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Development and management of a network of marine protected areas in the Red Sea and Gulf of Aden region

William Gladstone^{a,*}, Fared Krupp^{b,1}, Mohammed Younis^b

^a *Centre for Sustainable Use of Coasts and Catchment, School of Applied Sciences, University of Newcastle, P.O. Box 127, Ourimbah NSW 2258, Australia*

^b *Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA), P.O. Box 53662, Jeddah 21583, Saudi Arabia*

Abstract

Selected and managed effectively, regional networks of marine protected areas (MPAs) have the potential to be important strategies for conserving representative samples of global biodiversity and migratory species, and for the development of trans-national experience in resource management and conservation. This paper reviews current and proposed regional networks of MPAs, and describes the process of establishing an MPA network in the Red Sea and Gulf of Aden Region as a case study. Critical to the success of this network will be the implementation of a common, regionally agreed management framework, and the development of the necessary technical capacity and expertise in the planning and management of MPAs (currently lacking in several countries represented in the Network). This case study addresses the regional management framework, the mechanisms proposed to coordinate management of the participating MPAs, the mechanisms for strengthening regional capacity, and the potential constraints to achieving the objectives and goals of the network.

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1. Introduction

The systematic selection, establishment and management of systems or networks of protected areas have been recognized as a significant contribution towards global

*Corresponding author. Tel.: +61-2-4348-4123; fax: +61-2-4348-4145.

E-mail address: william.gladstone@newcastle.edu.au (W. Gladstone).

¹ Current address: Senckenberg Research Institute, Senckenberganlage 25, 60325 Frankfurt a.M., Germany.

conservation of biological diversity. The 3rd World Parks Congress (WPC) in Bali (1982) recommended the establishment of systems of terrestrial and marine protected areas (MPAs) that were representative of a nation's range of biogeographic variation [1]. Article 8a (in situ Conservation) of the Convention on Biological Diversity (1992) requires contracting parties to establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity [2]. The 4th WPC adopted the Caracas Action Plan, which had as one of its actions the development and implementation of national systems of protected areas [3]. National systems of MPAs have been proposed for, or established, in Canada [4]; Egypt [5]; Saudi Arabia [6,7]. Recognizing the value of national systems of MPAs, several countries have in recent years begun the process of developing systems of marine regionalisation as the first step towards strategically identifying locations for potential MPAs [8–10].

Networks of protected areas are established to conserve representative examples of biodiversity, or to protect a set of unique and high profile features [1,3,11,12]. The potential benefits arising from strategically located networks of protected areas include: the conservation of representative and outstanding examples of biodiversity; the conservation of sites required by migratory species (e.g. sea turtles, sea birds); the availability of a focus for education, research and monitoring; the development and fostering of international collaborations; the sharing of management expertise; and the sharing of equipment, infrastructure and human resources for research and monitoring, which is particularly cost efficient.

At a larger scale, regional networks have the potential to contribute to the conservation of representative examples of regional biological diversity. Regions contain distinctive components of global biodiversity that can only be conserved by regional cooperation, because they occur across several countries that share a common sea area. In this context, the benefits of conservation in one country are likely to be felt in neighbouring countries (e.g. through the conservation of transboundary fish stocks), and conversely, the impacts of lack of management are likely to be felt in neighbouring countries (e.g. through a decline in regional fish stocks). Processes determining large-scale patterns in coral reef biodiversity (e.g. habitat area) require habitat protection at a regional scale and “international management of reef resources” [13]. A regional-scale approach to the selection and management of MPAs has several important pre-requisites: region-wide information on the distribution of biological diversity [13]; political agreement for the concept; collaboration amongst neighbouring countries in the identification of the regionally representative network of locations; and a mechanism for coordinating management of MPAs in the network.

The status of MPAs in 18 regional sea areas around the world has been reviewed [14], with the aim of facilitating the establishment of a global, representative system of MPAs. All regions had a number of MPAs existing within them, however, the representation of regional biodiversity within these networks of MPAs was extremely variable and recommendations were made to upgrade the representativeness of existing networks by inclusion of additional MPAs. The structure of existing regional networks of MPAs varies from collections of MPAs in several countries

sharing a common sea area, to fully operational regional networks of MPAs that are based on a legal protocol, are regionally coordinated and networked by a range of management support activities. For example, as part of the Mediterranean Action Plan the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean was adopted by the Contracting Parties in June 1995. The Protocol calls for the establishment of a list of Specially Protected Areas of Mediterranean Importance (SPAMI), with the objectives of biodiversity conservation and protection of specific Mediterranean ecosystems. The activities of MPAs in the Mediterranean network are coordinated through a Regional Activity Centre in Tunisia that assists member countries in selecting, creating and managing MPAs. To protect the internationally significant tidal wetlands and dependent species of the Wadden Sea a Joint Declaration on the Protection of the Wadden Sea was signed by the Netherlands, Germany and Denmark in 1982, and the Common Wadden Sea Secretariat was established in 1987. About two-thirds of the Wadden Sea area is legally protected in the Trilateral Conservation Area, which includes an almost continuous series of protected areas, national parks and wildlife reserves. Cooperative management of the Trilateral Conservation Area occurs via the Wadden Sea Plan (1997), which includes common management principles, common management objectives for human activities, common ecological targets for the management of six major habitat types, and programs of shared research, monitoring and assessment [15]. The Contracting Parties to the Wider Caribbean Seas programme adopted a Specially Protected Areas and Wildlife (SPAW) protocol that establishes a regional network of MPAs to conserve and restore regional ecosystems. Networking activities include the Wider Caribbean MPA Managers network and a supporting database, a regional guide to funding protected areas in the wider Caribbean, and common guidelines and criteria for protected areas [16,17]. The Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region requires contracting parties establish a regional network of MPAs. The need for an effective networking system for the exchange of ideas and experiences amongst MPA managers in the region was recently highlighted [18].

The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) and the Regional Organization for the Protection of the Marine Environment (ROPME), with support from the European Union, are presently in the process of developing “Protocols Concerning the Conservation of Biological Diversity and the Establishment of Protected Areas” for the two regions, based on a common strategy. Activities under the two protocols are co-ordinated by the Secretariat of the Kuwait Convention for the ROPME Sea Area and by the Secretariat of the Jeddah Convention for the PERSGA Region [12].

This description of the regional network of MPAs for the Red Sea and Gulf of Aden is presented as a case study in: (1) the selection of sites participating in a regional network of MPAs; (2) the development of a regional management framework for a regional network; (3) the potential benefits for national, regional and global sustainable resource usage and conservation; (4) the potential constraints to effective implementation of a regional network of MPAs. Although the term ‘system of protected areas’ has been widely used in similar contexts, the term

'regional network of MPAs' has been adopted here, to highlight the importance of a system of MPAs that has an agreed, common management framework and in which activities are coordinated.

2. The Red Sea and Gulf of Aden region

The Red Sea and Gulf of Aden are globally renowned for their unique and beautiful marine and coastal environments, the diversity of species inhabiting them, the high degree of endemism, and the value of these resources for human development and as part of the region's cultural heritage. The coastal and marine ecosystems have been used by the inhabitants of the region in a sustainable manner for thousands of years [19]. In more recent years the use of these environments and resources has substantially increased with the development of petroleum-based economies that require sea transport for petroleum exports; the growth of international dive tourism; expansion of national and international fisheries operations; coastal developments; and general population growth in the coastal zone [20–22]. This has particularly occurred in Egypt, Jordan and Saudi Arabia. Despite the enormous economic growth that occurred in some countries in recent decades, many coastal communities continue to rely for their livelihood on small-scale usage of marine resources, especially fisheries e.g. in Djibouti, Somalia, Sudan and Yemen.

Running parallel to the economic and social development has been a growing awareness of the regional and international significance of many of the conservation values. There are 260 species of hermatypic corals in the Red Sea with 6% believed to be endemic [23–25]. Approximately 200 species of scleractinian corals have been reported from the Socotra Archipelago in the Gulf of Aden, which is significant given the small area of coral communities and the similarity in richness to the entire Red Sea [26]. About 1350 species of fishes are known from the Red Sea with an average endemism of 17% [27]. Distinct assemblages of reef fishes occur in the Gulf of Suez; the Gulf of Aqaba and the central and northern Red Sea; the southern Red Sea; and the Gulf of Aden [24]. There are very few accounts of the ichthyofauna of the Gulf of Aden [28,29].

Three species of sea turtle are known to feed and nest in the region: green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and loggerhead (*Caretta caretta*). Important nesting grounds located in the Tiran Islands, Wajh Bank, and Farasan Islands (Saudi Arabia); the south Sinai (Egypt); Dahlak Islands (Eritrea); Ras Sharma and Dhobah (Yemen) [20,30,31]. The Ras Sharma nesting site for green turtles is internationally significant with about 10,000 females nesting there each year. There are likely to be 4000 dugong (*Dugong dugong*) within the Red Sea and important areas for dugong within the Red Sea include the Tiran Islands, Wajh Bank, Farasan Islands, Jizan (Saudi Arabia); Quesir (Egypt); and the Dahlac Archipelago (Eritrea) [24,32,33]. Thirteen species of cetacea have been reported from the Red Sea and Gulf of Aden, including dolphins, toothed and baleen whales. There have been few systematic surveys, making the identification of significant sites for cetaceans difficult [34].

The available information on temperature, salinity, surface nutrient status, and primary productivity suggests that the Red Sea and Gulf of Aden can be divided into six regions, including five within the Red Sea itself [24]. The Red Sea regions are: northern, central, southern, Gulf of Suez, and Gulf of Aqaba. The latter two regions are also well separated according to differences in physical properties: the Gulf of Suez is shallow (average depth of 50 m), is vertically well mixed throughout the year, with well-developed latitudinal gradients in salinity and temperature. The Gulf of Aqaba is deep (800–1800 m), with vertical mixing that is seasonal, and less well-defined salinity and temperature gradients [24].

Marine and coastal ecosystems of the region include subtidal soft bottoms; sabkha; saltmarsh; sandy and muddy shores; rocky shores; mangroves; seagrass; coral reefs and coral communities [24,31]. Reef development varies from north to south in the Red Sea. The eastern shore of the Gulf of Suez has limited area of reef development but extensive small coral patch reefs and the western shore has a well-developed system of fringing reefs. The Gulf of Aqaba has narrow fringing reefs that plunge vertically into deep water. An almost continuous band of fringing coral reefs occurs on both sides of the Red Sea southward to about 18–20°N. Reef types diversify toward the southern limit of this distribution as the width of the fringing reef increases and other reef types occur offshore. A longitudinal series of coral reefs, effectively forming a series of barrier reefs, exist 10–40 km offshore of the Saudi Arabian coastline and extend southward for 400 km. Similar systems of reefs occur on the African side of the Red Sea. There are also isolated patch reefs and atoll-like structures, the most famous of which is Sanganeb Atoll in Sudan. South of 20°N the continental shelf widens and consequently reefs are less well developed vertically, and often occur in more turbid water [24,31]. In many places the coastal fringing reefs disappear and are replaced by stands of mangroves, sand beaches, and scattered patch reefs near the coast. Seasonal coverings of macroalgae are a feature of shallow coral reefs in the southern Red Sea, and they often form the major coverage of hard substrates in areas too turbid for coral growth. Reef diversity is greatest offshore and includes platform and patch reefs, barrier reefs, coral cays, and extensive fringing reefs around island systems, especially the Farasan and Dhahlak Island group [31,35].

Coral-based fringing reefs are less common in the Gulf of Aden, occurring on only 5% of the coastline of Yemen particularly in the Belhaf-Bir Ali area [31,36,37]. There are extensive areas of coral reefs in the Gulf of Aden coastline of Somalia around Saad ad-Din Island in the extreme north-west of the coast near the border with Djibouti, which may be the largest coral reefs in the Gulf of Aden [31]. There is only minor development of coral reefs around the Socotra Archipelago, existing mostly as small reef flats at a few locations on the northern sides of islands in the Archipelago. Coral communities are generally non-accreting, growing on rocky substratum or on fossil reef structures. The dominant biotic habitat on the more exposed southern coasts of the Archipelago consists of macroalgae communities growing on non-reefal rock. Despite the limited extent of coral reefs and coral communities in the Socotra Archipelago, the existing communities have a high regional conservation value. Coverage of living stony corals approaches 100% in some areas, and such high coverage is rare elsewhere in the Gulf of Aden and Arabian Sea [26,36,38,39].

3. The Red Sea and Gulf of Aden Regional Network of MPAs

MPAs were established in the Red Sea and Gulf of Aden to manage human uses, to support sustainable resource usage and economic development, and to conserve representative and significant biodiversity [35,40]. Although 75 MPAs have been established or recommended for the region [20], few are managed appropriately [20,35]. In addition, there were gaps within these MPAs in representation of regionally significant and representative habitats [14,20,21].

During the formulation of the Strategic Action Programme for the Red Sea and Gulf of Aden, a large-scale regional conservation project supported by the Global Environment Facility (GEF), it was decided that an ecosystem approach to conservation and management was most appropriate to assure long-term sustainability of the region's critical habitats and populations of globally important species [20]. This would be achieved by establishing an integrated regional network of MPAs supported by effective integrated management and planning. Site selection would ideally be based on a complete habitat and biodiversity mapping and socio-economic survey of the area; however, this was far beyond the scope of the project. Hence, a pragmatic approach was adopted and the following criteria were used to identify MPAs for inclusion in the regional network:

1. Participating MPAs should be representative of the region's biogeography and include typical examples of each biogeographic subunit, i.e. the Gulf of Aqaba, the Gulf of Suez, the northern, central and southern Red Sea, the Gulf of Aden and the Arabian Sea.
2. Participating MPAs should include viable proportions of all major habitat types within each biogeographic subunit, with an emphasis on key habitats, such as coral reefs, seagrass beds and mangroves.
3. Participating MPAs should protect indigenous plant and animal communities representative of each biogeographic subunit. Bird and turtle nesting sites, and seagrass beds used by dugong deserve special attention.
4. Participating MPAs should include unique cultural heritage, interesting geological formations and beautiful landscape.
5. Feeding, breeding and roosting sites, larval sources and sinks, and migratory routes of key biota need to be considered in the design of the network.
6. Sufficiently large terrestrial sectors should be included in coastal and MPAs, to serve as buffer zones.
7. In the initial phase, each PERSGA member country should contribute at least one MPA to the network.

While the first five criteria represent biological considerations, the sixth criterion, which is more of a political nature, is equally important, because it assures full participation and commitment by all countries of the region. While Egypt and Saudi Arabia had conducted extensive surveys along their coastlines and identified suitable sites for national networks of MPAs, additional surveys were conducted in Djibouti, Somalia, Sudan and Yemen [21]. Based on existing information and the results of



Fig. 1. Red Sea and Gulf of Aden Regional Network of MPAs.

these surveys, participating MPAs were selected by applying the criteria outlined here above, with an option of adding other areas once more information and more financial resources become available (Fig. 1).

Twelve MPAs were selected for the regional network of MPAs for the Red Sea and Gulf of Aden (Table 1): Iles des Sept Frères and Ras Siyan (Djibouti); Ras Mohammed National Park; Straits of Gubal (Egypt); Aqaba coral reefs (Jordan); Straits of Tiran; Wajh Bank, Sharm Habban and Sharm Munaybirah; Farasan Islands (Saudi Arabia); Aibat and Saad ad-Din Islands, Saba Wanak (Somalia); Sanganeb Marine National Park; Mukkawar Island and Dungonab Bay (Sudan); Socotra Islands; Belhaf and Bir Ali area (Yemen). The status of these MPAs vary from MPAs that have been established for many years with legal standing and well defined management plans, to MPAs that have been proposed but not officially declared by the national government. The network includes representatives of all major biogeographical sub-units (Gulf of Aden; north, central and southern Red

Table 1
Red Sea and Gulf of Aden Regional Network of MPAs

Country	MPA	Size	Year declared	Major habitats and regional significance	Impacts and conflicts	Management/projects
Djibouti	Iles des Sept Frères and Ras Siyan	Undefined	Proposed	High aspect, rocky islands and adjacent coastal stretch with mangrove-fringed bay; diverse coral reef formations; rich fish and invertebrate fauna at the junction between the Red Sea and the Gulf of Aden; nesting seabirds [20]	Recreation pressure, fishing (including illegal shark fishing), siltation caused by passing vessels	PERSGA survey under preparation
Egypt	Ras Mohammed National Park	Sea area 672 km ² Land area 6233 km ²	1983, extended to Strait of Tiran in 1992	Coral reefs, mangroves, turtles; important for environmental education, MPA training, ecotourism [40]	High recreation pressure, diving tourism	High, supported by EU project
Egypt	Straits of Gubal	Undefined	Declared	Islands off western Red Sea coast; well-developed and diverse coral reefs; rich reef-associated fauna; turtle and bird nesting [20]	Recreation pressure, anchor damage, fishing	GEF-Egypt and EU projects
Jordan	Aqaba Marine Park	7 km length	1997	Complex and diverse fringing reefs with a rich and diverse reef-associated fauna at the northern tip of the Gulf of Aqaba [20]	Recreation pressure, development pressure, shipping, phosphate loading	GEF-Jordan project
Saudi Arabia/Egypt	Strait of Tiran	Undefined	Proposed; in 1992 Egypt included part of the area in Ra's Mohammed National Park	Islands and extensive coral reefs with diverse reef associated fauna in transition area between Gulf of Aqaba and Red Sea; turtle nesting; dugong [20]	Small part of the area used by tourists from Egypt	None

Saudi Arabia	Wajh Bank, Sharm Habban and Sharm Munaybirah	2840 km ²	Proposed	Extensive shallow water area with mainland coast and offshore islands, most extensive coral reef system of entire Red Sea, diverse reef associated fauna, seagrass beds, mangroves (<i>Avicennia</i> and <i>Rhizophora</i>), turtles, bird nesting sites, key area for dugongs [20,25]	Collection of turtle and bird eggs, fishing	None
Saudi Arabia	Farasan Islands	3310 km ²	1996	Archipelago of coral islands with diverse range of habitats: coral reefs, seagrass beds, mangroves (<i>Avicennia</i> and <i>Rhizophora</i>); marine mammals; nesting seabirds and turtles [20,35]	Fishing, development, recreational pressure expected to increase	Terrestrial: high Marine: low
Somalia	Aibat & Saad ad-Din Islands, Saba Wanak	ca 300 km ²	Proposed	Low-lying mangrove islands; largest coral reef area in Gulf of Aden; largest salt-marsh, swamp and mangrove area in Gulf of Aden; mangroves (<i>Rhizophora</i> and <i>Avicennia</i>); very important nesting site for seabirds and probably turtles	Fishing, egg collection, collection of corals	None
Sudan	Sanganeb Marine National Park	12 km ²	1990	Atoll-like reef with highly diverse and complex coral reefs, diverse reef associated fauna, sharks, marine mammals, manta rays	Low recreation pressure, anchor damage from tourist boats	Low
Sudan	Mukkawar Island and Dunganab Bay	300 km ²	Declared	Coral reefs, whale sharks, largest schools of manta rays in Red Sea, bird nesting sites, oyster beds	Shark fisheries, oyster culture	None

Table 1 (continued)

Country	MPA	Size	Year declared	Major habitats and regional significance	Impacts and conflicts	Management/projects
Yemen	Socotra Islands	3625 km ²	1996	Island group with outstanding terrestrial plant and animal endemism; diverse and largely pristine marine environments and biota, unique marine biogeography [20,36]	Fishing	GEF-Socotra biodiversity project
Yemen	Belhaf and Bir Ali area	Undefined	Proposed	Coastal stretch and group of high aspect islands, scenic coastline, extensive coral reefs and rich fishing area, bird and turtle nesting, crater lake with mangroves [37]	Tourism development, fishing activities	None

Sea; Gulf of Aqaba; Socotra Archipelago) except for the Gulf of Suez; major habitat types within each sub-unit; prime examples of all types of coastal and marine habitats and species communities (Table 1).

4. Management framework

MPAs have the potential to provide a range of conservation, economic and social benefits provided they are managed appropriately [41,42]. The approach taken in the Red Sea and Gulf of Aden Regional Network has been to develop a regional framework for management. This regional framework includes the following components: (1) regional objectives, goals, and strategies for the Network that will be used as a basis for developing site-specific objectives, goals, and strategies in each MPA in the regional network; (2) mechanisms to strengthen the legal basis of the MPA Network, coordinate management across each of the MPAs; facilitate information exchange between MPAs in the Network; build capacity and strengthen institutions; and to establish linkages with other regional networks; (3) guidelines for planning and managing MPAs that are based on international best practices and adopted to suit the unique conditions of the Red Sea and Gulf of Aden; (4) support for the development of additional MPAs in each country through the provision of regional guidelines for the identification and selection of MPAs. This paper provides an account of management components (1) and (2), because of their potential relevance to other regional networks.

4.1. *Management: objectives, goals and strategies*

The development of a set of regionally agreed objectives, goals and management strategies for the regional network of MPAs involved a process of consultation with MPA experts from each country in a workshop in Sharm el Sheikh (Egypt) in November 2000. The objectives and goals were based on regional priorities, and on the objectives and goals of existing MPA management (Table 2). The objectives of the regional network of MPAs are:

1. To develop regional capacity in all aspects of MPA planning and management
2. To provide for the sustainable use of living marine resources
3. To support local and national economic and social development
4. To involve local communities and stakeholders as partners in MPA management
5. To conserve representative and prime examples of the biodiversity of the Red Sea and Gulf of Aden
6. To conduct research and monitoring programmes for the benefit of MPA management
7. To enhance public awareness for the marine resources and biodiversity of the Red Sea and Gulf of Aden and the principles of sustainable use
8. To protect the unique cultural heritage of the marine and coastal environments of the Red Sea and Gulf of Aden.

Table 2
Regional management framework for Red Sea and Gulf of Aden Regional Network of MPAs

Goals	Objectives	General Policies, Strategies and Activities
To develop regional capacity in all aspects of MPA planning and management	<p>To increase staff capacity in the planning, establishment and management of MPAs.</p> <p>To establish a regional group of MPA experts.</p> <p>To establish communication networks and the exchange of information and experiences amongst MPAs in the regional network, and with regional networks in other parts of the world.</p> <p>To develop site-specific master plans and management plans for each MPA in the regional network where these do not already exist.</p> <p>To monitor and review management performance.</p>	<ol style="list-style-type: none"> 1. Staff training in: MPA selection, planning and management; biodiversity conservation; fisheries; tourism; public awareness; marine ecology. This training to occur through formal courses and on-the-job training. 2. Relevant and up-to-date technology to be used for planning and management. Seek funding and infrastructure support for technology acquisition. Staff to be trained in the application of this technology in the planning and management of MPAs.
To provide for the sustainable use of living marine resources	<p>To protect the habitats and ecological processes that sustain living marine resources at all stages of their life cycle.</p> <p>To manage the use of living marine resources, in consultation with local communities and commercial enterprises.</p> <p>To monitor effectiveness of management.</p> <p>To re-establish traditional, community-based conservation practices.</p>	<ol style="list-style-type: none"> 1. Protection of critical habitats in each MPA by protective zoning. 2. Establish no-take zones in each MPA. 3. Develop inventories and stock assessments of key fisheries species. 4. Monitor stocks of key species caught within the MPA. 5. Protect areas within the MPA that have a high connectivity to other areas (in terms of their larval supply). 6. Require environmental assessment for all commercial activities within the MPA. 7. Enforce national regulations relating to the capture of living marine resources. 8. Prohibit collection of curios.
To support sustainable local and national economic and social development	<p>To encourage economic development activities based that are compatible with the conservation objectives of the MPA.</p> <p>To ensure that all economic development activities and uses of the resources of the MPA are sustainable and subject to environmental and social impact assessment, according to the relevant legal instruments.</p>	<ol style="list-style-type: none"> 1. Include areas to be set aside for development purposes in MPA zoning plans. 2. Alternative livelihoods to be provided for members of the local community significantly impacted by the establishment of the MPA. 3. Mechanisms for sustainable financing to be utilized to support the operations of the MPA.

To involve local communities and stakeholders as partners in MPA management

To involve stakeholders in a participatory manner in the development of management plans.
To involve the local community in day-to-day management of the MPA.
To engender within the local community a sense of partnership and commitment to the objectives of the MPA and its management activities.
To provide employment opportunities for the local community in the operations of the MPA.

To conserve representative and prime examples of the biodiversity of the Red Sea and Gulf of Aden

To conserve representative samples of the habitats, communities, species, landscapes, and seascapes occurring within the MPA.
To maintain the natural coastlines within the MPA.
To maintain water quality within the MPA.
To protect critical habitats within the MPA and, where necessary, restore those that have been degraded.
To protect significant, rare and endangered species occurring within the MPA and the habitats upon which they are dependent.
To use the best available information for planning and management decision-making.

4. Cost-recovery mechanisms to be used to restore the resources of the MPA that are damaged by unlawful use.
5. MPA staff to provide advice to developers on minimizing the environmental effects of their activities.

1. Local community members and stakeholders to review and comment on draft zoning plans and management strategies, and their comments to be used in drafting amendments.
2. Local community members to be trained to undertake tasks that support the management of the MPA, such as community ranger duties, the collection of fisheries data, monitoring of key groups of flora and fauna, liaison with tourists.

1. Comprehensive inventories and maps of all habitats to be compiled for each MPA where this has not already been done.
2. Representative examples of all habitats and the varieties of community types within them to be conserved by including them in protective zoning.
3. Areas of high conservation value to be conserved by protective zoning: areas of high species richness; areas with a number of different community types; areas important as sources of larval recruits; and areas of high aesthetic value.
4. Activities occurring outside the MPA to be managed to reduce their impacts on the MPA.
5. Undertake annual monitoring of the status of the major habitats within the MPA.
6. Mooring buoys to be provided in areas of high recreational usage.
7. Protect and, where necessary, restore mangrove stands.
8. Determine the status of marine turtles, sea birds, and marine mammals occurring in the MPA and the areas important for these groups. Areas important for marine turtles, sea birds, and marine mammals within the MPA to be conserved by protective zoning.

Table 2 (continued)

Goals	Objectives	General Policies, Strategies and Activities
To conduct research and monitoring programmes that support the objectives of the MPA	<p>To support and facilitate management-related research and incorporate the results of this research in improved management practices.</p> <p>To establish monitoring programmes for key indicators and undertake regular evaluations of management against performance targets.</p> <p>To provide reference locations for research and monitoring that are undisturbed by human activities.</p>	<ol style="list-style-type: none"> 9. Surveys of the use of marine turtles, sea birds, and marine mammals by the local community to be undertaken to determine the magnitude of current threats to their status within the MPA. National legislation relating to the conservation of marine turtles, sea birds, and marine mammals to be enforced. 10. Monitor the status of marine turtles, sea birds, and marine mammals within the MPA. 11. No introductions of non-indigenous or genetically modified species into the coastal areas or waters of the MPA. 12. Pollution from shipping and from land-based sources is not permitted in the MPA and surrounding areas. 13. Surveillance for pollution incidents to be developed and implemented. 14. Site-specific oil spill contingency plans to be developed for the MPA and integrated with the relevant national and regional oil spill contingency plans. <ol style="list-style-type: none"> 1. Monitoring programmes in each MPA to target the status of habitats, key fisheries species, marine turtles, sea birds, and marine mammals. Standard monitoring techniques to be used and the programmes to have an appropriate statistical design incorporating levels of detectable change. 2. Monitoring to also target public awareness and attitudes towards management, and infringements of MPA regulations. 3. Data collected during monitoring to be added to a database within each MPA and also in a regional database within PERSGA. 4. Results of monitoring to be compiled and reported annually and compared against performance targets. 5. Programmes of applied research to be developed to support management.

To enhance public awareness of the marine resources and biodiversity of the Red Sea and Gulf of Aden and the principles of sustainable use

To develop public awareness programmes for the local community and all stakeholders.
To provide opportunities for the public to appreciate the natural beauty of each MPA in an undisturbed setting.
To conserve reference locations that contain the complete diversity of ecosystems, habitats, and species in each MPA for their potential to educate the public.

1. Public awareness programmes to target the local community, all stakeholder groups, local educators and key decision-makers in government.
2. Public awareness programmes to provide the community with information on the following topics related to the MPA: the regional significance of the MPA; its management objectives and the reasons for its establishment; the results of research and monitoring programmes; the natural values and ecology of the marine and coastal environments; and the relationships between human activities and the health of these environments.
3. The content of the public awareness programmes to be delivered through: brochures; articles in newspapers; feature stories on television and radio; home pages on the Internet; articles in *Al-Sanbouk*; and visitor centres.
4. Areas of the MPA that have a high aesthetic value or public appeal to be conserved through protective zoning for public awareness activities.
5. Develop guidelines for recreational users to avoid damage to coral reefs through anchoring, littering, reef walking and diving.

To protect the unique cultural heritage of the marine and coastal environments of the Red Sea and Gulf of Aden

To provide for the maintenance of the traditional livelihoods of the indigenous inhabitants of the MPA.
To protect culturally significant areas.
To protect culturally significance species and their habitats, and to facilitate their sustainable use.

1. Protect culturally important sites.
2. Traditional conservation practices used within the MPA to be documented, and their continuation encouraged by integrating them into the management plan for the MPA.
3. Undertake social impact assessments prior to the establishment of MPAs and as part of the assessment process for developments within MPAs.
4. Protect habitats and resources required by species that are exploited for cultural purposes.



A number of the MPAs in the regional network have existing management plans (Aqaba; Farasan Islands; Mukkawar Island and Dungenab Bay; Ras Mohammed; and Socotra) based on site-specific conditions and issues [31,35,38–40]. Although regionally applicable, it is planned that the regional objectives, goals and strategies will be adapted to the situation of each MPA in the regional network during the process of developing site-specific management plans for individual MPAs.

4.2. Strengthening the legal basis of the MPA network

Most countries of the region have enacted site-specific legislation related to the establishment of specific MPAs. Only two countries (Egypt and Saudi Arabia) have enacted framework laws to support the establishment and management of protected areas throughout each country. In Egypt, Law 102 Concerning Natural Protectorates (1983) includes articles that: define a protected area; forbid certain activities within a protected area; control activities in adjacent areas; and specify the administrative body responsible for enforcement. In Saudi Arabia, Royal Decree M/12 of 1995 enacted the Protected Areas Act, which sets out the requirement for a network of protected areas to be established and managed, and the range of activities prohibited within all protected areas.

The only MPAs in the regional network that have been legally established are Ras Mohammed National Park; Straits of Gubal (Egypt); Aqaba (Jordan); Farasan Islands (Saudi Arabia); Sanganeb; Mukkawar Island and Dungenab Bay (Sudan); Socotra (Yemen). In those countries where this does not exist, there is a need to develop national legal frameworks that provide for the establishment and management of the remaining MPAs in the regional network, and provide a general legal basis for the establishment and management of MPAs throughout each country.

A regional framework for cooperative environmental management of the marine and coastal environments of the Red Sea and Gulf of Aden came into effect in 1982 with the signing in Jeddah of the Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (the “Jeddah Convention”). The Jeddah Convention contained a number of articles relating to the need for measures to prevent and combat oil pollution. The Action Plan for the Conservation of the Marine Environment and Coastal Areas in the Red Sea and Gulf of Aden was also signed in Jeddah at the same time. The Action Plan outlined a programme of Environmental Management, which included the establishment of MPAs as tools for the sustainable use of living marine resources. Much information has been collected since the signing of the Jeddah Convention and the implementation of the Action Plan and many MPAs have been established as a result. However, the major emphasis of the Jeddah Convention is on the prevention of oil pollution and it does not provide the necessary legal framework to assist countries in efforts to establish MPAs or to frame their own national legislation.

Efforts of individual countries to establish MPAs for the regional network will be facilitated by the development of a regional protocol that provides a legal

framework for governments to prepare legislation for the establishment and management of MPAs. The proposed Protocol Concerning Biological Diversity and the Establishment of Protected Areas for the PERSGA region will provide this legal framework. The Protocol will oblige Contracting States to protect regionally representative areas, as well as areas that are unique and highly sensitive. The implementation of the proposed Protocol will significantly strengthen national and regional efforts to establish MPAs in the regional network, and other MPAs.

4.3. Coordination of MPAs in the regional network

Coordination among each of the MPAs in the regional network will occur through a Regional Coordinating Committee and the establishment of a Regional MPA Activity Centre. The Committee will be comprised of national MPA focal points (being senior MPA managers or planners); scientists with leading experience in MPAs, sustainable use and biodiversity; and experts in socio-economic and public awareness aspects of MPAs. A Regional MPA Activity Centre will be established in Jeddah (Saudi Arabia) in the headquarters of the regional organization PERSGA. The functions of the Regional Activity Centre will be: to provide assistance to countries in establishing and managing their Network MPAs and other MPAs; to prepare reports and technical studies on MPAs, as directed by the Coordinating Committee; to develop, coordinate and provide training programmes and staff exchanges; to provide the physical location and resources for the web page and electronic databases; to provide a regional library of resource material on MPAs; to carry out other functions as directed by the Regional Coordinating Committee.

MPA Focal Points will be appointed in each country by the relevant national authority that is responsible for MPA establishment and management. The MPA Focal Points will be members of the MPA Coordinating Committee and will act as the national contact person for the regional network. MPA Focal Points will provide technical and management information on MPAs in their country. The Focal Points may be high-level managers in the regionally representative MPAs, with experience in MPA establishment and management.

4.4. Information exchange within the regional network

Countries in the regional network represent a range of development states, with widely varying standards of communications infrastructure. Facilitating communication and information exchange will be critical to success because the relevant management and technical capacity are lacking in some countries, and the sharing of information and management experiences will be important. A number of practical measures are proposed to facilitate information exchange, including (1) the establishment of an Association of Red Sea and Gulf of Aden MPA Managers and Scientists, to function as an active, professional society; (2) development of an MPA web site in the Regional Activity Centre that will serve as a source of

information for, and about, MPAs in the region and beyond. For countries with restricted access to the Internet the Regional MPA Coordinating Committee will act as the vehicle for securing international development funds to assist in the establishment of these facilities; (3) a regular MPA feature in the PERSGA Newsletter *Al-Sanbouk*; (4) production of a booklet/CD on the Regional MPA Network and other MPAs in the region; (5) publication of a directory of regional specialists in MPA planning and management, socio-economics, living marine resources and their management, biodiversity, public awareness, GIS, research and monitoring.

4.5. Capacity building and institutional strengthening

MPA planners and managers from countries with limited experience (Djibouti, Somalia, Sudan, and Yemen) will undertake supervised apprenticeships in MPAs in Egypt, Jordan or Saudi Arabia. Work placements will be organized with MPA management agencies in other countries outside the region as a means of exposing staff to alternate approaches to management and technological developments. Formal training priorities include the development of master and management plans, processes of public consultation and participation, sustainable financing, GIS, the use of web pages as a support tool for management and community awareness.

There is wide variation between countries in the infrastructure available to agencies responsible for the establishment and management of MPAs. Several countries have benefited from recent donor assistance (e.g. Egypt, Jordan, Yemen) and many years of national support (Saudi Arabia). There is limited infrastructure development and human capacity for MPA management in Djibouti, Somalia and Sudan. This will limit the ability of these countries to not only establish MPAs, but also to provide the necessary management of their MPAs in the regional network. The Regional Activity Centre will assess the infrastructure requirements of the relevant agencies in each country and, with the support of the Coordinating Committee, secure international funding to provide the necessary infrastructure.

4.6. Wider linkages

There are a number of regional networks of MPAs in other parts of the world that have experience in cooperative and coordinated activities. These include networks in the Mediterranean, Wadden Sea, and wider Caribbean. The Regional Activity Centre will establish relationships with each of these networks and arrange for exchange visits by staff of the Regional Activity Centre to investigate the operation of these networks and their associated activity centres.

5. Conclusion

A number of factors may constrain the implementation of the regional network of MPAs. Establishment and management of each of the MPAs will require continued

high-level political commitment. The regional organization (PERSGA) has been fully operational only since 1995 and it has limited technical and management capacity. This is expected to develop following the implementation of a number of regional projects funded by donor agencies. There may be insufficient financial support to establish and manage each of the MPAs in the Network, which is likely to limit the ability of several countries to implement the regionally agreed management. Some countries of the region can only offer limited opportunities for trained and highly educated personnel and many of these people leave the region, further limiting the technical and management capacity for MPA management. There is limited experience in the development and implementation of sustainable financing mechanisms for MPAs among participating countries. The major source of sustainable financing may be international dive tourism; however, at present this is only occurring on a significant scale in Egypt. And, further opportunities to develop this sector may be constrained by the threat of insecurity in some countries.

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