MANAGEMENT PLAN OF THE COASTAL AND MARINE AREA OF SHASH - GULF OF SIRT IN LIBYA : ASSESSMENT-DIAGNOSTIC

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ELABORATION OF THE MANAGEMENT PLAN OF THE COASTAL AND MARINE AREA OF SHASH - GULF OF SIRT IN LIBYA: DRAFT ASSESSMENT-DIAGNOSTIC REPORT

Table of Contents

Background /Introduction

With the support of SPA/RAC, and in 2022, the Libyan Ministry of Environment elaborated, the national strategy for the development of protected areas. The main aim of this strategy is to establish a national network of protected sites covering a representative set of zones and habitats within the country. One of these zones is the Gulf of Sirte which was listed in the strategy as a potential site to be declared as an MPA. Besides its high conservation value, the proposed area is one of the most important nesting sites for the loggerhead sea turtle in Libya and in the Mediterranean.

Accordingly, the Gulf of Sirte is now one of the beneficiary sites of the IMAP-MPA project that is being coordinated by UNEP/MAP Secretariat and implemented by SPA/RAC. The aim of that project is to develop an integrated monitoring of the sea and coasts, and to improve Marine Protected Areas (MPAs) management in the Southern and Eastern Mediterranean countries.

In this regard, the IMAP-MPA project has been selected to support the elaboration of the management and business plans of the Shash area in the Gulf of Sirte. The overall role of the project in this matter, as defined in the RAC/SPA tender document, is to elaborate a management plan of the coastal and marine area of Shash in the Gulf of Sirte.
Therefore, and within the framework of the project, this report intend to assess the prevailing “eco-socio-system” within the marine and coastal area, and advocate the role of all stakeholders who are striving for its management either directly or indirectly.

The present Phase 1 of the project consists of (i) assessing the situation in the Marine and Coastal Area of Shash (Gulf of Sirte) in Libya. This is achieved by synthesizing and updating the available data taking into account the evolution of land use and anthropogenic pressures. (ii) conducting a gap analysis to highlight the most relevant knowledge shortage in the study area. The outcomes of Phase 1 will be used to elaborate a management plan based on realistic objectives stemming from the identified priorities and challenges.

Chapter 1: GENERAL OVERVIEW AND CURRENT STATE IN THE AREA

1. Geographic context and location of the study area

Libya has a long coast that extends to 2,000 km. It is divided into three main regions according to the topography of the continental shelf, which is wide in the western region (coast of Tripolitania) and becomes less wide in the gulf of Sirte and narrows in the eastern region (coast of Cyrenaica). The habitat in the eastern part constitute mostly of a rocky coast, including rocky shores, sandy seabed's, shallow and deep-water (200 m+) with a considerable number of bays, submerged and partially-submerged sea caves. This variety in habitats and formations supports a range of benthic biota including marl beds and a range of marine communities. The middle region of Libya (The Gulf of Sirte), is mostly consists of sandy beaches interspersed with small rocky formations. It provides a suitable habitat for fish species, thereby supporting a more elaborate marine food web, which includes larger pelagic fish species (e.g. Bluefin Tuna and sharks), seabirds, marine mammals and reptiles. The western region is characterized by a wide continental shelf and a rocky coast interspersed with some sandy beaches.

The Gulf of Sirte (also known as the gulf of Sidra, Khalīj Surt, Syrtis Major) extends for roughly 443 km between the major cities of Miṣrātah and Banghāzī (Fig. 1). The study area is situated in the Municipality (*Baladiyyah*) of Sirte in the Tripolitania region[1].

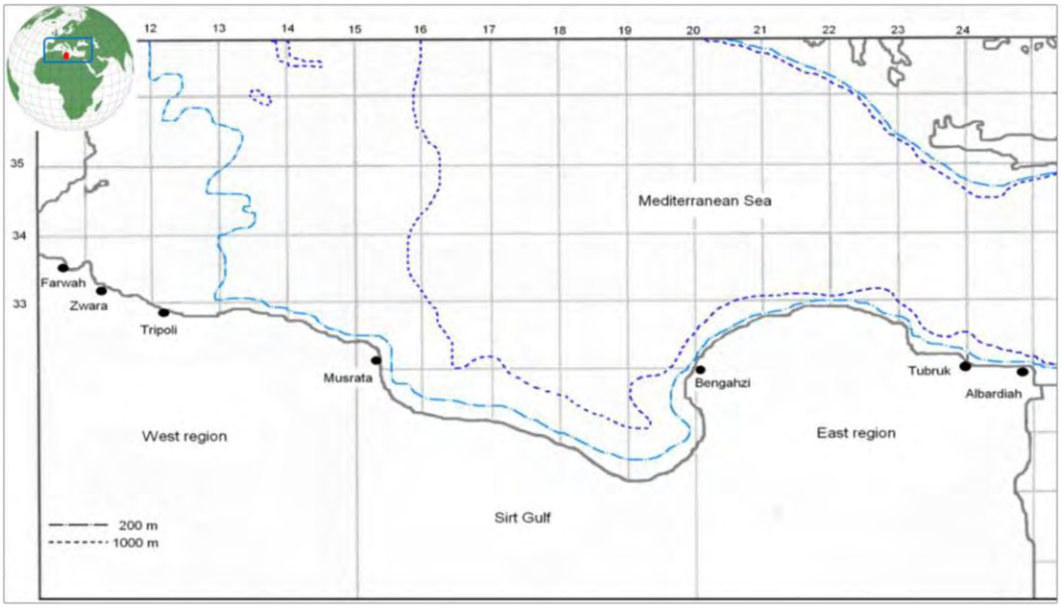

Figure 1: Map of the Libyan coast (Shakman, 2008)

[1] قرار مجلس الوزراء رقم 180 لسنة 2013 م بشأن اعتماد البلديات [Council of Ministers resolution No. 180 for the year 2013 AD the establishment of baladiyat]. اللجنة المركزية لانتخابات المجالس البلدية [The Central Committee for the election of baladiyah councils]. Retrieved 2022-04-14.

2. Historical background of conservation in the area

The Gulf of Sirte is one of the beneficiary sites of the IMAP-MPA project coordinated by UNEP/MAP Secretariat and implemented by SPA/RAC to develop the integrated monitoring of the sea and coasts and improve Marine Protected Areas (MPAs) management in Southern and Eastern Mediterranean countries.

An environmental and socioeconomic assessment of the Gulf of Sirte, elaborated by UNEP/MAP-SPA/RAC in collaboration with the Libyan experts within the EU funded IMAP-MPA project, highlighted the need for further expansion of sites within the Gulf and to secure fisheries sustainability. The socioeconomic survey conducted in the Gulf showed that about 66% of the fishers interviewed were very positive towards the creation of marine protected areas in the region. They stated that the Gulf includes zones such as Shash area, Lewaija and Ras Al-Ghara, which "are rich in biodiversity, but need to be protected from unsustainable practices such as illegal fishing".

In fact, 45.8% of the interviewed fishers highlighted the importance of the area extending from Al-Thalatheen to Khamseen beaches west of Sirte, including the shores west of Al-Thalatheen, and Shash and Tammt Al-Khamseen beaches, which have a total length of about 20 km. Group interviews were conducted with the local community in the Al-Thalatheen area and they welcomed the proposed reserve and the idea of including Al-Thalatheen area in the proposed protected area “MPA of Shash”. The Shash area is considered a hotspot area due to its rich biodiversity characterized by the presence of sea turtle species such as (*Caretta caretta*) that nests densely on these beaches, variety of cartilaginous fish species, *Posidonia oceanica* meadows, important species of mollusks such as *Tonna galea*, in addition to the presence of species of dolphins.

Following a technical workshop organized in 2021 by SPA/RAC in collaboration with the Ministry of Environment of Libya, and on the subject of ecological and socioeconomic assessments of the marine and coastal area of the Gulf of Sirte,, priority was given to the Shash area, one of the 3 Hotspot areas in the Gulf of Sirte, as a marine and coastal reserve due to its importance in terms of biodiversity and the presence of most endangered species.

Later, the area of Shash was declared as a Marine and Coastal Reserve by the Libyan Minister of the Environment within the Decision n°218 of 2022. This Ministerial Decision states that, first, all types of hunting and fishing activities are prohibited in this reserve; second, the Ministry of Environment, in coordination with the relevant authorities, is responsible for setting the boundaries and marine markers for the protected site.

3. Protected Area boundaries

The proposed basic boundaries of the Shash marine reserve extend from Al-Thalatheen Beach to Al-Nakhla Beach, west of Sirte, and include six beaches (Al-Thalatheen, West Al-Thalatheen, Shash, Tamet, Al-Khamseen, and Al-Nakhla). the borders also includes the area north of the coastal road, and 6 km into the sea, as well as Sabkhat Al-Khamseen, located South of the coastal road. The total length of the beaches is about 34 km, with a total area of about 240 km^2, of which 80 km are the area of Sabkhat Al-Khamseen (Fig. 2).

The length of the Shash beach is 4.85 km and it is generally sandy and extends inland to a distance of up to 100 meters in some places (Saied & Dreyag, 2019).

The 20 km area extending from the beach of Thalatheen to Khamseen west of Sirte and includes beaches (west of Thalatheen, Shash, Tamet, and Khamseen), is characterised by high abundance in biodiversity. For example, the presence of megafauna species such as sea turtle (*Caretta caretta*) that nests densely on these beaches, the presence of *Posidonia oceanica*, species of cartilaginous fish, important species of mollusks such as *Tonna galea*, in addition to the presence of delphinid species. Also, most parts of the sandy beaches are naturally protected due to the presence of barriers and trenches that isolate the area and prevent access to the beach except through rough and complex maze-like roads. During the interviews with the local stakeholders, a number of respondents suggested that the proposed reserve should extend to the beach of Al-Bwirat to be a total length of 60 km due to its importance as a breeding area for cartilaginous fish, the presence of *Posidonia oceanica* meadows and other important species.

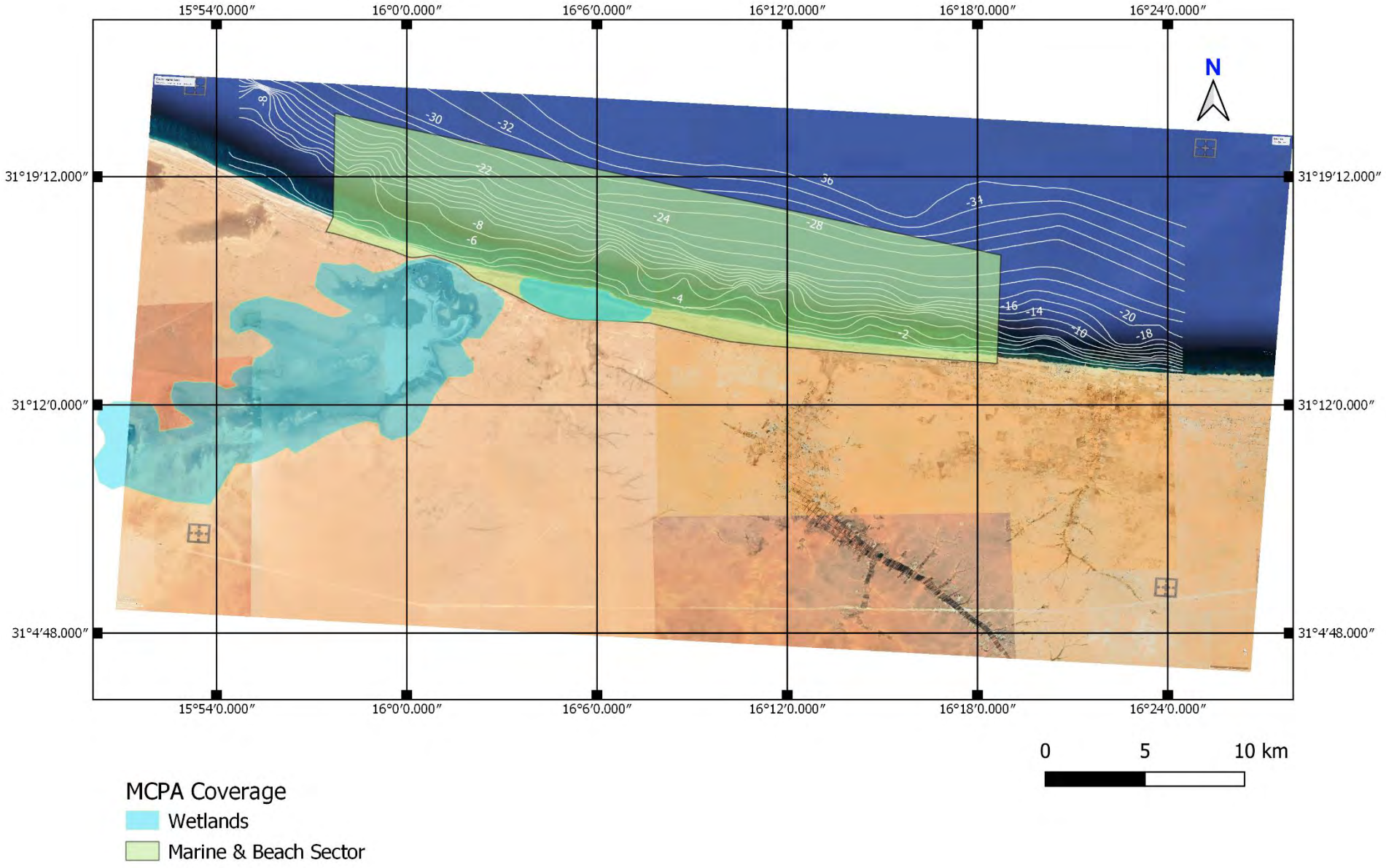

Figure 2: Location and boundaries of the Marine and Coastal Area of Shash

4. Methodology for the bibliographic review and assessment-diagnosis of the current state of the site

Desktop review of available information

In order to understand the current state of the area in question and to undertake a preliminary synthesis and compilation of existing documents, a literature review was conducted. The following data sources were considered:

- *Scientific and "grey" literature;*
- *Technical reports and published articles;*
- *The main findings of the valuable studies conducted in the area within the framework of the IMPA-MPA project, namely the ecological and the socio-economic study carried out by the Ministry of Environment;*
- *Previous studies on monitoring nesting sites of marine turtles conducted in the study area;*
- *Available national environmental and socio-economic database;*
- *Other relevant data and information already available to national consultants and experts.*

Data collection, compilation, and analysis

Starting from the already available documents and the conducted gap analysis, an extensive data and information gathering process was carried out at the local level, through interviews conducted by the national consultant.

Furthermore, contacts with the relevant sectors were made to collect information and (where possible) relevant documents on fisheries, recreational uses, cultural heritage, flag species habitats, etc.

Moreover, a geo-referenced database was elaborated by including base maps, available satellite images, infrastructure facilities (roads, Electricity lines, industrial units, etc.) as well as main pollution sources and other anthropogenic stress sources.

Consultation workshop with stakeholders

The objective of this workshop was (i) to inform the stakeholders about the tasks to be undertaken and to consult with them about the outcomes the objectives of the future management plan for the marine and coastal area of Shash - Gulf of Sirte. It took place in Tunis from 12 to 13 October 2022 and was attended by representatives of the Libyan Ministry of Environment, a number of local stakeholders from the MPA zone, the team of experts in charge of the elaboration of the management plan and representatives of SPA/RAC.

5. Natural heritage

5.1. Geophysical, geomorphological and oceanographic features

5.1.1. Geology, Geomorphology and Topography

Libya as a whole is a cratonic basin on the northern fringe of the African tectonic plate. Precambrian rocks occur in the south and southeast of the country. Libya contains

sequences of moderately deformed Paleozoic rocks, and Mesozoic sedimentary rocks are comparatively scarce. Tertiary rocks occupy the greater part of the gulf of Sirte region and northern Cyrenaica. Tertiary and Quaternary extrusive and intrusive rocks occupy large areas in the central part of the country and smaller areas in south-central Fezzan and northern Tripolitania[2].

The Sirte area is underlain by stratified marine and continental sedimentary rocks of Tertiary and Quaternary age. The oldest rocks cropping out in the area form large beds of originally marine limestone ranged in colour from white to yellow. Soft green, yellow, and gray marl, as well as clay and sandstone can be found intercalated with the limestone. These rocks, of probable Miocene age, lie at or near the surface in the Sirte plateau, but they are mantled by later Quaternary deposits in the coastal plain and in the Wadi Tlal and its tributaries. The coastal plain is covered by sand and loosely cemented sandstone of Quaternary age, and along the shore these deposits are covered by recent dunes of unconsolidated sand[3].

The geomorphology of the coastline in this section is characterized by sandy beaches of different sizes, forming sand dunes in some parts of the coast or interspersed with the rocks.

The coastline topography consists of a mosaic of rock formations, sandy beaches and seasonal wetlands (sabkhas). Along with being isolated from the coastal highway by vast salt marshes making it hard to access, this area has significantly low anthropogenic presence and activity. On the other hand, these factors also represent a priority and a challenge for monitoring efforts.

Shash Beach is considered semi-protected due to the artificial long berm extending parallel to the beach, which make access to it very difficult and through maze-like roads. The length of the totally sandy beach is 4.85 km and the extended dunes reach far from the beach for a distance of up to 100 meters in some places[4].

5.1.2. Oceanography

5.1.2.1. Bathymetry

Three bathymetric zones can be recognised all along the Libyan coast according to Sogreah (1975); these zones are closely associated with major formation of the African continent. The first and largest of these areas contains a relatively even plateu of about 50 000 km^2 that is an extension to the Gulf of Gabès in Tunisia. Its depth is less than 200 m, while its slope is less than 1%. The two other areas are either steeper or deeper[5]. The more northerly region consists of an underwater basin of particularly rugged bottom connected to the Pantelleria and Linosa trenches. The other area, east of 13° E longitude, forms the Tripolitanian precontinent, which joins the Libyan landmass to Malta and Medina banks by a ridge varying in depth from 200 to 500 m. The Tripolitanian precontinent is a fairly even area at a depth greater than 200 m. It is divided into two large but narrow underwater valleys, one from Tripoli extending to northwest, and the other closer toward Medina bank in Malta. Along the coast of this area, a series of fairly regular rocky ledges are found down to a depth of about 30 m,

[2]Goudarzi, G. H. 1970. Geology and mineral resources of Libya - A reconnaissance. U. S. Geol. Surv. Prof. Paper 660.
[3] Ogilbee, W., 1964, Ground water in the Sirto area, Tripolitania, United Kingdom of Libya: U.S. Geol. Survey Water-Supply Paper 1757-C, p. C1-C14.
[4] Saied & Dreyag, 2019. Project to protect sea turtles in the shores of Libya (Final Report 2019). 69 pages.
[5] Sogreah Consulting Engineers (1975). Trawl Fishing Ground Survey off the Tripolitania Coast. Ministry of Food and Marine Wealth, General Department of Marine Wealth, Socialist People's Libyan Arab Jamahiriya

a platform that is covered in some places by sand deposits of varying thickness. The eastern part of the Libyan coast, the Gulf of Sirt and Cyrenaica, is mainly rocky, and the continental shelf is steep and narrow (Zupanovic and EL-Buni 1982). In few areas of Cyrenaica the continental edge is only 5 km away from the coastline before the seabed plunges into the Herodotus Trench with a slope that reaches 30%.

In the gulf of Sirte, The eastern part (closer to Cyrenaica) is a deep region where the 100 m isobath is less than 20 km from the coastline While the southern and western parts of the Gulf are considerably shallower

In the area covered by the MCPA of Shash (Gulf of Sirte), the maximum depth ranges from -30m and -32m. The seabed of the area is made of flat slope except for the depths between -6m and -24m where the bathymetry map shows abrupt slopes (Figure 3)

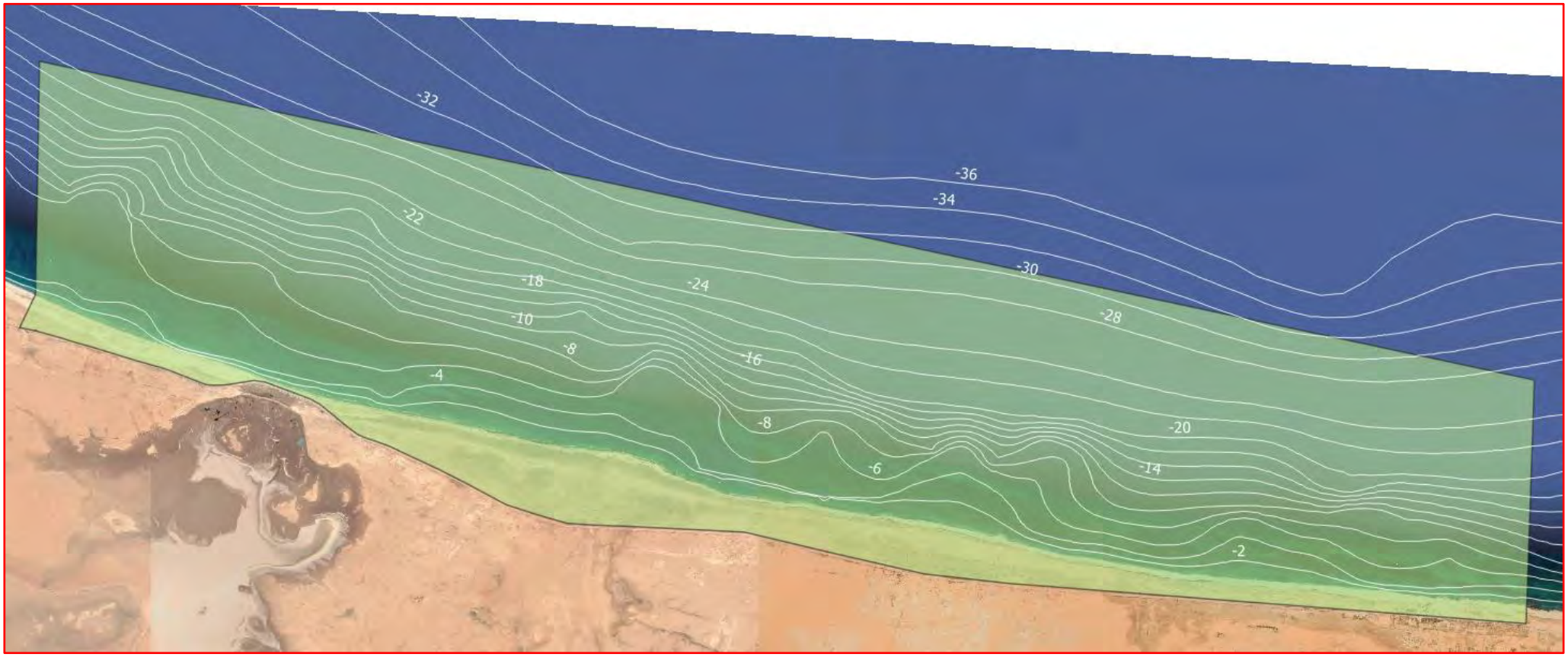
-32
-36
-34
-22
-30
-18
-24
-28
-10
-8
-16
-4
-8
-20
-6
-14
-2

Figure 3: Bathymetry of the MCPA of Shash (Gulf of Sirte)

5.1.2.2. Currents and waves

The seawater dynamics in the area between Sicily and Libya present many different meso-scale current paths with current speeds that could reach up to 50 cm/s, as widely reported. These current paths can be divided into three main types:

(i) the permanent Atlantic surface current that run at 25-30 m depth in the winter and up to 50 m depth in the spring, slowing towards the east, and moving along the north African coasts. This current reaches Libya through the Gulf of Gabès before splitting into two branches, one returning to the Gulf of Gabès following a north-westerly counter flow away from the coast, while the other continuing eastwards (Zupanovic et al., 1983);

(ii) (ii) the Mid-water current, which follows at 200-600 m depth, moving contrary to the east -to-west surface current;

(iii) (iii) the Deep-water current which flows in waters >1000 m deep. It consists of cold stable saline water moving in various directions and speed as its temperature or salinity changes[6].

The Atlantic Tunisian Current (ATC), slower than the Atlantic Ionian Stream, flowed southwards in a meandering (winding) pattern, before turning eastwards near the Libyan coast. It is a relatively fast current which decrease its velocity while moving south-eastward. The Atlantic Libyan Current (ALC), which can be considered as the eastward extension of the former ATC along the Libyan coast, appears to be progressively narrower towards the east. (Placenti, 2013; Sorgente *et al.*, 2011).

A further dominant feature in the gulf of Sirte is the Sidra Gyre, a sub-basin permanent anti-cyclonic spiral about 150–200 km in diameter. It strongly interacts with the ALC, pushing the coming Atlantic Water (AW) toward the Libyan coast in a narrow stream. The Sidra Gyre appears as the main dynamical mechanism that influences the outflow of AW outside the Sicily Channel and controls the inflow of warm and salty Ionian Surface Water from the eastern side of the Libyan shelf through its southern arm (Gerin *et al*., 2009; Sorgente *et al*., 2011; Placenti, 2013).

Regarding waves, the Libyan coast is generally exposed to waves caused by wind. The largest of these waves is formed in winter by the north-west winds, which is the fastest wind pattern blowing on the Libyan coast (Algraeo & Bouaziz, 2013).

5.1.2.3. Salinity

Salinity values ranged between 37.5 and 38.9 between the surface and bottom. High salinity values that can be found below 100–150 m depth are due to the inflow of the Levantine Intermediate Water current.

[6] IUCN (2011). Towards a Representative Network of Marine Protected Areas in Libya. Gland, Switzerland and Málaga, Spain: IUCN. 68 pages.

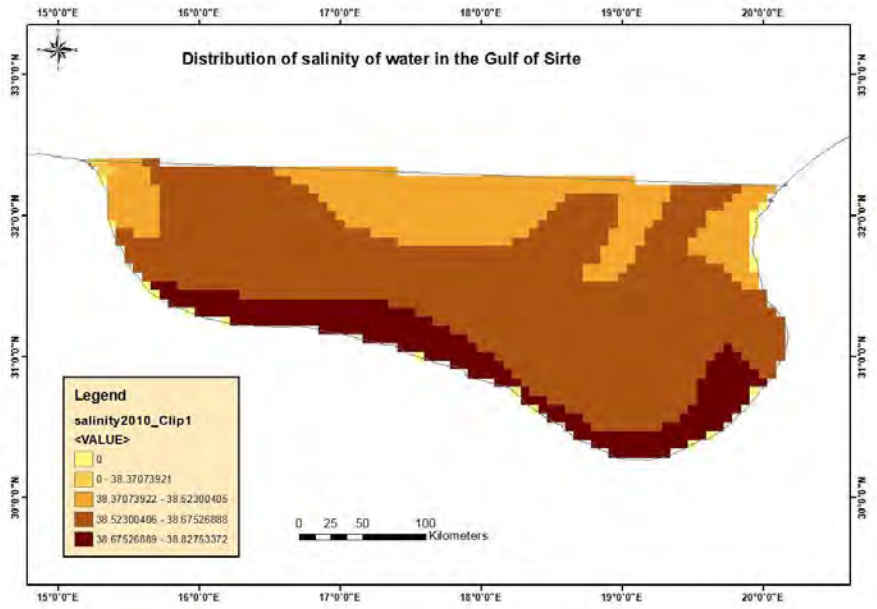

Figure 4: Distribution of water salinity in the gulf of Sirt (AVISO+, 2020; SPA/RAC–UN Environment/MAP, 2020b)

5.1.2.4. Water temperature

The temperature through the water column between Libya and Sicily varies between 12 ºC within the water column to 25-28 ºC at the surface. Sea surface water temperature is strongly influenced by seasonal air temperature variations reaching 29 ºC on average in August and falling to 12.5ºC in January. The presence of steep thermocline is evident, the base of which (about 17.5 °C) was located at a water depth of 50–75 m.

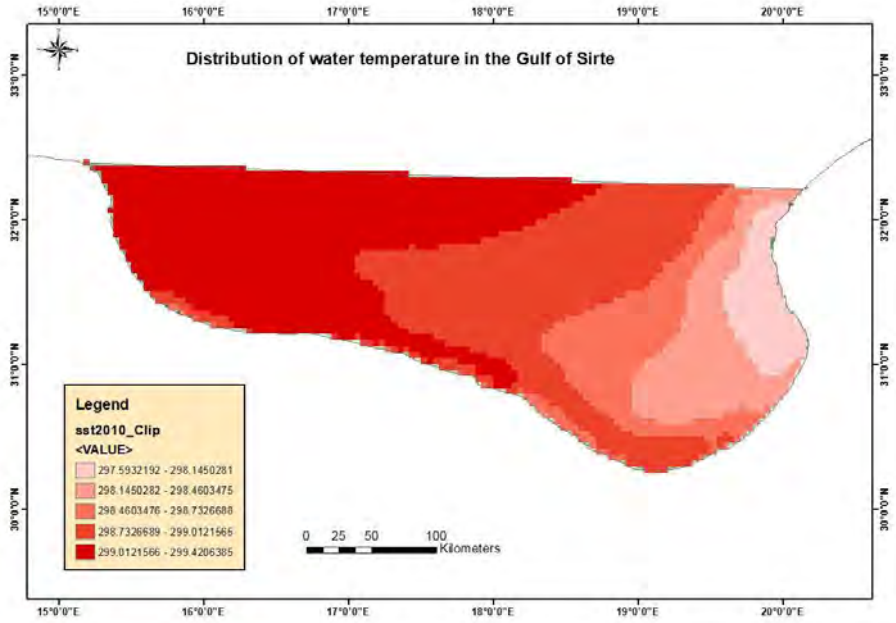

Figure 5: Distribution of water temperature in the Sirte gulf (AVISO+, 2020; SPA/RAC–UN Environment/MAP, 2020b)

5.1.3. Climate and hydrology

Libya has four main ecosystems within the country. These ecosystems have different climate conditions suitable to a variety of both flora and fauna[7]: Coastal Ecosystems, Semi-desert Ecosystem, Maquis formation and Desert Ecosystem. The study area lies within the coastal ecosystem.

In the coastal areas of Libya, the dominant climate is the Mediterranean climate, with warm summers and mild winters. The prevailing winds are from the north and east between May and October and from the north and west between November and April. Occasionally, strong south to south-east dusty winds, known as 'Ghibli', occur. The highest average wind speeds take place during the winter months (November to February, up to 18 knots of average wind speed) and are lower in intensity (around 6 knots) from June to August. The mean temperature is 15-17 ºC in February and 25-38 ºC in summer.

The annual rainfall is about 200–250 mm and rainfall is minimal across the year. Visibility is 98% year-round due to the dry climate. According to the National Centre for Metrological, the highest quantity of rainfall in the rainy season in Sirte was recorded at 22 mm in 2015 and a seasonal quantity around 101.9 mm in the same year.

The hydrological conditions of the coastal sea are dominated by three water mass layers. The surface layer, with low salinity and nutrients, comes from the Atlantic, crosses Gibraltar and moves eastwards reaching the Gulf. The intermediate layer, with a maximum salinity of 38.75 ‰ and high nutrient levels, moves westward out of the Levantine Sea. The deep layer (usually at a depth of >1000 m to the bottom), is cold, less saline and very homogeneous. It flows from the nearby Adriatic.

5.2. Biological features

Generally and according to EGA (2010), Libya has a limited space suitable for the living of species. From a total of 1.7 million described globally, Libya has about 2,135 plant and 4,590 animal species. For fauna, the most important of these taxa in terms of numbers is insects (81%), followed by birds (7%) while estimates of marine animal and plant species are about 1,500. For instance, there are 560 species of marine algae, and three species of endangered seagrasses in the Mediterranean Sea, and about 100 species of fish and three species of marine reptiles (turtles)[8].However, species diversity in Libya still needs further taxonomic studies to be well documented.

The middle region of the country (the Gulf of Sirte), consists mostly of sandy beaches interspersed with small rocky areas. It provides suitable habitat for fish species, thereby supporting a wider marine food web including larger pelagic fish species (*e.g.* Bluefin Tuna and sharks), seabirds, marine mammals and reptiles.

The data on biological richness in Libya is fragmented, very limited and insufficient due to a deficiency of literature reviews and field surveys.

[7]Environment General Authority (EGA), (2010). The Fourth National Report on the Implementation of the Convention of Biological Diversity (CBD).
[8] Mahklouf, Mohammed & Etayeb, Khaled. (2018). Biodiversity in Libya: Selected Countries in Africa. Global Biodiversity, Volume 3, Chapter 5. 113-133.10.1201/9780429469800-5.

There is a serious lack of comprehensive studies on marine organisms occurring in the area, and this part of the Mediterranean remains among the least known to scientists (Shakman, 2008).

Despite the lack of information describing the Libyan waters, most of the marine areas has been recognized and documented as being of high ecological value.

5.2.1. Terrestrial biodiversity

5.2.1.1. Terrestrial flora

Nearly 75% of terrestrial flora is concentrated in the coastal strip of the Libyan coast which in turn receives between 100 to 600 mm of rainfall. The flora of Libya includes 1750 species spread over 118 families and 744 genera[9].

Natural vegetation is sparse and generally restricted to drought-resistant plants. A recent survey conducted near the city of Sirte pointed out the presence of 75 plant species belonging to 67 genera and 32 families, 5 species of which are considered regionally rare[10]. Among these plant species the most abundant are *SalsolaTetrendra*, *Ristida pungens*, *Thymelaea 14irsute*, *Atriplx Mollis*, *Arthrocnemum glaucum*, *Limoniastrum monopetalum*, *Artemisia compestris*, *Calycotoma spinosum, Anabasis articulata, Nitraria retusa, Haldxylol salicormisah*, *Mesembryanthemum nodiforum*, *Retama raetam* and other plants that grow and increase in growth after the rainy season. These plants contribute heavily to the soil stabilization, combating desertification, and preserving biodiversity. Many of these plants were removed during the construction of buildings within the city, and the remaining plants are now concentrated in the coastal strip, the swamps in the center and on the outskirts of the city where little construction and urban expansion is taking place (Sebi'ei, 2009).

The only common phreatophytes are the date palms *Phoenix dactylifera* growing along the coast where the water table is close to the land surface. Reeds and other marshgrasses also exist locally. Natural vegetation like small trees can be found in wadis, particularly in Wadi Zamzam and Wadi Soffegin areas. Other plants such as eucalyptus *Eucalyptus camaldulensis*, acacia, several varieties of saltcedar, and tamarisk have been introduced into the country and thrive without irrigation. These varieties are used extensively as wind-breakers and firewood. Eucalyptus is also used for making charcoal[11].

Table 1: List of known coastal vegetation species in Sirte[12 &13]

N°	Species	Local name
1	*Acacia tortilis*	الطلح
2	*Achinaps spinasus*	شوك بل
3	*Amaranthus viridis*	ابوزنزير

[9] Environment General Authority (EGA), (2010). The Fourth National Report on the Implementation of the Convention of Biological Diversity (CBD).

[10] EGA, Sirte branch 2009 unpublished data in SPA/RAC–UN Environment/MAP, 2020a. Socio-economic study of the coastal and marine area of the Gulf of Sirte. By Almokhtar Saied, Salih Diryaq and Atef Limam. Ed SPA/RAC. IMAP-MPA Project, Tunis: 74 pages + annexes).

[11] Goudarzi, G. H. 1970. Geology and mineral resources of Libya - A reconnaissance. U. S. Geol. Surv. Prof. Paper 660.

[12] فائق حسن عويدات. (2008). التصحر في المنطقة الممتدة ما بين وادي هراوة شرقاً ووادي جارف غرباً بمنطقة سرت. رسالة ماجستير.

[13] Environment General Authority (EGA), (2010). The Fourth National Report on the Implementation of the Convention of Biological Diversity (CBD).

4	*Anabasis articulata*	عجرم بقل
5	*Artemisia compestris*	شعال
6	*Arthrocnemum glaucum*	بلبال الجمل
7	*Asphodellus microcarpus*	العنصيل
8	*Atractvlis prolifers*	لبد
9	*Atriplx mollis*	القطف
10	*Calycotoma spinosum*	قندول
11	*Colay cynithis vulgaris*	الحنظل
12	*Cornulaca monacantha*	طاهرة، سويدا
13	*Cynodon dactylon*	نجيل
14	*Eryngium maritimum*	الخيجية
15	*Eucalyptus camaldulensis*	سرول كافور
16	*Euphorbia terracina*	لبينة
17	*Euphorbia paralias*	لنقيز
18	*Juncus acutus*	يس سمار
19	*Haldxylol salicormisuh*	الرمث
20	*Hammada scoparia*	وين الدهان
21	*Limoniastrum monopetalum*	الزيته
22	*Lycium europaeum*	العوسج
23	*Lygeum spartum*	حلفاء مصنغة
24	*Nicotiana glueaca*	عكوز موسى
25	*Mesembryanthemum nodiforum*	الغسول
26	*Nitraria retusa*	غردق
27	*Pancratium martimum*	بوفرية سوسن السافي
28	*Polygonum equisetiform*	قرضاب
29	*Posidonia oceanica*[14]	تبن البحر، رجل
30	*Piturnathus tortuousus*	القزاح
31	*Phoenix dactylifera*	نخيل البحر
32	*Phragmites australis*	قصبة
33	*Priploca angustifolia*	
34	*Retama raetam*	الرتم
35	*Reaumuria hirtella*	ام الندى
36	*Rhantherium Suavepens*	عرفج
37	*Rhus oxyacantha*	الجداري
38	*Ristida pungens*	السبط
39	*Salsola tetrendra*	الجل
40	*Stipa lagasoae*	غدام
41	*Tamarix aphylla*	ثل
42	*Thymelaea hirsuta*	المثنان
43	*Tragnum nudatun*	الضمران
44	*Ziziphus lotus*	السدر

[14] *Posidonia oceanica* beach-cast litter accumulations, known as " banquettes "

5.2.1.2. Terrestrial fauna

The number of Arachnids classified in the area is about 170 species. Insects are the majority of the Libyan animal diversity. The approximate number is 3,763 species (EGA, 2010). In contrast, amphibians represent the smaller number of species within the Libyan Fauna with only three species occurring in the country. For reptiles, the classified species found in the country are 113 while the same reference (and other sources) stated that there are 356 species of Birds (100 are currently breeding in Libya) found in Libya (Isenmann *et al*., 2016).
Finally, there are 76 species of mammals found in Libya classified under 25 families and 47 genera. Among these, 12 are threatened and considered critically endangered or vulnerable, and 2 species of endemic gerbils (*Gerbillus grobbeni* and *Gerbillus syrticus)* (EGA, 2010).

5.2.1.3. Alien Terrestrial Species in Libya

According to Mahklouf (2019, 2021), a total of 29 invasive floral species have been documented in Libya. These species belong to 25 genera and 13 families most of them (12 families) are dicots and only one family is of the monocots (three genera with one species in each). The dominant families are Asteraceae with seven species, followed by Amaranthaceae with five species; then the families Solanaceae, Fabaceae, and Poaceae with three species each; while the rest of the families are represented by only one species each. Among these species, 12 were found to be highly invasive.

5.2.2. Marine Biodiversity

5.2.2.1. Plankton

The phytoplankton association in the Gulf of Sirte is abundant and composed of species belonging to Coccolithophyceae (about 40 species), followed by Diatoms, Dinoflagellates, and rare to very rare Silicoflagellates. Concerning ichthyoplankton, 40 larvae of fishes species have been documented belongs to 21 families (SPA/RAC–UN Environment/MAP, 2020b).

5.2.2.2. Marine flora

The floristic composition of marine vegetation in Libya is still comparatively unknown as far as in-depth ecological and botanical studies go. About 190 of benthic macrophyta species are recorded on the Libyan coast including 59 species belonging to phaeophyceae (brown algae), 35 to Ulvophyceae (green algae), 112 to Rhodophyceae (Red algae) and 2 species of seagrasses[15]. In the Gulf of Sirte, only 18 algae species have been listed by Nizamuddin *et al*. (1978) (Table 2) and 02 species of Magnoliophyta/seagrasses (*Posidonia oceanica* and *Cymodocea nodosa*). Among these species, 2 species of algae (*Caulerpa prolifera* and *Cystoseira foeniculacea*) and 2 species of seagrasses (*Posidonia oceanica* and *Cymodocea nodosa*) are listed at the list of endangered or threatened species found in the

[15] G.M. Guiry in Guiry, M.D. & Guiry, G.M. 2022. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. https://www.algaebase.org; searched on 10 mai 2022

Mediterranean (Annex II of the Protocol on Specially Protected Areas and Biological Diversity).

Table 2: List of Marine algae species in the gulf of Sirte (Nizamuddin et al., 1978), *Annex II of Protocol SPA/BD

Marine Algae species	Class	Order	Family
Chlorophyta			
Microdictyon tenuius J.E.Gray 1866	*Ulvophyceae*	*Cladophorales*	*Anadyomenaceae*
Caulerpa prolifera * (Forsskål) J.V.Lamouroux 1809	*Ulvophyceae*	*Bryopsidales*	*Caulerpaceae*
Flabellia petiolata (Turra) Nizamuddin, 1987	*Ulvophyceae*	*Bryopsidales*	*Udoteaceae*
Halimeda tuna (J.Ellis & Solander) J.V.Lamouroux, 1816	*Ulvophyceae*	*Bryopsidales*	*Halimedaceae*
Dasycladus vermicularis (Scopoli) Krasser, 1898	*Ulvophyceae*	*Dasycladales*	*Dasycladaceae*
Ochrophyta			
Padina pavonica (Linnaeus) Thivy, 1960	*Phaeophyceae*	*Dictyotales*	*Dictyotaceae*
Dictyota dichotoma (Hudson) J.V.Lamouroux, 1809	*Phaeophyceae*	*Dictyotales*	*Dictyotaceae*
Dictyota implexa (Desfontaines) J.V.Lamouroux, 1809	*Phaeophyceae*	*Dictyotales*	*Dictyotaceae*
Cystoseira foeniculacea * (Linnaeus) Greville	*Phaeophyceae*	*Fucales*	*Sargassaceae*
Sargassum natans (Linnaeus) Gaillon 1828	*Phaeophyceae*	*Fucales*	*Sargassaceae*
Rhodophyta			
Peyssonnelia rubra (Greville) J.Agardh, 1851	*Florideophyceae*	*Peyssonneliales*	*Peyssonneliaceae*
Lithothamnion corallioides (P.Crouan & H.Crouan) P.Crouan & H.Crouan 1867	*Florideophyceae*	*Corallinales*	*Hapalidiaceae*
Mesophyllum expansum (Philippi) Cabioch & M.L.Mendoza 2003	*Florideophyceae*	*Hapalidiales*	*Mesophyllumaceae*
Pneophyllum zonale (P.Crouan & H.Crouan) Y.M.Chamberlain 1983	*Florideophyceae*	*Corallinales*	*Corallinaceae*
Neogoniolithon hauckii (Rothpletz) R.A.Townsend & Huisman 2018	*Florideophyceae*	*Corallinales*	*Spongitaceae*
Lophocladia lallemandii (Montagne) F.Schmitz, 1893	*Florideophyceae*	*Ceramiales*	*Rhodomelaceae*
Osmundaria volubilis (Linnaeus) R.E.Norris, 1991	*Florideophyceae*	*Ceramiales*	*Rhodomelaceae*

Rytiphlaea tinctoria (Clemente) C.Agardh, 1824	*Florideophyceae*	*Ceramiales*	*Rhodomelaceae*

The information about the seaweeds in the Gulf of Sirte is insufficient and there is a lack of specific updated references of its distribution and status along the coast. However, the Gulf of Sirte is known to host meadows of *Posidonia oceanica* as evidenced by the huge accumulating of dead meadows along the coast and even blocking the old harbour of Sirte indicating the richness of the area by seagrasses (SPA/RAC–UN Environment/MAP, 2020b). The accumulation of dead *Posidonia oceanica/ Cymodocea nodosa* leaves were observed all along the study area, however, some of these accumulations were permanent whilst smaller ones were temporally formed and washed away by waves.

Posidonia oceanica distribution is poorly documented along the Libyan coast and there is no monitoring network for the coastal marine environment especially for Posidonia. Thus, we recommend carrying out a detailed mapping of the distribution of Posidonia meadows and setting up a monitoring network in the reserve of Shash.

5.2.2.3. Marine fauna

Despite the few and limited references and sources regarding marine fauna, the Libyan faunistic diversity can be considered relatively rich.

Marine mammals

Data from cetaceans in Libyan Sea are scarce and knowledge very uneven distributed. Among the marine mammals found in Libya, the Monk Seal (*Monachus monachus)* is classified as endangered (EGA, 2010). Other marine mammal species (cetaceans) occurring or are expected to be present in Libya includs: the bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphus*), striped dolphin (*Stenella coeruleoalba*), Risso's dolphin (*Grampus griseus*), rough-toothed dolphin (*Steno bredanensis*), Cuvier's beaked whale (*Ziphius cavirostris*), sperm whale (*Physeter macrocephalus*), and fin whale (*Balaenoptera physalus*) (Boisseau *et al*., 2010; IUCN, 2012).

Elasmobranches

Among 57 Elasmobranch species recorded along the Libyan coast, 14 can be found along the Sirte gulf representing 24.56% of the total species reported in Libya[16]. These Elasmobranch species are known to reproduce in this area and, in contrast, they can be found in most of the seasonal fish landing sites in this area.

Several shark species are targeted by fisheries (Shakman *et al*., 2020) 3 of them are Critically Endangered (*Carcharodon carcharias, Isurus oxyrinchus, Lamna nasus*), 4 are Endangered (*Cetorhinus maximus, Alopias superciliosus, Alopias vulpinus Mobula mobular*) and one Near Threatened (*Chimaera monstrosa*) following the IUCN categories (SPA/RAC–UN Environment/MAP, 2020b).

[16] Shakman E, Siafenasar A, Shefern A., Elmgwashi A., Al Hajaji M., Ben Abdalha A. and Fabrizio Serena (2020) National inventory of Chondrichthyes in the south Mediterranean Sea (Libyan coast) (*in press*).

In the Gulf of Sirt, a seasonal artisanal fishery targets sharks with specific fixed shark net named « kellabia ». Also, it has been observed that some longliners tend to target sharks because of the economic value of their meat on the national market and of their fins on the international market[17].

Bony Fish Species

A total of 304 bony fishes (Osteichthyes) belonging to 22 orders and 97 families were reported in the Libyan waters (Elbaraasi *et al.*, 2019). Out of these, 28 are reported in the Gulf of Sirte (Shakman & Kinzelbach, 2007; EGA, 2010).

Table 3: List of bony fish species caught by trammel nets in the Gulf of Sirte

Scientific name	family	Common name	Libyan name
Alepes djedaba	Carangidae	Shrimp scad	Saurou Asfar ,Saurou Imperially
Atherinomorus lacunosus	Atherinidae	Silverside fish	Namousa ,Owzaf
Crenidens crenidens	Sparidae	karenteen seabream (porgie)	Sparus Masrry
Diplodus annularis	Sparidae	Annular seabream	Sbarus
Diplodus sargus	Sparidae	White sea bream	Garagous
Epinephelus guaza	Serranidae	Dusky grouper	Dout
Fistularia commersonii	Fistularidae	Bluespotted Cornetfish	Gaeta
Hemiramphus far	Hemiramphidae	blackbarred halfbeak	Abo-meshfa
Herklotsichthys punctatus	Clupeidae	spotback herring	Sridna
Labrus bergylate	Labridae	Ballan wrasse	Abokathear
Lithoganthus mormyrus	Sparidae	Striped sea bream	Mankos
Mullus surmuletus	Mullidae	Striped red mullet	Treellya
Oblada melanura	Sparidae	Saddledbream	Kahlla
Pempheris vanicolensis	Pempheridae	Vanikoro sweeper	Samk deal, Gasaetlla
Planiliza carinata	Mugilidae	keeled mullet (roving grey mullet)	Buri
Sarpa salpa	Sparidae	Salema	Shelpa
Saurida undosquamis	Synodontidae	Brushtooth lizardfish	Makarona
Saurida undosquamis	Synodontidae	brushtooth lizardfish	Makarona
Sciaena umbra	Sciaenidae	Brown meagre	Grab
Scomberomorus commerson	Scombridae	Spanish Mackerel	Balameta Yamania
Scorpaena sp	Scorpaenidae	Scorpionfish	Shkorfo
Siganus luridus	Siganidae	Dusky spine-foot	Batata Khahlla , Shifsha
Siganus rivulatus	Siganidae	Marbled spine-foot	Batata beda
Sparisoma cretense	Scaridae	Parrotfish	Ghazla
Sphyraena obtusata	Sphyraenidae	Obtuse barracuda	Moshta , Maghzil Asfar
Sphyraena pinguis	Sphyraenidae	Red barracuda	Moshta,MaghzilMagrgab
Stephanolepis diaspros	Monacanthidae	Filefish	Halof boresha ,Halof Abo shuka

[17] UNEP-MAP SPA/RAC, 2005. Chondrichthyan fishes of Libya: Proposal for a research programme. By Seret, B. Ed. RAC/SPA, Tunis. 31pp.

Upeneus pori	Mullidae	Por's goatfish	Treellya Khadra

Other marine fauna

According to Bek Benghazi *et al*. (2020), the gulf of Sirte has a percentage of 31.98% (110 mollusc species) from a total of 344 molluscs species distributed along the Libyan coast.

5.2.2.4. Ornithological fauna

65 seabird species have been recorded along the Gulf of Sirt in the last three years. The table 19 shows more details on these species (Libyan national IWC, 2019). According to the results of the waterbirds' monitoring in the gulf between 2017 and 2019 (Tab. 4), the area is a potential site of national importance for Lesser Black backed Gull (*Larus fuscus*), Dunlin (*Calidris spp.*) and Common Starling (*Sturnus vulgaris*).

It is also worth noting that the Ministry of Environment of Libya has started the implementation of pilot monitoring for marine biodiversity related to the EcAp common indicators of seabirds with the support of SPA/RAC.

It is recommended to carry out missions to identify and count the different species frequenting the area within and around the MPA. This should be done over all seasons and not be limited to sporadic and time-limited surveys. Such important effort should be sufficient to update the status of some breeding and migratory species populations size.

The key threats to Libyan seabirds include: Hunting, Pollution, especially oil and chemicals from shipping; habitat loss; overfishing and bycatch[18]. A comprehensive and detailed study of these threats, especially hunting and bycatch, is recommended as priority for the conservation of birds not only in the Gulf of Sirte, but in all of Libya.

Regarding the legal framework, there is no actual enforcement of the regulations on hunting that, despite it was banned by law in 1998, still widely practised illegally in many parts of the country. The hunting of waterfowl/birds normally occurs in Libya during late summer and the autumn months, and thus all wetland sites require continuous, active monitoring during this time of year and may need some control on the hunting of migratory birds.

[18] BirdLife International (2022) Country profile: Libya. Available from http://www.birdlife.org/datazone/country/libya. Checked: 2022-11-02.

Table 4: Seabirds recorded in the Sirte gulf during 2017, 2018 and 2019 (Libyan national IWC, 2019).

No	Scientific name	Common name	2017	2018	2019
1	*Podiceps nigricollis*	Black-necked Grebe	1	103	0
2	*Podiceps cristatus*	Great Crested Grebe	0	5	0
3	*Phalacrocorax carbo*	Cormorant	2	2	17
4	*Egretta garzetta*	Little Egret	18	28	78
5	*Casmerodius albus*	Great Egret	3	0	7
6	*Ardea cinerea*	Grey Heron	2	4	7
7	*Platalea leucorodia*	Spoonbill	3	20	120
8	*Phoenicopterus roseus*	Greater Flamingo	0	314	177
9	*Tadorna tadorna*	Shelduck	76	0	32
10	*Tadorna ferruginea*	Ruddy shelduck	0	0	1
11	*Aythya nyroca*	Ferruginous Duck	0	0	2
12	*Anas acuta*	Pintail	0	22	0
13	*Buteo rufinus*	Long-legged Buzzard	1	0	0
14	*Circus aeruginosus*	Marsh Harrier	3	6	5
15	*Circus pygargus*	Montagu's harrier	1	0	0
16	*Circus macrourus*	Pallid harrier	0	1	0
17	*Falco tinnunculus*	Common kestrel	2	0	1
18	*Gallinula chloropus*	Moorhen	0	0	1
19	*Grus grus*	Common crane	1	0	25
20	*Himantopus himantopus*	Black-winged Stilt	0	2	22
21	*Cursorius cursor*	Cream Coloured Courser	12	0	0
22	*Charadrius hiaticula*	Ringed Plover	14	0	35
23	*Charadrius alexandrinus*	Kentish Plover	387	152	101
24	*Pluvialis squatarola*	Grey Plover	0	0	13
25	*Pluvialis apricaria*	Golden Plover	15	0	0
26	*Calidris alba*	Sanderling	0	5	20
27	*Arenaria interpres*	Turnstone	0	0	1
28	*Calidris alpina*	Dunlin	761	520	2226
29	*Calidris ferruginea*	Curlew Sandpiper	20	0	52
30	*Calidris minuta*	Little Stint	144	160	10
31	*Tringa ochropus*	Green Sandpiper	24	0	0
32	*Actitis hypoleucos*	Common Sandpiper	36	1	1
33	*Tringa tetanus*	Redshank	24	272	399
34	*Tringa erythropus*	Spotted Redshank	1	0	0
35	*Tringa nebularia*	Greenshank	1	27	13

36	*Tringa stagnatilis*	Marsh Sandpiper	13	0	0
37	*Limosa limosa*	Black tailed godwit	0	1	0
38	*Numenius arquata*	Curlew	6	0	5
39	*Philomachus pugnax*	Ruff	5	5	0
40	*Chroicocephalus ridibundus*	Black-headed Gull	20	0	98
41	*Chroicocephalus genei*	Slender-billed Gull	3	20	8
42	*Larus michahellis*	Yellow-legged Gull	58	58	1
43	*Larus audouinii*	Audouin's Gull	122	58	0
44	*Larus ichthyaetus*	Pallas gull	0	1	0
45	*Larus fuscus*	Lesser Black-backed Gull	955	28	0
46	*Sterna sandvicensis*	Sandwich Tern	0	8	42
47	*Chlidonias niger*	Black Tern	0	0	1
48	*Alcedo atthis*	Kingfisher	1	2	0
49	*Striptopelia senegalensis*	Laughing dove	0	1	0
50	*Streptopelia turtur*	Turtle dove	0	49	0
51	*Streptopelia decaocto*	Collared dove	0	72	0
52	*Motacilla alba*	White wagtail	22	57	51
53	*Upupa epops*	Hoopoe	0	10	0
54	*Galerida cristata*	Crested lark	7	7	0
55	*Alaemon alaudipes*	Hoopoe Lark	1	0	0
56	*Lanius excubitor*	Great grey shrike	0	3	0
57	*Oenanthe leucopyga*	White Crwoned Weatear	2	0	0
58	*Phylloscopus collybita*	Chiffchaff	0	6	0
59	*Erithacus rubecula*	European Robin	0	0	2
60	*Motacilla rubicola*	Stonechat	5	12	6
61	*Phoenicurus ochruros*	Black Redstart	9	0	0
62	*Luscinia svecica*	Bluethroat	0	0	1
63	*Corvus corax*	Common Raven	2	1	0
64	*Sturnus vulgaris*	Common Starling	2240	0	650
65	*Passer hispaniolensis*	Spanish sparrow	0	120	0
	Total of individuals		**5023**	**2163**	**4231**
	Total of species		**41**	**38**	**36**

5.2.2.5. Sea turtles

The shores of the Gulf of Sirte are considered one of the most important nesting sites for the loggerhead sea turtle in Libya and the Mediterranean. The remote, rarely disturbed long beaches of the gulf attract a considerable number of turtles every year for nesting. Studies conducted by the Libyan Program for the Protection of Sea Turtles on part of the Gulf, showed that the number of turtle nests exceeds 500 nests in some years.

Sea turtle protection is included in the decree issued by the Secretariat of Agriculture No. 453/1993 stating that ‘’All species of sea turtles and terrestrial tortoises are protected by law in Libya’’ furthermore ‘’Any use of these species or their products (skin, eggs, flesh) is banned by law in Libya’’ and that “Any violation of these articles will be prosecuted within the legal system according to Hunting Law No.28 of 1968’’.

Since 2005, the Libyan Sea Turtle Program has started as a national initiative for conservation and awareness of marine turtles implemented under EGA supervision and in collaboration with UNEP-MAP-SPA/RAC at three nesting beaches west of Sirte (Hamza & El Ghmati, 2006). The program was set-up for the first time in Libya to protect marine turtle nests at the selected sites for the whole nesting season. This activity came in the framework of implementing the national and regional Action plans for conservation of marine turtles adopted by MAP. The nesting density of sea turtles reached 9.69 nest/km in some parts of the gulf while the highest density was recorded in 2006 with 39.4 nest/km in Al Ghbeba site (Saied *et al*., 2008) making this region a very important nesting site in Libya. Loggerhead sea turtles continue its nesting activity till the last week of August and the first week of September every year.

Starting from 2017 until 2020, a regular monitoring program started under the technical supervision of EGA and SPA/RAC and with the financial support of MAVA Foundation covering all the Libyan coasts including our study area (Fig. 6).

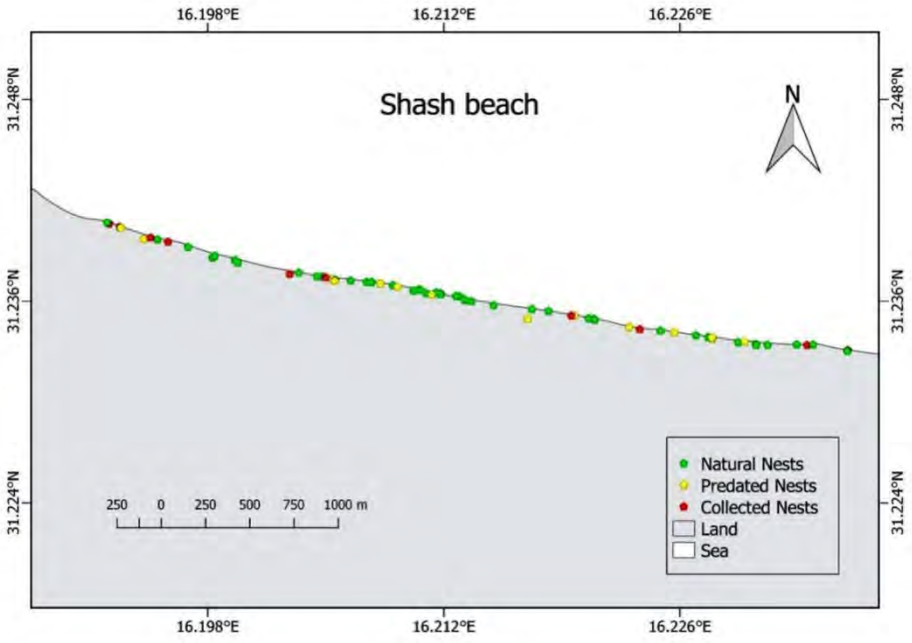

Figure 6: Distribution of sea turtles nests in a Sash beach (Saied & Dreyag, 2019)

In 2019, a total of 301 nests were recorded on 5 beaches (Thalatheen, Gharb Al Estiraha, Shash, Tamet and Khamseen) along the Reserve of Shash. 68 of these nests were protected from predation by installing square metal mesh "Hatcheries". the result was the successful hatching of 7566 eggs with an average success rate of 74.75% in these 5 beaches thanks to the conservation efforts (*in situ* and *ex situ*).

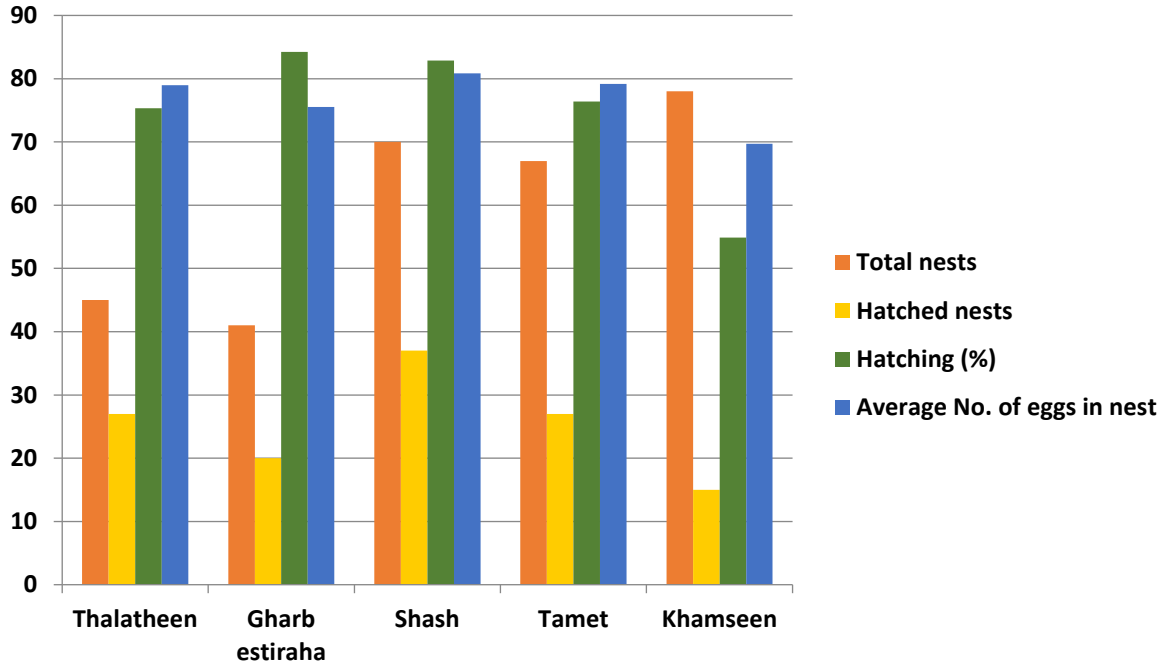

Figure 7: Nesting data of the loggerhead seaturtle (Caretta caretta) in 2019 along the Coastal Area of Shash (in 5 beaches) according to the Libyan Sea Turtle Programme (LibSTP).

Within the aim to define the level of genetic variation and demographic autonomy of the Libyan nesting aggregation compared to other Mediterranean populations, genetic sampling of the Libyan loggerhead turtle nesting population was begun in 2005. Genetic analysis from dead hatchlings/Embryos of nests at hatcheries showed that juvenile loggerhead turtles (with CC-A2 haplotype) were recovered at feeding grounds in western and eastern Italy, Lampedosa, north-eastern Spain and south Balearic islands. Hence, this suggest that the Libyan seaturtles use these areas as feeding grounds (Hamza & El Ghmati, 2006). the results also indicates that Libya is the most genetically diverse nesting area in the Mediterranean due to the presence of three unique haplotypes (CC-A26.1, CC-A65.1 and CCA68.1) (Saied *et al.,* 2012, Clusa *et al*., 2013). Genetic analysis suggested that juveniles from Libya remain in the eastern Mediterranean basin during the oceanic developmental phases, while at the time of the transition to the neritic stage they select foraging grounds closer to their natal beach such as southern Tunisia (Saied *et al.,* 2012).

On the other hand, Sea turtles in the Gulf of Sirte are facing predation threats from different animals throughout their life stages. There are predators of eggs, hatchlings, young and adult turtles. Predation of eggs and hatchlings in Libya are caused by Foxes, Jackals, dogs and Ghost crabs (Hamza & El Ghmati, 2006). Predation on turtles' eggs by the monitor lizard *Varanus* and parasitism of *Dipterans* larvae were reported in the study area in 2005 (Hamza & El Ghmati, 2006).

Table 5: Evolution of the nesting of the loggerhead sea turtle (*Caretta caretta*) along the Shash Reserve during the last decade according to the Libyan Sea Turtle Programme (LibSTP)

	Total number of nests العدد الكلي للأعشاش					Hatched nests عدد الأعشاش الفاقسة					Hatched eggs عدد البيض الفاقس					Hatching success % نسبة نجاح الفقس %					Average No. of eggs in a nest متوسط عدد البيض في العش الواحد				
Beach name	2009	2010	2017	2018	2019	2009	2010	2017	2018	2019	2009	2010	2017	2018	2019	2009	2010	2017	2018	2019	2009	2010	2017	2018	2019
Thalatheen شاطئ الثلاثين	49	65	50	72	45	26	27	34	58	27	1882	1602	2384	3666	1606	78.68	75.89	83.88	79.12	75.33	92	78.18	83.59	79.12	78.96
Gharb Al Estiraha شاطئ غرب الاستراحة	58	45	31	35	41	37	15	8	23	20	2126	835	504	1298	1273	76.61	79.45	92.14	76.31	84.25	75	70.06	68.37	73.96	75.55
Shash شاطئ شاش	105	94	49	66	70	57	62	49	53	37	3297	3587	951	3600	2480	77.5	73.70	80.44	85.11	82.89	74.63	78.5	73.15	79.81	80.86
Tamet شاطئ تامت	-	19	29	61	67	-	2	3	13	27	-	55	89	613	1633	-	45.45	58.17	63.92	76.38	-	60.5	51	73.77	79.19
Khamseen شاطئ الخمسين	-	-	42	64	78	-	-	4	25	15	-	-	296	1332	574	-	-	86.80	79.95	54.88	-	-	85.25	66.64	69.73

The predation of nests is intense in the coastal area of Shash due to the absence of human activities in some isolated and difficult to access areas. This led to the increase of wild predators such as foxes and jackals according to the Libyan Sea Turtle Programme (LibSTP). During 2019, 59 nests were attacked and destroyed by predators in Al-Khamseen beach even with the the presence of the metallic mesh on 6 nests (75.64% of predation rate) (Saied & Dreyag, 2019). In contrast, and in the Al-Talatheen Beach, poaching of turtle eggs has increased at the same year, as 8 nests (out of 45 nests recorded on the beach, at a rate of 17.78%) were raided and the eggs were collected by humans. At the same time, the number of nests attacked by wild animals was relatively low, amounting to only 4 nests. This may be attributed to the continues and intense presence of people on the beach which may deter and reduced the activity of predators. The surveyed beach is located near the village of Al-Thalatheen, which has about 100 houses according to the Libyan Sea Turtle Programme (LibSTP). In summary, for a total of 301 nests, the mean percentage of poached and predated nests in the Marine and Coastal Reserve of Shash were 11.36% and 35.16% respectively.

Table 5: Nest status at the five studied beaches in 2019

Beach name	Poached	Natural Predation	Total nests	Poached %	Natural Predation %
Thalatheen	8	4	45	17.78	8.89
Gharb Al Estiraha	6	9	41	14.63	21.95
Shash	12	13	70	17.14	18.57
Tamet	4	34	67	5.97	50.75
Khamseen	1	59	78	1.28	75.64
Mean	**6.2**	**23.8**	**60.2**	**11.36**	**35.16**

In an attempt to minimise and mitigate these impacts, marine turtle nests were transferred into fenced hatcheries not only to protect them from poaching and natural predation but also to protect them from being submerged by the sea when nests are located near shore (total of missed nests by submerging in 2019 are 25 flooded nests).

Another factor to consider for mitigation is the use of four-wheel drive vehicles during camping and summer which significantly affected the intensity of nesting in the area (Saied & Dreyag, 2019).

Finally, it's very important to maintain the effort of monitoring sea turtles at the main beaches of the study area along the coast, for the full season to keep data on annual fluctuations of nests, and to predict nesting densities in future. Moreover, it's strongly recommended to continue the sex ratio monitoring, collect the genetic and tracking data.

Setting up a national strategy or plan to increase the knowledge and awareness of specific stakeholders (fishers, schools, decision makers on national and local levels) is also recommended as a key step into the conservation of sea turtles in the gulf area.

5.2.2.6. Alien Marine Species in Libya

Despite its interesting geographical location in the central and warm part of the Mediterranean Sea allowing it to host both tropical species arriving from the east (Indo-Pacific origin) and extending from the west (tropical Atlantic origin), few studies and records of alien species in

Libyan waters has been carried out. The recent trend of increasing discovery of alien species is largely associated with increasing scientific interest in monitoring studies and the presence of a number of different relevant projects, which have recently been carried out along the Libyan coast to identify exotic species. In addition, there is no monitoring plan implemented for inventory and tracking the introduction and spread of invasive species.

According to a few recent studies inventorying Invasive Alien Species in Libya, a total of 87 alien marine species have been recorded in the country (See Annex 3). Fish constituted the highest percentage, with more than 32.56%, followed by macrophytes and molluscs with 21.92%, crustaceans 12.79%, alien parasites 8.14%, and finally Bryozoa, Ascidia, Sponges, Cnidaria and Echinodermata with 1,16%.

The blacklist of the most invasive marine species reported in the area includes 23 species among them 4 algae taxa (*Lophocladia lallemandii, Caulerpa cylindracea, Caulerpa taxifolia, Codium fragile*); 1 Angiosperm (*Halophila stipulacea*); 3 crustaceans (*Callinectes sapidus, Percnon gibbesi, Portunus segnis*); 3 mollusca (*Pinctada imbricata radiate, Bursatella leachii, Cerithium scabridum*) and 12 invasive fishes.

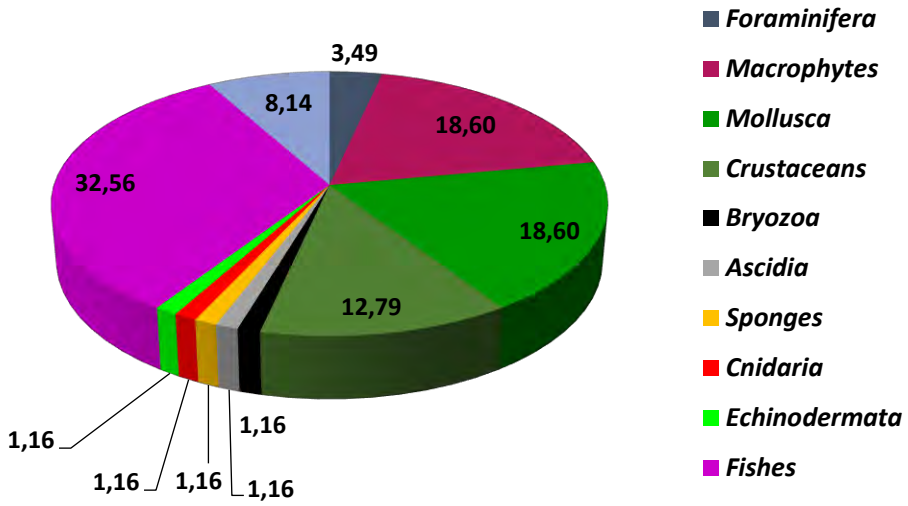

Figure 8: Proportions of alien marine species in the Libyan coast by taxonomic group

There is a strong competition between *Siganus luridus* and *S. rivulatus* in the central and eastern coast of Libya which seems to decrease towards the western coast (Shakman, 2008; Al-Razagi, 2017). Besides, among several venomous and toxic species recorded in Libya, the booming increase of *Lagocephalus sceleratus* which is starting to change the biodiversity and bio-composition in this area (Shakman *et al.*, 2019). This species is often caught by fishers due to its large body and unknowingly consumed and led to several cases of poisoning (Shakman *et al.*, 2019).

In conclusion, It is essential to further research and identify non-native species in the area and analyse the trend in their abundance and temporal occurrence. This is especially important for the invasive species in the Shash Reserve. It would also be appropriate to subsequently propose a monitoring protocol for invasive non-native species to the future managers of this protected area.
Local Ecological Knowledge, especially fishers' knowledge, was proved to be a cost-effective, reliable and resourceful approach to establish large scale monitoring based on

standard protocols and need to be considered to gather information on non-indigenous species in the area and their historical trends.

5.2.3. Habitat and biodiversity in the marine and coastal area

In the study area, a large diversity of habitats and ecosystems can be observed such as marine vegetation beds, hard rocky bottoms sandy and rocky beaches, dunes and various wetlands which provide high economic, biological, historical, social and ecological values. The Reserve is known to be an important sanctuary for water birds andsea turtle nesting sites.

Coastal Sand Dunes ecosystem

Coastal sand dunes, a major element of adaptation to erosion, are characterized by a high ecological diversity which is the result of a wide set of geomorphological features, environmental heterogeneity, and species variability.

The coastal dune ecosystems in the gulf area have been severely degraded as a result of the excessive exploitation of its natural resources, chaotic demographic expansion, and industrial growth. According to the results of the research presented in the Fourteenth Geographical Forum[19] which indicate that there has been no significant change in the land cover of Sirte during the last thirteen years, and that most of the desertified areas are almost stable, with an estimated percentage of 4% of their lands, and although they have witnessed a decrease in their area, it is not significant. It was also found that desertification in Sirte is linked to natural causes such as fluctuations in precipitation and droughts, and to human causes, represented by the unsustainable use of the vegetation cover, overgrazing of pastures, and the transformation of pasture lands into agricultural, residential or industrial areas. According to this study, the rangeland area increased in 2012 compared to 2001 at a rate of 14 km^2 /year. In contrast, the area of moving sand dunes decreased by 15 km^2 /year, while the area of semi-fixed sand dunes decreased at a rate of 116 km^2 /year.

There is a knowledge gap regarding the coastal dunes and their role in the whole ecosystem, moreover, many aspects of evolution and dynamics of coastal dunes are still widely unknown. Consequently, there is an urgent need to (i) study and monitor the sedimentary dynamics of coastal dunes as a first step; and (ii) to preserve this dune ecosystem as a second step through the planting of dune-fixing species and the reduction of pressures exerted on them, whether by stopping all grazing, removal of vegetation cover and the extraction of sand or by the development of accesses and walkways. Many actions, as pragmatic nature-based solutions, can be proposed to preserve the dunes ecosystem in the area.

Coastal Wetlands

There are no perennial rivers in Libya, but numerous dry watercourses (wadis) that cause flash floods after rain. While they dry quickly, pools and trickling streams may persist for a time after.
Saline pans and marshes form in places where seasonal water flow from wadis collects in depressions behind the coastal dunes. These areas ‘sebkhat’ support halophytic vegetation. Important examples include Sabkhat Tawargha, which runs parallel to the coast for some 100 km on the western side of the Gulf of Sirt. Noumerous smaller saltpans exist on adjacent coast area.

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[19] أعمال المؤتمر الجغرافي الدولي عشر 2015. الجغرافية والتنمية المستدامة خلال الفترة من 2013.10.1 م إلى 2013.10.3 م. منشورات جامعة سرت 2015 م

Gathered rain water fllow from the eastern end of tripoli hills (Jabal Trabulus) through several wadis to the great sebkha of Tawurgha which extends along the seashore behind the sand beach for 100 km between Misratah and Bueret Al Hassun. This area of salt-marshes and salt pans is up to 25 km wide and covers 230 000 ha, with fresh water springs at several places on the landward side. Other salt pans, some of considerable extent, occur inland on the Plain of Sirte. One of the largest, parts of which may be temporarily and very shallowly merged with water, is immediately north of Maradah, and its western end. The most important wetland in this region is the great marsh (30°22'N; 19°50'E) behind the coastal dunes at Ajdabiya. It is 70 km long and 12 km wide in places, and carries typical salt-marsh/swamp vegetation. There are clusters of salt pans at its southern and northern ends, but the marsh itself is virtually at sea level, and is permanently wet and brackish. This wetland is an important site for wintering and migrating birds, and also for other elements of the wetland fauna[20].

Important marine habitats in the study area

The Marine and Coastal Area of Shash is a site of Mediterranean importance for sea turtle species and for seagrass communities. Historically, it's also a site with monk seal presence. The reserve of Shash is also considered a cartilaginous fish nursery and fishing area.

Identifying the most important eco-biological elements for conservation purposes is a crucial step towards the proper management and sustainable utilisation of this area. For this purpose, various biocenoses and associations (categorization by UNEP/MAP-RAC/SPA, 2019) found in the reserve of Shash are shown in Table 6. This information reveals a large diversity of the study area. The presence of *P. oceanica* meadows, coastal habitat for sea turtles nesting and cartilaginous fish nursery need to be highlighted, because these are priority habitats under the Barcelona Convention (UNEP-MAP-RAC/SPA, 2019).

Table 6: Main marine habitats found in the study area listed under the Barcelona Convention (UNEP-MAP-RAC/SPA, 2019)

Habitat type	Habitat description and distribution in the region
LITTORAL	
MA5.5 Littoral sand	
MA5.51 Supralittoral sands	Most sandy beaches are habitat for many endangered and threatened species especially for the nesting of the loggerhead sea turtles
MA5.52 Mediolittoral sands	
MA5.52a Deposit of dead leaves of macrophytes	
MA6.5 Littoral mud	
MA6.52 Mediolittoral mud	Habitat present in the estuaries and deltas of major coastal rivers. Present mainly on margins of wadi mouths of in Turghat, Ain Wadi kaam and Maseed in the west; in the central region (gulf of Sirte) this is found at the active wadis
MA6.52a Habitats of transitional waters (e.g. estuaries and lagoons)	
MA6.521a Association with halophytes (*Salicornia* spp.) or marine angiosperms (e.g. *Zostera noltei, Ruppia maritima*)	
MA2.5 Littoral biogenic habitat	
MA2.51a Banks of dead leaves of macrophytes (banquette)	

[20] Hughes, R. H., & Hughes, J. S. (1992). A Directory of African Wetlands., UNEP, and WCMC, Gland, Nairobi and Cambridge.

MA3.5 Littoral coarse sediment	
MA3.52 Mediolittoral coarse sediment	Mid-beach with stones and pebbles, with a vertical extension that is usually slight.
MA3.52a Deposit of dead leaves of macrophytes	Accumulation of plant debris made up mostly of dead *Posidonia oceanica* leaves and/or leaves of other phanerogams. Found in the sandy beaches
MA1.5 Littoral rock	
MA1.51a Supralittoral euryhaline and eurythermal pools (enclave of mediolittoral)	
MA1.53 Upper mediolittoral rock	A rocky area located at sea level, dampened by both spray and the tops of the waves. A horizon present in the bottom part of the upper mediolittoral rock, between 10 and 50 centimetres above the average level of the sea, where there is strong wave action.
MA1.54 Lower mediolittoral rock	
MA1.54a Mediolittoral euryhaline and eurythermal pools (enclave of infralittoral)	
INFRALITTORAL	
MB1.54 Habitats of transitional waters (e.g. estuaries and lagoons)	Stretches of fine sand, muddy sand and mud in relatively closed-off areas up to a few metres deep. In lagoons located near the area
MB5.5 Infralittoral sand	
MB5.52 Well sorted fine sand	Stretches of fine sand at depths of between 2 and 25 metres that can present facies with epiflora. Some parts of lagoons, some open sea streaches that are deeper with softer sands and epiphytes, along the coast and especially on the continental shelf west of Libya.
MB5.53 Fine sand in sheltered waters	
MB5.54 Habitats of transitional waters (e.g. estuaries and lagoons)	
MB6.5 Infralittoral mud sediment	
MB6.51 Habitats of transitional waters (e.g. estuaries and lagoons)	
MB1.5 Infralittoral rock	
MB1.51 Algal-dominated infralittoral rock	Present from 0 to 40 m depth along the rocky bottoms. The biocenosis of photophilous algae is extremely rich and of great complexity, due to the strong physical gradients existing at its level. 35 subtypes have been identified in the Mediterranean.
MB2.5 Infralittoral biogenic habitat	
MB2.54 *Posidonia oceanica* meadows	The *Posidonia oceanica* meadow in the majority of infralittoral of Libyan waters.
CIRCALITTORAL	
MC5.5 Circalittoral sand	Stretches of heterogeneous sediment at depths of between 30 and 100 metres (margins that vary according to geographical sector) which may present facies with epiflora and epifauna. The gulf of Sirte (in areas with low currents) and on the open sea.
MC1.5 Circalittoral rock	
MC1.51 Coralligenous	Abundance of large erect invertebrates in open sea. This habitat is located mainly at a depth of 30 to 90 meters and forms landscapes of great aesthetic value.
MC1.51a Algal-dominated coralligenous	
UPPER BATHYAL	
ME6.5 Upper bathyal muds	
ME6.51 Upper bathyal muds	Vast stretches of clayey mud, usually compact, yellowish or bluish grey, relatively substantial, continuing at depths of over 150-250 metres. Information not available, need for specific survey equipment and capacity.

It is essential to develop monitoring and surveys to increase the knowledge and fill data gaps in marine biodiversity in the area. To this end, it is recommended to develop programs in the area covering the inventory, mapping and monitoring of coastal and marine biodiversity, particularly species and habitats of interest for conservation.

5.2.4. Protected Areas

The Libyan government has declared several areas as nature reserves and national parks designed to protect local plant and animal species, to increase their numbers and populations and, to reintroduce some endangered species that existed in the past in the same areas.

The first conservation legislation came into existence in 1949 which is the Forestry Law. its objective was to grant protection to forests and forest products, to soil, water sources and land under threat of desertification. Libya's national parks and nature reserves was maintained by the "Technical Committee of Wildlife and National Parks" which was created in 1990, as part of the General Secretariat of Agricultural Reclamation and Land Reform. Nowadays, it is managed by the Conservation and protection division, under the Ministry of Environment. The first protected area in the country was Al-Kouf National Park (1978) while today the number of protected areas reached 13 sites that as a whole made up about 18% of the country's total area (Shakman, 2019). In 2011, two sites have been declared as Marine Protected Areas (MPAs), Farwa Lagoon at the west and Ain Al-Ghazalah at the eastern part of Libya. These MPAs are managed by the Libyan Ministry of Environment.

Figure 9: Map of Libyan PA's, NP's and MPA's distribution according to Etayeb *et al.* (2018)

Libya has established a total of 13 protected areas (terrestrial and marine) and national parks since 1978 to 2011:

Name of protected area	Establishing date	Area (ha)	Landscape
1. El-kouf National Park	1978	100,000	Mountain and coastal forest
2. El-Hisha Protected Area	1984	160,000	Sebkha and fresh water springs

3. Al-Gharabolli National Park	1992	8,000	Coastal forest
4. Aboghilan National Park	1992	4,000	Mountain area
5. Ber Aiad Protected Area	1992	1,200	Mountain to plain area
6. Sorman National Park	1992	400	Forest of pine trees
7. Annagaza National Park	1993	4,000	Mountain forest
8. Sobrata National Park	1995	500	Coastal forest of pine trees
9. Msallata Protected Area	1998	1,800	Mountain area
10. Tala Protected Area	1998	200	Mountain area
11. Zolton Protected Area	1998	1,000	Coastal salt marshes
12. Farwa Lagoon Farwa Marine Protected Area	2009 2011	33 5,591	Coastal lagoon Island and coastal lagoon
13. Ain Al-Ghazala (Al-Bomba Gulf) Marine Protected Area	2011	29278	Marine, Islands and coastal lagoons

RAMSAR wetlands

The diversity of wetlands in Libya[21]:
1. Salt marshes (Sabkhas), such as Sultan, Abo Kemmash and Benghazi
2. Coastal lagoons, such as Ain Al-Ghazala and Azzayana
3. Water springs, such as Tawergha and Ain Kaam
4. Desert oases, such as Gaberoun and Bzimah Oasis
5. Dams, such as Almjenin dam, Wadi Attot and Al-Gatarah.
6. Artificial reservoirs, such as the man-made River reservoirs.

Among the approximatley 110 wetlands listed in Libya[22], two (02) RAMSAR sites exist in Libya:

- Ain Elshakika wetland was established in 2000. It is part of El Kouf National Park, and covers few hundred hectares. The site is an important wetland for migratory and resident waterbirds and has great potential for ecotourism and birdwatching[23]. The place is also being considered for small scale aquaculture projects.

- Ain Elzarga wetland was established in 2000 and covers an area of 50 hectares. The site is one of the most important wetlands in the area of El-Kouf National Park for migratory waterbirds. The birdwatching and ecotourism potential is considerable but undeveloped. Unsustainable hunting and destruction of vegetation, especially during summer, are known threats in the area.

6. Cultural heritage

6.1. Historic sites

Sirte contains many historical monuments and landmarks of a modern character, such as the old Christian cemetery of the IVth century in Markaz, the old hestoric mosque and the

[21] Mahklouf, Mohammed & Etayeb, Khaled. (2018). Biodiversity in Libya: Selected Countries in Africa. Global Biodiversity, Volume 3, Chapter 5. 113-133.10.1201/9780429469800-5.
[22] EGA - RAC/SPA waterbird census team (2012) - Atlas of wintering waterbirds of Libya, 2005-2010. Imprimerie COTIM, Tunisia.
[23] Ramsar Sites Information Service. Retrieved 14 April 2022

specialized souks. Recently, an archaeological site in the Giza district was discovered which dates back to the Byzantine era 1,400 years ago[24].

Bu Njem, ancient Gholaia, is an archaeological site in Sirte District (30° 34' 42" N, 15° 24' 47" E) where excavations have identified a Roman fort dating back to the 3rd century. The fort is a rectangular Roman fort surrounded by a small settlement. Several temples stood on small hills on the edge of the site, as well as a necropolis. The site was part of the Limes Tripolitanus which was a frontier zone of defence of the Roman Empire.

6.2. Recreational sites

There are 11 sites classified as tourist attractions (Table xx), and the beaches of the city of Sirte itself are considered among the important attraction sites as most of them are clean and in their natural state (SPA/RAC–UN Environment/MAP, 2020a).

Table 7: Recreational sites in the Sirte region

Site	Type	Category	Description
Sultan	Historical city	2	Historical Islamic city
Hassan Palace	Historical Palace	3	Historical Palace and building
Philaeni brothers	Bronze statues	3	Bronze Italian statues
Abu Njaim Fortress	Ottoman Fortress	3	Castle built in the Ottoman era
Roman Village	Historical Village	2	Historic Byzantine buildings
Ouagadougou Halls complex	Modern buildings	4	Modern conferences halls
The Christian cemetery	Historical cemetery	2	Christian cemetery from 5th century AD
Al-Qordhabia	Memorial	4	A memorial to the martyrs of Al-Qordhabia battle
Al-Qordhabia	Enormous water reservoir	4	Man-Made river water reservoir
Girza	Historical Village	3	Small village from Roman Period
Girza	Stunning nature	1	Cold water spring

Data source: SPA/RAC–UN Environment/MAP (2020a)

7. Socio-economic overview

7.1. Land use and infrastructures

The total surface of Sirte municipality in its administrative boundaries is 9,883 ha. agricultural and pastoral activities cover one third of this large surface, and mixed agricultural and housing occupy the other 17%. 18% of the land is reserved for construction urban and industrial structures. The medium and high-density population areas constitute only 10% of the total surface, and mainly concentrated around the city centre known as Markaz.

The area of land allocated for health purposes and education were about 30 hectares (0.3%) and 96 hectares (1%) according to the latest statistics.

Table8: Sirte Land Use in 2018

[24] General Culture Authority (GCA), Libya, Sirte office, unpublished report *in* SPA/RAC–UN Environment/MAP (2020a)

Sirte Land Use	Surface (ha)	% of total
Medium Density	499	5.0
High Density	462	4.7
Residential Agriculture	1 665	16.9
Informal	1 444	14.6
Administration	6	0.1
Build-up	1 789	18.1
Cemetery	6	0.1
Commercial	44	0.4
Culture	61	0.6
Education	96	1.0
Green Areas	98	1.0
Health	30	0.3
Sport and Recreation	84	0.8
Industrial	303	3.1
Agriculture	3 295	33.3
Transport	0	0.0

Data source: UN-Habitat, 2018

7.2. Demography and social development

7.2.1. Demography

The censuses of 1995 and 2006 had given the total Libyan population of the Sirte region at respectively 102,885 and 131,352 following an average yearly growth rate of 2.25%. The non-Libyan population was unclear[25], but estimated by the Bureau of Statistics and Census (BSC) in 2006 at 9,566 (thus 7% of the population) due to the change in the functional structure of the city after it became the first administrative headquarters in Libya. This later procedure upgraded the role of the city and expanded its area as a result of the increase in the population from the migration towards the city. In 2012, the national BSC survey estimated the Libyan population in Sirte dropping to 114,626 as many residents internally displaced and left the city while the non-Libyans were estimated to 2,847.

The current population of Sirte is 128,123 (according to statistics from July 2022) based on projections of the latest United Nations data[26]. The old districts of Sirte (Markaz, Hayy 2 and 3 and Ribat) had the highest density of population (UN-Habitat, 2018).

7.2.2. Education

Official statistics of 2009-2010 accounted for 27,008 children in elementary schools in Sirte, serviced by 89 schools distributed in 1,227 classes, 2,724 teachers and reserved teachers. In addition, Sirte had 4,890 public secondary schools' students, serviced by 19 colleges distributed in 215 classes,642 teachers and reserved teachers for 2009-2010. 8,567 students were registered at the Al-Tahaddi University (now University of Sirte) in 2009-2010 according to the Department of Planning and Development at the Ministry of Education. The university' capacity seems to continuously expands, in 2014-2015 it contains 11,853 students, 512 postgraduates and faculty members. The University of Sirte is one of the major scientific institutions in Libya, as new faculties and departments are continuously created in it, and the number of scientific and students is increasing. The university currently includes (10)

[25] The total non-Libyan population on in the country was given at 6.4% slightly decreasing (85% of them Arabs and 11% from Asia).

[26] World Population Prospects 2022; United Nations population estimates and projections. https://population.un.org/wpp/

faculties, and there are departments within each faculty that are as far as the cities of Zamzam and Abu Qurain (SPA/RAC–UN Environment/MAP, 2020a).

7.2.3. Health

The 2015 official statistics accounted for 2 hospitals in the region of Sirte, 1 is the Central Hospital and the other is Suburban, totalling 283 beds. According the Information Centre of the Ministry of Health, the main Sirte services are provided by primary health care (PHC) facilities. In addition, since 2009, there are 1 polyclinic, 11 health centres, 1 dental centre and 29 public health care (PHC) units[27]. The general health availability index was given at 64% for Sirte, comparatively to 81% at the national level. The drawbacks are observed mostly in terms of inpatient beds density and hospital admissions explained by the lowest density of facilities per 10,000 populations: 1.67 totalling only 4 beds, for a national average of 15 and a target of 25[28].

7.3. Economic development

According to the Bureau of Statistics and Census, statistics of Employment and Unemployment in 2013 accounted for a total manpower in the Sirte region of 45,200; in which 34.51% were females. The highest rate of workers was in administration and education services (Tab. 9) due to the administrative functions of the city. The modern development of the city of Sirte is intimately linked to the administrative functions it took under the pre-2011 regime, housing the parliament and proposed to be “capital of Africa”.

Table 9: Distribution of the working population along sectors in Sirte

Administration	27.7%
Education	26.1%
Public services	22.3%
Trade	9.9%
Health	5.7%
Transportation	4.5%
Industry	3.0%
Fishery	0.8%

Data source: UN-Habitat, 2018

Economic activities are diversified in Sirte. However, they remain marked by the predominance of their agricultural component.

7.3.1. Fishing and Fisheries

The fishing sector in Libya relies on four different types of fishing activities: Artisanal fishing (Batah fishing, Flouka, Mator and lampara metre), coastal trawling and tuna fishing. Sponge fishing is not so significant any more as it was in the past. Most of the catches come from the nets of the artisanal vessels targeting demersal fishes and lampara targeting the small

[27] Bureau of Statistics & Census: Statistical Book, from 2006 to 2015.

[28] UN-Habitat, 2018. City Profile of Sirte, Libya. Rapid city profiling and monitoring system. First draft, April 2018.39 p.

pelagic fishes. The tuna's industrial fishery provides less than 4% of the total landed fish. Inland fishery is negligible.

The Sirte region and its surroundings boasted 28 landing sites, most of them are seasonal and artisanal landing sites. There are also 8 ports and marinas which are permanent landing sites. The target species to catch are both cartilaginous and bony fishes using traditional fishing gear.

Port	Latitude	Longitude
EL KHAOUADA 1	31º32,016N	15º35,181E
EL KHAOUADA 2	31º29,799N	15º36,792E
BUEIRAT EL HASSUN	31º26,284N	15º40,686E
SHASH	31º14,505N	16º11,439E
SIRT	31º12,695N	16º35,017E
SULTAN	31º08,182N	17º06,352E
HARAWA	31º05,234N	17º17,618E
WADI LAHMAR (Tissain)	31º02,790N	17º26,303E

The fleet is mainly composed of artisanal vessels which use fixed nets (demersal and gillnets) or hooks (longlines and handlines). According to data from 2000, 1,266 boats were operated along the Libyan coast. Around 55% of the total number of boats was found in the western region while and around 23% was found in the Gulf of Sirte.

Table 10: Distribution and percentage of fishing vessels in three regions on the coast (Tripoli, Sirte and Green Mountain)

Boat type	Region		
	Tripoli	Sirte	Green Mountain
Batah	65	-	3
Flouka	662	211	262
Mator	187	192	149
Lampara	115	19	1
Total	**1029 (55%)**	**422 (23%)**	**415 (22%)**

Data source: Lamboeuf *et al.* (2000)

Among 422 boats operated along the coastal area of Sirte, the most important fishing gear used was Trammel nets (Haliq) using Flouka (211 boats) in water level of one meter to fifty meters depth, and are operated by mator (192 boats) in water of more than thirty meters depth. There were few Lamparas used to catch small pelagic fish in the Gulf of Sirte (only 19 boats). Moreover, the Batah, which is used in shallow water, was concentrated in the western region and only a small number of that type was found in the eastern while non are used in the Gulf of Sirte (Fig. 10 and Tab. 10).

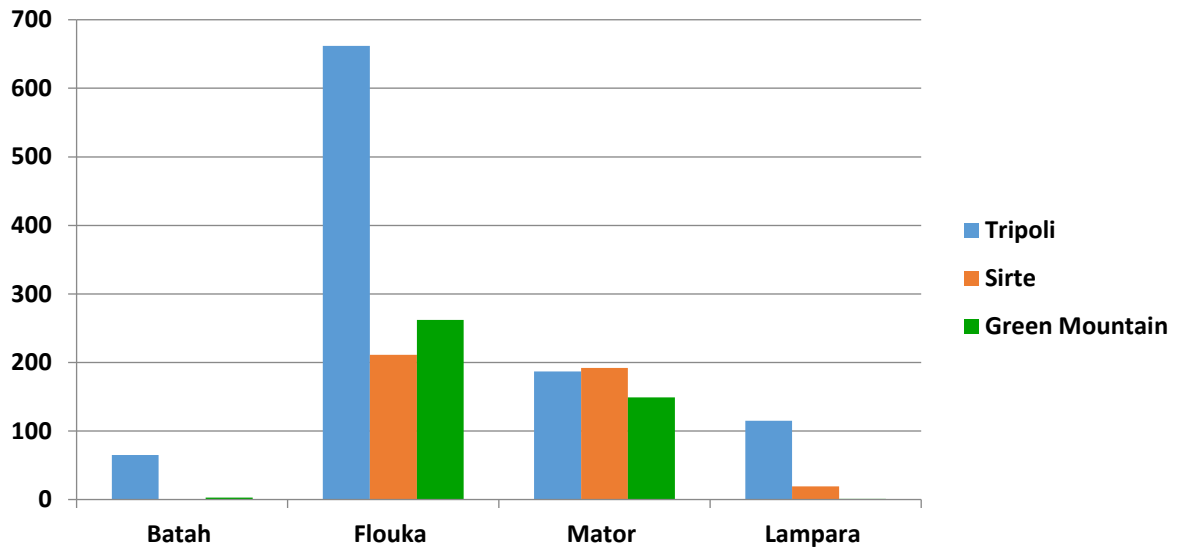

Figure 10: Distribution and percentage of artisanal fishing craft by type and regions (Tripoli, Sirte and Green Mountain)

Table11: Types of artisanal fishing boats in the gulf of Sirte

Common local name		description and characteristics
Flouka	*Gaïk*:	double-ended boats of 4-6 m, derived from traditional craft that were propelled by oars, often now *adapted* for outboard engine propulsion; more common in the western part of the country.
	Flouka:	Small fishing craft of *varied* sizes ranging from 2 to 7 m; shapes are diverse but generally with a flat transom and no deck; powered by outboard engines.
Mator	*Mator:*	Generally greater than 5-6 m in length running up to 18 m or more, with deck and roof for the *smallest units*, wheel house, fish hold, and net hauler for the largest; shape and design similar to units found in Tunisia, Greece and Egypt.
Lampara fishing unit	*Lampara*:	usually 12-13 m with deck, inboard engine, a small roof and a purse seine winch; associated with one to three *Dghaissas* carrying kerosene or butane gas lights to catch small pelagic fish using light attraction at night; some units may convert to net and/or line fishing during the off-season; only present in the western part of Libya.
	Dghaissa:	7-8 m, without *deck* and engine; serves as light boat in association with the *Lampara*.

Data source: Lamboeuf *et al*. (2000) modified

There are three types of fishes in the Sirte region, namely professional, recreational and diving fishers. The average age of fishers was 46.96 and 47.9% have experience of more than 20 years while only 18.8% have experience of less than 10 years. 39.6% of fishermen are older than 50 years, and 33.3% between 40-50 years demonstrating that the marine fishing sector does not attract young people (SPA/RAC–UN Environment/MAP, 2020a).

The total of the main fish species targeted by fisheries are 25, of which 14 are the main species targeted by professional fishers and 15 by recreational fishers while the diving fishers

were limited to 7 species, with intersections between the three types of fishing. The highest target species were the Dusky grouper (*Epinephelus marginatus*), followed by the White Sea bream (*Diplodus sargus*) and the Amberjack (*Seriola dumerili*).

Table 12: The main species targeted by fishermen in the Sirte region

Main species Frequencies			
Common name	**Scientific name**	**Responses**	
		N	**Percent**
Dusky grouper	*Epinephelus marginatus*	26	19%
White sea bream	*Diplodus sargus*	17	12%
Amberjack	*Seriola dumerili*	15	11%
Common dentex	*Dentex dentex*	12	9%
Seabass	*Dicentrarchus labrax*	10	7%
Little tunny	*Euthynnus alletteratus*	7	5%
Golden grouper	*Epinephelus costae*	6	4%
Morocco dentex	*Dentex maroccanus*	5	4%
Grey mullet	*Mugil cephalus*	5	4%
Barracuda	*Sphyraena sphyraena*	4	3%
Stingray	*Myliobatoidei*	4	3%
Mahi-mahi	*Coryphaena hippurus*	4	3%
Spinner shark	*Carcharhinus brevipinna*	3	2%
Bluefish	*Pomatomus saltator*	3	2%
Brown meagre	*Sciaena umbra*	3	2%
Pink dentex	*Dentex gibbosus*	2	1%
Mackerel	*Scomber scombrus*	2	1%
Grey triggerfish	*Balistes capriscus*	2	1%
Salema	*Sarpa salpa*	1	1%
Pompano	*Trachinotus ovatus*	1	1%
White grouper	*Epinephelus aeneus*	1	1%
Marblede Spinefoot	*Siganus rivulatus*	2	1%
Saddled bream	*Oblada melanura*	1	1%
Smooth-hound	*Mustelus mustelus*	1	1%
Shi Drum	*Umbrina cirrosa*	1	1%
Total		**138**	**100%**

Data source: SPA/RAC–UN Environment/MAP (2020a)

Statistics indicate that the total fish production from the Libyan waters amounted to 50,000 tons in 2000, and this production consisted of approximately 21,000 tons of small pelagic fish (sardines, mackerel, and anchovy), about 2,000 tons of bluefin tuna, and about 24,000 tons of other fish species[29]. However, this production decreased significantly between 2000 and 2013, when Libya's production of marine fisheries reached about 41,700 tons (FAO, 2016).

[29] الخمسي, ر, م. 2008. ا . تزراع السمك فى ليبيا ودوره فى تنمية الثروة السمكية. الهيئة الوطنية للبحث العلمي. الطبعة 1-200.

Elasmobranchs and sea turtles constitute part of the bycatch in most local artisanal fisheries in the study area. Different elasmobranchs species have been caught in the spawning period in the gulf (SPA/RAC–UN Environment/MAP, 2020b) and stranded adult loggerhead turtles showed clear signs of entanglement and interaction with longline fisheries (Hamza & El Ghmati, 2006).

Fishery data (including catch estimates for both target and bycatch species, either kept or discarded) in Libya is not well defined and management of fisheries is unachievable in the absence of this kind of data. Also it is very difficult to estimate accurate results that can describe the state of exploitation of the fish stocks

The collection of such data should commence immediately and be continuous in order to establish a database, which allows analysis to determine its current status of the fisheries. Catch estimates can be obtained in a variety of ways including fishery observers, logbooks, dockside and shoreside monitoring. It is therefore imperative that efforts are made to collect fishery data for catch estimates. Likewise, this situation calls for urgent conservation measures to reduce the demonstrated high mortality in fishery's bycatch.

7.3.2. Aquaculture

Aquaculture is a recent activity in the Libya started at the beginning of the 1990's using wild juveniles of seabass (*Dicentrarchus labrax*), gilthead sea bream (*Sparus aurata*) and several species of mullet (*Mugil* spp.). However, Despite the Government's effort in promoting aquaculture and pushing private enterprises to start up, the production is still below the expected performances due to lack of administrative and practical technical and managerial experience. The most important technical body engaged in aquaculture matters is the Marine Biology Research Centre (MBRC) at Tajura, which is now under the authority of the National Marine Investment Institute. The main marine species cultured on a commercial basis in Libya are gilthead seabream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), and Atlantic Bluefin tuna (*Thunnus thynnus thynnus*). Attempts were undertaken to rear other marine species such as amberjack (*Seriola dumerilii*) or kuruma prawn (*Penaeus japonicus*). The maximum annual production of aquaculture reached about 300 tons in 2006, and started to decrease remarkably in the following years and stabilized around 10 tonnes since 2011 (FAO, 2017). The farming of Atlantic bluefin tuna is a new activity in Libya, rearing of this species was initiated in 2003 by two private companies which produced approximately 350 and 150 tonnes in 2003 and 2004 respectively (FAO, 2017).

In Sirte, the only aquaculture activity is the Sultan's farm project which is under construction (Shtawee, 2021). This project plans to build 15 concrete ponds, 8 salt water wells, 1 water collection tank. It seems that there are technical errors in the design of the basins and well water has not been analysed to test its quality. However, the service buildings of the project have been partially completed (Shtawee, 2021).

7.3.3. Oil exploration and production

The Libyan oil production in 2004 was estimated at 1.6 million barrels per day, and oil and gas production are the main source of income in the country. The Gulf of Sirte region contains most of the oil and gas fields in Libya. There are five important sedimentary basins in Libya, two of which are in the planning Gulf region. These two basins Sirte and Kufra are the two basins most in oil and gas exploration. The production of Crude Oil according to Operating Companies was 19.8 Millions of Barrels in 2015 against 31.7 Millions of Barrels in 2010 according to the Central Bank of Libya. Eight international companies operate in the Sirte

Basin, and the National Oil Company owns most of the shares in these companies. Oil discoveries changed the regional role of Sirte, as it is close to major oil fields in the East and to its exporting ports of As Sidr (190 km) and Ras Lanuf (216 km) that are included in the Sirte administrative region (governorate).

7.3.4. Agriculture and water sources

33% of the surface of the municipality is still reserved for agriculture, 17% for mixed agriculture and housing and 1% for green spaces (UN-Habitat, 2018). The biggest part area of land was allocated for agriculture in the city of Sirte with about 3295 hectares, corresponding to a rate of 33.3% of total land in Sirte. Agricultural activities in the Gulf of Sirte limits cultivated areas for grains (wheat, barley), vegetables (tomatoes, potatoes, onions, carrots, turnips), fruits (olives, dates, plums, sloes, watermelon, grapes, and oranges), and fodder crops.

Drinking water in Sirte was historically from wells as shallow as 5 meters. The first drinking water network was developed in 1964, with water collected in Abu Hadi, 20 km south of the city. Then a desalination plant was constructed in 1976 in Za'afaran, delivering up to 7 million cubic meters per year. In 1993, it was connected to the Great Man-Made River (GMMR) network providing today most of the water to the city and its region. It uses to deliver around 35,000 m^3/day, while the consumption reached in some periods around 2006 up to 60,000 m^3/d, especially in the summer, creating complex water scarcity issues[30].

7.3.5. Industry

The industrial activities of the city of Sirte are old, where the traditional industries such as hand-made shoes, making wool, and netting baskets, leather dyeing, and simple metal industries represented in drawing and hammering metals, in addition to repairing machines and equipment, and mostly the raw materials are agricultural, or animal, which is from the region adjacent to the city of Sirte. The city of Sirte did not witness the modern industry until the beginning of the second half of the twentieth century, which is the industry of freezing and marketing fish (Sebi'ei, 2009). The size of land occupied by the industry has reached 5.4 hectares in 1966 and increased to 303 ha in 2018 (Sebi'ei, 2009; UN-Habitat, 2018).

7.3.6. Energy, Electricity and water desalination

The first power plant in Sirte was built in 1960, a second in 1966, and then a seawater desalination plant and the production of electric power was installed in 1976. The total capacity was 42 MW in 2008 along with the desalination plant used for residential, commercial and industrial purposes (Sebi'ei, 2009). The desalination offer better supply option than water transfer at least in terms of cost, since importing water requires a great amount of energy.

7.3.7. Tourism

In 2006, the total land used in recreational activities reached 355.63 hectares, including green areas, parks, playgrounds, space and private areas. This proportion represents

[30] السبيعي، بشير عبدالله بشير، و محمد المبروك المهدوي. "أثر التغير الوظيفي على هوامش المدن: دراسة في جغرافية المدن" رسالة ماجستير. جامعة سرت، سرت، 2009. مسترجع من http://search.mandumah.com/Record/766687

(26.2%) of the total land used in industry (1327.28 hectares). We note a continuous decrease in the total area reserved for recreational activities due to amendments in the city plan, which resulted in deducting a large parts of recreational areas in favour of agricultural lands east of the city (Sebi'ei, 2009). According to the General Authority for Tourism, 700.000 hectares in Sirte have been identified as tourism areas in 2015 and 979.000 hectares have been mapped in the same year.

The structure of the tourism sector in Sirte is relatively undeveloped due to the security situation and the repeated civil unrest that the city has witnessed, as the number of hotels in the city of Sirte decreased from 11 hotels in 2007 to only two hotels in 2020 (SPA/RAC–UN Environment/MAP, 2020a).

It is crucial to promote and organize sustainable tourism on the site, in particular by preparing and building up the necessary facilities and taking in consideration the protection of the cultural and historical heritage of the region

8. Pressures and potential threats to the marine and coastal environment

In Libya, the high concentration of the population in the coastal zones led to acute depletion of natural resources due to urbanization, reclamation of ground water and desertification. In the middle region (Gulf of Sirte), it is mostly threatened by overfishing, destructive fishing methods and invasive biota from the ballast water since most of the oil terminals and harbours are located in this area. In the western region (Tripoli), the most threatening human activity is the industrial pollution coming from the Abokhamesh complex and Mellita oil terminal for Petrochemicals. From 2011, the political circumstances prevailing in Libya are affecting the marine and coastal environment acutely. In particular, the lack of control by the authorities to stop some harmful practices such as illegal fisheries[31].

The most important threats facing the Marine and Coastal Area of Shash are:

Illegal fisheries

Illegal fishing methods (e.g. the use of explosives and chemicals) are very active in recent times, especially in the absence of law and law reinforcement in the country due to the frequent crises it is going through. This is also triggered by the spread of ammunition and explosives from which some fishermen extract gunpowder in order to make home-made fishing explosive charge (known locally as Gelatena). Although most of the artisanal fishers in the Sirte region are trying to address this issue, and according to what was shown by the socio-economic study in the Gulf of Sirte that was conducted in 2021, the activity of explosive fishing led to an impact on the abundance of fish species and their habitats in a way that was noticed by most of fishers in comparison to 10 years before.

Bycatch

Unreported fish catch has increased strongly due to lack of control of fishing activities in the Libyan waters. Discards are also very high. Since 2011 due to many conflicts, there is no longer any control over fishing activities in Libya which is probably still growing significantly, particularly in the form of illegal foreign fishing (Khalfallah *et al*., 2015; Manach *et al*., 2015). Many deaths of marine mammals and sea turtles are being recorded every year in the shores extending from Thalatheen to the bouweirat due to bycatch by nets or hooks, for example in

[31] NATIONAL INTEGRATED MONITORING AND ASSESSMENT PROGRAMME (IMAP) FOR COAST AND HYDROGRAPHY INDICATORS FOR LIBYA

2019 the death of 29 sea turtles and 3 dolphins was recorded in this area (Saied & Dreyag, 2019).

A comprehensive study on the bycatch and discarded species in the Gulf of Sirte is very urgent and should be a priority at this stage.

Pollution

Oil pollution on the Libyan coast is caused by frequent discard of oil and oil products from localised sources such as ports, coastal refineries, and municipal sewage discharge.
The Gulf of Sirte in general is considered an oil port area, which makes it threatened at all times by oil leaks and spills from both tankers and refineries. this issue requires the development of emergency and mitigation plans to deal with any possible leaks. Coastal habitats are affected considerably by deposition of oil. The rocky shores are particularly vulnerable to oil pollution due to the accumulation of tar that may take long time to recover in comparison with the sandy beaches (Guidetti *et al*., 2000).

Tar balls resulted from past oil spills and from exchange of Oil Tankers' ballast water, ranged from 5-50 different size balls/m^2 were observed in various densities at the beaches in the Reserve of Shash (Hamza & El Ghmati, 2006).

The collection of solid wastes from urban areas in Sirte is still traditional with unsafe dumping. Anthropogenic pollutants were the most obvious types; i.e. plastic bags, containers, old nets, fishing lines, cans, used tires. Some cans and containers were driven by currents from as far as Italy and Greece. Natural debris including wood, reed stalks, Posidonia leaves, discarded sponges were also observed to in some parts of the three beaches according to the Libyan Sea Turtle Programme reports.

Measures to minimize this pollution should be applied, especially that the area is now declared as a Marine and Coastal Reserve. Moreover, pollution accidents from oil tankers discharges, if it happens, will change coastal habitats near the reserve of Shash, and thus need to be monitored frequently.

Hunting of migratory birds

Libya is one of the 10 highest Mediterranean nations in terms of birds illegally killed every year. aproximatly 503,000 birds are annually hunted in Libya according to a scientific review carried out by BirdLife International in 2015[32]. According to this study, among Mediterranean countries, Libya is the only one currently without any legal framework to regulate hunting and trapping to prevent illegal killing. Libya is also among the three highest countries in hunting and killing the Houbara bustard (*Chlamydotis undulata*), which is listed as 'Vulnerable' on the IUCN Red List. The number of individual birds illegally killed is estimated to have increased substantially in Libya in the last 10 years, mainly due the recent revolution, which have made weapons and ammunition readily available. The primary reason for illegal killing of birds in this country is for food. Shooting of birds is more frequent in Libya than live trapping.

Recently, the phenomenon of hunting migratory birds has been intensely active, especially in the western shores of the city of Sirte, where there are the salty marshes of Shash and Sabkhat Al-Khamseen.

[32] Birdlife International (2015). The Killing. https://www.birdlife.org/sites/default/files/attachments/01-28_low.pdf

Activities of the local population

The site is used for local picnics and beach visits in summer. The residents of the Al-Thalatheen and Garf regions are active in the area from Al-Thalatheen to Shash through the summertime which coinside with the breeding season of sea turtles. accordingly, activities of poaching all along the reserve of Shash are known to take place during this period. In addition, increased amounts of urban solid waste drifting by the sea and left by the beach visitors are also observed. Therefore, more efforts to raise awareness of the local population and involve them in the marine conservation efforts are strongly recommended.

The effect of the Gulf Steam power station

Al-Khaleej Steam Station, an oil and natural gas power station, is located on Al-Qubeiba Beach, which is adjacent to Al-Thalatheen Beach from the east. Its effect is not limited to changing the sea water temperature through the discarded water used for cooling, but rather has a direct impact on the marine organisms. The station's filters are often disposed of without first processing or rehabilitation procedures, which call for more efforts and building a partnership with station personnel to reduce the negative impact of the station on marine ecosystems.

9. Legal and institutional aspects related to biodiversity and marine and coastal conservation in Libya

Many legislation and regulations have been issued aiming to protect the natural ecosystems as well as International Conventions and Agreements signed by Libya.

9.1. Relevant institutional framework

From May 2021, by Decision of the Head of the National Unity Government the properties and staff of the Environment General Authority (EGA) were transferred to the newly created Ministry of Environment (MoE). The later became therefore the main government department in charge of environment in Libya. Its functions and organisational structure were defined by Decision 300/2021 that entrust the MoE with the following prerogatives:

- *Proposes plans and programs for the environment and follow up on approved ones, taking into account the environmental dimension in economic and social development plans.*
- *Supervising approved programs and plans for environmental sanitation, which are supervised by other competent agencies and municipalities.*
- *Keeping pace with scientific and technical development in the field of environmental protection and qualifying technical personnel in this field.*
- *Cooperating with international bodies to remove the causes of pollution in coordination with the relevant national bodies.*
- *Carrying out awareness campaigns by various means to introduce the environment and the rules and principles for protecting it from pollution and removing its causes.*
- *Registering all chemicals that may result in pollution of the environment, including fertilizers, agricultural pesticides, and pesticides used for public and veterinary health purposes, by forming joint technical committees with the competent sectors and in accordance with the regulations approved by these sectors.*
- *Carrying out environmental inspections of service and production activities that result in pollution.*
- *Monitoring water sources and protecting them from pollution.*

- *Granting the necessary permissions to practice activities that may result in environmental pollution in accordance with the regulations and legislation in force.*
- *Granting the necessary permissions for manufacturing, importing, selling, trading or releasing chemicals that may result in pollution to the environment through a joint committee between the ministry and the concerned sector, so that the provisions of the legislation in force are taken into account.*
- *Evaluates the potential effects of using seeds, genetically improved strains, and genetically engineered treatments prior to entry or transit into Libya.*
- *Proposes the establishment of protected areas and develop programs and plans aimed at protecting and preserving biodiversity in its various environments, in coordination with the relevant authorities.*
- *Granting permission to practice the activities concerned with protecting the environment and following it up.*
- *Determining the environmental requirements that must be taken into account when implementing any project after evaluating and reviewing the environmental impact study.*
- *Coordinating and cooperating with national committees in all sectors concerned with international agreements and treaties related to the environment.*
- *Follow up on international agreements and developments in the field of environment, and to benefit from them locally.*
- *Preparing a national plan to confront emergency environmental situations and disasters in cooperation with the relevant authorities and presenting it for approval.*
- *Encouraging and supporting civil institutions and associations accredited by the competent authorities whose activities fall within the field of environmental protection.*
- *Proposing and reviewing legislation related to environmental protection or participating in its preparation.*
- *Conducting studies and research related to environmental protection locally, in cooperation with relevant local and international research centres, bodies and institutions.*

The Ministry of Environment of Libya has a central role in the implementation of the country's National IMAP. It coordinated the process undertaken for the elaboration of the National IMAP and is liaising with the members of the National Team to ensure the timely organisation of the field monitoring surveys. The MoE will be the centralized body for the systematic monitoring of the Libyan shorelines, collection of datasets and reporting to Barcelona Convention Secretariat under IMAP, as well as for national purposes.

The Marine Biology Research Centre (MBRC), established in 1981 (Act No. 1582/1981), is another important player in the implementation of the National IMAP of Libya. Its premises and laboratories are located on the coast of Tajura (15 km east of Tripoli) and has prerogatives to:

- *conduct studies and field surveys of marine living and non-living habitats and resources,*
- *provide technical advice and consultation on marine wealth issues,*
- *publish the results of carried out studies and findings in various media types,*
- *cooperate with national, regional and international similar institutions and organizations through organization of joint research projects,*
- *organize symposia and conferences and exchange information.*

Other institutions and organisations could contribute in terms of capabilities to the implementation of the monitoring and/or management activities of the MCPA of Shash: University Departments (Universities of Tripoli, Tubruk and Omer Al-Moukhtar), local authority or municipality and NGOs.

9.2. Relevant National Legislation

In Libya, since 1958, there have been a series of Laws and Decrees concerning environmental protection, which have dealt with the treatment of effects and risks of environmental pollution, with, in theory, the imposition of severe penalties on violation of the provisions of such laws.

A summary list of key laws and decisions that have been issued since the establishing of Marine wealth sector is given below:

- *Law No. 7/1982, regarding the protection of environment. The third chapter addressed the protection of marine biology and the hazards of oil pollution on fishes.*
- *Law No. 15 / 1984, for preventing overhunting of wild animals.*
- *Law No. 14/1989, related to the exploitation of marine resources and its implementing regulations. It is the basic legislation concerning the regulation of the use and conservation of marine wealth. It deals with the permitted type of fishing gear, the sizes of fish/species and other marine organisms allowed to be caught, and issues relating to the supervision and control of the industry regarding safety.*
- *Secretariat of Marine Wealth (SMW) Decision No. 71/1990, which elaborates the provisions of Law No. 14 and the procedures governing its application, SMW Decision No. 80 of 1991, which provides technical explanations and specifications for the implementation of Law No. 14.*
- *Law No. 15/2003, which replaced Law No. 7/1982, concerning environmental protection. In this Law, Chapter 3 contains 21 articles, comprehensively covering marine fisheries and marine wealth conservation, identifying the means and procedures necessary for the protection of fish stock, and banning the dumping of oils and other pollutants from vessels into the sea and the discharge of land-based sewage and industrial water into the marine environment. It also prohibits the use of explosives, radioactive and other poisonous substances for fishing, and bans dredging for sponges. It also regulates the nomination of marine reservations for the preservation of threatened marine organisms.*
- *Act No. 453 / 1993, issued by the General People's Committee of Agriculture and animal wealth to prohibit the hunting of terrestrial and sea turtles.*

In addition, the following laws, regulations, legal frameworks and strategies are of importance to the conservation of marine biodiversity are:

- *SMW Decision No. 97 of 1993, relating to prohibitions on trawling in specific areas during the July and August spawning period for certain species. This decision was replaced by the General People's Committee Decision No. 271 of 2004 which defines those areas in which trawl fishing is banned. In brief, this decision prohibits trawlers from fishing in the defined areas during the months of May, June, July, and specifies the areas within which the trawlers are permitted to fish other than these areas ;*
- *Sea turtle protection is included in the decree issued by the Secretariat of Agriculture No. 453/1993 stating that ''All species of turtles and tortoises are protected by law in*

Libya'' furthermore stating that ''Any use of these species or its products (skin, eggs, flesh) is banned by law in Libya'' and that "Any violation of these articles will be prosecuted within the legal system according to Hunting Law No.28 of 1968'' ;

- *The General People's Committee Decision No. 37 of 2005, which declares a protected fishing zone along the Libyan coastline, prohibiting all methods of fishing in the declared permitted zones without advance permission issued by an official authority to be determined by the GPC.*
- *Law No. 81 of 1971 regarding seaports. This Law includes 155 articles, covering rules concerned with vessels, loading and unloading of explosives and dangerous material, and rules covering for oil loading and unloading, together with the penalties applicable on the violation of its provisions with regard to the set of obligations and prohibition stipulated by this law.*
- *Law No. 8 of 1973 with respect to the prevention of oil pollution to sea waters. This law includes a set of rules and provisions for its application, derived from the 1954 London Convention, which is considered an integral part of this law. The provisions of this law are limited to oil pollution sources, excluding other sources.*
- Act No. 205 / 2001 issued by General People's Committee regarding the establishment of Animal Wealth General Authority and one of its tasks to take care of the protectorates and national parks.
- Libyan National Action Plan on Proposed New Marine and Coastal Protected Areas and National Parks (2002).
- Action Plan for the conservation of Marine and Coastal birds in Libya.
- Action Plan for the conservation of marine turtles and their habitats in Libya.

Other important laws and decrees issued in the field of biodiversity conservation:

- *Act No. 25/1950, for protection of forests.*
- *Law No. 12/1956, for forests organizing and regulation.*
- *Law No. 47/1971, for the protection of forests and pastures.*
- *Law No. 5/1982 related to the protection of forests and pastures; amended by Law No. 14 / 1992.*
- *Act No. 3/1984, issued by General People's Committee of Agriculture and land reclamation concerning the protection of grasslands and forests from fire.*
- *Decision of the Secretary of General People's Committee of Agriculture No. 365/1995 for issuing some roles to protect the forests and pastures.*

Decisions related the institutional and regulatory framework of protected areas and national parks:

- *Law No. 14 with Articles 75- 78 concerning the development of protected areas. This Law was outlined in 1991, and came into force in 1992.*
- *Act No. 11/1990, issued by the General People's Committee concerning the establishment of Technical Committee for Wildlife, which conferred upon the technical and administrative supervision on the protected areas and national parks.*
- *Act No. 326/1998, related to the transfer of the responsibility and supervision of protected areas to the municipalities' councils.*

- *Act No. 205/2001, issued by General People's Committee regarding the establishment of Animal wealth General Authority and one of its tasks to take care about the protectorates and national parks.*

9.3. International and regional Conventions

Libya has signed and ratified a number of international conventions, protocols and action plans which include recommendations for species protection and also Appendices listing a number of species both marine and terrestrial. Libya is a Contracting Party in CITES, Biological Diversity, Barcelona Convention, RAMSAR convention, Bonn Convention on Migratory Species (CMS), and AEWA (the Afro-Eurasian Waterbird Agreement of the Convention on Migratory Species) (see table xx below).

Table 13: Regional and international conventions dealing with marine and coastal conservation ratified by Libya

Convention	Adoption	Ratification
The Convention on Wetlands of International Importance, especially as Waterfowl Habitat (RAMSAR)	1971	2000
The World Heritage Convention	1972	1978
The Convention on International Trade in Endangered Species of Wild Fauna and Flora	1973	2003
The African Convention on the Conservation of Nature and Natural Resources (Algiers Convention)	1968	1969
Barcelona Convention for Protection against Pollution in the Mediterranean Sea	1976	1979
The Convention on the Conservation of Migratory Species of Wild Animals (CMS)	1979	2002
Specially Protected Areas and Biodiversity Protocol (1995) and its Annexes (amendment)	1995	1995
The Convention on Biological Diversity	1992	2001
The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS)	2001	2002
Afro-Eurasian Waterbird Agreement of the Convention on Migratory Species (AEWA)	2005	2005

Chapter 2: MANAGEMENT AND CONSERVATION ISSUES / GAP ANALYSES AND PRIORITY CHALLENGES

1. Analysis of the environmental situation (constraints, problems, impacts and potentialities)

The sandy beaches found in the area are the most important marine turtle nesting sites in Libya. The area is also one of few landing sites for cartilaginous fisheries in Libya (February to April), using specific gillnests (Kellabia).

Seabirds and waders are abundant in the summer. However, the sebkhas (such as Taourgha, Hisha and Um lazaam) south of the sandy beach dunes are too far to be surveyed for waterbirds, due to the vast surface area and inaccessibility in many of its parts. This area is poorly known and needs an extensive survey to evaluate its ecological and economic importance. On the other hand, the Shash beach is well known as an important site for dolphin species, some types of cartilaginous, and important types of molluscs such as *Tonna galea*, in addition to the loggerhead sea turtle *Caretta caretta* that nest heavily on these beaches. The beach is protected in many parts due to the presence of barriers and tunnels that prevent access to the beach and only through rugged and forked maze-like roads one can gain access to it.

The coastal area of the reserve and the adjacent Bwirat area from the western side are considered important sites for the breeding of cartilaginous fish, the presence of *Posidonia oceanica* and other important species.

Table 14: important and flag species listed in Annexes II and III of the Protocol SPA/BD

No	Species	Class	Annex
1	*Posidonia oceanica*	Magnoliophyta	II
2	*Sargassum acinarium*	Heterokontophyta	II
3	*Carcharodon carcharias*	Chondrichthyans	II
4	*Cetorhinus maximus*	Chondrichthyans	II
5	*Mobula mobular*	Chondrichthyans	II
6	*Alopias vulpinus*	Chondrichthyans	III
7	*Carcharhinus plumbeus*	Chondrichthyans	III
8	*Heptranchias perlo*	Chondrichthyans	III
9	*Caretta caretta*	Reptiles	II
10	*Chelonia mydas*	Reptiles	II
11	*Charadrius alexandrines*	Aves	II
12	*Larus audouinii*	Aves	II
13	*Phoenicopterus roseus*	Aves	II
14	*Sterna sandvicensis*	Aves	II
15	*Balaenoptera physalus*	Mammalia	II
16	*Tursiops truncates*	Mammalia	II
17	*Delphinus delphis*	Mammalia	II
18	*Physeter macrocephalus*	Mammalia	II

19	*Stenella coeruleoalba*	Mammalia	II
20	*Alosa alosa*	Osteoichthies	III
21	*Alosa fallax*	Osteoichthies	III
22	*Anguilla Anguilla*	Osteoichthies	III
23	*Epinephelus marginatus*	Osteoichthies	III
24	*Thunnus thynnus*	Osteoichthies	III
25	*Xiphias gladius*	Osteoichthies	III

The SWOT Analysis matrix to identify Strengths, Weaknesses, Opportunities, and Threats related to environmental component and natural resources of the site, is as follows:

STRENGTHS	WEAKNESSES
▪ Exceptional terrestrial and coastal ecosystem diversity (Dunes, sandy beaches, rocky beaches; hard bottoms; sands; marine vegetation beds, salt marches) ▪ Site of Mediterranean importance for seagrass communities ▪ Site of Mediterranean importance for nesting of the sea turtle *Caretta caretta* and spawning of elasmobranchs ▪ Suitable habitat for different endangered species such as large pelagic fish species (e.g. Bluefin Tuna, and elasmobranches species) and marine mammals. ▪ Important areas for resting and feeding of migratory birds ▪ Historical habitat for the monk seal ▪ Terrestrial/marine floristic richness; ▪ More than 25 species listed in Annexes II and III of the Protocol SPA/BD ▪Existence of endemic flora/fauna species ▪Importance of the dune system which ensures the braking of dune erosion and the retreat of the beach, the maintenance of the natural state of the site, and the preservation of biological diversity.	▪ Sensitivity of the ecosystems; presence of fragile and very vulnerable habitats such as the *Posidonia oceanica* meadow ▪ Degradation of site/habitats. ▪ Overexploitation of natural resources particularly strong fishing pressure on fish stocks. ▪ Missing and/or incomplete data on marine ecosystems ▪ Lack of assessment and monitoring of the impacts of these activities on biodiversity and more particularly on fishery resources ▪ Unknown population dynamics information of seabird and waterbird species present in the area (numbers, phenology, etc.) ▪ Presence of introduced species among them 23 are invasive , ▪ With the exception of loggerhead turtle, no other monitoring of protected populations of birds and other species has been carried out. ▪ Delays in the creation and elaboration of the legal texts which manage and govern MPAs in Libya. ▪ Lack in studying biological indicators, as well as climate change in this region ▪ Lack of financial and technical support.
OPPORTUNITES	**THREATS**
▪ Existence of a legislative framework: the area of Shash was declared as a Marine and Coastal Reserve by the Libyan Minister of the Environment within the Decision n°218 of 2022 ▪ The natural and other protections to the beaches and dunes makes the site difficult to access ▪ Attractive area for eco-tourism	▪ Unsustainable practices such as illegal fishing, using dredges and explosives which critically impacting the fish stocks and certain species of sharks ▪ Capture of cartilaginous fish during their breeding season ▪ No enforcement of the national laws governing fishing and hunting activities ▪ Soil erosion, sand dune encroachment, urban encroachment on agricultural lands, decreasing

▪ Several awareness activities and several planned conservation and ecological monitoring programmes have been/are being implemented in Libya included Sirte gulf ▪ The presence of the Al-Gara island in the Gulf of Sirte, as the breeding ground of the largest population of the Lesser crested tern (*Thalasseus bengalensis*) in the Mediterranean provides more importance to the Gulf as a hotspot of biodiversity.	the groundwater level and increasing its and the soil salinity ▪ Existence of invasive species ▪Poaching; Ransacking and looting of turtle nests ▪ Illegal hunting and trapping of migratory bird species ▪ Extraction and sale of sand for construction whether in a legal or illegal way ▪ Oil pollution (passage of tankers and future offshore drilling) ▪ Driving on sandy beaches and dunes

2. Analysis of the socio-economic situations (constraints, problems, impacts and potentialities)

The SWOT Analysis matrix to identify Strengths, Weaknesses, Opportunities, and Threats related to the socio-economic component, land use planning and local development of the site, is as follows:

STRENGTHS	WEAKNESSES
▪The fishers have a favourable opinion regarding the creation of a reserve in the area and fishers' expectations about the benefit of the proposed reserve area to their fishing activity were positive ▪ Important seaside, scientific, educational, historical and cultural potential in the area ▪ An important fishery resource: The site contributes to the overall catch of Libya and to the viability of the fishing activity at the regional level, the site is appreciated due to the abundance of fish ▪ The coastal area of the site has not been subject to any development. It is still in an almost natural state. ▪ Existence of potential for tourism development	▪ Frequency of illegal and destructive fishing activities (dredges and explosives) ▪ Frequency of illegal hunting and trapping of migratory bird species ▪ No law enforcement ▪Poor management of the site during the summer season ▪ Lack of control and responsible Behaviour ▪ Lack of awareness and communication ▪Scattered historical information, weak promotion of cultural heritage assets. ▪ Lack of an awareness program for fishes ▪ Lack of studies on the pollution impacts ▪Knowledge gaps regarding bycatch and discarded species in the Sirte gulf
OPPORTUNITES	**THREATS**
▪ Existence of national laws and legislations regulating fisheries ▪ Important economic centre for fishing activities contributing to the regeneration of jobs and investments ▪ Tourist-oriented region ▪ National and local will to promote ec-otourism	▪Unauthorized dumping of waste left by visitors ▪ Mismanagement of waste ▪ Sand dredging and relocating ▪Harvesting of species for commercial purposes and poaching ▪ Increased fishing activities in the area ▪ Weak enforcement of existing regulations on the use of fishing gear, quantities and size of catches ▪ Growing human pressure on the dune belt, agricultural land and green spaces

	▪ Use of four-wheel drive vehicles during camping and summer causing trampling of vegetation and destruction of turtle nests ▪ Lack of awareness raising

3. Analysis of the legislative situation (constraints, problems, impacts and potentialities)

Although there are many laws and legislations aimed to protect the biodiversity and natural habitats, their actual implementation and enforcement has been hindered. These laws need to be implemented and enhanced (Etayeb *et al.*, 2012).
Also, there is a considerable delay in elaborating and adopting a National Strategy on Biodiversity or a Conservation Action Plan and this should be considered a priority to be implemented immediately. The first draft of the national strategy accomplished by the EGA in 2002 was submitted for adoption by the General People's Congress but was not approved. Later, in 2009, the EGA organised a national workshop to discuss its contents and find ways of developing a second draft of the strategy. Between 2012 and 2014 efforts have been renewed to adopt a national marine and coastal protected area strategy and draft the first comprehensive national legislation regarding protected areas selection, finance and management in Libya. The project "Management Support and Expansion of Marine Protected Areas in Libya" was launched recently in 2022, and implemented as part of the MedProgramme initiative led by Barcelona Convention UNEP/MAP and funded by the Global Environment Facility (GEF).

Moreover, the current environmental legislation (Law no.15/2003 on the Environment) states in its articles and executive regulations that a comprehensive Environment Impact Assessment process must be conducted prior to developing any area in Libya. This procedure is apparently only properly followed in the oil and gas industry and most other national authorities do not respond positively to these regulations.

The difficulties to take such steps are due to the following reasons:

- *Lack of coordination between different organizations and institutions to implement these legislations plus the overlapping of their tasks and responsibilities.*
- *Instability in the administrative bodies and institutions.*
- *Lack of public environmental awareness.*
- *Lack of national specific bodies and agencies that can implement these legislations, as well as Lack of capacity building and training in the field of environment protection.*
- *The current legislations do not address the new problems of biodiversity and Biosafety; they are outdated and need to be updated.*

The following SWOT Analysis matrix synthetizes Strengths, Weaknesses, Opportunities, and Threats related to legislative situation:

STRENGTHS	WEAKNESSES
▪ Several legal frameworks to conserve biodiversity, directly and indirectly, through the regulation of human activities have been set up ▪ The area of Shash was declared as a Marine and Coastal Reserve by the Libyan	▪ Lack of a comprehensive national study on the status of biodiversity ▪ Lack of coordination between different organizations and institutions to implement these legislations plus the overlapping of their tasks

Minister of the Environment within the Decision n°218 of 2022.	▪ Lack of public environmental awareness ▪ Instability in the administrative bodies and institutions
OPPORTUNITES	**THREATS**
▪ Existence of national laws and legislations regulating marine fishing ▪ Several regional and international conventions dealing with marine and coastal conservation	▪ Delay in adopting a National Strategy on Biodiversity Conservation and Action Plan ▪ Absence of a list of protected species or habitats in Libya nor any updating of the regulations on hunting and fishing activities

4. Presentation and evaluation of the challenges for the protection and conservation of the site

SPA/RAC has collaborated with the Ministry of Environment to elaborate the national strategy for the development of MPAs network. This strategy has already listed the Gulf of Sirte as a potential site to be declared as an MPA through 3 selected Hotspot areas (Shash, Lewaija and Ras Al-Ghara). Recently, the Shash area in the Gulf of Sirte was declared as a Marine and Coastal Reserve by the Libyan Minister of the Environment in Decision n°218 of 2022. This Ministerial Decision states that, first, all types of hunting and fishing activities are prohibited in this reserve; second, the Ministry of Environment, in coordination with the relevant authorities, is responsible for setting the boundaries for the protected site. Besides its high conservation value, the proposed area is one of the most important nesting sites for the loggerhead sea turtle in Libya and in the Mediterranean. Two years ago, in 2020, SPA/RAC released two reports on ecological and socio-economic studies conducted in the area. The results identified significant threats related to the management, conservation and development in the studied area and categorized them as follows:

<u>The lack of comprehensive baseline data:</u>
Significant lack of historic data, especially concerning the main protected species and habitats at Mediterranean level and lack of studies on biological indicators due to a deficiency of expertise.

<u>The lack of monitoring programmes for endangered and threatened species:</u>
Despite the significant efforts made on inventorying and monitoring of sea turtles, there is no other monitoring of other endangered species in the area. The main difficulties hindering this are mainly lack of financial and technical capacities, in particular lack of specialists in some fields.
There is an immediate need to identify adequate biological and socioeconomic indicators harmonised with the Ecological Objectives of the EcAp to assess the ecological health of fragile habitats and species.

<u>Update and enforce legislation to conserve biodiversity</u>
Beside the absence of a national list of protected species and habitats in Libya, there has been no update to the regulations on hunting and fishing activities at national level. The coordination between different organizations and institutions to implement these legislations is almost absent.

<u>Uncontrolled pollution</u>

The availability of field data on the effects of industrial activity on the surrounding marine environment, where artisanal fisheries and ecosystem have to be preserved, is very scant. Most of the Libyan oil industry ports are in the Gulf of Sirte which is probably the most affected are by the release of ballast water (Magazzu & Angot, 1981) particularly the coastal area. Therefore, a comprehensive assessment on the impacts of ballast water in this region is urgently needed.

Negative impact of fisheries and hunting on biodiversity

Unsustainable practices particularly capture of cartilaginous fish species during their breeding season and illegal fishing activities are noticed in the region. This is mainly through the use of shark gill nets, dredges and explosives which have negative impact on endangered species such as large pelagic species (e.g. Bluefin Tuna, and elasmobranches species) and on the fish stocks in general. Harvesting of species for commercial purposes, poaching and disruption of the reproduction of the various protected and economically valuable species by human action also reported in the region. The impacts on biodiversity are compounded by a lack of human activity management and difficulties in law enforcement (control of by-catch and IUU).

Introduction and spread of alien and invasive species

Available knowledge on NIS is still poor and fragmented, especially in relation to their ecological and socio-economic consequences.

Lack of capacity building and training in the field of environment protection

Capacity building is very important, therefore, it needs to be considered regularly through training and workshops in the fields of the Marine and Coastal Reserve for stakeholders in the region.

Impacts of the local population's activities

It has been noticed that there is an increasing anthropic pressures on the dune belt, agricultural land and green spaces (Urbanization, coastal development and tourism) near the city of Sirte. Mismanagement of waste and sand plunder are also reported in the region. Indeed, given the increasing demand for water and the scarcity of this natural resource, desalination of seawater is a growing activity to support the development of water demanding sectors. However, despite the fact that even desalinisation plants require going through an Environmental Impact Assessment, there is a deficiency of policy and guidelines for this activity and a strong need to study and then mitigate its impacts on biodiversity.

Lack of financial and human resources.

While there have been many studies conducted along the Libyan coastline, during the past three decades, aiming at the marine and coastal biodiversity, and have shown the importance of the Gulf of Sirt and its potential to designate one or more MPAs within the gulf, new challenges have emerged. Thus, essential needs can be drawn accordingly:

- Develop research programmes to compile and gather data and fill knowledge gaps on biodiversity;
- Create Inventories, maps and monitoring of coastal and marine biodiversity;
- Assess identify and then mitigate the impacts of threats to biodiversity;
- Safeguard sensitive habitats, species and sites;

• Coordinate and implement capacity building and technical support through various capacity building activities (need to conduct several studies and training for many researchers in these fields);

• Encourage the exchange of resources, experience and information among all stakeholders and partners as well as guiding decision-makers to maintain successful conservation of habitats and species at national level;

• Establish national reference information related to NIS, launch studies on their impact and implement adaptive management to mitigate their ecological and socio-economical losses.

• Socio-economic studies are essential for the sustainable development of industrial installations, artisanal fisheries and tourist activity;

• Establish a national network and collaboration platforms to exchange knowledge, information and experience;

• Enhance public awareness and education on the need for conservation of species and habitats.

Chapter 3: CHALLENGES, AND PROPOSED MANAGEMENT OBJECTIVES

3.1 Challenges

Pollution:

Different forms and sources of pollution can be found in the study area and may have direct and indirect impacts on the area. According to the socio-economic study that was conducted in the gulf of Sirte, there are issues in managing sewage, solid wastes and pollution from the oil industry dominant in the gulf.

Sewage: There is a comprehensive and operational sewage treatment facility with the capacity to treat up to 20,000 cubic meter of sewage water per day. This station collect and treat the waist water through the newly constructed sewage pipe network that links most of Sirte city. However, some concern is expressed regarding the sewage coming from the urban areas outside of Sirte which are not connected to the sewage network. These urban areas still rely on black wells to aggregate their waste water before being emptied, transported and released without treatment. Some of these urban areas are very close to the sea shore which would have considerable impacts and implication on the surrounding marine environment.

Solid wastes:

Solid waste management is conducted by a governmental company which gather and disposed of it. However, the disposal method is in question since the dumping site is not very far from the Marine Reserve area since it is roughly 9 km from the city centre and only 150m from the seashore. Giving that the country generate roughly a 90 tuns of solid days per day, and with the absence of any recycling, treatment or management plan for the dumping site, this would pose a considerable threat to the marine environment in the area especially with the plastic and toxic wastes coming from construction sites and factories.

Oil pollution:

The Gulf of Sirte is the main oil industry area in Libya in which it contains most of the refineries, well and ports. There are 4 ports that are dedicated to oil transportation, these are the port of Sidra, the port of Ras Al-Anuf, the port of Brega and the port of Zueitina. This has created a considerable source of both threats and impacts in the gulf area. Discarded oil, and some of the by-products from the refineries along with cooling and ballast water from the transporting ships are some of the threats that should be further invitigated and metigation measures are taken to reduce and minimise these impacts. An emergency intervention plan should also be prepared in the case of a large oil spill to protect the marine environment in the gulf.

Other sources of pollution:

There are other rather local sources of pollution that also need to be taken in consideration such as the brine and hot water released from the electricity and desalination stations found in the gulf area. Although local and on a smaller scale, the hot and highly saline water discharges from these facilities could cause a considerable

damage to the nearby marine environment specially to sponges, coralligenous formations and seagrass meadows.

Fisheries:

Although the fishing fleet operating in the gulf vicinity is mostly artisnial and of a small scale, the presence of and the increasing use of destructive and illegal methods will have heavy impacts on the area. The use of dynamite, chemicals and other destructive methods has been reported from several parts along the coast of Sirte. The lack of law enforcement measures combined with the unstable political situation in the country has increased the use of these methods. Finding the middle ground to communicate with the local fishers and convincing them the destructive impacts of these methods on the long term, should be the main challenge to be tackled by conducting public awareness and awareness-raising activities in the area, and find, suggests and support alternative methods and activities to reduce the use of these methods.

Another implication for conservation found in the gulf is targeting certain elasmobranch species during their breading season. The fishing method known as “Kelabia” is a specific net with larger mesh especially designed to catch sharks and other larger fish species. Along with targeting sharks, other species such as cetaceans (small dolphins) and sea turtles are known to get entangled in the nets resulting in bycatch.

Birds hunting:

Another issue to be approached *via* public awareness and regulation. During the months of summer and autumn (the migration season), hunters will camp in small groups along the coastline and in the nearby wetlands for weeks during which they hunt the passing migrating flocks. The impact of this activity is sever especially on certain species such as the houbara bustard (*Chlamydotis undulata*) as highlighted previously in this report.

Management of turtle nesting sites:

Given the importance of the area for turtle nesting, the proper management of nesting sites is among the most important challenges for the protected area. Close collaboration should be established with the Libyan Sea Turtle Program. In addition to the protection of turtles, the management of the nesting sites has a potential to contribute in the awareness raising for the area as well as in enhancing its visibility and national and Mediterranean levels.

Filling knowledge gaps:

The proper management and sustainable utilisation of this living resources in the area requires a better knowledge about its natural features, habitats and species. It requires also accurate assessment of the threats such as the alien species, the bycatch of vulnerable species etc.

Establishing an adequate governance scheme for the MPA

The success of the protected area will depend largely on the efficiency of its governance approach. In addition to the management team, the MPA should be endowed with a framework allowing (i) close consultation with the stakeholders, (i) adequate engagement of local population and (iii) a balance between conservation and social/economic benefits. The governance system should sufficiently flexible and adaptable to the changing context and circumstances in the area.

The relevance and feasibility of a governance based on co-management should assessed taking into account the local context as well as the orientations set at national level in relation to the management of protected areas.

3.2 Proposed management objectives

Based on the above analysis of the environmental, socio-economic and legislative contexts, it is proposed to build the management plan for the coastal and marine area of Shash - Gulf of Sirt in Libya according to the following objectives. These objectives are meant for a period of 5 years after which they should be revised according to the evaluation of the implementation of the management plan. Considering that the management plan to be elaborated is the first management planning initiative for the area, it is highly recommended to have it focusing on improving the knowledge about the habitats and species populations and on the most urgent key conservation issues:

- *Improve the knowledge about the area's key habitats and species: Posidonia meadows, wetlands, elasmobranch and bird species.*
- *Ensure the continuation of the seasonal monitoring and management of turtle nesting in the area.*
- *Establish close and trusty relationship between the management unit and the key users of the area.*
- *Adequate visibility of the protected area through (i) awareness raising and advocacy targeting local decision-makers and other stakeholders; (ii) implementing an education programme made of activities with schools and the establishment of a visitor centre open for the general public and students.*

These proposed objectives were reviewed and approved during a workshop organised by the Ministry of Environment with the support of SPA/RAC in Tripoli (June 2023).

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Annex 1: Marine alien species recorded in Libyan waters until 2021

Invasive alien species are in red

Species	First record location and year	Status	Establishment	Distribution	References
Foraminifera					
Amphisorus hemprichii Ehrenberg, 1839	E – 2004	AL	Unknown	E	Langer (2008)
Amphistegina lobifera Larsen, 1976	E – 1979	CR	Est.	E	Blanc-Vernet et al. (1979)
Coscinospira hemprichii Ehrenberg, 1839	E – 2004	CR	Unknown	E	Langer (2008)
Phaeophycae					
Padina boergesenii Allender & Kraft, 1983	E – 1974	AL	Est.	A	Nizamuddin (1981)
Padina boryana Thivy, 1966	E – 1974	AL	Est.	A	Nizamuddin (1981)
Stypopodium schimperi (Kützing) M.Verlaque & Boudouresque, 1991	E – 1977	LA	Est.	A	Nizamuddin (1981)
Rhodophyta					
Acanthophora nayadiformis (Delile) Papenfuss, 1968	1888	CR	Est.	A	De Toni & Levi (1888)
Anotrichium furcellatum (J.Agardh) Baldock, 1976	2015	CR	Est.	E	Verlaque et al. (2015)
Chondria coerulescens (J.Agardh) Falkenberg, 1901	W – 1989	CR	Est	W	Godeh et al. (1992)
Lophocladia lallemandii (Montagne) F.Schmitz, 1893	1918	AL	Est.	A	Petersen (1918)
Polysiphonia atlantica Kapraun & J.N.Norris, 1982	E – 1989	CR	Cas.	E	Godeh et al. (1992)
Chlorophyta					
Avrainvillea amadelpha (Montagne) A.Gepp & E.S.Gepp, 1908	2012	AL	Est.	E	Verlaque et al. (2017)
Caulerpa cylindracea Sonder, 1845	1990	AL	Est.	A	Nizamuddin (1991)
Caulerpa taxifolia var. *distichophylla* (Sonder) Verlaque, Huisman & Procaccini, 2013	W – 2017	AL	Est.	W	Nizamuddin et al. (1979) Shakman et al. (2017), Mahklouf & Talha (2018)
Cladophora herpestica (Montagne) Kützing, 1849	E – 1986	AL	Ques.	E	Nizamuddin (1988)
Codium fragile subsp. *atlanticum* (A.D.Cotton) P.C. Silva, 1955 = *Codium fragile* subsp. *fragile*	1984	AL	Est.	A	Nizamuddin (1991)
Codium taylorii P.C.Silva, 1960	1977	AL	Est.	A	Nizamuddin (1991)
Ulva fasciata Delile, 1813	1979	CR	Est.	A	Nizamuddin et al. (1979) Shakman et al. (2017), Mahklouf & Talha (2018)

Magnoliophyta					
Halophila stipulacea (Forsskål) Ascherson, 1867	2009	AL	Est.	A	RAC/SPA (2009)
Bryozoa					
Amathia verticillata (delle Chiaje, 1822)	W – 2018	AL	Est.	W	Rizgalla et al. (2019) d
Ascidia					
Symplegma brakenhielmi (Michaelsen, 1904)	W – 2018	AL	Est.	W	Rizgalla et al. (2019) d
Sponges					
Paraleucilla magna Klautau, Monteiro & Borojevic, 2004	W – 20189	AL	Est.	W	Katsanevakis et al (2020)
Amphipoda					
Hamimaera hamigera (Haswell, 1879)	E – 1972	AL	Cas.	E	Ortiz & Petrescu (2007)
Cirripedia					
Tetraclita squamosa rufotincta Pilsbry, 1916	E – 2007	AL	Cas.	E	Zaouali et al. (2007a)
Copepoda					
Euchaeta concinna Dana, 1849	E – 1990	AL	Cas	E	Halim (1990)
Decapoda					
Callinectes sapidus	E – 2018	AL	Est.		Corsini-Foka et al. (2021)
Eucrate crenata (De Haan, 1835)	1999	AL	Est.	A	Zgozi et al. (2002)
Penaeus aztecus Ives, 1891	E – 2020	AL	Est.		Abdulrraziq et al. (2021)
Percnon gibbesi (H. Milne-Edwards, 1853)	W – 2004	AL	Cas.	W	Elkrwe et al. (2006)
Plagusia squamosa (Herbst, 1790)	S – 2006	AL	Est.	A	Zaouali et al. (2007b)
Portunus segnis Forsskål, 1775	E – 2017	AL	Est.	A	Shakman et al. (2017)
Isopoda					
Apanthura sandalensis Stebbing, 1900	E – 1976	AL	Est.	E	Negoescu (1981)
Paradella dianae (Menzies, 1962)	E – 2001	AL	Cas.	E	Zgozi et al. (2002)
Stomatopoda					
Erugosquilla massavensis (Kossmann, 1880)	E – 2002	AL	Est.	E + S	Zgozi et al. (2002)
Bivalvia					
Fulvia fragilis (Forsskål in Neibuhr, 1775)	1997	AL	Est.	A	Zgozi et al. (2002); Rizgalla et al. (2019) c
Malleus regula (Forsskål in Niebuhr, 1775)	2001	AL	Est.	A	Giannuzzi-Savelli et al. (2001)
Pinctada imbricata radiata (Leach, 1814)	1913	AL	Est.	A	Monterosato (1917)
Gastropoda					
Aplysia dactylomela Rang, 1828	W – 2018	AL	Est.	W	Rizgalla et al. (2019) a
Bursatella leachii Blainville, 1817	E – 2000	AL	Cas.	E	Zgozi et al. (2002)

Cellana rota (Gmelin, 1791)	E – 2007	AL	Cas.	E	Zaouali et al. (2007b)
Cerithium scabridum Philippi, 1848	W – 2018	AL	Est.	W	Rizgalla et al. (2019) d
Clypeomorus bifasciata (G.B. Sowerby II, 1855)	E – 1994	AL	Cas.	E	Giannuzzi-Savelli et al. (1997)
Conomurex persicus (Swainson, 1821)	2006	AL	Est.	A	Ben-Souissi et al. (2007)
Conus fumigatus Hwass in Bruguière, 1792	E – 1976	AL	Cas.	E	Röckel (1986)
Diodora ruppellii (G. B. Sowerby I, 1835)	W – 2019	AL	Est.	W	Rizgalla et al. (2019) b
Erosaria turdus (Lamarck, 1810)	2007	AL	Est.	A	Ben-Souissi et al. (2007)
Haminoea cyanomarginata Heller & Thompson, 1983	W –2018	AL	Cas.	W	Rizgalla et al. (2018)
Nerita sanguinolenta Menke, 1829	E – 1994	AL	Cas.	E & S	Giannuzzi-Savelli et al. (1994)
Okenia longiductis Pola, Paz-Sedano, Macali, Minchin, Marchini, Vitale, Licchelli & Crocetta, 2019	W – 2018	AL	Est.	W	Rizgalla et al. (2019) d
Cephalopods					
Sepioteuthis lessoniana Férussac, 1831	W – 2015	AL	Cas.	W	Shakman et al. (2017)
Echinodermata					
Ophiocoma scolopendrina (Lamarck, 1816)	E – 2007	AL	Ques.	E	Zaouali et al. (2007b)
Cnidaria					
Phyllorhiza punctata von Lendenfeld, 1884	W– 2015	AL	Est.	W	Rizgalla & Crocetta (2020)
Fishes					
Abudefduf vaigiensis (Quoy & Gaimard, 1825)	W – 2019	AL	Est.	W	Osca et al. (2020)
Acanthurus monroviae Steindachner, 1876	W –2019	AL	Est.	W	Bariche et al. (2020)
Alepes djedaba Forsskal, 1775	E – 1990	AL	Est.	A	Ben Abdalha et al. (2005)
Atherinomorus forskali (Rüppell, 1838)	E – 1929	AL	Est.	A	Norman (1929)
Crenidens crenidens Forsskal, 1775	E – 1999	AL	Ques.	E & S	Al-Hassan & El-Silini (1999)
Etrumeus golanii DiBattista, Randall & Bowen, 2012	W – 2017	AL	Est.	A	Shakman et al. (2017)
Fistularia commersonii Ruppell, 1838	E – 2004	AL	Est.	A	Ben Abdalha et al. (2005)
Hemiramphus far Forsskal, 1775	E – 2006	AL	Est.	A	Shakman & Kinzelbach (2006)
Herklotsichthys punctatus Ruppell, 1837	E – 2005	AL	Est.	E & S	Shakman & Kinzelbach (2007c)
Lagocephalus sceleratus Gmelin, 1789	E – 2009	AL	Est.	A	Kacem-Snoussi et al. (2009)
Lagocephalus suezensis Clark & Gohar, 1953	E – 2009	AL	Est.	A	Kacem-Snoussi et al. (2009)
Liza carinata Valenciennes, 1836	E – 2005	AL	Est.	A	Shakman & Kinzelbach (2007c)
Parexocoetus mento Valenciennes, 1847	E – 1966	AL	Est.	E	Ben Tuvia (1966)
Parupeneus forsskali (Fourmanoir & Guézé, 1976)	E – 2018	AL	Est.	E	Bariche et al. (2020)

Pempheris rhomboidea Kossmann and R Cuvier, 1831 Auber, 1877	E – 2004	AL	Est.	A	Ben Abdallah et al. (2004)
Pterois miles (Bennett, 1828)	E – 2019	AL	Est. Cas.	E &W	Al-Mabruk & Rizgalla (2019)
Sargocentron rubrum Forsskål, 1775	E – 1968	AL	Ques.	E	Stirn (1970)
Saurida lessepsianus Russell, Golani, Tikochinski, 2015	1982	AL	Est.	A	Zupanovic & EL-Buni (1982)
Scomberomorus commerson Lacepède, 1800	E – 2003	AL	Est.	A	Ben Abdallah et al. (2003)
Siganus luridus Rüppell, 1829	E – 1968	AL	Est.	A	Stirn (1970)
Siganus rivulatus Forsskål, 1775	E – 1968	AL	Est.	A	Stirn (1970)
Sphyraena chrysotaenia Klunzinger, 1884	E – 1968	AL	Est.	A	Stirn (1970)
Sphyraena flavicauda Rüppell, 1838	E – 1998	AL	Est.	A	Ben Abdallah et al. (2003)
Stephanolepis diaspros Fraser-Brunner, 1940	E – 1965	AL	Est.	A	Zupanovic & EL-Buni (1982)
Torquigener flavimaculosus (Hardy & Randall, 1983)	E – 2017	AL	Cas.	E	Al-Mabruk et al. (2018)
Upeneus moluccensis Bleeker, 1855	E – 1968	AL	Est.	A	Stirn (1970)
Upeneus pori Ben-Tuvia & Golani, 1989	E – 1994	AL	Est.	A	Ben Abdalha et al. (2005)
Alien parasites					
Allolepidapedon petimba	W – 2016	AL	Unknown	W	Salem (2017)
Apounurs sigani	W – 2016	AL	Unknown	W	Abdelnor et al. (2019)
Glyphidohaptor plectocirra	W – 2016	AL	Unknown	W	Abdelnor et al. (2019)
Hatschekia siganicola	W – 2016	AL	Unknown	W	Abdelnor et al. (2019)
Neoallolepidapedon hawaiins	W – 2016	AL	Unknown	W	Salem (2017)
Nybelinia africana	W – 2016	AL	Unknown	W	Salem (2017)
Tetrancistrum polymorphum	W – 2016	AL	Unknown	W	Abdelnor et al. (2019)

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