

SCIENTIFIC FIELD SURVEY REPORT
FOR THE DEVELOPMENT OF
MARINE PROTECTED AREAS
IN LIBYA



Ain El Ghazala and Bomba Bay
20-27 September 2010

STRATEGIC PARTNERSHIP
FOR THE MEDITERRANEAN SEA
LARGE MARINE ECOSYSTEM



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PREFACE

The white coastline of Libya embraces one of the last portions of the Mediterranean where marine biodiversity is still rich and human impact relatively low. Long stretches of the coast are unpopulated and host outstanding biodiversity hotspots which are breeding and nesting grounds for several endangered and keystone species of Mediterranean importance. Unfortunately, in the last decades, the rate of exploitation of marine resources has accelerated tremendously and the national political situation has delayed the implementation of serious conservation measures to protect this unique heritage.

In September 2010, the Regional Activity Centre for Specially Protected Areas (RAC/SPA) of UNEP/MAP and WWF Mediterranean Programme Office (WWF MedPO) organised with the Environmental General Authority of Libya (EGA) a field survey to gather key biological and socioeconomic information of the area comprising Ain El Ghazala and the Gulf of Bomba. This area was subsequently declared by Libyan authorities as a new Marine Protected Area (Establishment No 2:2011).

RAC/SPA and WWF MedPO collaborate within the Biodiversity Component of the Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem - MedPartnership project, led by UNEP/MAP. Within this partnership, RAC/SPA is responsible for the implementation of a 5-year regional project for the development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of MPA creation and management (MedMPAnet Project). The overall objective of the MedMPAnet Project is to increase the capacity to conserve regionally important coastal and marine biodiversity through the creation of an ecologically representative, coherent and effective MPA network in the Mediterranean region as required by the Barcelona Convention's Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol). More specifically, the MedMPAnet Project focuses on the identification and creation of new MPAs. WWF MedPO coordinates the MedPAN South Project, a 4-year collaborative project aimed at improving the management effectiveness of MPAs and supporting the creation of new ones. WWF MedPO partners with more than 20 national and international organizations to deliver an ambitious programme of support for the MPAs and relevant authorities in the countries of the south and east of the Mediterranean where MPAs still face many challenges.

The main objective of the joint MedMPAnet and MedPAN South Pilot Project in Libya is to provide the Libyan environmental authorities with a strong (ecological and socio-economic) argument in support of initiating the establishment of a network of coastal and marine protected areas along the Libyan coasts.

The present report includes a summary description of the field survey carried out by international and national experts in Ain El Ghazala and Bomba Bay. The experts collected data on the marine biotopes and species, main threats and put together a socio-economic profile of local fishermen and hunters with a view to elaborating management plan outlines. During the field activities, on-the-job and formal training sessions were provided to strengthen the capacity of local scientists and experts on MPA design, underwater biodiversity assessment and socio-economic aspects related to MPA establishment.

1. INTRODUCTION



Figure 1. The study area



Figure 2. The Ain El Ghazala lagoon and Elba Island

1.1 MEAN GEOGRAPHICAL FEATURES

The area encompassing Ain El Ghazala and Khalij Al Bomba, or the Gulf of Bomba, lies along the easternmost stretch of the Libyan coastline and is characterized mainly by a rocky shoreline and a broader coastal plain with intermingled sandy beaches and tiny inlets (ouadi) (Fig. 1). Flatter expanses of sabkha (e.g. sebkhat Temimi) and wetland environments fringe the shores of the Gulf of Bomba, including the area around the major lagoon of Ain El Ghazala. According to Reynolds et al (1995), Ain El Ghazala Lagoon is a roughly thumb-shaped indentation of the Gulf of Bomba that covers an area of some 180ha. The lagoon is shallow, with an estimated average depth of 2m and a maximum depth of 4.2m. It is fed by freshwater springs from various points around the southern shore.

In the area there are four small islands (Fig. 2-3). The largest is Jazirat al `Ulba (Elba Island), located just off Ain El Ghazala lagoon, while the other three are found close to the promontory of Qusur al Bumbah. These islets stretch along an east-west line and are called respectively Jazirat Barda`ah (Bardaa Island), Al Jazirah al Wati`ah (Al Watiah island) and Jazirat Misratak (Misratak Island).



Figure 3. The Gulf of Bomba and the three islets of Qusur al Bumbah



Coastal area of Ain El Ghazala lagoon. © Renaud Dupuy de la Grandrive, RDG / RAC-SPA

1.2 DATA AVAILABLE FROM PREVIOUS STUDIES

Ain El Ghazala lagoon

Ain El Ghazala lagoon is reported as a well-preserved environment with a variety of diversified assemblages and natural monuments which are unique in the Mediterranean Sea and associated with an exceptional biological wealth (Pergent et al., 2006). The main characteristics of this site are: the salt marsh, with *Salicornia arabica* and common reed (*Phragmites communis*) and sharp-pointed rush (*Juncus acutus*) fringes, the seagrasses *Cymodocea nodosa* (which cover 77% of the lagoon) and *Posidonia oceanica* (mainly developed in the entrance of the lagoon and towards Elba Island). Elba Island (N32.23149 E23.28186) which constitutes a nesting area for numerous birds (in spring for *Larus michahellis* and in summer for *Thalasseus benghalensis*). The large seagrass meadows at Ain El Ghazala lagoon are reported as an indicator of absence of pollution (Reynolds et al. 1995). Salinity levels are close to that of seawater and there is a high level of dissolved oxygen.

Pergent et al. (2006) report on the peculiar *Posidonia oceanica* atoll-like structures found at both the entrance to the lagoon and close to Elba Island. The algal assemblage for both the lagoon and the area outside the lagoon is relatively poor with only 10 species reported by Godeh (2009) and 31 by Pergent et al. (2006). These two studies do not report the presence of any invasive species. However, Djellouli et al. (2008) described two invasive algal species for the same area—*Halimeda* sp. and *Penicillus capitatus*—and one seagrass, *Halophila stipulacea*.

The lagoon of Ain El Ghazala hosts a breeding site of the loggerhead sea turtle *Caretta caretta*. Mating occurs inside the lagoon (Pergent et al. 2006) while egg deposition takes place outside along the sandy coastal region located to the east (Hamza, 1998; Laurent et al., 1999).

Fish fauna is reported to be very rich although no specific studies have been carried out and data refers to fish landing. The fishery is a small scale one with fishermen using small wooden boats of four principle kinds: Mator, Batah, Lampara and Flouka. Flouka and Batah are largely the most common fishing boats. Trammel nets are the most common fishing gear.

Shakman and Kinzelbach (2007) reported 41 fish taxa and 2 molluscs from a study on commercial fisheries and fish species composition in the eastern coastal waters of Libya, while Pergent et al. (2006) report 9 fish species as commonly landed specifically at Ain El Ghazala.

Birds have been extensively studied in several surveys (Azafzaf et al., 2006; EGA-RAC/SPA-AEWA-WI, 2006; Etayeb et al., 2007). Pergent et al. report a list of 26 water birds and 10 terrestrial birds in the area of Ain El Ghazala. In surveys carried out in 2005 and 2006 (Azafzaf et al., 2006) over 500 birds, including cormorants, waders and gulls, were observed at Temimi salt marsh in both years, while at Ain El Ghazala there were over 300 in 2005 and 600 in 2006, mainly grebes and cormorants, plus some waders, gulls and terns. Ain El Ghazala has been recognized as an Important Bird Area by BirdLife International and has been suggested as a wetland of international importance under the Ramsar Convention and as a Specially Protected Area of Mediterranean Importance (SPAMI) under the Barcelona Convention (Robertson and Essghaier 2001). The Lesser crested tern *Sterna (Thalasseus bengalensis)* nests on Elba island and the breeding population here is about 60-80 adults (Meininger et al., 1994a,b; Azafzaf et al., 2006). Illegal water bird hunting activities have been reported to be quite extensive in Temimi wetlands and Ain El Ghazala (Etayeb et al., 2007) although reports were based only on the presence of spent cartridges and bird corpses.

1.3 MISSION OBJECTIVES

The joint MedMPAnet-MedPAN South mission aimed to:

- contribute to identifying the priority taxa and geographical areas to be sampled for designating a future MPA;
- undertake a rapid assessment underwater survey to complement existing data, gather qualitative-quantitative data on abundance and distribution of coastal fish, benthic macro-algae and macro-invertebrates and habitat distribution and provide recommendations on the boundaries of the future MPA;
- collect data on the social, cultural and economic resources and main threats to the coastal and marine environment and the surrounding area;
- Provide theoretical and on-the-job training to officers and scientists of EGA and other Libyan institutions to enable them to plan and carry out marine biodiversity sampling using rapid assessment techniques.

The mission to Bomba Bay, although marred by bad weather and a malfunctioning outboard motor which limited our activities in the field, was successful to a degree as we were able to dive and carry out an extensive, if preliminary, socio-economic survey.

2. METHODS

2.1 BENTHOS: FAUNA AND FLORA

This task aimed at reporting information on the most important benthic assemblages including a list of dominant mega-fauna and mega-flora species and on the habitat structure of the infralittoral zone of the selected sites. It was decided to gather data on flora, fauna and habitat by conducting random trails whenever possible, censuring the number of species/habitats encountered and, where possible, assigning a rank of importance and assessing the overall status of the ecosystem and the presence of threats.

Fish fauna

The aim of this task was to gather information on fish fauna inside the lagoon and around the small islets of Bomba Bay. It was decided to gather data on fish fauna by conducting random trails both by scuba diving and snorkelling to collect species inventories at site level. In addition to this we had the chance to observe fish landings at the small Ain El Ghazala fishing harbour.

Other fauna

Qualitative data on other fauna, namely birds and reptiles, were collected during the field trip.

2.2 SOCIO-ECONOMIC OVERVIEW

The team of experts had the chance to observe fish landings, take small trips around the Bay of Bomba and mainly talk with several fishermen and other stakeholders, establishing a good and trusting relationship with them. In a matter of two days, and with the fundamental help of EGA people, the team was able to submit an unstructured questionnaire to a few fishermen, in order to understand points of interest for the experts and possibly for further missions (see Box 1).

Box 1: Unstructured interview

Unstructured interviewing is the most widely-used form of interviewing for gathering information about a community and its people. Community members are interviewed informally during the course of an ordinary day—in their boats, in the fields, in their homes, while sharing food or drink, on the street—wherever convenient. Despite its casual approach, this type of interviewing still requires considerable skill on the part of a researcher if it is to be done effectively. Developing rapport, getting informants to open up and provide the information desired, knowing how to end the interview, and making sure that the information is systematically elicited, however informal its elicitation may seem, are some of the essential skills that a researcher must have when employing this method (McGoodwin, 2001). We had sufficient time to interview informants on several occasions, especially fishermen. Thus, in some cases we sat down with the express purpose of carrying out an interview, with a clear plan in mind but flexible so as not to constrain the informant's responses. The idea behind this kind of interview is to get people to open up and express themselves in their own terms and at their own pace (McGoodwin, 2001).

Considering the good results from this approach a similar questionnaire was extended to other potential stakeholders and users of the area when we had the chance to meet them.

The general questions regarding identified activities were:

- 1) What is the (approximate) number of people involved in each of the identified activities?
- 2) Where are these activities located?
- 3) What are the main tools, gears, etc. used in each of the identified activities?

The specific questions we had in mind when gathering data for fishery activity were:

- 1) What is the number and age of fishers at each identified location?
- 2) What is the number, size and typology of gears at each location?

We also wanted to gather data on:

- 1) age
- 2) level of education
- 3) nationality
- 4) number of years fishing in the area
- 5) kind of boat
- 6) kind of gear used
- 7) kind of fish caught
- 8) number of fish caught
- 9) number of working days per year
- 10) where they fish
- 11) where fish is sold out
- 12) what they catch there
- 13) when they go there
- 14) what are their main expenses
- 15) what are the main problems linked to the job

The specific questions we had in mind when gathering data on tourists and campers were aimed at finding out:

- 1) age
- 2) level of education
- 3) residence city/village
- 4) activities when camping
- 5) when they started hunting/fishing in the camp site
- 6) when they started camping
- 7) when they finished camping
- 8) number of people in each camp site and what they do
- 9) how long they stay in one camp
- 10) number of birds they catch
- 11) number of fish they catch
- 12) the species of fish they catch
- 13) other species they catch
- 14) the species they like to catch
- 15) their motivation for camping/hunting/fishing is
- 16) method used to catch their prey

3. RESULTS

3.1 SITE CHARACTERIZATION: MARINE BIODIVERSITY

3.1.1 Underwater marine biodiversity assessment

Dive 1: Tower site



Figure 4. Location of the first three trails in the Ain El Ghazala lagoon and Elba Island.

Seagrass meadows and benthic assemblages

Random trials for benthic communities were carried out by snorkelling in nearshore waters in the eastern side of the lagoon just opposite to the Ain El Ghazala little harbour. We called this the Tower site (N 32.18660 E 23.31257) due to the presence on land of abandoned military infrastructures (Fig. 4, Dive 1). The site was characterized by very low water transparency, high sedimentation and the presence of spotty freshwater springs. We surveyed the intertidal and sublittoral communities along a 200m-long trail for 30 minutes. The intertidal was poor and characterized by calcarenitic platforms and boulder fields covered by unidentified filamentous microflora, mainly cyanophyceans and diatoms. The upper infralittoral communities from the low tidal level to about 1m depth were mainly composed of soft bottoms, mussel beds and sparse boulder fields. Below 1m depth the sublittoral communities were mainly dominated by soft bottoms and *Cymodocea nodosa* beds. *Mytilus galloprovincialis* and the pearl oyster *Pinctada radiata* were the dominant macrofauna species. The most abundant macroalgae were *Cystoseira crinita*, *Padina pavonica*, *Valonia cfr utricularis* and *Anadyomene stellata*, most of them growing on mussel shells. Several colonies of *Clavelina* sp. were censused along the trail. It is also worth mentioning the presence of a few individuals of the sea orange sponge *Tethya aurantium*.

We were prevented from assessing fish fauna by extremely poor water visibility.



Ascidians and *Pinctada radiata*



Facies with mussels and ascidians



Halimeda tuna



Cymodocea nodosa

Tower site (Dive 1, N 32.18660 E 23.31257)
Photos: Renaud Dupuy de la Grandrive © RDG/
RAC-SPA, Mathieu Foulquié © MF/RAC-SPA

Dive 2: Atolls site

Seagrass meadows and benthic assemblages

At the entrance of the lagoon several *Posidonia oceanica* atoll-like structures are present in very shallow waters (<1.5m). Two of these atolls (N32.19355 E23.30050), each covering about 150m², were surveyed to assess the species composition of the main benthic and fish assemblages (Fig. 4, Dive 2). Around each atoll the seascape was dominated by sandy bottoms covered by sparse *Cymodocea nodosa* beds. On the northern side of the atoll mixed beds of *C. nodosa* and *Caulerpa prolifera* were also recorded. The sandy anemone *Condylactis aurantiaca*, the hermit crab *Diogenes pugilator* and the giant tun gastropod *Tonna galea* were recorded on sandy bottoms and within the *C. nodosa* beds.

Inside the atolls the dead matte was covered by *Pinctada radiata* beds mixed to *C. nodosa* and *Hexaplex trunculus*. Both the oyster and the dead matte represented suitable substrates for several sessile benthic species. The main macrozoobenthic species were the anemone *Anemonia viridis* and the actinian *Aiptasia diaphana*, the sponge *Ircinia* sp., the bivalve *Pinna nobilis* and the tunicates *Clavelina* sp. and *Aplidium conicum*.

Fish assemblages

Around each *Posidonia oceanica* atoll, the fish fauna was mainly characterized by cryptic fish, namely *Gobius bucchichi* and *Gobius fallax*, and large schools of *Diplodus annularis*, *Atherina* sp. and *Siganus rivulatus*.

A few individuals of *Symphodus tinca*, *Mullus barbatus* and *Syngnathus typhle* were also recorded.

Inside the atolls the fish species recorded were again *Diplodus annularis*, *Siganus rivulatus* and to a lesser extent *Diplodus sargus*, *Coris julis* and *Symphodus rostratus*. A few individuals of the blenniid *Parablennius tentacularis* and of the gobiid *Gobius bucchichi* were found sheltering inside empty shells of *Pinctada radiata*.



Cymodocea nodosa meadow on sand at the periphery of the atoll



External border of a *Posidonia oceanica* atoll



Ascidians and *Cymodocea nodosa* inside the atoll



The lessepsian bivalve *Pinctada radiata* inside the atoll



Mussels colonization inside a *Posidonia oceanica* atoll



Litter of dead leaves of *Posidonia oceanica* around the atolls



Heraplex trunculus inside *Cymodocea nodosa* meadow



Pinna nobilis inside a *Posidonia oceanica* atoll

Atolls site (Dive 2, N32.19355 E23.30050)

Photos: Renaud Dupuy de la Grandrive © RDG/RAC-SPA, Mathieu Foulquié © MF/RAC-SPA

Dive 3: Elba Island

Seagrass meadows and benthic assemblages

We had the chance to observe several (about eight) large-sized turtles, *Caretta caretta*, swimming around the boat just off Ain El Ghazala Bay. A snorkelling survey was conducted in shallow waters close to Elba Island (N32.23660 E23.27299; Fig. 4, Dive 3). Elba is an island about 2km from the coast just off the mouth of the Ain El Ghazala lagoon. It is a flat island of about 3km². Vegetation is dominated by sparse *Salicornia fruticosa* and *Halimione portulacoides*, and most of the shore is covered by dense banquettes of *Posidonia oceanica*. We made a rapid assessment survey on the northwestern side of the island close to a trawling vessel wreck. The underwater seascape is dominated by a barren habitat on a rocky flat, partially covered by sediments probably belonging to surrounding sandy areas. This rocky area shows evident signs of illegal blast-fishing. Rare *Posidonia oceanica* shoots were recorded underneath large boulders and inside crevices of the rocky flat. The dominant algae were encrusting red algae, mainly *Peyssonnelia* spp., and turfing forms belonging to the Laurencia complex *Ceramium* spp. and *Cladophora* spp.. Some individuals of the red stone alga *Phymatolithon calcareum* and of the green alga *Dasycladus vermicularis* were observed. Summering forms of the macroalgae *Dictyota dichotoma* and stipes of an unidentified monopodial *Cystoseira* species were also abundant. A few individuals of the green algae *Penicillus capitatus*, *Valonia utricularis* and *Halimeda* sp. were recorded. The sponges *Aplysina aerophoba* and *Ircinia* sp. were abundant and several individuals were recorded at about 1-3m depth along with the dendrophylliid *Balanophyllia europaea* and the sessile polychaete *Protula* sp.. Echinoderms fauna was mainly characterised by the red sea star *Echinaster sepositus*, *Astropecten* sp., the sea cucumber *Holothuria tubulosa* and a few small-sized individuals of the sea urchins *Arbacia lixula* and *Paracentrotus lividus*, mainly sheltered in crevices. Some *Pinna nobilis* were observed at about 3-4m depth.

Fish assemblages

The fish fauna was slightly richer here than that found at the inner lagoon sites and was mainly composed of the labrids *Symphodus tinca*, *Symphodus ocellatus*, *Thalassoma pavo* and *Coris julis*, the sparids *Diplodus sargus* and *Diplodus annularis*, the siganid *Siganus rivulatus* and *Siganus luridus* and several juveniles of the scarid *Sparisoma cretense* and of the grouper *Epinephelus costae*.



Posidonia oceanica hill facies on sandy bottom (-21m)



Ripple marks of coarse-grained sand with litter of dead *Posidonia oceanica* leaves (-23m)



Cymodocea nodosa around *Posidonia oceanica* hill facies (-21m)

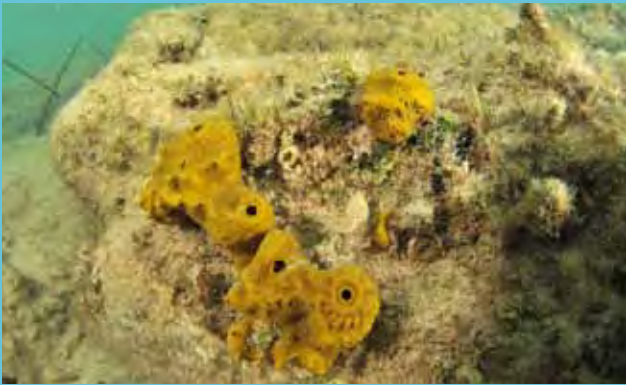
Elba Island (Dive 3, N32.23660 E23.27299)
Photos: Renaud Dupuy de la Grandrive © RDG/
RAC-SPA, Mathieu Foulquié © MF/RAC-SPA



Submarine reliefs around Elba island



Dasycladus vermicularis



Aplysina aerophoba



Cymodocea nodosa



Pinna nobilis



Cymodocea nodosa on gravel



Astropecten sp.



Posidonia oceanica on rocky substrate

Elba Island (Dive 3, N32.23660 E23.27299)

Photos: Renaud Dupuy de la Grandrive ©RDG/RAC-SPA, Mathieu Foulquié ©MF/RAC-SPA

Dive 4-7: Bomba Bay

Seagrass meadows and benthic assemblages

Two dives were carried out off the military base of Bomba Bay. At the same time, snorkelling random trails were conducted in the Bomba Bay close to the military harbour. The first dive lasted about 20 minutes and was located about 1km west of Al Watiah island, close to Misratah Island (Fig. 5, Dive 4). The seascape at about 6m depth was a large barren rocky platform partially covered by patches of *Posidonia oceanica*. Here, most of the meadow appears heavily damaged probably due to mechanical impacts and/or modification of bottom currents and sediment availability.

The second dive lasted 70 minutes and was carried out in shallow waters (<3 m depth) on the western side of Al Watiah island (Fig. 5, Dive 5). Al Watiah is a flat barren island about 5km N-NW of the harbour of the military base. Vegetation was scarce and most of the shore was covered by dense banquettes of *Posidonia oceanica*.

Underwater, the seascape was dominated by a barren habitat on a rocky flat rich with crevices, partially covered by sediments and large patches of *P. oceanica* meadow. This rocky area also showed evident signs of illegal blast-fishing. The edges of the *Posidonia oceanica* beds were highly covered by sediments and large patches of dead matte were evident. The dominant algae were encrusting red algae, mainly *Peyssonnelia* spp., and turf forms belonging to the *Laurencia* complex, *Ceramium* sp., *Flabellia petiolata*, *Dasycladus vermicularis* and *Halimeda* sp.. Summering forms (e.g. stipes without fronds) of an unidentified monopodial *Cystoseira* species and *Padina pavonica* were also abundant on rocky substrates. A few specimens of the green algae *Penicillus capitatus* were recorded.

Aplysina aerophoba, *Chondrilla nucula* and *Ircinia foetida* were the most abundant sponge species and patches of *Cliona* sp. were observed on rocky substrates. The solitary coral *Balanophyllia europaea* and the polychaete *Protula* sp. were also recorded. Echinoderms fauna was mainly characterised by the red sea star *Echinaster sepositus* and some individuals of the sea urchins *Arbacia lixula* and *Paracentrotus lividus*, mainly sheltered in crevices.

The seascape of the shallow waters of the Bomba Bay coastal site (Fig. 5, Dive 6) located SE of the military base (N32.392593 E23.135857) was sandy close to the coastline about 10m offshore mixed habitats of *Posidonia oceanica* meadow, rocky substrates covered by turf and fleshy macroalgae were dominant. Sparse shoots of *Cymodocea nodosa* were also present on sandy substrates.



Figure 5. Location of the three trails in the Gulf of Bomba.



Buried shoots of *P. oceanica* in the Gulf of Bomba. © F. Badalamenti/WWF



Dead shoots and a buried edge of a *P. oceanica* meadow in the Gulf of Bomba. © F. Badalamenti/WWF

The dominant algae were the encrusting red algae, mainly *Peyssonnelia* sp., and turf forms belonging to the *Laurencia* complex, *Ceramium* sp., *Flabellia petiolata*, and *Dasycladus vermicularis*. Summering forms (e.g. stipes without fronds) of an unidentified monopodial *Cystoseira* species, *Dictyota dichotoma* and *Padina pavonica* were also abundant on rocky substrates. Several specimens of the green algae *Penicillus capitatus* were recorded on sandy bottoms at the edges of the *P. oceanica* meadow.

Again *Aplysina aerophoba*, *Chondrilla nucula* and *Ircinia foetida* were the most abundant sponge species, while some individuals of *Cliona* sp., *Hemimycale columella* and *Crambe crambe* were observed on subvertical rocky substrates. The solitary coral *Balanophyllia europaea* was widespread on rocky substrates and several specimens of the bivalve *Pinna nobilis* and the anemone *Condylactis aurantiaca* were recorded on sand. The encrusting bryozoan *Schizomavella mamillata* was observed on *Cystoseira* stipes. Echinoderms fauna was mainly characterized by a few individuals of the sea urchins *Arbacia lixula* and *Paracentrotus lividus*. One individual of *Astropecten* sp. was observed on sand.

Fish assemblages

The fish fauna at Dive 4 and Dive 5 sites was richer than the previous sites and was mainly composed of the pomacentrid *Chromis chromis*, the mullid *Mullus barbatus* and the labrids *Symphodus tinca*, *Symphodus ocellatus*, *Symphodus mediterraneus*, *Thalassoma pavo* and *Coris julis*. Large schools of the sparids *Diplodus sargus*, *Diplodus vulgaris* and *Diplodus annularis*, and of the siganid *Siganus rivulatus* and *Siganus luridus* were also present. Both juveniles and adults of the scarid *Sparisoma cretense* and several juveniles of the groupers *Epinephelus costae* and *Epinephelus marginatus* and of the common dentex *Dentex dentex* and the gilthead seabream *Sparus aurata* were identified.

Two *Scorpena maderensis* and one *Octopus vulgaris* were also observed. Among cryptic fish fauna the dominant species were the gobids *Gobius bucchichi* and *Gobius cruentatus*.

Probably due to the high habitat heterogeneity of Dive 6, fish fauna was also very rich and a total of 22 species were recorded. The species recorded were the pomacentrid *Chromis chromis*, the mullid *Mullus barbatus*, the labrids *Symphodus tinca*, *Symphodus ocellatus*, *Thalassoma pavo* and *Coris julis*, the sparids *Diplodus sargus*, *Diplodus vulgaris*, *Diplodus annularis*, *Pagrus pagrus* (juv), *Sparus aurata* (juv) and *Oblada melanura*, the siganids *Siganus rivulatus* and *Siganus luridus*, the scarid *Sparisoma cretense*, the serranids *Epinephelus aeneus*, *Epinephelus costae*, *Epinephelus marginatus* and *Serranus scriba*, the centracanthid *Spicara maena* and finally the dasytid *Taeniura grabata*. Among cryptic fishes the gobid *Gobius bucchichi* was the only species observed.

Dive 7 was carried out by snorkellers close to the military harbour. The area was dominated by sand close to the beach and by well-preserved seagrass meadows (i.e. *Cymodocea nodosa* and *Posidonia oceanica*) moving offshore (Fig. 6).

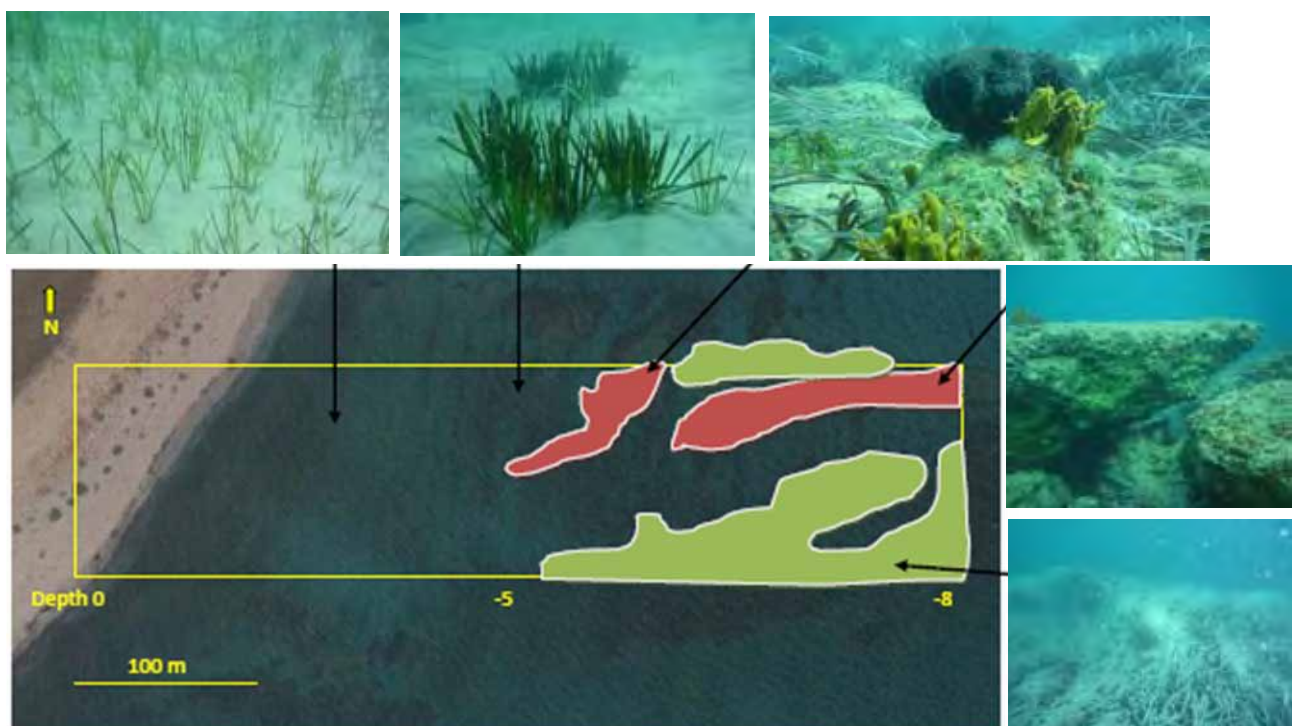


Figure 6. Dive 7 was carried out by snorkellers close to the military harbour. Photos: ©Yassine Ramzi Sghaier / RAC-SPA.

Fish species recorded included *Chromis chromis*, *Coris julis*, *Diplodus vulgaris*, *Epinephelus marginatus*, *Epinephelus costae*, *Mullus surmuletus*, *Oblada melanura*, *Scorpaena maderiensis*, *Serranus scriba*, *Siganus luridus*, *Siganus rivulatus*, *Sparisoma cretense*, *Spicara maena*, *Symphodus tinca*, *Taeniura grabata* and *Thalassoma pavo*. Among algae the presence of a few species of *Cystoseira* was noteworthy and among invertebrates *Pinna nobilis* and *Cladocora caespitosa*.



Submarine relief



Black horned sponge



Serranus scriba



Extension of the *Posidonia oceanica* meadow on the sandy bottom

Dive 4, 5, 6, Bomba Bay
Photos: Renaud Dupuy de la Grandrive © RDG/
RAC-SPA, Mathieu Foulquié © MF/RAC-SPA



Posidonia oceanica inside a sandy bowl



Dasycladus vermicularis and *Posidonia oceanica*



Posidonia oceanica patches on rocky substrate



Dense *Posidonia oceanica* meadow



Sponge: *Chondrilla nucula*



Structure of the rocky shelf around Al Watiah island



Symphodus tinca and *Sparisoma cretense*



From the surface, view of the structure of the rocky shelf

Dive 4, 5, 6, Bomba Bay

Photos: Renaud Dupuy de la Grandrive © RDG/RAC-SPA, Mathieu Foulquié © MF/RAC-SPA

Dive 8-10: Bardaa Island



Fig. 7. The dives around Bardaa Island confirmed the habitat and species composition of previous dives.



Posidonia oceanica matte



Posidonia oceanica meadow on rocky bottom



Palmophyllum crassum under a rocky overhang



Serranus scriba

Dive 8, North of Bardaa Island (-26m)
Photos: Renaud Dupuy de la Grandrive © RDG/
RAC-SPA, Mathieu Foulquié © MF/RAC-SPA



Spicara maena and *Siganus* spp.



Posidonia oceanica patches on rocky bottom



The fire worm *Hermodice carunculata*



Epinephelus costae



Black horned sponge



Taeniura grabata, new species recorded



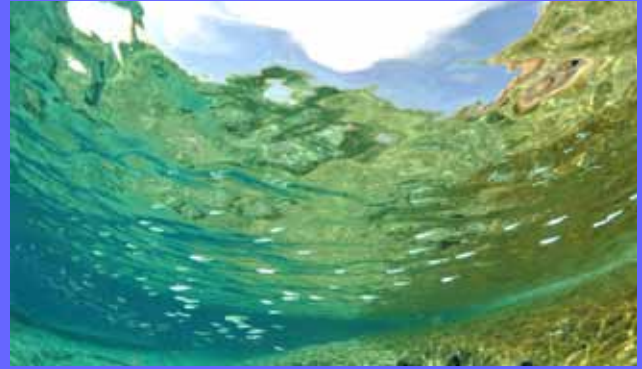
Posidonia oceanica on large rocky shelf

Dive 8, North of Bardaa Island (-26m)
Photos: Renaud Dupuy de la Grandrive © RDG/RAC-SPA, Mathieu Foulquié © MF/RAC-SPA

Dive 9, East of Bardaa Island (-18m)
Photos: Renaud Dupuy de la Grandrive © RDG/RAC-SPA, Mathieu Foulquié © MF/RAC-SPA



Orange horned sponge



Atherina sp. bank near the shore



Diplodus vulgaris and *Siganus luridus*



Posidonia oceanica between rocky slabs



Submarine relief



Submarine relief and erosive figures



Dense *Posidonia oceanica* meadow



Posidonia oceanica patches on rocky bottom

Dive 9, East of Bardaa Island (-18m)
Photos: Renaud Dupuy de la Grandrive © RDG/
RAC-SPA, Mathieu Foulquié © MF/RAC-SPA

Dive 10, close to Bardaa Island (snorkelling)
Photos: Renaud Dupuy de la Grandrive © RDG/
RAC-SPA, Mathieu Foulquié © MF/RAC-SPA

3.1.2. Catch composition of fishing boats

On different days three fishing landings were observed (one from a small rowing boat and two from engined artisanal fishing boats). The two fishermen of the small rowing boat hauled their gillnets in the inner part of the lagoon. The composition of this catch was dominated by small individuals of the marbled spinefoot *Siganus rivulatus* and the annular seabream *Diplodus annularis*. Larger individuals included a few specimens of *Stephanolepis diaspros* and *Balistes capricus* (photo below). Almost one third of the fish species recorded are *Lessepsians* who have entered the Mediterranean Sea via the Suez canal.



A detail of the catch by fishermen of the Ain El Ghazala harbour.
© F. Badalamenti/WWF



The two boats whose landings were assessed on 23.09.10.
© F. Badalamenti/WWF

The two engined boats each with three fishermen aboard (photo above) hauled their trammel nets N-NW of Elba Island at about 30m depth, probably on mixed sandy and rocky bottoms.

The catch of the first boat was dominated by medium-sized individuals of the siganid *Siganus rivulatus*, the sparids *Pagellus erythrinus*, *Diplodus annularis* and *Diplodus sargus*. Larger individuals included a few specimens of *Mullus surmuletus* and one specimen of *Dasyatis pastinaca*. Approximately 15% of the fish species recorded in this catch were *Lessepsians* who have entered the Mediterranean Sea via the Suez canal.

The composition of the fish sold was highly diversified and included reef-associated, sandy and pelagic fish species. This catch probably also belongs to the area N-NW of Elba Island at about 30m depth.

In addition to the sparid species already identified from landings, it is worth mentioning the presence of two sciaenid species *Umbrina cirrosa* and *Sciaena umbra*, of the carangids *Alepes djedaba* and *Caranx crysos*, and of the Lessepsian yellowtail barracuda *Sphyraena flavicauda*.



Small scale fishing activity in Ain El Ghazala area. © Renaud Dupuy de la Grandrive RDG / RAC-SPA

Catch composition of a *batah* boat with two fishermen from India. Fishing area inside the Ain El Ghazala Lagoon.

Abundance classes: R=rare; LA=less abundant; A=abundant.

Latin name	Common name	Distribution	Abundance
<i>Balistes capriscus</i>	Grey triggerfish	Atlantic and Mediterranean Sea	LA
<i>Diplodus annularis</i>	Annular seabream	Eastern Atlantic, Mediterranean and Black seas	A
<i>Diplodus sargus</i>	White seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Diplodus vulgaris</i>	Common two-banded seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Fistularia commersonii</i>	Bluespotted cornetfish	Indo-Pacific immigrated via the Suez Canal to the Mediterranean Sea	R
<i>Lagocephalus sceleratus</i>	Silver-cheeked toadfish	Indo-West Pacific immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Lithognathus mormyrus</i>	Sand steenbras	Eastern Atlantic, Mediterranean, Black, and Azov Seas. Western Indian Ocean including Red Sea	LA
<i>Remora remora</i>	Suckerfish or sharksucker	Cosmopolitan in warm waters	R
<i>Siganus rivulatus</i>	Marbled spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	A
<i>Sparisoma cretense</i>	Parrotfish	Eastern Atlantic and Mediterranean Sea	LA
<i>Spondylisoma cantharus</i>	Black seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Stephanolepis diaspros</i>	Reticulated leatherjacket	Indo-Pacific immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Xyrichtys novacula</i>	Pearly razorfish	Atlantic and Mediterranean Sea	LA

Catch composition of the first artisanal fishing boat with three fishers from Egypt assessed on 23.09.10. Fishing area outside the lagoon.

Abundance classes: R=rare; LA=less abundant; A=abundant.

Latin name	Common name	Distribution	Abundance
<i>Dasyatis pastinaca</i>	Common stingray	Northeast Atlantic and Mediterranean Sea	R
<i>Diplodus annularis</i>	Annular seabream	Eastern Atlantic, Mediterranean and Black seas	A
<i>Diplodus sargus</i>	White seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Diplodus vulgaris</i>	Common two-banded seabream	Eastern Atlantic, Mediterranean and Black seas	R
<i>Fistularia commersonii</i>	Bluespotted cornetfish	Indo-Pacific immigrated via the Suez Canal to the Mediterranean Sea	R
<i>Mullus surmuletus</i>	Surmullet	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Pagellus erythrinus</i>	Common pandora	Eastern Atlantic and Mediterranean Sea	LA
<i>Pagrus pagrus</i>	Red porgy	Atlantic and Mediterranean Sea	R
<i>Sarpa salpa</i>	Salema	Eastern Atlantic and Mediterranean Sea	R
<i>Siganus rivulatus</i>	Marbled spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	A
<i>Siganus luridus</i>	Dusky spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Sparisoma cretense</i>	Parrotfish	Eastern Atlantic and Mediterranean Sea	LA
<i>Spondyliosoma cantharus</i>	Black seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Symphodus tinca</i>	East Atlantic peacock wrasse	Eastern Atlantic, Mediterranean and Black seas	R
<i>Trachinus araneus</i>	Spotted weever	Eastern Atlantic and Mediterranean Sea	R

Catch composition of the second artisanal fishing boat. Fishing area outside the lagoon.

Abundance classes: R=rare; LA=less abundant; A=abundant.

Latin name	Common name	Distribution	Abundance
<i>Dentex dentex</i>	Common dentex	Eastern Atlantic and Mediterranean Sea	LA
<i>Diplodus annularis</i>	Annular seabream	Eastern Atlantic, Mediterranean and Black seas	A
<i>Diplodus sargus</i>	White seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Diplodus vulgaris</i>	Common two-banded seabream	Eastern Atlantic, Mediterranean and Black seas	R
<i>Mullus surmuletus</i>	Surmullet	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Pagellus erythrinus</i>	Common pandora	Eastern Atlantic and Mediterranean Sea	LA
<i>Pagrus pagrus</i>	Red porgy	Atlantic and Mediterranean Sea	LA
<i>Siganus rivulatus</i>	Marbled spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	A
<i>Siganus luridus</i>	Dusky spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Synapturichthys kleinii</i>	Klein's sole	Eastern Atlantic, Western Indian Ocean, Mediterranean Sea	R
<i>Scorpaena maderensis</i>	Madeira rockfish	Eastern Atlantic and Mediterranean Sea	R
<i>Sparisoma cretense</i>	Parrotfish	Eastern Atlantic and Mediterranean Sea	LA
<i>Spondylisoma cantharus</i>	Black seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Synodus saurus</i>	Atlantic lizardfish	Atlantic and Mediterranean Sea	R
<i>Trachinus araneus</i>	Spotted weever	Eastern Atlantic and Mediterranean Sea	R

Catch composition of the fishmonger likely encompassing the catches of two boats. Fishing area outside the lagoon on sandy-rocky mixed habitats.

Abundance classes: R=rare; LA=less abundant; A=abundant.

Latin name	Common name	Distribution	Abundance
<i>Alepes djedaba</i>	Shrimp scad	Indo-Pacific immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Caranx crysos</i>	Blue runner	Eastern Atlantic and Mediterranean Sea	A
<i>Chelon labrosus</i>	Thicklip grey mullet	Eastern Atlantic, Mediterranean and Black seas	A
<i>Dentex dentex</i>	Common dentex	Eastern Atlantic and Mediterranean Sea	LA
<i>Diplodus annularis</i>	Annular seabream	Eastern Atlantic, Mediterranean and Black seas	A
<i>Diplodus sargus</i>	White seabream	Eastern Atlantic, Mediterranean and Black seas	A
<i>Diplodus vulgaris</i>	Common two-banded seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Lagocephalus sceleratus</i>	Silver-cheeked toadfish	Indo-West Pacific immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Lithognathus mormyrus</i>	Sand steenbras	Eastern Atlantic, Mediterranean, Black, and Azov Seas. Western Indian Ocean including Red Sea	A
<i>Mullus surmuletus</i>	Surmullet	Eastern Atlantic, Mediterranean and Black seas	A
<i>Pagellus erythrinus</i>	Common pandora	Eastern Atlantic and Mediterranean Sea	LA
<i>Pagrus pagrus</i>	Red porgy	Atlantic and Mediterranean Sea	LA
<i>Sciaena umbra</i>	Brown meagre	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Siganus rivulatus</i>	Marbled spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Siganus luridus</i>	Dusky spinefoot	Western Indian Ocean immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Sparisoma cretense</i>	Parrotfish	Eastern Atlantic and Mediterranean Sea	LA
<i>Sparus aurata</i>	Gilthead seabream	Eastern Atlantic and Mediterranean Sea	LA
<i>Spondyliosoma cantharus</i>	Black seabream	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Sphyraena flavicauda</i>	Yellowtail barracuda	Indo-West Pacific immigrated via the Suez Canal to the Mediterranean Sea	LA
<i>Symphodus tinca</i>	East Atlantic peacock wrasse	Eastern Atlantic, Mediterranean and Black seas	R
<i>Umbrina cirrosa</i>	Shi drum	Eastern Atlantic, Mediterranean and Black seas	LA
<i>Xyrichtys novacula</i>	Pearly razorfish	Atlantic and Mediterranean Sea	LA

3.2 SITE CHARACTERIZATION – SOCIOECONOMIC FACTORS

3.2.1 Description of main human activities along the coastline

The coastline of Bomba Bay does not seem to be affected by many human activities. From south to north we encountered the small harbour of Ain El Ghazala, basically a jetty protruding from a tiny creek before the bay cul de sac, where a coastguard base (or maritime police base) and a former aquaculture plant are located (Fig. 2). Ain El Ghazala has been a focal point for aqua farming activity under the Aquaculture Projects Corporation (GADA/APC) since 1989, when an experimental floating cage culture was started. Limited trials of mussel culture were initiated in 1991 using seed stock imported from Italy (Reynolds et al., 1995). The bivalves were suspended from rafts inside tubular nets for the grow-out period, and the first trials appeared to be successful in the sense that the stock grew to a marketable size with no major problems encountered. The main concerns regarding the success of this activity included: water temperature, which is too hot in summer; water exchange, which is limited by the sand bar at the mouth of the lagoon; and the low availability of fish juveniles.

According to reports from fishermen, aquaculture farming started around 1985 following a plan of aquaculture development in Libya. Several studies were carried out before establishing the farm: one idea was to collect fingerlings in the bay using nets and then rear juveniles in cages. Today the farm has only two or three functioning cages and is managed at a family level with three people working there under a government concession given to private businesses. Data on this activity are scant and controversial. It seems that fish are reared when and if juveniles are available and there is a lack of a plan or protocol for fish feeding and harvesting. That aquaculture in the area was not likely to be a strong business activity was stated in an FAO report on the possibility of expanding aquaculture in the country (Reynolds et al., 1995). The report stated that: “the local population would stand to gain far more benefits through a properly organized nature reserve than from an aqua farming project of low to marginal productivity”.

The substantial failure of the aquaculture plants led to the development of a small-scale fishery in the area. At present, approximately 30/35 fishermen operate with 13 boats from the Ain El Ghazala harbour.

Further north another aquaculture plant is located in an area close to a semi-enclosed bay. A building close to the lagoon hosts facilities. Unfortunately this building was closed at the time of our visit. It was possible to see some structure within the lagoon where it appears that extensive aquaculture is practiced using a system similar to that called *lavoriero*. Here, data are scant and it was not possible to talk to people. However, it appears that within the closed bay eels and sometimes tilapia are reared, and there is a potential scheme to set up four eel farms in Bomba Gulf.

Another tiny aquaculture plant where prawns are reared is located nearby. However, no direct data or observations were possible. Further west the Timimi harbour has a tiny inlet hosting a few fishing boats. There was no chance to visit the harbour.

Close to the northern board of Bomba Bay a large part of the territory hosts a military base with a harbour. Along the coast herds of camels are commonly found and are apparently free to roam on the plain close to the coast. Several sheep folds are also found along the Timimi plain and shepherds are seen at dusk leading flocks to graze.

Near the sea shore the whole area is characterized by the presence of small huts, roughly 50 overall, spaced a few kilometres apart. These huts are made with canvas, generally white, on a concrete platform ranging from 10-20m². There is usually one hut per site but sometimes there are two or three. At closer sight these shelters reveal what is probably one of the most important human activities in the area. They are constructed and used by tourists who spend their holiday there hunting and fishing all kinds of animals.

Only unstructured questionnaires were used and were submitted to boat owners, campers (hunters), fish sellers, fishermen, military personnel and speargun fishers. The following sections describe the main stakeholders in the area, the main uses of the sea and the coastal area and the main conflicts.

3.2.2 Main activities and stakeholders identification

The main activities identified in the Gulf of Bomba and Ain El Ghazala lagoon are:

- Aquaculture
- Boat hiring by local people to fishermen

- Fish selling
- Fishing (small scale)
- Fishing (illegal trawling)
- Fishing (blast-fishing)
- Fishing (speargun)
- Bird hunting
- Camel grazing (nomadic)
- Mollusc collection for fish bait
- Sheep grazing
- Strategic/military sites
- Tourism, intended as local/family camping for fishing and hunting water birds

After stakeholder identification, interviews were carried out with fishermen (8 people), followed by campers/hunters (5), military personnel (2), fish sellers (1), boat owners (1), spear gun fishers (1). A descriptive report is provided for fishermen and campers/hunters.



Bird hunting activity in the area
Photo credit: Renaud Dupuy de la Grandrive © RDG / RAC-SPA

3.2.3 Fisheries

In Ain El Ghazala there are 13 boats, 5 of which are not equipped with an engine. Small boats are managed by two people and the larger ones by three people. Fishermen are generally young (20-30 years old) although sometimes one is older (around 50 years old). Fairly frequently the crew of one boat are members of the same family. All the fishers in Ain El Ghazala are foreign, mainly Egyptian. The boat owners are Libyan. Catches are sold to fishmongers and the income is generally divided into three parts, one for the fishermen, one for the boat (to cover expenses) and one for the owner. The Egyptians come from cities and villages not far from the border and their stay in Ain El Ghazala has not been long. The same applies for fishers coming from other, sometimes distant countries such as India.

The most frequent gear is a trammel net, at least in summer. In other seasons long lines are also common. Fishermen fish almost every day. They fish inside the lagoon when the weather is not good and outside whenever possible. Inside the lagoon the target species are siganids and sparids, mainly *Diplodus annularis* and to a certain extent also *Lithognathus mormyrus* and *Mullus barbatus*. Balistids and trumpet fish are also caught inside the lagoon. Outside the target species include sparids such as *Pagellus erythrinus*, *Pagrus pagrus*, *Dentex dentex*, *Diplodus sargus*, *Diplodus annularis*, *Lithognathus mormyrus*, *Epinephelus marginatus* and *Mullus surmuletus*. Catches are given to fish sellers close to the dock and stored in the boot of normal cars. Fish are sold mainly in Tobruk and in other villages close by.

Fish caught in Ain El Ghazala are larger and landings heavier than those usually observed in similar fisheries of other Mediterranean harbours, especially for sparids. The catch of large quantities of Siganids caught inside the lagoons is unprecedented in our experience, with the exception of some Egyptian fisheries.

We had no chance to see landings from long line, but fishermen reported that they are able to catch large groupers of up to 15kg, and large sparids, using sardines and squid as bait.

It appears probable that some conflict exists with other fishing activities, in particular illegal trawling, carried out very close to the coast at night, and with illegal fishing by campers using explosives. Minor problems were reported concerning interaction with mammals, "dolphin-like species", and turtles. Turtles are sometimes caught in the fishing gears and quite often die, possibly because of the lack of a specialized centre nearby that can rescue and rehabilitate them.

Given that many of the fishermen are foreign one of the main problems is the issue of legality (visa). Apart from this, they did not complain much about costs, fuel is cheap, and buying other fishing tools does not seem to be a problem at present. However, it should be kept in mind that these fishermen live close to the harbour (10m away) in very rural barracks, they have no family there and basically eat what they catch. They spend most of their free time fixing fishing gears and tools or repairing the boats. They have a lot of free time and consume very little. In this way they save money, but their life is confined to this small area, far from their origins and families.

3.2.4 Campers and hunters

There are roughly 30/50 camps in the whole area. Each camp is made up of a tent pitched on a concrete base. Campers stay in small family groups, generally only men with children. Once the tent is pitched, a dormitory is organized under canvas. Each tent can host up to 5/6 people, one or two are children aged from 6. There is an electricity generator in the camp to provide the tent with light and allow the use of satellite television. Each group of campers generally has two cars: one a normal car, the other a kind of 4x4 or pick-up used for outdoor activities.

Camping starts in spring and ends in autumn. A family can spend from one week to two months in a campsite and sometimes moves from one camp to another. The main activity is bird hunting, followed by fishing.

All the areas mentioned above are suitable for protection but, as stated above, there is a need for collection of further data and information.

4. CONCLUSION AND RECOMMENDATIONS

Further field survey will allow for comprehensive data collection to provide specific recommendations on boundaries and zoning of the future MPA. However, preliminary assessments indicated that the area shows some very important features that deserve protection, namely the Ain El Ghazala lagoon, the small islands of Bomba Bay, the seagrass meadows, the salt marshes, the sandy beaches and the rocky shores with *Dendropoma petraeum*. The preliminary identification of threats and use of the marine environment will help the MPA relevant authorities in the future management planning process. Moreover, some indicators for the development of a future monitoring programme can be envisaged (Box 2).

Box 2: Provisional list of important group of indicators for the development of a future monitoring programme based on current knowledge of the area.

- | | |
|----------------------|----------------------|
| • Fish assemblages | • Posidonia oceanica |
| • Bird populations | • Invasive species |
| • Turtle populations | • Illegal activities |

Ain El Ghazala lagoon

The lagoon appears to be very productive and also in a good state of conservation. The physical characteristics of the lagoon, together with the presence of a large *Cymodocea nodosa* meadow, make it a fundamental site to be preserved to maintain the ecological status and functions of the whole area. The lagoon is reported to be a spawning site for turtles but is very likely also important for several other marine species as both a spawning and nursery ground. The lagoon is also an important source of revenue and food for the tiny fishing community of Ain El Ghazala. Protection measures should take into account the presence of this activity. The future of aquaculture in this area should be clarified. In addition, the actual role of the lagoon as nursery and feeding ground should be better investigated including the fish assemblage composition inside the lagoon, considering that Siganids—invasive species—dominate catches.

Bomba Bay Islands and Posidonia oceanica meadows

The portions of the islands we saw both from the surface and underwater seem very interesting as they host a highly heterogeneous seascape characterized by priority habitats (Box 3) and species (Box 4) for the Mediterranean Sea. However, while we had the chance to see small *Dentex dentex* and different species of groupers in very shallow waters, our observations did not fit with reports from spear gun fishers. It seems that both abundance and, in particular, the size of predatory fish species has declined dramatically in a few decades. The habitats found underwater, and in particular the *P. oceanica* meadows, seem to suffer from changed sediment dynamics. Most of the meadow we observed while diving has been choked—or is about to be choked—by sand. In some areas the meadow is patchy and a fragmentation process seems to have occurred, driven by sediment movement and possibly mechanical damage. Between the patches what seems to be a sandy substrate is actually a dead mat covered by a layer of sand.

From our interviews we discovered that illegal trawling is a common activity. Egyptian and European trawlers are commonly spotted early in the morning or during the night trawling very close to the shore. Speargun fishers reported not only reduced catches and smaller trophy fish but also seascape changes.

Many rocky areas were reported to have been buried by sediment as well as the *P. oceanica* meadows. Another activity that may potentially have caused disruption is blast-fishing. We know it is common and we know people were aware of our presence and stopped this activity as a result, so we cannot report any blast-fishing undertaken during our stay except during the day of the snorkeling dives in Barda island. Therefore, it is not easy to say how common this technique is and how destructive it is for the underwater habitats.

Salt Marshes

We had the chance to observe some of the salt marshes of the area, in particular those close to Timimi. We can say that these areas, together with the Ain El Ghazala lagoon, are important for the life cycles of many marine species, but not exclusively these. The areas are fundamental for migratory water birds that are targeted by hunters. These areas need protection as they are threatened by illegal hunting and by a fishing activity that is not easy to assess, but which certainly includes techniques with an extreme impact such as those involving explosives.

Box 3: Principal marine habitats recorded in Ain El Ghazala and Bomba gulf

- *Posidonia oceanica* meadows: macro atolls, posidonia on rocky bottom, posidonia on sandy bottom, posidonia on gravels, hill facies, drop off matte, dead matte
- *Cymodocea nodosa* meadows
- Mixed *Posidonia* and *Cymodocea* meadows on rocks and gravels
- *Caulerpa prolifera* meadows
- *Cystoseira* spp. belts
- Little rocky marine habitats > photophyll algae biocenosis
- Rocky habitats: slabs, overhangs, micro faults
- Semi-dark marine caves
- Sandy substrates
- Gravelly substrates
- Mussel facies
- Ripple marks of coarse-grained sand with litter
- Ripple marks of coarse-grained sand without litter
- Huge rocky submarine shelf
- Submarine relief with erosive figures.

Box 4: List of species included in Annex II and Annex III of the Protocol SPA /BD

- 7 species Annex II
- Aplysina aerophoba*
 - Caretta caretta*
 - Cymodocea nodosa*
 - Cystoseira* sp.
 - Dendropoma petraeum*
 - Pinna nobilis*
 - Posidonia oceanica*
- 2 species Annex III
- Epinephelus marginatus*
 - Paracentrotus lividus*

Close to the salt marshes we saw several dumping sites for plastic and tin. Plastic in particular is moved around by the wind and eventually reaches the sea, becoming a potentially serious problem for marine animals such as turtles and mammals.



Waste, in particular plastics, is a potentially serious problem for marine turtles and mammals
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Sandy beaches and rocky shores with *Dendropoma petraeum*

Unfortunately, we were not able to survey these habitats. However, RAC-SPA representatives confirmed on the basis of previous missions that sandy beaches west of Ain El Ghazala lagoon are important nesting sites for *Caretta caretta* and that some *Dendropoma petraeum* structures are found nearby.

Important actions for the future management and protection of the area

While planning the establishment of a marine protected area in Ain El Ghazala and Bomba Bay, it seems important to suggest some other actions that should run in parallel. These include:

1. Establishment of a turtle rescue centre: this should complement the Libyan Sea Turtle Programme implemented jointly with RAC/SPA in the framework of the Action Plan for the conservation of Marine Turtles in the Mediterranean Sea. It should involve an overall process of awareness-raising for the whole local population as well as training of local people in turtle rescue and surgery techniques. In addition, fishermen should be trained concerning the importance of turtles and how to cope with an individual entangled in the net. Finally, a centre should be built and supported not only to function as a rescue centre but as an education centre to encourage participation in and awareness of nature conservation. Spawning, nesting and feeding areas of the turtle *Caretta caretta* should be protected. Turtle populations and biology should be monitored over time.
2. An extensive education campaign is needed, addressing campers, to make them aware of existing natural resources and how they are contributing to damaging them. They should be made aware of the life cycle and importance of migratory birds as well as the importance of salt marshes. Alternative outdoor recreational activities should be promoted and taught (i.e. bird watching and the construction of shelters for observing nature, photography competitions). Migratory and water bird populations should be monitored over time.
3. Illegal fishing is a plague worldwide. Awareness campaigns should be promoted to encourage the eradication of blast-fishing. The problem of illegal trawling is a more difficult issue to tackle. Further investigations are needed to better understand the phenomenon by assessing the kind, frequency and national origins of illegal trawlers in the area. Meanwhile, an extensive long-lasting project to assess the health and trends of *Posidonia oceanica* in the area should be prepared. Fish assemblages and, in particular, predatory assemblages should be monitored before and after protection.
4. A more general education and communication strategy should be planned to raise public awareness on biodiversity conservation and the benefits and opportunities that it generates. This should be coupled with a capacity building programme focused on MPAs and sustainable management of coastal and marine resources, targeting local government authorities and specific economic sectors. There is a need to train on the basic knowledge for those stakeholders who will be engaged in the future design, establishment and management of MPAs.
5. Finally, there is an urgent need to update the legal and institutional framework of conservation in Libya, with more emphasis on marine and coastal protected area selection, funding and governance.

Considering all the above, a new mission is recommended to gather additional data to better provide recommendations for the future management of the MPA.

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