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The ecological and social basis for management of a Red Sea marine-protected area

William Gladstone^{*,1}

*National Commission for Wildlife Conservation and Development, P.O. Box 61681,
Riyadh 11575, Saudi Arabia*

Abstract

The Farasan Islands in the southern Red Sea of Saudi Arabia have nationally and internationally significant conservation values, and are important for a range of marine-based resource uses. In preparation for the establishment of a marine protected area around the Farasan Islands and its management, surveys were undertaken to assess the state of the coastal and marine resources, and the issues associated with human activities. Stakeholders were interviewed about issues and their attitudes towards the proposed protected area, and constraints to planning and management were identified. Marine habitats included seagrass beds, mangroves, and extensive areas of fringing reef dominated by a diverse coral community or a mixture of coral and macroalgae. Although used for a diverse range of human activities (fishing, shipping, transport, military purposes, recreation, waste dumping, sand extraction) impacts were minimal and localized. The most immediate threat to the marine resources was over-exploitation by fisheries. The types of management activities appropriate to the MPA, and the scale of management, were constrained by a number of unique and important factors: declines in national financial support for conservation efforts, a lack of trained personnel, difficulties in attracting staff to this remote location, loss of community support, the absence of a tourist base from which economic instruments could be developed, and the lack of local non-governmental organizations. Management recommended for the Farasan Islands Marine-Protected Area included zoning, community participation in management, public awareness, and training as a first step, followed by site-specific management actions, research and monitoring, and infrastructure development. © 2000 Elsevier Science Ltd. All rights reserved.

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

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

¹Current address: Sustainable Resource Management and Coastal Ecology Unit, School of Science and Technology, University of Newcastle, Central Coast Campus, PO Box 127, Ourimbah NSW 2258, Australia.

1. Introduction

The Red Sea and Gulf of Aden is a globally significant semi-enclosed sea area, in terms of its unique biodiversity, species endemism, significance for maritime culture, and its renewable resources [1]. The marine and coastal habitats and resources of the region are generally in a healthy condition and exploited at low levels. There are, however, localized impacts arising from unsustainable fishing practices, tourism developments, oil pollution, and degraded water quality and usage is expected to increase rapidly in the near future [1]. A regional network of representative marine-protected areas (MPA) is planned for the Red Sea and Gulf of Aden as part of a regional strategy for biodiversity conservation and sustainable resource use [2]. Critical to the success of this strategy will be the development of locally appropriate management plans that have local community support, and are implemented. There is currently only one model for MPA management in the Red Sea, at Ras Mohammed in Egypt [3]. Its applicability to other locations in the region is limited because of high usage by tourists, modern infrastructure, strong legal framework, trained staff, self-financing mechanism, the amount of research and monitoring information available for management, and its receipt of significant international aid.

In this paper, I describe the basis for management of a MPA more typical of the context elsewhere in the Red Sea: the Farasan Islands in Saudi Arabia. Although little known outside the Red Sea, the Farasan Islands were regarded as having a high conservation value because of the diversity of marine habitats, their importance for marine mammals, turtles and seabirds, and limited fishing activities by a small artisanal fishery [4]. The dramatic industrial and commercial development of Saudi Arabia in recent decades has led to rapid population growth, coastal developments, an increase in domestic tourism, and the rise of relatively new industries such as commercial fishing [1]. The sea between the Farasan Islands and the coast is currently Saudi Arabia's major fishing ground in the Red Sea, and continued growth is expected as demand for seafood increases. In recognition of this it was decided to establish a MPA around the Farasan Islands. Although Saudi Arabia is a wealthy country in the region, in terms of the establishment and management of MPAs it is similar to other countries due to the lack of information for planning, lack of trained personnel, and increasing usage of marine resources. Author offer this paper as an example of MPA management from a region with limited examples and with unique constraints, compared to the Indo-Pacific and Caribbean regions [5–8].

2. Methods

Field surveys and stakeholder interviews were undertaken by the author over a period of 9 months. Aerial surveys were used to map the distribution of the major marine and coastal habitats, the locations of human uses, and the use of the MPA by marine mammals and turtles. These were followed by field surveys from a boat, mostly using snorkel, to map the locations of specific reef habitats (defined by the

presence and coverage of dominant species), and assess the impacts of human activities. In specific locations detailed estimates of coral cover and other benthic lifeforms were done on SCUBA using the line intercept method [9]. The timing, locations and intensity of use of beaches by turtles for nesting were investigated by aerial and boat surveys; evidence of nest disturbance by humans was also recorded. Surveys of the coastline by vehicle were employed to assess the status of coastal habitats, the impacts of human uses, and the use of some beaches by nesting turtles. The significance of reefs within the MPA to fishers was determined from the relative levels of usage as observed during aerial and boat surveys, and examination of the Coast Guard records that showed the destination of all fishing trips made from selected ports around the Farasan Islands.

All stakeholder groups were interviewed about their perceptions of the state of the Farasan marine environment, conflicts with other resource users, their knowledge about the marine environment, traditional management practices, their needs for management, and acceptance of the concept of the Farasan Islands MPA. These stakeholders included artisanal fishers and their village leaders (the chief fisher), representatives of the commercial and industrial fisheries, educators, business people, tourists, and representatives of the relevant government agencies (fisheries, ports and shipping, wildlife, military). Stakeholders were interviewed personally, and in the case of fisher, in small groups.

3. Results

3.1. Description of the Farasan Islands MPA

The Farasan Islands (16°40'N, 42°00'E) are located 42 km offshore of the coastal city of Jizan (Fig. 1). The Farasan Islands MPA encompasses a total area of 3310 km², of which 2600 km² is sea. Within the boundaries there are 128 islands (representing 630 km of shoreline) with extensive areas of shallow, fringing coral reefs and sand shelves. The population of the Farasan Islands at the time of the study was about 5000, inhabiting Farasan Island (four villages), Saqid Island (four villages), and Qummah Island (one village).

3.2. Conservation values

Critical habitats within the MPA include reefs, mangrove stands, seagrass beds and fish nurseries (Table 1). Fringing reefs co-dominated by hard corals and macroalgae were the most extensive reef-based habitat in the MPA, fringing about 50% of MPA shoreline (Fig. 1). Coral-dominated reefs fringed about 36% of the MPA shoreline. Coverage of living hard corals on some reefs was very high, e.g. varying between $63.95 \pm 9.81\%$ (Mean \pm SD) and $83.07 \pm 4.47\%$ at two sites around the Abalat Islands. Seagrass beds are largest and most numerous in the shallow waters between Farasan and Saqid Islands (Fig. 2); elsewhere they are small and scattered. The total area of mangroves is about 300 ha. Importantly, two of the six

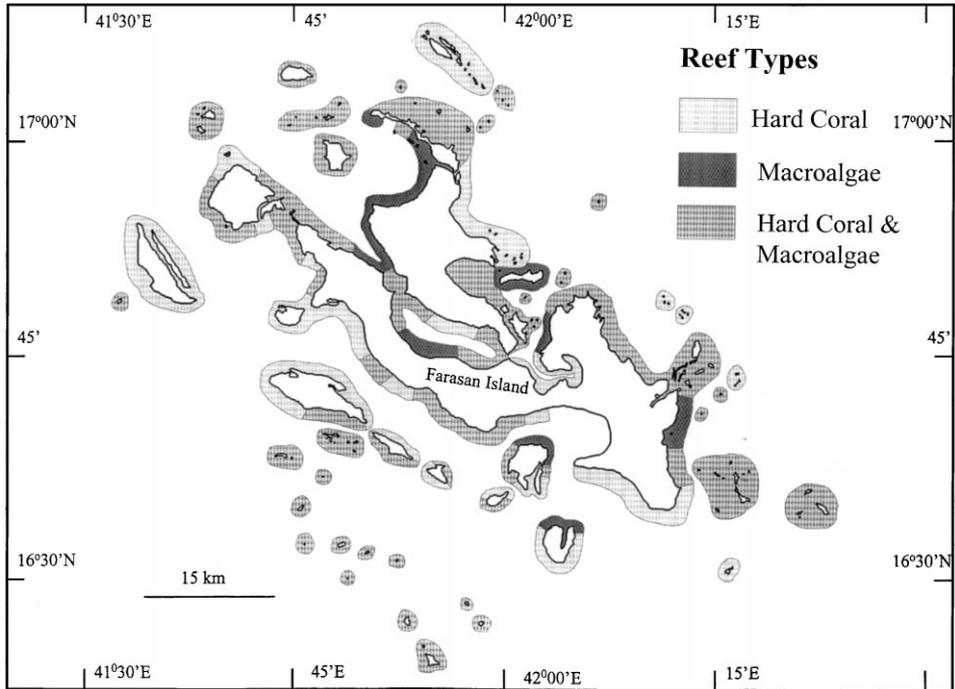


Fig. 1. Major reef types within the Farasan Islands MPA.

Red Sea populations of *Rhizophora mucronata* occur in the MPA. Mangroves are patchily distributed and appear limited by the lack of freshwater input. The largest stands occur within the port of Farasan Islands (Fig. 2).

Three species of dolphin, one species of whale, and dugong occur in the waters of the MPA (Table 1). The presence of Bryde's whales is significant because it is the first confirmed record of this species in the Red Sea, and their presence in summer and winter suggests this species is a permanent resident of the MPA [10]. Large numbers of the three dolphin species were commonly observed throughout the MPA, and there are no human threats to their status. However, both *S. chinensis* and *T. truncatus* are declining elsewhere [11]. The apparently good numbers of both species in the Farasan Islands MPA, and the lack of comparable damaging human activities further highlight the conservation significance of the MPA. Dugong occur in the shallow waters of between Farasan and Saqid Islands in the vicinity of seagrass beds. Limited hunting occurred in the past [12], but is not practiced nowadays. Although the population of dugongs in the MPA is probably small, they are globally threatened, so their presence within the MPA is significant.

Two species of sea turtles are common and nest within the MPA (Table 1). Nesting occurs during both the warm (May–September) and cooler months (January–March) at many islands, and although not concentrated at any particular locality is more common on the smaller islands (Fig. 2). Artisanal hunting for turtle

Table 1
Conservation values of the Farasan Islands MPA

Critical habitats

Reefs (4 major types):

- Fringing and patch reefs dominated by hard corals;
- Fringing and patch reefs dominated by macroalgae (mostly *Sargassum* spp. and *Turbinaria* spp.);
- Fringing reefs that are a mixture of hard corals and macroalgae;
- Platform coral reef.

Seagrass beds: seven species of seagrass (*Thalassia hemprichii*, *Thalassodendron ciliatum*, *Halodule uninervis*, *Halophila ovalis*, *H. stipulacea*, *Cymodocea rotunda*, *Enhalus acoroides*).

Mangrove stands: two species of mangrove (*Avicennia marina* and *Rhizophora mucronata*).

Fish nurseries: in addition to seagrass and mangroves an additional four nursery habitats recognized (beaches, reef flat, *Sargassum* spp. patch reefs, low lying coastal areas inundated during winter).

Important species

Corals: 49 species of reef-building corals and 11 species of other types of corals (preliminary survey).

Fishes: 231 species (preliminary survey).

Marine mammals: bottlenose dolphin (*Tursiops truncatus*), long-snouted spinner dolphin (*Stenella longirostris*), humpback dolphins (*Sousa chinensis*), Bryde's whales (*Balaenoptera edeni*), dugong (*Dugong dugong*).

Sea turtles: green (*Chelonia mydas*) and hawksbill (*Caretta imbricata*).

Seabirds: internationally significant population of pink-backed pelicans (*Pelecanus rufescens*), common noddy (*Anous stolidus*), crab plover (*Dromas ardeola*), osprey (*Pandion haliaetus*), sooty falcon (*Falco concolor*). Nationally significant populations of the pink-backed pelican (*P. rufescens*), brown booby (*Sula leucogaster*), spoonbill (*Platalea leucorodia*), crab plover (*D. ardeola*), bridled tern (*Sterna anaethetus*).

was occurring in the Farasan Islands in the late 1980s [13]. However, during the present study, artisanal fishers and the chief fishers in each village reported that turtles were no longer hunted because it was illegal and young people did not like the taste of the meat or eggs. No physical evidence of hunting (e.g. skeletons) was found during the surveys. Fishers reported that eggs are occasionally taken and evidence of egg collecting was observed on one occasion near a fishing camp. Two recently dead hawksbill turtles found on the beach at Jinabah Bay showed evidence of being caught in nets, and a hawksbill turtle was freed from an abandoned gill net.

The islands and their surrounding waters provide rich feeding grounds and breeding sites for internationally and nationally important populations of several seabirds [14] and two species of raptor (Table 1). Potential threats identified include predation by cats on islands with fishing camps, and the practice of fishers to collect eggs and sell them in the local markets.

3.3. Cultural values

The Farasan Islands MPA has a number of national and regionally significant cultural values. It is the last area in Saudi Arabia where traditional diving for pearl

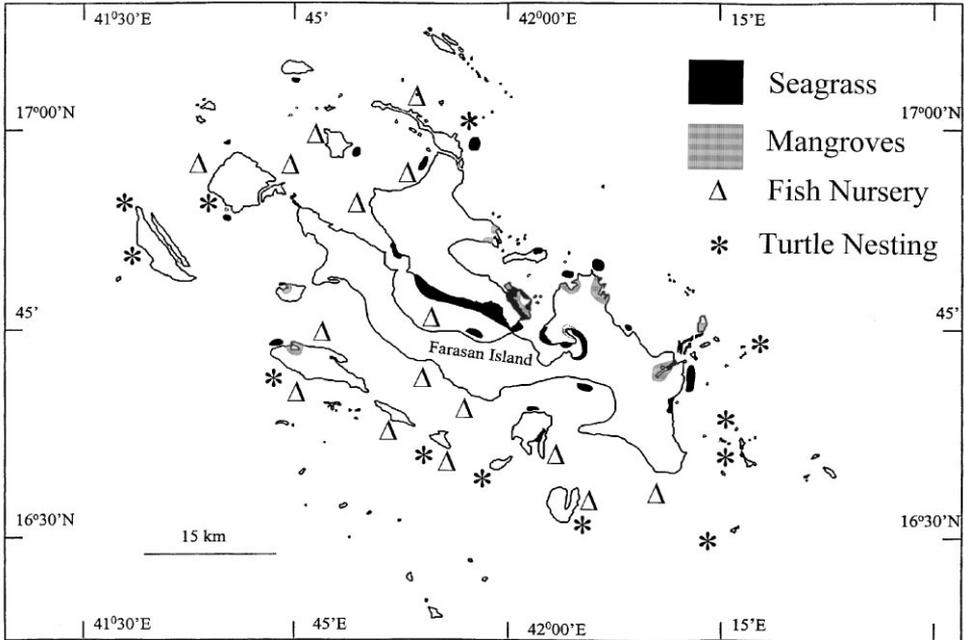


Fig. 2. Locations of seagrass beds, mangrove stands, and turtle nesting sites within the Farasan Islands MPA.

shell continues, and is the only area where artisanal fishing is still done by nationals (most of the fishing elsewhere is done by foreign workers). The harid festival in April–May celebrates the annual spawning aggregation of the longnose parrotfish (*Hipposcarus harid*), during which large numbers of parrotfish aggregate at one location off Farasan Island to spawn, and are harvested by local residents [15]. This is both a globally unique ecological phenomenon, and a significant cultural event in Saudi Arabia. No formal system of customary tenure of reefs or subtidal resources was practiced in the Farasan Islands. Although the Farasan Islands have been inhabited for many hundreds of years, the population has always been relatively small, the villages widely dispersed, and fishing effort was low. The only form of traditional resource management involved the rotation of fishing effort amongst reefs to prevent over-fishing that was coordinated by the chief fisher of each village.

3.4. Human uses and issues

3.4.1. Fisheries

Three types of fisheries operate within the boundaries of the MPA: artisanal, investor, and industrial fisheries. The artisanal fishery involved locals fishing from small (5–8 m), outboard-powered fibreglass boats mostly targeting emperors, snapper, grouper, jack and tuna. Between 59 and 76% of the artisanal fishing effort occurred on reefs within the MPA (Fig. 3). The investor fishery consisted of larger

(10 m) fibreglass fishing boats owned, but not operated, by a local Saudi business person and crewed by employed foreigners. Most investor boats fished outside the MPA, their larger size allowing them to travel further offshore. The industrial fishery's activities within the MPA include demersal fish trawling, small-scale gill netting, and fish trapping. Demersal fish trawling mostly occurred in the deeper waters west of the MPA and was only recorded on three occasions within the MPA during this study. By contrast, gill-netting and fish trapping occurred routinely throughout the MPA (Fig. 3). Gill-netting targeted small rabbitfishes in shallow reef flats, and fish trapping targeted groupers, snappers and emperors on reef slopes.

Smaller-scale components of the artisanal fishery within the MPA included traditional pearl diving, and clam harvesting. Five divers collected pearl shell (*Pinctada radiata*) during summer in the shallow waters of Rogbain Island. *P. radiata* were abundant around Rogbain Island, but were uncommon elsewhere, and current collecting appeared to be sustainable. Owing to the ages of the divers (between 55 and 60 years old), and the lack of interest from younger people in pearl diving, it is likely that this traditional practice will soon cease. Clams (*Tridacna maxima*) were harvested on a part-time basis by three fishers from a few accessible fringing reefs, and sold in the local markets. Clam stocks were reduced by this activity: surveys of three reefs used by collectors revealed recent mortalities of $47.75 \pm 21.19\%$ (Mean \pm SD), $32.25 \pm 28.70\%$, and $11.10 \pm 19.23\%$. Clams were easily harvested in the shallow reef flats, and the harvesting process damaged

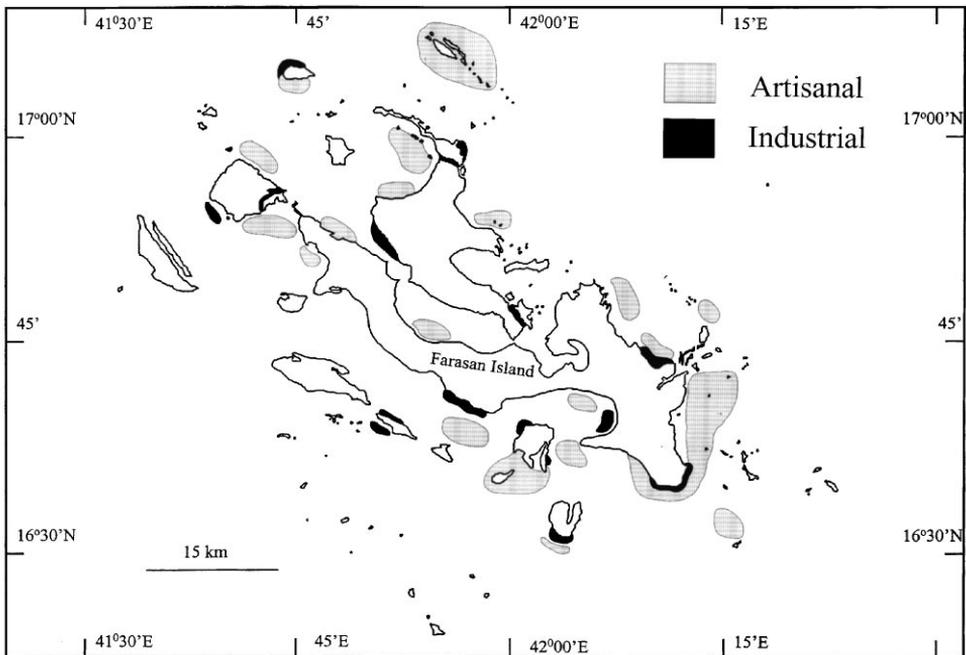


Fig. 3. Artisanal and industrial fishing grounds within the Farasan Islands MPA.

surrounding corals. Clam collecting was prohibited by the Wildlife Commission until more information could be gathered on its sustainability. This intervention appears to have stopped the collecting in these locations: on the reef with the highest levels of mortality the amount of recent clam mortality had fallen to 1.7%, and there was no significant difference in numbers of living clams at the time harvesting was stopped (35.7 ± 7.37 per 200 m^2 transect) and 12 months later (36.7 ± 4.50 per 200 m^2 transect; $F_{1,4} = 0.04$, $P = 0.85$).

There was a conflict between the artisanal and other fishers arising from declines in numbers and sizes of fishes caught by the artisanal fishers. Artisanal fishers also reported that they spent greater amounts of time to catch the same weight of fish as previously, and their incomes from fishing had declined. Artisanal fishers believed the decline in catches was due to increased activities of the investor and industrial fisheries around the Farasan Islands. In particular, they cited the effects of habitat disturbance and the capture of juvenile fishes by the gill-netting operations of the industrial fisheries; the use of fish traps in the same areas fished by the artisanal fishers (fish traps are not traditionally used by the artisanal fishers of the Farasan Islands); the tendency of foreign workers in the investor fishery to fish continuously (because they are living away from their families and because they are paid a share of the weight of the catch); and the habit of foreign workers to fish individual reefs continuously and deplete the stocks.

3.4.2. *Recreation and tourism*

The use of the MPA for recreation was restricted to swimming and picnicking by small groups of locals at only a few locations, mostly Jinabah Bay beach on Farasan Island. From 4000 to 5000 domestic tourists visit Farasan and Saqid Islands during the school vacations. The most popular location is the beach along Jinabah Bay for camping, and where the island's only hotel was located. The most conspicuous impact was litter. Recreational fishing was uncommon, and involved either line fishing from boats, the setting of gill nets from the shore, or illegal spearfishing (this activity is prohibited in Saudi Arabia).

3.4.3. *Shipping*

Shipping activities within and adjacent to the MPA include a daily car ferry service and speed boats operating as water taxis between Jizan and Farasan Island; weekly barges transporting diesel fuel to supply desalination and power generating plants; a small dry dock facility in the protected waters between Farasan and Saqid Islands; and cargo ships and oil tankers travelling to and from Jizan through the shipping channel along the northern boundary of the MPA. In addition, the main body of the Red Sea (approximately 20 km west of the MPA) is a major international shipping route, used for an estimated 25,000–30,000 ship transits annually [1]. Current impacts from these shipping activities are limited and include littering from the ferry, small oil leakage from ships in the dry dock, and tar balls on many west-facing beaches closest to the international shipping route.

3.4.4. *Other activities*

All freshwater is supplied by two desalination plants, from which the heated brine waste is discharged directly into the sea, with minimal local impacts. Most sewage is dumped inland, and disposal into the sea occurs only at one site inside Farasan Port, with no apparent impacts on the mangroves and seagrass beds from the small volumes discharged. Beach sand is being removed from the shoreline in several locations for local construction projects. This has destroyed the low-lying shoreline vegetation (mostly *Zygophyllum* spp.) and has the potential to disrupt shoreline dynamics and for sand to be carried by wind and currents to nearby seagrass beds. There are seven Coast Guard stations and camps throughout the MPA. Limited artillery exercises occur annually in the waters of the MPA, near areas used by marine mammals and nesting seabirds.

3.5. *Management*

The major issue identified in the MPA was the decline in fish catches for the local artisanal fishers, most likely as a result of increases in the effort of all sectors. Other issues were: removal of beach sand; localized oil pollution; clam collecting; and littering from the ferry. Coastal development was minimal but is expected to grow, reflecting the growth experienced in other parts of Saudi Arabia in recent years. Management of the MPA will be constrained in the immediate future by limited implementation, due to the lack of trained staff (management and technical), infrastructure and finances. It was therefore decided that preventive management that includes a zoning system to separate the activities of the conflicting fisheries and conserves habitat, a process for stakeholder participation in management, a public awareness programme, and staff development should be the first component to be implemented. Subsequent management required includes specific management actions; research and monitoring; and infrastructure development.

3.5.1. *Stakeholder participation and awareness*

Stakeholder participation in management will occur through the establishment of a Farasan Islands MPA Council. Council members need to include representatives of relevant government agencies based in the Farasan Islands (wildlife, education, fisheries, defence, ports, local municipality), fishing and tourism representatives, and chief fishers to represent the artisanal fisheries. The chief fisher is the most experienced and knowledgeable fisher in each village. Their traditional roles are recognized by the government and they act as official representatives of the fishers in any dealings with the government. The Council's function will be to address community concerns, and oversee the implementation and review management. This should be accompanied by a programme of public awareness and education about the MPA. The potential to raise public awareness about the MPA is great because of the compulsory attendance of children at school, high ownership of televisions, residents use of the daily ferry service, and the importance of the chief fishers in villages as a source of information and advice.

3.5.2. Zoning

A zoning system has been designed to provide priority access for local artisanal fishers to reefs within the MPA and manages some of their activities; it limits the activities of the commercial and industrial sectors and protects important habitats. Five zones are utilized (Tables 2 and 3; Fig. 4). They are named for the concept of a “Hima”, a traditional protected area established by the desert Bedouin tribes of Saudi Arabia to protect water sources [4]. The same zones are used in managing terrestrial protected areas. A number of uses regulated by the zoning system are currently not occurring within the MPA, such as aquarium fish collecting, dive tourism, and extensive waste dumping. However, in the absence of management similar uses have spread in other parts of the Red Sea and caused significant local impacts [1] and may occur in the future as the usage and population of the Farasan Islands increases. The zoning system allows for continued resource throughout the MPA. The exclusion of industrial fisheries from the shallow waters around Farasan and Saqid Islands and the exclusion of investor fisheries from the entire MPA will reduce conflicts between these sectors and the artisanal fishery. These actions will cause minimal impacts to the investor and industrial fisheries because there are many alternative sites for the industrial fishery within the MPA and because most boats in the commercial fishery work outside the MPA. The zoning system conserves unique and representative areas, critical habitats (e.g. turtle nesting beaches, seagrass beds, mangroves, and other fish nurseries), culturally and ecologically significant locations

Table 2
Zones, and their objectives, as applied to the Farasan Islands MPA

Zone	Management objectives and locations utilized within the Farasan Islands MPA
Resource use hima	Relatively large areas in which the emphasis is on sustainable resource management. They are a means for allocating the exclusive rights to use such resources for fishing to local people. Locations: all areas with the MPA not zoned otherwise
Biological hima	Small areas set aside to protect critical habitats e.g. mangroves (Shura Island), seagrass beds (Tobtah, Shura Island), other fish nurseries (Ra’s Abra, Jinabah Bay, Ad-Dosan Island, Khur Abu Tuq, Saqid Island), turtle nesting beaches (Abu Shari’a, Hindiyah, North Kulum, Solubah, Domsuk, Abker, Ad-Dosan Islands) and culturally significant areas (Rogbain Island, Kharij As-Sailah)
Natural hima	Small areas of high natural excellence established for the conservation of waterbirds (NE coast of Farasan Island, Abu Mashari, North Solain, Sumair, Murain, Shuma, At Toruq, West Mandhar, Omm Al Qidain and Abu Shugar Islands), public education, low impact recreation and research (Abalat Islands, platform reef and coral cay between Sumair and Hindiyah Islands, Khur Qummah)
Special natural hima	Areas important for conserving biological diversity: Zifaf Island (representative coral-dominated reef; seagrass beds and other fish nurseries); small Sasu Island (representative coral and algae-dominated reef; mangroves); southern Saqid Island (dugong habitat and extensive seagrass beds)
Recreational hima	Areas of high scenic and amenity value managed for their educational and recreational values: Jinabah Bay, Ra’s Al Taraf

(such as the site of the annual hard festival in Kharij As Sailah), and areas important for endangered species, e.g. dugong, that were identified during the field surveys.

3.5.3. *Capacity building*

Staff will be required for the day-to-day management activities within the MPA, planning and management, and technical support. Specifically, training will be required in coastal zone planning and management, MPA management, public participation, marine resource management, marine ranger duties, monitoring techniques, social impact assessment, and marine biodiversity.

3.5.4. *Specific management actions*

Specific management actions required and not covered by the zoning system include the following:

- seabird and marine mammal conservation strategies;
- removal of rats and cats from islands used for turtle and seabird nesting;
- negotiate with artisanal fishers to re-locate fishing camps from islands used by nesting turtles (there are many small islands that appear to be suitable alternatives);
- establishment of a 100 m wide buffer zone landward of the shoreline in which sand collecting is prohibited;
- a litter management programme;
- prohibit the sale of harid caught during the annual festival;
- an oil spill contingency plan.

3.5.5. *Research and monitoring*

Owing to logistic constraints and lack of suitably trained staff, the field work for this study was undertaken solely by the author. The scale of the MPA (more than 3000 km²) and the time available meant that it was not possible to gather detailed information on the range of resources, the stakeholders and the issues. I am confident, however, that major patterns in the distribution and abundance of resources, and the issues associated with human uses, are accurate and suitable for initial planning purposes. Further studies that will improve future planning and management include:

- a detailed inventory of the marine and coastal biodiversity;
- stock assessments for the major species caught by fishers, and catch and effort data for the three fisheries sectors;
- local oceanography (suitable for the development of an oil spill contingency plan) and water quality;
- socio-economic significance of the marine resources;
- opportunities for sustainable financing of the MPA;
- a survey of introduced species, especially cats and rats.

Table 3
Permitted uses within each of the zones in the Farasan Islands MPA (A: allowed; X: not permitted)^a

Activity	Zones					
	Resource use hima	Biological hima	Recreational hima	Natural hima	Special natural hima	
<i>Artisanal fishing</i>						
Hook/line	A	A	A	X	X	X
Trolling	A	A	A	A1	A1	A1
Nets	A2	X1	X	X	X	X
Traps	X	X	X	X	X	X
<i>Fishing camp</i>	A	X	A	X	X	X
Industrial fishing	A3	X	X	X	X	X
Trawling	X	X	X	X	X	X
Investor fishing	X	X	X	X	X	X
Pearl diving	A	A	A	X	X	X
Recreational fishing	A	A	A	X	X	X
Coral collecting	X	X	X	X	X	X
Aquarium fish collecting	A4	X	X	X	X	X
Spearfishing	X	X	X	X	X	X
Shell collecting	A5	X	A4	X	X	X
Egg collecting	X	X	X	X	X	X
Boating	A	A	A	A	A6	A6
Diving/snorkelling	A	A	A	A	A	A
Education activities	A	A	A	A	A	A
Research	A	A7	A	A7	A7	A7
Military use	A8	X	X	X	X	X
Desalination effluent	A9	X	X	X	X	X

Dumping/waste disposal	X	X	X	X	X	X
Sewage discharge	A10	X	X	X	X	X
Construction	A9	X	X	X	X	X
Dredging	A9	X	X	X	X	X
Seabird egg collecting	X	X	X	X	X	X
Access	A	A	A	X2–4	A	A
Domestic animals	A	X	A	X	X	X
Destruction of mangroves	X	X	X	X	X	X
Destruction of seagrass	X	X	X	X	X	X

^aNotes: A1: Trolling targets pelagic species of fish. This activity is unlikely to have significant impacts on populations of reef fishes in either NH or SNH.
 A2: Nets are allowed in the RUH; however, nets are not permitted in mangrove areas.

A3: Permitted in areas other than around Farasan and Saqid Islands.
 A4: For recreational collectors, a limit of five individuals of any one species may be collected per month. Commercial collecting will be managed through a permitting system.

A5: For recreational shell collectors a limit of five specimens per person per day is recommended. Commercial shell collecting not permitted.
 A6: Allowed, except in the SNH in Khur Maadi.

A7: Allowed, but manipulative research requires NCWCD permit.
 A8: Allowed, but recommended that NCWCD be consulted to reduce potential impacts.

A9: Allowed but only as an extension of current facilities. It is recommended that only developments of the highest national interest occur within the MPA. These activities will be subject to preparation and approval of an environmental impact statement, including environmental safeguards.
 A10: Allowed, only if treated to tertiary level.

X1: Nets are normally not permitted in a Biological Hima. The only time and locality in which nets are permitted is in K harj As Sailah when they are used as part of the annual harrid festival.
 X2: No access at any time of the year to Abu Shugar Island.
 X3: Access prohibited between May and August to the following islands: Sumair, Murain, Shuma, At Toruq, West Mandhar.
 X4: Access prohibited between October and February to the following islands: Solain, Abu Mashari, Abalats, Omm al Qidain.

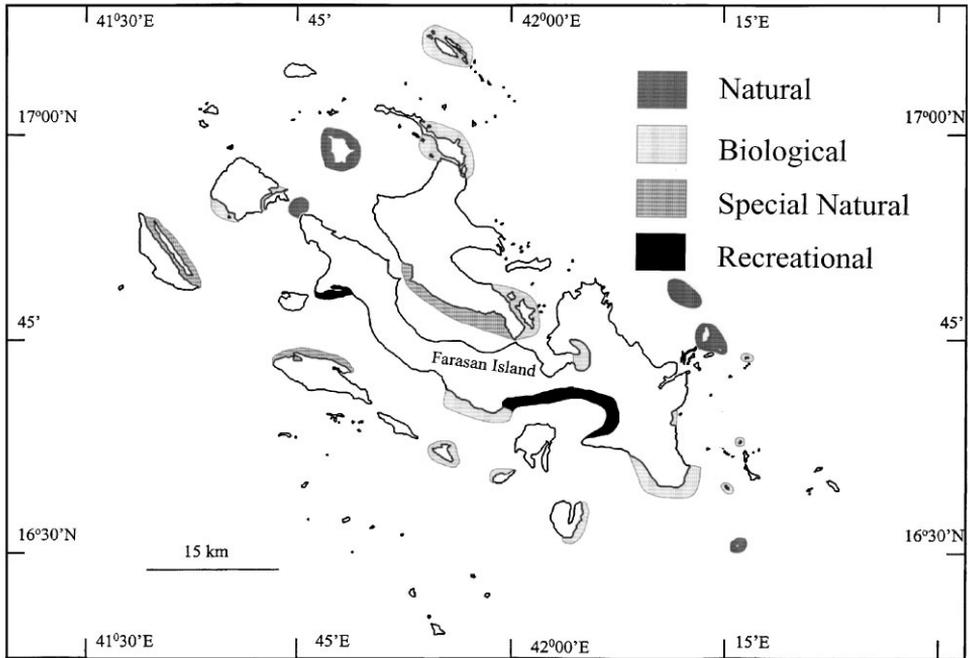


Fig. 4. Locations of zoning himas within the Farasan Islands MPA. Areas not covered by the himas shown are zoned Resource use hima (see Table 3 for an explanation of the activities allowed in each hima).

A monitoring programme was established to provide biological information useful for future management reviews. Baseline data was gathered for the following parameters: fishes (by underwater visual surveys); coverage of major benthic lifeforms; coverage of seagrass; harid stocks (using length and weight from a sample of fishes collected during the annual festival); clam stocks; populations of dugong, dolphins, whales, turtles (by aerial surveys). To be valuable for future management reviews, this monitoring needs to be continued annually.

4. Discussion

In general, the habitats and biological diversity of the Farasan Islands MPA were in good condition at the time of this study. This is a consequence of its isolation, harsh climate, historically low population, difficulty of access, and low development pressure. The Farasan Islands are part of a large, linked ecosystem that includes a chain of smaller islands closer to the coastline, and large areas of coastal seagrass beds and mangroves. West of the Farasan Islands is a large network of barrier reefs. Although ecosystem-scale management is desirable [16–18], it is not always feasible. The decision to establish the MPA around the Farasan Islands, rather than also

including these coastal areas and reef systems further offshore, was based on the limited personnel, technical, and financial capacity to manage such a large area (about 6500 km²) at the present time.

The major issue in the Farasan Islands MPA is the conflict between artisanal and other fisheries, resulting from declining catches. The underlying cause of this is most likely the modernization of the artisanal fishery and the unmanaged expansion of the investor and industrial fisheries. Unsustainable fishing in other parts of the Red Sea and Gulf of Aden has been associated with the rapid increase in the coastal population, limited scientific information for management, and the unmanaged activities of international fisheries [1]. In addition to the ecological benefits, providing for a sustainable artisanal fishery in the Farasan Islands MPA is socially important because of limited alternative employment opportunities within the Farasan Islands. Many of the other issues for conservation and resource management which occur elsewhere in the Red Sea and Gulf of Aden region are absent from the Farasan Islands MPA. These issues include declining water quality; loss of subtidal and coastal habitats through reclamation and dredging; significant oil pollution; and illegal shark fisheries [1]. There has been a significant local degradation of coastal and marine habitats in other parts of the Red Sea associated with the growth of international and domestic tourism [19]. The Farasan Islands MPA would be a suitable destination for dive tourism; however, the policy of the government of Saudi Arabia to restrict the entry of foreign tourists into the country (apart from religious pilgrimages) has avoided extensive developments of this sort.

The majority of countries around the Red Sea and Gulf of Aden are developing, with limited financial resources available for environmental management and with significant projects in environmental management and capacity building funded by the international donor organizations. By comparison, as a result of its large financial resources, the Kingdom of Saudi Arabia generously supported conservation programmes and was one of the first countries in the region to adopt a national strategic plan of protected areas [4]. Declining oil prices in recent years reduced government revenue and forced cuts in the budgets of many ministries and agencies. The extent of management possible in the Farasan Islands MPA will be constrained by reducing financial support. A range of economic instruments have been proposed or implemented to finance management of marine protected areas or coastal resources, especially where a tourism industry is using the protected area [3,20–22]. Tourist levies are presently not feasible for the Farasan Islands because of the absence of international tourists, and the small numbers of domestic tourists and other recreational users. Although their activities will be reduced within the MPA, investor fishers and the industrial fisheries will benefit from sustainable management of fisheries resources within the MPA due to flow-on benefits from increased larval and adult fish production to areas outside the MPA. However, levies on these sectors will be difficult to introduce because taxation is virtually non-existent within Saudi Arabia, there is no history of “user-pays”, and the government is a major shareholder in the industrial fisheries operation. In addition, non-governmental environmental organizations effectively do not exist within Saudi Arabia, making it

impossible for some management activities to be undertaken by other groups. A major benefit from the declaration of the MPA and increased fish stocks will be the return to the traditional management practices of the artisanal fishers, thereby reducing the reliance on government-funded management. In the interim, the adoption of a minimal management system, involving zoning enforced by a small group of marine rangers, public awareness and stakeholder cooperation will be sufficient at existing usage levels.

The implementation and management of MPAs is a new activity within Saudi Arabia [23]. The necessary experience is limited and there is a need for further education and training to provide appropriate staff. In the past, on-the-job training of staff was successfully undertaken by the international consultants as a part of their project activities. However, there are now fewer consultants and staff in these projects often move into higher-level management positions. It will also be difficult to attract trained staff to work in the MPA and remain there for long enough to develop trusting relationships with local resource users. The majority of educated personnel presently come from the large cities in Saudi Arabia. The isolation and harsh climate of the Farasan Islands are unattractive to most potential staff. The great and daily significance of close and extended family relationships within Saudi society will also deter staff from either moving to the Farasan Islands, or remaining there for long periods of time. Also, salaries of government workers are low compared with similarly trained personnel working in the private sector, which has led to difficulties in retaining staff in similar positions. Management is more likely to succeed if suitable local Farasan Islanders are educated and trained for positions within the MPA as rangers and educators. The local community generally supported the establishment of the MPA when interviewed. Locally recruited staff will also have both a greater understanding and commitment to the local environment, and are therefore likely to remain as long-term staff.

The participation and support of artisanal fishers, especially chief fishers, will be critical. Artisanal fishers supported the establishment of the MPA, and limitations on their activities (through zoning), only if limitations on the activities of the investor and industrial sectors were implemented and enforced. This will require marine rangers to be active in their enforcement of the zoning plan, and awareness amongst workers in all fisheries sectors of the zoning system. There is successful stakeholder involvement in the management of the Gulf of Aqaba Protectorates in Egypt [3]. Stakeholders include a large number of tourist-based industries with a considerable financial investment within the Protectorates that rely on a healthy marine environment as the basis for their business. However, in the Farasan Islands MPA, most stakeholders (apart from the fisheries sectors and the local community) are a range of government agencies, including ports, defence, municipalities, fisheries, water and agriculture. Historically, management at the bureaucratic level in Saudi Arabia has been territorial, and viewed as a constraint to development of coordinated environmental management capacity, in common with other countries in the region [1]. The ability of these agencies to agree to coordination, and to cooperate in management planning, will be a major determinant of the success of the MPA.

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