



HAWAR ISLANDS PROTECTED AREA

(KINGDOM OF BAHRAIN)

M A N A G E M E N T P L A N

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CONTENTS

<u>ACKNOWLEDGEMENTS</u>	2
<u>CONTENTS</u>	3
<u>LIST OF ABBREVIATIONS</u>	5
<u>1. INTRODUCTION</u>	6
<u>2. MANAGEMENT FRAMEWORK</u>	9
2.1 NATIONAL AND INTERNATIONAL CONTEXT	9
2.2 LEGISLATIVE CONTEXT	11
2.3 MANAGEMENT OF THE HAWAR ISLANDS	12
<u>3. STRATEGIC OBJECTIVES</u>	14
3.1 CONSERVATION	14
3.2 RECREATION	14
3.3 SCIENCE AND EDUCATION	14
3.4 NATIONAL SYSTEM	14
<u>4. HAWAR ISLANDS – A DESCRIPTION</u>	15
4.1 HAWAR ISLANDS	15
4.2 CLIMATE	16
4.3 OCEANOGRAPHY	16
4.4 BATHYMETRY	18
4.5 GEOLOGY AND GEOMORPHOLOGY	18
4.6 BIOGEOGRAPHY	19
4.7 MARINE HABITATS	20
4.8 RARE, VULNERABLE AND ENDANGERED MARINE SPECIES	22
4.9 AVIAN FAUNA	24
4.10 TERRESTRIAL FAUNA	29
4.11 TERRESTRIAL AND INTER TIDAL FLORA	30
4.12 HISTORY	32
4.13 MAJOR HUMAN USES	34
4.14 ARCHAEOLOGICAL HERITAGE	35
<u>5. POTENTIAL PRESSURES - HAWAR ISLANDS</u>	40
5.1 FISHING	40
5.2 PETROLEUM AND MINERAL EXPLORATION AND PRODUCTION	40
5.3 TOURISM	41
5.4 POLLUTION	41
5.5 DESALINATION	42
5.6 LAND-FILLING AND DREDGING	42
5.7 INTRODUCED SPECIES	42
<u>6. MANAGING THE HAWAR ISLANDS PROTECTED AREA</u>	45
6.1 CONSERVATION OF BIODIVERSITY	45
6.2 COMMERCIAL AND RECREATIONAL FISHING	46
6.3 PETROLEUM AND MINERAL EXPLORATION AND PRODUCTION	48





6.4 TOURISM _____	49
6.5 POLLUTION _____	50
6.6 DESALINATION _____	50
6.7 LAND-FILLING AND DREDGING _____	51
6.8 OTHER ACTIVITIES _____	51
6.9 INDIGENOUS CULTURAL HERITAGE _____	52
6.10 EDUCATION _____	52
6.11 RESEARCH _____	53
6.12 COMPLIANCE AND ENFORCEMENT _____	54
6.13 STAKEHOLDER AND COMMUNITY LIAISON _____	54
7. REVIEWING THIS PLAN _____	55
7.1 PERFORMANCE ASSESSMENT _____	55
7.2 REVIEWING THE PLAN _____	55
8. BIBLIOGRAPHY _____	56
8.1 SUMMARY OF IUCN GUIDELINES FOR PROTECTED AREA MANAGEMENT CATEGORIES _____	58
8.2 SEAGRASS RESEARCH TECHNIQUES AND BACKGROUND INFORMATION SOURCES _____	60

LIST OF ABBREVIATIONS

CBD	– Convention on Biological Diversity
EIA	– Environmental Impact Assessment
IBA	– Important Bird Area
ICJ	– International Courts of Justice
IUCN	– The World Conservation Union
MOHME	– Ministry of Housing, Municipality and Environment
MoU	– Memorandum of Understanding
NBSAP	– National Biodiversity Strategic Action Plan
NCWP	– National Commission for Wildlife Protection
NGO	– Non-Governmental Organizations
OUB	– Outstanding Universal Value
ROMPE	– Regional Organization for the Protection of the Marine Environment (Kuwait Agreement)
WHC	– World Heritage Convention



1. INTRODUCTION

The earliest known references to the use of the name 'Hawar' or 'Hawarin' are to be found in the book 'Al Ekmal' written 475 H (1082) by the Amir Al Hafiz (Ebin Macolla). The name Hawar is most probably derived historically from the islands' association with white gypsum. The legacy of this name, the Hawar Islands (Fig. 1), are an archipelago of 36 desert islands of classic Arabian scenic variety, diversity and environmental purity. The islands have an abundance of significant and threatened bird and endangered marine species, both resident and migratory, and combine to form an archipelago of great beauty and global importance.

The Bahrain National Charter §3(5) proclaims the protection of the Hawar Islands as a Nature Reserve and National Heritage. It also states that as a result of increasing pressure on the limited natural resources, the government seeks to establish an ideal condition to exploit the natural resources without negatively affecting the environment or the health of the people.

Listed as a Ramsar Site in February 1997, the undisturbed state of the outer islands provides an unrivalled sanctuary in the Arabian region for numerous species of breeding sea birds, while the marine environments about the islands embody a myriad habitats and seascapes that are home to a remarkable array of marine fauna. The marine environments in Hawar Islands represent prime examples of undisturbed indicator habitats that are areas of high productivity, with food webs based on extensive areas of macroalgae, sea grasses and blue green algae.

The loss of the potential of these virtually untouched and pristine marine ecosystems, the biodiversity they support, and possible untold benefits to humankind are also factors worthy of consideration in defining the significance of the islands. The islands represent an un-spoilt marine wetland comprising multiple exceptional and unique inter-tidal and coastal zones, terrestrial habitats and marine ecosystems, all of international importance. They are an outstanding example representing significant on-going ecological and biological processes, of the evolution of terrestrial, coastal and marine ecosystems in an arid environment of extremes in temperature and salinity.

At a human level, protection of the Hawar Islands is a great challenge in the face of modern development in Bahrain, and for that matter, the Arabian Gulf region. For many years, the islands have confronted immense political challenges targeted at its security, stability and identity, and overcome them. The International Court of Justice acknowledged this success on 16th March 2001, whereby the identity of these islands and the continuous sovereignty and submission to the Kingdom of Bahrain were confirmed. Today the challenge is related to identity and cultural uniqueness. The challenge is targeted at its wildlife, natural inheritance and its pristine environment. This period imposes a threat to the nature well-being and security of the archipelago, both qualitatively and quantitatively affecting its sustainable productivity. The challenge lies in Bahrain's ability to invest wisely, whilst preserving the originality of the natural identity of the islands. The natural identity that was



preserved for centuries without any disturbance, the need for creating a balance between the development on these islands, and the protection of natural inheritance has been acknowledged at an international level.

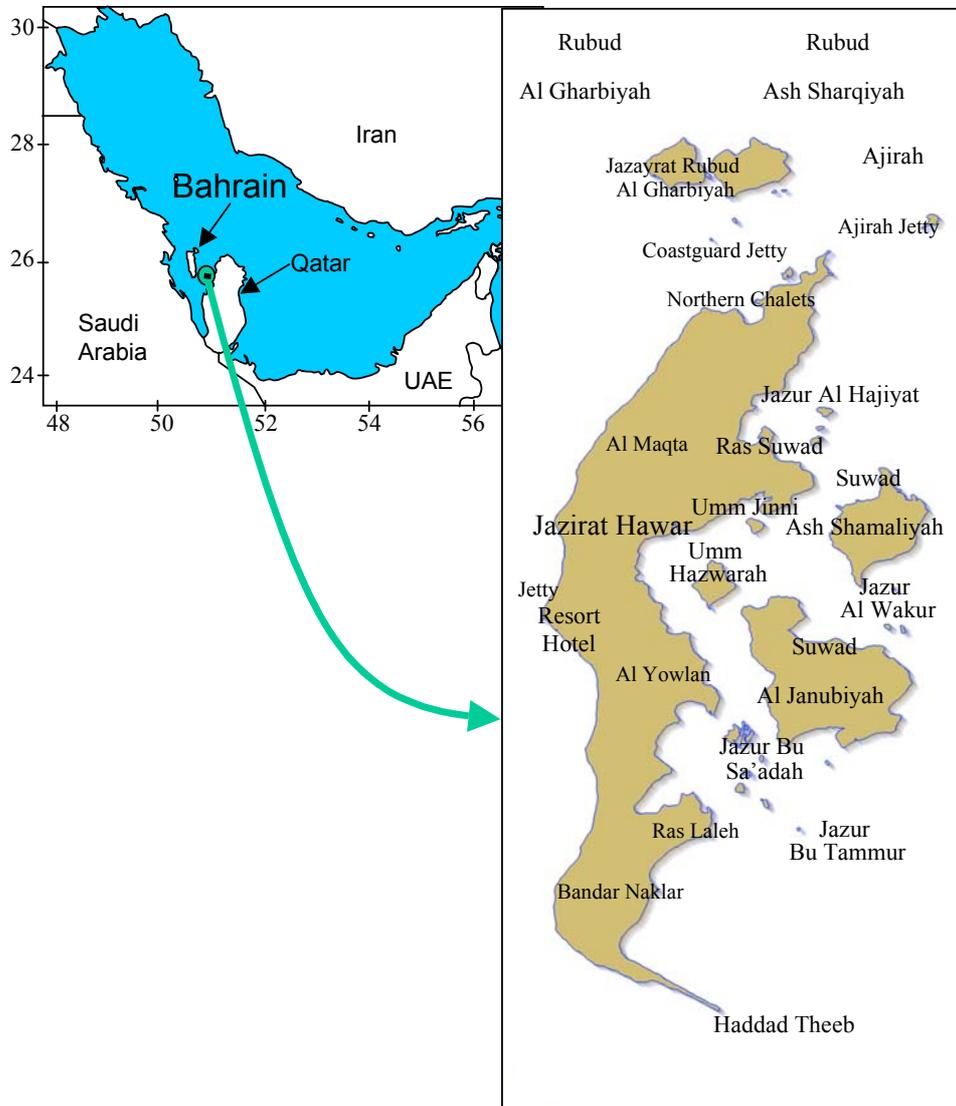


Fig. 1: The Hawar Islands and their geographical setting.

Development on Hawar Island started in the beginning of the eighties in the form of simple tourist service establishments, such as chalets along the shore. Following this, a resort and a hotel on the western coast of Hawar and some offshore smaller islands were developed. To date, construction has been characterized by randomness or haphazardness and also by the lack of comprehensive or integrated planning. In order to avoid the negative impacts of the past and to develop an appropriate long term plan for the islands, the government has established a high level commission called the Commission for Developing and Building Hawar. Through this Commission any proposed development in any sector must take into its consideration the needs and requirements of other sectors, which controls development with negative or

conflicting aspects with regard to any other sector, including the environment, and through which balance must be sought to avoid the dominance of any one single sector.

In keeping with Bahrain's obligations under national wishes and decrees, and international agreements and protocols, and as representatives of the Government of the Kingdom of Bahrain, it is the stated aim of the National Commission for Wildlife Protection to

- a) Structure a multiple-use conservation system for the Hawar Islands, to preserve representative as well as special ecosystems in the environment
- b) Establish a formal management framework to ensure the various uses of the reserve are managed in an equitable, integrated and sustainable manner
- c) Develop a strategy so that the management of biological and recreational resources takes into account the essential and sometimes competitive activities of tourism, recreation, scientific study and mineral and petroleum exploration and production; and
- d) Ensure there is an equitable balance among the various uses of the areas and that these do not have a detrimental impact on the environment.

Bahrain intends to learn from past experiences and from the experiences of other countries to safeguard its environs from any major negative impact. As a great old local saying goes, *"A wise man is he who learns from history and does not let history learn from him"*.



The varied avifauna of the Hawar islands includes large numbers of Flamingos and Western Reef Herons which contribute to the maintenance of marine ecosystems such as shallow mudflats, where they feed on small crustaceans and fishes. The inter-linkages between the various animal groups and the differing environments are the backbone of all ecological processes on the islands.



2. MANAGEMENT FRAMEWORK

2.1 National and International Context

The Hawar Islands have major international and national significance. The Protected area provides a unique representation of a pristine Arabian Gulf ecosystem, from the supra tidal and inter tidal environments of the coastline to the seagrass beds offshore. The protected area provides habitat for a diverse range of marine and terrestrial species. For example, the endangered dugong (*Dugong dugon*) and the green sea turtle (*Chelonia mydas*) inhabit the nearshore waters, and over 150 species of birds use the islands as a flyway or as a wintering breeding / foraging area. Hawar is an archipelago comprising of six major and over thirty smaller islands of various sizes with a total land area of over fifty sq. km. The islands are approximately 26 km southeast of mainland Bahrain, lying close to the Qatar Peninsula (Fig. 2). Once the subject of an international boundary dispute between Qatar and Bahrain, the islands were officially recognised as belonging to the Kingdom of Bahrain by the International Courts of Justice (ICJ) in March 2001.

2.1a Regional Priority Areas.

Although only the largest island is named Hawar, the names ‘Hawar’ or ‘Hawar Islands’ are used locally to describe the entire archipelago.

The islands lie on the migration path of thousands of endangered birds, and are home to one of the largest breeding colonies of Socotra cormorants (*Palacrocorax nigrogularis*) and to marine turtles and dugongs. Hawar also has cultural heritage of international significance, with coastal environments containing evidence of an association with and use by indigenous people for a period of over five thousand years. Rock shelters provide evidence of human decorative traditions which indicate an antiquity of cultural development in the Middle East, predating even the earliest such evidence from Europe. Hawar is also gaining an international reputation for nature-based tourism and birdwatching.

The recognition of the islands at a global level stems from recent efforts to promote the inscription of marine small islands and coastal areas into the World Heritage List. Severe under-representation in World Heritage coverage of tropical coastal, marine and small island ecosystems is evident across the globe, and while World Heritage status is highly valued, very few of the 721 sites inscribed on the World Heritage List are there for their marine values.

A recent meeting of experts in Hanoi, Vietnam, concluded that the Gulf seagrass habitats are of outstanding universal value at a global level, and recommended they should be protected through international instruments such as the World Heritage Convention (WHC 2002). Although there are a number of national conservation programmes and regional initiatives, they tend to be species-specific and not, as yet, directed at preserving marine habitats other than coral reefs. There is a need for focussed attention on the remaining habitats, particularly seagrass pastures, if endangered and genetically-distinct populations of dugongs and green turtles are to survive.



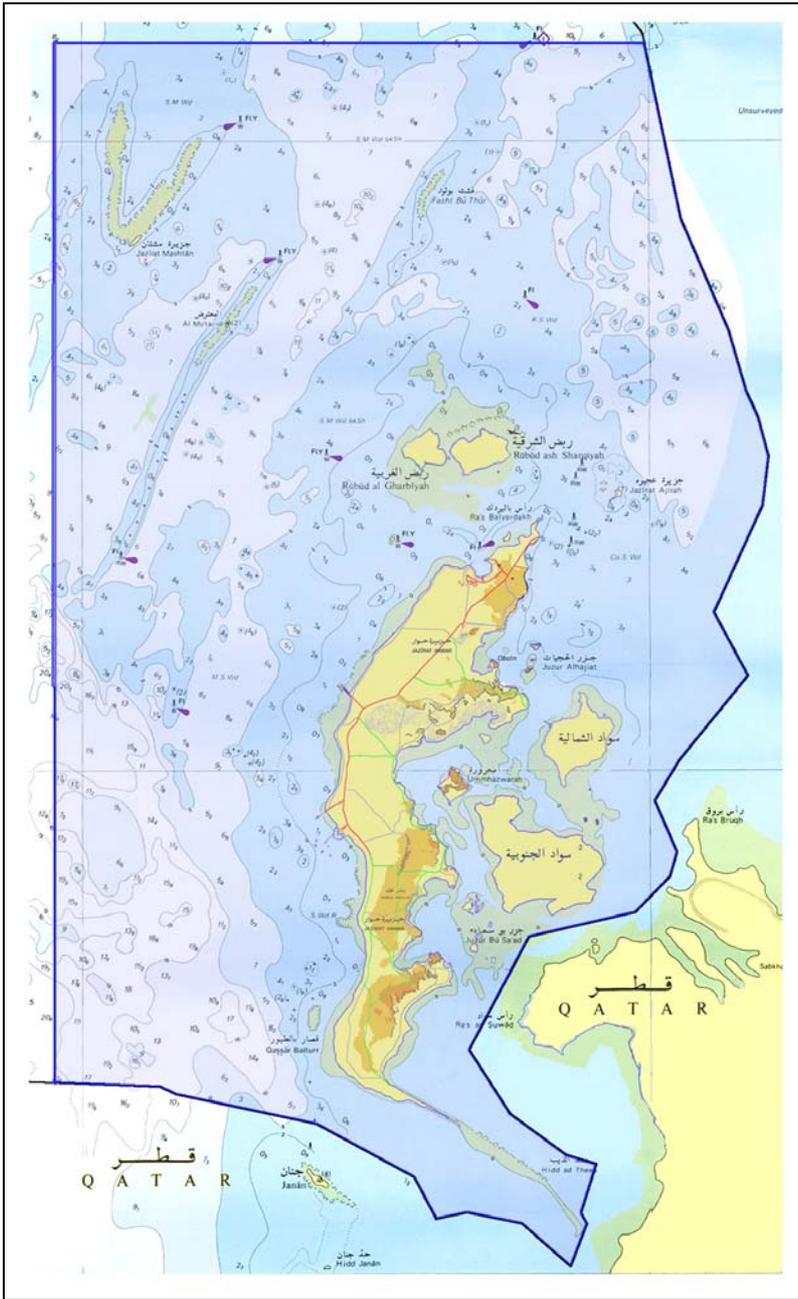


Fig. 2: Proposed Hawar Islands protected area for World Heritage listing.

The group of experts identified two areas of importance in the Arabian Gulf as tropical coastal, marine and small island ecosystems that may merit consideration for World Heritage listing, one of which was the Hawar Islands in the Kingdom of Bahrain. This area was unanimously recognised to be of Outstanding Universal Value (OUV) in terms of their tropical coastal, marine and small island biodiversity attributes. The experts recommend that, as a matter of high priority, the State Party (Bahrain) consider nominating the site onto the World Heritage List.

2.2 Legislative Context

The legal system subscribes to the Islamic law, Sharia, which, as indicated in the Koran, places heavy responsibility on man to guard and protect wild animals and their habitats. Conservation projects are presently attempting to revive the Islamic views of the inter-relationship between man and his environment (Samour et al. 1989). Traditional forms of protected area or range reserves (Hema) may have origins over 4,000 years ago in the pre-Islamic period. In their present form they are based on the dictates of the prophet Mohammed who established a legal system that until relatively recently continued to govern these protected areas, preventing hunting and grazing for a period of time and restricting areas to a ruler or tribe (Samour et al. 1989). Between 1976-79, the Crown Prince re-established one site, Al-Areen Hema, to become one of the first comprehensive attempts to revive the Islamic views of nature (Clark 1985; Izzedin 1980).

Bahrain took the first steps towards effective measures to protect its wildlife on the recommendations of the Prime Minister. Plans were developed for the establishment of a wildlife park to serve the needs of both conservation and education. National designations of protected areas include wildlife parks (Hema) and wildlife reserves. The Environmental Protection Committee has divided the protected areas categories into three priorities: priority 1: full protected status; priority 2: conservation status; priority 3: seasonal management status. In addition, a degree of protection is given to the southern part of Bahrain Island and the smaller archipelagos, as well as the isolated Hawar Islands. In the case of the latter, the government has imposed access restrictions to all but fishermen and those with official permits (UNEP/IUCN, 1988).

Bahrain's commitment to the preservation of the Hawar Islands was formalized in 1995 with Royal Decree No. 2 (1995), to instigate the creation of a Wildlife Sanctuary around the Hawar Islands. The legislation to protect the islands was completed with Edict No. 16 (1996) issued by the Council of Ministers establishing the islands as a protected area. This edict has since been further reinforced by the nomination of Hawar as a Ramsar Site (the islands were nominated on ratification of the Ramsar agreement on 26 February 1997 through Royal decree No. 3 1997), and by the Ministerial Order (MOHME) for the Protection of Wildlife in June 1996.

Bahrain is currently undergoing tremendous political changes initiated by the government. Part of this process includes upgrading the governance to one of democracy, through which it is envisioned that enforcement and application in protecting the environment will be heightened. As a measure of success in this process and as an example of heightened awareness at a national level for the environment, Environmental Impact Assessments (EIAs) are now required for all major development in the Kingdom. Public attitudes and expectations are also changing with an individual personal realization of a certain level of self-empowerment. There is a new general consensus emerging through NGO's and individual stakeholders alike, which encourages respect for the pristine nature and fundamental ecological value of natural habitats. Hawar has become an icon and rallying point for local environmental and conservation groups who



now often use the islands to raise public awareness on many national environmental issues.

The government has used the following mechanisms and protocols for the protection of wildlife: the Establishment of Bahrain Wild Life Committee, now the National Commission for the Protection of Wildlife (NCWP); the formation of a National Biodiversity Committee, with the main objective to formulate a National Biodiversity Strategy and Action Plan (NBSAP); the establishment of Marine Protected Areas (Mashtan Island was adopted in April 2002), membership in the Kuwait Action Plan for the Protection of Marine Environment drafted under the auspices of the Regional Organization for the Protection of the Marine Environment (ROPME) in 1978, ratification of the Convention of Biological Diversity (CBD) in 1993 and of the Convention on Wetlands of International Importance as Waterfowl Habitats (Ramsar) in 1998.

In keeping with international conventions, the Kingdom of Bahrain intends to recognize the Hawar Islands Protected Area under the IUCN classification system of Protected Areas. The range of management regimes are broadly described by the IUCN protected area management categories IUCN Commission on National Parks and Protected Areas (1994) (See Annex 9.1 for summary). The Hawar Islands are to be managed as an IUCN Category II — National Park: Protected Area Managed Mainly for Ecosystem Conservation and Recreation.



Numerous nesting Socotra cormorants, which incidentally are rarely found on the island of Socotra, from which they derive their name, are the backbone of Hawar's avifauna, nesting in aggregations totaling some 200,000 birds in any given year.

2.3 Management of the Hawar Islands

2.3a Ecosystem-based Management

The Hawar Islands should be managed as a single marine protected area with an ecosystem-based approach under a cooperative management arrangement. The management regime for the Hawar Islands should be recognized by the leaders of the Kingdom of Bahrain through a Memorandum of Understanding (MoU) with the National Commission for Wildlife Protection. Under the MoU, the NCWP would be responsible for carrying out the day-to-day management including the policies and prescriptions incorporated in the Hawar Islands Protected Area Management Plan and for developing and executing annual management programs for areas of common interest. These programs would be developed through consultation with several additional agencies. Under this



arrangement the Department of Fisheries would be responsible for management, law enforcement and related activities in relation to fisheries in the Hawar Islands Protected Area. The text of the MoU later should be available through the NCWP website and also at the UNESCO Office Doha website www.unesco.org/doha/.

2.3b Planning

The Secretary General of the National Commission for Wildlife Protection will be responsible for the preparation of the Management Plan for the Hawar Islands Protected Area. To ensure consistent and complementary management with other programmes in the Kingdom of Bahrain, extensive consultation between the agencies should be carried out during the preparation of the management plan and any subsequent revisions.

2.3c IUCN Protected Area Management Category

As noted in Section 2.2, the Hawar Islands Protected Area will be identified with an IUCN protected area management category. The Hawar Islands Protected Area is to be managed under this plan predominantly for conservation, recreation, science and education (see Section 3, Strategic Objectives). Consistent with these strategic objectives, and the purpose for which the reserve was declared, the Hawar Islands Protected Area will be designated as an IUCN “National Park” under IUCN Category II - National Park: Protected Area Managed Mainly for Ecosystem Conservation and Recreation.



Seen from the air, part of a herd of 64 Dugong surface to breathe northwest of the main Hawar Island. These seafaring mammals have slow reproductive rates, and are endangered throughout their range. The Gulf population is the second largest in the world.



3. STRATEGIC OBJECTIVES

The strategic objectives for the management of the Hawar Islands Protected Area focus on conservation, recreation, science and education. These will be designed to provide for the protection and conservation of the unique marine biodiversity, and to maintain the key ecological processes of the protected area while allowing appropriate recreational activities. The strategic objectives of science and education promote increased understanding of the protected area and also aim to engender community stewardship. These strategic objectives are consistent with IUCN Category II, National Park management category, and form the basis for the management of the Hawar Islands Protected Area as described in this Plan. The strategic objectives are:



3.1 Conservation

- ◆ To maintain the marine biodiversity of the protected area; and
- ◆ To maintain key ecological processes and life support systems.

3.2 Recreation

- ◆ To provide for and manage recreational and cultural uses to the extent compatible with the conservation objectives for the protected area.

3.3 Science and Education

- ◆ To promote education, nature appreciation and scientific research on the biological, geophysical and cultural values of the protected area.

3.4 National System

- ◆ To manage the area as part of a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems.



Seagrass meadows like this one on Hawar support grazing marine megafauna such as green turtles and dugongs. The loss of these habitats would signal the loss of some of the most valuable of ocean inhabitants.

4. HAWAR ISLANDS – A DESCRIPTION

4.1 Hawar Islands

The Hawar Islands are an archipelago comprising of over thirty islands of various sizes with a total land area of over fifty sq. km. The islands lie some 26 km southeast of mainland Bahrain close to the Qatar Peninsula. Only the largest island is named Hawar, although ‘Hawar’ or ‘Hawar Islands’ are locally used collectively to describe the entire archipelago. The main islands include Jazirat Hawar (main island), Rubud Al Gharbiyah, Rubud Ash Sharqiyah, Suwad Ash Shamaliyah, Suwad Al Janubiyah, Umm Hazwarah, Umm Jinni, Ajirah, Mashtan, and Mu’tarid. Most of the Hawar Islands are made up of limestone formed from marine deposits transformed into solid rocks to form coastal cliffs with elevation that occasionally exceed 13 meters.

The protected area is bordered at the Northwest corner by the intersection of Latitude 25°50.5’N and Longitude 50°39.5’E, extended due east and south respectively to intersect at the international boundary with the State of Qatar, enclosing an area of approximately 581 sq km.

The islands are flat desert islands close to sea level, surrounded by shallow water seldom deeper than six meters. The salinity of the surrounding water ranges between 48 – 52 ppt (total salt content), while that in the enclosed lagoons and dried mudflats (sabkha) areas can reach a maximum of 80 ppt. The tide is generally semidiurnal with the low and high tide occurring twice per day. The highest tide occurs in the middle of the month and the beginning of the lunar cycle. The tide height however, does normally not exceed 2.5 m.

The largest island Hawar, is largely flat with a maximum length and width of 17 and 3 km respectively. The highest elevation (28 m) is in the middle of an area called Al Jabal. Limestone structures are found along most of the eastern side of Hawar. The larger Suwad and Rabdh islands are generally sandy flats at sea level with gently sloping coastal areas. Mudflats are common around the Rabdh Islands which are visited by many species of wading birds feeding on a diverse array of crustaceans. Al Mahזורah Island is one of the limestone islands with elevations up to eight meters. Al Wukoor Island lies in shallower waters dividing the two islands of north and south Suwad from each other. These higher grounds are important breeding sites for rare species of birds such as the sooty falcon and osprey. Generally, the islands accommodate a range of specialized plant and animal communities adapted to the environmental conditions.

The mudflats in the northeast of Hawar are large, semi-enclosed, shallow water, highly productive areas. A large variety of sea grasses and algae flourish there. Other mudflats occur in areas sheltered from wave action, where sedimentation occurs leading to the deposition of fine-grained sand and mud. These particular habitats attract burrowing invertebrates such as worms, crustaceans and mollusks, which are food for many visiting wading birds. Algal mats, some distributed in a hexagonal pattern with a darker coloration are characteristic.



A wide variety of marine organisms exist around the Hawar Islands. One of the most common of all families are the sea jellies (Cnidaria), characterized by the brown jellyfish (*Cassiopeia* spp.), which swims upside down and is one of the most common. Another commonly found species is the crab *Scylla saratan* found on intertidal sand and rocks. Hawar is also considered an important fishing ground for kingfish and groupers. It is also possible to see schools of many other different fish species such as silver biddies, keeled mullet and gray grunt. This gives the Hawar Islands a special importance in terms of marine resources (the fishery yield on Hawar Islands reaches 450 tons with the kingfish comprising around 60 % of the total catch).

The coastal environment of the Hawar Islands is varied. The western coast is characterized by smooth topographical edges, whereas the eastern coast has many lunar-shaped bays, adjoining the adjacent smaller islands. Sandy shores are found close to the Al Jabal area and Ras Al Bahar in the south and in the village in the northwest. In the east between the sandy and rocky shores, there are wetlands and inter-tidal zones known as sabkha.

4.2 Climate

Bahrain's (and Hawar's) climate is tempered by its island nature. It is characterized by high summer temperatures, scanty irregular rains (less than 100 mm annual total, and most precipitation occurs in winter), high relative humidity and persistent northwest winds. Mean winter temperatures are around 25 to 27 °C while summers enter the 40s. Humidity is lowest in summer months. June-October are typically hot and humid (reaching maximum temperatures of > 42°C), while December to April are generally mild (average temperatures of 10°-20°C). Temperatures can drop significantly from December through to March. Relative humidity varies from 40 to 95 %.

4.3 Oceanography

The ecological and biological processes that are responsible for the creation of the variety of inter-tidal and coastal zones are an outstanding example of significant on-going ecological and biological processes. Much of the dynamics of the marine environment about Hawar are dependent on the relative strength of coastal currents, tidal movements and seasonally high extreme temperatures.

The Gulf itself is a semi enclosed shallow continental gulf measuring 1000 km in length and varying in width from a maximum of 340 to 60 km (at the Straits of Hormuz). The average depth is about 35 m and maximum is 100 m. The Gulf is subject to wide climatic fluctuations, with surface water temperatures generally ranging from 12 in the winter to > 35°C in the summer and salinity from 28 to 60 ppt (total salt). The narrow straits of Hormuz restricts water exchange with the Arabian Sea, which means the waters become highly saline because of high evaporation and low inputs of fresh water. Corals and other marine organisms in the Gulf are more tolerant than elsewhere, and many can withstand environmental extremes that would normally kill other individuals.



Within the Gulf lies the smaller Gulf of Salwa, in which the Hawar Archipelago is located. Extending northwards from Qatar, tidal flows and water movements generated around the Hawar Archipelago differ from the dominant northwesterly wind direction (Fig. 3). The most influential tidal streams or currents are from the northeast following largely the deeper waters east of Fasht Adhm and Ghumais shoals along the Qatari coast with an almost unimpeded flow southward towards Hawar. On approaching the archipelago this body of water, less saline than those to the west, is split by the islands into a variety of tidal flows about, around and through the island chain, in many places accelerated through narrow gaps and in the shadow of Hawar's numerous eastern protruding headlands. In so doing, and in conjunction with local topographic conditions, it forms areas of slack water and eddies of varying salinity and turbidity, resulting in extensive mudflats and the growth of algal mats. Tidal flows originating north and west of Hawar appear to be much weaker moving on a much broader front channeled by the alignment of such reefs as Mu'tarid and Fasht Bu Thur along the western shore of Hawar. At several points this coastal drift is increasingly influenced by wind-generated water movements, exposed to the more open waters to the northwest in the Gulf of Salwa.

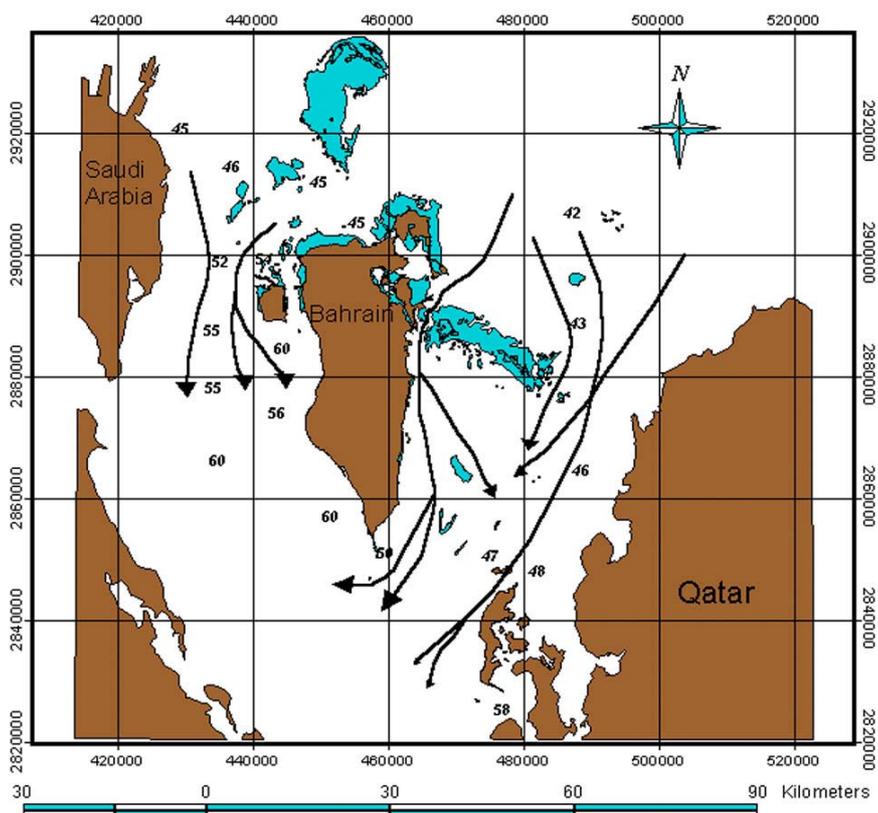


Fig. 3: predominant current pattern for water flowing into the Gulf of Salwa. Smaller eddies are formed along the southwest coast of Jazirat Hawar and a smaller branch of the incoming current runs down the eastern coast of the islands.

4.4 Bathymetry

The Gulf is a shallow sea, averaging 35 m and reaching a maximum of 100m. This drops drastically at the Gulf of Salwa, where water depths rarely exceed 20 m. Water depth around the Hawar islands rarely exceeds 2.5 m, averaging only 1.8 m. The deepest waters lie to the southwest, reaching 17 m. On the west coast of Hawar the subtidal area slopes gently away from the island for over a kilometer to a depth 8-10 meters.

4.5 Geology and Geomorphology

Hawar is separated by a narrow strait of ~3 km from the small peninsula of Ras Abaruk on the west coast of Qatar, and the geomorphology of the east coast of the island is very similar, consisting of indentations and bays backed by low, sandy limestone cliffs and raised beach deposits of the Early Holocene period.

Bahrain and the Hawar Islands are set in one of the most geologically stable areas worldwide. Large-scale tectonic movements have had little impact on the creation of the islands, and the current visible physical topography is a landscape that has evolved during recent geological times, reflecting periods of numerous changes in sea level, of submergence and subsequent re-emergence.

During periods of glaciation the entire archipelago was dry land, a part of a drainage system or catchment area that linked the Arabian Peninsula with the Tigris and Euphrates river basin, draining through a dry marine embayment system, the Gulf. These were periods dominated by aeolian activity and extreme wind storms (*shammals*), which deposited large quantities of sand from the Arabian desert and created the wide variety of wind-sculptured and sand blasted landforms still visible on Hawar today. It is likely that the now sub-tidal dry river bed (wadi) drainage pattern of the islands developed during these dry periods.

Periods of submergence exposed the islands limestone core to marine influences, and earlier coastal deposits and the underlying strata resulted in the formation of Hawar's cliff formations as sea levels stabilized and through ongoing processes of sedimentation and accretion. Around Hawar most of the inter-tidal and sub-littoral areas are underlain by hard flat lying or gently dipping rock, only thinly veneered by sediments. However, the filling with sediments over time of the original now submerged drainage pattern and pits in the now submerged wind-eroded landscape of previous eras are thought to have provided macroalgae with the necessary habitat and promoted their substantial colonization around Hawar. This ongoing and creative process is thought to have given rise to the extensive algal covered mud banks found in the lagoons of eastern Hawar that now form a major and significant series of micro-ecosystem. Through a regenerative process of growing on their own decaying biomass, the macroalgae have raised the level of the banks above the surrounding substrate. Usually these banks are covered by at least 0.5 m of water however they are occasionally exposed during periods of lowest tides.

The sweeping bays of the eastern shore and in the lee of Ras Suwad and Suwad Al Janubiyah are all areas of accretion and they are in some places areas of



extreme of high salinity. These low energy areas vary considerably in character; parts of some are only swept by the sea at time of extreme high tide, with the depth of sediments over the underlying bedrock varying with position relative to major tidal flows and submergence times. In the many bays of the eastern shore of Hawar, excepting Dawhat Al Naklah and south of Suwad Al Janubiyah, extensive mats of blue green algae exist in front of the fringing heavily vegetated shore.



The effects of coastal erosion are evident from the undercut on the eastern shores of Jazirat Hawar. The relatively soft limestone is typically eroded in this fashion until the rock becomes unstable, and falls to the sea.

4.6 Biogeography

The topography of the islands and surrounding marine environment is the result of the interplay between several key factors besides geography and climate. The physical isolation of Hawar and its flora and fauna from the Arabian Peninsula and the main island of Bahrain occurred around 7,000 - 6,500 BP, when sea levels are thought to have obtained their present levels. The Geology of Hawar also reflects innumerable other changes in sea level from -120 m to +5 m as experienced throughout the quaternary era, the result of global climatic changes with a final submergence of a desert landscape in the late Holocene followed by its subsequent emergence.

The Gulf of Salwa, of which Hawar is a part, is classified by the UNDP as a distinct biogeographical province. The Hawar Islands embody this classification, and must be regarded as a distinct and unique entity within this Gulf.

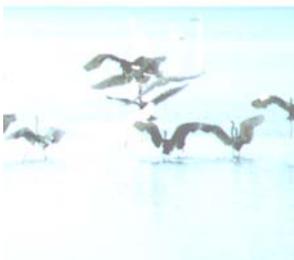
The gently sloping strata of the western extent of the islands masks the contrasting appearance of the cliff fringed eastern shore and the eastwards protruding headlands (which reach a maximum height of 14 m). The line of



cliffs extends along and fringes much of the southern perspective of all the headlands which stand back from the shore, fronted by sabka or mudflats.

Relic areas of carbonate formations have been eroded to form the cliff-lined islands of Umm Hazwarah, Ajirah, Al Hajiyat and the sea stacks of Wakur. In the areas of coastal cliff, the intertidal zone is a relic of the receding cliff face interrupted by steep beaches of shingle and scree. Umm Hazwarah is a unique island in that it has a central wadi system complete with an inner rim rock formation of enclosing escarpments.

Substantial differences can also be found between the topography of the larger islands of North and South Suwad. The interiors of these islands are similar in many ways to areas found on the main island of Hawar (extensive areas of weathered surface pavements) but at much lower elevations. On North or Suwad Al Shamaliyah numerous small and well-vegetated depressions cover the pavement areas and are home to flora not found elsewhere on Hawar. On South or Suwad Al Janubiyah a variety of aeolian features stand out in the general landscape. Circular structures constructed from horizontal bedded aeolian sandstones have been identified as prehistoric burial mounds.



Aeolian rock formations protrude into the eastern lagoon off the main island of Hawar.

Many of the smaller islands are little more than sand or shingle accumulations on areas of exposed bedrock molded by the ongoing processes of sedimentation and accretion. The intertidal zone about these islands varies according to tidal or weather induced influences. The main island of Hawar is topographically to a certain degree an amalgam of many of the elements of the outer islands.

4.7 Marine Habitats

The small reef of Fasht Bu Thur (approximately 100 m in length) has 65 % coverage of the hard corals *Porites nodifera*, *Cyphastrea microphthalma* and *Siderastrea savignyana*. These species are thought to be the most saline

resistant coral species recorded to date, existing around Hawar at the very edges of their environmental tolerance (salinity and temperature tolerance in particular).

However, the primary marine habitat surrounding the Hawar Islands are extensive seagrass beds. Indeed, much of the southern reaches of the Gulf are home to extensive seagrass pastures, off the coasts of the Bahrain, Qatar, the United Arab Emirates (UAE), and, to a lesser extent, the southern coast of Saudi Arabia (Fig. 4). There is limited literature related to seagrasses of the Gulf which documents the value of seagrass beds as critical marine habitats. Seagrasses with the pristine characteristics of those surrounding the Hawar Islands, which consolidate and stabilize bottom sediments, create and maintain good water quality (clarity), produce a surfeit of oxygen in the water column, and generate food and a nursery habitat for a myriad of animals, which includes the dugongs, turtles, and fisheries. These seagrass beds comprise four species (*Halodule uninervis*, *Syringodium isoetifolium*, *Halophila ovalis* and *H. stipulacea*) and are generally associated with relatively fine-grained sediment types (Basson et al. 1997). Most beds are dominated by *Halodule uninervis* although mixed stands also occur (Sheppard et al. 1992).

In Hawar there are extensive continuous carpets of this species from 0.75 m to 2.5 m depth. There are also numerous grazed patches at these depths (estimated to be 2.5 m long and 1.0 to 1.5 m wide and oval), evidence of extensive grazing by the herbivorous green turtles. *Halodule* is abundant down to 4 m depth at least, but deeper than 2.5 m, growths of *Halodule* are patchy, mostly due to the loss of continuous soft sediments and the presence of a rocky base in large patches. All other sediments underlying the seagrasses are a very soft muddy substrate. The seagrass understory is a lush growth of *Halophila stipulacea*. Leaf blades of *Halophila stipulacea*, found at all sampling sites during a recent UNESCO-sponsored site visit to the islands (Phillips 2003), were longer and larger than seen on any previous survey in the Gulf. Within the same samples also were the following algae: *Avrainvillea thalli*, *Digenia simplex thallus*, and *Caulerpa mexicana*.

At shallow stations where *Halodule* is most abundant, there is a dense, thick leaf baffle in the water column, and an accompanying thick interlocking matrix of rhizomes in the sediment, which result in abundant decaying leaf litter, comprised of dehisced leaves and litter in all stages of decay. This leaf baffle is effective in consolidating sloughed-off leaves, and retaining them until they are mineralized. In so doing, the seagrass beds are producing a prodigious quantity of organic material, which directly supports feeding food chains (turtles and dugongs in this case) and the detritus food chains, which support marine fisheries. This also indicates that the plants have been here a long time in an unspoiled state, especially since there are no epiphytes on the leaves. It is suggested that a great amount of research be conducted on these seagrass beds, given the almost total lack of research on Gulf seagrasses. Studies needed are those on density, biomass, primary productivity, and growth rates of the seagrasses (see Annex 9.2 for potential research studies). Until these studies are carried out there is no practical way to quantify their contribution to local fisheries.



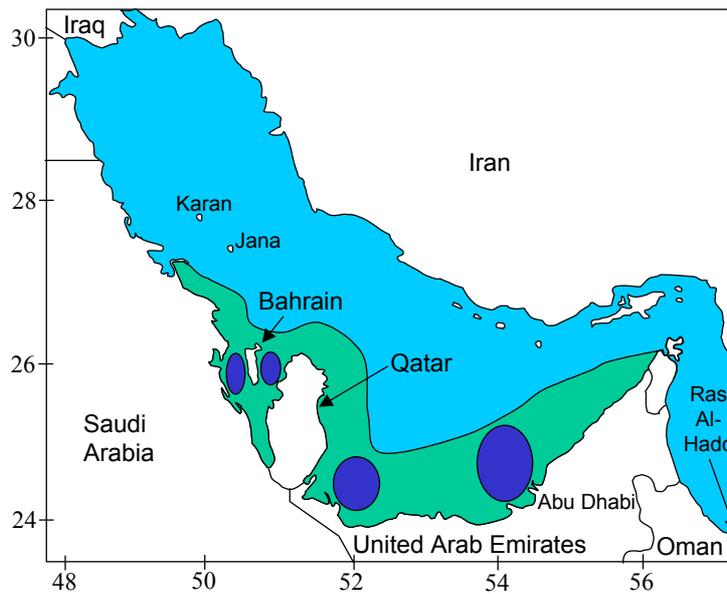


Figure 4: The Gulf region. Lighter shading in the southern reaches of the Gulf indicates the general location of seagrass pastures. Darker shading indicates main dugong distribution.

All seagrasses are in a very active state of growth, e.g., new leafy shoot production, and root and rhizome growth. In general the seagrass health is in excellent condition, with little to no epiphytes on the leaves. This lack of epiphytes indicates clean water, which translates into a lack of anthropogenic nutrient discharges in the area. In comparison to seagrasses all over the world, the Hawar Island marine environments are one of a kind, and unique habitats. The seagrass growths are luxuriant and without a doubt worth conserving.

4.8 Rare, Vulnerable and Endangered Marine Species

4.8a Dugongs

The seagrass beds surrounding the Hawar Islands are (in part) home to the world's second largest assemblage of endangered dugongs (*Dugong dugon*) comprising upwards of 7000 individuals (the largest population resides off the coast of Australia). The most important foraging habitats for dugongs in the Gulf are on either side of Bahrain, particularly around the Hawar Islands, off Saudi Arabia between Qatar and the UAE, and off Abu Dhabi (Preen 1989) (Fig. 3). The dugongs belong to the monotypic Order Sirenia and are the only herbivorous marine mammals. They can live to be 70 years of age and grow to over three meters in length and 400 kilograms in weight. Dugongs have extremely low reproductive capacities as they do not become sexually mature until about ten years of age, with subsequent calving only occurring at intervals of seven or more years. Outside the Gulf, the nearest population is in the Gulf of Cutch, northern India, suggesting the Gulf population is genetically and physically isolated. Until some thirty years ago, dugongs formed the staple diet of many Gulf-bordering villages, and had been used for their leathery skin and fats rendered into oils (Preen 1989). This suggests that populations were



significantly larger than at present, and further reduction in population size might adversely impact their survival outlook.

These factors coupled with extensive hunting by humans have elevated dugongs to a listing of Vulnerable (VU A1cd) in the World Conservation Union IUCN Red Data Book, whereby they face a high risk of extinction in the wild in the medium-term future. These populations are also regarded as conservation-dependent, indicating that any cessation of conservation activities would result in them qualifying for one of the more threatened IUCN species categories within a period of five years (Hilton-Taylor 2000). Being herbivores, the seagrasses upon which the dugongs in the Gulf depend are thus of supreme importance to the survival of this isolated, globally important population.

4.8b Green Turtles

Significant populations of herbivorous green turtles (*Chelonia mydas*) also depend on the seagrasses of the Gulf. They feed among the seagrass pastures bordering the southern Gulf, and some 1000 females/year nest on Karan and Jana islands of the Saudi Arabian coast (Miller, 1989, Pilcher 2000), and another 4000 females/year nest outside of the Gulf at Ras Al-Hadd, Oman (Ross & Barwani 1982). A smaller number nests off the southern coast of Iran. The green turtles in the Gulf also have low reproductive capacities, with estimates of sexual maturation periods of 15 to 40 years, and a survival rate of hatchlings of roughly only one in one thousand. Green turtles have several key physiological features that set them apart from other Testudines, and as with other reptiles, the sex of hatchlings is dependent on temperature during incubation (Miller 1985). Adults can reach over one meter in length and weigh over 150 kilograms, and feed nearly exclusively on seagrasses. The Gulf green turtles exhibit strong nesting site fidelity, returning to the same beaches to nest within and over several seasons (Pilcher 2000). This fidelity coupled with a relatively low emigration rate from the Gulf, other than to the Omani nesting site, suggests that populations which nest and feed within the Gulf are, much as the dugongs, genetically and physically isolated.

Threats to the turtle populations in the Gulf include moderate egg and adult harvesting, mortality in commercial and artisanal fishing gears, loss of nesting habitats, and significant loss or alteration of foraging grounds. While most Gulf-bordering nationals do not generally eat turtles or their eggs, many fishing boat crews are being replaced with a number of other nationalities who do, and unless the nesting beaches are patrolled the fishermen frequently dig up clutches of eggs. Fishermen are also known to take adults on an opportunistic basis (Miller 1989). An important modern impact is the extensive dredging and land-filling projects of several Gulf-bordering nations, which are altering or completely destroying foraging (seagrass) pastures. As in the case of the dugongs, the seagrasses upon which the green turtles in the Gulf depend are of supreme importance to the survival of these isolated, regionally important populations.





Green turtles *Chelonia mydas* surface to breathe while mating in waters of the Arabian gulf. The Hawar Islands represent part of the foraging habitat for these endangered marine voyagers. Their migrations take them across the breadth of the Gulf, and at times out into the Arabian Sea.

4.8c Dolphins

The islands are also home to the bottlenose dolphin (*Tursiops truncatus*), whose forehead is short and pointed, 3.5 m in length, gray dorsally and whitish ventrally, and the Indo-pacific humpback dolphin (*Sousa chinensis*), which grows up to three meters in length with a long forehead. The Indo-pacific humpback dolphin's dorsal fin is small, pointed backward and located on a hump in the middle of the dorsal side. The dolphin is pale to dark gray with some darker patches occasionally. These marine mammals breathe air and feed mostly on marine fishes.

4.9 Avian Fauna

Hawar Islands, in particular, the smaller islands on the eastern side of Hawar are notable for the high species diversity of breeding and annual migratory birds. The islands are also famous for accommodating a large population of breeding birds, which form massive colonies not often rivaled in other parts of the world. Birds migrate from the north and vice versa into, over and through the gulf on well known flyways, however the global importance and total number of species is still being determined. Major significance comes from the islands' unrivalled position in providing undisturbed breeding habitat for the endemic Socotra cormorant and the Asia Regional / Western Gulf's reef heron and ospreys. Hawar has the largest known breeding concentrations of these species, all of which are suffering loss of breeding habitat elsewhere in their range - a situation which also applies to species that migrate into the Gulf for breeding purposes from the southern hemisphere during summer months such

as the sooty falcon and most tern species. There is a very real risk that the sooty falcon could become extinct as a breeding species in other parts of the Gulf region as breeding habitats are now being developed.



A flock of Socotra cormorants returns to Hawar after a fishing expedition. The birds, which number in the hundreds of thousands on the islands, exert a significant pressure on marine resources.



Some of the less-common avian fauna sightings on the Hawar Islands include the slender-billed gulls (*Larus genei*), the great gray shrike (*Lanius excubitor*), kentish plovers (*Charadrius alexandrinus*), greater sand plovers (*Charadrius leschenaultii*), the little stint (*Calidris minuta*), curlew sandpipers (*Calidris ferruginea*), the dunlin (*Calidris alpina*), collared doves (*Streptopelia decaocto*), rufous bush robins (*Cercotrichas galactotes*), crested larks (*Galerida cristata*) and hoopoe larks (*Alaemon alaudipes*), the pallid harrier (*Circus macrourus*), kingfishers (*Alcedo atthis*), the grey francolin (*Francolinus pondicerianus*), desert larks (*Ammomanes deserti*), the common myna (*Acridotheres tristis*), and the house sparrow (*Passer domesticus*). Among the most numerous birds occupying the Hawar island are the following:



4.9a Western Reef Herons (*Egretta gularis*)

A marine bird with yellow eyes and feet, and olive yellow legs and bill, reaching up to 65 cm in length with a wingspan of upto 104 cm. It catches small fishes while walking in the water. Herons breed in east and west Rubud islands from June to August. The female builds a nest on the bushes along the shore. Females lay 2 to 4 eggs, which hatch after 3 to 4 weeks. The bird is a year-round resident, with more than 300 pairs on the islands, the largest population of this species in the gulf.

4.9b White-Cheeked Tern (*Sterna repressa*)

A migratory marine bird which comes to Hawar to breed reaching up to 34 cm in length with a wingspan of some 83 cm. The head is black from above and white on both sides, the rest of the body is gray while the bill and legs are red. It feeds on small fishes. The female lays 1 to 3 eggs from May to August which hatch after three weeks. There are around 3400 pairs breeding on the main



island of Hawar, Rabdh north and west, Hijyat, Um Jany and Abu Suaadah islands.

4.9c Bridled Tern (*Sterna anaethetus*)

A migratory marine bird with black and white body up to 32 cm in length. It feeds on fishes and crustaceans, and some 1800 pairs breed from May to August in Hawar, in particular, on Rabdh islands, Al Hijyat and Um Jany.

4.9d Saunder's Little Tern (*Sterna saundersi*)

A coastal migratory breeding bird distinguished by its white forehead, with the rest of the head black and a yellow bill. The dorsal side and wings are gray. The body attains 22 cm with a wingspan of some 50 cm. The bird feeds on small fishes and breeds during May to August. The female lays 1 to 2 eggs, which hatch after three weeks.

4.9e Lesser-Crested Tern (*Sterna bengalensis*)

A migratory bird reaching up to 37 cm body length which feeds on fishes and crustaceans. The beak is straight, long and characteristically an intense orange color. There is around 600 breeding pairs on Hawar, especially on Abu Saadah Island, from May until August.

4.9f Caspian Tern (*Sterna caspia*)

A coastal migratory but also a resident bird reaching up to 54 cm in length and a wingspan up to 154 cm. The head, dorsal side and wings and legs are black whereas the rest of the body is bright white. The bill is reddish and some 7 cm in length. It feeds on fishes and breeds during October to March on Rabdh east and west, Ajeerah, Suwad, north, Al Wukoor and Abu Suaadah islands. The female lays 1 to 3 eggs typically hatching after three weeks.



The Hawar Islands represent a unique developmental habitat for thousands of birds. Without these valuable migratory stop points, populations in other parts of the globe would rapidly become extinct.

4.9g Greater Flamingos (*Phoenicopterus ruber*)

An aquatic bird reaching up to 145 cm in body length and a wingspan of 165 cm, and a height of 155 cm. It has a characteristically long neck and legs, and a large downward-bent bill. The bodies of the adults are covered by white pink feathers. The young are colored gray to brown. All feed on floating microorganisms in the water column and in the mud. Males and females combine to build their nest, which is made up of a hollow pile of mud. Females lay a single egg, which hatches after 4 weeks. There are typically around 1000 flamingos on the northern Hawar Islands of Rabdh east and west.

4.9h Osprey (*Pandion haliaetus*)

This is a resident bird of prey, which breeds on nearly all the islands. The body length reaches up to 58 cm with a wingspan of up to 170 cm. Its head is white with a black line at the back of the eyes. The body is covered dorsally with brown feathers and ventrally with white feathers. It feeds on fishes and breeds from April to July. The Ospreys build large nests from twigs and pieces of wood on level ground or on a higher level. Females typically lay 3 to 4 eggs, which hatch after 5 weeks.

4.9i Sooty Falcon (*Falco concolor*)

This is one of the rarest birds of prey. It has a small body and inhabits offshore islands such as Al Mahzoorah, Al Hijyat and Al Wukoor, feeding on smaller birds, insects and reptiles. In spring, it migrates from Madagascar and East Africa to the Hawar Islands, breeding from July to September each year. The Falcon grows up to 32 – 36 cm with a wingspan, which reaches to 110 cm. The male is gray with dark brown eyes surrounded by a yellow orange band, and yellow legs. Females are normally larger and darker than males. Females normally lay three eggs, which hatch after four weeks.

4.9j Socotra Cormorant (*Phalacrocorax nigrogularis*)

These are dark black aquatic birds that are regarded as the symbol of Hawar because of their great numbers. They have long bills, and short legs with webbed feet, which are used for swimming. They inhabit marine and coastal waters, feed on fishes and breed on the Suwad Islands in the winter. With a population of around some 200,000, the colony on Hawar is considered among the two largest colonies for this species in the world. The body attains some 84 cm with a wingspan of 110 cm. Females lays 3 to 4 eggs on the ground, which usually hatch after 21 days.

The populations of no fewer than eight species of breeding bird (out of the 22 breeding in Hawar) are considered to be of international importance (Table 1), namely Socotra cormorant, western reef heron, osprey, sooty falcon, white-cheeked tern, bridled tern, lesser crested tern and Caspian tern (King 1999). The islands are also of international importance for over-wintering slender-billed gulls (King 1999). International importance is when the number of a species present exceeds 1% of its estimated regional or biogeographical population of that species or relevant subspecies (Table 1).



Table 1: Internationally important breeding and visiting species in Hawar

BREEDING SPECIES	Population (pairs)	1% level (pairs)*
Socotra cormorant <i>Phalacrocorax nigrogularis</i>	20539	2000
Western reef heron <i>Egretta gularis</i>	>325	30
Osprey <i>Pandion haliaetus</i>	>20	<1
Sooty falcon <i>Falco concolor</i>	15	<1
White-cheeked tern <i>Sterna repressa</i>	3408	2000
Bridled tern <i>Sterna anaethetus</i>	1850	500
Lesser crested tern <i>Sterna bengalensis</i>	644	200
Caspian tern <i>Sterna caspia</i>	28	5
VISITING SPECIES		
Slender-billed gull <i>Larus genei</i>	>3750	750

* 1% levels from Rose & Scott (1994) and Evans (1994)

In addition, there are thousands of passage and wintering shorebirds, although further survey appears to be necessary to assess the true significance of Hawar to this group. At present, sufficient data on shorebirds is available only for the two Rubud Islands, the northernmost islands in the archipelago, and these are certainly of national importance.

Only the main island, Jazirat Hawar, lacks significant populations of nesting birds, with the exception of a single nesting pair of ospreys in the north. All outlying islands hold breeding populations of one more of those species for which the archipelago is deemed of outstanding universal value (OUV), which, regardless of other fauna present, is alone sufficient to World Heritage listing for the entire area.

Table 2. Percentages of regional or world populations of important waterfowl and other species found in Hawar

SPECIES	PERCENT	REGION
Socotra cormorant <i>Phalacrocorax nigrogularis</i>	>10%	World
Western reef heron <i>Egretta gularis</i>	11%	SW Asia
Osprey <i>Pandion haliaetus</i>	>20%	Arabian Gulf
Sooty falcon <i>Falco concolor</i>	>25%	Arabian Gulf
White-cheeked tern <i>Sterna repressa</i>	2%	World
Bridled tern <i>Sterna anaethetus</i>	3-4%	Red Sea/Gulf
Lesser crested tern <i>Sterna bengalensis</i>	3%	Gulf/S. Asia
Caspian tern <i>Sterna caspia</i>	6%	Red Sea/Gulf
Slender-billed gull <i>Larus genei</i>	5%	SW Asia

Hawar was included in the Directory of Wetlands in the Middle East, which documented all sites meeting the qualifying criteria for Ramsar designation under the 1971 convention. Hawar was also specifically identified an Important Bird Area (IBA) by BirdLife International (Evans 1994). The international significance of Hawar for birds, particularly its breeding populations, suggests

its continued protection is paramount for the ongoing ecological processes entailing a much wider geographical area.

4.10 Terrestrial Fauna

The islands also support a diverse array of terrestrial fauna which complement the avian inhabitants and complete the complex coastal / desert ecosystems. Among the island residents is the jerboa (*Jaculus jaculus*), a hopping nocturnal rodent, which feeds on herbs and desert plants which is well adapted to the harsh desert conditions. It is characterized by long ears, which grow up to 20 – 25 mm. There are also sundevalls jirds (*Meriones crassus*), the most common of desert rats, characterized by the presence of black hair on the tip of its tail and white hair behind its ears, and a white abdomen. They inhabit sandy areas, build burrows in the sand and feed on herbs and desert plants.

4.10a Reptiles

Among the herpetofauna are the spiny-tailed lizards (*Uromastix aegyptia microlepis*), which reach up to 65 cm and feed on plants and herbs (the young feeds on fishes and insects). They construct burrows, which reach down to two meters deep to evade the daytime heat. The color of its skin changes with changes in temperature, with the lizards appearing black at dawn and changing to yellow at higher temperatures. The lizards have a life span of some 80 years. There is also the jayakars agama lizard (*Agama jayakar*), a blue-throated lizard which has been considered one of the most beautiful of its family, and which can be seen on the desert bushes. The lizard has a gray coloration with a hint of white on its abdomen; the tail is orange in color. However, this color changes if the animal is disturbed. The throat sac transforms into blue and greatly distends, giving the lizard its distinctive appearance.

Among the snakes are common sand snakes (*Sammophis schokari*) which are the most common snakes in Arabian deserts. They can move as fast as 16 km/h, and hide between herbs and bushes, feeding on small mammals, birds and other reptiles. If provoked, they produce a loud hissing sound and they have been named hissing snakes. The islands also support small numbers of rat snakes (*Goluber ventromaculatus*), sandy pale brown snakes with black or brown bands on the head commonly found in burrows, between rocks and vegetation. They feed on mammals such as mice, and move very fast while holding the head upright.

The short-nosed lizard *Mesalina brevirostris* and a rock gecko *Pristurus* sp. have also been found on the islands. One additional gecko, a species of *Hemidactylus* house gecko, has also been reported around the hotel on Jazirat Hawar, presumably being a recent accidental import.

Although there is currently only sparse data on terrestrial reptiles, none of those species confirmed as present is regarded as threatened within their known regional ranges, or even within Hawar. A degree of academic and scientific (evolutionary biological) interest may lie in the observation that different color morphs of certain of these species occur on different islands within the Hawar group, meriting further study.



4.10b Invertebrates

There is only limited information currently available on the terrestrial invertebrate populations of Hawar, although there is nothing to suggest either the presence of any rare species or any degree of threat to those that are known. Further work by professional entomologists is nonetheless recommended, regardless of the success or otherwise of the pending biosphere reserve nomination.



4.11 Terrestrial and Inter Tidal Flora

A rapid assessment of the flora of some of the islands of the Hawar Archipelago has been conducted in January 2003. Unfortunately, the survey followed a long period of drought, and therefore only a small number of perennial plants (15) was recorded, whereas Al-Eisawi conducted a systematic survey and counted a number of ca. 120 species for Hawar (King pers. comm.). The differences of the survey results can be attributed to different survey methods and duration, survey sites, and above all, different meteorological conditions, especially precipitation.

The species recorded during the present survey, however, very well represent the major salt marsh types of the Gulf (*Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Halopeplis perfoliata*, *Suaeda vermiculata* and others), as well as the characteristic floristic landscape elements of the Gulf of Salwa region, such as *Zygophyllum qatarense*, and *Lycium shawii*. Overall the vegetation of the locations visited is rather homogeneous in species composition. Many of the islands show a typical vegetation zonation with an *Arthrocnemum macrostachyum* population closest to the water line, followed landwards by *Halocnemum strobilaceum*, *Halopeplis perfoliata*, and *Suaeda vermiculata* zones. This pattern of vegetation provides an excellent open laboratory for environmental education and plant ecological research at university level.

The shrubs recorded during this survey are of very high ecological importance, since they are the most important inter tidal and terrestrial primary producers. They also provide habitat structure for wildlife, feeding habitat and shelter for species, such as birds, spiny tailed lizards and other terrestrial reptiles, cape hare, and invertebrates, and they provide building material for nestings birds, such as osprey and other species.

From the economic point of view, there is currently an increasing international attempt to utilise halophytic germplasm for agricultural biosaline cash crop production, and habitat restoration. Many of the below mentioned halophytes are tolerant to seawater, and salinities above seawater, and have a high potential for saline cash crop development. Protection of this halophytic diversity is highly recommended for ecological and economic reasons. In this context Hawar has to potential to function as a reserve for biological diversity protection.



It is now important to conduct detailed studies into the flora and vegetation, including species lists, and maps, which are essential parts of habitat monitoring and management plans.

Another interesting point worth mentioning is the abundance of lichens throughout the survey area. Hawar's lichens diversity, as well as the ecological importance of lichens received no or little attention, and it is recommended to conduct a study into this ecosystem component. The below table (Table 3.) provides information on dominant perennials on individual islands of the Hawar Archipelago.

Table 3.: Dominant perennial plant species on individual islands of the Hawar Islands.

	Rubud Ash Sharqiyah	Jazirat Bu Sudash	Jana Biah	Umm Haswara	Sawad Al Shamaliyah	Hadiyat North	Hidd Al Theeb	Bandar Nakhla
<i>Aeluropis</i> sp.								X
<i>Anabasis setifera</i>				X	X			
<i>Arthrocnemum macrostachyum</i>	X	X	X	X	X	X	X	X
<i>Cassia italica</i>								X
<i>Cistanche tubulosa</i>	X	X	X			X		
<i>Halopeplis perfoliata</i>	X	X	X	X	X		X	X
<i>Halocnemum strobilaceum</i>	X	X						X
<i>Limonium axillare</i>		X		X	X		X	
<i>Lycium shawii</i>								X
<i>Phoenix dactylifera</i>								X
Poaceae sp.								X
<i>Salsola cyclophylla</i>				X				
<i>Salsola drummondii</i>			X		X		X	X
cf. <i>Sporobolus iocladius</i>					X			
<i>Suaeda vermiculata</i>	X	X	X		X	X	X	X
<i>Zygophyllum qatarense</i>				X				



4.12 History

Activities over the last 7,500 years in much of the Gulf, since the beginning of the Late Stone Age have led to the alteration of much of the original and natural coastline. The islands of Hawar have escaped such interference and development due to a lack of surface water or aquifers, ensuring that human influences (despite widespread evidence of anthropological activities across the islands) remained at a minimal subsistence level. The isolation of the islands became final with the total abandonment of the tribal subsistence settlements to nature in the late 1960s.

Extensive physical remains of sophisticated surface water collecting systems, the age and origins of which have yet to be determined, are common throughout the islands. The need for such systems can be contrasted with the main island of Bahrain, where numerous aquifer-fed natural wells, and consequent plentiful supplies of easily-accessible freshwater, gave rise to the great civilization of Ancient Dilmun ~4000 BP. Physical archaeological evidence on the islands suggests that human activities on Hawar changed little with time and the water collection systems reflect a cultural aspect of Bahrain's distinctive archaeological history that was previously unknown. The undisturbed and distinctive nature of Hawar's historical sites from the Late Stone Age period, pre-Dilmun, to the late Islamic periods, despite recent military activities, give it a previously underrated importance and significance.

A more complete isolation for all but the main island occurred in the modern era as political circumstances further isolated the islands. The recent boundary dispute between Qatar and Bahrain, ensured an element of protection and provided ideal conditions for the preservation of nature and archaeological remains, given that the archipelago was a virtual closed military area during the (recently concluded) period of dispute.

Little documentation remains of the vibrant subsistence economy that once characterized Hawar, even though the settlements were abandoned within living memory. The first detailed survey of the islands of Hawar appears to have been undertaken by the British East India Company (Honorable Company Marine) in the 1820's, at which time they were called Warden's Islands, with the largest island named Al Howakh (Hawar). That survey reported two fishing villages on the islands, while a third is located halfway down the western shore of the main island. The most obvious signs of this recent chapter of Hawar history is found by way of the ruins of the old villages, the graveyards and the surface water collection systems. The best preserved is that on the shore of the northern circular bay of Dawhat Hawar. Several buildings which were refurbished in recent times, including an ancient Mosque, still survive. Associated with this village is a small hunting lodge built in the 1930-40's for the ruling family.





Rock carvings made with exquisite precision dot the hillocks (jebels) of Jazirat Hawar. The preservation of such evidence, of past cultures linking modern-era Bahrain with its historic civilizations and heritage, will open windows to the past through which we may better understand the origins, culture, traditions and folklore of the Bahraini people.

On the eastern shore of the main island, the only evidence of a permanent settlement is found close to the shore under the escarpment face north of Dawhat Al Naklah. Associated with this small village or extended family unit are a number of water cisterns, a millstone, a wadi dam and several cemeteries. Facing eastwards, it is most probable that this community in particular made full use of all the natural resources of Hawar, including birds and their eggs as well as exploiting shellfish and fish stocks. Evidence exists that both dugong and turtles were hunted and eaten by the village communities on Hawar, as were the eggs of Socotra cormorants. The size of the buildings and pottery shards (pieces of Chinese or other Oriental salt-glazed porcelain at this site indicate that a higher level of affluence was also attained here than at other settlements.

A small number of prehistoric (Late Stone Age) sites have been identified, particularly on the main island of Hawar, but the continuous historic use of the same natural resources has probably resulted in the loss or deterioration of other remains as a result of more recent human activity. The date and origins of the surface drainage system on Hawar are unknown, and comparisons with any local Bahraini or Qatari feature are not available. In Bahrain, the ancient Dilmun civilization developed around a plentiful supply of water, whereas



Qatari culture is based on a nomadic herding economy, as well as fisherfolk. Extensive water catchment systems of a similar nature have, however, been identified on many of the islands of Abu Dhabi, United Arab Emirates, stretching from the city of Abu Dhabi westwards towards the Qatar peninsula. Interestingly some pottery shards collected on Hawar were tentatively identified as originating in what is now the United Arab Emirates, along with other pottery shards probably originating on Bahrain.

Besides existing on a traditional subsistence economy, the islanders were also actively engaged in the pearling industry, although to what extent is not known. Nor has any date yet been ascribed to the commencement of the industry on the islands, although evidence from elsewhere in the Gulf suggests that it may have commenced as early as the Late Stone Age. The mining of gypsum also occurred on Hawar and appears in references to the islands during the period of British protection. Evidence of such mining activity have yet to be found on the islands but many of the traditional homes of families who were formerly associated with Hawar but who now reside on the main island of Bahrain are said to contain elaborate ceiling designs made from Hawar gypsum.

The physical isolation of the islands became more acute for its people in the late 1960's, when facilities such as healthcare and education were nonexistent. As motorized fishing boats became more readily available, the people of Hawar abandoned their settlements and moved to the fishing villages of southern and western Bahrain, so that by the time of Independence for Bahrain in 1971 no people remained on the islands.

The garrisoning of Hawar by the Bahrain Defense Forces resulted in the establishment of a permanent headquarters in 1984, complete with Hospital, power station, water desalination plant and deep-water jetty. The Hospital now provides medical services for the military and all visitors to the island. The power station is powered by diesel generators and has sufficient capacity currently for all the islands' needs. The deep-water jetty is used by Hawar ferries, which transport people to and from the mainland. Potable water is scarce as the flash plant produces insufficient for all current needs, and additional supplies are barged in on a regular basis. Deep exploratory water wells have recently been bored, although these found only extremely saline aquifer water.

4.13 Major Human Uses

4.13a Tourism

Tourism is a major source of visitors to the island. The peak tourist season is generally from May to November, with rises during local school holidays. Eighty five percent of visitors to Hawar are Bahrain Nationals. The Hawar Resort Hotel recently reported receiving 17,500 visitors a year. Booking records are minimal for the northern chalets; with estimates of chalet use from 4000 to 6000 persons per year.



4.13b Military

Until recently some 5000 troops were stationed on the Hawar Islands to deter landings by foreign illegal immigrants. With the recent conclusion of the border dispute with Qatar, these forces have been cut back to less than 2000, with their associated equipment and supplies.



4.13c Science and Conservation

The islands are used by staff from the National Commission for Wildlife Protection and foreign scientists to study resident and migratory birds, and plans are underway to develop further research programs based on the marine ecosystems, and educational activities involving the Youth Science Center and the local University.

4.13d Fishing and other Resource Extraction

Bahrain has some 400 registered fishing dhows, which have mostly over-tapped the local fishery resources. At present many of these vessels are not operating, and most fishing around the Hawar Islands is via artisanal methods by indigenous fishing groups. To the north but outside of the protected area lie the commercial shrimp trawling grounds.

4.14 Archaeological Heritage

Several short expeditions to the Hawar Islands have revealed a surprisingly diverse array of ancient remains. In 1995 Paulo Costa (University of Palermo) and Khalid Alsendi (Bahrain National Museum) visited the main island for one day, during which they found six cemeteries (including one for children), dams, water cisterns, gypsum quarries, ancient mosques and prayer walls. In December 1998 a four-day survey by Ernie Haerinck and two colleagues from the University of Ghent recorded some 40 sites on the main island, covering a period of around 6000 years. In October 2000 Peter Hellyer and Simon Aspinall (Abu Dhabi Islands Archaeological Survey) made a two day visit to Hawar and the smaller islands of Rubud Ash Sharqiyah, Jazur Al Hajiyat, Umm Hazwarah and Suwad Al Janubiyah, finding several more sites. Over three days in January 2003, Clare Gillespie and Sarah Wood visited a number of sites on Jazirat Hawar and Umm Hazwarah, Suwad Al Shamaliyah and Jazur Al Hajiyat, with staff members of Bahrain's National Commission for Wildlife Protection. To date, no archaeological excavations have taken place on the Hawar Islands.

Despite the increased presence from the military and other developments, minimal disturbance appears to have befallen the archaeological sites on the main island, and none to sites on the outlying islands. The archaeology of the Hawar Archipelago is therefore unique in being virtually undisturbed, and is worthy of further investigation.

The islands at first sight appear barren and little suited for human habitation, being devoid of natural groundwater, this being, in turn, reflected by limited vegetation growth. However there exist an extraordinary variety of remains, indicating a human presence over many millennia. Lack of fresh water must



have presented serious hardship, even when, until around 4,000 BP, the climate was wetter than at present, but remains reveal that the islands' inhabitants were remarkable ingenious in collection and storage of rainfall. On the two jebel areas on the main island of Hawar, deliberately enlarged natural striae in the surface, possibly dating to prehistoric times, lead downwards to sites where water could be collected. All over the main island are large water cisterns and delivery channels. The geomorphology of the east coast of the Jazirat Hawar consists of indentations and bays backed by low, sandy limestone cliffs and raised beach deposits of the Early Holocene period, many of which form the locations of prehistoric camp sites. There are also two regions of soft sandstone jebel, formed by cemented dune sands, which weather into cavernous holes (trefoni), many being sites rock carvings. Such rock carvings are difficult to date, but some, at least, may be prehistoric.



A single large circular grindstone, bearing the engraved name Rashid Sad, lies near the beach not far from an ancient settlement at the southwest of Jazirat Hawar. It is unlikely that the villagers ever grew cereal crops, especially as water was precious on Hawar. The presence of this grindstone is as yet unexplained.



Contemporary records of the Hawar Islands date back to 1783 when, after the defeat of the Persian garrison on the main island of Bahrain by the Al-Khalifah clan (who had moved there from their home in Zubara on the NW coast of Qatar), a branch of the Dowasir tribe from Saudi Arabia petitioned the ruler of Bahrain for permission to settle on the Hawar Islands. The request was granted by the Qadi of Zubara, the highest-ranking official of the Al Khalifah government. In 1845 the Hawar Dowasir were invited to settle in Bahrain by the ruler, and established the villages of Budaiya and Zellaq on the west coast. Thereafter they appear to have commuted between the Hawar Islands and Bahrain, spending the five month pearling season in Bahrain and the remaining months in their villages, pearling, fishing, hawking and collecting sea birds' eggs. As well as the traditional activities of fishing, pearling and hunting, gypsum quarrying provided a source of income to the seasonal inhabitants of



the islands. Carved gypsum from Hawar was used to face houses and palaces such as the residence of Sheikh Isa bin Ali, constructed on Muharraq in 1800.

Captain George Brucks, a British Navy Officer, commissioned by the East India Company to survey the Gulf coast from 1821 to 1829, comments on the Hawar Islands (named the Warden Islands on British maritime maps), that, ‘The principal (island) is called Al Howahk...it has two fishing villages on it and belongs to Bahrain.’ In 1908 JG Lorimer published his Gazetteer of the Persian Gulf, in which he stated, ‘The main island of Hawar is about ten miles long, north and south, and roughly parallel to the Qatar coast. There are no wells but there is a cistern to hold rainwater built by the Dowasir of Zellaq in Bahrain who have houses in two places on the island and use them in winter...’. A report in the following year by Captain Prideaux (the British Political Agent in Bahrain) confirms this, stating that ‘the Dowasir of Budaiya and Zellaq in Bahrain are in the habit of every winter partially migrating to the Howar Islands for fishing... and hawking.’ He also refers to the two villages established on Jazirat Hawar.

The last inhabitants of the coastal villages left as recently as three to four decades ago, and there are still elderly people living in Bahrain who can recall their youth in the Hawar Islands. Nasser bin Makki Al Dosari, who was born on Jazirat Hawar in 1922, said, ‘When I was young, I used to help the guards of the islands before the police fort was built...we would check that the gypsum cutters who used to come from the main island of Bahrain had a valid permit...’. Other elderly people, Hamoud bin Muhanna al Dosari, born in 1920, and Abdullah bin Ali Al Dosari, born in 1924, recalled that people used to go to Bahrain for about five months for the pearling season, and spend the remaining seven months inhabiting their villages on Jazirat Hawar.

4.14a Settlements

Five villages and smaller settlements of the more recent Islamic period have been identified on Jazirat Hawar, (the main island of the group), with rectangular stone-built houses and mosques, one of which is still in good condition. Some houses have walls up to roof height and beams still in place. A settlement on the south-east coast, apparently abandoned some considerable time ago, may well be one of the villages observed by Captain Brucks in the 1820s. It has a number of ashy middens between the buildings and the beach, yielding a variety of shells including the hinges of very large pearl oysters *Pinctada radiata*, and a range of eighteenth and nineteenth century potsherds including Chinese ceramics, and fragments of Indian glass paste bangles.

4.14b Water Catchment

There are several large, deep cisterns on Jazirat Hawar and evidence of a water-catchment system on Umm Hazwarah. The cisterns have small, shallow channels to drain water into them from the gullies, which ran towards the coast. All are still in good condition, stone-lined and plastered, with steps, usually of concrete blocks, on the inside. They show signs of recent maintenance, but may be of some antiquity, as, with regular maintenance they could have lasted for many generations. One open cistern has a second, covered tank divided from it by a low wall containing an opening in which a simple filter could have been



fitted. On the north-eastern side of the jebel outcrop nearest the resort hotel is a cistern of a different type, ca. 2 m in diameter, filled with sediment but still about 5m deep. It would have collected water running off the rock surfaces nearby.

4.14c Rock Carvings

The long jebel south-east of the hotel and another rocky outcrop on the north-east coast of Jazirat Hawar has numerous rock carvings. They closely resemble the carvings occurring on the mainland of Qatar on nine major sites around the northern half of the country, eight of them coastal, and as isolated instances on other smaller coastal jebel outcrops. On all these sites there are shallow, circular cup-marks, either single or in pairs or in configurations of double rows of cups, usually seven in each row but sometimes more, and 'rosettes' of nine cups surrounding a larger central cup. Associated features are narrow, oval shapes, which have been interpreted as footprints. The carving sites on Jazirat Hawar contain several examples of the parallel rows of cups, seven in each row, plus numerous isolated shallow holes and several instances of three small holes arranged in a triangle, a pattern which is not known to occur in Qatar. The north-east jebel on Jazirat Hawar also has two examples of the nine-cup rosette formation. Footprint carvings, always in pairs, occur on both jebels.

Of great interest is the presence on the two Hawar jebel outcrops of numerous carvings of boats, as these are known on only one site in Qatar, that at Al Jusasiyah. Many of them very closely resemble some of the Al Jusasiyah carvings, depicting lozenge-shaped vessels, pointed at both ends. Such boats, known locally as badan, are known to have been in use for inshore fishing in the Gulf until the end of the nineteenth century. Unlike the Qatari carvings, none have banks of oars. They range in length from 7 cm to an astounding 2.14 m, and in one group, on the jebel south-east of the hotel, there are 23 vessels, all aligned along the natural direction of the rock surface, as in the Al Jusasiyah carvings. The smallest trails a rope with a triangular stone anchor clearly depicted. Such anchors, either triangular or circular (known as sinn in Arabic) were in use in the Gulf for many thousands of years.

The carvings have clearly been made over a long period of time, although they cannot yet be assigned a date or dates. Some of the boat carvings on the south-eastern jebel are so worn and faint they are hardly visible except when the sun is at a low angle. Others look comparatively recent and appear to have been made with metal tools. Some boats depicted on the north-eastern jebel appear rather more recent and are placed across the natural line of the jebel.

4.14d Ancient History

Dating such carvings is difficult in the absence of associated stratified remains, and comparative studies form elsewhere in the region. Haerinck considers them as Neolithic (Late Stone Age), and this is a possibility, especially as camps of this period, probably dating back 6000 – 7000 years, are located at the foot of the jebel. The carvings are all at the southern end, above the camp sites. However, the very similar boat carvings at Jebel al Jusasiyah in Qatar and the configurations of cup marks on that and other sites are not associated with Late Stone Age settlements, and have not yet been assigned a date. A number of sites



containing small, oval, graves made of stone slabs without a covering mound have been identified on the main island. Lacking the conventional Muslim orientation, they are presumed to be pre-Islamic, but, in the absence of excavation, no date can be assigned to them. Similar groups of burial cairns, some containing over a hundred tumuli, exist on the nearby Ras Abaruk Peninsula on Qatar's western coast.

Elsewhere on the islands of the Hawar Archipelago, a number of stone hearths, collapsed stone mounds (possibly pre-Islamic burials) and other collapsed stone structures have been identified on the island of Suwad al Janubiyah. The hearth structures are similar in type to many hundreds that have been found on the islands of Abu Dhabi, several of which have been dated through radiocarbon dating. A wide variety of dates has been obtained from these Abu Dhabi hearths, ranging from the Dilmin period, (ca. 4000 BP, 2,000 BC) to the Late Islamic period, and the Suwad al Janubiyah sites may lie anywhere within this lengthy period. Radiocarbon dating is required to determine their age.

Collapsed stone structures, as well as water catchment systems, have also been identified on Umm Hazwarah, which, again, cannot be dated from surface evidence, while pottery shards, of a probable Late Islamic date, have been noted on the low-lying island of Rubud Ash Sharqiyah as well as on the southernmost of the three islands known as Jazirat al Hajiyat, where they were in association with a collapsed structure.

It is clear from the wealth of sites identified on brief visits to the Hawar Islands by archaeologists over the past seven years that human activity has continued, perhaps intermittently, over many thousands of years. Future excavations should reveal more about the way of life of the islands' inhabitants.



Far from being devoid of color, the desert islands of Hawar offer a true kaleidoscope of flowers and root parasites which contrast richly with the earthen tones of the sandstone islands. It is minute distractions such as these, which highlight the unseen yet ever-present importance of the archipelago.

5. POTENTIAL PRESSURES - HAWAR ISLANDS

The seas around Bahrain contain complex and unique tropical marine ecosystems, especially coral reefs and seagrass beds, with high biological diversity and many endemic species. These habitats are surrounded by some of the driest land in the world, such that continental influences are limited. However, these waters are also major shipping lanes due to the major supplies of petroleum products, with a high-risk bottleneck at the narrow straits of Hormuz. While parts of the region are still in a pristine state, environmental threats (notably from habitat destruction, over-exploitation and pollution) are increasing rapidly, requiring immediate action to protect the region's coastal and marine environment. Traditionally, the people of Bahrain used to protect marine habitats and prohibited hunting during specific months of the year. They also developed types of protected areas, which were known as *Mahmiya*, even before the establishment of Islam. These protected areas were well established and managed, an early predecessor to today's concept of sustainable development.



5.1 Fishing

The use of gillnets throughout the region damages coral reefs and other marine ecosystems. Industrial fishing results in large bycatches that include turtles, dolphins and non-commercial fin-fish. At a national level, there is a lack of surveillance and enforcement of existing regulations. Over-fishing of most fish species is evident in many areas, and this may also be having secondary effects by removing predators (families Lethrinidae, Balistidae and Tetradontidae) thereby catalysing outbreaks of the crown-of-thorns starfish which is a serious problem in the region. Artisanal fisheries use illegal gears (e.g. monofilament nets, spearguns) that damage the resource and its supporting habitats. Damage to marine habitats by discarded or lost fishing nets is a major threat. These nets, and especially 'active' nets, are also a very significant threat to marine megafauna, particularly marine turtles and cetaceans.

The use of traditional pots for fishing often results in lost pots which continue to be a hazard to fishes (ghost pots), and regulations are needed which will ensure the breakdown of the pots over a period of time so that any caught fish will be able to escape.

5.2 Petroleum and Mineral Exploration and Production

Oil pollution comes from both production and transport, and many millions of tons per annum pass through the Gulf. There have been numerous oil spills that have affected the Gulf coastline. Chronic contamination is common from the oil terminals and tankers. Medium sized spills from ballast and bilge water discharges, and leaks from terminals cause localized damage and smother intertidal habitats. At a regional level, few ports have reception facilities to collect oily wastes and the problem will continue mostly through a lack of enforcement of existing regulations, and there is inadequate control and

monitoring of procedures, equipment and personnel and training. The potential exists for large oil spills and disasters from oil tank ruptures and collisions at sea. There have been at least three major hydrocarbon spills in the Gulf in the past two decades that have been coincident with mass marine mammal mortality. Other activities associated with hydrocarbon exploration / production also threaten marine life (e.g. seismic surveying).



The Hawar Islands have been the subject of oil exploration in the past, and scattered test wells continue to be drilled in the buffer zone. Between 1939 and 1960 a series of exploratory surveys and drillings were undertaken culminating on February 25th 1961 with the drilling to a depth of 8,200 ft of well 'Hawar No. 1' on Suwad Al Shamaliyah. It turned out to be a dry hole with only trace amounts of oil being found.

5.3 Tourism

A potential environmental hazard exists in the form of unregulated tourist access to the islands. Historically this has not exceeded the carrying capacity of the islands, but with scarce fresh water availability and the concomitant development associated with tourist influxes, a measure of control will be needed if the islands are to survive in their natural state.

Between 1986 and 1988 around 100 recycled prefabricated chalets were moved to two sites on Hawar (in the north around Dawhat Hawar Bay and at a southern location, now the site of the Hawar Resort Hotel). The site occupied by the southern chalets was further developed in 1996 with the addition of the small 40 roomed Hawar Resort Hotel and four two-story self-catering apartment blocks. Visitors to both the hotel and the northern chalets are currently restricted to the hotel or chalet grounds other than bus trips along the single tarmac road joining the two sites. In 1998, another 40 Ministry of Housing units were built as part of a development plan. Conceived to be the nucleus of a new community on Hawar; the completed units currently remain unoccupied.

In 2001, a 4-meter deep-water channel was completed, dredged through the rocky substrate on the western shore of Hawar. A substantial rock-armored jetty was constructed to service the new channel. Material cut from the channel was used to create the jetty and two artificial islands, stated at the time to be temporary. The future environmental consequences of the design of the jetty on ongoing coastal processes will likely need considerable address.

5.4 Pollution

Pollution exists in a number of forms. Flotsam and jetsam litter nearly all beaches, washed in through the natural geological funnel that is the Gulf of Salwa, and conforming with predominant Gulf current gyres. This litter, if left to accumulate, threatens to overshadow the natural productivity of the coastal vegetation and other ecosystems, and is detrimental to the aesthetic values on which much of Hawar's value is based.



An open-fill solid waste pit located close to the eastern shore is not only unsightly but also poses a physical threat to birds and a health threat to humans. Plastic and nylon string wastes can be ingested by birds, or they can become entangled while foraging. Uncovered decomposing refuse poses a health hazard to all who come in close proximity with the disposal site, and efforts should be made to regularly dispose of waste in more conventional manners.

Most sewage is discharged untreated or partially treated into nearshore waters and often directly into sensitive marine habitats off major urban areas. There are virtually no sewage treatment plants in the region, and existing plants require regular maintenance, and continuous damage is occurring to coastal habitats because there are inadequate pollution control regulations, monitoring and enforcement. Algal blooms have been reported as a result of sewage discharges. Domestic sewage is currently only partially treated, if at all, and potentially could contaminate the limited local groundwater sources, and the surrounding environment.



5.5 Desalination

There is extensive use of desalinated water to meet demands of the population and industry. There are numerous desalination plants operating along the Gulf coastline which discharge hot brine and maintenance chemicals (chlorine and anti-scalants) directly near seagrass beds. Power stations also discharge saline high-temperature water that result in temperature and salinity increase in surrounding waters causing localized coral bleaching and mortality, and contamination of other marine ecosystems.

5.6 Land-Filling and Dredging

Extensive coastal development, including dredging and filling, is destroying large tracts of shallow marine habitats around Bahrain. To an extent these activities have also taken place on a smaller scale, but if these were to continue damage to Hawar's marine ecosystems could be irreversible. Sedimentation for instance, which smothers delicate marine ecosystems, is an invariable result of poor construction, dredging and land reclamation (land-filling). Urban, industrial and port development coupled with inadequate environmental planning, and little or no environmental assessment near developed areas is severe. There is generally a lack of management, awareness, and enforcement of regulations, which often results in physical damage to marine habitats through ignorance or willful neglect. Coastal development has caused the loss of important habitats in recent years, especially from road, port/harbor, hotel and heavy industry construction. Further development plans for Hawar could threaten even greater and more pristine areas.



5.7 Introduced Species

Several terrestrial species have been introduced to the Hawar Islands as part of uninformed wildlife restocking plans. These animals have replaced domestic

goats and have become a dominant force within terrestrial ecosystems. Of the introduced species, only the Addax is not a truly Arabian species, and it is possible the other species roamed the islands during ancient periods characterized by lower sea levels. Among these is the introduced cape hare (*Lepus capensis*), a burrowing nocturnal animal characterized by its long ears. The long ears are significant in cooling down the body temperature by providing moisture. They are also used as a sensing device to avoid any danger. The body is covered by pale sandy brown soft fur mixed with black coloration. The animal benefits from the hair that grows on its feet while running on the sand at a speed of up to 70 km/h. Major introduced species include the following:



5.7a Arabian oryx (*Oryx leucoryx*)

This is one of the native animals of the Arabian Peninsula, and which enjoys a special status among the Arab people. The Oryx is silvery white and inhabits open desert areas. It has brown legs with black hoofs, and the tail is black and its face has specific black marks extending down to the lower part of its neck. It has two long horns reaching up to 90 cm. The female gives birth to a single calf each time, and the resulting newborn is sandy brown, between 137 - 177 cm in length, and weighing between 120 – 130 kg.



5.7b Nubian ibex (*Capra ibex nubiana*)

The Nubian ibex inhabits mountainous desert areas in the middle east region. It feeds on wild herbs and characteristically has short, strong and muscular limbs with rubbery hooves. The male has long curved and strong horns up to one meter in length. Males are also characterized by possessing beard and a black stripe on the dorsal side opposite to the chest area. The body is covered by reddish brown hair. This color takes different shades depending on different habitats and the color of the background. The body length reaches between 110 – 150 cm and weights range from 45 to 75 kg.



Nubian Ibex



5.7c Arabian Rheem Gazelle (*Gazella sugutturosa marica*)

The Rheem is one of three Gazelles of the Arabian Peninsula (the other two are the Al Admy and the Al Efy). The Rheem differs from other species by inhabiting sandy parts of the desert and thus is known as a sand gazelle. They are small gazelles, pale sandy white and with two curved horns. The inner side of legs and abdomen are covered with bright white hair, and their height rarely exceeds 60 cm. The body is generally 100 – 120 cm in length and the weight ranges from 15 to 28 kg.

5.7d Addax (*Capra nubiana*)

A large wild animal, closely related to the Arabian oryx but originating from Tunisia, and reaching up to 105 cm in height. It has long curved and wavy horns up to 90 cm in length. Physical characteristics include a black spot on its forehead and nose, whereas the rest of the body is white. In the winter, the body becomes covered by dense brown hair covering its shoulder and dorsal side. Typical Addax weigh between 80 - 120 kg.



Highly curious after many years of protection on the Hawar Islands, the Arabian-origin Gazelles often approach visitors and vehicles on Jazirat Hawar, where they roam freely. Replacing the domestic sheep and goats, the gazelles are active grazers on the main island and their numbers will need to be controlled to prevent over-harvesting of the natural floral resources.



6. MANAGING THE HAWAR ISLANDS PROTECTED AREA

This section of the plan outlines in brief how the protected area is to be managed as required under National Protected Area Management guidelines. Future drafts should outline the management goals and management strategies for the Hawar Islands Protected Area. The management goals and strategies will derive from the requirements of national legislation and Royal decrees, the strategic objectives for the Protected area (Section 3), and an analysis of the potential pressures on the key values of the area (Section 5). The values and major uses of The Hawar Islands Protected Area are described in Section 4.

Because of the high degree of ecological interaction between the mainland Bahrain waters and the protected area components, and the fact that The Hawar Islands Protected Area encompasses large, complex marine ecosystems, the management of The Hawar Islands Protected Area should follow a cooperative and ecosystem-based management approach.

6.1 Conservation of Biodiversity

The key ecological values of The Hawar Islands Protected Area are the rich and extensive seagrass communities, assemblages of endangered dugongs and green turtles, demersal fish and shrimp, in addition to the valuable extensive and varied avifauna. Currently little is known about the benthic communities. There is a regular use of benthic systems for feeding and as a habitat for reproduction of endangered marine fauna, with a continuous movement of water and animals in and out of the Gulf of Salwa and the nearer shore habitats of both the national and Hawar Island waters. Of particular note for management purposes are the large marine mammals, marine reptiles and sea birds, most of which are endangered or vulnerable fauna. The marine benthic flora and fauna of the marine habitats are of scientific interest due to the presence of some of the best seagrass pastures known to science. These habitats have not been systematically studied. Management of the Hawar Island Protected Area waters would benefit from increased knowledge about the ecosystems and ecosystem functioning of these waters including further study into the geological history of ecosystems of the protected area that have influenced current ecological processes.

The major potential or existing human-induced pressures on the ecological values of the Hawar Island Protected Area waters include: any activity which negatively impacts on the water quality; fishing activities which impact on populations of fish and non-target species; destruction of habitat by trawling; tourism where there are inappropriate interactions of humans with marine fauna; entanglement in and ingestion of litter; predation or competition from introduced species; alteration of terrestrial and marine ecosystems through land-filling and dredging, and some aspects of exploration and extraction of petroleum and minerals including seismic surveys.

Natural processes can also have major effects on the biodiversity of the region. Major natural processes such as extreme sea surface temperature fluctuations



are known to cause great local habitat variation and rapid change. Large fragments of living coral reef are known to have been lost due to bleaching during such events, for instance. It must be noted though that natural cycles promote high levels of biodiversity by producing local environmental heterogeneity (Meffe et al. 1997).

6.1a Management Goals — Conservation of Biodiversity

1. To apply ecosystem-based management to The Hawar Islands Protected Area;
2. To ensure that the abundance and species diversity of marine communities and ecosystem processes in the protected area waters are not adversely affected by human activities;
3. To promote the maintenance of the high water quality required to sustain the marine communities and habitats of the Hawar Islands Protected Area;
4. To foster broad community stewardship, and commitment to the protection, of the diverse values of the protected area, and;
5. To increase the knowledge of marine communities and species and key ecological processes in the Commonwealth waters.

6.1b Management Strategies — Conservation of Biodiversity

1. To work with the Bahraini Government agencies in the integrated planning and management of the Hawar Islands ecosystems;
2. To restrict and prohibit activities inconsistent with the maintenance of biodiversity, habitat, ecosystem structure and function;
3. To support the improved management of recreational fishing by the Department of Fisheries;
4. To provide educational material aimed at promoting an awareness of the ecological values of the protected area, promoting community stewardship and reducing the impacts of human users on the marine communities of the protected area waters;
5. To encourage research to increase knowledge of marine species and communities and ecosystem processes, and;
6. To investigate the possible establishment of sanctuary or “no take” zones in the Commonwealth waters during the period of this plan.

6.2 Commercial and Recreational Fishing

Commercial fishing has historically been limited to shrimp fishing and a limited amount of fin-fish fishing in the waters of the Hawar Islands Protected Area (see section 4.12d). The potential impacts of commercial fishing on the ecological and physical values of the protected area waters should take into consideration that actions generally should not be taken for commercial



purposes in the protected area except in accordance with a management plan for said area.

This management plan should ultimately endorse that commercial fishing will no longer be permitted in the Hawar Islands Protected Area save for recognized artisanal fishing by indigenous fishermen.

6.2a Management Goals — Commercial Fishing

1. To eliminate the current and potential impacts of commercial fishing on the ecological values of the waters of the Hawar Islands Protected Area.

6.2b Management Strategies — Commercial Fishing

1. To exclude commercial fishing from the waters of the Hawar Islands Protected Area with the exception of recognized indigenous fishermen using artisanal fishing methods.
2. In cooperation with the Department of Fisheries, develop a coordinated compliance and enforcement regime for commercial fishing in the buffer zone to the Hawar Islands Protected Area.
3. To monitor the incidence of fishing traps (gargoor) lost within the Hawar Islands Protected Area. In association with the relevant fishing industry associations, the National Commission for Wildlife Protection should develop codes of conduct and procedures for retrieving ghost traps as appropriate.

While recreational fishing is currently a minor activity within the Hawar Islands Protected Area, with the development of tourism it is envisioned there will be a concomitant increase in pressure on marine ecosystems from the recreational fishery. Recreational fishing will probably remain family-oriented, and it is doubtful it will achieve commercial-operator status. Recreational fishing can potentially impact the ecological values of the protected area particularly through reducing populations of target and non-target fish species and increasing litter.

National regulations should specify the methods of recreational fishing permitted in protected areas. These might include the use of a line and baited hook or lures. Spear-fishing should generally not be allowed without a permit. The NCWP should be in a position to make determinations relating to recreational fishing in the protected area waters, and the Secretary General should do so if considered necessary during the life of this plan. Legislation is required which prohibits activities in relation to native species (including fish) e.g. killing, injuring or taking; except in accordance with this management plan.

6.2c Management Goals — Recreational Fishing

1. To minimize the potential negative impacts of recreational fishing on ecological values in the Hawar Islands Protected Area.
2. To allow recreational fishing in the Hawar Islands Protected Area waters consistent with the conservation of the values of the Hawar Islands



Protected Area. (NCWP should take a precautionary approach on this issue).

3. To improve individual responsibility and support for sustainable fishing through education programs and capacity building of Bahraini nationals and foreigners alike.

6.2d Management Strategies — Recreational Fishing

1. To allow recreational fishing in the Hawar Islands Protected Area in accordance with any provisions made through the NCWP, including any individual and unique determinations made by the Secretary General.

2. With the Department of Fisheries, to reduce impacts of recreational fishers, through restrictions such as bag and possession limits and prohibitions on sale.

3. To support education programs targeting recreational fishers. These should be aimed at reducing the environmental impacts of recreational fishing and promoting community stewardship of fish and the marine environment.

5. In consultation with the Department of Fisheries, to carry out monitoring of recreational fishing activities in the protected area waters to assess the impacts and sustainability of recreational fishing (e.g. through the use of the log books of charter operators). Should there be indications of significant biodiversity impacts from recreational fishing, the NCWP should consider further management options, which may include appropriate restrictions.

6.3 Petroleum and Mineral Exploration and Production

The Gulf is a major area for oil and gas production and exploration and the Gulf of Salwa is considered as prospective. Offshore and onshore exploration has been carried out within the protected area prior to its establishment and has continued in areas adjacent to it.

As described in section 5.2, petroleum exploration and production activities have a potential for negative impacts on the marine environment. The management goals and strategies for petroleum and mineral activities relate to minimizing potential impacts on the Hawar Islands Protected Area waters from activities in the vicinity of the protected area. Consistent with this first draft of the management plan and the categorization of the Hawar Islands Protected Area as an IUCN II — National Park, mining operations should be prohibited within the protected area.

A well-balanced Management Plan for the Hawar Islands Protected Area should take into account the development pressures both at National and Regional levels with regard to petroleum extraction. This plan should be able to address the needs for exploration and extraction while using the best available practices, which preserve the natural heritage of the islands.



6.3a Management Goals — Petroleum and Mineral Exploration and Production

1. To prevent adverse impacts on the physical, ecological, social and cultural values of the protected area waters from petroleum or mining activities in the vicinity of the Hawar Islands Protected Area.

6.3b Management Strategies — Petroleum and Mineral Exploration and Production

1. To maintain the exclusion of petroleum and mineral exploration and production from Commonwealth waters.

2. To liaise with the appropriate national agencies concerning the assessment of application permits and exploration release areas in the vicinity of the Hawar Islands Protected Area.



6.4 Tourism

Tourism provides an opportunity for visitors to appreciate the physical, natural and cultural values of the protected area. The main commercial tourism activity in the Hawar Islands Protected Area comprises limited recreational fishing and relaxation / reinforcement of family values and ties. Part of the management goals and strategies for this activity are included in the section on recreational fishing (section 6.2). Other current and potential impacts of these activities include littering and an increase in domestic sewage and solid waste.

The provision of tourism activities needs to be consistent with the strategic objectives of the Hawar Islands Protected Area. The management strategies for tourism activities relate to current and possible future tourism activities in the Hawar Islands Protected Area and aim to reduce any negative impacts on the ecological values of the Hawar Islands Protected Area, in particular the avifauna and endangered large marine fauna.

As noted in relation to commercial fishing, action should not be taken for commercial purposes in the Hawar Islands Protected Area, except in accordance with this management plan. Should any commercial activity be proposed to take place in the Hawar Islands Protected Area in the future, a permit should be required from the NCWP Secretary General. The Secretary General should assess such applications taking into account the strategic objectives for the Hawar Islands Protected Area and the likely impacts of the proposed activity.

Where the activity involves a species that is protected under existing national legislation, it may also need a permit under the guidelines concerning such legislation. Where there is likely to be a significant impact on such a species, the activity may require assessment and approval by the Hawar Islands Protected Area Management Liaison Committee. Any such assessment should take into account the specific nature of the individuals, particularly as described in Section 4.8, and the precautionary principle should be applied in all cases.

6.4a Management Goals — Tourism

1. To provide for the operation of low impact tourism activities which add to the recreational and educational experience of the protected area users.
2. To ensure that tourist operations do not negatively impact on the ecological or cultural heritage values of the Hawar Islands Protected Area.
3. To ensure tourism is carried out in an ecologically sustainable manner.

6.4b Management Strategies — Tourism

1. To monitor the location and extent of tourism operations in the Hawar Islands Protected Area and investigate sustainability levels.
2. To review guidelines for human interaction with avifauna and endangered marine fauna.
3. To consider on a case by case basis commercial tourism proposals and potentially allow the activity under permit.
4. To liaise with national authorities regarding the issue of commercial tour permits as required.
5. To provide educational material and license conditions to commercial wildlife tour operators aimed at reducing any negative impacts of tourism on the Hawar Islands Protected Area.

6.5 Pollution

Pollution has been identified as a potential threat to the values of the Hawar Islands Protected Area (see section 5.4). Potential sources of pollution include major oil spills from shipping, low level oil and fuel spills, litter, flotsam and jetsam from recreational and commercial users, and sewage and other wastes from land based sources or vessels.

6.5a Management Goals — Pollution

1. To reduce potential negative impacts on the values of the Hawar Islands Protected Area from potentially polluting activities.

6.5b Management Strategies — Pollution

1. To undertake education and information programs in cooperation with other national agencies, as appropriate, aimed at: reducing litter which may negatively impact on wildlife and water quality, and minimizing the discharge of sewage and other wastes from recreational and commercial vessels.

6.6 Desalination

Effluents from desalination processes prevalent in the Arabian Gulf region have been identified as a potential threat to the values of the Hawar Islands Protected Area (see section 5.5). Potential habitat degradation could occur



through excessive hyper-saline or hot water discharges in the vicinity of the protected area.

6.6a Management Goals — Desalination

1. To reduce potential negative impacts on the values of the Hawar Islands Protected Area from desalination activities.

6.6b Management Strategies — Desalination

1. To review any current and future plans for the development of desalination infrastructure in the Kingdom of Bahrain which might impact the Hawar Islands Protected Area, and work with the relevant authorities to ensure construction and operation of said facilities is in keeping with environmental conservation standards adopted at a national level.



6.7 Land-Filling and Dredging

Land-filling and dredging have been identified as serious threats to the values of the Hawar Islands Protected Area (see section 5.6). Negative impacts include extreme siltation of marine and coastal habitats, alteration of coastal oceanographic processes, deterioration of aesthetic values, loss of productivity of seagrass ecosystems, and the potential loss of priceless cultural relics.

6.7a Management Goals — Land-Filling and Dredging

1. To eliminate negative impacts on the values of the Hawar Islands Protected Area from any terrestrial-, coastal- or marine-based land-filling and dredging activities.

6.7b Management Strategies — Land-Filling and Dredging

1. To develop legislative processes in cooperation with other national agencies as appropriate, aimed at eliminating land-filling and dredging as options for development of the Hawar Islands Protected Area.

2. To review any current and future plans for the development of infrastructure on the Hawar Islands Protected Area and ensure they comply with a no-land-filling and no-dredging policy.



6.8 Other Activities

As noted previously, action should not be taken for any commercial or other purposes in the protected area except in accordance with this management plan. In particular, commercial and military operations in the Hawar Islands Protected Area might require a permit or clearance under the national regulations. The use of The Hawar Islands Protected Area for any other purposes should be considered on a case-by-case basis, taking into account the strategic objectives for the protected area and the likely impacts of the proposed activity. These may be allowed under permit or special dispensation from the appropriate authorities, but not without considerable review for their environmental impacts.



In particular this section applies to the establishment, use, and dismantling of military installations within the protected area. This plan should address the methods through which habitats are restored, and determine targets for the restoration of altered habitats, while also addressing the defense needs of the nation.



6.9 Indigenous Cultural Heritage

The indigenous cultural values of The Hawar Islands Protected Area relate to the long association of Hawari people with the coastline and resources of the marine and terrestrial environments from prehistoric times. Very few threats to indigenous cultural values pertaining to the protected area have been identified. It is possible that indigenous cultural values could be threatened by events causing serious pollution or by restrictions to indigenous peoples' access to, and involvement in, the protected area and its resources.

6.9a Management Goals — Indigenous Cultural Heritage

1. To support involvement of indigenous people in management of the Hawar Islands Protected Area as appropriate.

6.9b Management Strategies — Indigenous Cultural Heritage

1. Maintain liaison and consultation with local indigenous communities.
2. In consultation with other agencies, investigate and support opportunities for the involvement of indigenous people in the management of the protected area.
3. Local indigenous people should be consulted regarding any use of their cultural knowledge and traditions.

6.10 Education

Education is a major mechanism through which to achieve the management goals and thus the strategic objectives of the Hawar Islands Protected Area. Public education should be provided through the production and distribution of printed material, face-to-face contact, and educational displays such as at the Bahrain Youth Science Center and other such public access points.

6.10a Management Goals — Education

1. To improve public awareness, understanding and appreciation of the marine and coastal environments of The Hawar Islands Protected Area and of the potential impacts of human activities on these environments.
2. To reduce the negative impacts of human activities on the values of the protected area and engender community stewardship of the marine environment through public education.

6.10b Management Strategies — Education

1. Prepare an education strategy which includes:



- ◆ Providing information to increase public awareness and appreciation of the natural, physical and cultural values of the Hawar Islands Protected Area.
- ◆ Providing information on the potential negative impacts of human activities on the values of the Hawar Islands Protected Area and ways to minimize these impacts.
- ◆ Utilizing the facilities at the Bahrain Youth Science Center and other such facilities.
- ◆ Providing and distributing information via written material, the Internet and face-to-face contact and investigating other options for the provision of visitor information.



6.11 Research

The Hawar Islands Protected Area could provide opportunities for a wide variety of research programs investigating aspects of the seagrass beds, large endangered marine fauna, effects of re-introduced terrestrial fauna, avifauna ecology, breeding and migration, and cultural and environmental history.

There are currently large gaps in the knowledge of the marine, avian and terrestrial communities, species and ecosystem processes in the Hawar Islands Protected Area, particularly in the near-shore waters and seagrass beds. Improving knowledge of these aspects is critical to improving management of the protected area. One of the key gaps in knowledge and research is in the geological origins of the protected area. Another is knowledge of species and ecosystem processes of the seagrass beds. Under the NCWP mandate, carrying out research in the Hawar Islands Protected Area should require a permit from the Secretary General.

6.11a Management Goals — Research

1. To encourage research that will improve knowledge of the values of the Hawar Islands Protected Area and inform its management.
2. To ensure that information from research is made available to managers of the Hawar Islands Protected Area.
3. To provide opportunities for research, which is of intrinsic benefit to science and humanity, provided these do not impact negatively on the values of the protected area.
4. To minimize potential negative impacts from research on the values of the Hawar Islands Protected Area.

6.11b Management Strategies — Research

1. Prepare a research plan to include areas of priority research required for management.
2. Develop and implement mechanisms for improving feedback of research results to management.



3. Develop and implement mechanisms to encourage appropriate research at the Hawar Islands Protected Area.

4. Utilize existing scientific data from a variety of sources such as those generated from previous research studies.

5. Research which involves the killing, injuring or taking of endangered species should be assessed on a case by case basis and should only be allowed under permit.



6.12 Compliance and Enforcement

Visitors to and users of The Hawar Islands Protected Area should be subject to the provisions of any existing national regulations and those of this management plan. A Memorandum of Understanding (MoU) should be drawn up between the Hawar Islands Protected Area Management Liaison Committee, the Department of Fisheries and the Bahrain Defense Force, under which responsibility for law enforcement in the Hawar Islands Protected Area is outlined. In the case of fisheries-related activities, enforcement should primarily be the responsibility of the Department of Fisheries. Relevant officers of each organization should be considered for appointment as wardens under the management guidelines of this plan.

A compliance and enforcement plan should also be prepared for the Hawar Islands Protected Area.

6.13 Stakeholder and Community Liaison

Ongoing stakeholder and community liaison should be carried out as part of the planning and management of the Hawar Islands Protected Area. The Hawar Islands Protected Area Management Liaison Committee should be the major forum for regular formal liaison between the relevant government and non-governmental agencies. The involvement of outside expertise will be sought as appropriate.

Any proposed amendments to the management plan should involve consultation with stakeholders.



Seen from offshore, the islands rise majestically to form a plateau upon which ancient civilizations built their homes and eked out a living, a legacy that remains to this day.

7. REVIEWING THIS PLAN

7.1 Performance Assessment

A performance assessment framework should be developed in line with the national system of protected areas. The performance assessment model for the management of the Hawar Islands Protected Area should include a legislative framework; strategic objectives; analysis of potential pressures on the major values of the protected area; management goals; management strategies; and performance measures, targets and monitoring programs.

The first elements will be dealt with in detail in future editions of this management plan, particularly in sections 3, 5 and 6. The performance measures, targets and monitoring programs will be further developed from these elements.

The performance assessment framework and reports should be produced in consultation with the National Commission for Wildlife Protection, and reviewed annually by a Hawar Islands Protected Area Management Liaison Committee, as yet to be established. Performance assessment should focus on the effectiveness of the management strategies detailed in this management plan, compliance with the provisions of the plan and national regulations, and performance against the IUCN Protected Area Management Category II.

7.2 Reviewing the Plan

It is suggested that this management plan operate for 7 years. A review of the plan should be commenced approximately two years before the date of termination. The review will objectively examine the appropriateness of the management prescriptions in the light of any new information concerning the biodiversity, technical advances, environmental safety and the needs of the community.

Performance assessment should be carried out during the life of this plan and the results will be used in the development of the next (second) management plan for the Hawar Islands Protected Area.

Any revisions of this management plan must take into account, first and foremost, the wildlife that inhabit the area and are the main justification for its Outstanding Universal Value.



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8.1 Summary of IUCN Guidelines for Protected Area Management Categories



Category Ia: Strict Nature Reserve: Protected Area managed mainly for science. Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

Category Ib: Wilderness Area: Protected Area managed mainly for wilderness protection. Large area of unmodified or slightly modified land and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.



Category II: National Park: Protected Area managed mainly for ecosystem conservation and recreation Natural area of land and/or sea, designated to

(a) protect the ecological integrity of one or more ecosystems for this and future generations,

(b) exclude exploitation or occupation inimical to the purposes of designation of the area, and

(c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III: Natural Monument: Protected Area managed for conservation of specific natural features. Area containing one or more specific natural or natural/cultural feature which is of outstanding value because of its inherent rarity, representative or aesthetic qualities or cultural significance.



Category IV: Habitat/Species Management Area: Protected Area managed mainly for conservation through management intervention. Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.



Category V: Protected Landscape/Seascape: Protected Areas managed mainly for landscape/seascape conservation and recreation Area of land, with coast and seas as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, cultural and/or ecological value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI: Managed Resource Protected Areas: Protected Area managed mainly for the sustainable use of natural ecosystems Area containing predominantly unmodified natural systems, managed to ensure long term

protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.



8.2 Seagrass Research Techniques and Background Information Sources

8.2a Outline

The following outline describes the primary research methods and data analysis requirements for seagrasses, which would be applicable to the Hawar Islands seagrass beds.

- ◆ Qualitative assessment of the macroalgal and seagrass flora of an area:
 - Field collecting (intertidal and subtidal)
 - Processing and preservation of the seaweed and seagrass specimens
 - Identification of seaweeds and seagrasses (no marine flora list for the area is available, hampering identification of seaweeds).
- ◆ Aerial surveys combined with ground-truth observations. These phytosurveys are particularly useful for the study of algal and seagrass communities of large areas (e.g. kilometers of coastline):
 - Remote sensing (aerial photography and satellite images)
 - Other data acquisition
 - Ground-truth observations
 - Creation of vegetation maps on the basis of remote sensing in combination with the ground-truth observations
- ◆ Quantitative sampling:
 - Investigation of spatial community variation
 - Transect sampling (used in zonation studies of intertidal communities of both seaweeds and seagrasses)
 - Quadrat sampling (useful for studying community variation along a coastline or for zonation studies)
 - Investigation of temporal community variation
 - Establishment of permanent quadrats
- ◆ Measurement of environmental variables:
 - Water temperature, spatial and temporal measurements
 - Shore height above or depth under low water mark
 - Sand inundation, substrate, slope
 - Light (radiometers, transparency methods such as secchi disk, etc.
 - Water motion (waves, tides and currents): measurement of cumulative water motion, maximum force and continuous measurement of water velocity
 - Salinity, oxygen and nutrients
- ◆ Data analysis
 - Data uploading: spreadsheets and databases
 - Preliminary data analysis: data exploration by means of basic statistics
 - Multivariate statistics
 - Transformation of data
 - Ordination: multivariate techniques arranging sites along axes on the basis of species composition
 - Indirect and direct ordination methods
 - Linear and unimodal models



8.2b Recommended Literature for Seagrass Research Methods and Regional Coverage

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