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POST-2020 SAP BIO

LIBYA
CONSERVATION OF MEDITERRANEAN MARINE AND COASTAL BIODIVERSITY BY 2030 AND BEYOND

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CONSERVATION OF MEDITERRANEAN MARINE AND COASTAL BIODIVERSITY BY 2030 AND BEYOND

Ecological Status, Pressures, Impacts, their Drivers and Priority Response Fields

POST-2020 SAPBIO

Strategic Action Programme
for the **Conservation** of **Biodiversity**
and **Sustainable Management**
of **Natural Resources**
in the **Mediterranean Region**

ion of Mediterranean marine and
odiversity by 2030 and beyond

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Mediterranean Action Plan
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List of Acronyms

EGA	Environment General Authority
MBRC	Marine Biology Research Centre
LSAFF	Libyan Society of Artisanal Fishery Friends
LSB	Libyan Society for Birds
LOCN	Libyan Organization for Conservation of Nature
MAP	Mediterranean Action Plan
SPA/RAC	Specially Protected Areas Regional Activity Centre
NASR	National Authority for Scientific Research
SAP	Strategic Action Plan for the Conservation
IUCN	The International Union for Conservation of Nature
UNEP	United Nations Environment program
IWC	International Waterbirds Census
LibSTP	Libyan Sea Turtle Program
NOC	National Oil Corporation
LISC	Libyan Iron and Steel Company
EIA	Environmental Impact Assessment

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Executive Summary

Libya is characterized by a coastline that occupies about 36% of the southern coast of the Mediterranean extending for about 2000 km. Although, there are no comprehensive studies on the marine environment and its components, most the available information are gathered from various pilot studies implemented by some national institutions such as Environment General Authority (EGA), Universities, Marine Biology Research Centre (MBRC) in collaboration with some international organizations and institutions.

After 2011, with difficult security situation of the country, many research activities and monitoring programs have been carried out targeting sea turtles, waterbirds, marine mammals, fisheries, coastal habitats and alien species, as well as, other activities and programs aimed to study or enhance the establishing of marine protected areas (MPA). These activities were funded nationally or as projects of international budget. However, information gaps still remain especially in the field of Phyto and Zooplanktons, cartilaginous fishes, cetaceans and invasive species, despite, there are recent studies on this taxon, but they were limited to inventories or checklists. Consequently, the need for protection and conservation programs are the priorities, as well as, the integrated management and action plans to protect the native species and control the invasive species.

The Libyan coastline is suffering from sewage, industrial and ballast pollution. There are some recent tries from different agencies in Libya to mitigate their impacts on the sea in general due to the pressure from the NGO's on the government. However, still there are no comprehensive studies that can be cited related to the industry and ballast water pollution. The other threats are illegal fishing and overfishing in Libya, although, the existing regulations prohibiting that. Still there are some isolated instances of illegal fishing especially in the eastern part of Libya. Moreover, many invasive species have been recorded in the Libyan waters since they negatively impacted the diversity and the ecological balances in the region. The total number reached 73 species recorded in the Libyan waters; the highest percentage was for fishes (32.88%), followed by macrophytes (21.92%), molluscs (16.44%), crustaceans (13.70%), and parasites (9.59).

During the last decade, many studies, projects, monitoring and training programs have been conducted in collaboration between EGA and SPA /RAC aimed to conserve the biodiversity of coastal and marine ecosystems, for instance the monitoring of the breeding of Sea turtles, socioeconomic study of MPAs in Libya and training program related to the monitoring of marine mammals. Moreover, the implementation of the IMAP in Libya regarding the sea birds and non-indigenous species, and more recently, the preparation of the Libyan National Action Plan for Non- Indigenous Species 2020 – 2025. However, several research projects are still needed in the region which should focus on areas that have not been thoroughly investigated yet, such as: Sirt gulf, the small gulfs and bays

in the eastern region and the wetlands along the Libyan coast. Diversity studies on the coastal region are also lacking despite their importance and it is recommended to fill these gaps.

The funding is rather limited and this is one of the main reasons behind the scarcity of the studies in the area. Although the Libyan country has many major industrial institutions, such as the National Oil Corporation (NOC) and the Libyan Iron and Steel Company (LISC), which can support research projects, monitoring programs, and the conservation processes of the environment and biodiversity. However, the current situation of the country (wars and conflicts that threaten the country's stability) is the most obstacle to obtaining funds from these agencies.

1.

Reference documents and information consulted

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1-1. Documents provided by SPA/RAC:

- SPA/RAC. 2018. Libyan National Action Plan for Non- Indigenous Species 2020 – 2025.
- SPA/RAC. 2017. National monitoring programme for Biodiversity in Libya; by: Esmail Shakma], [Contract n° 09_EcAp MED II SPA/RAC_2016], SPA/RAC, Tunis, [60] pp.
- MedPAN and SPA/RAC, 2019. The 2016 status of Marine Protected Areas in the Mediterranean. By Meola B. and Webster C. Ed SPA/RAC & MedPAN. Tunis 222 pages.
- SPA/RAC. 2010. National document of Libya aiming at the identification of important ecosystem properties and assessment of ecological status and pressures to Mediterranean marine and coastal biodiversity in Libya. Prepared by Shakman, E. 58 pages.
- UNEP-MAP SPA/RAC 2010. The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities. By Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S., Limam, A., Lleonart, J., Torchia, G., and Rais, C., Ed. SPA/RAC, Tunis; 100 pages.
- UNEP-MAP-SPA/RAC, 2010. Impact of climate change on marine and coastal biodiversity in the Mediterranean Sea: Current state of knowledge. By S. Ben Haj and A. Limam, SPA/RAC Edit., Tunis: 1-28.
- UNEP-MAP-SPA/RAC: Strategic Action Programme For The Conservation of Biological Diversity (SAP BIO) in The Mediterranean Region, Tunis, 2003.
- SPA/RAC. 2003. Information note about the strategic action plan for the conservation of marine and coastal biodiversity in the Mediterranean (SAPBIO). 37 pages.
- SPA/RAC. 2003. Biodiversity of coastal wetlands in the Mediterranean. Project for the preparation of a Strategic Action Plan for the Conservation of the Biodiversity in the Mediterranean Region (SAP BIO).
- Libyan National Action Plan for conservation of marine turtles and their habitats. One of the well implemented programs in Libya. Volunteers and specialists are enthusiastic and very keen to work even in a difficult security situation.
- Libyan National Action Plan for the Conservation of Marine and Coastal birds.This activity is still going on, especially for the IWC with some limitation of the number of covered sites due to the general country security situation.
- Libyan Action plan on cartilaginous fishes in Mediterranean Sea. This action plan should be implemented along the Libyan coast.
- Libyan action plan on introduction of species and invasive species in Mediterranean Sea. This action plan should be implemented along the Libyan coast and follow up.
- Libyan action plan for the conservation of cetacean in the Mediterranean Sea. The implementation of this action plan is going on with collaboration between EGA, SPA/RAC and ACCOBAMS. Training programs have been done.
- Libyan action plan for the conservation of marine vegetation in the Mediterranean Sea.Some studies have been done as an implementation of this action plan, but the programme need to be continued.

- Libyan action plan for the management of the Mediterranean monk seal. Some stages of this action have been conducted, but the implementation should be continued.
- Marine turtle nesting activity assessment on Libyan coasts. Phase 3: survey of the coast to west of Misratah.
- Report of the Medposidonia project – Libya.
- Pergent G., Pergent-Martini C., (2000) Field study in Libya, study of the vegetation in the lagoon of Farwa. RAC-SPA. and University of Corsica- contract N. 38-99: 1-48.
- UNEP-MAP SPA/RAC 2010. The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities. By Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S., Limam, A., Lleonart, J., Torchia, G., and Rais, C., Ed. SPA/RAC, Tunis; 100 pages.

1.2. National documents and publications identified and available:

- Badalamenti, F., Ben Amer I., Dupuy De La Grandrive, R., Foulquie, M., Milazzo, M., Sghaier, Y. R., Gomei, M. and Limam, A. 2011, Scientific field survey report for the development of Marine Protected Areas in Libya. 32 pages
- Libyan National report on the implementation of AEWA for the period 2012-2014.
- The forth Libyan National report on the implementation of CBD 2010, in Arabic.
- Libyan National report CMS 2019.
- Ben–Abdallah R., AL-turky A., Fituri A. (2005) Records of exotic fishes in the Libyan coast. Libyan Journal of Marine Science 10: 1-8.
- Contransimex C. (1977) Final report concerning the results of the fisheries oceanographic survey, carried out by the Romanian researcher teams on board "Delta Dunarii" and "Gilort" in the eastern territorial waters of the Libyan Arab Republic between Ras Azzaz and Ras Karkura II: 173-563.
- Lamboeuf M. (2000) Artisanal fisheries in Libya, census of fishing vessels and inventory of artisanal fishery metiers. FAO-COPEMED-MBRC pp 42.
- Lamboeuf M., Reynolds J. E. (1994) The fishing fleet of Libya: preliminary results of the 1993 frame survey. TBN No. 16.
- Shakman E. A., Kinzelbach R.(2007a) Distribution and characterization of Lessepsian migrant fish along the coast of Libya. Acta. Ichthyologica et Piscatoria 37 (1): 7-15.
- Shakman, E.A., Kinzelbach, R. (2007b) Commercial fishery and fish species composition in coastal waters of Libya. Rostocker Meereskundliche Beiträge 18: 65-80.
- Shakman, E., Winkler H., Oeberst R. and Kinzelbach, R. (2008) Morphometry, age and growth of *Siganus luridus* (Rüppell, 1828) and *Siganus rivulatus* (Forsskal, 1775) (Siganidae) in the central Mediterranean (Libyan coast). 43 (3) 521-529.

- Ben-abdalha R., Shakman E., Al-Turky A. (2001) food and feeding habits of little tunny *Euthynnus alletteratus* in the western Libyan coast. Mahdia, Tunisia.
- Ecological study about the influence of industrial water waste on the coast of Abukamash (Libya) chemical compound 99-2000, (MBRC).
- Nizamuddin M. 1984. Diatoms of Libya. Al-insha Printing Press, Damascus- Syria, 144p.
- Sogreah 1977. Trawl fishing ground off the Tripolitanean coast. Final report. Part v: 1-144 and final report: introduction and general conclusion: 1-30.

1.3. Other documents:

- Survey of the Libyan territorial waters and the adjacent international waters in the central Mediterranean. Communication présentée au 23 congrès Assemblée Plénière CIESM, Athènes 3-11 (4) 72 J.
- Using the Ecosystem Approach to Implement the Convention on Biological Diversity. Key Issues and Case Studies. IUCN, Gland, Switzerland and Cambridge, UK, P.1-118.
- CIESM Atlas of Exotic Macrophytes in the Mediterranean Sea. CIESM task force 2009.
- CIESM Atlas of Exotic Fishes in the Mediterranean Sea. CIESM task force 2002.

1.4. Quality and comprehensiveness of available information documents

In fact, all the documents that were used and referred to in this report, especially those issued by the SPA/RAC, are in good quality with important information and beneficial, because most of the information and data were collected from the field. Some of the topics adopted by the SPA/RAC need updating, for example the report on MPAs in the Mediterranean region.

For the national reports that are related to international conventions and agreements, most of them are not up-to-date, and the updated ones are only a compilation of old information and data have been sent to the organization or the Convention Secretariat. However, this is due to the instability of the country since 2011, as well as the security situation, wars in different regions, and the political instability. These also affected the process of paying participation fees of the conventions and agreements.

2.

Marine and coastal ecosystem status

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2.1. Biological characteristics:

2.1.1. Description of water column biological communities

Unfortunately, the information about the planktons are very few, there is no a comprehensive study on these organisms in the Libyan coast. Nizamuddin (1984), listed the diatoms of Libya includes other marine and fresh water organisms. Over 60% of the total organisms are planktonic, the reported number of diatom's genera is 92, 390 species and 102 varieties.

As stated by a study performed along Tripoli coast, there are three groups of the phytoplankton (Diatoms, Dinoflagellates and Cyanobacteria), 40 genus of phytoplankton 28 of them are Diatoms and 12 are Dinoflagellates. Moreover, a few of Cyanobacteria and other unidentified species were reported. This study also showed that *Dinophysis* and *Ceratium* were more abundant in comparison with dinoflagellates, as well as, the Diatoms *Proboscia indica* and *Rhizosolenia* were more abundant. (Table 1) (SPA/RAC, 2010).

In 2006, a survey Med-Sud-Med was carried out in the western coast of Libya, it is reported that the phytoplankton of the western coast is characterized by plenty of diatoms and dinoflagellates, rare coccolithophores and very rare Silicotlagellates. The highest concentration of phytoplankton is observed in Musrata region and diatoms were the dominant phytoplanktons, followed by coccolithophores and then Silicoflagellates.

Table 1.

Phytoplankton (Diatoms) collected from Tripoli coast, 2009. MBRC.

Diatoms	Diatoms
Amphora sp.	*Entomononeis sp*
Chaetoceros sp	*Centronella sp*
Climacosphenia sp	*Coscinodiscus sp*
Cocconeis sp	*Grammatophora sp*
Biddulphia sp	*Proboscia indica*
Licmophora sp	*Odontella sp*
Navicula sp	*Nitzschia sp*
Pinnularia sp	*Pleurosigma sp*
Pseudonizschia sp	*Rhbdonema sp*
Rhizosolenia sp	*Striatella sp*
Triceratium sp	*Tabellaria sp*
Eucampia sp	*Dytilum sp*
Bellerochea sp	*Skeletonema sp*
Gyrosigma sp	*Hemiaulus sp*

The main scope of the survey Med-Sud-Med 2006 which carried out at the area from Zwara to Misrata was to investigate the area of major concentration of Ichthyoplankton (eggs, and larvae of fish). The predominant species was anchovy (*Engraulis encrasicolus*) representing 51% of the collected larvae, round sardine (*Sardinella aurita*) with 9.6% of the larvae and minor fraction of other species (Serranidae, Gobidae and Labridae). Among the larvae species collected in Libyan waters: 11 orders, 39 families, 39 Genus and 40 species were identified (SPA/RAC, 2010). Furthermore, some zooplanktons were recorded in Tripoli coast, the samples were collected from 9 sites with other organisms including; worms, eggs and other unidentified items (Table 2).

Table 2.

Invertebrates collected of Tripoli coast, summer 2009. MBRC.

Invertebrates	Invertebrates
Copepoda	Copepods Larvae
Tintinides	Gastropods
Foraminifera	Polychaeta larvae
Larvacea	Ascidacea
Cladocera	Echinodermata
Hydrozoa	Bryozoa
Thalliacea	Decapodes
Lamellibranchia	Chaetogntha

2.1.2. Information on invertebrate bottom fauna, macro-algae and angiosperms including species composition, biomass and annual/ seasonal variability

Macroalgae

Despite, there are no comprehensive studies on the marine vegetation of Libya, the available information indicate that the richness is not high. There are 15 genera (29 species) of Chlorophyta, 19 genera (34 species) of Phaeophyta, 76 genera (112 species) of Rhodophyta and 2 genera (3 species) in the Cyanophyta (Nizamuddin, 1979). According to a study of Godeh *et al*. (1992), which conducted at the east part of Libya (coasts of Tobruk and Ain Ghazala) the findings are Forty six marine algal species were collected. Eighteen species of them were belonging to Chlorophyta, twelve species belonging to Phaeophyta and sixteen species belonging to Rhodophyta (Table 3).

Table 3

Number of algae in the east part of Libya (Tubruk and Ain alghazalha).

Marine algae	Tubruk	Ain alghazlaha
Green algae	14	09
Brown algae	11	01
Red algae	16	00

Halimeda sp. is found near the hill meadow in Ain-Al-Ghazala. It's also reported as introduced species.

The study of Godeh *et al*. (1992) mentioned that *Penicillus capitatus* is found in large numbers in Ain-Al-Ghazala. On the other hand, it is usually mentioned as a rare species in the Mediterranean.

Samples of benthic algae were collected in 2007 from Tripoli (Tajoura) coast, from different depth ranging from 5 to 30 m. The findings of this study are 47 species of algae where 14 of them are Chlorophyta, 9 species Ochrophyta and 23 Rhodophyta (SPA/RAC, 2010).

A study was conducted in Benghazi coasts, published in 2011, focused mainly on marine brown algae. A total of 37 species (19 genera), ten species of them were new records, belonging to Phaeophyceae were identified with clear dominancy of Cystoseira genera (8 species). The comparison with other previous studies of Benghazi coasts marine algae showed the progressive increase of the brown algal flora year after year than those recorded at 1979 only 7 and in 1992 the number was 25 (Godeh *et al*., 1992).

Sea grass

Two sea grass species *Posidonia oceanica* and *Cymodocea nodosa* are well studied in the Mediterranean Sea, The former is totally distributed along the coasts of Libya and the latter is partly found in different areas. Despite, there is no a comprehensive study on these species, a few studies have been carried out on these species in the Libyan coast, a study was conducted at the beginning of the last century in Farwa lagoon by Scordia (1937) mentioned in (Pergent and Pergent-Martini, 2000). Other scientific studies were conducted; one of them implemented by MBRC in 1970, and recently, two studies were conducted as a part of the Action Plan for the conservation of marine plants in the Mediterranean, a project adopted during the 11th meeting of the Barcelona convention's contracting parties in October 1999. The implementation of this project has been entrusted to the SPA/RAC. The first study was conducted in Farwa lagoon with the main findings; three macrophyte species predominate, namely the marine phanerogams *Cymodocea nodosa* and *Posidonia oceanica*, and the alga *Caulerpa prolifera*. On a more scientific note, the presence of a *Posidonia oceanica* population within this lagoon presenting characteristics unique for the Mediterranean warrants further study (Pergent and Pergent-Martini, 2000). The second study was carried out in the vicinity of Ain-Alghzala lagoon and revealed three main plant formations: the Cymodocea nodosa meadow that covers most of the bed of the lagoon, the Posidonia oceanica meadow that is present at the mouth of the lagoon and in open sea and the photophilous populations on rocks at the edges of the shore. However, *Halophila stipulacea* is reported in Ain-Al-Ghazala as introduced species from the Red sea. However, the species is extending south-west along the shorelines of the Mediterranean Sea.

Cephalopods

- A total of 24 species of the cephalopods were recorded in the Libyan coast (SPA/RAC, 2017), these species belong to 8 families and 3 orders (table 4). These are the findings of different surveys and studies which conducted along the Libyan coast. Most of these species are commercial with economic value in the Libyan markets. However, no integrated study about these species and the gap of knowledge is still existed.

Table 4.

Species of cephalopods recorded in Libya.

No.	Family	Species
1.		*Sepia elegans,* (Blainville, 1827)
2.	Sepiidae	*Sepia officinalis,* (Linnaeus, 1758)
3.		*Sepia orbignyana,* (Ferussac, 1826)

No.	Family	Species
4.	Sepiolidae	*Rossia macrosoma,* (Delle Chiaje, 1829)
5.		*Heteroteuthis sp,* (Gray, 1849)
6.		*Sepiola rondeleti,* (Leach, 1817)
7.		*Rondeletiola minor,* (Naef, 1912)
8.		*Sepietta oweniana,* (Orbigny, 1840)
9.	Loliginidae	*Loligo forbesi,* (Steenstrup, 1856)
10.		*Loligo vulgaris,* (Lamarck, 1798)
11.		*Alloteuthis ntedia,* (Linnaeus, 1758)
12.		*Alloteuthis subulata,* (Lamarck, 1798)
13.	Enoploetuthidae	*Abralia veranyi,* (Ruppell, 1844).
14.	Ommastrephidae	*Illex coindetii,* (Verany, 1839)
15.		*Todaropsis eblanae,* (Ball, 1841)
16.		*Todarodes sagittatus,* (Lamarck, 1798)
17.	Thysanoteuthidae	*Thysanoteuthis rhombus, (*Troschel, 1857)
18.	Octopodidae	*Octopus macropus, (Risso,* 1826)
19.		*Octopus vulgaris (Cuvier,* 1797)
20.		*Scaeurgus unicirrhus, (*Orbigng, 1840)
21.		*Pteroctopus tetracirrhus,* (Delle Chiaje, 1830)
22.		*Eledone cirrhosa,* (Lamarck, 1798)
23.		*Eledone moschata,* (Lamarck, 1798)
24.	Argonautidae	Argonauta argo, (Linnaeus, 1758).

Sponges

Despite, there are a very few studies on the sponges in Libya, commercial bath sponges are natural resources with high economic potential yet deserving accurate management of stocks (Milanese *et al*., 2008). Five species are well distributed in the Mediterranean (*Hippospongia communis*, *Spongia officinalis*, *S. lamella*, *S. mollissima*, *S. zimocca*) are currently under the threat due to the overfishing and spreading diseases. These species are included in the SPA & Biodiversity Protocol of the Barcelona Convention (Annex II) and in the Bern Convention (Appendix III), and their harvesting should be regulated or organized by some rules in the different countries. However, no efficient and coordinated trans-national sponge fishery strategy has been established (Milanese *et al*., 2008). A study has carried out at the area from Al-khomas to Misrata, observed many economic species *Spongia officinalis* and *Hippospngia communis* and other species like *Arcorina cerebum*, *Axinella* sp, *Petrosia* sp and *Calyx nicaensis* (Report 2009, MBRC; SPA/RAC, 2010).

Other Benthic animals

The coastal region of the Mediterranean is considered as a biological hotspot, with a richness of Marine Gastropods around 2000 species (Zenetos *et al*., 2002; Bazairi *et al*., 2010). Habitat diversity along the Libyan coast line reflects the diversity of benthic animals, especially the intertidal zone and the continental shelf that occupied by marine molluscs (Abushaala *et al*., 2014), as well as, the existence of Lagoon ecosystems which are the common feature at the Mediterranean southern coasts.

Indeed, the Libyan coast includes four large coastal lagoon systems: Farwa in the west, and Ain zzyana, Khalige Al-Bomba lagoon and Ain Al-Ghazalah in the eastern region. The recent recorded number of Molluscs in the western part of Libya is 36; Gastropods 25, Bivalvia 10 and one species of polyplacophora (Abushaala *et al*., 2014). Two other studies were carried out in the eastern part of Libya, the first was in Albrega by Héra and Haris (2015), and they reported a total of 12 Gastropods species including three new records and 28 Bivalvia species including three new recorded species. The second study was in Ain Azzyana lagoon 10 km north to Benghazi city. This study recorded 15 species of gastropods and three species of bivalves (Amer and El-Toumi, 2018). The more recent study conducted by Bek-Benghazi *et al*. (2020) along the Libyan coast on marine Mollusca species, was based on published articles, technical reports, grey literature and unpublished data that collected during the study period. It reported a total of 343 Mollusca species (187 Gastropods, 119 Bivalvs, 27 Cephalopods, 5 Polyplacophora and 5 Scaphopods.

In term of Crustaceans, the study of Abushaala *et al.* (2014) in the western coasts of Libya, recorded a total of 37 species, where six species are Isopods, 23 species of Decapoda, Amphipoda seven species and one species of Balanomorpha. The study of Amer and El-Toumi (2018) in the eastern part of the country, documented eight species of Crustaceans, three species of Ostracoda, two spesies of Isopoda and three species of Amphipoda.

2.1.3. Information on vertebrates other than fish Marine Mammals presence and status in Libya

Biodiversity-Marine mammals

As reported in the National monitoring program for Biodiversity in Libya and National document of Libya aiming at the identification of important ecosystem properties and assessment of ecological status and pressures on Mediterranean marine and coastal biodiversity in Libya, the studies and literature concerning marine mammals are very limited (table 5). So far, only two published papers (Bearzi, 2008: Boisseau *et al.* 2010) on cetaceans. Bearzi (2006), according to the information mentioned collected from the fishermen; dolphins are abundant and increased in numbers. The species of cetaceans that are existed in the Libyan waters including:

- Bottlenose dolphin (*Tursiops truncatus*)
- Common dolphin (*Delphinus delphis*)
- Striped dolphin (*Stenella coeruleoalba*)
- Risso's dolphin (*Grampus griseus*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Sperm whale (*Physeter macrocephalus*)
- Fin whale (*Balaenoptera physalus*).

In addition to these publications, there are other sources that provide information about the cetaceans such as the Mediterranean Database on Cetaceans Stranding (www.medaces.uv.es). However, there are no comprehensive studies and monitoring activities focused on Cetaceans and marine mammals in general in Libya. So far, there are only

two published studies on Cetaceans in Libya (Bearzi, 2006; IFAW, 2007) and a few reports on Pinnipeads published by the Regional Activity Centre for Specially Protected Areas (SPA/RAC).

Table. 5.
Sightings of cetaceans in Libya.

	Species	Sightings in Libya	Source
1.	Fin Whale *(B. Physalus)*	Confirmed stranding records in December 2007 in Tubruk and February 2008 in Sirt. In the 2nd of August 2020 with a length of 13 m.	Notarbartolo di Sciara *et al.,* 2003
2.	Pilot Whale *(G. melas)*	Three animals Stranded in June 2001 off Derna city and one Carcass in the beach of Sousa	
3.	Bottlenose Dolphin *(T. truncates)*	- Tripoli harbour - Benghazi Harbour and frequent sightings along the coast of Cyrenaica.	- Bearzi, 2006 - Benamer, personal communication
4.	Risso's Dolphin *(G. griseus)*	Common in the Mediteranean	Notarbartolo di Sciara *et al.,* 2002
5.	Sperm Whale *(P. macrocephalus or P. catodon)*	- Deep waters between Crete, Egypt and Cyrenaica - One stranded in 1983 West to Benghazi (near Zwaiteena).	Frantzis *et al.,* 1999; IFAW, 2007; Gannier *et al.,* 2002
6.	Striped dolphin *(S. coeruleoalba)*	- Few sightings in the Libyan waters east to Benghazi	- IFAW, 2007
7.	Rough toothed dolphin *(Steno bredanensis)*	In the offshore area west to Sousa	IFAW, 2007

For the other marine mammals, in particular the monk seal (Monachus monachus) a critically endangered species, there are historic information that emphasize the presence of some colonies in Cyrenaica during the 1970s (Norris, 1972; Sergeant *et al.,* 1978; UNEP 2003). Until 2011, there was no information about this species, but a female monk seal was caught by a fishing net in the area ajacent to Ain Al-Gazalah MPA (Alfaghi *et al*, 2013). However, a study was carried out between EGA, SPA/RAC-MAP/UNEP and ICRAM in the late spring of 2002 with the purpose of identifying potential "hotspots" for the presence of the Mediterranean monk seal in the Cyrenaica coastal region (Hamza *et al.,* 2003).

Marine turtles

Along the Libyan coast, three species of sea turtles are reported; Green turtle *Chelonia mydas*, Leatherback turtle *Dermochelys coriacea,* which are irregular and rarely observed, and Loggerhead turtle *Caretta caretta,* which is the only nesting species that well studied at Libyan coast (Schleich, 1987; Laurent *et al*., 1997; 1999). The nesting activity of this species has been documented in the literatures since the 1980s (Armsby, 1980). The scientific studies specific for this species are began in the mid-90s with national surveys of nesting sites. EGA and MBRC with a support from SPA/RAC started a national survey aimed to investigating the nesting and existing 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 resulted in 44.8% loss of eggs. In 1996, Phase 2 targeted the area between Sirte and Misratah, recorded 66 crawl tracks. The last phase of the project was in 1998, found 15 crawl tracks of nesting loggerhead females and reported that this particular part of Libya practices a tradition of turtle egg consumption. Moreover, recent studies also reported that the levels of turtle bycatch by fishermen nets and other fishing gear are also another threat for Mediterranean turtles (*www.medasset.org/07.2020*).

In 2005, Environment General Authority (EGA) launched an initiative to implement the national action plan for the conservation of sea turtles and their habitat, the *Libyan Sea Turtle Program (LibSTP)* aimed to study, protect and to raise awareness on sea turtles in Libya. Moreover, the program trains enthusiasts and students to voluntarily survey and protect nesting beaches of sea turtles. Surveys in 2005-2008 reported that nesting is mainly concentrated in four 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 2005 survey showed that 73 nests were protected on 3 beaches west to Sirte and more than 3000 hatchlings were successfully released. In 28 beaches along the Libyan coastline, a total of 550 and 841 nests were recorded in 2006 and 2007 respectively. In the season of 2009, 358 nests were recorded in five nesting sites in the region of Sirt. The monitoring program emphasize that the Gulf of Sirt is the most important area for sea turtle breeding and feeding. Surveys conducted twice a week from May 20th till September 30th. Initial results indicated that the whole sandy beaches within the Gulf of Sirt are very important areas for loggerhead sea turtles nesting.

Then, a regular monitoring program started with a supervision of EGA and support from SPA/RAC which continued until 2020. The program was including training courses for EGA staff and other interested NGO's, this resulted in many teams working in different sites during the nesting season of Loggerhead turtles under the supervision of the national coordinator. A recent study of Loggerhead turtles was carried out in two sites west to Tobruk (Al-Qurdaba and Umm-Alfraes) reported a total of 21 nests with about 40 tracks (Aldoushy *et al*., 2020).

Aquatic birds

Comparing to the neighboring countries, Libya, with its dry climate, seems as having few wetlands and waterbirds. It is also, in term of Ornithology, the least known country of Mediterranean Africa (Smart *et al*., 2006). In a preliminary description of the birds of Libya, Bundy (1976) presents little information as a check list about Libyan birds. Wetlands International (2002) reported that Libya has never contributed to the International Waterbird Census (IWC), and that the only data available are from a few expeditions. There were few papers on Libyan ornithology in general, or on waterbirds in particular. Of these, Meininger *et al.,* (1994) reported the important nesting colonies of Lesser Crested Tern *Thalasseus bengalensis*. Etayeb (2002) recorded the aquatic birds in the farthest western part of the country (Farwa) as a part of MSc. Degree. Defos du Rau *et al.,* (2003) documented the birds observed during a survey of coastal areas in April 2001. A paper by Gaskell (2005) reported valuable new information on the status and distribution of some Libyan birds in 2004 and 2005.

There has been increasing of interest in Libyan wetlands over the last two decades. In 1995 the UNEP Mediterranean Action Plan (MAP), which brings together 21 countries round the Mediterranean, including Libya, within the framework of the Barcelona Convention ("Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean"), adopted a 'Protocol concerning Specially Protected Areas (SPA) and Biological Diversity in the Mediterranean'. Annex II of the Protocol includes a 'List of Endangered or Threatened Species', including 15 waterbirds, for which a Bird Action Plan has been developed (UNEP MAP and SPA/RAC 2003). Moreover, in 2000 Libya became a contracting party to the Ramsar Convention. In 2005 Libya joined the African- Eurasian Waterbird Agreement (AEWA). In January 2005, the Environment General Authority (EGA) co-sponsored the first ornithological survey of wetlands in Libya, under a Memorandum of Agreement with the SPA/RAC and AEWA, and with support from Wetlands International, the Instituto Nazionale per la Fauna Selvetica (INFS) (Italy) and the Office National de la Chasse et de la Faune Sauvage (ONCFS-France). The survey was carried with a general aim to fill the gaps in knowledge of wintering waterbirds in Libya, and objectives: 1) to search for Slender-billed Curlew, a Critically Endangered species, 2) to investigate the status in Libya of the other 14 species in the SPA/RAC Bird Action Plan, 3) to carry out the first comprehensive midwinter waterbird census in Libya, and 4) to identify wetlands of major importance for wintering waterbirds (Smart *et al*., 2006). A repeat surveys were carried out in January 2006 until 2010; these resulted in the publishing of the Atlas of Wintering Waterbirds of Libya 2005–2010 (EGA-SPA/RAC, 2012). Then, the wintering census continued for the years after 2010 till 2020. The results of the census of wintering waterbirds in Libya for the years 2011 and 2012 have been published (Bourass *et al*., 2013; Etayeb *et al*., 2015). Since 2013, the number of covered sites has been decreased (fig. 1) due to the general security situation, conflicts and wars in some regions in the country. These affected the January census and general results about the number of species and individuals (fig. 2, 3).

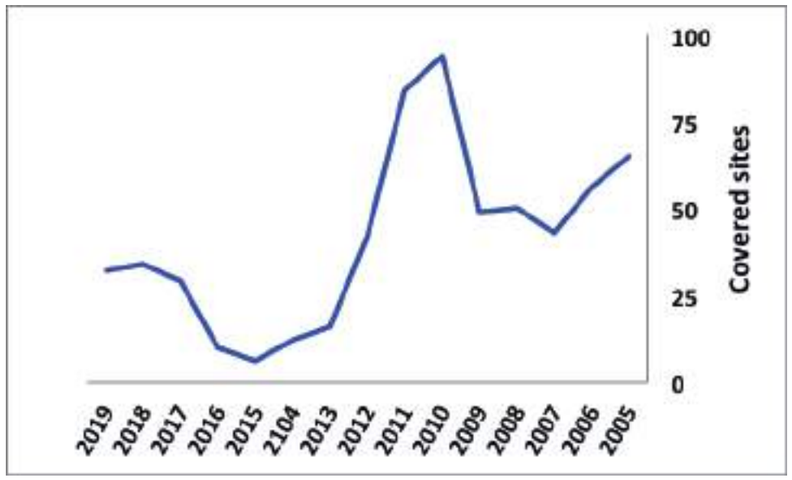

Fig. 1.
Number of covered sites during the wintering census of waterbirds in Libya.

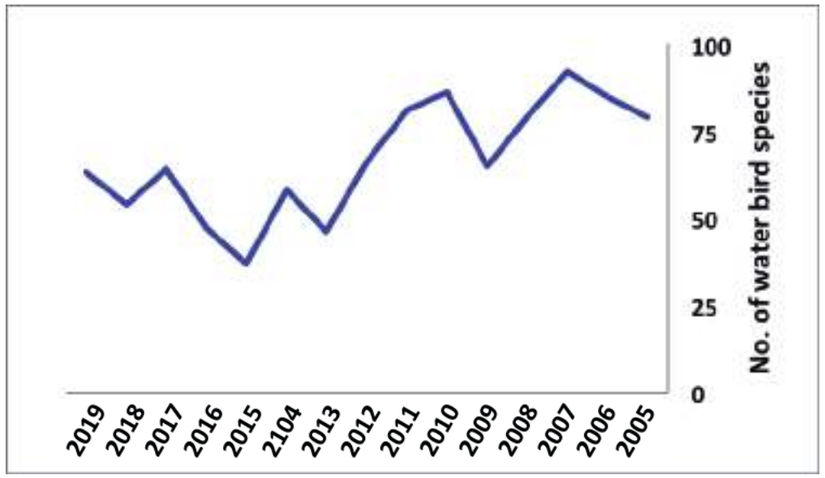

Fig. 2.
The fluctuation of the number of waterbirds.

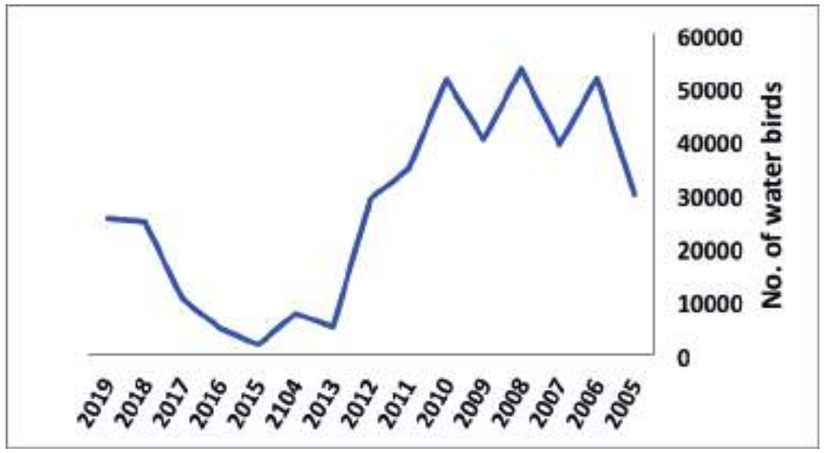

Fig. 3.
The number of waterbirds through the years of IWC.

Breeding Seabirds in Libya

Many studies have documented the breeding of seabirds in different sites along the coastline of Libya (Meininger *et al*., 1994; Azafzaf *et al*., 2006; Etayeb and Essghaier, 2007; Hamza, 2014). The seabirds species breed in Libya are:

1 _ Lesser Crested Tern *Thalasseus bengalesnis*

2 _ Common Tern *Sterna hisundo*

3 _ Little Tern *Sterna albifrons.*

4 _ Caspian Tern *Hydroprogne caspia* (single record)

5 _ Yellow-legged Gull *Larus cachinananus michahellis*

6 _ European Shag *Phalacrocorax aristotelis desmarestii*

In addition to the Kentish plover *Charadrius alexandrines* listed in the annex II, SPA/RAC-MAP/UNEP. The confirmed breeding grounds of these species are listed in table 6.

Table 6.
Nesting sites of Sea birds in Libya

Site Name	Coordinates	Remarks	Species
Farwa area	33°07'28.6"N 11°41'25.0"E 33°06'58.3"N 11°37'49.7"E	Farwa Island Al-Qetaya Islet	Little tern & Kentish plover Little tern & Common tern
Zuwaytinah	30°47'28.0"N 19°54'08.8"E	Al-Ghara Island	Lesser crested tern &Yellow legged gull
Ain EL Ghazala	32°13'58.5"N 23°16'35.5"E 32°22'28.8"N 23°14'04.0"E	Al-Elba Island Al-Bardáa Island	Lesser crested tern &Yellow legged gull Lesser crested tern & Shag &Yellow legged gull

Other seabirds are wintering in Libya have been reported during the IWC (2005-2020; table 7)

Table 7.
Seabirds species recorded in Libya

	Common name	Scientific name
1	Yelkouan Shearwater	*Puffinus yelkouan*
2	Gannet	*Morus bassanus*
3	Cormorant	*Phalacrocorax carbo*
4	Shag	*Phalacrocorax aristotelis*
5	Osprey	*Pandion haliaetus*
6	Great Skua	*Stercorarius skua*
7	Pomarine Skua	*Stercorarius pomarinus*
8	Slender-billed Gull	*Chroicocephalus genei*
9	Black-headed Gull	*Chroicocephalus ridibundus*
10	Little Gull	*Hydrocoloeus minutes*
11	Mediterranean Gull	*Larus melanocephalus*
12	Audouin's Gull	*Larus audouinii*
13	Herring Gull	*Larus argentatus*
14	Pallas's Gull	*Larus ichthyaetus*
15	Common Gull	*Larus canus*
16	Lesser Black-backed Gull	*Larus fuscus*
17	Yellow-legged/Caspian Gull	*Larus michahellis / cachinnans*
18	Caspian Tern	*Hydroprogne caspia*
19	Sandwich Tern	*Sterna sandvicensis*
20	Lesser Crested Tern	*Thalasseus bengalensis*

Seabirds were well documented during the IWC (2005-2020). The number of species ranged from 7 – 20, the minimum was 07 in 2015 and the maximum of 20 was in 2007. The total number of individuals also varied between 598 to 36,000 (Table 8).

Table 8.
Total numbers of sea birds species and individuals depend on IWC (2005 – 2020).

Year	No. of species	No. of individuals
2005	18	20,938
2006	18	36,029
2007	20	24,789
2008	18	35,017
2009	13	24,134
2010	16	33594
2011	16	17753
2012	12	19493
2013	13	3640
2014	11	1973
2015	7	598
2016	9	3503
2017	14	8138
2018	9	12793
2019	10	13622
2020	9	9438

2.1.4. Inventory of the temporal occurrence, abundance and spatial distribution of exotic, non-indigenous and invasive species

The attention about exotic, non-indigenous and invasive species has been increased during the last two decades. Many studies addressed the phenomena of invasion and alien species (Ruiz *et al*., 1999; Ben-Abdallah *el al*., 2005; Occhipinti-Ambrogi, 2007;

Bazairi *et al*., 2013). Invasive Alien Species are considered as a major cause of biodiversity loss across the world, not only affecting nature but also economy, food security and human health. However, Invasive alien species have therefore been prioritized as a key issue to discuss in international environmental policy, including Objective 2 of the Mediterranean Strategy for Sustainable Development 2016-2025 and Target 15.8 of the Sustainable Development Goals (SDGs). Both call for the prioritization of exotic, non-indigenous and invasive species for prevention or control to stop loss of native biodiversity (*www.iucn.org*). The exotic, non-indigenous and invasive species are well documented in the Libyan waters, many national and international researchers paid more attention about the alien species in Libya (e.g. Ben abdalaha *et al*., 2005; Shakman *et al*., 2008; Bazairi *et al*., 2013; Shakman *et al*., 2017, 2019). Moreover, the number of exotic species has increased from seven in 1970s up to 73 in 2020s (fig. 4). In the Libyan coast 24 exotic fish species have been recorded. The recent observations of marine alien species are due to the well collaboration between the researchers and the fishermen as a step for effective monitoring program on invasive species. This collaboration resulted in many publications about new records of exotic species such as; Rizgalla *et al*., (2019a; 2019b) recorded the invasive cockle *Fulvia fragilis* and the alien fissurellid *Diodora ruppellii* respectively. More recently, Rizgalla and Crocetta, (2020) reported a First record of *Phyllorhiza punctata* in Libyas, this species is a well-established alien species in the Mediterranean Sea.

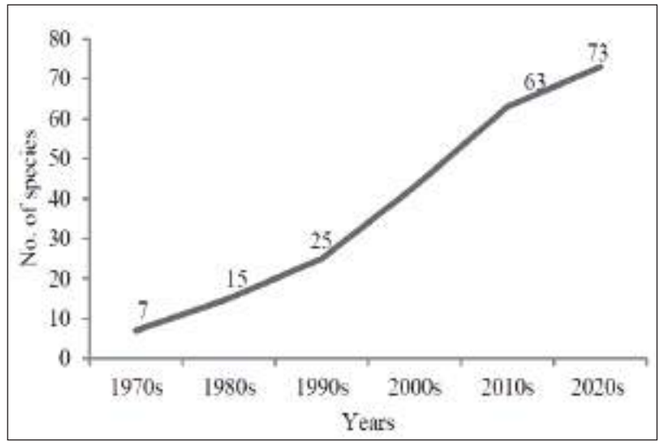

Fig. 4.
The increasing trend of alien marine species along the Libyan coast (Shakman *et al*., 2019).

2.1.5. Fishery and fishes in the coastal area of Libya

In term of landing sites, there are 131 sites along the Libyan coast, where 91 % are permanents and 8% are seasonal. However, three types of landing sites were observed; harbors (42.86%), protected bays (31.75%) and open beaches (25.4%) (shakman *et al*., 2014; SPA/RAC, 2017).

Fishing vessels

The number of boats has increased since the study of Lamboeuf (2000) from 1866 to 3687 which is reported by Shakman *et al.* (2014), with different numbers among the regions (table 9). The last study showed that 70.06% of the Libyan fishing vessels are Flukas, 18.14% are Mators, 3.28% for Lampara, 0.41% are Tarrad, 0.16% are Gayag, 5.97% Daghysa and 1.98% are Batah boats (Fig. 5). The majority of Libyan fishing vessels is concentrated in the western part of the Libya. Moreover, flouka and Lampara are used for catching small pelagic fish in the coastal areas; and more concentrated in the western part with a few of them in the Gulf of Sirt almost in Musrata. Batah, is a kind of boats that concentrated and used in the shallow waters and commonly found in the western region (Farwa area), but a small number can be found in the eastern region at Attimimi and Ain-Alghazala (Shakman and Kinzelbach, 2007b).

Table 9.
Number and percentage of fishing vessels along the Libyan coast (2005)

Region	East	Middle	West	Total	Source
Number & persentage	415 (22%)	422 (23%)	1029 (55%)	1866	Lamboeuf, 2000
	308 (20.4%)	317 (20.98%)	886 (58.6%)	1511	Shakman and Kinzelbach, 2007b
	705 (19.12%)	582 (15.79%)	2400 (65.09%)	3687	Shakmann *et al*., 2014

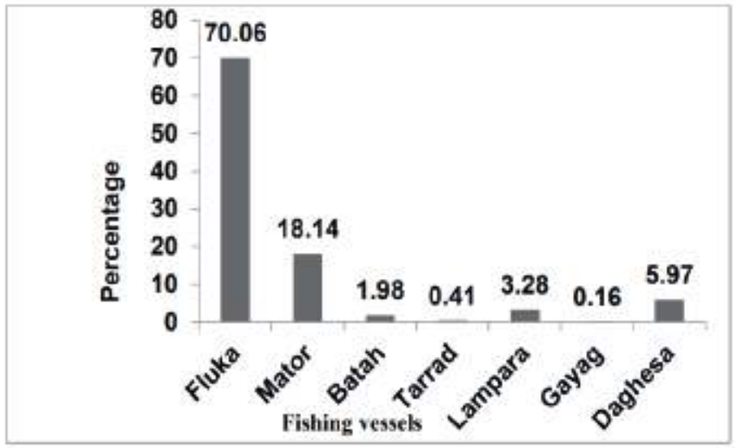

Fig. 5.
Fishing vessels used in the coastal area along the coast of Libya (Shakman *et al*., 2014).

The common used fishing gears in the coastal area are trammel nets. From one to fifty meters depth they are used by flouka, whilst in depths of more than fifty meters they are operated by mators. Trammel nets can be also used by batah in depth of up to 5 meters. Other fishing gear for instance (long line, gill nets etc.) can be used also by Flouka (Shakman *et al*., 2014).

Fish species composition

The highest diversity of fishes along the Libyan coast is in the eastern region (45.65%). While in the Gulf of Sirt, fishes represent 23.91% and 30.43% is the percentage of fishe diversity in the western region of Libya. However, the catch composition suggested that sardines represent 24% of total catches, where round sardinella in particular (*Sardinella aurita*, 20% itself), this species is the most common in Libyan catches, followed by porgies and seabreams (Sparidae, 13%), horse and jack mackerels (Carangidae, mostly*Trachurus* spp. 12%), and goatfishes (Mullidae, 7%) (Figure 2b). Spinefoots (Siganidae, 6.8%), European anchovy (*Engraulis encrasicolus,* 3.5%) and chub mackerel (*Scomber japonicus,* 3.3%) (Khalafallah *et al.*, 2015).

In Gulf of Sirt (the middle region), a total of 21 fish species were reported; the highest percentage of native fish species was 17.11% for Annular Seabream *D. annularis* (Sparidae) and 4.56% was the lowest for Saddled Bream *Oblada melanura* (Sparidae). Furthermore, the highest percentage of exotic fish species was 36.82% for Dusky Spine-foot *S. luridus* (Siganidae) and the lowest percentage was 0.07% for Blue-spotted Cornetfish *F. commersonii* (Fistularidae) (SPA/RAC, 2010).

A total of 28 fish species were found in the western region of Libya. The percentage of Annular Seabream *Diplodus annularis* (Sparidae) was the highest among the native fish species (10.74%) and the lowest was 0.16% for Red Sea Bream *Pagellus bogaraveo* (Sparidae); whilst the highest percentage of exotic fish species was 40.06% for the Dusky Spine-foot *S. luridus* (Siganidae) and 0.03% for Blue-spotted Cornetfish *Fistularia commersonii* (Fistularidae) (Shakman and Kinzelbach, 2007a; SPA/RAC, 2010).

Chondrichthyan in the Libyan coast

Since 1977 the number of cartilaginous fish species was 39 (Contransimex, 1977). A report of SPA/RAC (2010) about the identification of important ecosystem properties and assessment of ecological status and pressures to Mediterranean marine and coastal biodiversity in Libya has documented a total of 55 species of Chondrichthyes (table 10). During the last decade, with more marine researches and activities almost not targeted the Chondrichthyans, the number reached a total of 58 species belong to 22 families of Chondrichthyans were recorded along the Libyan coast (Fig. 6). The majority of these species are distributed in the eastern region (SPA/RAC, 2017). Recently, Taboni *et al*., (2015) recorded the existence of tiger shark, *Galeocerdo cuvier,* where male and female accidentally caught by a drifting longline for swordfish in Libyan coast.

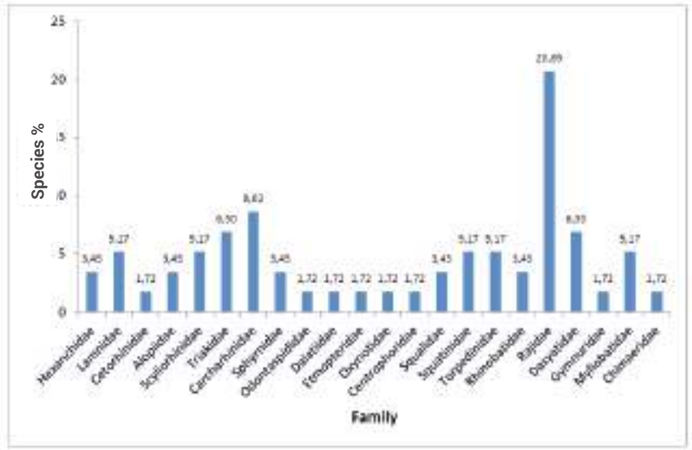

Fig. 6.
Chondrichthyan in the Libyan coast (SPA/RAC, 2017).

Table 10.
Chondrichthyan fishes in the Libyan coast (SPA/RAC, 2010).

Scientific name	Common name	Local name
Heptranchias perlo *	Sharpnose sevengill shark	Kalb busaba
Hexanchus griseus	Bluntnose sixgill shark	Kalb buseta
Squalus acanthias *	Piked dogfish	Kalb bushoka
Squalus blainvillei	Longnose spurdog	Kalb bushoka
Centrophorus granulosus *	gulper shark	Bushoka melian
Centrophorus lusitanicus	Lawfin gulpershark	Bushoka melian
Oxynotus centrina	Angular roughshark	Hamar
Dalatias licha	Kitefin shark	Kalb fond
Squatina aculeate	Sawback angelshark	Safan ahrish
Squatina oculata	Smoothback angelshark	Safan
Squatina squatina	Angel shark	Safan
Alopias vulpinus *	Thresher shark	Thaleb
Cetorhinus maximus	Basking shark	Douda
Carcharodon carcharias	Great whit shark	Girsh abiad
Isurus oxyrinchus	Shortfin mako	Zurgaya
Lamna nasus	Porbeagle	Zurgaya
Scyliorhinus canicula	Smallspotted catshark	Ghatat
Scyliorhinus stellaris	Nursehound	Ghatat
Galeus melastomus	Blackmoth catshark	Kalb
Galeorhinus galeus	Tope shark	Kalb
Mustelus asterias	Starry smoothhound	Matsola menagata
Mustelus mustelus	Smoothhound	Matsola
Mustelus punctulatus *	Blackspotted smoothhound	Matsola mubagaa
Carcharhinus brevipinna	Spinner shark	Borisha
Carcharhinus limbatus	Blacktip shark	Borisha
Carcharhinus plumbeus	Sandbar shark	Boderwa
Prionace glauca *	Blue shark	Zurgaya twila

Scientific name	Common name	Local name
Sphyrna lewini	Scalloped hammerhead	Aina figarna
Sphyrna zygaena	Smooth hammerhead	Aina figarna
Rhinobatos cemiculus	Blackchin guitar fish	Mahrat ahrish
Rhinobatos rhinobatos	Common guitar fish	Mahrat
Torpedo marmorata	Marbled electric ray	Wazwaza
Torpedo nobiliana	Electric ray	Wazwaza
Torpedo torpedo	Common torpedo	Wazwaza menagata
Dipturus batis	Skate	Meseha
Dipturus oxyrinchus	Longnosed skate	Meseha
Leucoraja fullonica	Shagreen ray	Meseha
Leucoraja melitensis	Maltese ray	Meseha
Leucoraja naevus	Cuckoo ray	Meseha
Raja asterias	Starry ray	Meseha
Raja clavata	Thorn back ray	Meseha
Raja miraletus	Brown ray	Meseha
Raja montagui	Spotted ray	Meseha
Raja polystigma	Speckled ray	Meseha
Raja radula	Rough ray	Meseha
Rostroraja alba	White skate	Meseha
Dasyatis centroura	Rough tail sting ray	Bogra
Dasyatis pastinaca	Common sting ray	Bogra
Dasyatis tortonesei	Tortoneseis ray	Bogra
Pteroplatytrygon violacea	Blue sting ray	Bogra kahla
Taeniura grabata	Round sting ray	Bogra
Gymnura altavela	Spiny butterfly ray	Raya
Myliobatis Aquila	Common eagle ray	Far
Pteromylaeus bovines	Bull ray	Far
Chimaera monstrosa	Rabbit fish	Ghontcha

* = Species are included in annex 3 to the SPA/BD Protocol.

2.2. Habitat types

Libya has the second largest continental shelf, of about 65,000 km2, and some of the richest fishing grounds in the Mediterranean (Khalafallah *et al*., 2015), and a long coast which extends to 2000 km (Fig. 7). According to the topography of the continental shelf, it is divided into three main regions:

East region: Covers about 600km from Dersia to Egyptian border (21º.20` E, 32º.47` N, 25º.10` E, 35 º.35` N). The habitat constituted mostly of a rocky coast, including rocky shores, sandy seabed's, shallow and deep-water (200 m+) with many bays, and submerged caves. This region has several wetlands namely Ain Al-Ghazala which is a part of MPA, Ain AL-Zeana, Ain Al-Zargha and Ain Alshagegh. Moreover, there are many estuaries such as; Wadi Al Hamsa, Wadi Al Khalij and Al Burdi, these areas are well known sites for many endangered species (sea turtles and birds) (SPA/RAC, 2017).

Middle region (Sirt gulf): The extended area from Misrata to Dersia (15º.05`- 21 º.20` E, and 31 º15 - 32º.47` N), with a total distance of 920 km, and the width of the gulf is 250km, and the continental shelf is quit wide. The area contains many sobkhas such as; Sultan 70 km. east to Sirt and Alhisha west to Sirt 160 km. The coastline is sandy, and characterized by some lagoons such as; Ain-Ezzayyana, Abu-Dreza. This region is considered as important habitat for different endangered elasmobranches species and sea turtles (SPA/RAC, 2010; 2017).

Western region: The area which extended from Tunisian border to Misrata (11º.33` E, 32 º.50`N to 15 º.05`E) with a distance of about 390 km, about 70% of this coast is sandy habitat and the rest are marshy areas, rocky beaches and headlands. The western region is characterized by a wide continental shelf making this area the best fishing region in the Mediterranean (SPA/RAC, 2017).

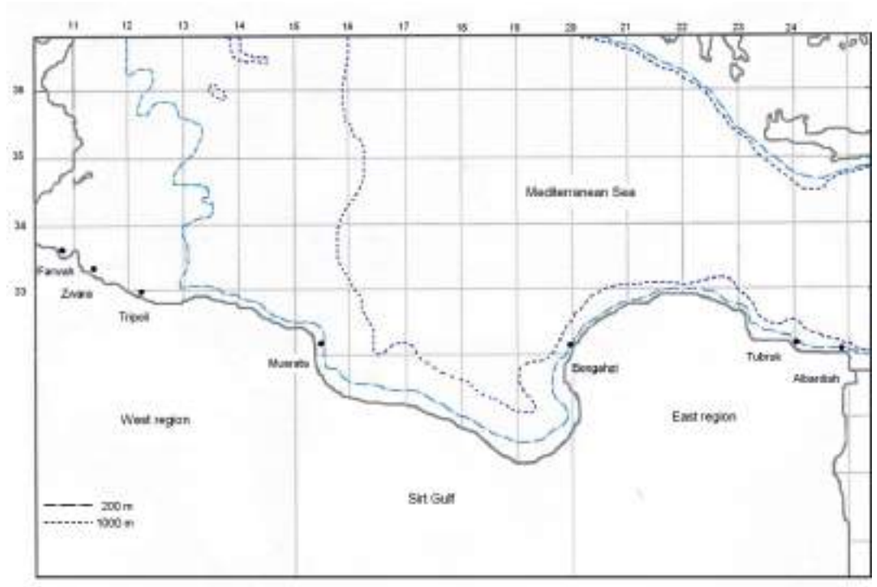

Fig. 7.
The Libyan coastline (SPA/RAC, 2010).

Bays and coastal lagoons

The Libyan coastline is characterized by many bays and coastal lagoons. Most of them are existed in the eastern region.

Al-Burdi Bay: located east to Tubruk 150 km. toward the Egyptian borders (Fig. 8), it is connected from the south with two valleys. The site is important for many aquatic birds such as Cormorant and Herons, as well as for many families of fishes such as Mugilidae, Blennidae and Gobidae.

Fig. 8.
Photo of Al-Burdi, © Etayeb.

Tubruk bay: The largest natural bay in the coastline of Libya, located in Tubruk city (fig. 9). The dept is ranged between 0.5 to 3 m. The site is utilized as a harbour for the region even for the oil. This site is suffered from ballast water and also sewage due to marine shipping activities. However, different family of fish such as Mugilidae, Siganidae, and also macroalgae like *Ulva spp*. are present in the area.

Fig. 9.
Tubruk bay

Ain-Alghazala Bay: Ain El-Ghazala is located at 32° 09,171 N 23°19,744 E, 60km west of Tobruk (Fig. 10). The area is characterized by a lagoon which covers 180ha with an average depth of 2m (maximum depth of 4.2m), with inflow of fresh water from springs. Shores are covered by sparse salt marsh vegetation (Azafzaf *et al*., 2005). In January 2011 Ain Al-Ghazala bay was officially declared as marine protected area (MPA). Moreover, the bottom is dominated by two sea grasses, *Posidonia oceanica* and *Cymodocea nodosa*, it is an interesting site for different species of aquatic birds and the Island at the opening of the lagoon (Al- Elba) is known as breeding ground for Lesser crested tern. Different family of fishes such as; Mugilidae, Blennidae, Gobidae are existed. In 2012, the borders of the MBA were enlarged to include a large part of the Bomba Gulf (decision no: 199 of 04/07/2012) (Etayeb and Ali, 2013).

Al-Bomba Bay: Situated about 65 km east to Darnah City (fig. 10), characterized by shallow water with a depth ranged between one to three meters. It is surrounded from the west and south by salt marshes. The gulf is rich by macroalgae, particularly *Valonia sp*., with patchy distribution of *Posidonia oceanica*, benthic invertebrates and fish fingerlings (especially sea bream and sea bass). The area utilized by a limited number of local fishermen, and being shallow, the bay is best suited to remain a recreation area.

Fig. 10.
Ain Al-Ghazala and Al-Bomba

Ain Zayanah Lagoon: located at latitude 320 06′ N and longitude at 200 05′ E (Fig. 11) is a brackish water lagoon situated about 15Km north-east of Benghazi, covering an area of 50 ha with an average depth of 2 m, and 5 Km long and some hundred meter width, It is connected to the sea by a canal (Khalafalla *et al*., 2015). The lagoon is supplied by water from springs, and the overall salinity of the lagoon varies between 18 to 22 ‰ in summer and 15 to 34‰ in spring. The bottom is mainly salty lime with very abundant *Cerastoderma sp*. bivalves.

Fig. 11.
Ain Zayanah Lagoon

Farwa Lagoon: Farwa Lagoon and Island is situated in the north-west of Libyan coast (11°54'45"E, 33°05'33"N) 150 km. west to Tripoli at the border area between Libya and Tunisia (fig. 12). The lagoon covers a surface area of 31 km² (13 km long and 2.5 km wide on average). Its depth varies from 0.5 to 2.5 m, with a depth of 6 m in the central channel; tidal area is about 40 cm, large, on average (sand and mudflats). The lagoon is separated from the sea by Farwa Island (sand bar), an elongated sand bar extending from east to west for 11km and which is 0.5–1km wide (Azafzaf *et al.*, 2005; Etayeb and Essghaier, 2007). There is a blocked opening at the eastern end of the sand bar; it was replaced by an artificial opening in 1995 about 3 km west to the natural one. As a result, the eastern region of the lagoon is characterized by shallow depths and a high degree of confinement. The rest of the Lagoon is dominated by three benthic macrophyte species, namely the marine phanerogams *Cymodocea nodosa, Posidonia oceanica* and the alga *Caulerpa prolifera* (Pergent and Pergent-Martini, 2000). At the far western part of the Island there are accumulations of Posidonia and other sea grass which appears in large area during low tide. This area called Ras-Attalgha, is one of the most important roosting sites for marine birds.

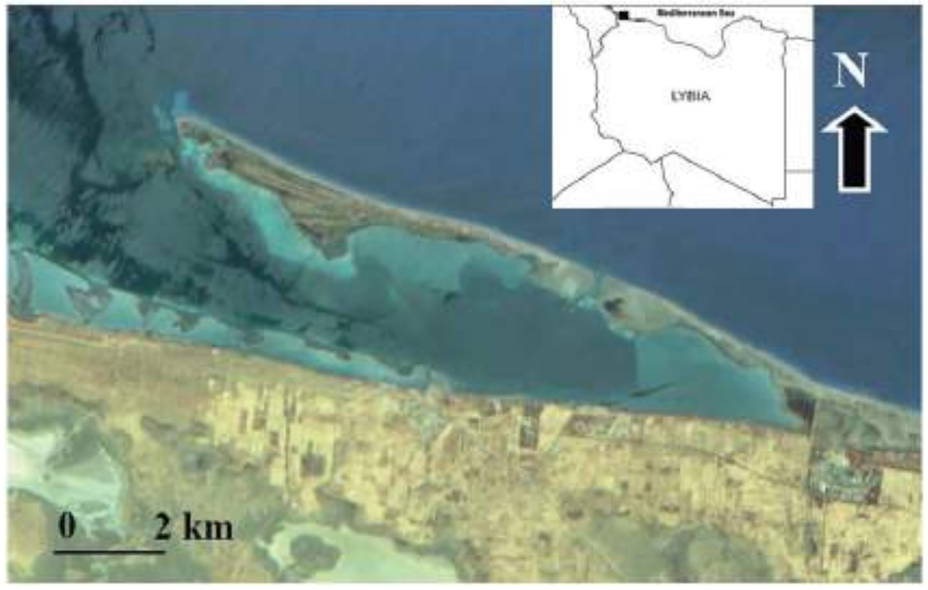

Fig. 12.
Farwa lagoon and Island.

2.3. Identification of the country's marine and coastal biodiversity gaps needed for scientifically sound based conservation

Libya has a long coastline and vast areas of beaches, this coast is characterized by many habitats and ecosystems, each habitat has own characteristics and diversity, which requires studying each environment separately. During the last decade, the study of marine environment has flourished through many researches by national and international researchers. Among the most important points was the issue of financial support. However, the National Authority for Scientific Researches devoted efforts to support researches in different fields, including the ecological studies, which of course aim to conserving the nature and natural resources. On the other hand, there have been studies and research supported by international institutions and organizations, for example the WWF and the UNEP/MAP-SPA/RAC where many studies have been conducted on the marine environment and its biodiversity components. But these studies were in specific areas, it is true that they are important areas for biodiversity, but what about the rest of the areas along the Libyan coastline? Particularly, the Libyan coastline included many areas and distances that human activities have not reached or reduced. Those areas requires to be taken into account in order to study and collect what has been studied and update the old ones, because the marine and coastline ecosystems and their components are able to be changed with the changes that occur, for example: climate changes and Habitats destruction due to human activities and pollution, as well as the subject of alien species and the negative effects they cause on native species and ecosystems in the region.

Among the features of the Libyan coastline is the presence of many wetlands, which are considered as coastal habitats that support the marine environment, despite, many studies have been carried out on some of these areas, there is no integrated study on Libyan coastal wetlands. Moreover, wetlands are very important for the biodiversity of marine ecosystem and sea birds, thus the need for studying these ecosystems is necessary to protect their biodiversity, as well as, to fill the gap of knowledge scientifically and professionally. It is also required to carry out an integrated study on invasive species; on the other hand, native species must be studied to see how they are affected by the environmental changes that have occurred recently (climate change, pollution, invasive species and other different negative human activities). Furthermore, it is needed to establishing a comprehensive inventory of coastal and marine wetlands. One of the most important studies that should be focused on and which are still very poor in Libya, are the study of marine planktons (phyto and zooplanktons), and benthic fauna.

3.

Pressures and impacts

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The decline of marine and coastal biodiversity is often the result of many pressures, either singular or combined. These pressures are: the increasing presence of invasive and non-indigenous species, climate change, microbial pathogens and other environmental disturbances, including fishing pressure. The impacts on native species and habitats can be catastrophic: biological invasions of non-indigenous species are often associated with climate change and other environmental disturbances, for example: microbial diseases may come from invasive species, and their success can be due to climate change as well (UNEP-MAP and SPA/RAC, 2010).

3.1. Biological disturbance

The spread of alien species is a global phenomenon that has effects on most ecosystems. Although invasion biology is a well-investigated discipline, there are still gaps in knowledge that may prevent gaining a complete and realistic picture of the impact and scale of biological invasions (*Bonanno* and *Orlando-Bonaca, 2019).* Moreover, invasive species have been documented as the second most common cause of species extinctions (Bellard *et al.,* 2016) while their ecological impacts can disseminate along the food web and affect ecosystem functioning (Gallardo *et al.,* 2016). Non-indigenous species also often have important socio-economic and health impacts (Vilà and Hulme, 2018) and can cause important loss of ecosystem services (Walsh *et al.,* 2016). In the marine ecosystem, high environmental connectivity through the water increases the spread of species, this make the efforts to control biological invasions more difficult. The higher the dispersion capacity of the invader and the larger the invaded area, the more challenging it is to control the invader's population impacts can disseminate along the food webs and affect ecosystem functioning (Ojaveer *et al.,* 2015). Most studies, in fact, have investigated very few exotic species at local scale, while the long-term effects of invasive species are poorly known (Bonanno and Orlando-Bonaca, 2019). However, Port areas have been considered bio-invasion hotspots, alien species are frequently reported within harbors and marinas due to the concentration of several invasion vectors. Their translocation assisted via their attachment to the hulls of shipping vessels or within ballast water (Rizgalla *et al.,* 2019). However, the actual distribution of non-indigenous species (NIS) in Mediterranean ports is still poorly understood (Tempesti *et al.,* 2020).

The worldwide exchange of faunas is one of the most important impacts on the regional ecosystems. Particularly in fishes, starting with freshwater species, the identification of a part of the Eastern Mediterranean Sea as Lessepsian Sea basin was taken into consideration; with more and more Lessepsian species establishing populations in the eastern Mediterranean during the last decades. Parasite-host associations might be affected in some native and introduced species which will result in new combinations and might result in negative effects on the ecology of the concerned species, or create potential threats to local fisheries and fish farming or affecting the whole ecosystem (SPA/RAC, 2010).

The Libyan coast is about 2000 km long and is characterized by a wide continental shelf that encompasses various habitats and topography (Shakman *et al.* 2017). The geographic location of Libya, in the central and “warm” part of the Mediterranean Sea is

interesting as it can host tropical organisms arriving from the east (Indo-Pacific origin) or expanding from the west (Tropical Atlantic origin) (Shakman *et al.* 2017). A comprehensive study was conducted along the Libyan coast by Shakman *et al.,* (2008) on the status, biology and ecology of *Siganus luridus* and *S. Rivulatus*. This study suggested that there might be a competition between native (*Sarpa salpa* and *Sparisoma cretense*) and Lessepsian fish species (*Siganus luridus* and *S. rivulatus*) on the same resources. Furthermore, this indicates that the population of the native species *S. salpa* has declined dramatically during the last years. However, five fish species have become commercial in the Libyan market.

Although, there are many studies that confirm the effect of pathogenic microorganisms on the marine environment, these pathogens arrive from different sources (UNEP-MAP and SPA/RAC, 2010), one of the most important sources is sewage water, which the marine environment suffers from, as a result of the increasing population and urbanization. In Libya, during the last two decades, the increase of sewage discharges directly to the sea without treatment is notably. Although, there are no published studies or reports, but the matter is clear and evident by monitoring the sites of drainage and the associated organic materials that lead to an unusual growth of marine algae which called Harmful Algal Blooms (HABs), and increases the percentage of bacteria in the sea water. The latter will definitely lead to the presence of diseases in fish and benthic organisms nearby the sites of discharge. However, there are some unpublished studies, for example: a study was conducted in 2007 on the bacterial pollution of sea water caused by sewage in the area extending between Al Khums and Misrata (SPA/RAC, 2017). There is a study by Rizgalla (2016) on the health status of dusky grouper, *Epinephelus marginatus* in Libya; suggests that the cause of mortality of this species have mostly been attributed to Nodavirus infections.

Several studies have demonstrated that intensive fishing severely affects all levels of biological organization of marine life. The negative impacts of inappropriate fishing activities on marine biodiversity were recorded in the national reports of most of the Mediterranean countries. The results of MEDITS (International Bottom Trawl Survey in the Mediterranean), indicate that overexploitation has resulted in a serious decline in many fish stocks (Sogreah, 1977; UNEP-MAP and SPA/RAC, 2010).

Despite there is no published documentation of some fishing violation that occur in Libyan waters, as well as illegal fishing operations, the impact is evident through the decrease in the abundance of fishes in the market, as well as the opinions of professional fishermen that the fishes are decreased dramatically (personal interviews), and this happened during The last two decades with the development of hunting techniques and the use of prohibitions such as dynamite and chemicals (pesticides). Shakman *et al.* (2014) reported that 70% of landing sites in Libya using dynamite for fishing, this action drastically damaged the aquatic marine habitat.

3.2. Emerging issues

Climate changes are global phenomena that have negatively affected biological diversity in general and marine diversity in particular (UNEP-MAP and SPA/RAC, 2010). Regardless of the causes that led to their coming out and exacerbation, marine ecosystems and their components suffer significantly from its consequences. The biodiversity in the coastal area is affected by the phenomenon of red tides, and the abnormal bloom of plants, especially the planktons that leads to reduced oxygen in the water, causing fishes death. In Libya, this usually occurs at the end of spring and early summer particularly in the western part of Libya, and it moves with the currents to reach other regions. However, there is no a certain scientific explanation for how it occurs and spread, but the reason for its occurrence is likely to be due to the rise in temperatures.

Climate change is considered one of the most important factors that facilitated in the spread of invasive species, especially those coming from the Red Sea (lessepsian species). Moreover, the decrease or increase of pollution depending on the directions of currents, such as the pollution from Abu-Kammash petro-chemical compounds, which distributed in adjacent areas for example: the affect on sea grass and sea weeds in farwa lagoon. Moreover, the pollution due to water distillations compounds in different cities along the coastline of Libya, that affecting the physiological and behaviour of the marine species (SPA/RAC, 2010).

Climate changes, high sea water levels and associated currents have led to a deterioration in some coastal ecosystems, for example Farwa Island in the far west of Libya is suffering from erosion, reaching more than 10 meters during the last four years, beside that, the huge accumulation of dead Poseidonia in the western opening of the lagoon. Of course, this process is not only caused by climate change, but human interventions also play a major role in the phenomenon of erosion by changing some natural features of the Island and lagoon.

Other human activities affecting the marine and coastal ecosystems are the establishing of quarries, which lead to a degradation of the coastal environment, fish breeding grounds and larval growth. These activities can be found in the western part of the country. Furthermore, the dredging of beach sands and it's consequent deterioration on the coastal environment and its biodiversity, as well as the disturbance caused by dredging and transportation operations and its negative impact on seabirds (Etayeb *et al.,* 2015).

There is no doubt that all ecosystems are suffered from plastic pollution, especially the marine and coastal environment. The majority of marine litters are plastics, and its proportion consistently varies between 60% and 80% of the total marine debris (Gregory and Ryan, 1997). Plastic reach the marine environment when left behind by beachgoers, accidentally lost and carelessly handled. They also reach the sea as litters carried by rivers, valleys and drainage systems. Conversely, in coasts away from urban areas most of the litter is made up of fishing gears. The threats to marine life are mostly due to ingestion of plastic debris and tangle in packaging bands, ropes, lines and drift nets (Gregory and Ryan, 1997). Many species are suffered from plastic pollutants, which lead to their mortality, and there are many studies reported the presence of particles of plastic in the guts of some species of seabirds (e.g., Moser and Lee, 1992). There are also studies that have recorded the death of loggerhead sea turtles *(Caretta caretta)* in the Central Mediterranean as a result of ingesting white plastic bags white plastic (Gramentz, 1988). However, a floating plastic bag can look like a lot of jellyfish, algae, or other species that make up a large component of the sea turtles' diets.

There is also potential hazard to marine ecosystems due to the accumulation of plastic fragments on the sea floor. This can reduce the gas exchange between the surface waters and the pore waters of the sediments, resulted in hypoxia or anoxia in the benthos can affect on the normal ecosystem functioning, and alter the life nature on the sea floor (Goldberg, 1994).

4.

Current response measures

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4.1. Marine protected areas and other area based conservation measures

4.1.1. Al-El-Ghazala MPA

Ain El-Ghazala is located at 32° 09,171 N 23°19,744 E, 60km west of Tobruk (Fig. 10). The area is characterized by a lagoon which covers 180ha with an average depth of 2m (maximum depth of 4.2m), with inflow of fresh water from springs. Shores are covered by sparse salt marsh vegetation (Azafzaf *et al.,* 2005). In January 2011 Ain Al-Ghazala bay was officially declared as marine protected area (MPA). Moreover, the bottom is dominated by two sea grasses, *Posidonia oceanica* and *Cymodocea nodosa,* it is an interesting site for different species of aquatic birds and the Island at the opening of the lagoon (Al- Elba) is known as breeding ground for Lesser crested tern. Different family of fishes such as; Mugilidae, Blennidae, Gobidae are existed. In 2012, the borders of the MBA were enlarged to include a large part of the Bomba Gulf (decision no: 199 of 04/07/2012) (Etayeb and Ali, 2013).

4.1.2. Farwa Lagoon

Farwa Lagoon and Island is situated in the north-west of Libyan coast (11°54'45"E, 33°05'33"N) 150 km. west to Tripoli at the border area between Libya and Tunisia (fig. 12). The lagoon covers a surface area of 31 km² (13 km long and 2.5 km wide on average). Its depth varies from 0.5 to 2.5 m, with a depth of 6 m in the central channel; tidal area is about 40 cm, large, on average (sand and mudflats). The lagoon is separated from the sea by Farwa Island (sand bar), an elongated sand bar extending from east to west for 11km and which is 0.5–1km wide (Azafzaf *et al.,* 2005; Etayeb and Essghaier, 2007).

4.1.3. Proposed MPAs

During the past three decades, many studies have been conducted along the Libyan coastline, which targeted the marine and coastal biodiversity, these studies have generally agreed about the importance of the Sirte Gulf and many reports have recommended the area to be designated as a marine protected area (MPA). Recently, the SPA/RAC and EGA started the initial studies and procedures to establish the Sirt Gulf MPA. (Socioeconomic and biodiversity studies).

Sirt Gulf is situated in the middle of the country (see fig. 7) is mostly sandy beaches with small rocky areas, it is provides appropriate habitat for fish species, thus, supporting a wider marine food web, which includes larger pelagic fish species (e.g. Bluefin Tuna and sharks), seabirds, marine mammals and reptiles. It is considered as important habitat for different endangered elasmobranches species and sea turtles. The beach in some regions is connected to sea through salt marshes including Sultan Sabkhta (11 km long). This region includes many important wetlands such as; Alhesha (protected area) and Tawergh complex (Smart *et al.,* 2007). Among the characteristics of the Sirt Gulf is the presence of the Al-Gara island, which is the breeding ground of the largest population of the Lesser crested tern (*Thalasseus bengalensis*) in the Mediterranean, and this provide

more importance to the Gulf as a hotspot of biodiversity. Regrettably, due to the presence of oil terminals and harbours, the area is threatened by ballast water and oil pollution. Moreover, the overfishing of sharks, the disturbance of sea turtles and sea birds add more burdens.

4.2. IMAP in Libya

The title and main goal of IMAP-MPA Project is 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. In Libya, the project began by preparing some reports within the Ecosystem Approach EcAp program, the first report was "SPA/RAC. 2010. National document of Libya aiming at the identification of important ecosystem properties and assessment of ecological status and pressures to Mediterranean marine and coastal biodiversity in Libya. By Dr. Shakman, E. 58 pages". The second one was titled; National Integrated Monitoring and Assessment Programme for Coast and Hydrographic Indicators for Libya.

During the last two decades, sea turtle monitoring programme was continuing, as for the waterbirds, despite the scarcity of financial resources. Recently there has been a notable activity regarding the monitoring of marine mammals, especially whales and dolphins. Moreover, a national team has been specially trained by ACCOBAMS in cooperation with SPA/RAC about the monitoring of sea mammals.

In 2017, a report on national monitoring programme for Biodiversity in Libya was prepared by Dr. Esmail Shakma [Contract n° 09_EcAp MED II SPA/RAC_2016].

In 2018, an implementation of the IMAP in Libya regarding the sea birds and non-indigenous species, within the Barcelona Convention ecosystem approach (EcAp) and based on the Integrated Monitoring and Assessment Programme (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 view of this, the Environment General Authority of Libya (EGA) 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, with the support of the United Nation Environment Programme /Mediterranean Action Plan (UNEP/MAP) - Specially Protected Areas Regional Activity Centre (SPA/RAC).

4.3. Legal and institutional frameworks governing the conservation and sustainable use of marine and coastal biodiversity

4.3.1. Institutional frame work

- The Environmental General Authority (EGA).

This governmental body established in 1982 that takes care about the environmental issues in Libya, and it's the focal point for all the conventions and agreements related to the environment. The EGA is responsible for marine environment via the unit of marine biology protection, Department of conservation of Nature.

- Marine Biology Research Centre (MBRC)

A research center that responsible of marine researches and studies, belong to the MWA.

- The Marine Wealth Authority

A governmental agency belongs to the Ministry of Agriculture. MBRC is one of the centers works under this Authority.

- The National Authority of Science and Technology

A governmental body has a responsibility for supporting and funding the researches in different fields including marine biology.

- The Universities of the coastal cities

4. 3. 2. Legislative Framework

1. Libyan legislation related to marine and coastal environment

- Law number 7 / 1982: Regarding the protection of environment. The third chapter addressed the protection of marine biology and the hazards of oil pollution on fish species.
- Law number 15 / 1984: For preventing the overhunting of wild animalsn.
- Law 14 – 1989: Basic legislation to establish marine wealth sector competition and regulation of marine wealth use and preservation.
- Decision No. 106 – 1988: To establish basis and procedures for providing subsidies and encouragement to operators in the national marine fisheries.
- Decision No. 5 – 1990: Provision for custom duty exemption for fishing gear and equipment.

- Decision No. 71 – 1990: Elaborates provision of Law 14 and procedures of its legal interpretations.
- Decision No. 80 – 1991: Provides technical explanations and specifications for the implementation of Law 14 (mentioned above).
- Decision No. 17 1991: To prohibit contracts with foreign owned companies fishing in Libyan waters or using any foreign vessels to exploit marine wealth in Libyan territorial waters. To stipulate that licenses for the use of marine wealth should be issued to Libyan nationals only.
- Law No. 23 -1991: Basic legislation authorizing creation and operation of fishing cooperation.
- Decision No. 95 – 1993: Prohibition on use of monofilament nets and No. 11 hooks for fishing.
- Decision 97 -1993: Prohibition on trawling in some areas during July and August spawning period for certain species.
- Decision 98 – 1993: Authorizes MWS staff in the municipalities and regions and Libyan trawler captains and their assistants working with National Fishing & Marketing Company NAFIMCO to act as legal officers.
- Act number 453 / 1993: Issued by the General People's Committee of Agriculture and Animal Wealth to prohibit the hunting of terrestrial and sea turtles.

5.

Assessment of marine and coastal status and pressures and impacts on the marine and coastal biodiversity

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5.1. Marine and coastal status and pressures relevant for national marine and coastal areas

Nowadays, it is notably and confirmed that marine environments and its biodiversity are threatened due to illegal fishing along the coastline. Many types of illegal fishing been practiced such as; the use of unauthorized fishing gear and dynamite, which has widely spread, especially after the year 2011, and this leads to the loss and deterioration of marine wealth, including the destruction of habitats, which cannot be compensated or reestablished. Another problem is the pollution caused by sewage water, and this is also found along the coastline (Libyan coastal cities). It can be almost confirm that there is no treatment for the sewage that is discharged into the sea because all treatment plants are not working (personal communication Khaled S. Etayeb). Moreover, there is a new phenomenon in Libya, which is the establishment of many waste dumping areas in coastal wetlands, and as soon as the water level increases due to the rain or valleys water, all that wastes and garbage will reach the sea.

It is certainly true, that there are vast areas away from urban and human settlements, particularly the central region (Gulf of Sirt), which is supposed to be free of pollution and anthropogenic activities, however, and because of Libya is an oil country and has many oil harbors and terminals, especially in the middle region, thus, the area suffers from the pollution due to ballast water and oil. These negatively affect the marine organisms that live in the area, whether they are fish, whales, sharks, sea turtles, or sea birds. Therefore, it can be said that there are some environments need urgent action in order to protect them because they are the basis for the formation of populations in the marine habitats. Marine phanerogams, especially *Posidonia* and *Cymodocea*, must urgently protect and should be the priorities in the conservation strategy. Furthermore, study the hotsots of these species such as Farwa, Ain Al Ghazala, Ain Al Zayana, Al Bardi, Tobruk Gulf and wherever there is a threat to these species along the coast is needed.

Another important issue is the coastal wetlands, which are considered as kidney and defense line for the marine environment, especially the lagoons, because they are the shelters and breeding sites for many fishes, mollusks and other marine organisms, as well as water birds. This requires a comprehensive study of these sites to find out and investigate what they suffer from, then develop the policies to protect and conserve them.

5.2. Critical impacts and effects on marine and coastal biodiversity

The critical impacts, whether on the environment or on the biodiversity, it is always meant the disasters that cause permanent destruction to the ecosystems, as well as great affect its natural components. Some of these disasters are the result of human activities, even if indirectly, while the second type is the natural disasters where human has no involvement. In case of overlapping between natural disasters and human interference, the situation will be complicated and severely affect the natural ecosystems and their biotic and non-biotic components. For example, Farwa Island, which is considered one of the hotspots for marine biodiversity, it is exposed to the risk of erosion and the intensity of sea currents

that lead to the elimination of the Posidonia grass and this is due to the climatic changes in recent years, as well as due to the irrational human activity when the location of the natural opening in the east of the Island has been changed for the establishment of the Abu-Kamash Petrochemical Factory. Unfortunately, during the past four years, the erosion rate exceeded 10 meters. The area used to be rich in species such as octopus and many species of fishes; the most common is mullet fish. Currently, all fishermen complain about the lack of fish, the problem of erosion, and the over-accumulating of Posidonia in the western opening of the lagoon within the path of the valley, which is losing its natural depth.

In the eastern region of Libya, since the region is famous for the export of oil and there are many oil harbors and terminals, particularly the Gulf of Tobruk, which is richest in marine biodiversity, but the presence of the commercial city harbor, the oil harbor, as well as the desalination plant are negatively affected the biodiversity in the region due to the ballast water. It should also be noted that the region is highly vulnerable to the spread of invasive species due to its proximity to the eastern region of the Mediterranean, where the Suez Canal is located, which is a major corridor for invasive species to the Mediterranean.

Another negative impact is caused by illegal fishing, which the most coastal marine areas are suffered from, such as using the dynamite, which caused habitats loss and destructions.

Although, there is no significant negative impact of tourism on the Libyan coastline, except for one area that has been negatively affected, it is Al-Burdi site, which is characterized by the meeting of two valleys with sea water forming a natural estuary. However, during the period before 2011, a touristic hotel was established in the area where the valleys meet the sea, which contributed to the existence of a barrier to prevent or reduce the natural flow of water in the valleys to the sea, and this area is important for sea birds as well as for the spawning process of some fish species.

Since 2011, and with the absence of the government due to political conflicts, it has caused a neglect of guarding the territorial waters and the entry of foreign fishing vessels with high fishing techniques; this negatively affected the fish stocks and biodiversity in general.

There are many wetlands along the Libyan coast, and they are various in their topography and characteristics according to their location, for example: coastal lagoons, sabkhas, small Islands, tidal areas, marshes and small bays. These habitats are considered as important for the marine environment and its biodiversity. Human activities that lead to the degradation and disturbance of these critical ecosystems have been identified, for example urbanization, overfishing inside the lagoons, the drainage of sewage in them, as well as the establishment of strategic factories that produce wastes that exceed the capacity of the lagoons (e.g., Farwa and Zayana in Benghazi). Moreover, hunting of aquatic birds that utilizing these areas as stopover or for breeding...etc, especially in the lagoons and bays in the eastern region, such as Ain al-Ghazala, the bays near the city of Derna, and the sabkhas in the central region, such as Ben Jawad and Sultan sabkhas east to Sirt.

6.

Assessment of national priority needs and response actions

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Certainly, based on what has been presented in this report regarding environmental problems and the lack of some available information, the need is urgent to conduct studies on some species and taxa, as well as on some habitats that are considered of importance or vulnerable to any environmental risks or hazards due to the negative human intervention and activities. Therefore, the common priority needs are the comprehensive studies of the marine and coastal areas and their biodiversity components. Although, some species need to be monitored rather than studying such as: Sea turtles, the monitoring program need to be continued.

6.1. Needs

There are no comprehensive studies on the diversity, ecology and biology for marine fauna and flora; the following are the needed studies:

- Study of marine algae, particularly after the spread of the alien species.
- Continuing the study of sea grass *Posidonia oceanica* ecosystem, and other seaweeds.
- Study of the Planktons either phyto and zooplanktons.
- Study of Mulluscas in certain area such as: Sirt Gulf in the middle of Libyan coastline.
- Implementation of Chondrichthyan fishes project along the Libyan coast presented by RAC-SPA, 2005.
- Study of wetlands along the coastline by collaboration with RAMSAR Convention and its regional initiatives to implement the national survey of wetlands by using ramsar sheets for the sites that potentially designated as ramsar sites.
- Fish stock assessment along the coastal waters.
- Impact of fisheries on sea turtle.
- Studies the impact of ballast water on marine biodiversity and environment.
- Studies the marine benthos along the Libyan coast.
- Mapping of the Libyan coast to describe the habitats and topography type.
- Training courses for capacity building in deferent fields such as:
  - Monitoring of the breeding of sea turtles.
  - Monitoring of sea birds and breeding.
  - Monitoring of sea meadows ecosystems.
  - MPAs management and communication.
  - Monitoring of marine mammals.
  - Monitoring of non-indigenous and invasive species.
  - Fund raising methods

6.2. Urgent actions proposed

- Studies of the impact of ballast water on marine life and environment.
- Implementation of Chondrichthyan fishes project along the Libyan coast presented by RAC-SPA, 2005
- Developing a national strategy on ballast water.
- Training courses for capacity building in deferent fields such as:
  - Monitoring of sea birds and breeding.
  - MPAs management and communication.
  - Monitoring of non-indigenous and invasive species.
  - Fund raising methods.

7.

Funding problems and opportunities

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Funding and availability of funds are a major and determining factor for the implementation of any program. Achieving the objectives of national strategies and action plans requires the mobilization of the necessary financial resources to implement their projects and executive programs, which requires continuous communication through national authorities and national coordinators with international and national organizations and programmes.

7.1. Regular national sources, potentially available:

Previously, most projects were funded by the government through some agencies, institutions, and research centers. However, co-funding of some projects occurred with some international organizations or institutions and conventions. For example, many environmental projects that have been implemented in Libya, especially those carried out by the EGA, were partially supported by the MAP. For the projects and studies of the marine environment and marine biodiversity, the funding was provided by SPA/RAC. Furthermore, there are other projects that have been supported by the IUCN in the form of small projects (small grants) for some NGOs. There are also some projects to support the coastal ecosystems have been funded by the CEPF, also directed to NGOs in Libya.

Although the Libyan country has many major industrial institutions, such as the National Oil Corporation (NOC) and the Libyan Iron and Steel Company (LISC), which can support research projects, monitoring programs, and the conservation processes of the environment and biodiversity. However, the current situation of the country (wars and conflicts that threaten the country's stability) is the most obstacles to obtaining funds from these agencies.

The EGA and the Ministry of Agriculture, who have the responsibility for studying and protecting the marine environment, should support marine projects, research and studies. The Ministry of Agriculture, through the General Authority for Marine Wealth and the Marine Biology Research Center, should finance or seek for funding for the studies, researches, and monitoring the marine and coastal environment and their biodiversity. Moreover, the EGA is the national focal point for the international conventions, agreements and organizations that working in the field of environment. It is also responsible for financing the environmental projects, particularly those related to marine and coastal environments and their biodiversity.

In general, the experience of fundraising is still new in Libya. However, it is possible to benefit from those who have experience for training some Libyan people on methods and mechanisms of fundraising to finance the environmental projects.

8.

Conclusions and recommendations

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- Libya has about 36% of the southern coast of the Mediterranean extending for about 2000 km. Unfortunately, the information about many taxa are very few, there are no comprehensive studies on the marine and coastal biodiversity. Thus, the gap of knowledge still exists.

- Two sea grass species *Posidonia oceanica* and *Cymodocea nodosa* are well studied in the Mediterranean Sea, The former is totally distributed along the coasts of Libya and the latter is partly found in different areas.

- Five species of sponges are well distributed in the Mediterranean *(Hippospongia communis, Spongia officinalis, S. lamella, S. mollissima, S. zimocca)* are currently under the threat due to the overfishing and spreading diseases.

- The attention about exotic, non-indigenous and invasive species has been increased during the last two decades, as well as for the number of these species is in increase where reached a total of 73 in 2019, since the number was 7 during the 1970s.

- In term of landing sites, there are 131 sites along the Libyan coast, where 91 % are permanents and 8% are seasonal. However, the number of boats has increased since 2000. It was 1866 and in 2014 it reached a total of 3687, with different numbers among the regions.

- The highest diversity of fishes along the Libyan coast is in the eastern region (45.65%). While in the Gulf of Sirt, fishes represent 23.91% and 30.43% is the percentage of fish's diversity in the western region of Libya.

- The decline of marine and coastal biodiversity is often the result of many pressures. These pressures are: the increasing presence of invasive and non-indigenous species, climate change, microbial pathogens and other environmental disturbances, including fishing pressure. The impacts on native species and habitats can be catastrophic; biological invasions of non-indigenous species are often associated with climate change and other environmental disturbances, for example: microbial diseases may come from invasive species, and their success can be due to climate change as well.

- Pollution in its various forms and sources is a constant threat to the marine environment and its biotic and abiotic components. The Libyan coast suffers from many sources of pollution, including oil, ballast water, sewage and plastic pollution. It resulted in a great burden on the marine and coastal environment and its biodiversity.

Recommendations:

- Conducting integrated studies on Elasmobranches fish species to fill the gap of knowledge and creating a database on these species (their presence and biology).
- Establishment of MPAs on sites of particular interest (e.g., Sirt Gulf, Alburdi and Ain Azziana) and elaboration of management plans for the existing MPAs (Farwa and Ain Al-Gazala). - Continuing the studies on some species that have been studied in certain areas and identifying the hotspots along the Libyan coast.
- Continuation of monitoring programs for some studied species such as seaweeds, sea turtles, sea birds and Monk Seal.
- Paying more attention to the endangered species that are included in the IUCN red-list, as well as for those included in the SPA & BD Protocol, Annex II.
- Conducting awareness campaigns about the illegal fishing, and encourage fishermen to adopt the use of artisanal fishery for the sustainability of marine resources.
- Implementing the action plans that were submitted to the SPA/RAC concerning the protection of marine biodiversity, especially the action plan on non-indigenous species.
- Developing a national strategy on ballast water.
- Conducting surveys to assess the impact of to the sewage drainage along the Libyan coast, and demonstrating the extent of the impact on the marine environment and its components, as well as the health problems it causes to humans.
- Updating the laws and regulations related to the marine environment, and issuing some laws that guarantee the protection and sustainability of marine resources.

References

- Abushaala, N., Shaibi, T. and Howaege, H. 2014. Mollascan fauna of hard substrate along the coastal zone of western Libya. International Journal of Bioassays, 3 (09), 3211-3217.
- Aldoushy,M., Ahmed, A. F. A., Idris, M. Y. M., Mohamed, I. M. A., Samie, M. A. A., Mayof, A. A. M., Emgower, S. A. B. and Said, R. E. M. 2020. The effects of nesting ground temperatures on incubation and hatchability of loggerhead turtle *Caretta caretta* inhabiting the Mediterranean Sea Coast, Libya. Egyptian Journal of Aquatic Biology & Fisheries. Vol. 24(5):111 – 124.
- Alfaghi I., Abed A., Dendrimos P., Psaradellies M., Karamanlidis A., 2013. Aquatic Mammals, 39 (1), 81-84.
- Amer, A. and El-Toumi, F. 2018. Taxonomical study on macroinvertebrates in Ain- Zayanah lagoon. Benghazi- Libya. Journal of Pure & Applied Sciences. Vol17 No.1: 433-438.
- Armsby, J.k. 1980. Kouf National Park marine survey. Final Report: April- July 1980. ACSAD technical report.
- Azafzaf, H., Baccetti, N., Defos du Rau, P., Dlensi, H., Essghaier, M.F., Etayeb, K., Hamza, A. & Smart, M. 2005. *Report on an Ornithological Survey in Libya from 3 to 17 January 2005.* Unpublished report to Regional Activities Centre/Special Protected Areas (MAP/UNEP), Tunis, Environment General Authority, Libya, and African-Eurasian Waterbird Agreement (UNEP/AEWA).
- Azafzaf, H., Etayeb, K.S. & Hamza, A. 2006. Report on the census of Lesser Crested Tern *Sterna bengalensis* in the Eastern coast of Libya. (1-7 August 2006). EGA, SPA/RAC-MAP-UNEP. 31pp.
- Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S., Limam, A., Lleonart, J., Torch ia, G., & Rais,C. 2010: Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities.- UNEP-MAP SPA/RAC. Ed. SPA/RAC, Tunis; 100 pp.
- Bazairi, H., Sghaier, Y., Benamer, I., Langarh, H., Pergent, G., Borass, E., Verlaque, M., Ben Souissi, J., Zenetos, A. (2013) Alien marine species of Libya: first inventory and new records in El-Kouf National Park (Cyrenaica) and the neighboring areas. *Mediterranean Marine Science* 14(2): 451-462.
- Bearzi G. 2006. Action Plan for the conservation of cetaceans in Libya. Regional Activity Centre for Specially Protected Areas (SPA/RAC), Libya's Environment General Authority and Marine Biology Research Center. 50 p.5
- Bearzi G.; Fortuna C.; Reeves R., 2008. Ecology and Conservation of common bottlenose dolphins Ecology and (*Tursiops truncates*) in the Mediterranean Sea, Marine Mammal Society Reviews

- Bek-Benghazi, N., Al-Mgoushi, A., Hadud, D. And Shakman, E. 2020. A national inventory of marine Mollusca in the Libyan waters. In press.
- Bellard, C., Cassey, P., Blackburn, T.M., 2016. Alien species as a driver of recent extinctions. Biol. Lett. 12, 20150623. *https://doi.org/10.1098/rsbl.2015.0623*.
- Ben-Abdallah R., Alturky A., Fituri A. 2005. Records of exotic fishes in the Libyan coast. Libyan Journal of Marine Science 10: 1-8.
- Boisseau O., Lacey C., Lewis T., Moscrop A., Danbolt M., McLanaghan R., 2010. Encounter rates of cetaceans in the Mediterranean Sea and contiguous Atlantic area, Journal of the Marine Biological Association of the United Kingdom, 90(8): pp.1589–1599.
- Bonanno, G. and Orlando-Bonaca, M. 2019. Non-indigenous marine species in the Mediterranean Sea, myth and reality. Environmental Science & Policy Vol. 96, June 2019, Pages 123-131.
- Bourass E., Baccettib N., Bashimamc W., Berbasha A., Bouzainena M., De Faverib A., Galidana A., Saieda A., Yahiaa E., Zenatellob M. 2013. Results of the seventh winter waterbird census in Libya, January–February 2011. 20 – Bull ABC Vol 20 No 1: 20 – 26.
- Bundy G. 1976. The birds of Libya. British Ornithologist Union, 1976 NW1 4RY 102 pp.
- Contransimex C. (1977) Final report concerning the results of the fisheries oceanographic survey, carried out by the Romanian researcher teams on board "Delta Dunarii" and "Gilort" in the eastern territorial waters of the Libyan Arab Republic between Ras Azzaz and Ras Karkura II: 173-563.
- Defos du Rau P, Essghaier MFA, Etayeb Kh. 2003. Inventaire preliminaire des zones humides cotieres de Libya. Faune sauvage (ONCFS). 259: 44-48.
- EGA-SPA/RAC Waterbird Census Team. 2012. Atlas of Wintering Waterbirds of Libya, 2005–2010. Tunis: Imprimerie COTIM. Temporarily available at: *http://www.isprambiente.gov.it/files/pubblicazioni/pubblicazionidipregio/Atlas_of_wintering_waterbird* _in_Libya_20052010.pdf.
- Etayeb, K.S. 2002. Study of migratory and resident birds in Ras-Attalgha and western part of Farwa Island. M.Sc. Th esis,Zoology Department, University of Tripoli, Libya.
- Etayeb, K. S. and Ali, A. M. 2013. A socioeconomic assessment of Ain Al-Ghazala Marine Protected Area, Libya. Commissioned by WWF Mediterranean
- Etayeb, K. S., Bourass, E., Berbash, A., Bashimam, W .and Essghaier, M. F. A. 2015. Human disturbance affecting sensitive components (waterbirds) of wetlands; A case study on waterbirds in Libyan Ramsar sites. LIBYAN JOURNAL OF MARINE SCIENCE, (14) : 16- 28.
- Etayeb, K.S. and Essghaier, M.F.A. 2007. Breeding of marine birds on Farwa Island, Western Libya. *Ostrich*, 78, 419–421.
- Frantzis A.; Swift R.; Gillespie D.; Menhennett C., Gordon J.; Gialinakis S., (1999) Spermwhale Presence off South-West Crete, Greece, Eastern Mediterranean, European Research on Cetaceans, 13; 214.
- Gallardo, B., Clavero,M., Sánchez,M.I., Vilà,M., 2016. Global ecological impacts of invasive species in aquatic ecosystems. Glob. Chang. Biol. 22, 151–163. *https://doi.org/10.1111/gcb.13004.*
- Gannier A.; Drouot V.; Goold C., 2002. Distribution and relative abundance of Sperm whale in the Mediterranean, Mar Eco Prog Ser. 243; p 281-293.
- Gaskell, J. 2005. Recent changes in the status and distribution of birds in Libya. *Sandgrouse* 27(2): 126-138.
- Godeh M., Nizamudeein M., El-Menifi F., 1992. Marine Algae from Eastern Coast of Libya (Cyrenaica), Pak.J. Bot 24(1):11-21.
- Goldberg, E.D., 1994. Diamonds and plastics are forever? Marine Pollution Bulletin 28, 466.
- Gramentz, D., 1988. Involvement of loggerhead turtle with the plastic, metal, and hydrocarbon pollution in the Central Mediterranean. Marine Pollution Bulletin 19, 11–13.
- Gregory, M.R., Ryan, P.G., 1997. Pelagic plastics and other seaborne persistent synthetic debris: a review of Southern Hemisphere perspectives. In: Coe, J.M., Rogers, D.B. (Eds.), Marine Debris––Sources, Impacts and Solutions. Springer-Verlag, New York, pp. 49–66
- Hamza, A. 2014. Breeding ecology, migration and population genetics of lesser crested terns Thalasseus bengalensis emigrata. University of Hull.
- Hamza A.; Mo G.; Tayeb K, 2003. results of preliminary mission carried out in Cyrenaica, Libya, to assess Monk seal presence and potential costal habitat, Monachus Science 6 (1).
- Héra, Z. & Haris, A. 2015. *Marine molluscs from Marsa El Brega, Libya (Mollusca: Gastropoda and Bivaliva).* Natura Somogyiensis, 27: 37-44.
- IFAW, (2007), Report of Cetacean Surveys conducted by the International Fund for Animal Welfare in the Eastern Mediterranean Sea
- Khalfallah, M., Belhabib, D., Zeller, D. and Pauly, D. 2015. Reconstruction of Marine Fisheries catches for Libya (1950-2010). Fisheries Centre, University of British Columbia, Vancouver, BC, V6T 1Z4, Canada
- Lamboeuf M. 2000. Artisanal fisheries in Libya, census of fishing vessels and inventory of artisanal fishery metiers. FAO-COPEMED-MBRC pp 42.
- Laurent L., M.N. Bradi, D.A. Hadoud & H.M. EL Gomati. 1997. Assessment of sea turtle nesting activity in Libya. Marine Turtle Newsletter 76: 2-6.
- Laurent, L., M.N. Bradi, D.A. Hadoud, H.M. EL Gomati & A.A. Hamza. 1999. Marine turtle nesting activity assessment on Libyan Coasts. Phase 3: Survey of the coast to the west of Misratah. Joint Project of: Marine Biology Research Centre (Tajura, Libya), MEDASSET, SPA/RAC (MAP-UNEP), TCEP (Tripoli), WWF International Mediterranean Programme. SPA/RAC, Tunis. 47 pp.
- Meininger, P.L., Wolf, P.A., Hadoud, D. and Essghaier, M. 1994. Rediscovery of Lesser Crested Terns breeding in Libya. *British Birds* 87: 160-170.
- Milanese, M., Sar`a, A., Manconi, R., Ben Abdalla, A. and Pronzato, R. 2008. Commercial sponge fishing in Libya: Historical records, present status and perspectives. Fisheries Research (89) 90-96.
- Moser, M.L. and Lee, D.S. 1992. A fourteen-year survey of plastic ingestion by western North Atlantic seabirds. Colonial Waterbirds 15, 83–94.

- Nizamuddin M. 1984. Diatoms of Libya. Al-insha Printing Press, Damascus- Syria, 144p.
- Nizamuddin M., West JA. And Menez EC. 1979. A list of marine algae from Libya . Bot. Mar. 22: 465-476.
- Norris, K.J. 1972. Monk seals in Libya. Oryx, 11: 328-330.
- Notarbartolo di Sciara G., Aguilar A., Bearzi G., Birkun A., Jr., Frantzis A. 2002. Overview of known or presumed impacts on the different species of cetaceans in the Mediterranean and Black Seas. In: G. Notarbartolo di Sciara (Ed.), Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies. A report to the ACCOBAMS Secretariat, Monaco, February 2002. Section 17, 4 p.
- Notarbartolo-di-Sciara G.; Zanardelli M.; Jahoda M.; Panigada S.; Airoldi S., (2003), The fin whale Balaenoptera physalus (L. 1758) in the Mediterranean Sea Mammal Review, 33, 2; p105–150.
- Occhipinti-Ambrogi, A., 2007. Global change and marine communities: Alien species and climate change. *Marine Pollution Bulletin*, 55, 342-352.
- Ojaveer, H., Galil, B.S., Campbell, M.L., Carlton, J.T., Canning-Clode, J., Cook, E.J., Davidson, A.D., Hewitt, C.L., Jelmert, A., Marchini, A., McKenzie, C.H., Minchin, D., Occhipinti-Ambrogi, A., Olenin, S., Ruiz, G., 2015. Classification of non-indigenous species based on their impacts: considerations for application in marine management. PLoS Biol. 13, e1002130.
- Pergent G., Pergent-Martini C., 2000. Field study in Libya, study of the vegetation in the lagoon of Farwa. RAC-SPA. and University of Corsica- contract N. 38-99: 1-48.
- Rizgalla, J. 2016. An investigation of the health status of wild Libyan dusky grouper, *Epinephelus marginatus* (Lowe), with characterisation of a new disease, Dusky Grouper Dermatitis (DGD). A thesis submittedto the University of Stirling for the degree of Doctor of Philosophy.
- Rizgalla, J. and Crocetta, F. 2020. First record of Phyllorhiza punctata von Lendenfeld, 1884 (Cnidaria: Scyphozoa: Rhizostomeae) in Libya through social media data mining. BioInvasions Records 9
- Rizgalla, J., Shinn AP. and Crocetta, F 2019a. First documented record of the invasive cockle *Fulvia fragilis* (Forsskål in Niebuhr, 1775) (Mollusca: Bivalvia: Cardiidae) in Libya. *BioInvasions Records* 8(2): 314–319.
- Rizgalla, J., Shinn, A. P. and Crocetta, F. 2019b. The alien fissurellid Diodora ruppellii (G. B. Sowerby I, 1835): a first record for Libya from Tripoli Harbour. Bioinvasions Records, 8 (4), pp. 813-817. *https://doi.org/10.3391/bir.2019.8.4.09*
- Ruiz, G.M., Fofonoff, P.W., Hines, A.H., Grosholz, E.D., 1999. Non-indigenous species as stressors in estuarine and marine communities: assessing invasion impacts and interactions. *Limnology and Oceanography*, 44, 950-972.
- Schleich H. 1987. Contributions to the herpetology of kouf National Park (NE-Libya) and adjacent areas. Spixiana 10: 37-80.
- Sergeant, D., K. Ronald, J. Boulva and F. Berkes. 1978. The recent status of Monachus monachus, the Mediterranean monk seal. Biological Conservation 14: 259-287.

- Shakman E., Ben Abdalha A., Talha F., Al-Faturi A., and Bariche M. 2017. First records of seven marine organisms of different origins from Libya (Mediterranean Sea). Bioinvasions Records. 4(6): 377–382.
- Shakman, E., Eteayb, K., Taboni, I. and Ben Abdalha, A. 2019. Status of marine alien species along the Libyan coast. J. Black Sea/Mediterranean Environment, Vol. 25, No. 2: 188-209.
- Shakman E.; Etyab K.; Taboni I., Et-wail M2; Ben Abdallah A 2014. Status of artisanal fisheries of the Libyan coast. International Congress on "Estuaries and Coastal Marine Protected Areas" ECPA 2014 (Izmir –Turkey).
- Shakman E. A., Kinzelbach R. (2007a) Distribution and characterization of Lessepsian migrant fish along the coast of Libya. Acta. Ichthyologica et Piscatoria 37 (1): 7-15.
- Shakman E. A., Kinzelbach R. (2007b) Commercial fishery and fish species composition in coastal waters of Libya. Rostocker Meereskundliche Beiträge 18: 65-80.
- Smart M, Essghaier MF, Etayeb K, Hamza A, Azafzaf H, Baccetti N, Defos Du Rau P, 2006. Wetlands and wintering waterbirds in Libya, January 2005 and 2006. Wildfowl 56: 172-191.
- Sogreah 1977. Trawl fishing ground off the Tripolitanean coast. Final report. Part v: 1-144 and final report: introduction and general conclusion: 1-30.
- Taboni, Ben. Abdallah A., Serena F., Shakman E 2016. First documented presence of Galeocerdo cuvier (Péron & Lesueur, 1822) (Elasmobranchii, Carcharhinidae) in the Mediterranean basin (Libyan waters). Marine biodiversity Records, 2-5.
- Tempesti, J., Mangano, M. C., Langeneck, J., Lardicci, C., Maltagliati, F. and Castelli, A. 2020. Non-indigenous species in Mediterranean ports: A knowledge baseline. Marine Environmental Research. Vol 161.
- UNEP, (2003), The Conservation of the Mediterranean Monk Seal: Proposal of Priority Activities to be Carried Out in The Mediterranean Sea.
- Vilà,M., Hulme, P.E., 2018. Impact of Biological Invasions on Ecosystem Services. Springer, Berlin, Germany.
- Walsh, J.R., Carpenter, S.R., Vander Zanden, M.J., 2016. Invasive species triggers a massive loss of ecosystem services through a trophic cascade. Proc. Natl. Acad. Sci. 113, 4081–4085. *https://doi.org/10.1073/pnas.1600366113.*
- Wetlands International. 2002a. Numbers and distribution of wintering waterbirds in the Western Palearctic and Southwest Asia in 1997, 1998 and 1999. Global Series No. 11, Wetlands International, Wageningen, the Netherlands.
- Zenetos, A, Siokou-Frangou, I, Gotsis-Skretas, O 2002. The Mediterranean Sea In: Europe`s biodiversity - biogeographical regions and seas - seas around Europe**.** *https://www.eea.europa.eu/publications/report_2002_0524_154909 /regional-seas-around-europe/MediterSea.pdf/view.*

SPA/RAC WORKING AREAS

*SPA/ RAC, the UNEP/ MAP **Specially Protected Areas Regional Activity Centre**, was created in 1985 to assist the Contracting Parties to the Barcelona Convention (21 Mediterranean contries and the European Union) in implementing the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol).*

POST-2020 SAPBIO

Strategic Action Programme for the **Conservation** of **Biodiversity** and **Sustainable Management** of **Natural Resources** in the **Mediterranean Region**

SPAMI

Specially Protected Areas of **Mediterranean Importance**

Marine turtles

Cetaceans

Mediterranean Monk Seal

Cartilaginous fishes
(Chondrichtyans)

Marine and coastal bird species

Listed in Annex II of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean

Specially Protected Areas

Monitoring

Coralligenous and other calcareous bio-concretions

Marine vegetation

Dark Habitats

Habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena

Species introduction and invasive species

POST-2020

SAP BIO

Strategic Action Programme
for the **Conservation** of **Biodiversity**
and **Sustainable Management**
of **Natural Resources**
in the **Mediterranean Region**

UN environment programme

Mediterranean Action Plan
Barcelona Convention

SPA/RAC
The Mediterranean Biodiversity Centre

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