posters
- Reading materials and activities
- Special events and mass media
- Education planning guides
- Newsletters

Overseas fellowships and training

Overseas fellowships will provide the opportunity for several groups of park staff and government officials to improve their knowledge of marine ecosystems and resources management. These groups include: government planners, managers and decision makers; marine environmental and fishery scientists; future protected area managers; public awareness staff; and trainers. Such study will involve long-term higher education degrees (MSc or PhD), diplomas, and short courses.

Research associated with higher education degrees should be applied, and wherever possible relate to marine environmental issues and needs of Sudan in general and the Dugonab Bay MPA in particular. This training will enhance the national capacity to manage the marine environment, particularly in environmental survey, EIA and monitoring, protected area management, public awareness, and related fields. Possible courses include the following:

PhD degrees (4–5 year course of applied study by research, to include extensive research and fieldwork within or around the national park, ideally directly or indirectly addressing management issues).

MSc degrees (1-2 year courses, e.g. Marine Environmental Protection, Tropical Coastal Management).

Diplomas (15 months duration in the following, or which include the following as principal topics):

- Environmental and/or socio-economic data collection and analysis
- EIA and monitoring
- Public awareness
- Protected area management
- Other topics (to be determined during initial months of project)

Short-term (vocational) courses

(~3 months, which may be either complete courses, or part of other broader courses and training programmes):

- Scuba diving
- Use of computer software
- Equipment operation/maintenance
- Instrumentation
- Analytical work
- Technician training
- Video/public awareness
- Cartography

Regional Workshops

Regional workshops will be of great value for enhancing MPA management capacity not only in the Dugonab Bay MPA, but also in other MPAs in Sudan, and within the regional network. The following workshops are tentatively suggested:

Management of Protected Areas Workshop

This one-week workshop will be held in year 2 of the project and will review the extent of marine and coastal protected networks in the PERSGA region together with future requirements. The following are among the topics which will need to be considered:

- Problems and opportunities for marine protected areas in the PERSGA region;
- Development of a common analytical framework for identification of key biophysical features and socio-economic parameters for the Dugonab Bay MPA and other MPAs in the PERSGA region;
- Designing a marine protected area, management plans and integration of marine protected areas in the national and regional process.

Survey and Monitoring Workshop

This one-week workshop will be held in year 3 of the project and will review environmental survey and monitoring techniques used in the Yemen and the Egypt GEF projects, as well as introduce other PERSGA member countries to the techniques as appropriate.

As a result of the review and critique which will include field survey and trials (and which will take close account of the PERSGA standard survey methodologies) attempts will be made to agree adoption of standard methodologies which are broadly acceptable at the regional level.

Environmental Impact Assessment Workshop

This one-week workshop will be held in year 4 of the project and will review the problems associated with coastal area development, the prevalence and practice of EIA in the PERSGA region and perceived future requirements. Case studies will play a key role in the analysis. The workshop will need to address: the identification of potential impacts; prediction and measurements of impacts; identification of monitoring requirements; and communication of impact assessment results. General EIA guidelines for the region will be developed although it is recognised that precise EIA requirements may differ from country to country.