SYNTHETIC OVERVIEW ON THE ECOLOGICAL CHARACTERIZATION OF THE COASTAL AND MARINE AREA OF GULF OF SIRTE

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List of acronyms

ACCOBAMS: Agreement on the Conservation of Cetaceans in the Mediterranean, black sea and adjacent Atlantic Area

AEWA: Agreement on the conservation of African – Eurasian Migratory waterbirds

DG NEAR: Directorate General for Neighbourhood and Enlargement Negotiations

EcAp: (Ecosystem Approach).

EGA: Environment General Authority

ENI: European Neighbourhood Instrument

EU: European Union

FAO: Food and agriculture Organization

GES: Good Environmental Statues

IMAP: Integrated Monitoring and Assessment Programme

IUCN: International Union for the Conservation of Nature

MAP: Mediterranean Action Plan

MBRC: Marine Biology Research Center

MEDPOL: The programme for Assessment and Control of Marine Pollution in the Mediterranean Region

MPA: Marine Protected Area

NIS: Non-Indigenous Species

POM: Particulate Organic Matter

SPA/RAC: Special Protected Areas Regional Activity Centre

WoRMS: World Register of Marine Species

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Executive summary

The Gulf of Sirte is an important area in the southern Mediterranean region for several environmental parameters, habitat and marine biodiversity as well as it is a hotspot for biodiversity. Most the beaches are sandy interspersed with small rocky areas, and thus supporting a wider marine food web. This Gulf is connected by many salt marshes (Sabkha) such as Sultan Sabkha 11 km. long, also the terrestrial protected areas such as Al-Heesha and Tawergha. It is a suitable habitat for many endangered species such as large pelagic species (e.g. Bluefin tuna, and elasmobranch species), sea turtles, seabirds and marine mammals. On the negative side, the area has suffered from ballast water due to the presence of active oil terminals and ports. In addition, the overfishing of the elasmobranch species and human disturbance on sea turtles and aquatic birds. The island of Al-Gara in this area is important as the breeding ground for the largest population of the Lesser Crested Tern (*Thalasseus bengalensis*) in the Mediterranean, giving provides the Gulf greater importance as a biodiversity hotspot.

General introduction and context

The Specially Protected Areas Regional Activity Centre (SPA/RAC) of the Mediterranean Action Plan (UNEP/MAP) has been designated as co-executing agency in the framework of the regional project "Towards achieving the good environmental status of the Mediterranean Sea and coast through an ecologically representative and efficiently managed and monitored network of marine protected areas" (“IMAP-MPA Project”). The "IMAP-MPA" Project is funded by the European Union (EU) - Directorate General for Neighbourhood and Enlargement Negotiations (DG NEAR) and the European Financial Instrument of the 2018-2022 Green MED III: The European Neighbourhood Instrument (ENI) South, for Water and Environment. It is coordinated and implemented by the UNEP/MAP Secretariat and executed through its Programme for Assessment and Control of Marine Pollution in the Mediterranean Region (MEDPOL) and the Regional Activity Centre for Specially Protected Areas (SPA/RAC) for the benefit of six countries (Algeria, Egypt, Lebanon, Libya, Morocco and Tunisia) with regards to the MPA component exclusively executed by SPA/RAC.

The IMAP-MPA Project aims to contribute to the achievement of the Good Environmental Status (GES) of the Mediterranean Sea and its coasts. It therefore proposes to consolidate, integrate, and strengthen the Ecosystem Approach (EcAp) for the management of Marine Protected Areas (MPAs) and their sustainable development, which will achieved by monitoring and assessing the ecological status of the Mediterranean Sea and its coastline, including MPAs, in a comparative and integrated manner.

More specifically, the project aims to improve MPA management through the coordinated implementation of of the Barcelona Convention Roadmap for a comprehensive and coherent network of well-managed MPAs to achieve Aichi Target 11 in the Mediterranean and to strengthen the integration of the Monitoring and Assessment Programme (IMAP) into this process. It will therefore consolidate and further develop the Mediterranean network of ecologically representative, interconnected and effectively managed and monitored MPAs, through the improvement of national biodiversity governance and policies; the development and implementation of MPA management plans and the improvement of MPA management throught targeted actions.

In Libya, SPA/RAC collaborated with the Environmental General Authority in the elaboration of the national strategy for the development of an MPA network. This strategy has already identified the Gulf of Sirte as a potential site for MPA designation. The current project will therefore support the development of the management and business plans of the Gulf of Sirte. In addition to 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.

It is worth mentioning that SPA/RAC and the Environmental General Authority (EGA) will collaborate together and lead the elaboration of the management plan of the future MPA of Gulf of Sirte, in a participatory and concerted process jointly with the national authorities in charge of the protected areas and in consultation with other relevant governmental bodies, civil society and socio-professional and economic actors concerned by the protected area, during national/local consultation processes.

The process will build on the complementary ecological and socio-economic studies, to ensure that the final versions of the management plans take into account both conservation objectives and the need to integrate the future marine protected area into its economic and social environment. For that purpose, SPA/RAC and EGA have launched a study to provide a synthetic ecological characterisation overview of the coastal and marine environment of the Gulf of Sirte.

Report elaboration

The Libyan coast represents 2000 km of the southern Mediterranean coastline. It is characterised by a wide continental shelf with diverse habitats and topography. The geographical location of Libya is in the central and warm part of the Mediterranean Sea. It is also interesting because it can host thermophilic organisms arriving from the east (Indo-Pacific origin) or expanding from the west (Tropical Atlantic origin). The central region (Gulf of Sirte), consisting mainly of sandy beaches interspersed with small rocky areas, and provides suitable habitat for fish species, thus supporting a wider marine food web that includes larger pelagic fish species (e.g. Bluefin tuna and sharks), sea turtles, seabirds and marine mammals. It is considered as an important habitat for different endangered elasmobranchs and sea turtles. There are many salt marshes (Sabkha) connected to the sea including Sultan Sabkha which 11 km long. This region includes terrestrial protected areas such as Al-Heesha and Tawergha. Therefore, the area sufferes from ballast water due to the existence of active oil terminals and ports. There is also overfishing of the sharks and human disturbance of sea turtles and birds.

In light of the above, this report is a compilation of all available information for the Gulf of Sirte, with the aim of assessing the natural habitats and marine species, and proposing recommendations for the management of the future MPA. This has been done on the basis of existing data and available information and taking into account thre following three surveys and records:

- Records of marine Mollousc species were based on a compilation of published articles, technical reports, grey literature and unpublished data collected during surveys and awareness campaigns since the seventies of the last century. In addition, the data included in the report belong to the analysis of samples collected along the entire Libyan coast during two periods: January 2005 to March 2006, and January 2013 to January 2017. The scientific names follow those of the World Register of Marine Species (WoRMS) (http://www.marinespecies.org).
- Records of cartilaginous fishes were based on a compilation of published articles, articles in press, grey literature and unpublished data, including surveys and awareness campaigns carried out over the last two decades. The the data included in the report represent the analysis of samples collected along the entire Libyan coast during two periods: from January 2005 to March 2006 and from January 2013 to January 2017. These surveys were carried out at 131 landing sites along the Libyan coast, with a particular focus on

the seasonal landing site in the area from Misrata to Benghazi coast (Gulf of Sirte). This area is a good habitat for the reproduction of several elasmobranch species (Per. observ.), where fishers use a type of gill net (kellabia) in depths of 1000 to1500 m long and 2-3 m with 25-30 cm handmade mesh size, to catch several species of sharks. Some other data were collected by observers,

- For bony fishe diversity, the results presented in this paper paper are mainly based on a total of 12 surveys that were carried out on-board local fishing vessels, from December 2009 to December 2013, with regular monitoring of fishery landings and local fish markets were periodically monitored during the same period. However, most of the samples were collected from small-scale fisheries using artisanal fishing gears such as; trammel nets, various types of gillnet, mid-water and bottom longlines, and encircling nets. Fishers were actively involved in this research, in some cases providing voucher specimens and/or photographic documentation of species considered rare or new to the fishing area. Taxonomic identification was mostly based on Fisher et al. (1987), Nelson (2006) and in some cases, specific literature, and specimens were preserved. Information collected during field surveys was compared with information obtained from an extensive bibliographic search of both scientific and grey literature. Scientific names were checked according to the World Register of Marine Species (WoRMS) (http://www.marinespecies.org). and then listed in alphabetical order (EL-baraasi et al., 2019).
- Records of fisheries are based on a survey carried out along the Libyan coast in 2013. The surveyed extends from Farwah in the western part of Libya to the Al Bardiyah Gulf in the easternmost part at the Libyan border with Egypt (Fig. 1). The aim of this survey was to determine the number of vessels, their types and the fishing gear used in the coastal area at 131 landing sites. In addition, important complementary information on fishing vessels and fishing gears was collected from local fishers and fishers' associations (Shakman et al., 2014).

1. General framework of the study area

1.1.Gorgraphical situation and general description of the area

The Gulf of Sirte is located in the middle of the Libyan coastline, which extends about 2000 km in the southern Mediterranean Sea. According to the topography and the type of habitats, the Libyan coastline has been divided into three main regions: Eastern region, Gulf of Sirte and Western region (Shakman 2008) (Fig. 1).

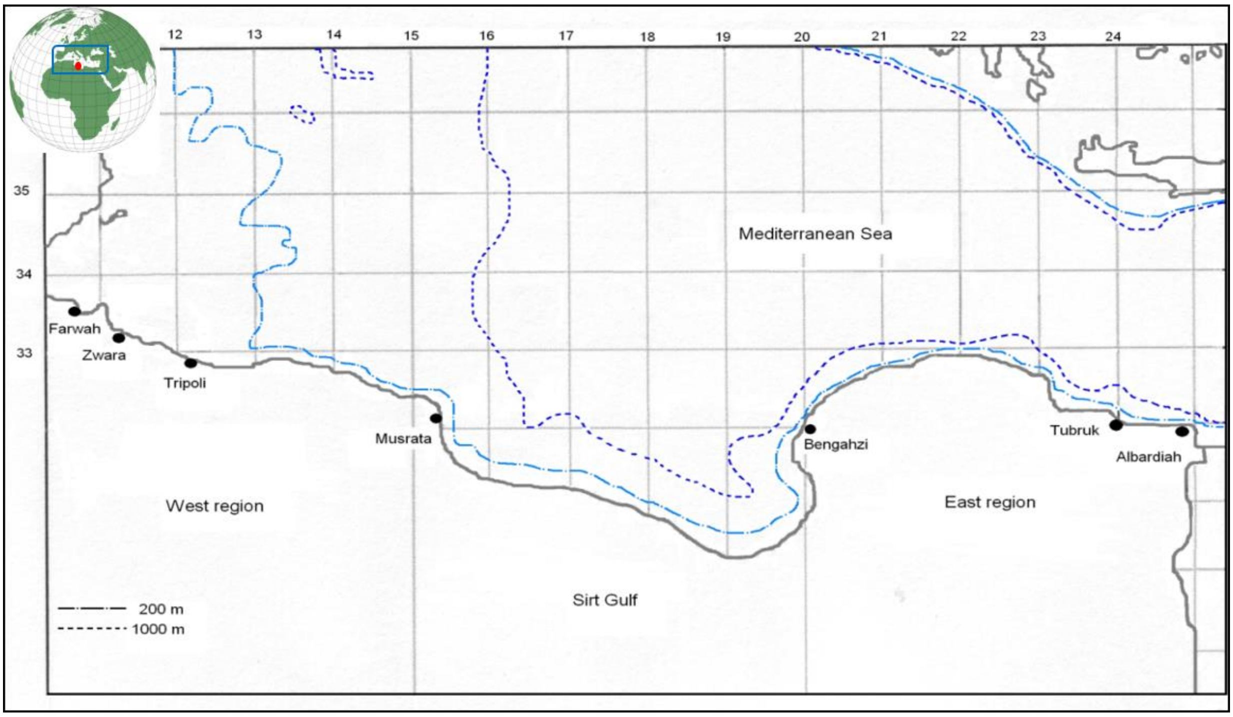

Figure 1 : Map of the Libyan coast (Shakman, 2008)

The Gulf of Sirte (central region) (Fig. 2) consists mainly sandy beaches interspersed with small rocky areas. It is provides suitable habitat for fish species, thereby supporting a wider marine food webs that includes larger pelagic fish species (e.g. Bluefin tuna and sharks), sea turtles, seabirds, marine mammals and is considered an important habitat for several endangered elasmobranch species and sea turtles. The beach is connected to the sea through some salt marches such as; Sultan Sabkha (11 km. long) and includes the protected areas such as Alhesha and Taurgh. The area from Buerat El Hassun to Benghazi is mainly composed of salt marshes such as Sultan, Besher, Kweim, Shwerab, and Karkora.

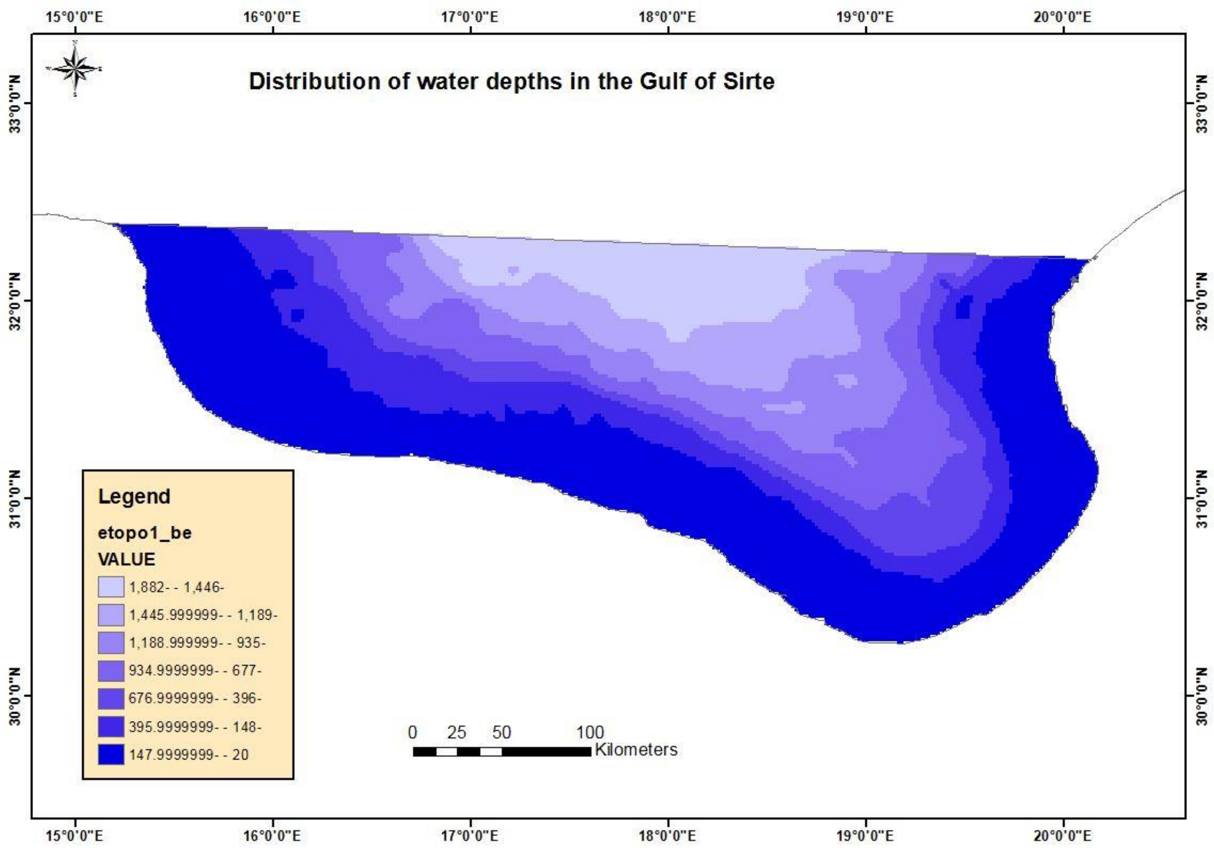

Figure 2 : The bathgymetry of the middle region (Sirt Gulf) (AVISO+, 2020)

1.2.Oceanography

From a hydrological point of view, the offshore and inshore Libyan waters in the Gulf of Sirte (between 11.8°E - 20°E and 30.4°N - 34ºN) are poorly studied and the main oceanographic features are not fully understood. In general, the available information is scarce and even the most complete and updated database of all Mediterranean hydrological data , the Medar/MEDATLAS II (Medar Group, 2002), shows a significant lack of data in this region since the beginning of the century. The thermohaline characteristics and the water mass circulation along the Libyan coast are as mentioned above, not fully understood and the little information available allows only a rather rough description of the hydrological conditions of the area (Guibout, 1987). The classical circulation patterns (Ovchinnikov, 1966) indicate an anticyclonic (clockwise rotation) motion for both surface and deep waters. However, the Atlantic water moves from west to east along the continental slope, as confirmed by numerical simulations (Beranger *et al.*, 2005). The model results are consistent with the circulation patterns suggesting a classical type of anticyclonic circulation away from the coast in both the surface and deep layers. The Libyan coast is quite smooth and a wide continental shelf

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characterises the shape of the seabed along the edge of the escarpment. In the Gulf of Sirt, the shelf is reaching its maximum extension (about 80 km) and gradually thins westward before expanding again back to Tunisia (Bonanno *et al*., 2015).

1.2.1. Physical and chemical Parameter

1.2.1.1.Temperature and salinity

The temperature profiles show a well-developed thermocline at a mean depth of about 24 m, and a progressive decrease in temperature from about 28 °C at the surface to 13.6 °C near the bottom (Fig. 3). The salinity maximum (Smax), the signature of the LIW core, shows values ranging from 38.92 to 38.71‰. Salinity clearly decreases moving from east to west in the Gulf of Sirte (Fig. 4). Both temperature and salinity appear almost constant near the bottom indicating a homogeneous bottom layer (Bonanno *et al*., 2015).

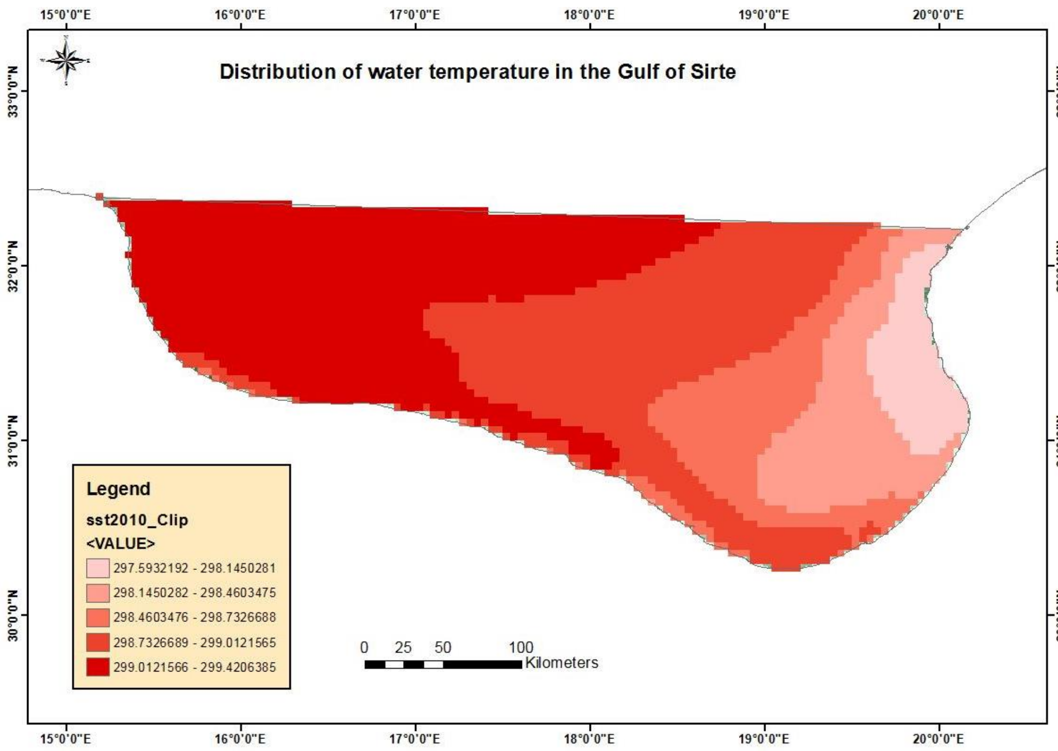

Figure 3 : Distribution of water temperature in the Gulf of Sirte (AVISO+, 2020)

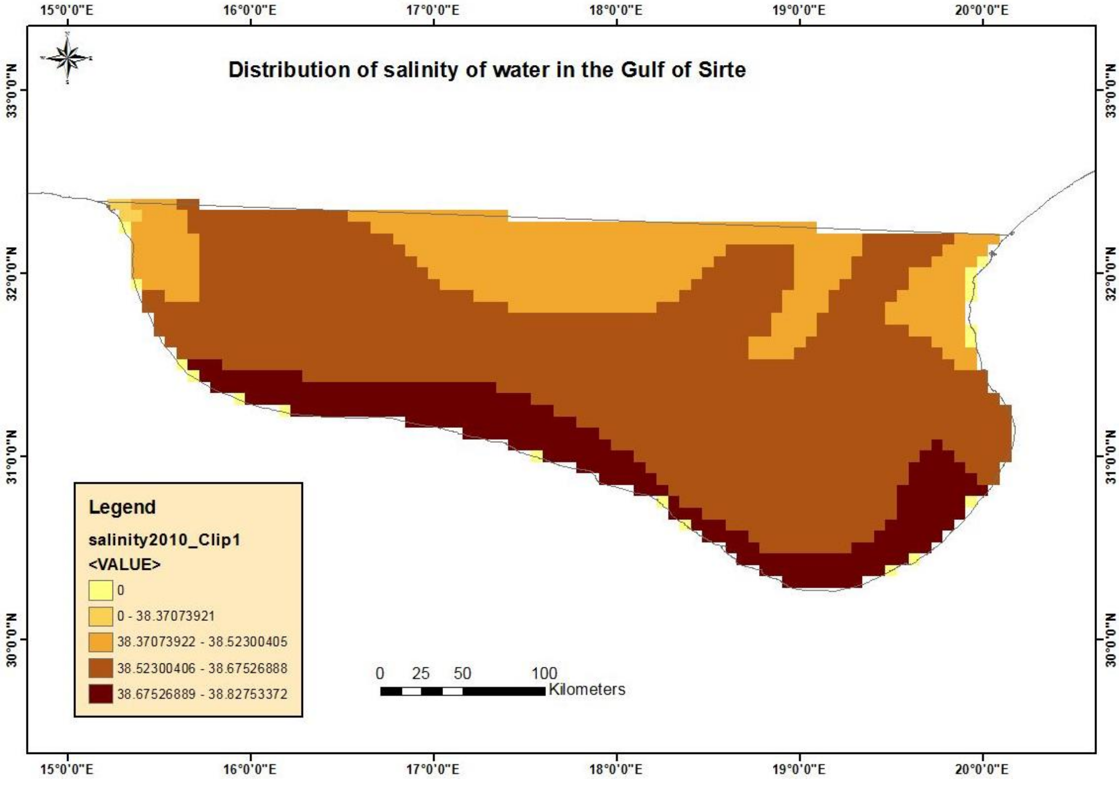

Figure 4 : Distribution of water salinity in the Gulf of Sirte (AVISO+, 2020)

1.2.1.2.Nutrients

Nutrients are essential for the development of primary production. The two most important nutrients in the marine environment are nitrogen and phosphorus. The relationship between these two nutrients determines the biology of the planktonic organisms in the sea (Bethoux *et* *al.*, 1998; Schroeder *et al.*, 2010). The uptake of nutrients from the biological community determines a distribution gradient in the water column with a strong loss in the euphotic zone and an increase in the deep waters, due to the sinking of the organic material and its further remineralisation (Bonanno *et al*., 2015). In the Gulf of Sirt, nitrate concentrations in the surface layer (0-150 m) are <0.1 µ mol, with nitrate concentrations are about 2 µmol at 150 m. The values of nitrate in intermediate (150 m to 400 m), transitional (400-800 m) and deep (>800 m) layers in the Gulf are 3.82, 5.48 and 4.94 µmol, respectively. Phosphate (PO4) and silicate (Si(OH)4) have a similar profile in the water column of Gulf of Sirte with mean concentrations of 0.02 and 0.70 µmol in the euphotic zone (0 to 150 m), 0.1 and 17 3.5 µmol in the intermediate layer (150 to 400 m), 0.2 and 6.5 µmol and in the transition layer (150 to 400 m). Finally, in the deep stations of the Gulf (>800 m), concentrations of PO4 and Si(OH)4. The average 0.2 and 7.1 µmol, respectively. The ammonium concentration (NH4) are 0.7, 0.6 and 0.8 µmol and in the deep layer (>800m) of the Gulf, the ammonium concentration is 0.97 µmol. Furthermore, the ammonium concentration is higher in coastal area than offshore, probably due to anthropogenic inputs (Bonanno *et al*., 2015).

1.2.1.3.Particulate Organic Matter (POM)

The POC and PON concentrations ranged between 8.47-146.87µg/l and 1.47-24.40µg/l, respectively. The highest POC values were recorded in the euphotic layer (max = 146.87 µg/l at St. L3387). The POC and PON values were not particularly high, with lowest value a depth >100m. The clear relationship between POC and PON also provides a means to detect carbon contamination in the samples, which may have resulted in the input of other organic matter sources. The C/N ratio values show a general balance between the trophic components (autotrophy, heterotrophy and detritus). In particular, a high level of efficiency of the autotrophic compartment was found in the eastern part of the study area, where the mean C/N values ranged between 6 and 8. (Bonanno *et al*., 2015).

2. Inventory of existing habitats, formations and species in the area

2.1.Coastal lakes

2.1.1. Sebkhet Qasr Ahmed (32° 00,105 N 15°08,408 E)

The area around the steel works at Qasr Ahmed (including some artificial ponds and waste areas to the north of the steelworks) has fully covered, together with parts of the sebkhet viewed from the road between the wetland and the sea, covers a distance for about 25 km south of Qasr

Ahmed. The coastline here is low sandstone rock, not sand dunes; and just inland there is some sandy agricultural land which supports a few Eurasian Curlews (*Numenius arquata*). Inland there is a large area of salt marsh, with some surface water, apparently very saline, with *Arthrocnemum/Salicornia* vegetation. According to the Ramsar criteria, this site is classified as Mainly Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats), also partly 8 anthropogenic wastewater treatment areas (Azafzaf *et al*., 2005). (Fig. 5)

Figure 5 : Sebkhet Qasr Ahmed (© K. ETYAEB)

2.1.2. Ain Taourgha (32° 00,129 N 15°08,419 E)

Ain Taourgha is a natural freshwater spring (Fig. 6), with the highest discharge of 2.4 cubic m/s in Libya (Hamza, 2004). The area is located on the western edge of the coastal plain south-east of Misrata. The natural spring has traditionally supported a date production and complex systems of water management and distribution. The water, which is very slightly saline, is drained from the oasis after use through a system of canals into the vast adjacent Sebkhet Taourgha. Located on the coastal plain between the spring and the sea, the site is of great interest for its long cultural and historical traditions, and for its good diversity of waterbirds and habitats (Azafzaf, *et al*., 2005).

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Figure 6 : Ain Taourgha (© K. ETYAEB)

2.1.3. Sebkhet Taourgha (32° 00,129 N 15°08,419 E)

Sebkhet Taourgha is immediately adjacent toAin Taourgha, and receives runoff water from the spring. It is part of the vast coastal plain that stretches over a large area south of Misrata and merges with the neighbouring sebkhets of Qasr Ahmed to the north, and Om Al-Adham and Al Hisha to the south. This whole vast area a little over 200,000 hectares. The whole area has a very varied vegetation of *Salicornia / Arthrocnemum* between depressions which collect water in winter and probably largely dry out in summer. Sebkhet Taourgha, at least near the spring, probably has a rather less halophytic vegetation than the other areas, with stands of *Juncus* and other freshwater plants; of particular interest is the species *Phyla nodiflora*, long considered extinct in Libya a long time ago, and rediscovered in 2001 covering good parts of the banks of some canals (Hamza, 2004). According to the Ramsar criteria, the site is classified as inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al.*, 2005).

2.1.4. Sebkhet Al Hisha (31°38,915 N 15°16,189 E)

Sebkhet Al Hisha is a vast Salt Lake between the springs and the sea (Fig. 7), separated from the sea by a tongue of higher land. With Sebkhet Qasr Ahmed, Sebkhet Taourgha, and Sebkhet

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Om Al Adham, it is part of the vast Taourgha complex, one of the largest and most natural wetlands in North Africa. We were only able to cover a tiny fraction of the area (full coverage would require much more time and appropriate means of transport in an area very difficult to enter). The area is characterised by the typical salt-loving vegetation of North African sebkhets, mainly stands of *Arthrocnemum*. Water levels depend on local rainfall – during our visit, the site was relatively dry.

Figure 7 : Sebkhet Al Hisha (© K. ETYAEB)

2.1.5. Ain Al Hisha (31°38,915 N 15°16,189 E)

Ain Hisha is a group of freshwater springs (Fig. 8) where fresh water comes to the surface at the edge of a higher, limestone coastal plain. Like Taourgha, it has a long history of settlement and cultivation. The original village now appears to have beenlargely abandoned, and the remaining buildings, made of wood from the palm trees surrounding the springs, have a distinctive character of their own. The site is import as one of the few surviving springs on the edge of the desert, and for its long cultural history. It is one of the nuclei of the larger Al Hisha site, and the even larger Taourgha complex Ramsar Classification: The springs are mainly inland Y (Freshwater springs), with 9 smaller artificial parts (Canals and drainage ditches) (Azafzaf, *et al*., 2005).

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Figure 8 : Ain Al Hisha (© K. ETYAEB)

2.1.6. Sebkhet Al Hisha (31°38,915 N 15°16,189 E)

Sebkhet Al Hisha is a large Salt Lake between the springs and the sea (Fig. 9), separated from the sea by a tongue of higher land. With Sebkhet Qasr Ahmed, Sebkhet Taourgha, and Sebkhet Om Al Adham, it forms part of the vast Taourgha complex, one of the biggest and most natural wetlands in North Africa. We were able to cover only a tiny fraction of the area (full coverage would require much more time and appropriate means of transport in an area very difficult to enter). The area is characterised by the typical salt-loving vegetation of North African sebkhets, mainly stands of *Arthrocnemum*. Water levels depend on local rainfall – during our visit, the site was relatively dry. Ramsar Classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats).

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Figure 9 : Sebkhet Al Hisha (© K. ETYAEB)

2.1.7. Sebkhet Sultan (31° 06,256 N 17°10,667 E)

An extensive Salt Lake of about 2,000 ha behind the coastal dunes east of Sirt, towards the base of the Gulf of Sirt (Fig. 10). Extensive fringing *Arthrocnemum* vegetation. During our visit the water were slightly deeper deeper than at Taourgha sebkhets, so conditions for water birds were good. Probably dries out in most summers. A total of 418 waterbirds were recorded, including a gull roost (with 34 Audouin's Gulls, a RAC/SPA Bird Action Plan species), and a good variety of waders, in particular almost 100 Eurasian Curlews. A typical coastal sebkhet, one of the many along the Gulf of Sirt, Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

Figure 10 : Sebkhet Sultan (https://www.google.com/maps/`2020)

2.1.8. Wadi Lahmer (31°01,336 N 17°28,536 E)

The mouth of a relatively small wadi between the main coastal road and the sea (Fig. 11), just to the east of Sebkhet Sultan, including the beach. The course of the stream was practically dry when we visited it, and no doubt only flows after heavy local rainfall. Ramsar classification: Partly Marine/Coastal E (Sand, shingle or pebble shores), Inland N (Seasonal/intermittent/irregular rivers/streams/creeks)

Figure 11 : Wadi Lahmer (© K. ETYAEB)

2.1.9. Sebkhet Ben Jawad (30° 51,359 N 17°52,362 E)

A coastal sebkha, 17 km long, between Sirt and Ras Lanouf (Fig. 12), towards the southernmost part of the Gulf of Sirt. It is a typical sebkhet with *Arthrocnemum* vegetation, which dries out in summer. Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

Figure 12 : Sebkhet Ben Jawad (https://www.google.com/maps)

2.1.10. Sebkhet Ras Lanouf (30° 23,418 N 18°39,794 E)

A coastal sebkhet just to the east of Ras Lanouf (Fig. 13), similar in character to Sebkhet Sultan, but smaller. Presumably dries out in summer. Salt Lake behind the coastal dunes, surrounded by *Arthrocnemum* type vegetation, quite close to the main coastal road and the sea. Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

Figure 13 : Sebkhet Ras Lanouf (https://www.google.com/maps)

2.1.11. Sebkhet Al Agaylah (30° 15,108 N 19°15,505 E)

A small coastal sebkhet at the base of the Gulf of Sirt, easily visible from the main road, to the east of Al Agaylah village. Ramsar Classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

2.1.12. Sebkhet Hafiroun and Sebkhet Brega (30° 21,732 N 19°30,557 E)

Small coastal sebkhets at the base of the Gulf of Sirt, on either side of the town of Brega, holding some water during our visit. No doubt dries out in summer Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

2.1.13. Sebkhet Al Gnayen (30° 03, 1612 N 30°03, 4979 E)

A huge sebkhet, 95 km inland from the city of Ajedabia. The site could only be seen from the main road. At the time of our visit, the area was completly dry and sandy, with no vegetation to indicate recent presence of water; not surprisingly, we found no waterbirds present. Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

2.1.14. Sebkhet Shuwayrib (30° 26,700 N 19°48,150 E)

A coastal sebkhet at the base of the Gulf of Sirt, Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

2.1.15. Sebkhet Zuwaitina (31°00,000 N 20°10,000 E)

An extensive area of depressions, holding water in winter, inland of the Zuwaitina oil terminal, on the coast of the Gulf of Sirt, to the south of Benghazi, on the other hand, the presence of extensive seagrass beds in the Gulf of Sirt, apparently the second most important in the Mediterranean, may be one of the reasons for the presence of the terns, Ramsar classification: Inland R (Seasonal/intermittent saline/brackish/alkaline lakes and flats) (Azafzaf, *et al*., 2005).

2.1.16. Sebkhet Chott El Bedin (31°12,963N 20°09,753 E)

A small salt/brackish sebkhet, covering 20 or 30 hectares, behind the coastal dunes, south of Benghazi on the eastern coast of the Gulf of Sirt, with a beach and plantations of palms (Fig. 14). Ramsar classification: Partly Coastal E (Sand, shingle or pebble shores), partly Inland (Seasonal/intermittent saline/brackish/alkaline marshes/pools) (Azafzaf, *et al*., 2005).

Figure 14 : Sebkhet Chott El Bedin (© H. Azafzaf)

2.1.17. Garah Island

An island of modest altitude (max. c. 8 m a.s.l.), with low sandstone cliffs or gentle slopes surrounding modest hills with scattered rocks and low halophytic vegetation (mainly *Suaeda*)

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growing on sandy substrate (Fig. 15). A few taller *Balanites* bushes are present. The surface area is about 5 ha and the coordinates are 30°47’25.9’’N 19°54’0.6’’E, 20 km SW of Zwaytinah harbour. Administrative district: Baladīyat Ajdābiyā. This Island annually hosts the largest colony of the Lesser Crested Terns (*Thalasseus bengalensis*). The area also is a breeding ground for the Shag (*Phalacrocorax aristotolis*) (Hamza *et al*., 2008).

Figure 15 : Garah Island (© H. Azafzaf)

2.2.Species biodiversity in the Gulf of Sirte

2.2.1. Phytoplankton biodiversity

For the chlorophyll studies is lacking a long the Libyan coast, especially in the Gulf of Sirte. The fig. 16. Shows the distribution of chlorophyll along the Gulf of Sirte.

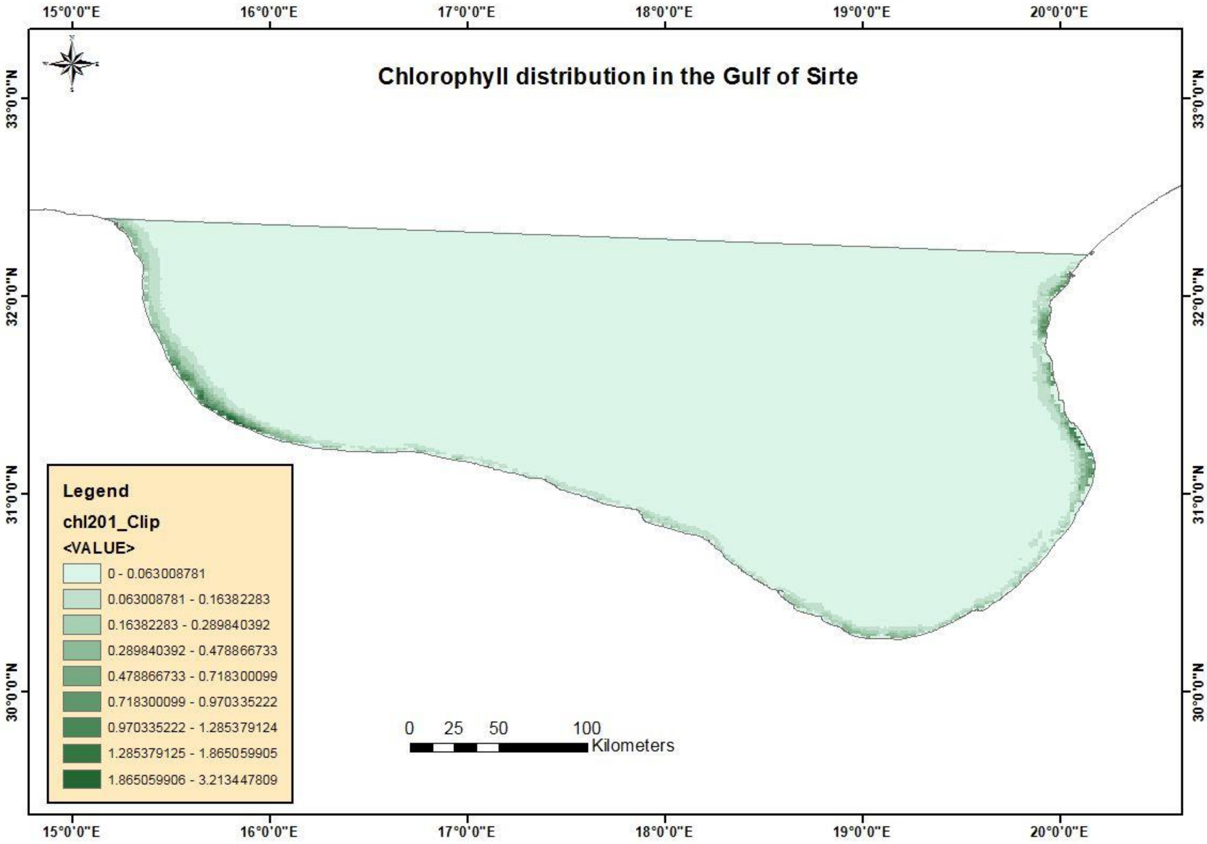

Figure 16 : Distribution of chlorophyll along the Gulf of Sirte (AVISO+, 2020)

Phytoplankton are tiny micro-organisms that are a key component of the oceanic ecosystem. Phytoplankton play a key role in global biogeochemical cycles, especially in the carbon-carbonate cycle (Honjo, 1976; Westbroek *et al.*, 1994). The results of quantitative analyses indicated that the phytoplankton community of the Gulf of Sirte is rich during the summer period (*Coccolithophyceae*), followed by Diatoms, Dinoflagellates, and rare to very rare Silicoflagellates There is a general negative trend in the primary production association from East to West.(Bonanno *et al.*, 2015).

2.2.1.1.Coccolithophores

Coccolithophores are unicellular planktonic algae belonging to the phylum Haptophyta, and have been one of the major contributors to calcium carbonate production in the oceans since the Middle-Late Mesozoic. They are attracting increasing attention for their potential in assessing the response of marine organism calcification to ocean acidification. Unlike any other plant in the ocean, coccolithophores surround themselves with a microscopic plating made of limestone (calcite). These scales, known as coccoliths, are shaped like hubcaps and are only three one-thousandths of a millimetre in diameter. Coccolithophore production in the

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Mediterranean Sea is seasonally controlled (Knappertsbusch, 1993). In summer, the productivity is at least one order of magnitude lower and the presence of a seasonal thermocline leads to the development of a vertical zonation. In the Gulf of Sirte, the Coccolithophores identified are listed in Table. 1. (Bonanno *et al*., 2015).

Table 1 : Coccolithophores identified from samples collected during the MedSudMed-08 Oceanographic Survey (Bonanno et al., 2015).

No.	Species	Family	Class
1	*Algirosphaera Schlauder, 1945*	Rhabdosphaeraceae	Prymnesiophyceae
2	*Braarudosphaera bigelowii (Gran & Braarud) Deflandre, 1947*	Braarudosphaeraceae	Prymnesiophyceae
3	*Calcidiscus leptoporus (G.Murray & V.H.Blackman) Loeblich Jr. & Tappan, 1978*	Calcidiscaceae	Prymnesiophyceae
4	*Calciopappus rigidus Heimdal, 1981*	Syracosphaeraceae	Prymnesiophyceae
5	*Calciopappus Gaarder & Ramsfjell, 1954*	Syracosphaeraceae	Prymnesiophyceae
6	*Calciosolenia murrayi Gran, 1912*	Calciosoleniaceae	Prymnesiophyceae
7	*Calciosolenia Gran, 1912*	Calciosoleniaceae	Prymnesiophyceae
8	*Ceratolithus cristatus Kamptner, 1954*	Ceratolithaceae	Haptophyta
9	*Ceratolithus Kamptner, 1950*	Ceratolithaceae	Haptophyta
10	*Coccolithus pelagicus f. hyalinus (K.R.Gaarder & J.Markali) A.Kleijne, 1991*	Coccolithaceae	Prymnesiophyceae
11	*Coronosphaera mediterranea (Lohmann) Gaarder, 1977*	Syracosphaeraceae	Prymnesiophyceae
12	*Coronosphaera Gaarder, 1977*	Syracosphaeraceae	Prymnesiophyceae
13	*Cricosphaera Braarud, 1960*	Hymenomonadaceae	Prymnesiophyceae
14	*Discosphaera tubifera (Murray & Blackman) Ostenfeld, 1900*	Rhabdosphaeraceae	Prymnesiophyceae
15	*Emiliania huxleyi (Lohmann) W.W.Hay & H.P.Mohler, 1967*	Noelaerhabdaceae	Prymnesiophyceae
16	*Ericiolus H.A.Thomsen, 1995*	Ceratolithaceae	Haptophyta
17	*Florisphaera profunda Okada & Honjo, 1973*	Coccolithophyceae	Prymnesiophyceae
18	*Gephyrocapsa oceanica Kamptner, 1943*	Noelaerhabdaceae	Prymnesiophyceae
19	*Gephyrocapsa Kamptner, 1943*	Noelaerhabdaceae	Prymnesiophyceae
20	*Gladiolithus flabellatus (Halldal & Markali) Jordan & Chamberlain, 1993*	Ceratolithaceae	Haptophyta
21	*Gladiolithus R.W.Jordan & A.H.L.Chamberlain, 1993*	Ceratolithaceae	Haptophyta
22	*Helicosphaera carteri (Wallich) Kamptner, 1954*	Helicosphaeraceae	Prymnesiophyceae

23	*Helicosphaera pavimentum*	Helicosphaeraceae	Prymnesiophyceae
24	*Helicosphaera Kamptner, 1954*	Helicosphaeraceae	Prymnesiophyceae
25	*Holodiscolithus* Roth, 1970	***	Haptophyta
26	*Oolithotus fragilis (Lohmann) Martini & C.Müller, 1972*	Calcidiscaceae	Prymnesiophyceae
27	*Pontosphaera Lohmann, 1902*	Pontosphaeraceae	Prymnesiophyceae
28	*Rhabdolithes claviger (G.Murray & Blackman) Voeltzkow, 1902*	Coccolithophyceae	Prymnesiophyceae
29	*Rhabdolithes O.Schmidt, 1870*	Coccolithophyceae	Prymnesiophyceae
30	*Scyphosphaera apsteinii Lohmann, 1902*	Pontosphaeraceae	Prymnesiophyceae
31	*Scyphosphaera Lohmann, 1902*	Pontosphaeraceae	Prymnesiophyceae
32	*Siracosphaera*	Hymenomonadaceae	Coccolithophyceae
33	*Small placoliths*	***	Coccolithophyceae
34	*Syracosphaera histrica Kamptner, 1941*	Syracosphaeraceae	Prymnesiophyceae
35	*Syracosphaera pulchra Lohmann, 1902*	Syracosphaeraceae	Prymnesiophyceae
36	*Umbellosphaera irregularis Paasche, 1955*	Umbellosphaeraceae	Haptophyta
37	*Umbellosphaera tenuis (Kamptner) Paasche, 1955*	Umbellosphaeraceae	Haptophyta
38	*Umbellosphaera Paasche, 1955*	Umbellosphaeraceae	Haptophyta
39	*Umbilicosphaera sibogae (Weber Bosse) Gaarder, 1970*	Calcidiscaceae	Prymnesiophyceae
40	*Umbilicosphaera Lohmann, 1902*	Calcidiscaceae	Prymnesiophyceae

2.2.1.2.Diatoms

Diatoms are photosynthec algae, they have a siliceous skeleton (frustule) and are found in almost all aquatic environments including fresh and marine waters, soils, in fact almost everywhere that is moist. Quantitative distribution shows high abundance values in the first 100 - 150 metres off the coast of the area studied. The Diatoms are non-motile or capable of only limited movement along a substrate by secreting of mucilaginous material along a slit-like groove or channel called a raphe. Being autotrophic they are restricted to the photic zone (water depths down to about 200m depending on clarity). There are both benthic and planktonic forms. Diatoms are formally classified in the division of Chrysophyta, class Bacillariophyceae. They are less abundant near the coast, especially in the easternmost part of the Gulf. In general, diatoms are a common phytoplankton component of the Libyan coast.

2.2.1.3.Dinoflagellates

In the study area, the quantitative distribution of dinoflagellates shows high densities in the summer period in the first 25 - 50 metres of the water column, mainly in the stations close to the coast.. In offshore areas, there is a clear decrease in abundance (Bonanno *et al*., 2015).

2.2.1.4.Silicoflagellates

The silicoflagellates of the Gulf of Sirte showed, as expected, very low values and were restricted to the deeper central zone. Only Dictyocha fibula specimens, which never exceed a density of 150 cell/l (Bonanno *et al*., 2015), constitute the recognizsd assemblage.

2.2.1.5.Ichtyoplankton biodiversity

The ichthyology of the Libyan waters has very little studied in the past, the information is rather general, mainly referring to the whole Mediterranean Sea, or giving statistical data on landings without specefic reference to species composition (Bonanno *et al*., 2015). A composition of 40 species of fish larvae belonging to 21 species was collected (Table. 2).

Table 2 : Larvae collected during the MedSudMed-08 Oceanographic in the Sirt gulf. (Bonanno et al., 2015).

No.	Family	Species
1	Murenidae	*Murena Helena*
		Echelus myrus
		Conger conger
		Ariosoma balearicum
2	Clupeidae	*Sardinella aurita*
		Engraulis encrasicolus
		Cyclothone braueri
		Vinciguerria attenuate
		Vinciguerria nimbaria
		Vinciguerria powerii
3	Vinciguerria	*Synodus saurus*

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		Lestidiops jayakari pseudosphyraenoides
		Paralepis affinis
		Paralepis coregonoides
4	Paralepidae	*Ceratoscopelus maderensis*
		Lobianca dofleny
		Diaphus holti
		Electrona rissoil
5	Myctophidae	*Hygophum benoiti*
		Lampanyctus crocodilus
		Lampanyctus pusillus
		Myctophum punctatum
6	Ophidiidae	*Ophildion barbatus*
		Parophidion vassal
7	Centriscidae	*Macroramphosus scolopax*
8	Scorpaenidae	*Scorpaena scrofa*
9	Serranidae	*Epinephelus alexandrines*
10	Carangidae	*Trachurus* spp.
11	Bramidae	*Brama brama*
12	Sparidae	*Pagrus pagrus*
		Lythognatus mormirius
13	Cepolidae	*Cepola macrophtalma*
14	Pomacentridae	*Chromis chromis*
15	Labridae	*Coris julis*
16	Ammodytidae	*Gymnammodytes cicerelus*
17	Callionymidae	*Callionymus maculatus*
18	Scombridae	*Auxis rochei*
19	Scophthalmidae	*Lepidorhombus boscii*

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20	Bothidae	*Botus podas*
21	Stomiidae	*Stomias boa*

2.2.2. Seaweeds biodiversity

2.2.2.1.Marine Algae

The information about the seagrasses in the Gulf of Sirte is lacking, the seagrass meadows are an important habitat for many marine species for spawning, breeding, feeding and nesting. The Gulf of Sirte is known by meadows of *P. oceanica*; however, there is a lack of specific updated references of its distribution and status along the coast. For the marine algae specie only 18 species have been listed by (Nizamuddin *et al*., 1978) in the Gulf of Sirte and (Table. 3) provided information on these species.

Table 3 : Marine algae species in the Sirt gulf (Nizamuddin et al., 1978)

No.	Marine Algae species	Order	Class	Family
1	*Microdictyon umbilicatum* (Velley) Zanardini, 1862	Cladophorales	Ulvophyceae	Anadyomenaceae
2	*Caulerpa prolifera* (Forsskål) J.V.Lamouroux, 1809	Bryopsidales	Ulvophyceae	Caulerpaceae
3	*Flabellia petiolata* (Turra) Nizamuddin, 1987	Bryopsidales	Ulvophyceae	Udoteaceae
4	*Halimeda tuna* (J.Ellis & Solander) J.V.Lamouroux, 1816	Bryopsidales	Ulvophyceae	Halimedaceae
5	*Dasycladus vermicularis* (Scopoli) Krasser, 1898	Dasycladales	Ulvophyceae	Dasycladaceae
6	*Padina pavonica* (Linnaeus) Thivy, 1960	Dictyotales	Phaeophyceae	Dictyotaceae
7	*Dictyota dichotoma* (Hudson) J.V.Lamouroux, 1809	Dictyotales	Phaeophyceae	Dictyotaceae
8	*Dictyota implexa* (Desfontaines) J.V.Lamouroux, 1809	Dictyotales	Phaeophyceae	Dictyotaceae
9	*Cystoseira abrotanifolia var. discors* Jones & Kingston	Fucales	Phaeophyceae	Sargassaceae
10	*Sargassum acinaria* C.Agardh, 1821	Fucales	Phaeophyceae	Sargassaceae
11	*Peyssonnelia rubra* (Greville) J.Agardh, 1851	Peyssonneliales	Florideophyceae	Peyssonneliaceae
12	*Lithothamnion corallioides* (P.Crouan & H.Crouan) P.Crouan & H.Crouan, 1867	Corallinales	Florideophyceae	Lithothamniaceae
13	*Mesophyllum expansum* (Philippi) Cabioch & M.L.Mendoza, 2003	Hapalidiales	Florideophyceae	Mesophyllaceae
14	*Pneophyllum zonale* (P.Crouan & H.Crouan) Y.M.Chamberlain, 1983	Corallinales	Florideophyceae	Mastoporaceae

15	*Neogoniolithon mamillosum* (Hauck) Setchell & L.R.Mason, 1943	Corallinales	Florideophyceae	Spongitaceae
16	*Lophocladia lallemandii* (Montagne) F.Schmitz, 1893	Ceramiales	Florideophyceae	Rhodomelaceae
17	*Osmundaria volubilis* (Linnaeus) R.E.Norris, 1991	Ceramiales	Florideophyceae	Rhodomelaceae
18	*Rytiphlaea tinctoria* (Clemente) C.Agardh, 1824	Ceramiales	Florideophyceae	Rhodomelaceae

2.2.2.2.Seagrass

The central coastal region is dominated by the Gulf of Sirt, where the continental shelf extends almost 200 km offshore and whose shallow waters support the second largest seagrass meadows in the Mediterranean. Seagrass meadows are an important habitat for many marine species for spawning, breeding, feeding and nesting. In the Gulf of Sirte, meadows of *P. oceanica*are known to exist, but there is a lack of specific updated references of its distribution and status along the coast. Although, there are no studies focused on the seagrasses in the area, the huge accumulation of dead meadows along the coast indicates the richness of the area by seagrasses, for example; the old harbour of Sirte is blocked by seagrasses (Personal observation).

2.2.3. Mollusca biodiversity

The Gulf of Sirte represents 31.98% (110 mollusc species) of the total of 344 mollusc species distributed along the Libyan coast (Table. 4) (Bek Benghazi *et al*. 2020).

Table4 : Mollusca species in Sirt gulf (Bek Benghazi et al. 2020)

No.	Scientific name	Family
1	*Arca barbata (Linnaeus, 1758)*	Arcidae
2	*Abralia (Asteroteuthis) veranyi* Rüppell, 1844	Enoploetuthidae
3	*Acanthocardia echinata (Linnaeus, 1758)*	Cardiida
4	*Acanthocardia tuberculata (Linnaeus, 1758*	Cardiidae
5	*Aequipecten opercularis (Linnaeus, 1758)*	Pectinidae
6	*Alloteuthis ntedia (Linnaeus, 1758).*	Loliginidae
7	*Alvania cimex (Linnaeus, 1758)*	Rissoidae
8	*Alvania discors (Allan, 1818)*	Rissoidae
9	*Alvania macandrewi (Manzoni, 1868)*	Rissoidae

10	*Aporrhais pespelecani (Linnaeus, 1758)*	Aporrhaidae
11	*Arca noae Linnaeus, 1758*	Arcidae
12	*Arcidae Lamarck, 1809*	Arcidae
13	*Arcopella balaustina (Linnaeus, 1758)*	Tellinidae
14	*Bittium reticulatum (da Costa, 1778)*	Cerithiidae
15	*Bolinus brandaris (Linnaeus, 1758*	Muricidae
16	*Brachidontes variabilis (Krauss, 1848*	Mytilidae
17	*Calliostoma conulus (Linnaeus, 1758)*	Calliostomatidae
18	*Calliostoma laugieri (Payraudeau, 1826*	Calliostomatidae
19	*Calliostoma zizyphinum (Linnaeus, 1758*	Calliostomatidae
20	*Callista chione (Linnaeus, 1758)*	Veneridae
21	*Cardium (Acanthocardium) echinatum Linnaeus, 1758*	Cardiidae
22	*Cardium Linnaeus, 1758*	Cardiida
23	*Centrocardita aculeata (Poli, 1795)*	Carditidae
24	*Cerastoderma edule (Linnaeus, 1758)*	Cardiida
25	*Calliostoma laugieri (Payraudeau, 1826*	Cardiidae
26	*Cerastoderma glaucum (Bruguière, 1789)*	Cardiidae
27	*Cerithium vulgatum Bruguière, 1792*	Cerithiidae
28	*Chamelea gallina (Linnaeus, 1758)*	Veneridae
29	*Columbella rustica (Linnaeus, 1758)*	Columbellidae
30	*Conus auricomus Hwass in Bruguière, 1792*	Conidae
31	*Conus ventricosus Gmelin, 1791*	Conidae
32	*Cryptospira strigata (Dillwyn, 1817)*	Marginellidae
33	*Cythnia albida Carpenter, 1864*	Rissoellidae
34	*Diodora italica (Defrance, 1820)*	Fissurellidae
35	*Donax trunculus Linnaeus, 1758*	Donacidae
36	*Donax venustus Poli, 1795*	Donacidae
37	*Dosinia lupinus (Linnaeus, 1758)*	Veneridae
38	*Episcomitra cornicula (Linnaeus, 1758)*	Mitridae
39	*Epitonium clathrus (Linnaeus, 1758)*	Epitoniidae
40	*Epitonium turtonis (W. Turton, 1819)*	Epitoniidae
41	*Euthria cornea (Linnaeus, 1758*	Buccinidae
42	*Flexopecten flexuosus (Poli, 1795)*	Pectinidae

43	*Fustiaria rubescens (Deshayes, 1826)*	Fustiariidae
44	*Gastrana fragilis (Linnaeus, 1758)*	Tellinidae
45	*Gibbula ardens (Salis Marschlins, 1793)*	Trochidae
46	*Gibbula magus (Linnaeus, 1758)*	Trochidae
47	*Glycymeris glycymeris (Linnaeus, 1758)*	Glycymerididae
48	*Glycymeris nummaria (Linnaeus, 1758)*	Glycymerididae
49	*Glycymeris pilosa (Linnaeus, 1767)*	Glycymerididae
50	*Goniofusus spectrum (A. Adams & Reeve, 1848)*	Fasciolariidae
51	*Haliotis tuberculata Linnaeus, 1758 –*	Haliotidae
52	*Heteroteuthis Gray, 1849*	Sepiolidae
53	*Hexaplex Perry, 1810*	Muricidae
54	*Illex coindetii (Verany, 1839).*	Ommastrephidae
55	*Lima lima (Linnaeus, 1758)*	Limidae
56	*Lima* Bruguière, 1797	Limidae
57	*Limaria tuberculata* (Olivi, 1792)	Limidae
58	*Littorina saxatilis (Olivi, 1792*	Littorinidae
59	*Loligo forbesi Steenstrup, 1856*	Loliginidae
60	*Loligo vulgaris Lamarck, 1798*	Loliginidae
61	*Loripes orbiculatus Poli, 1795*	Lucinidae
62	*Mactra stultorum (Linnaeus, 1758)*	Mactridae
63	*Malleus regula (Forsskål in Niebuhr, 1775)*	Malleidae
64	*Mauritia scurra (Gmelin, 1791)*	Cypraeidae
65	*Modiolus barbatus (Linnaeus, 1758)*	Mytilidae
66	*Moerella pulchella (Lamarck, 1818)*	Tellinidae
67	*Naria spurca* (Linnaeus, 1758)	Naticidae
68	*Natica hebraea (Martyn, 1786)*	Naticidae
69	*Naticarius stercusmuscarum (Gmelin, 1791)*	Neritidae
70	*Nucula (Nucula) nucleus (Linnaeus, 1758)*	Octopodidae
71	*Octopus macropus Risso, 1826.*	Octopodidae
72	*Octopus vulgaris Cuvier, 1797*	Ostreidae
73	*Ostrea edulis Linnaeus, 1758*	Cardiidae
74	*Papillicardium papillosum (Poli, 1791)*	Cardiidae
75	*Parvicardium exiguum (Gmelin, 1791)*	Patellidae

76	*Patella rustica Linnaeus, 1758*	Patellidae
77	*Phorcus mutabilis (Philippi, 1851)*	Trochidae
78	*Phorcus turbinatus (Born, 1778)*	Trochidae
79	*Polititapes aureus (Gmelin, 1791)*	Veneridae
80	*Pteria hirundo (Linnaeus, 1758)*	Pteriidae
81	*Pteroctopus tetracirrhus (Delle Chiaje, 1830).*	Octopodidae
82	*Raphitoma purpurea (Montagu, 1803)*	Raphitomidae
83	*Rondeletiola minor (Naef,1912).*	Sepiolidae
84	*Rossiamacrosoma (Delle Chiaje, 1830)*	Sepiolidae
85	*Ruditapes decussatus (Linnaeus, 1758*	Veneridae
86	*Scaeurgus unicirrhus (Orbigng, 1840).*	Octopodidae
87	*Sepia elegans Blainville, 1827*	Sepiolidae
88	*Sepia officinalis Linnaeus, 1758*	Sepiidae
89	*Sepia orbignyana Férussac [in d'Orbigny], 1826*	Sepiidae
90	*Sepietta oweniana (Orbigny1840)*	Sepiolidae
91	*Sepiola rondeletii Leach, 1817*	Sepiolidae
92	*Smaragdia viridis (Linnaeus, 1758)*	Neritidae
93	*Solen marginatus Pulteney, 1799*	Solenidae
94	*Spondylus gaederopus Linnaeus, 1758*	Spondylidae
95	*Tarantinaea lignaria* (Linnaeus, 1758)	Fasciolariidae
96	*Thysanoteuthis rhombus Troschel, 1857.*	Thysanoteuthidae
97	*Todarodes sagittatus(Lamarck1798).*	Ommastrephidae
98	*Todaropsis eblanae (Ball, 1841).*	Ommastrephidae
99	*Tricolia pullus (Linnaeus, 1758*	Phasianellidae
100	*Tritia cuvierii (Payraudeau, 1826)*	Nassarlidae
101	*Tritia gibbosula* (Linnaeus, 1758)	Nassariidae
102	*Tritia incrassata* (Strøm, 1768)	Nassariidae
103	*Tritia reticulata (Linnaeus, 1758)*	Nassariidae
104	*Trophonopsis muricata (Montagu, 1803)*	Muricidae
105	*Truncatella subcylindrica (Linnaeus, 1767*	Truncatellidae
106	*Turritellinella tricarinata (Brocchi, 1814)*	Turritellidae
107	*Venerupis corrugata (Gmelin, 1791)*	Veneridae
108	*Venerupis Lamarck, 1818*	Veneridae

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109	*Venus gallina Linnaeus, 1758*	Veneridae
110	*Venus verrucosa Linnaeus, 1758*	Veneridae

2.2.4. Elasmobranch biodiversity

A total of 57 elasmobranchs belonging to 25 families have been recorded along the Libyan coast out of about 88 species were mentioned in the references (FAO, 2018a; FAO 2018b; Otero *et al*., 2019). 14 elasmobranchs have been distributed along the Gulf of Sirte representing 24.56%, several elasmobranchs species reproduce in this area and most of the seasonal landing sites are found in this area and different sharks are the target species for fishing (Shakman *et al*., 2020 in press.), more details about this species in the (Table. 5). Including the IUCN categories

Table 5 : List of cartilaginous species in the Libyan coast. IUCN Categories are considered (NT = Near Threatened, VU = Vulnerable, LC = Least Concern, EN = Endangered, CE = Critically Endangered, DD = Data Deficient. (IUCN, Red List) (Shakman et al., 2020)

Species	Authors	Common name	Occurrence	IUCN Categories
Heptranchias perlo	(Bonnaterre, 1788)	Sharpnose sevengill shark	Occasional	DD
Hexanchus griseus	(Bonnaterre, 1788)	Bluntnose sixgill shark	Occasional	LC
Carcharodon carcharias	(Linnaeus, 1758)	Great white shark	Rare	CR
Isurus oxyrinchus	Rafinesque, 1810	Shortfin mako	Occasional	CR
Lamna nasus	(Bonnaterre, 1788)	Porbeagle	Rare	CR
Cetorhinus maximus	(Gunnerus, 1765)	Basking shark	Rare	EN
Alopias superciliosus	Lowe, 1841	Bigeye thresher	Rare	EN
Alopias vulpinus	(Bonnaterre, 1788)	Thresher	Rare	EN
Galeus melastomus	Rafinesque, 1810	Blackmoth catshark	Occasional	LC
Scyliorhinus canicula	(Linnaeus, 1758)	Small-spotted catshark	Frequent	LC
Pteroplatytrygon violacea	(Bonaparte, 1832)	Pelagic stingray	Frequent	LC
Taeniurops grabatus	(Geoffroy St. Hilaire, 1817)	Round stingray	Occasional	DD

Mobula mobular	(Bonnaterre, 1788)	Devil fish	Rare	EN
Chimaera monstrosa	Linnaeus, 1758	Rabbit fish	Rare	NT

2.2.5. Bony fish biodiversity

Regarding to the last inventory of the Libyan coast, 304 bony fishes were recorded, 111 species of which were distributed along the Gulf of Sirte, representing about 35.86%. The table. 6 shows information about the bony fishes along the Gulf of Sirte (El-Baraasi *et al*., 2019).

Table 6 : Bony fish species in the Sirt gulf (Libya) (El-Baraasi et al., 2019)

No.	Scientific name	Family
1	*Arnoglossus kessleri (Schmidt, 1915)*	Bothidae
2	*Auxis thazard (Lacepède, 1800)*	Scombridae
3	*Campogramma glaycos (Lacepède, 1801)*	Carangidae
4	*Cyclothone pygmaea Jespersen & Tåning, 1926*	Gonostomatidae
5	*Diaphus holti Tåning, 1918*	Myctophidae
6	*Diaphus rafinesquii (Cocco, 1838)*	Myctophidae
7	*Echelus myrus (Linnaeus, 1758)*	Ophichthidae
8	*Electrona risso (Cocco, 1829)*	Myctophidae
9	*Etrumeus golanii (DiBattista, Randall & Bowen, 2012)*	Clupeidae
10	*Glossanodon leioglossus (Valenciennes, 1848)*	Argentinidae
11	*Gnathophis mystax (Delaroche, 1809)*	Congridae
12	*Gobius paganellus Linnaeus, 175*	Gobiidae
13	*Gonichthys cocco (Cocco, 1829)*	Myctophidae
14	*Gonostoma denudatum Rafinesque, 1810*	Gonostomatidae
15	*Hygophum benoiti (Cocco, 1838)*	Myctophidae
16	*Hygophum hygomii (Lütken, 1892)*	Myctophidae
17	*Lagocephalus sceleratus (Gmelin, 1789)*	Tetraodontidae
18	*Lagocephalus suezensis (Clark & Gohar, 1953)*	Tetraodontidae
19	*Lampanyctus pusillus (Johnson 1890)*	Myctophidae
20	*Lestidiops jayakari (Boulenger, 1889)*	Paralepididae
21	*Lobianchia dofleini (Zugmayer, 1911)*	Myctophidae
22	*Microchirus variegatus (Donovan, 1808)*	Soleidae
23	*Myctophum punctatum Rafinesque, 1810*	Myctophidae

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24	*Notoscopelus bolini Nafpaktitis, 1975*	Myctophidae
25	*Pagellus erythrinus (Linnaeus, 1758)*	Sparidae
26	*Scophthalmus maximus (Linnaeus, 1758)*	Scophthalmidae
27	*Synapturichthys kleinii (Risso, 1827)*	Soleidae
28	*Vinciguerria poweriae (Cocco, 1838)*	Phosichthyidae
29	*Zu cristatus (Bonelli, 1819)*	Trachipteridae
30	*Acanthocybium solandri (Cuvier, 1832)*	Scombridae
31	*Alectis alexandrina (Geoffroy Saint-Hilaire, 1817)*	Carangidae
32	*Alepes djedaba (Forsskål, 1775)*	Carangidae
33	*Alosa alosa (Linnaeus, 1758)*	Clupeidae
34	*Alosa fallax (Lacepède, 1803)*	Clupeidae
35	*Anguilla anguilla (Linnaeus, 1758)*	Anguillidae
36	*Arctozenus risso (Bonaparte, 1840)*	Paralepididae
37	*Argyropelecus hemigymnus Cocco, 1829*	Sternoptychidae
38	*Argyrosomus regius (Asso, 1801)*	Sciaenidae
39	*Arnoglossus imperialis (Rafinesque, 1810)*	Bothidae
40	*atichthys flesus (Linnaeus, 1758)*	Pleuronectidae
41	*Benthosema glaciale (Reinhardt, 1837)*	Myctophidae
42	*Brama brama (Bonnaterre, 1788)*	Bramidae
43	*Buglossidium luteum (Risso, 1810)*	Soleidae
44	*Capros aper (Linnaeus, 1758) N PS*	Caproidae
45	*Centrolophus niger (Gmelin, 1789)*	Centrolophidae
46	*Cephalopholis taeniops (Valenciennes, 1828)*	Serranidae
47	*Ceratoscopelus maderensis (Lowe, 1839)*	Myctophidae
48	*Chauliodus sloani Bloch & Schneider, 1801*	Stomiidae
49	*Ctenolabrus rupestris (Linnaeus, 1758)*	Labridae
50	*Cyclothone braueri Jespersen & Tåning, 1926*	Gonostomatidae
51	*Dalophis imberbis (Delaroche, 1809)*	Ophichthidae
52	*Deltentosteus quadrimaculatus (Valenciennes, 1837)*	Gobiidae
53	*Evermannella balbo (Risso, 1820)*	Evermannellidae
54	*Fistularia commersonii Rüppell, 1838*	Fistulariidae
55	*Gouania willdenowi (Risso, 1810)*	Gobiesocidae
56	*Gymnothorax unicolor (Delaroche, 1809)*	Muraenidae

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57	*Hemiramphus far (Forsskål, 1775)*	Hemiramphidae
58	*Herklotsichthys punctatus (Rüppell, 1837)*	Clupeidae
59	*Hirundichthys rondeletii (Valenciennes, 1847)*	Exocoetidae
60	*Ichthyococcus ovatus (Cocco, 1838)*	Phosichthyidae
61	*Kajikia albida (Poey, 1860)*	Istiophoridae
62	*Kyphosus sectatrix (Linnaeus, 1758)*	Kyphosidae
63	*Lagocephalus lagocephalus (Linnaeus, 1758)*	Tetraodontidae
64	*Lampanyctus crocodilus (Risso 1810)*	Myctophidae
65	*Lepidotrigla dieuzeidei Blanc & Hureau, 1973*	Triglidae
66	*Liza carinata (Valenciennes, 1836)*	Mugilidae
67	*Lobotes surinamensis (Bloch, 1790)*	Lobotidae
68	*Lophotus lacepede (Giorna, 1809)*	Lophotidae
69	*Luvarus imperialis Rafinesque, 1810*	Luvaridae
70	*Micromesistius poutassou (Risso, 1827)*	Gadidae
71	*Mola mola (Linnaeus, 1758)*	Molidae
72	*Mugil cephalus Linnaeus, 1758*	Mugilidae
73	*Muraena helena Linnaeus, 1758*	Muraenidae
74	*Mycteroperca rubra (Bloch, 1793)*	Serranidae
75	*Naucrates ductor (Linnaeus, 1758)*	Carangidae
76	*Nerophis ophidion (Linnaeus, 1758)*	Syngnathidae
77	*Obatrachus didactylus (Bloch & Schneider, 1801)*	Batrachoididae
78	*Oedalechilus labeo (Cuvier, 1829)*	Mugilidae
79	*Ophisurus serpens (Linnaeus, 1758)*	Ophichthidae
80	*Parablennius sanguinolentus (Pallas, 1814)*	Blenniidae
81	*Paralepis coregonoides (Risso, 1820)*	Paralepididae
82	*Pempheris rhomboidea Kossmann & Räuber, 1877*	Pempheridae
83	*Pomatoschistus minutus (Pallas, 1770)*	Gobiidae
84	*Ranzania laevis (Pennant, 1776)*	Molidae
85	*Ruvettus pretiosus Cocco, 1833*	Gempylidae
86	*Scomberomorus commerson (Lacepède, 1800)*	Scombridae
87	*Scorpaena maderensis Valenciennes, 1833*	Scorpaenidae
88	*Seriola fasciata (Bloch, 1793)*	Carangidae
89	*Seriola rivoliana (Valenciennes, 1833)*	Carangidae

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90	*Sphoeroides pachygaster (Müller & Troschel, 1848)*	Tetraodontidae
91	*Sphyraena chrysotaenia Klunzinger, 1884*	Sphyraenidae
92	*Sphyraena flavicauda Rüppell, 1838*	Sphyraenidae
93	*Sprattus sprattus (Linnaeus, 1758)*	Clupeidae
94	*Stomias boa boa (Risso, 1810)*	Stomiidae
95	*Stromateus fiatola Linnaeus, 1758*	Stromateidae
96	*Symbolophorus veranyi (Moreau, 1888)*	Myctophidae
97	*Symphodus doderleini (Jordan, 1890)*	Labridae
98	*Synchiropus phaeton (Günther, 1861)*	Callionymidae
99	*Syngnathus phlegon Risso, 1827*	Syngnathidae
100	*Tetrapturus belone Rafinesque, 1810*	Mediterranean spearfish
101	*Thunnus alalunga (Bonnaterre, 1788)*	Scombridae
102	*Trachipterus trachypterus (Gmelin, 1789)*	Trachipteridae
103	*Trachyrincus scabrus (Rafinesque, 1810)*	Macrouridae
104	*Trichiurus lepturus Linnaeus, 1758*	Trichiuridae
105	*Trisopterus luscus (Linnaeus, 1758)*	Gadidae
106	*Upeneus moluccensis (Bleeker, 1855)*	Mullidae
107	*Upeneus pori Ben-Tuvia & Golani, 1989*	Mullidae
108	*Vinciguerria attenuata (Cocco, 1838)*	Phosichthyidae
109	*Xiphias gladius Linnaeus, 1758*	Xiphiidae
110	*Epinephelus marginatus*	Serranidae
111	*Thunnus thynnus*	Scombridae

2.2.6. Sea turtles

Along the Libyan coast, three species of sea turtles have been reported: the Green turtle *Chelonia mydas*, the Leatherback turtle *Dermochelys coriacea*, which are irregular and rarely observed, and the Loggerhead turtle *Caretta caretta*, which is the only nesting species that well studied along the Libyan coast (Schleich, 1987; Laurent *et al*., 1997; 1999). The nesting activity of this species has been documented in the literature since the 1980s (Armsby, 1980). The scientific studies of this species began in the mid-1990s with national nesting surveys. EGA and MBRC, with a technical and financial support from SPA/RAC, started a national survey to investigate the presence and the nesting activity of this species along the Libyan coast (1995-1998).

The results of the 1995 survey, (June and July), recorded a total of 176 nests and 342 crawl tracks. It also reported a significant threat of predation caused by carnivores and sand crabs that resulting in 44.8% egg loss. In 1996, Phase 2 of the survey targeted the area between Sirte and Misratah, and 66 crawl tracks were recorded. The final phase of the project undertaken in 1998 found 15 crawl tracks of nesting female loggerheads and reported that this particular part of Libya practices a tradition of turtle egg consumption. Recent studies led by MEDASSET have also reported that the levels of turtle bycatch in nets and other fishing gears is another threat for Mediterranean turtles (www.medasset.org/07.2020).

In 2005, the General Environment Authority (EGA) launched an initiative to implement the National Action Plan for the Conservation of Sea Turtles and their habitat and the Libyan Sea Turtle Program (LibSTP), which contributes to study, protect and to raise awareness of sea turtles in Libya. The program also trains conservationists and students to voluntarily monitor and protect sea turtle nesting beaches. Surveys in 2005-2008 showed that nesting is mainly concentrated in four main areas: the Gulf of Sirte, the region around Benghazi, some sandy beaches of Aljabal Alakhdar (Cyrenaica) and the region of Derna-Tubrok. The results of the 2005 survey showed that 73 nests were protected on 3 beaches west to Sirte and more than 3000 hatchlings were successfully released. In 2006 and 2007, a total of 550 and 841 nests respectively were recorded on 28 beaches along the Libyan coast. . During the 2009 season, 358 nests were recorded at five nesting sites in the region of Sirte. The monitoring programme emphasises that the Gulf of Sirte is the most important area for sea turtle breeding and feeding. Surveys were conducted twice a week from May 20th till September 30th. Initial results indicate that the all-sand beaches in the Gulf of Sirte are very important nesting areas for loggerhead sea turtles. In 2015, a detailed study in the Gulf of Sirte focuses on two areas that were monitored to study the breeding behavior of the loggerhead turtles and the impact of some environmental and biological factors on it. It was found that the nesting period for this species is extended from the end of May to the beginning of September (Saied, 2015). Table 7 shows some results from the monitoring on the nesting of *Caretta caretta* in the gulf of Sirt (Saied, 2015).

Table 7 : Information on the nesting of seaturtle Caretta caretta along the Sirt gulf (Saied, 2015).

Year	Nesting	Nesting %

2006	436	37.04
2007	348	29.57
2009	208	17.67
2010	185	15.72
Total	1177	100

Then, starting from 2017 until 2020, a regular monitoring programme started under the technical supervision of EGA and SPA/RAC and with the financial support of MAVA Foundation. The programme has included training courses for EGA staff and other active NGOs representatives and has contributed to the establishment of many teams working in different sites during the loggerhead turtles nesting season under the supervision of EGA national coordinator.

In 2019, the survey included the entire Gulf of Sirte, where the density of nests was concentrated on the western coast, the side farthest from the city and human activities. In contrast, the absence of human activity led to an increase in wlidlife (predators) such as foxes. However, the percentage of hatching was relatively good, ranging from 54% to 93%. The Table 8. Shows the detailed information in the western coast of Sirte (Saied and Dreyag, 2019)

Table 8 : Information on the seaturtle Caretta caretta nesting in the western coast of Sirt (Saied and Dreyag, 2019)

Area	Total number of nests	Hatchery nests	Hatchery %
Zafaran coast	20	8	70.03
Qepepa coast	22	12	54.55
Thalathean coast	45	27	75.33
Qarab al estraha	41	20	84.25
Shash coast	70	37	82.89
Tamet coast	67	27	76.38
Khamseen coast	78	15	54.88
Al Nakhla coast	21	1	93.06
Albuirat coast	31	11	69.83

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2.2.7. Marine Mammals

Information on marine mammals is very scarce and limited, despite the country's long coastline (IUCN 2011, IOC 2003). For the cetaceans, only two papers have been published (Bearzi *et al*., 2008 and Boisseau *et al*. 2010). According to IUCN (2012), four species have been found in the Gulf of Sirte. In addition, many observations of stranded fin whales have been made on some beaches of the Gulf (Table. 9).

Table 9 : Marine mammals in the gulf of Sirt (IUCN, 2012).

No.	common name	Scientific Name	Family
1	Common Bottlenose Dolphin	*Tursiops truncatus* (Montagu, 1821)	Delphinidae
2	Short-beaked Common Dolphin	*Delphinus delphis* Linnaeus, 1758	Delphinidae
3	Sperm Whale	*Physeter macrocephalus* Linnaeus, 1758	Physeteridae
4	Striped Dolphin	*Stenella coeruleoalba* (Meyen, 1833)	Delphinidae
5	Fin whale	*Balaenoptera physalus* Linnaeus, 1758	Balaenopteridae

2.2.8. Seabirds

Regarding to the Libyan birds, the first study was published in 1934 by Zavattari (1934), after which Bundy (1976) has published the Libyan birds. There have been several other publications on waterbirds (Gaskell, 2005; Smart et al., 2006; Hering, 2009). However, in mid-winter 2005, the first waterbird survey was carried out, organised by the General Environment Authority (EGA), with the support of AEWA and SPA/RAC. This survey has become a regular event and some preliminary results have been published published (Azafzaf et al., 2005; Smart et al., 2006). Several publications were prepared (Etayeb *et al*., 2007, 2015; Bourass *et al*., 2013).

The book of Libyan birds was published in 2016, filling all the knowledge gaps on birds in Libya (Isenmann *et al*., 2016). In the Gulf of Sirte, 65 seabird species have been found in the last three years and the table 19 shows more details for these species (Libyan national IWC, 2019).

Table10 : Seabirds recorded in the Sirt 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 alpine*	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*	Starling	2240	0	650
65	*Passer hispaniolensis*	Spanish sparrow	0	120	0
	Total of individuals		**5023**	**2163**	**4231**
	Total of species		**41**	**38**	**36**

3. Inventory of remarkable species listed in Annexes II and III of the Protocol

In the Gulf of Sirte, 24 species are listed in the Annexes II and III, of which 9 species are listed in Annex III and the other in Annex II.The table 11 provides some information on these species.

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Table 11 : The species listed in the annexes II and III in the Gulf of Sirte

No	Species	Class	Annex
1	*Posidonia oceanica*	Magnoliophyta	II
2	*Sargassum acinarium*	Heterokontophyta	II
3	*Chrcharodon carcharias*	Chondrichthyans	II
4	*Cetorhinus maximus*	Chondrichthyans	II
5	*Mobula mobular*	Chondrichthyans	II
6	*Caretta caretta*	Reptiles	II
6	Chelonia mydas	Reptiles	II

7	*Charadrius alexandrines*	Aves	II
8	*Larus audouinii*	Aves	II
9	*Phoenicopterus roseus*	Aves	II
10	*Sterna sandvicensis*	Aves	II
11	*Balaenoptera physalus*	Mammalia	II
12	*Tursiops truncates*	Mammalia	II
13	*Delphinus delphis*	Mammalia	II
14	*Physeter macrocephalus*	Mammalia	II
15	*Stenella coeruleoalba*	Mammalia	II
16	*Alopias vulpinus*	Chondrichthyans	III
17	*Alosa alosa*	Osteoichthies	III
18	*Alosa fallax*	Osteoichthies	III
19	*Anguilla Anguilla*	Osteoichthies	III
20	*Carcharhinus plumbeus*	Chondrichthyans	III
21	*Epinephelus marginatus*	Osteoichthies	III
22	*Heptranchias perlo*	Chondrichthyans	III
23	*Thunnus thynnus*	Osteoichthies	III
24	*Xiphias gladius*	Osteoichthies	III

4. Distribution of communities and species of conservation

- ***Posidonia oceanica***: There are no studies focused on the *P. oceanica* in the sirt gulf, there is a lot of accumulation of dead meadows along the coast indicating the richness of the area by *P. oceanica*, and it has distributed along the Gulf of Sirte (personal observation) and it should be survey and monitoring.

- **Elassmobranchs:** These species are found along the Gulf of Sirte and in different seasons, and as mentioned in this report, there are seasonal landing sites for catching these species in this region, especially in summer, which is the breeding season for most of them. These species are caught for fish oil and meat. Due to the lack of awareness about the importance of these species and therefore, it is highly recommended that several studies and awareness campaigns on the ecology and biology of these species should be carried out to educate the local communities.

- **<u>Fish</u>:** Due to the impact of alien species in this area, the changes in biodiversity that resulted in a threat to the native species, such as competition for habitat and food (e.g. *Sarpa salpa*, and *Siganus luridus*, *S. rivulatus*) (e.g. *Sphyraena sphyraena, S. viridensis* and *S. flavicauda, S. chrysotaenia*). In addition, of the threatened species that are distributed along the coast, several native fishes are vulnerable to threat such as *Epinephelus marginatus* which is distributed along the Sirte coast, especially in rocky habitats.

- **<u>Sea turtles (*Caretta caretta*)</u>:** this species is distributed along the Gulf of Sirte (Saied et al., 2019). The western coast (extending from Misurata in the west to Sirte in the east) is considered to have the highest areas of nesting density of this species, with at least 511 loggerhead nests recorded annually. The eastern coast of Sirte (extending from the town of Sirte in the west to Bin Jawad in the east), which approximately 251 km east of Sirte, should be monitored and detailed studies are recommended.

- **<u>Seabirds</u>:** The existence of Al Ghara Island in the Gulf of Sirt gives an additional importance to the area, as the largest population of the Lesser Crested Tern in the Mediterranean nests on this island. This species is included in the Annex II of the SPA/BD Protocol as a threatened species in the region. Many studies have been conducted on this species since the last century and the latest one was in 2014 entitled "Breeding ecology, migration and population genetic of leser crested tern *Thalasseus bengalensis emigrate* " (Hamza, 2014). The Island is in front of the biggest oil port (Zwetina Oil Company), which provides reasonable protection for this island and the breeding species. The only one threat is from the fishers who stop on the island to clean their nets after fishing.

5. Non-Indigenous and/or Invasive species

5.1.Inventory of Non-Indigenous species (NIS)

The Mediterranean Sea is currently a hotspot for marine bio-invasions (Edelist *et al.* 2013; Katsanevakis *et al.* 2014; Nunes *et al*. 2014). In 2018, a total of 824 taxa of marine alien species were considered established in all European seas (Tsiamis *et al*., 2018), while for the Mediterranean Sea alone, Zenetos *et al*. (2017) reported 613 established and 208 casual alien species. By December 2019, a total of 666 established marine alien species have been reported in the Mediterranean, excluding Foraminifera (Zenetos and Galanidi, 2020). The geographical location of Libya, in the central and "warm" part of the Mediterranean Sea is interesting as it

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can host tropical organisms arriving from the east (Indo-Pacific origin) or expanding from the west (Tropical Atlantic origin) (Shakman *et al.* 2017). Regarding to the last inventory of the Libyan coast, 73 alien species have been recorded, of which 42 species were distributed along the Gulf of Sirte. the Table 10 provides information on these species (Shakman *et al*., 2019).

Table 12 : Marine alien species recorded in the gulf of Sirt until March 2018, establishment according to Zenetos et al., (2010) (Est. = established, Cas. = casual, Ques. = Questionable and Unk. = unknown) AL= Alien; CR= Cryptogenic; REX= Range expanding (Shakman et al., 2019)

Species	**FR: location**	**Status**	**Establishment Success**	Reference
Padina boergesenii Allender & Kraft, 1983	E. – 1974	AL	Est.	Nizamuddin, 1981
Padina boryana Thivy, 1966	E. – 1974	AL	Est.	Nizamuddin, 1981
Stypopodium schimperi (Kützing) M.Verlaque & Boudouresque, 1991	E. – 1977	AL	Est.	Nizamuddin, 1981
Acanthophora nayadiformis (Delile) Papenfuss, 1968	1888	CR	Est.	De Toni & Levi, 1888
Lophocladia lallemandii (Montagne) F.Schmitz, 1893	1918	AL	Est.	Petersen, 1918
Caulerpa cylindracea Sonder, 1845	1990	AL	Est.	Nizamuddin, 1991
Codium fragile subsp. atlanticum (A.D.Cotton) P.C.Silva, 1955 = Codium fragile subsp. fragile	1984	AL	Est.	Nizamuddin, 1991
Codium taylorii P.C.Silva, 1960	1977	AL	Est.	Nizamuddin, 1991
Ulva fasciata Delile, 1813	1979	CR	Est.	Nizamuddin *et al.*, 1979
Halophila stipulacea (Forsskål) Ascherson, 1867	2009	AL	Est.	Rac-SPA, 2009
Plagusia squamosa (Herbst, 1790)	S. – 2006	AL	Est.	Zaouali *et al.*, 2007b
Portunus segnis Forsskål, 1775	E. – 2017	AL	Est.	Shakman *et al.*, 2017

Eucrate crenata (De Haan, 1835)	1999	AL	Est.	Zgozi *et al*., 2002
Erugosquilla massavensis (Kossmann, 1880)	E. – 2002	AL	Est.	Zgozi *et al*., 2002
Malleus regula (Forsskål in Niebuhr, 1775)	2001	AL	Est.	Giannuzzi-Savelli, *et al*., 2001
Pinctada imbricata radiata (Leach, 1814)	1913	AL	Est.	Monterosato *et al*., 1917
Fulvia fragilis (Forsskål in Neibuhr, 1775)	1997	AL	Est.	Zgozi *et al*., 2002
Conomurex persicus (Swainson, 1821)	2006	AL	Est.	Ben – Souissi *et al*., 2007
Erosaria turdus (Lamarck, 1810)	2007	AL	Est.	Ben – Souissi *et al*., 2007
Haliotis rugosa pustulata Reeve, 1846	E. – 1994	AL	Est.	Giannuzzi *et al*., 1994
Nerita sanguinolenta *Menke, 1829*	E. – 1994	AL	Cas.	Giannuzzi- Savelli *et al*., 1994
Siganus luridus *Rüppell, 1829*	E. – 1968	AL	Est.	Stirn, 1970
Siganus rivulatus *Forsskål, 1775*	E. – 1968	AL	Est.	Stirn, 1970
Sphyraena flavicauda *Rüppell, 1838*	E. – 1998/	AL	Est.	Ben Abdallah *et al*., 2003
Sphyraena chrysotaenia *Klunzinger, 1884*	E. – 1968	AL	Est.	Stirn, 1970
Herklotsichthys punctatus *Ruppell, 1837*	E. – 2005	AL	Est.	Shakman & Kinzelbach, 2007b
Saurida lessepsianus *Russell, Golani, Tikochinski, 2015*	1982	AL	Est.	*Zupanovic & El-Buni, 1982*
Hemiramphus far Forsskal, 1775	E. – 2006	AL	Est.	Shakman & Kinzelbach, 2006

Fistularia commersonii *Ruppell, 1838*	E. – 2004	AL	Est.	Ben Abdallah *et al*., 2005
Atherinomorus lacunosus (Forster, 1801)	E. – 1929	AL	Est.	Norman, 1929
Alepes djedaba Forsskal, 1775	E. – 1990	AL	Est.	Ben Abdallah *et al*., 2005
Upeneus pori Ben-Tuvia & Golani, 1989	E. – 1994	AL	Est.	*Ben Abdallah et al. 2005*
Upeneus maluccensis Bleeker, 1855	E. – 1968	AL	Est.	Stirn, 1970
Crenidens crenidens Forsskal, 1775	E. – 1999		Ques.	AL-Hassan & EL-Silini, 1999
Pempheris rhomboidea Cuvier, 1831	E. – 2004	AL	Est.	Ben Abdallah *et al*., 2004
Liza carinata Valenciennes, 1836	E. – 2005	AL	Est.	Shakman & Kinzelbach, 2007b
Scomberomorus commerson *Lacepède, 1800*	E. – 2003	AL	Est.	*Ben Abdallah et al. 2003*
Stephanolepis diaspros *Fraser-Brunner, 1940*	E. – 1965	AL	Est.	*Zupanovic & El-Buni, 1982*
Cephalopholis taeniops (Valenciennes, 1828)	W. – 2007	REX	Ques.	Ben-Abdallah , *et al*., 2007
Lagocephalus suezensis *Clark & Gohar, 1953*	E. – 2009	AL	Est.	Kacem-Snoussi et al. 2009
Lagocephalus sceleratus Gmelin, 1789	E. – 2009	AL	Est.	Kacem-Snoussi et al. 2009
Etrumeus golanii *DiBattista, Randall & Bowen, 2012*	W. – 2017	AL	Est.	Shakman *et al*., 2017

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5.2.Impact of Non-Indigenous species (NIS)

- ***Changes in marine biodiversity:*** *NIS can have an impact on biodiversity, according to Crise et al. (2015), alien species can disrupt the food web structure, displace native species (competition for space and food), alter genetic pools through hybridisation and can also act as pests and cause diseases. In the Gulf of Sirte, the NIS have increased and altered the biodiversity (Shakman et al., 2019).*
- ***Competition****: In Libyan waters, several studies begun to adress the impact of alien species, particularly fish species. For example, Shakman (2008), demonstrated strong competition between Siganus luridus and S. rivulatus on the central and eastern coast of Libya, decreasing towards the western coast.*
- ***Accompanied of parasites:*** *various parasites come to the Libyan coast with the alien fishe (Salem, 2017; Abdelnor et al., 2019).*
- ***Venomous and toxic species:*** *were recorded in Libya (Milazzo et al., 2012). For example, Lagocephalus sceleratus caused the death of three fishermen who had eaten the gonads of this species; other cases (two fishermen) of high toxicity were reported in the central and eastern part of Libya, resulting in hospitalisation in intensive care for more than seven days (personal communication, a local fishers). L. sceleratus is often caught and unknowingly consumed by fishers due to its large body (Golani, 2010). Despite national marketing bans, L. sceleratus is illegally sold beheaded and eviscerated along the Mediterranean coasts of Egypt and Turkey, with subsequent risk of poisoning to the unknowing public (Halim and Rizkalla, 2011; Aydin, 2011). This species has sharply increased in the eastern part of Libya, where large numbers of juveniles and adults were recently observed (personal observation by Shakman, July 2018).*
- ***Socio-economic impacts:*** *Currently, there is no demonstrated impact of P. segnis on the Libyan coast, and only a few individuals have been recorded (Shakman et al., 2017). However, this species has a high negative impact on fisheries in the Gulf of Gabes in Tunisia (Crocetta et al., 2015). In addition, P. miles has been found in the eastern coast of Libya. This species is expected to spread further along the Libyan coast and concerns have been raised about its potential environmental impact (Azzurro et al., 2017).*

6. Natural and anthropogenic pressures and threats to the marine and coastal environment of the area and their impacts on marine and coastal biodiversity

6.1.Fishery

6.1.1. Landing sites

The coastline is flat and generally arid, with sandy beaches backed by extensive salt marshes and scrubland. a total of 28 landing sites were found in the Gulf of Sirte gulf(Table. 11; Fig. 17), most of them seasonal landing sites to catch the Elasmobranchs fishes (Shakman *et al*., 2014; Lambouf *et al*., 2000; Lambouf *et al*., 1994).

Table 13 : Landing sites along the Sirt gulf Libyan coast (Lambouf et al., 1994)

Landing site name	Longitude and latitude	Description

Mina qasr ahmed	32°23' N 15°13' E	Deep water harbor for medium size boats, 210 km east of Tripoli. Localised pollution hazards.
Rumia	32°13' N 15°19' E	19 km south of Mina Qasr Ahmed fish harbour gate. Take asphalted road passing in front of commercial harbour, go round the steel complex staying close to the sea, at the end of the asphalted road continue on a dirt road due south leaving an old Korean camp on the left
Chesh	31°14' N 16°20' E	7.8 km east of Sirt bypass branching, 24/25 km from Sirt centre, across from butcher and coffee shop.
Sirt	31°13' N 16°35' E	449 km east of Tripoli, 570 km west of Benghazi
Sultan	31°08' N 17°08' E	About 55 km east of Sirt, before the antiquity site take north along the fence. Go right at the end of the fence near the sea (all = 3 km)
Sultan sabkha	31°08' N 17°08' E	About 55 km east of Sirt, before the antiquity site take north along the fence. Go right at the end of the fence near the sea (all = 3 km). Beach sheltered by reef barrier
Harawa	31°05' N 17°24' E	25/27 km east of Sultan take north at the eastern end of Harawa village, follow wide dirt road at a major crossing turn left following the main tracks and shortly after take right following a fence, reach the site after 2/3 km passed the desalinization plant.
Wadiel ahmar	31°01' N 17°29' E	10 km east of Harawa, 70 km west of Ben Jawad, turn north between the wadi and the village entrance on a dirt road leading to a sand quarry and the marsa.
Ben jawad	30°49' N 18°05' E	228 km west of Ajdabiya, 181 km east of Sirt.
Ras lanuf compound	30°32' ''N 18°30' E	7 km west of Mina Ras Lanuf entrance, drive in the compound towards the hotel (1.5 km) then turn west (0.5 km).
Mina ras lanuf	30°31' N 18°34' E	Mina entry is just west past the chemical complex (NOT) the entrance with a big tanker painted on the wall).
EL jeriah	30°26' N 18°39' E	19 km east of Mina Ras Lanuf, turn off on dirt road 200 m west of two wrecked burned cars, drive 4.1 km.
Um gharaniq	30°17 N 18°57 E	26.5 km west of Al Aqaylah village 41.5 km east of Mina Ras Lanuf, near Jabal El Kheish, dirt road going up towards radar station, leave the fence on the left and reach down to the beach (all = 1 km).
ALaqaylah	30°16' N 19°03' E	14 km west of Al Aqaylah village, 54 km east of Mina Ras Lanuf, dirt road starts with (tire + steel rod + plastic bottle mark), go north across hills then down to *sebkha* along the beach.
Besher	30°24' N 19°32' E	About 16717 km east of Besher village, palm trees and old industrial camp and houses, dirt road towards north, go down and cross the *sebkha* between garbage dump and chemical complex fence, then go west on the dunes for 0.7 km
Besher sabkha	30°24' N 19°32' E	About 16/17 km east of Bishr village, palm trees and old industrial camp and houses, dirt road towards north, go down and cross the *sabkha* between garbage dump and chemical complex fence.

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Mina al braygah	30°25' N 19°35' E	148 km east of Ben Jawad, 80 km west of Ajdabiya.
Kweim sabkha	30°25' N 19°35' E	Adjacent to Brega, 148 km east of Ben Jawad, 80 km west of Ajdabiya.
Shwerab sabkha	30°57' N 20°02' E	18 km north of Ajdabiya, go west on tarmac road through town.
Shwerab	30°57' N 20°02' E	18 km north of Ajdabiya, west on tarmac road for 8 km cross the town. Site is in the direction of refinery. Sheltered by reef barrier.
Shat elbadin	31°17' N 20°07' E	35/40 km north of Azzuitina branching road, 20 km north of Sultan, sign on main road Shat el Badin, go east to the village then turn north at the end of village, continue north 4 km to a sign (man silhouette cut in metal plate), turn west on dirt road leading to sand quarry before entering the quarry turn south in the dunes for 0.5 km to reach the sea.
Karkora sabkha	31°28' N 20°00' E	About 11 km north of Al Maqrun, 14 km south of Gminis, take west tarmac road signed El Mteiflah, continue 11 km first tarmac road to wind mill, then dirt road through *sabkha*. Local saltworks.
Murrah	31°29' N 20°00' E	About 11 km north of Al Maqrun, 14 km south of Gminis take west asphalted road signed El Mteiflah, continue 11 km first asphalted to wind mill then dirt road through *sabkha*.
Habib	31°36' N 19°58' E	From Gminis fishing site take dirt road leading south, after 0.75 km turn west at old store house leading in WW II surplus dumping field and continue 0.7 km south.
Bata	31°42' N 19°57' E	6 km north of Gminis crossing, 45 km south of Benghazi, wide paved road leading to the beach.
Abou douara	31°45' N 19°55' E	11 km north of Gminis crossing 40 km south of Benghazi, conspicuous small white marabou (Sidi Nail) on top of a hill. Dirt road starts on the southern side of the village between farms, at the marabou turn south for 0.5 km
Nayla	31°46' N 19°55' E	11 km north of Gminis crossing 40 km south of Benghazi, conspicuous small white marabou (Sidi Nail) on top of a hill. Dirt road starts on the southern side of the village between farms. Leave marabou on the south and continue to the beach.
Mreissah	31°57 N 19°57 E	At marabou Sidi Bu Fakhirah take west for 4 km towards the beach.

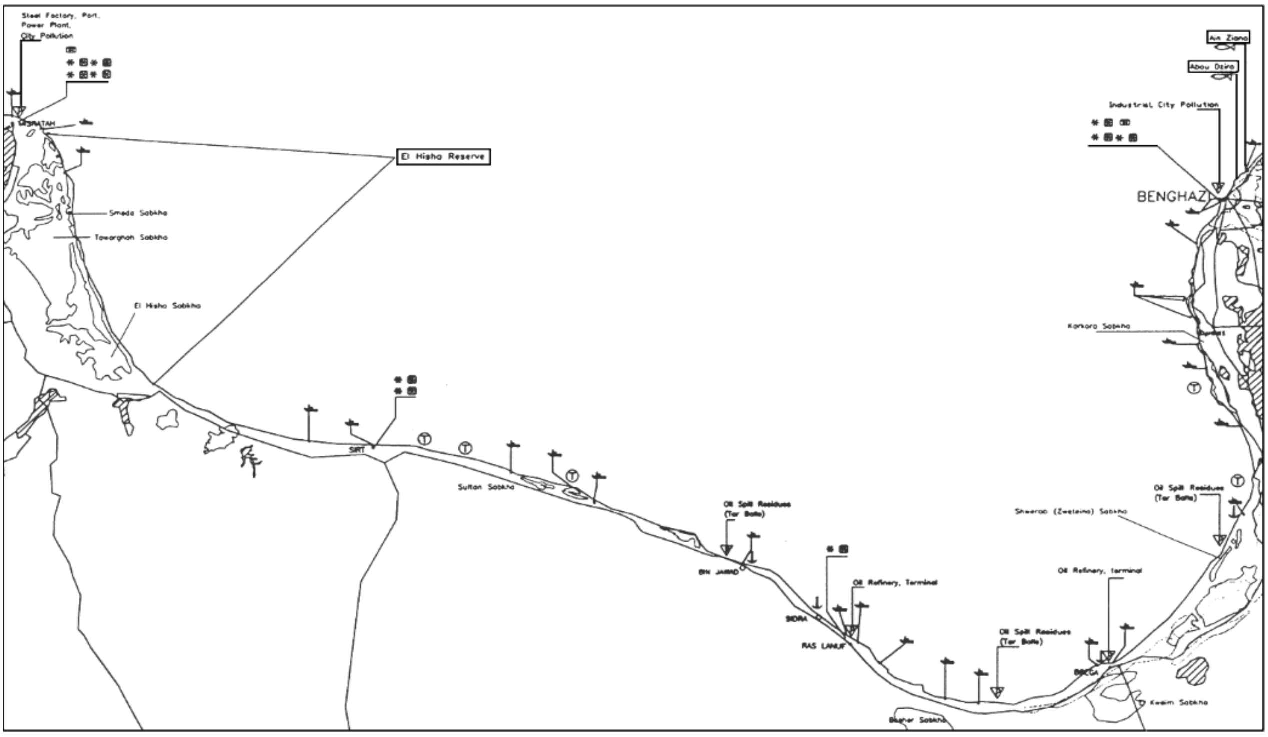

Figure 17 : Sirte map showing the landing sites (Lambouf et al., 1994)

6.1.2. Fleet of artisanal fishery

In the Gulf of Sirte, Fluka (small boats from 3.5m to 9m, working in the coastal area with motor) was the most used fishing vessels with more than 72%, followed by Mator (large boats from 9 to 18m, working in the coastal area) (Fig. 18).

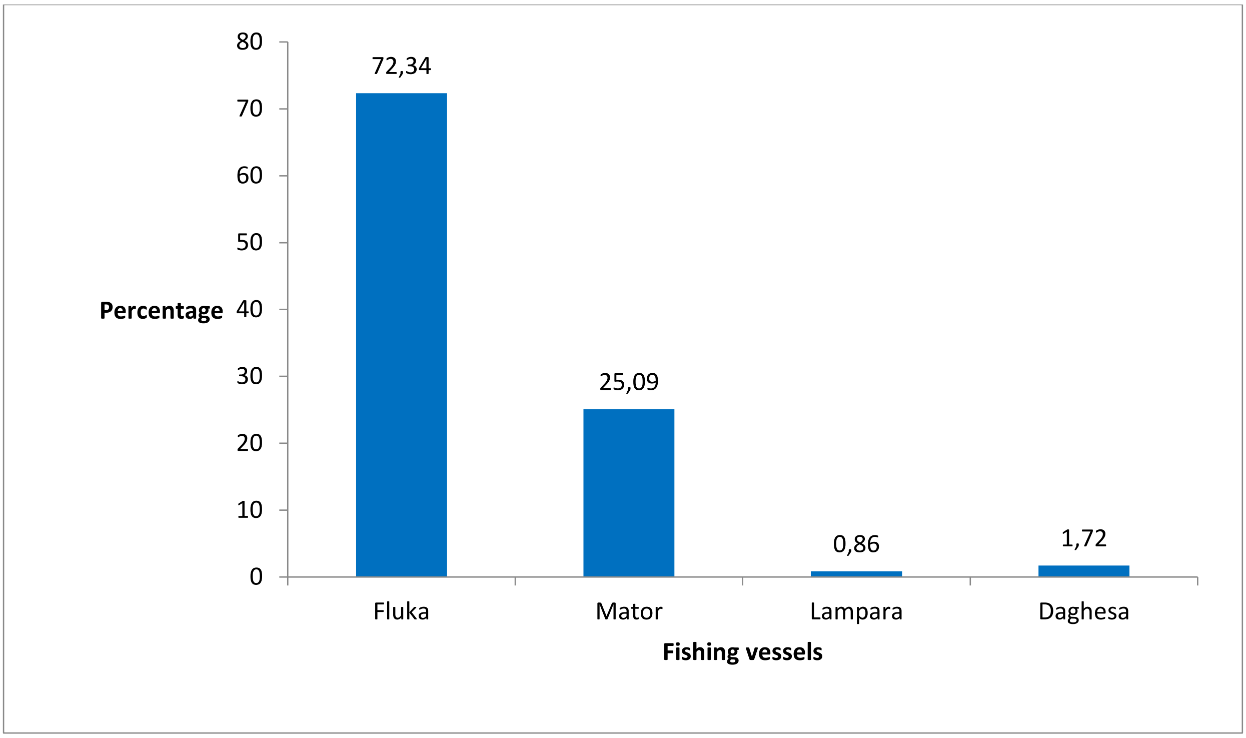

Figure 18 : Artisanal fishing vessels in the sirt gulf year (Shakman et al., 2014)

6.1.3. Fishing gear used

Most of the fishers use the mixed fishing gear (nets and hooks), more than 56%, followed by the use nets more than 21%. The trammel nets are the most common fishing gear, other fishing gears are used occasionally (Fig. 19).

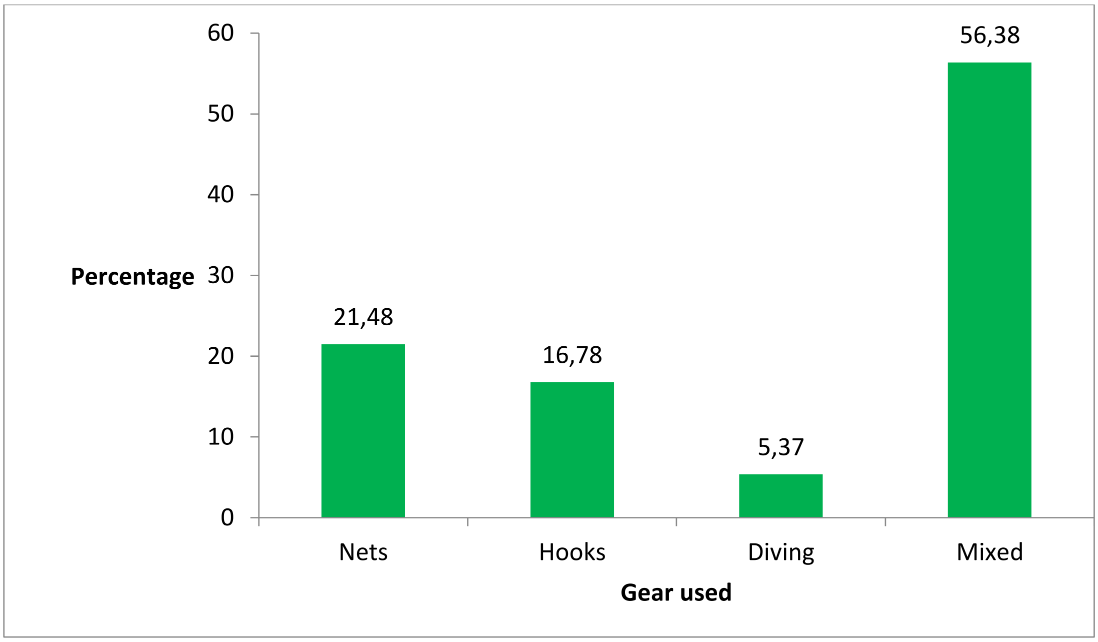

Figure 19 : Fishing gears used in the Sirt gulf (Shakman et al., 2014)

Fishers using a type of gill net (kellabia): 1000-1500 m long and 2-3 m high gillnets with a mesh size of 25-30 cm, (handmade), which used to catch several species of sharks such as (*Carcharhinus plumbeus*, *Carcharhinus brevipinna*, *Carcharhinus limbatus*) (Fig. 20).

Figure 20 : Gillnet (kellabia) using to catch sharks in Sirt gulf Libya (© E. Shakman)

6.2.Pollution

Pollution hazards from oil spills, terminals, solid waste and chemical waste dumping in some *sabkha* areas, the information about the pollution in the Gulf of Sirte lacking, as we know in this area there are petroleum activities to produce and export the oil, ballast water and oil pollution are expected, Saad et al., (2018) conclude that the large scale oil pollution has led to the deterioration of water quality, and the water associated with oil "or" productive water "is estimated at 44 million barrels of water per day, assuming an average rate of four million barrels of water per million barrels of oil. With a production rate of only 11 million barrels pet day, it is proposed to develop wastewater treatment plants to treat the water produced during oil extraction and its purification and re-injection into waterways. The ballast water is a particular threat to this area because most of the oil terminals and ports are located in this area, in addition, the overfishing of sharks and disturbance of sea turtles and sea birds add other burdens.

6.3. Trace elements

The trace metals (Ni, Cd, Cu, Pb, Co, V, Mo) in the water column of the Gulf of Sirte have been described (Bonanno *et al*., 2015). The concentration on in the surface water varies from 38,74 to 125 nmol/l, while in the deep water the concentrations range from 47,50 to 78,15 nmol/l.

Copper: shows a range of variability from 3,33 to 14,24 nmol/l in the surface waters, and from 1 to 6,37 nmol/l in deep layers.

Nickel*:* Nickel concentrations are characterised by high values (6,97 nmol/l) in the surface waters, while the highest concentrations are recorded in deep waters and is 10,57 nmol/l.

Vanadium*:* Vanadium concentrations in surface waters vary between 15,01 and 34,81 nmol/l. and the concentrations in the deep waters were between 12,43 and 28,30 nmol/l at 900 and 600 metres.

Cobalt: The atypical behavior of the cobalt distribution with a high cobalt concentration in surface waters (1,06 nmol/l), and the concentration in the depths of 700 and 800 m ranges between 0,02 and 1,27 nmol/l.

Cadmium: Cadmium does not show the typical nutrient-like distribution along the water column. The results of chemical analysis highlight the presence of high concentrations in surface waters (from 0,06 to 0,3 nmol/l), the highest values measured in deeper waters (0,32 nmol/l at 700 m).

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Lead: chemical analyses distribution in seawater show the highest values in surface waters (0,29 - 2,07 nmol/l) and a range of variability deep waters 0,8-4 nmol/l.

6.4.Non-indigenous species

In Libyan waters, several studies have begun to adress the impact of alien species, particularly fish species. For example, Shakman (2008) and later Al-Razagi (2017) demonstrated strong competition between *Siganus luridus* and *S. rivulatus* in the central and eastern coast of Libya, which decreases towards the western coast. In addition, several venomous and toxic species have been recorded in Libya (Milazzo *et al*. 2012). For example, *Lagocephalus sceleratus* is often caught and unknowingly consumed by fishers due to its large body (Golani 2010). Also, these species altered the diversity in this area (Shakman *et al*., 2019).

6.5.Catch the Elasmobranchs

Chondrichthyans are generally slow growing, late maturing, have low fecundity and productivity, long gestation periods, high natural survivorship of all age classes and longevity (Cailliet *et al*., 2005). These biological characteristics result in low reproductive potential and low capacity for population growth for many species. In the Gulf of Sirte, several elasmobranch species have been caught in the spanning period (Fig. 21).

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Figure 21 : Catch the elasmobranchs species in the Sirt gulf (© MBRC)

7. Impacts of climate change on marine and coastal biodiversity

Global climate change and its impacts on the marine environment, such as, ocean warming, ocean acidification, and sea level rise (at the rate of about 1 mm per year), is an ongoing phenomenon which is certainly affecting the biodiversity. However, we do not know exactly how profound the consequent changes in marine ecosystems will be (Lejeusne *et al*., 2010; Giorgi & Lionello, 2008).The Mediterranean climate is expected to become warmer and drier with an increase in inter-annual variability due to extreme heat and drought events (Giorgi & Lionello, 2008). Although, the Mediterranean Sea is likely to fully affected by this warming trend, and data on this phenomenon are mainly reported for the north-western Mediterranean (Lejeusne *et al*., 2010). The temperature differences observed in the Mediterranean during summers of 1999 and 2003 led to catastrophic mass mortality events, particularly of benthic invertebrates (sponges, gorgonians, bryozoans and molluscs) (Bensoussan, 2010). The 2003 event resulted in mortality of *P. oceanica*, but also in large flowering episodes for this seagrass (Marbà & Duarte, 2010). In general, these studies are lacking in Libya, and especially in the Gulf of Sirte.

8. Existing/planned conservation and ecological monitoring programmes in the Sirt gulf

Several planned conservation and ecological monitoring programmes have been implemented along the Libyan coast, including the Gulf of Sirte. The table 13 shows information on them

Table 14 : Conservation and ecological monitoring programmes in the Gulf of Sirte

Monitoring programme	Description of the monitoring programme	Implementing agency
Ringing programme for Mediterranean Lesser Crested Terns *Thalasseus bengalensis emigrates*	Ringing to collect the information on the population during migration and to follow the three different colonies in Libya	EGA
Libyan Sea Turtles Conservation Programme	Since 2005, the Libyan Sea Turtle Programme (LibSTP) was launched by the Environment General Authority in Libya (EGA) to monitor most of the important nesting beaches in order to protect beaches, nesting females and hatchlings and to determine eco-biological parameters necessary for any conservation activity (importance of nests, density of nests and hatching and emergence rates)	EGA
Satellite Tracking	Two missions were organised in 2009 and 2010 in cooperation between the Environment General Authority of Libya (EGA), the Stazione Zoologica of Napoli (SZN) and SPA/ RAC in the periods from 19 – 25 July 2009 and 5 – 11 July 2010. The fieldwork was carried out as part the Libyan Sea Turtle Program (LibSTP) the nesting monitoring activities in the west Sirte region. During the first mission in 2009 three female loggerhead turtles were equipped with satellite transmitters, one in Misurata (32.383°N, 15.056°E) and two in Sirte (31.206°N, 16.588°E). In 2010 two further turtles that nested in Sirt were equipped	EGA

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Sex-ratio estimations of loggerhead sea turtle hatchlings	Recalling the articles of the SPA protocol and the revised Action Plan for the Mediterranean Sea Turtles, , taking into account the new developments in scientifically based conservation measures, and considering the potential effects of global warming on future population structure and on the dynamics of these endangered species (Hawkes et al. 2009, Witt et al. 2010), the present study aimed to provide data on hatchling sex ratio estimation from five nesting beaches west of Sirte, which are among the most important nesting sites for loggerhead turtles in Libya and potentially in the Mediterranean (Hamza, 2010)	EGA
Fishery survey	Survey of the area located between the Sicilian island to the north, Tunisia and Libya in the south and the Gulf of Sirte and the narrow continental shelf and coast of Tobruk for the purpose of the economic viability of this area during the study period of 18 August and up to 19 September in 1972	MBRC
Fishery	The study was conducted in the central area of the Libyan coast for the purpose of the economic viability of marine fisheries area in the Gulf of Sirte the study took place from 22 December 1974 to 12 May 1975, and it resulted to map and identify some of the economic importance of fish assemblages, fish, crustaceans and sponge places in central Libya	MBRC
Fishery	The study was conducted along the Libyan coast, at depths ranging from 50 metres to 300 metres and at distance of 12 nautical miles from the coast, to assess fish stocks and fishing grounds in Libya as well as many other field studies along the Libyan coast. Through this project a technical Report was published with 30 detailed reports and 15	MBRC

	field documents containing the results of studies in various project activities and of interest to the development of marine resources and fisheries in Libya	
Fishery and biodiversity	It had Conducted during August 2003 to evaluate the abundance and distribution of benthic fish, especially the economic species. study area (East and Central) and using the method of bottom trawling and compile information in accordance with criteria and programme of international surveys of the benthic Mediterranean shelf (MEDISTS)	EGA
Ichtyoplankton	This study was conducted to determine the species and distribution of fish larvae and eggs present in Libyan waters in the area extending from Misrata in the west to Benghazi in the east during the period 15/7/2008 until 31/7/2008	MBRC
Biomass for pelagic fish	The use of echosounder (Acoustic) type (EK60) with different wavelengths accomplished during the period 20/8 - 05/09/2008 along the Libyan coast from the Tunisian border in the west to the city of Tubruk in the east for the purpose of biomass estimation for pelagic fish (Mackerel, Sardine, Bouga and anchovies)	MBRC
Commercial fishery and fish species composition in coastal waters of Libya	The number of boats found in this study was 1,511; of which 64.3% were “flouka”, 24.1% were “mator”, 6.9% were “lampara”, and 4.8% were “batah”, the highest fish species diversity in the coastal area was in the eastern region (45.65%), while in the Gulf of Sirte and western regions the Fig. was 23.91% and 30.43% respectively	Tripoli Univerity
Libyan National Action Plan for Non- Indigenous Species 2020 - 2025	The objectives of this action are to collect and regularly update of data to support EcAp, to regularly publish the data and relevant	EGA, Experts from universities, research centers and NGOs

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	information, to provide training and refresher courses for specialists, to conduct awareness-raising and educational campaigns for the general public, stakeholders and decision-makers and to coordinate and cooperate with other countries	

It is worth noting here that starting since 2017, and under the joint collaboration between SPA/RAC and EGA, within the Barcelona Convention Ecosystem Approach (EcAp) and based on the IMAP requirement, Libya has developed its national monitoring programme for biodiversity and non-indigenous species including the sites and the priority lists of marine species and habitats to be monitored at the national level during the 2nd phase of the IMAP implementation (2019-2021). In this contex, the Environment General Authority of Libya (EGA), with the support of SPA/RAC, has undertaken the task to implement pilot monitoring activities of marine biodiversity related to the EcAp common indicators of (i) seabirds and (ii) non-indigenous species.

Recently, there has been a notable activity regarding the monitoring of marine mammals, especially whales and dolphins, where a national team has been specially trained in marine mammals monotoring by ACCOBAMS in collaboration with SPA/RAC.

9. Challenges related to the management and conservation and development

- Discharge of ballast water: most of the oil ports are located in the Gulf of Sirte, and desspite of the lack of studies on the pollution, it is certain that this area is affected by ballast water, especially the coastal area.

- The impact of alien species: there are many alien species that have been recorded in this area and have a clear impact, and one of these impacts is the change in biodiversity and competition between these species and native species, as well as the presence of some poisonous species that have an impact on fishing.

- Overfishing, especially the cartilaginous fish species: although there is no use of prohibited fishing methods in this area, cartilaginous fish are caught during their breeding season using seasonal landing sites and special nets, despite the presence of many endangered species.

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- Urbanisation: coastal development and tourism in some areas, particularly near the city of Sirte.

- Building tourist facilities on sandy beaches: in some areas, a place is built for marine tourism and strong lighting, especially in the summer season, in which turtles nest, which leads to the disturbance and decrease in the nesting moreover, collecting turtle eggs as a treatment or stimulant.

- Collecting sand from sandy beaches: in some sandy areas, sand is extracted for the construction, which leads to sand erosion and this effects on the seagrass (*Posidonia oceanica*), which is an important habitat for many important marine species and also for oxygen, in addition to its direct impact on sea turtles.

- Illegal fishing in this region: is also a problem, with foreign vessels being caught in this area as a result of the security situation in the country, as well as shark fishing during the breeding season.

10. Needs

- Capacity building in the MPAS is important, therefore, it needs a training and workshops in the fields of MPAs for the stakeholders in the region.

- Studies for the impact of NIS, the coastal areas, and their conservation along the Gulf of Sirte because there are various impacts of these species and it needs to work regarding to the Libyan Action Plan of NIS.

- Collaboration between organisations and researchers in the Mediterranean establishing a national and regional network and collaboration platforms to exchange the information and experiences.

- The legislation of biodiversity and its impact need to be updated, and the lack of coordination between the organisations and institutions that are supposed to implement these legislations as well as the overlapping in their tasks and the stability in the administrative bodies and institutions.

- Public environmental awareness about the MPAs and the conservation in this region.

- Budget and funding for studies and training.

- A comprehensive study of biological indicators in the area.

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- A comprehensive study on the bycatch and discarded species in the Gulf of Sirte.
- Detailed study in collaboration with the The International Commission for the Conservation of Atlantic Tunas (ICCAT) and the General Fisheries Commission for the Mediterranean (GFCM),as this area is very important for spawning.

11. Conclusion and recommendations

- Over the last three decades, many studies have been conducted along the Libyan coast, focusing on marine and coastal biodiversity, and have generally shown the importance of the Gulf of Sirte and its potential, which could lead to designate one or more MPAs.
- The Gulf of Sirte is a biodiversity hotspot, it is a mostly sandy coast interspersed with small rocky areas and hazards that that sea turtles nesting sites it provides suitable habitat for several species, thereby supporting a wider marine food web that includes larger pelagic fish species, reptiles, seabirds, and mammals.
- It is considered to be an important habitat for several endangered species such as the number of fish, elasmobranch, sea turtles, marine mammals, and seabirds which they have scattered along the Gulf of Sirte.
- The beach is connected to the sea through some salt marshes together with Sultan Sabkha, which measures 11 km long; some of them are protected areas such as Alhesha and Taurgh.
- There is lack on the information of oceanography and despite the scarcity of studies in this region regarding to the biodiversity and its impact, there is remarkable diversity in this region for the communities (flora and fauna), and this needs comprehensive studies.
- There are remarkable 24 species have been listed in Annexes II and III of the SPA/RAC in this area, some information about these species have been shown.
- There is a lack in the studyof biological indicators, as well as climate change in this region, and due to the importance of these issues, several studies and training need to conduct for many researchers in these fields.
- There are 28 landing sites along the Gulf of Sirte, most of them are seasonal land sites and the target species to be caught are cartilaginous fishes using traditional fishing

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gear, although there is lack in the studies of pollution, several studies and personal observations mentioned to ballast water and oil pollution as well as hydrocarbon.

- Changes in biodiversity, several alien species have been added to the national checklist and some of their impacts have been found
- 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, gives greater importance to the Gulf as a biodiversity hotspot.

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