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POST-2020 SAP BIO

LEBANON
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**

United Nations Environment Programme
Mediterranean Action Plan
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List of Acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
CBD	Convention on Biological Diversity
CC	Climate Change
CDR	Council for Development and Reconstruction
CoM	Council of Ministers
CZ	Coastal Zone
CZM	Coastal Zone Management
EIA	Environmental Impact Assessment
ERML	Environmental Resources Monitoring in Lebanon
EU	European Union
FAO	Food and Agriculture Organization
FLOUCA	Fish Landing Operational Utility for Catch Assessment
GFCM	General Fisheries Commission for the Mediterranean
GoL	Government of Lebanon
IBA	Important Birds Area
IOE	Institute of the Environment
ICZM	Integrated Coastal Zone Management
IUCN	International Union for Conservation of Nature
LU	Lebanese University
MAP	Mediterranean Action Plan
MCR	Marine and Coastal Resources Program
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
MPA	Marine Protected Area
NA	National Action
NBSAP	National Biodiversity Strategy and Action Plan
NIS	Non-Indigenous Species
NCMS-NCSR	National Centre for Marine Sciences - National Council for Scientific Research
NGO	Non-Governmental Organization
NT	National Target
PA	Priority Area
PINR	Palm Island Nature Reserve
PSU	Practical Salinity Unit
SPA/RAC	Specially Protected Areas Regional Activity Centre
SAP BIO	Strategic Action Plan for the conservation of Biological Diversity in the Mediterranean Region
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SPNL	Society for the Protection of Nature in Lebanon
TCNR	Tyre Coast Nature Reserve
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UOB	University Of Balamand

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Executive Summary

The objective of the Post-2020 SAPBIO report for Lebanon was to provide the necessary baseline information regarding the important changes that occurred during the previous years and since the adoption of the SAPBIO in 2003, in particular regarding the status of species and ecosystems as well as in relation to new challenges for conservation policies. This is based on the advances that have been made in marine and coastal biodiversity conservation and management leading to relevant environmental policies for the sustainable use of marine living resources. In-depth background research was undertaken covering national and regional documents deemed beneficial for the objectives of the report. Additional documents and information were provided by stakeholders and experts through revision of the report and an online workshop.

Marine ecosystems of Lebanon have experienced major advances in research and knowledge. There has been a marked increase in scientific publications in peer reviewed journals and technical reports on almost all aspects related to marine ecosystems, identifying gaps and leading to the development of a number of national strategies and monitoring plans. Several initiatives have been launched in the past couple of decades to properly and sustainably manage marine and coastal resources while taking into consideration the well-being of coastal communities.

Regarding marine and coastal ecosystem status, records show a total of 385 phytoplankton species including several toxic microalgae; more than 800 zooplankton species; 1639 invertebrate bottom species with 243 species of macroflora including cyanobacteria; three species of marine angiosperms; and species of special interest and their status in Lebanon. In addition, 39 species of sharks and seven species of marine mammals and their status around the Mediterranean were listed. Furthermore, the country hosts four marine reptiles and 40 avian species of high concern. As for Non-indigenous species (NIS), a non-exhaustive list of 215 species is already available with new species constantly being identified.

Concerning the fisheries sector, significant advancements have been achieved, mostly in the development of a catch/effort monitoring system, management plans based on the Ecosystem Approach to Fisheries (EAF), biological and fish stock assessments and socio-economic evaluations. This progress is allowing the Ministry of Agriculture (MoA) to start devising management approaches using science as the basis for decision making.

The report also summarized the conclusions of initiatives covering habitat types for both coastal and deep-sea zones with an emphasis on vermetid platforms and deep-sea canyons as singular habitats, while at the same time describing the transboundary issues of concern, mainly shared fisheries resources, NIS and pollution. For the first time in

Lebanon, deep-sea field surveys were carried out in 2016 and resulted in the identification of six main habitats and 622 species with some species new to science, others new to the Mediterranean and several new to Lebanon.

Analysis of reviewed documents led to the identification of marine and coastal biodiversity gaps needed for scientifically sound conservation measures. Main gaps identified include constantly updating national species lists, mapping coastal and deep-sea marine habitats, follow-up on national initiatives and implementing national monitoring plans, and enhancing coordination between the Government of Lebanon (GoL) and stakeholders to meet national conservation objectives.

Main pressures and impact that cause biological disturbance, especially those of anthropogenic origin, are described (habitat destruction, pollution, dams etc.) for both coastal and deep-sea ecosystems. Climate change (CC) and its potential effect on coastal ecosystems like Sea Surface Temperature (SST), Sea Level Rise (SLR), NIS, Ocean acidification, and Ocean deoxygenation showed the need to launch research activities to determine CC impact. Monitoring the impact of SLR on vermetid platforms emerged as a priority while other effects require long-term monitoring programs. In addition, the upcoming oil and gas sector is considered as both a threat and an opportunity. The sector itself, if not well managed, will result in major disturbance and pollution of the marine environment, while it can be considered an opportunity to increase knowledge of coastal and deep-water environment through EIAs and other research activities.

In response to pressures and impacts, response ranged from the management of current Marine Protected Areas (MPA; Palm Island Nature Reserve, Tyre Coast Nature Reserve and Abassieh Coast) to proposing new MPAs according to the 2012 "Lebanon's Marine Protected Area Strategy" (nine new MPA sites, five estuaries and four deep-water sites), to the proposition of new draft laws such as the draft laws to declare Ras el Chakaa as an MPA and Jounieh Canyon as deep-sea nature reserve, to protecting coastal ecological and cultural sensitive sites, Ramsar sites, and Important Birds Areas.

On the legal and institutional framework levels, the main actors and their responsibilities were identified such as public institutions, private sector entities, cooperatives, NGOs, associations, universities and research institutions. Furthermore, articles in Law No. 444/2002, the "Protection of the Environment Law" and associated application decrees regarding the marine and coastal environment, in addition to other domestic laws related to the conservation and protection of marine and coastal biological resources were highlighted. Moreover, the report outlined strategies, plans and draft laws that contribute to the protection of marine and coastal resources such as the updated 2016 National Biodiversity Strategy and Action Plan (NBSAP), the National Monitoring Programme for Marine Biodiversity in Lebanon (2018), the National Action Plan Concerning Marine Species Introductions and Invasive Species in Lebanon (2018), the Integrated Coastal Zone Management (ICZM) draft law and strategy amongst many others. These were further supported by relevant international agreements to which Lebanon is party, especially the Convention on Biological Diversity and the Barcelona Convention for the Protection against Pollution in the Mediterranean Sea, particularly the SPA and biodiversity Protocol and the ICZM Protocol for the Mediterranean, in addition to other agreements regulating transboundary issues.

On another note, different economic sectors along the CZ act in a way that damages their own interests through the degradation of natural resources, therefore negatively affecting the wellbeing of coastal community. Coastal ecosystems and biodiversity are impacted in an uneven distribution among regions due to differences in vulnerabilities and exposures to different stresses like pollution, sea-filling activities, habitat loss and CC. In addition, human health is affected by certain NIS species that intoxicate consumers and may lead to death while others cause extreme pain, edema and erythema by their stings. A newly discovered potential threat are toxic microalgae that may affect the quality of bathing waters and impact coastal tourism. On the other hand, the main negative effect of CC is expected to be manifested on coastal habitats through the acceleration of NIS invasions mainly from the Red Sea and the submergence of vermetid platforms. Regarding the loss of habitats, more than 60 sites with protection value were identified.

As a result of the review of relevant publications, the needs of the country were categorized at three different levels in terms of marine and coastal biodiversity: 1) at the institutional, legal and governance level, the main findings revolved around the enforcement of existing laws, the promulgation of new ones, and the implementation of national plans and strategies; 2) at the research, training and capacity building level, actions are mostly required in avoiding the duplication of tasks and projects, in supporting monitoring, training and capacity building, and in ensuring financial and technical support for sustainable research and management; and 3) at the monitoring and scientific data level, the need was for launching long-term monitoring schemes, collection of long-term data series, and storage of, and sharing and access to scientific data at national scale. Within this context, it is paramount to follow the recommendations forwarded by the updated National Report presented to the CBD in 2019 in order to achieve Lebanon's National Targets set in the NBSAP.

Finally, sustained, long-term funding emerged as the main challenge for continuous marine biodiversity studies and for launching and sustaining monitoring activities. There is a need for financial and material resources and for academic programs to support well-established research avenues and monitoring initiatives, such as studying marine dynamics, biological interactions, energy flows, impacts of pollution, sediment loading and transport amongst other equally important factors. Currently, several opportunities for biodiversity conservation and monitoring though have been presented through growing interest in the oil and gas sector, the fisheries sector, and CC.

In conclusion, biodiversity conservation and the sustainable use of marine and coastal resources including the management of NIS and mitigation of CC impacts have recently experienced a marked increase in scientific publications and plans and strategies at national level. Nevertheless, sustaining this momentum suffers from the absence of needed resources, but more importantly from absence of prioritization at political level. Nevertheless, all of this is quite challenging when placed against the background of constant political instability in Lebanon and the Middle East.

1.

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- RAC/SPA - UNEP/MAP, 2013. Synthesis report of the ecological characterization of the marine areas of Nakoura, Tyre and Saida in Lebanon. By Ramos-Esplá A.A., Bitar G., El-Shaer H., Forcada A., Limam A., Ocaña O., Sghaier Y.R., and Valle C. Ed. RAC/SPA - MedMPAnet Project, Tunis: 38 p + annexes.

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- SPA/RAC–UN Environment/MAP, 2017. Ecological characterization of potential new MPAs in Lebanon: Batroun, Medfoun and Byblos. By Ramos-Esplá, A.A., Bitar, G., Forcada, A., Valle, C., Ocaña, O., Sghaier, Y.R., Samaha, Z. & Limam A., Ed SPA/RAC. MedMPA Network Project, Tunis: 120 pages + annexes.

- SPA/RAC-UN Environment/MAP, (2018a). National Monitoring Programme for Marine Biodiversity in Lebanon; by Bitar G., Ramadan Jadradi, G., Hraoui-Bloquet S., & Lteif M., Ed SPA/RAC EcAP Med II project, Tunis, 111pp.

- SPA/RAC-UN Environment/MAP, M. (2018b). National Action Plan Concerning Species Introductions and invasive species in Lebanon. By Bariche, M., Forcada, Ed SPA/RAC., Tunis: 37 pages + Annexe.

- SPA/RAC-UNEP/MAP, 2020a. On the occurrence of the Mediterranean monk seal *Monachus monachus* (Hermann, 1779) in the Lebanese waters (Eastern Mediterranean Sea). By Badreddine, A., Limam, A., & Ben-Nakhla, L. Ed. SPA/RAC. Tunis: pages 12.

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UNEP-MAP-RAC/SPA, 2002. Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest.

UNEP-MAP-RAC/SPA. 2015. Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest. Denise BELLAN-SANTINI, Gérard BELLAN Ghazi BITAR, Jean Georges HARMELIN, Gérard PERGENT. Ed. RAC/SPA, Tunis. 168 p+ Annex (Orig. pub. 2002).

1.2. National documents and publications identified and available

Aguilar, R., Garcia, S., Perry, A.L., Alvarez, H., Blanco, J., Bitar, G. (2018). 2016 Deep-sea Lebanon Expedition: Exploring Submarine Canyons. Oceana, Madrid. 94 p. DOI: 10.31230/osf.io/34cb9.
The primary aim of this deep-sea expedition was to close the knowledge gap about deep-sea biodiversity off the Lebanese coast. Through this expedition the following five canyons were surveyed: Beirut Escarpment (Ouzai), Saint Georges Canyon, Jounieh Canyon, Sayniq (Saida) Canyon, and Chekka-Batroun Canyon.

El Khoury, R., Alhaj, D., Nader, M., Abou Dagher M., El Indary, S., Afif, C, Ghoussainy, R., Ghanem, R. and Tabaja, T. (2020). 'Update of the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon'. Republic of Lebanon, 144p.
This SEA aimed to ensure that impacts and their sources are identified, and that effective measures to manage these impacts are in place early on prior to the start of petroleum exploration and extraction activities.

Kouyoumjian H. and Hamze M. (2012). 'Review and Perspectives of Environmental Studies in Lebanon'. INCAM-EU/NCSR Lebanon pp. 328.
A very comprehensive report that provided a comprehensive overview of the environmental studies in Lebanon. It covered all physical and biological components of the Lebanese marine and coastal ecosystems in the country.

Abboud-Abi Saab, M. (2008). Tintinnids of the Lebanese Coastal Waters (Eastern Mediterranean), CNRS Lebanon/UNEP/MAP/RAC/SPA. 192 pp.
This document is an assessment of the Tintinnids along the Lebanese coast. It contains basic information on the marine environment in general and planktons in particular.

Lakkis S. (2011a). 'Le Phytoplancton Marin du Liban (Méditerranée Orientale)', Biologie, Biodiversité, Biogéographie. 303pp.
This document is an assessment of the phytoplankton along the Lebanese coast. It contains basic information on the marine environment in general and phytoplankton in particular.

Lakkis S. (2011b). 'Le Zooplancton Marin du Liban (Méditerranée Orientale)', Biologie, Biodiversité, Biogéographie. 565pp.
This document is an assessment of the zooplankton along the Lebanese coast. It contains basic information on the marine environment in general and zooplankton in particular.

Total E&P Liban Sal. (2019). Block 4 (Lebanon) offshore exploration drilling Environmental Impact Assessment (EIA). RSK/H/P/P80754/04/01 Block 04 rev0. This report exposes the results obtained from the EIA for oil drilling activities in Block 4.

1.3. Quality and comprehensiveness of available information documents

Marine ecosystems of Lebanon have experienced major advances in research and knowledge. There has been a marked increase in scientific publications in peer reviewed journals and technical reports commissioned by international organizations on almost all aspects related to marine ecosystems, identifying gaps and leading to the development of a limited number of national monitoring plans for valuable species. To this end, the Ministry of Environment (MoE) commissioned MORES s.a.r.l for the development of a bibliography in 2014 under the activity entitled "Coastal & Marine Biodiversity Data Collection and Biodiversity Reporting" within the context of the project "Market Policy and Legislative Development for Mainstreaming the Sustainable Management of Marine and Coastal Ecosystems in Lebanon" (MoE/UNEP/GEF). The activity identified more than 800 publications from 1912 until 2014. By consulting these documents, in addition to publications since 2014, it can be deduced that a fair description of marine ecosystems and associated biodiversity is available.

In terms of biodiversity, the main challenge remains in adopting a single, scientifically viable national list of species due to the different numbers reported by authors. A unified national list of marine species supported by habitat mapping needs to be developed by the concerned authorities and regularly updated to be used as the corner stone in conservation and monitoring programs and policies.

To this end, mapping of specific marine habitats in selected areas was described by SPA/RAC-UN Environment/MAP, 2018a, but their distribution at national level needs to be further investigated and studied. Furthermore, the UNEP/MAP-SPA/RAC carried out field biodiversity surveys and ecological characterization of nine marine and coastal biodiversity hotspots in Lebanon under the framework of the "Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of Mediterranean MPAs creation and management (MedMPAnet Project)" (RAC/SPA-UNEP/MAP, 2014; SPA/RAC–UN Environment/MAP, 2017).

In addition, and due to the developing oil and gas sector, certain deep-sea habitats and canyons have been surveyed for species diversity and underwater maps of the benthic environment produced.

In conclusion, an acceptable baseline of good quality information has been established that, nevertheless, still needs to be populated further with on-going extensive research directed towards filling identified scientific gaps while avoiding the replication of existing studies.

2.

Marine and coastal ecosystem status

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2.1. Biological characteristics

2.1.1. Description of water column biological communities

Lebanese marine water temperatures follow a diurnal cycle and are subjected to natural increases or decreases due to the alternation of seasons (Fakhri, 2005; Kouyoumjian and Hamze, 2012). Marine waters are characterized by two annual thermohaline phases: a cold-water winter phase dominates between December and March while a warm-water phase is identified between June and November. Hassoun el *al.* (2019) revealed that temperature ranged between a minimum of 17 °C and a maximum of 31.5 °C with an average of 22.8 ± 4 °C.

Freshwater flooding from rivers during the cold phase keeps salinity low in coastal waters and moderate offshore. The surface salinity fluctuated between 38.5 Practical Salinity Unit (PSU) in winter and 39.7 PSU in summer at offshore stations with greater fluctuations in near shores with an annual average salinity of 38.91 PSU (Abboud-Abi Saab *et al.,* 2008b; Kouyoumjian and Hamze, 2012; Hassoun *et al.,* 2019).

The Lebanese marine environment can be described as oligotrophic and of low productivity similar to the Levant region where the basin shows relatively clear and transparent waters. In the winter season, water turbidity is higher after storms due to fresh water input from rivers and from disturbance of the sea bed (Abboud-Abi Saab, *et al.,* 2008b) while water transparency reaches up to 40 m in September and October (Lakkis, 2018).

Seasonal and geographical distribution of phytoplankton

Lebanese phytoplankton communities have been extensively studied over several decades. More than 385 species, belonging to 85 genera, including 227 Dinoflagellates and 151 Diatoms, five Silicoflagellates and two Ebriidae were identified including several Non-Indigienous Species (NIS) (Abboud-Abi Saab, 2009; Lakkis, 2011a; Kouyoumjian and Hamze, 2012; Lakkis, 2018). The annual cycle of phytoplankton is characterized by its seasonal and geographical distribution in species and biomass. Geographical distribution studies revealed an annual mean of total number of cells estimated at around 9 x 10^6 cells/L in central Lebanon and a density in North Lebanon ranging between 100 x 10^3 and 4.5 x 10^6 cells/L (Abboud-Abi Saab, 2008; Lakkis, 2018) distributed as follows:

- Winter season (December-March): characterized by its relative cold water with an important mixing of sea water masses bringing nutrients from the deep layers to the euphotic zone in addition to important fresh water input from rivers. Phytoplankton displays moderate density but high richness of species. Chlorophyl a (CHL-a) is low during this period of the year, averaging 0.09±0.04 mg.m^{-3} (Abboud-Abi Saab *et al.,* 2008b; Lakkis, 2011a; 2011b). The main species recorded in this season belong to the genus *Thalassionema sp., Thalassiothrix sp., Chaetoceros sp., Biddulphia sp., Coscinodiscus sp., Leptocylindrus sp.,* and *Ceratium sp.*

- Spring season (March-May): marked by a significant bloom of phytoplankton with optimum conditions where CHL-a reaches its peak values of 0.41 ±0.12 mg.m^{-3} during this period with an average density estimated between 400 and 500,000 cells L^{-1} of

sea water (Abboud-Abi Saab., 2008; Lakkis, 2011a, 2011b). Nevertheless, this season is marked by the lowest species diversity where dozens of species prevail. This bloom is directly related to favourable conditions in temperature, nutrients & hydrological stability. The main genera observed are *Skeletonema, Chaetoceros, Rhizosolenia, Bacteriatrum sp., Nitzschia sp., Ceratium sp., Dinophysis sp., Protoperidinium sp.*

- Summer season (May-September): marked by a low level of nutrients and an increase in water temperature generating a clear thermocline (between 35 m and 75 m) and stratification of the water column. Therefore, the phytoplankton biomass and richness drop and the CHL-a is at its lowest levels of the entire year reaching as low as 0.05±0.07 $mg.m^{-3}$ (Abboud-Abi Saab *et al.,* 2008a; Lakkis, 2011a; 2011b). The dominant genera are *Protoperidinium sp., Ceratium sp., Dinophysis sp., Oxytoxum sp., Pyrocystis sp.* and *Podolampas sp.*

- Autumn season (October-November): a slight increase in nutrient level (MoA, 1996; Abboud-Abi Saab, 2008) due to autumn rains and a moderate bloom of certain genera like *Chaetoceros sp., Rhizosolenia sp., Ceratium sp.,* and *Protoperidinium sp.* are usually observed (Abboud-Abi Saab *et al.,* 2008a; Lakkis, 2011a, 2011b).

Regarding vertical distribution of phytoplankton, populations presented much higher variability with maximum species richness in the first 25 m compared to deeper water where phytoplankton becomes rare. Concentrations of phytoplankton tended to increase significantly in the whole water column during the winter mixing period (Abboud-Abi Saab, 2008; Lakkis, 2018). Nevertheless, this distribution is not static where in winter, phytoplankton are not observed deeper than 50 m depth while in spring and summer chlorophyll concentrations were found at 90 m and even at 120 m. Such movements are characteristic for Dinoflagellates which can move vertically while Diatoms float passively (Lakkis, 2011a; Lakkis, 2018).

In recent decades particular attention has been given to potentially toxic microalgae and the relationship between the occurrence of harmful algal blooms and environmental conditions (Abboud Abi-Saab et al, 2008a; Abboud Abi-Saab and Hassoun, 2017; Acaf *et al.,* 2020). Different toxic microalgae were identified with the thermophilic *Ostreopsis spp.* representing the main species (Acaf *et al.,* 2020). Previously, Abboud Abi-Saab and Hassoun (2017) stated that several toxic algal species could have disastrous consequences on the marine environment: blooms of *Skeletonema costatum* may have an adverse impact on fish; the presence of *Chaetoceros spp.* in large concentrations may clog the gills of farmed fish and could also cause bleeding; and toxic blooms of *Pseudo-nitzschia spp.* are associated with the production of domoic acid, a toxin that may induce a form of neurological damage known as Amnesic Shellfish Poisoning (ASP) in consumers of affected marine organisms. However, some species in the potentially toxic species list are reported as poisonous in some areas but harmless in others. Genotype and environmental conditions, including nutrient status, have been suggested as triggers of the variability in toxin production (Accoroni *et al.,* 2016; Abboud Abi-Saab and Hassoun, 2017; Acaf *et al.,* 2020). Therefore, regular monitoring of environmental conditions, species populations, and ecotoxicological analysis, in addition to assessing toxins in the food chain are essential as it is customary for local inhabitants of the Coastal Zone (CZ) to consume certain species of macroalgae and seafood. Cases of intoxication, if any, would have gone undiagnosed due to the lack of awareness on the issue in public health officials and medical practitioners as well as the general public in Lebanon (Acaf *et al.,* 2020).

Seasonal and geographical distribution of zooplankton

Zooplankton species are highly abundant and of various types in Lebanese waters. They include Protista, Cnidaria, Ctenaria, Crustacea, Chaetognatha, Molluska as well as ichtyoplankton species. Around 800 species were identified (220 microzooplankton, 563 macrozooplankton) and additional NIS are being recorded yearly (Lakkis, 2011b; Lakkis, 2018). Tintinnids in particular are the most investigated group of microzooplankton communities (Abboud-Abi Saab, 2008). These investigations were limited to 60 m depth without considering deep-water masses. So far, a total of 150 taxa that include 117 species, two varieties and 31 unidentified species have been reported (Abboud-Abi Saab, 2008; Ouba and Abboud-Abi Saab, 2020). In Lebanon, the peak zooplankton density is reported in the summer months, immediately after the spring phytoplankton while it decreases in the winter months (Lakkis, 2011b; Abboud-Abi Saab, 2012; Total E&P, 2019).

During a sampling mission between March and April 2019, and within the context of the oil and gas sector, TOTAL E&P Liban carried-out an EIA in Block 4 (facing the coast from Jounieh to Anfeh and covering 1911 km^2 with water depth ranging from 320 m to 1780 m and where the nearest boundary to the coastline is approximately of 6 km) where 110 taxa of zooplankton and phytoplankton were collected and identified at a depth ranging from 0-300m (Figure 1; TOTAL E&P, 2019). The survey provided a snapshot of the plankton communities at 20 km offshore Beirut in water depth of more than 1500 m. These results only provide a semi-quantitative representation of the plankton communities that occur in this area at this time of the year. The plankton samples were quite diverse; however, the abundances were always low, which is consistent with offshore oligotrophic waters typical in the eastern Mediterranean area. It is also consistent with the low nutrient concentrations and spring seasonal conditions during which the Environmental Baseline Survey (EBS) was conducted (Total E&P, 2019).

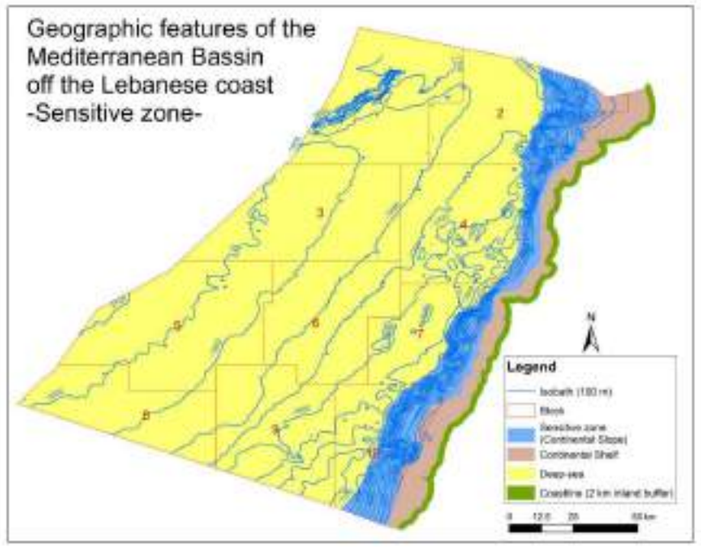

Figure 1:
Lebanese Exclusive Economic Zone (EEZ) and oil exploration blocks

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

Benthic organisms can be assessed according to their distribution on hard substrata, classified as littoral rock (supra and midlittoral), infralittoral rock (upper, middle and lower horizons) and circalittoral rocky bottoms. The limits between these zones are not static or well defined as they are subject to tide patterns, wave action and overall water level and movement. Therefore, this limit is defined according to the presence of certain species that are related to specific ecological conditions (Lakkis and Novel-Lakkis, 2000; Lakkis 2011; SPA/RAC-UN Environment/MAP, 2018a; Lakkis 2018).

There are different groups of marine invertebrates including Annelida, Arthropoda, Brachipoda, Bryozoa, Chaetognatha, Chordata, Cnidaria, Echinodermata, Foraminefera, Nemertea, Phoronida, Mollusca, Porifera that have been identified (SPA/RAC-UN Environment/MAP, 2018a; Aguilar *et al.,* 2018, TOTAL E&P, 2019). Since the opening of the Suez Canal though, the number of Indo-Pacific species reaching the Lebanese coast has continuously increased therefore contributing to an increase in the number of species recorded.

Until now, the total number of species counted is 1588 species including 243 species of Macrophyta (with the Cyanobacteria) with 29 NIS, and 1072 invertebrates (without the nematode) with 156 NIS (Bitar *et al.,* 2017; SPA/RAC-UN Environment/MAP, 2018a).

In addition, several marine invertebrate species observed in Lebanon have been listed of special interest (Table 1).

Table 1:
Marine invertebrate of special interest (SPA/RAC-UN Environment/MAP, 2018a)

Species	Barcelona Convention (www.unenvironment.org)	Bern Convention (www.coe.int)	European Union (EU) Habitat Directive (https://ec.europa.eu)	CITES (https://cites.org/eng/)	Status in Lebanon
Cnidaria					
Cladocora caespitosa	II	-	-	II	Very rare in Lebanon (0-5m).
Phyllangia americana mouchezii	-	-	-	II	Not rare, common in caves (2-47m).
Echinodermata					
Lithophaga lithophaga	III	III	-	-	Used to be very common, actually it is very rare and threatened by overexploitation or toxic algae (Stypopodium shimperi) or climate change effects.
Mollusca					
Dendropoma anguliferum	II	II	-	-	Common in most places (0m).
Luria lurida	II	II	-	-	Very rare species in Lebanon (2-25m).
Lithophaga lithophaga	II	II	IV	II	Common along the Lebanese coast (3-15m).
Naria spurca	II	II	-	-	Uncommon species along the Lebanese coast, usually observed as empty eroded shells along beaches.
Pinna nobilis	II	-	IV	-	Rare species in Lebanon (7-42m). Observed in Enfeh,Ras el Chakaa, Tyre, Ras El Bayada.
Tonna galea	II	II	-	-	Very rare, observed in Palm Island Nature Reserve (PINR) and Tyre Coast Nature Reserve (TCNR) (7-15m).
Porifera					
Aplysina aerophoba	II	II	-	-	Common in North Lebanon, very rare in the South. Observed in photophilic/ hemi-sciaphilic rocku substrata (0-30m).
Aplysina sp. nov	II	II	-	-	Observed in very located caves, very common in Raoucheh cave, common in Ras el Bayada caves and rare in Kfarabida cave (1-5m).
Axinella polypoides	II	II	-	-	Observed in crevices in infralittoral lower horizon. Common in the South (very rare in Saida), rare in Ras el Chakaa (25-47m).
Spongia (Spongia) officinalis	III	III	-	-	Non-abundant species but encountered all along Lebanese coast in caves and rocky crevices (3-20m).

Macroflora

A review of the marine flora of Lebanon resulted in a checklist of 243 taxa including 29 NIS (Bitar *et al.,* 2017). Totals though are still increasing due to the continuous identification of NIS and of new native species with the major origin and pathway of introduction of NIS being the Indo-Pacific Ocean via the Suez Canal (Belous and Kanaan, 2015; Kanaan *et al.,* 2015; Bitar *et al.,* 2017; Lakkis, 2018). The total number of exotic macrophytes listed is probably under-estimated because several exotic species recorded from other Levantine countries have not yet been documented in Lebanon (Bitar *et al.,* 2017).

Badreddine *et al.,* 2018a, applied the CARLIT (CARtography of LIToral communities) index along the Lebanese coast. The results showed that the calculated Ecological Status (ES) along 164 km of the Lebanese coast varied from 29.9% belonging to the good ES class, 37.1% to the moderate, 12.1% to the poor and 9.9% to the very poor. The study also established a baseline for the distribution of shallow benthic communities and recorded the presence of large brown algae forests of *Cystoseira* and *Sargassum* species that represent key ecosystems in shallow habitats. Four species of Fucales have been recorded in this study: *Cystoseira amentacea*, *Cystoseira compressa*, *Cystoseira rayssiae* and *Sargassum vulgare*. The large brown algae forests are potentially regressing along the Lebanese coastline highlighting the need of setting up regular monitoring in order to develop conservation plans. Furthermore, the SPA/RAC-UN Environment/MAP, 2018a reported on the "Marine Macrophyta of Special Interest" observed in Lebanon (Table 2; Annex II: Mapping of habitats and species).

Table 2:

Marine Macrophyta of special interest, observed in Lebanon modified from (SPA/RAC-UN Environment/MAP, 2018a)

Species	Mediterranean Flora Red Book (www.IUCN.org)	EU Habitat Directive (https://ec.europa.eu)	Barcelona Convention (www.unenvironment.org)	Bern Convention (www.coe.int)	Status in Lebanon
Magnoliophyta					
Cymodocea nodosa	+	-	II	I	Common in northern parts of Lebanon and rare in its southern parts. Usually in shallow waters (1-4m) and up to 31m depth.
Ocrophya					
Cystoseira amentacea amentacea	-	-	II	-	Very infrequent, observed at Nakoura and PINR.
Cystoseira dubia	-	-	II	-	On rocky substratum and rhodolithes, uncommon, encountered mainly in the North, Ras el Chakaa (30-42m).
Cystoseira foeniculacea	+	-	II	-	Attached on flat rock and cobbles, encountered in the South (Saida & Nakoura) (5-15m).
Sargasssum tricocarpum		-	II	-	Rare species on rocky substratum in the lower infralittoral, observed in the north (28-30m).
Rhodophyta					
Lithothamnion corallioides	+	V	-	-	Common in Lebanon (35-47m).
Phymatolithon calcareum	+	V	-	-	Rare in East Mediterranean, observed in Lebanon in deeper maerl beds (PINR, Ras el Chakaa; 40-67m).

Angiosperms

Marine angiosperms (sea grasses) provide several valuable ecological and physical functions to the marine ecosystem especially as breeding and grazing grounds (Kouyoumjian and Hamze, 2012). The knowledge of sea grasses in Lebanon, including scientific assessments and publications is very limited and, in most cases, outdated especially regarding their distribution, plant size shoot density and meadow biomass (Sghaier *et al.,* 2014). According to literature, there are three main species of Magnoliophyta (Angiosperms) in Lebanese coastal waters, *Zostera noltei, Halophila stipulacea,* and *Cymodocea nodosa*. Lakkis and Novel-Lakkis (2000) carried-out a study on the distribution of phytobenthos along the Lebanese coast and concluded that *Zostera noltei* is the least abundant, followed by *Halophila stipulacea,* then *Cymodocea nodosa*.

A study on the density of *Cymodocea nodosa* and the status of the meadows in the coastal waters of the PINR – North Lebanon concluded that its presence is limited to very specific areas of the Reserve with relatively low percent coverage (MoE/TRAGSATEC, 2009). In addition, an underwater survey of *Cymodocea nodosa* in 2012 and 2013 was undertaken along the Lebanese coast within the framework of the Regional Project MedMPAnet. Enfeh Peninsula, Ras el Chakaa cliffs, Raoucheh cliffs, Sidon, Tyre and Nakoura were surveyed (Annex I: Coastal sites of interest in Lebanon) and *Cymodocea nodosa* was mainly recorded in the northern parts of the country and rarely in the South where it was observed only around Tyre beach. It is worth mentioning that the study noted the abundance of germinated seeds in June of 2012 colonizing deeper sediments reaching as far as 31 m depth (Annex II: Mapping of habitats and species; Sghaier *et al.,* 2014).

The low values in morphology, shoot density and biomass in the summer period at the studied sites may be attributed to the fact that the Eastern Mediterranean represents the limit of the distribution of the *Cymodocea nodosa* (Sghaier *et al.,* 2014). In addition,

the scarcity of extensive areas of sandy seabed and the destruction of existing ones by anthropogenic activities and pollution may be an additional factor limiting the distribution of angiosperms in Lebanese coastal waters (MoE/ TRAGSATEC, 2009).

2.1.3 Information on vertebrates other than fish

Cartilaginous fish species

The Mediterranean is known to house a high diversity of cartilaginous fish with 77 species of sharks, rays and chimaeras found in its waters. Of these, four species are considered to be either vagrant or probably vagrant, or Lessepsian immigrants from the Red Sea (Dulvy *et al.*, 2016). The most recent listing for Lebanon recorded 39 species (Bariche and Fricke, 2020) with different status in the Mediterranean (Table 3; Dulvy *et al.*, 2016).

Table 3:
Cartilaginous fish species in Lebanon (Dulvy et al., 2016; Bariche and Fricke, 2020)

Species list	Cited by Bariche and Fricke (2020)	Mediterranean Red List Category and Criteria (Dulvy, 2016)	International Legal Instruments (Dulvy *et al.*, 2016)
Carcharhinus obscurus	x	Data Deficient	-
Carcharhinus altimus	x	Data Deficient	-
Carcharhinus falciformis	x	-	-
Carcharhinus limbatus	x	Data Deficient	-
Carcharhinus plumbeus	x	Endangered A4d	BCN Conv.: Annex III
Centrophorus granulosus	x	Critically Endangered A4b	BCN Conv.: Annex III
Cetorhinus maximus	x	Endangered A2bd	CMS: Appendix I & II / CITES: Appendix II / BCN Conv.: Annex II
Chimaera monstrosa	x	Near Threatened	-
Dalatias licha	x	Vulnerable A3d+4d	-
Dasyatis marmorata	x	Data Deficient	-
Dasyatis pastinaca	x	Vulnerable A2d	-
Dasyatis tortonesei	x	-	-
Dipturus oxyrinchus	x	Near Threatened	-
Etmopterus spinax	x	Least Concern	-
Galeus melastomus	x	Least Concern	-
Gymnura altavela	x	Critically Endangered A2bd	-
Heptranchias perlo	x	Data Deficient	BCN Conv.: Annex III
Hexanchus griseus	x	Least Concern	
Isurus oxyrhincus	x	Critically Endangered A2bd	CMS: Appendix II / BCN Conv.: Annex II
Mustelus mustelus	x	Vulnerable A2bd	BCN Conv.: Annex III
Mustelus asterias	x	Vulnerable A2bd	BCN Conv.: Annex II
Oxynotus centrina	x	Critically Endangered A2bd	BCN Conv.: Annex II
Prionace glauca	x	Critically Endangered A2bd	BCN Conv.: Annex III
Pteromylaeus bovinus	Listed as *Aetomylaeus bovinus*	Critically Endangered A2c	-
Pteroplatytrygon violacea	x	Least Concern	-
Raja clavata	x	-	-
Raja miraletus	x	Least Concern	-
Raja montagui	x	Least Concern	-
Glaucostegus cemiculus	Listed as *Rhinobatos cemiculus*	Endangered A3bd	BCN Conv.: Annex II
Rhinobatos rhinobatos	x	Endangered A2b	BCN Conv.: Annex II
Scyliorhinus canicula	x	Least Concern	-
Scyliorhinus stellaris	x	Near Threatened	-
Squalus blainville	x	Data Deficient	-
Squatina aculeata	x	Critically Endangered A2bcd	BCN Conv.: Annex II
Squatina oculata	x	Critically Endangered A2bcd+3cd	BCN Conv.: Annex II
Squatina squatina	x	Critically Endangered A2bcd+3d	BCN Conv.: Annex II
Taeniura grabata	Listed as *Taeniurops grabatus*	Data Deficient	-
Torpedo marmorata	x	Least Concern	-
Torpedo nobiliana	x	Least Concern	-
Torpedo torpedo	x	Least Concern	-

Marine Mammals

An important diversity of marine mammalian species can be found in the Mediterranean with 14 species recorded in the East Mediterranean including the Monk Seal (Table 4; TOTAL E&P, 2019).

Table 4:
Marine mammal species recorded in the East Mediterranean (Total E&P, 2019)

Common name	Scientific name	International Union for Conservation of Nature (IUCN) Status	
		Global	Mediterranean
Fin whale	*Balaenoptera physalus physalus*	Vulnerable	Vulnerable
Humpback whale	*Megaptera novaeangliae*	Least concern	
Sperm whale	*Physeter macrocephalus*	Vulnerable	Endangered
Curvier's beaked whale	*Ziphius cavirostris*	Least concern	Vulnerable
Killer whale	*Orcinus orca*	Data deficient	
False killer whale	*Pseudorca crassidens*	Near threatened	
Pygmy killer whale	*Feresa attenuate*	Least concern	
Long-finned pilot whale	*Globicephala melas*	Least concern	Data deficient
Risso's dolphin	*Grampus griseus*	Least concern	Data deficient
Rough-toothed dolphin	*Steno bredanensis*	Least concern	
Common bottlenose dolphin	*Tursiops truncatus*	Least concern	Vulnerable
Stripped dolphin	*Stenella coeruleoalba*	Least concern	Vulnerable
Short-beaked common dolphin	*Delphinus delphis*	Least concern	Endangered
Mediterranean Monk seal	*Monachus monachus*	Endangered	Critically endangered

As for Lebanon, data is sporadic and species richness differs from one reference to another as noted by Kouyoumjian and Hamzé, 2012 and SPA/RAC-UN Environment/MAP, 2018a. The main literature lists a total of seven species observed off the Lebanese coast: Rough-toothed dolphin (*Steno bredanensis*), Common bottlenose dolphin (*Tursiops truncatus*), Sperm whale (*Physester macrocepahlus*), Cuvier's beaked whale (*Ziphius cavirostris*), Risso's dolphin (*Grampus griseus*), Striped dolphin (*Stenella coeruleoalba*), and the Mediterranean monk seal (*Monachus monachus*) (SPA/RAC-UN Environment/MAP, 2018a; SPA/RAC-UNEP/MAP, 2020a).

The National Council for Marine Sciences - National Council for Scientific Research (NCMS-NCSR) conducted two mammalian scientific missions onboard the CANA vessel in coordination with ACCOBAMS (Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea, and Contiguous Atlantic Area): 1) over two years (2011-2013); and 2) in August 2018 (ACCOBAMS, 2018; *www.cnrs.edu.lb)*. Both missions did not identify any new species than the ones listed and concluded that the common bottlenose dolphin is the most abundant species in Lebanese waters.

In winter 2019-2020 though, Orcas (*Orcinus orca*) were observed and documented along the Lebanese coast and one was found washed dead on the southern shores of Lebanon. Cross-checking the individuals' distinctive markings behind their dorsal fin and the white patch above the eye in international datasets allowed the identification of at least one individual (SN113) while experts are still working on identifying the washed dead individual as its body was in a state of decay. Markings also allowed the understanding of the migration route of this pod of Orcas starting from Iceland towards the Mediterranean (*https://www.dailystar.com.lb/News/Lebanon-News/2020/Feb-24/501679-orca-at-risk-after-record-journey-to-lebanon.ashx*).

As for the Mediterranean monk seal, it is the only seal species present in Lebanese waters. While once considered locally extinct, a total of 47 monk seal sightings were recorded from 2003 until April, 2020 (SPA/RAC-UNEP/MAP, 2020a). These sightings occurred from Beirut to Tripoli, and records were collected from media reports, photos or videos from fishermen, divers and experienced seamen, sea lovers, and Non-Governmental Organizations (NGOs). The documentation was not sufficient to verify the total number of individuals (Ramadan-Jaradi, 2017; RAC/SPA-UN Environment/MAP, 2018a). However, the Mediterranean monk seal is extremely affected by socio-economic development and habitat loss (Khalaf and Fakhri, 2017) and is considered critically endangered due to its small population which does not exceed 400 individuals in the Mediterranean Sea (SPA/RAC-UNEP/MAP, 2020a).

Marine Herpetofauna

Marine herpetofauna in Lebanon totals four species (SPA/RAC, 2017). The most common are the Loggerhead turtle (*Caretta caretta*) and the Green sea turtle (*Chelonia mydas*) that regularly nest along some of the few remaining Lebanese sandy beaches (SPA/RAC-UNPE/MAP, 2020a) with annual nesting numbers being speculative due to sporadic monitoring initiatives. On the other hand, rare records exist for the other two species, the Leatherback turtle (*Dermochelys coriacea*) and the Olive Ridley Sea turtle (*Lepidochelys olivacea*) (RAC/SPA-UN Environment/MAP, 2018a).

Marine Ornithofauna

Lebanon's geographical position is along one of the most important flyways for the migration of birds in the Mediterranean, but the fragmentation of coastal habitats as the drying of coastal wetlands, extensive urban development, and hunting and continuous anthropogenic disturbances are creating tremendous pressure on all bird species including those with marine affinity. In order to conserve and better protect marine Ornithofauna, a 3-year assessment between 2005 and 2008 by A-Rocha Lebanon and the Society for the Protection of Nature in Lebanon (SPNL) led to the declaration of 15 Important Bird Areas (IBA) in Lebanon with the PINR as the only coastal site (MoE/UNDP/GEF, 2014).

The latest review of bird species in Lebanon increased the total number from 395 in 2008 to 404 in 2019 (Ramadan-Jaradi and Itani, 2019). More specifically, the study of marine birds in the northern part of Lebanon by Ramadan-Jaradi in 2017 recorded 86 species among them 35 foreshore species, 18 coastal, six maritime, and 27 species with different affinities (Ramadan-Jaradi, 2017).
The "Atlas for Marine and Coastal Birds of Lebanon" developed in 2019 by Ramadan-Jaradi under the project "Market Policy and Legislative Development for Mainstreaming

the Sustainable Management of Marine and Coastal Ecosystems in Lebanon" is currently under press (MoE/IUCN/UNEP/GEF). It contributes to raising awareness about threats and informs experts in the country about priority areas and keystone species that merit attention and protection. The Atlas includes 40 bird species of high concern recorded along the Lebanese shore line and for a distance of 7 km offshore with 2 globally threatened (Leach's Storm Petrel *Hydrobates leucorhous* [Vulnerable], and *Yelkouan Shearwater Puffinus yelkouan* [Vulnerable]), and eight globally Near Threatened species.

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

Non-Indigenous Species (NIS), are "species of fauna or flora which are found outside their known area of distribution" (https://www.iucn.org/theme/species/our-work/invasive-species). In the present case, they are species for which the Mediterranean Sea is not part of their original distribution area (UNEP-MAP-RAC/SPA, 2011). A NIS is considered invasive when it spreads rapidly, colonizing the new environment and causing damage (UNEP-MAP-RAC/SPA, 2011; Otero *et al.,* 2013). The IUCN definition, also adopted by the Convention on Biological Diversity, states that 'invasive alien species' (IAS, often abbreviated to 'invasive species') are those "alien species which become established in natural or semi-natural ecosystems or habitats and become an agent of change, increasing in abundance and distribution and threatening native biological diversity" (Otero et *al.* 2013). In aquatic environments, such species can be either introduced directly by people (aquaculture, the aquarium industry, etc.) or accidentally by fouling and ballast water from ships, or allowed passage by human actions (Otero et al, 2013) like the opening of canals between water bodies.

The opening of the Suez Canal established a direct major route of invasion for Indo-Pacific fauna and flora. Most of the NIS in the Mediterranean are thermophilic, originating in tropical seas and recorded after a relatively long period of their migration (Nader *et al.,* 2012a; Otero *et al.,* 2013; Zenetos *et al.,* 2017; Bitar *et al.,* 2017; Rotter *et al.,* 2020). The enlargement of the Suez Canal and the increase in shipping volume throughout the region coupled with changing climatic variables is expected to boost the rate of arrivals of aliens into the Eastern Mediterranean (El Khoury *et al.,* 2020; Rotter *et al.,* 2020).

To date, hundreds of NIS species have become a familiar sight, at least in the East Levantine corner of the Mediterranean (Boustany *et al.,* 2015; Zenetos *et al.,* 2017; SPA/RAC-UN Environment/MAP, 2018a, 2018b). Due to its geographical location 400 km from the Suez Canal, the Lebanese coast is one of the first recipients of NIS species of Indo-Pacific origins. The most recent records for NIS were reported in the "National Action Plan Concerning Species Introductions and Invasive Species in Lebanon" listing a total of 215 marine NIS (SPA/RAC-UN Environment/MAP, 2018b).

Other studies and reports focused on certain species like *Siganus sp., Lagocephalus sceleratus, Fistularia commersonii, Portunus pelagicus, Marivagia stellata, Heteropriacanthus cruentatus,* and *Ostreopsis sp.* amongst others (Abboud-Abi Saab and Hassoun, 2017; El Khoury *et al.,* 2020; SPA/RAC-UN Environment/MAP, 2018b; Bitar and Badreddine, 2019; Badreddine and Bitar, 2019) and new species are being continuously recorded. The "National Monitoring Program for Marine Biodiversity in Lebanon" (SPA/RAC-UN Environment/MAP, 2018a) includes a chapter entitled "National monitoring program for non-indigenous species". Its objectives are to supply information enabling the assessment of the ecological status of habitats, to make sure that these species are at levels that do not harm the ecosystem and that their introduction is minimized to the greatest degree possible. NIS though have created a lucrative parallel industry for Levantine fisheries (Section 3.1.1; Carpentieri *et al.,* 2008; MoE/UNEP/GEF, 2016a; FLOUCA-Web, DFW-MoA, personal communication).

2.1.5 Information on species of commercial interest for fishing (fish, mollusk and shellfish)

Lebanese fisheries are classified as small-scale, artisanal, and traditionally based on bottom stationary gear (trammel nets and longlines), purse seine nets, and beach seines with the majority of fishing boats less than 12 m in length (Pinello *et al.,* 2020). Fishing usually occurs to a maximum depth of 200 m while most activities take place at an average depth of 50 m. Living marine resources are managed by the Ministry of Agriculture (MoA) while the Ministry of Public Works and Transport (MoPWT) is in charge of the fishing boat registry including insurance of vessel permits (Majdalani, 2005; Sacchi and Dimech, 2011; Nader *et al.,* 2020; Pinello *et al.,* 2020). The number of licensed fishing vessels in 2019 was 2084 boats with an estimated catch of 3,185 T according to the Department of Fisheries and Wildlife at the Ministry of Agriculture (DFW-MoA).

As for Catch/Effort, several initiatives targeting valuable species of commercial importance were launched to monitor and to assess fisheries catch and stocks in Lebanon. The Food and Agriculture Organization (FAO)-EastMed project (www.faoeastmed.org) in collaboration with the DFW-MoA in Lebanon supported an agreement with the Marine and Coastal Resources Program- Institute of the Environment-University of Balamand (MCR-IOE-UOB) to initiate a "Pilot Survey on Fisheries Dependant Data Collection in Lebanon Including Training" implemented in 2013-2014. The action contributed to improve and implement the national fisheries dependent data collection program through the expansion of the original Fish Landing Operational Utility for Catch Assessment FLOUCA developed at the MCR-IOE-UOB into a web driven utility named FLOUCA-Web for the benefit of the MoA. The national data collection system is on-going since 2013 (Pinello and Majdalani, 2018; Nader *et al.,* 2020) and updated information on commercial fisheries can be directly requested from the DFW-MoA.

In 2016, sardine and herring species represented the top species caught in Lebanon (Table 5). They were all grouped taxonomically under the Family Clupeidae due to the confusion amongst fishermen to identify them at species level (Pinello and Majdalani, 2018). Complicating the issue of identification is the fact that they are caught and consumed mainly as juveniles (Nader *et al.,* 2020). The DFW-MoA in collaboration with the FAO-EastMed Project are currently supporting the NCMS-NCSR in assessing the stocks of four commercial species (*Sardinella aurita, Pagellus erythrinus, Lithognathus mormyrus, Pagellus acarne*) (personal communication, DFW-MoA; Jemaa *et al.,* 2016; EastMed, 2019; Lteif *et al.,* 2020).

Moreover, and based on the Ecosystem Approach to Fisheries (www.fao.org), a national management plan for the purse seine fishery was developed by the MCR-IOE-UOB with the support of FAO-EastMed project and in collaboration with, and for the benefit of the DFW-MoA. Even though the purse seine fishery employs a lower number of fishers (403 fishers) compared to fisheries using other gears, it is considered to be a fishery with high CPUE (206.6 Kg/day) (Pinello and Dimech, 2013). Implementation of the management plan is pending and still waiting to be adopted by the concerned authorities.

Table 5

Top 5 marine species catch in Lebanon in 2016 (Pinello and Majdalani, 2018)

Species scientific name	English name	Arabic name	Catch in 2016 (Tons/year)
Clupeidae	Sardines, herrings	سردين	1,263
Pagellus acarne	Axillary seabream	نقط، ذكر جربيدي	271
Euthynnus alletteratus	Little tunny	بلميدا	255
Diplodus sargus	White seabream	صرغوص	239
Chelon auratus	Golden grey mullet	بوري دهبان	169

Furthermore, the most expensive species recorded in 2016 were the shrimps followed by mullets, lobster and grouper (Table 6). Shrimps were grouped taxonomically under the Family *Penaeidae* due to the same reasons forwarded for *Clupeidae* (Pinello and Majdalani, 2018).

Table 6

Top 5 marine species price in Lebanon in 2016 (Pinello and Majdalani, 2018)

Species scientific name	English name	Arabic name	Price average in 2016 (LBP/kg)
Penaeidae	Shrimps	قريدس	61,320
Mullus surmuletus	Surmullet	سلطان إبراهيم	53,400
Mullus barbatus	Red mullet	يهودي، سلطان رملي	48,102
Scyllarides latus	Mediterranean slipper lobster	كركند	45,108
Epinephelus aeneus	White grouper	لقز رملي	33,872

2.2. Habitat types

Marine habitats in Lebanon are not well defined or mapped for fauna and flora associations. Studies surveyed specific coastal and deep-sea sites mainly for conservation needs while others surveyed deep-sea habitats within the context of the emerging oil and gas sector.

The Lebanese marine and coastal environment hosts a wide variety of ecosystems (Kouyoumjian and Hamzé, 2012) that range from shallow features such as vermetid reefs, coralligenous habitats, seagrass meadows and seagrass beds, rodolith/maerl beds, to deep-sea systems such as underwater canyons and bathyal muds (SPA/RAC-UN Environment/MAP, 2018a; Aguilar *et al.,* 2018; Total E&P, 2019).

Coastal habitats

The "National Monitoring Program for Marine Biodiversity in Lebanon" report (SPA/RAC-UNEP/MAP, 2018a) described more than 20 benthic biocenosis of hard substrata (littoral rock, infralittoral rock and upper circalittoral rock) and soft substrata (infralittoral soft bottoms and upper circalittoral). It concluded that certain characteristics of Lebanon's benthic habitats are peculiar creating difficulties for the use of the Mediterranean habitat/biocenosis classifications (SPA/RAC-UNEP/MAP, 2018a). Among these limitations:

- The scarcity of research on marine habitats.
- The specificity and difference of certain habitats from other parts of the Mediterranean Sea.
- The relative homogeneity of the infralittoral fauna and flora (late summer thermocline at 40-50 m depth).
- The effect of some NIS on habitats.
- The very pronounced seasonal changes in fauna/flora composition.

Other technical documents produced in the last decade described the biotic and abiotic features of several sites based on marine field biodiversity surveys, mainly Enfeh Peninsula, Ras Chekaa cliffs, Batroun, Medfoun, Byblos, Raoucheh, Saida, Tyre, Nakoura (Annex I: Coastal sites of interest in Lebanon; RAC/SPA-UNEP/MAP, 2014; SPA/RAC–UN Environment/MAP, 2017) and can be summarized as follows:

- Species richness: Ras Chekaa, Tyre and Enfeh present the highest values of species richness (>200 *sp.*) while Raouche represents the lowest (<100 *sp.*).
- Habitats: For the evaluation of habitats (biocenosis, associations or facies), Ras Chekaa scored the highest Total Value by Zone (TVZ) among studied sites (TVZ=26.46). On the other hand, when the evaluation of the habitats refers to the number of Habitats by Zone (HZ), Raoucheh scored higher than Ras Chekaa (1.14 and 0.98 respectively).
- Interesting species: Ras Chekaa presented the highest value (1.0), whereas Raoucheh and Saida recorded the lowest one (0.19).
- Fish populations: the highest mean biomass was recorded from Ras Chekaa at 29.28 gr/125m^2 and the lowest was recorded from Medfoun and Byblos at 0.07 gr/125m^2 each.
- Naturalness: Ras Chekaa remains pristine with the highest level of naturalness (0.54) while Saida scored the lowest level (0.06).

Maps produced were for the geomorphological feature, topography profiles, and fish biomass and abundance (Annex III: Bionomical Maps of Enfeh Area, Ras el Chakaa, Saida area, northern Tyre area, southern Tyre area).

Deep-sea area:

There is a lack of data regarding ecosystems and species in the Eastern Mediterranean in general and in the Levantine Basin in particular. It is more pronounced when it comes to deep-water ecosystems that are known to contribute significantly to the total biodiversity of the Mediterranean (Aguilar *et al.,* 2018). A deep-sea exploration project "Towards Deep-Sea Conservation in Lebanon project" funded by the MAVA Foundation for Nature was undertaken in 2016 by OCEANA and Partners upon the request by the MoE (*https://www.rac-spa.org/node/1760*). The project (2016-2018) aimed at closing this gap through its surveying mission that was conducted in October 2016. In total, six main habitat types were documented over a broad depth range (36 to 1050 m): Coralligenous habitat and rhodolith/maërl beds, sandy bottoms, sandy-muddy bottoms, rocky bottoms, canyon heads, and bathyal muds. The survey also identified 622 taxa (Aguilar *et al.,* 2018), among which some species are new to science (e.g. the porifera *Axinella sp.*, the starfish *Luidia sp.* and the stony coral *Anomocora sp.*), some new to the Mediterranean such as *Hacelia superba* and the lantern shark (*Etmopterus pusillus*), and others new to Lebanon (e.g. the glass sponge *Fareea bowerbankii*, the rabbitfish *Chimaera monstrosa* and the long-nosed skate *Dipturus oxyrinchus*; Annex II: Mapping of habitats and species; Aguilar *et al.,* 2018).

In addition, mapping by TOTAL E&P Liban in Block 4 (section 2.1.1; Figure 1) during the EIA study within the context of the oil and gas sector (Total E&P, 2019) revealed a relatively flat and homogeneous seafloor dominated by soft sediments. Abundant mollusks, white sea urchins, crabs and fish were observed (*Diplacanthopoma brachysoma*; *Lepidion sp.*) within a pre-identified pockmark area where outcrops have formed dark hard reliefs one or two meters in height. Comparing results with regional studies in the Levantine Basin suggest that the offshore seafloor of the Lebanese coast is low in productivity and supports an impoverished infaunal community. This is consistent with the low organic and nutrient enrichment found in the sampled sediment (Total E&P, 2019).

2.3 Singular habitats in the Country

Lebanonwith its small surface and extreme anthropogenic impacts, does not encompass any remaining pristine or singular habitats. Yet according to literature, distinctive habitats are still considered valuable due to their richness and importance: Coralligenous assemblages, Vermetid platforms, Deep-sea canyons, and *Cystoseira* forests (Badreddine, 2018b; SPA/RAC-UN Environment/MAP, 2018a; Aguilar *et al.,* 2018).

Vermetids platforms

Vermetid platforms in Lebanon are biogenic formations built up by the association between the two sessile gastropods *Dendropoma anguliferum* and *Vermetus triquetrus* and the encrusting coralline algae *Neogoniolithon brassica-florida* (Badreddine *et al.,* 2019).

This habitat was extensively studied in the past decade allowing the understanding of the status of vermetid reefs along the Lebanese coastline (Badreddine *et al.,* 2019). Results highlighted that this habitat is very fragile to disturbance where the reef building species *Vermetus triquetrus* and *Dendropoma anguliferum* were hardly found alive and in low densities. This raises concerns about the survival of such reefs in the Levantine Basin (Annex II: Mapping of habitats and species; Badreddine *et al.,* 2019) and the loss of its services on overall coastal biodiversity.

Deep-sea canyons

The "Towards Deep-Sea Conservation in Lebanon project" expedition in 2016 surveyed five canyons: Beirut Escarpment (Ouzai), Saint Georges Canyon, Jounieh Canyon, Sayniq (Saida) Canyon, and Chekka-Batroun Canyon (Annex II: Mapping of habitats and species; Figure 4) and documented more than 622 species belonging to different taxonomic groups including new records for the Mediterranean Sea (Table 7).

Table 7

Minimum and maximum depth for taxa recorded in deep-sea canyons off the coast of Lebanon (Aguilar *et al.,* 2018)

	Minimum depth (m)	Maximum depth (m)
Flora		
Chlorophycea indt.	36	?
Ochrophyta	49	71
Rhodophyta	36	297
Fauna		
Foraminifera	56	1015
Phoronida	113	113
Porifera	36	863
Cnidaria	46	979
Annelida	56	977
Arthropoda/Chelicerata	618	618
Brachiopoda	63	975
Bryozoa	56	546
Chaetognatha	784	784
Nemertea	979	979
Echinodermata	45	979
Arthropoda/Crustacea	55	1015
Mollusca	56	1012
Chordata	36	1014
Chordata/Tunicata	38	551

2.4 Transboundary issues

According to the most recent report on fisheries stock status from GFCM, around 78% of the assessed commercial fish stocks in the Mediterranean are overexploited (FAO, 2018). The precise status of Lebanese stocks is not known, largely due to a scarcity of information (Aguilar *et al.,* 2018; Nader *et al.,* 2020). Currently, the FAO-Eastmed project is coordinating regional efforts to determine the shared stocks of commercial fish species in the Eastern Mediterranean. No report has been published yet showing achieved results (EastMed, 2019; *www.faoeastmed.org*).

Other transboundary issues of concern include mainly marine pollution, NIS and the emerging oil and gas sector in Lebanon and surrounding countries. It is well established that pollution is transported to nearby countries with sea currents. A case in point is the oil spill along the Lebanese shorelines due to the Israeli War against Lebanon in 2006 where the oil slick reached Syria and Turkey (Khalaf *et al.,* 2006; MoE/UNEP/UNDP; 2013a). Oil and gas exploration in the Levantine Sea will increase the pressure on marine environments by disturbances caused by the sector and by increasing the possibility of related accidents (Total E&P, 2019; El Khoury *et al.,* 2020).

Another transboundary issue of major concern is the introduction of NIS from Indo-Pacific origin, more specifically through the Suez Canal. Species with negative impact requires joint efforts to set the appropriate strategies and mitigate damages (Nader *et al.,* 2012; Boustany *et al.,* 2015; SPA/RAC-UN Environment/MAP, 2018b). Within this context, the MoE, with the support of UNEP/MAP-SPA/RAC and as part of regional efforts, developed national action plans to prevent and monitor the introduction of new alien marine species and to mitigate their negative impacts (SPA/RAC-UN Environment/MAP, 2018a, 2018b). It is paramount that organizations and countries concerned with maritime transboundary issues related to biodiversity launch discussions with the Egyptian authorities to lead on initiatives that will result in instituting measures that will prevent the migration of Indo-Pacific species into Mediterranean waters.

2.5 Identification of the Country's marine and coastal biodiversity gaps needed for scientifically sound based conservation

Significant effort was made in the past decade to fill in existing gaps and update outdated information. Coastal waters were well covered by different institutions especially the NCMS-NCSR, Lebanese University (LU), UOB, American University of Beirut (AUB), and National experts working on various actions. As for deep-sea ecosystems, they were mainly described by the "Towards Deep-Sea Conservation in Lebanon project" expedition in 2016 that targeted five major sites with a main objective to increase the protection of Lebanese waters, specifically of habitats/ecosystems found in deep areas (Aguilar *et al.,* 2018). The TOTAL E&P, 2019 EIA carried out in Block 4 (section 2.1.1; Figure 1) for water and sediment sampling and analysis, marine mammal observations, and archaeological observations at 20 km offshore Beirut in water depth more than 1500 m (Figure 1) allowed filling some biotic and abiotic gaps related to deep-water environments in Lebanon.

A synthesis of the efforts held for filling gaps for both the CZ and the deep-sea allows concluding the following:

- Nationally adopted species lists need to be generated.
- A program to map marine habitats with clear objectives must be launched and sustained.
- Follow up on national initiatives and coordination of efforts based on national targets (NBSAP, MoE/UNEP/GEF, 2016b; Lebanon 6th National Report to the CBD, MoE/UNEP/GEF, 2019) and national monitoring plans (National monitoring programme for biodiversity in Lebanon, SPA/RAC-UN Environment/MAP, 2018a, b) is a must.
- The GoL is invited to coordinate actions according to the expertise of academic and research bodies, national experts, NGOs and other relevant institutions to meet the NAs set in the NBSAP and the objectives of other relevant plans and strategies.
- Implement national plans to address national priorities, and relate them to academic and research bodies to direct activities in support of those plans.

The National Council for Marine Sciences - National Council for Scientific Research (NCMS-NCSR) conducted two mammalian scientific missions onboard the CANA vessel in coordination with ACCOBAMS (Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea, and Contiguous Atlantic Area): 1) over two years (2011-2013); and 2) in August 2018 (ACCOBAMS, 2018; *www.cnrs.edu.lb*). Both missions did not identify any new species than the ones listed and concluded that the common bottlenose dolphin is the most abundant species in Lebanese waters.

In winter 2019-2020 though, Orcas (*Orcinus orca*) were observed and documented along the Lebanese coast and one was found washed dead on the southern shores of Lebanon. Cross-checking the individuals' distinctive markings behind their dorsal fin and the white patch above the eye in international datasets allowed the identification of at least one individual (SN113) while experts are still working on identifying the washed dead individual as its body

3.

Pressures and impacts

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Lebanese marine ecosystems face, from a general perspective, similar pressures and threats as the entire Mediterranean. The CZ (8% of the Lebanese territory) suffers from severe anthropogenic pressure as it accommodates more than 55% of the total Lebanese population and concentrates most of the major economic activities (MoE/UNDP/ECODIT, 2011; Abou Dagher el *al.*, 2013). As a result, many commercial interests influence this area and compete for space. Thus, the status of the Lebanese coast has been described as declining due to over-exploitation, sea-filling and pollution from different origins, making the current uses of the coastal area unsustainable.

3.1. Biological disturbance

3.1.1. Non-indigenous, invasive species and microbial pathogens

Available information states that the two herbivorous lessepsian species *Siganus rivulatus* and *Siganus luridus* are the most abundant (80%) in coastal waters competing with the endemic *Sparisoma cretense* and *Sarpa salpa* representing only 20% and 0.2% respectively of the abundance of herbivorous populations along the Lebanese coast (Bariche *et al.,* 2004). Nevertheless, these new intruders increased the recycling of algal material through their gastrointestinal system where, before this intrusion, the decomposition needed months to take place. In addition, they presented a preying opportunity to other infralittoral predators such as groupers (Bariche *et al.,* 2004, 2005, 2006a, 2006b).

Another disturbance is recorded by the diet of the toxic puffer fish *Lagocephalus sceleratus* that is constituted mainly of fish, followed by crustaceans and cephalopods. Pieces of nets and lines were recorded in several specimens revealing the damage that this species may cause to fisheries resources and fishing gears (Khalaf *et al.,* 2014; Boustany *et al.,* 2015). In addition, several other well-established NIS as *Fistularia commersonii* and *Pterois miles* have a carnivorous diet. The negative impacts of NIS on biological diversity and recruitment rates have not been evaluated and therefore need to be assessed and monitored in order to introduce mitigation measures (SPA/RAC-UN Environment/MAP, 2018b).

This said, with the "bloom" of NIS and the overfishing status of native species, a new lucrative parallel industry for Levantine fisheries was created (Carpentieri *et al.,* 2008). In Lebanon, species like the Kuruma prawn (*Penaeus japonicus*), Goldband goatfish (*Upeneus moluccensis*), Por's goatfish (*Upeneus pori*), Blue Crab (*Portunus pelagicus*), the Spiny oyster *(Spondylus spinosus)* and the Marbled spinefoot (*Siganus rivulatus*) to mention a few are found in the market (FLOUCA-Web; DFW-MoA, personal communication; Carpentieri *et al.,* 2008).

3.1.2. Impact of fisheries

The impact of fisheries on overall biodiversity is lacking. Most species though are considered to be overfished, but to date this is not supported by empirical data due to lack of scientific assessments. Quotas and fishing seasons are non-existent except for the purse seine fishery and the sector suffers from difficulties in implementing applicable

laws. Since the launching of the FLOUCA Web catch/effort monitoring system, the DFW-MoA has been more active in monitoring fishermen and gear used (section 2.1.5), but due to limited resources, political interference and ongoing crises, progress has been slow and moderately effective. Certain protected species such as sharks and rays, sea turtles, and dolphin amongst other species are caught accidently and go unreported. Even though legal fishing gears are described by Lebanese laws and decrees (i.e. Decree No. 346/1 of 2010 that describes legal gears and defines purse seine seasons and conditions for its use), a wide range of illegal fishing techniques are still being employed such as beach trawling, spear fishing using scuba diving gear, dynamite, and fishing nets with illegal mesh sizes causing pressure on fish stocks and marine biodiversity. Their impact though on the overall ecosystem and associated biodiversity remains unknown. Furthermore, the composition of the catch is not recorded in order to determine if the fish are juveniles or have reached the adult stage when harvested. This remains to be investigated.

Bariche et *al.* (2006a) concluded that "the Lebanese purse seine fishery targets 0 age-class juveniles of many species in the nurseries" which translates into considerable impacts on pelagic fish communities in the eastern Mediterranean. Purse seining is one of the major fishing practices in Lebanon in terms of catch with a very high CPUE (206.6 Kg/ Day) compared to other boat-gear categories (average of 9 kg/day) (Pinello and Dimech, 2013; Nader *et al.,* 2020). Consuming juveniles of sardines is a traditional culinary practice and consumers do not usually purchase adult individuals. In addition, during the deployment and retrieval of the purse seine, the net usually drags on the sea bottom acting as a bottom trawl causing tremendous damage to benthic habitats.

As already stated in section 2.1.5, the Lebanese fisheries sector is artisanal in nature making it very difficult to monitor and regulate. In addition to purse seining, other fishing practices are most likely leading to significant decrease in overall marine populations with or without economic values. As for fishing by fishing poles and pots, they are considered as recreational fishing gears that are widespread along the Lebanese coast. Bycatch of endangered and protected species such as cartilaginous fishes, sea turtles, sea birds and marine mammals, albeit accidental, might be affecting the resilience of the populations of these species. Records of dead sea turtles are habitual in the media and social networks. The reasons for such mortalities are not usually investigated preventing the introduction of specific protection and mitigation measures.

Recently, the "Stranding Network for Sea Turtles and Cetaceans & A Protocol for Monitoring the Interaction between Marine Litter and Marine Turtles in Lebanon" between the MoE and the SPA/RAC recorded between November 2018 until November 2019 a total of 32 dead sea turtles and three dolphins all over the Lebanese coast. Among the stranded sea turtles, eight individuals were necropsied and showed high rates of plastic ingestion (around 30%; SPA/RAC-UNEP/MAP, 2020b).

In some cases, necroscopy of dead animals (sea turtles, dolphins, orca) are carried-out by the NCMS-NCSR. Furthermore, fishing practices alter marine habitats by destroying seagrass meadows, coralligenous and maërl beds and removal of target and non-target species like the date mussel (*Lithophaga sp.*) and other shellfish (Nader *et al.,* 2020).

3.2. Vulnerable marine ecosystems

3.2.1. Coastal ecosystems

The Lebanese coastline hosts more than 70% of the human population with the highest concentration in cities as Beirut and the surrounding Mount Lebanon region. This region accounted for 1.97 million people, or 44% of the total resident population (MoE/ UNDP/ GEF, 2011; MoE/UNEP/GEF, 2016a; Ghoussein *et al.,* 2018). Such high population density is leading to extreme artificialization and privatization of the coast. In addition, the main economic sectors are also located on this thin strip resulting in large land-based sources of pollution (municipal effluents & solid waste, industrial effluents, agricultural runoff, oil pollution, noise and visual pollution etc.). Waste water is released untreated in coastal environments, landfills are created on the shoreline through sea-filling activities, solid waste from rivers washes into coastal waters during winter storms, maintenance of fishing and recreational boats occurs without any oversight (oils and paints and their by-products are released directly into the sea), all leading to a cumulative, negative impact on marine habitats and species alike (MoE/UNDP/ECODIT, 2011; Badreddine, 2018a; El Khoury *et al.,* 2020). The high artificialisation rate along the coast altered current and wave regimes causing high sedimentation rates in ports and harbours and depriving other locations of much needed sand. Exposed sandy beaches are eroding, and soft, shallow habitats are being lost (Mitri *et al.,* 2020). Currents and waves transport chemical and organic pollutants along the coast subjecting all life forms to a variety of risks ranging from bioaccumulation of pollutants to the direct ingestion of macro and micro plastics. Such factors can seriously degrade and damage faunal and floral species in shallow waters through:

- Destruction of the fragile vermetid platforms.
- Depriving species from essential oxygen.
- Increase in water turbidity that damages respiratory and other organs.
- Sedimentation negatively affecting benthic species (seagrass meadows, benthic sessile species, macrophytes, etc.)
- Transmission of microbes to dwelling species along the shore (MoE/UNEP/ UNDP, 2013a).

In addition, pollution due to the discharge of oily boat engine wastes, use of antifouling chemicals and ballast waters from day-to-day shipping operations may be the most damaging since it is steady and occurs everywhere. Moreover, even low levels of contamination can kill larvae, debilitate organisms and cause disease. Oil slicks kill birds, marine mammals and fish, particularly near coasts, and coagulated oil severely damages coastal habitats (MoE/UNEP/UNDP, 2013a; Total E&P, 2019; El Khoury *et al.,* 2020).

Furthermore, the diversion of the majority of coastal rivers towards potable water and irrigation disrupted the flow of rivers into the CZ and in association sediment and organic loading. The problem is expected to worsen in the near future due to the GoL policy to build up to 18 dams and 23 hill lakes for water collection (MoEW, 2015) of which four are under construction and three completed (www.energyandwater.gov.lb). Blocking river

flow by dam construction, coupled with extreme coastal artificialization will surely lead to extensive disturbance in the sediment intake of beaches leading to disequilibrium in coastal dynamics and further erosion in addition to the disruption to food webs (Mitri*et al.,* 2020). For example, the loss of sandy beaches will add tremendous pressure on the nesting populations of marine turtles (NBSAP, MoE/UNEP/GEF, 2016a). As well, the disturbance of river flow is expected to have negative impacts on marine coastal productivity given its interdependency with organic and sediment loading from rivers into coastal areas (SOER, MoE/UNDP/ECODIT, 2011; El Khoury et *al.* 2019).

3.2.2. Deep-sea ecosystems

The "Towards Deep-Sea Conservation in Lebanon project" mission in 2016 reported that marine litter was observed across all of the studied areas, in all habitat types (please refer to section 2.3), and at all depths. In some cases marine litter were coastal carried by currents, while in others it was apparent that large objects such as appliances, tires, and barrels had been dumped directly at sea. These observations reflect the broader and significant challenges that Lebanon faces regarding the disposal and management of the country's solid waste and the negative impacts this sector poses on shallow and deep-sea marine environments. Such contaminants carry different pollutants and their impacts are not well known as deep-sea habitats are poorly researched in Lebanon (Aguilar *et al.,* 2018).

3.3 Emerging issues

3.3.1. Climate Change (CC)

Effects of CC on the Lebanese marine ecosystems and habitats have not been directly investigated. Nevertheless, impacts of CC have been correlated with CC effects and projected for the country (Table 8).

Table 8

Impacts of effects on marine ecosystems and habitats (MoE-IUCN, 2020; under development)

CC Component \ Effects	Sea Surface Temperature (SST)	Sea Level Rise (SLR)	Non-Indigenous Species (NIS)	Ocean acidification	Ocean deoxygenation
Marine ecosystems and biodiversity	• SST will be general and contribute to changes in biogeography of organisms ranging from phytoplankton to marine mammals, therefore altering community composition and interactions between species. • The vermetid platform characteristic species Dendropoma anguliferum and Vermetus triquetrus and Neogoniolithon brassica-florida is vulnerable to CC in the Mediterranean (Badreddine *et al.,* 2019). • Causes necrosis/ or bleaching of coralligenous assemblages affecting the main builder species (e.g. Mesophyllum spp. and Lythophyllum spp.) • High water temperature will allow the thermophilic NIS to have an advantage over indigenous species pushing them to deeper waters in certain cases and competing on shared resources. Its mitigation has been clearly defined in national target 11 coping with Aichi target 9 (MoE/UNEP/GEF, 2016b; SPA/RAC & MEDPAN, 2019).	• An increased depth due to SLR diminishes the amount of light received for the growth of fragile seagrass meadows and other algal species. • Flooding of estuaries, will affect the structure of their fragile natural habitats by changing their physical and chemical characteristics affecting the whole ecosystem on which species and food chains depend (El Khoury *et al.,* 2019; Mitri *et al.,* 2020). • Sparse sandy beaches where sea turtles are still able to spawn will be more and more unsuitable for nesting (El Khoury *et al.,* 2019; Mitri *et al.,* 2020). • Rocky coasts and vermetid platforms will face drastic changes due to high temperature, SLR, acidification and extreme violent storms (Badreddine *et al.,* 2019). • Sessile organisms (e.g., barnacles, mussels) will face mass mortality and drastic biodiversity loss of mussel beds. • Declines or losses in species can have cascading effects on the whole intertidal community of rocky shores and the services they provide.	• Several of NISs have drastically affected certain species populations by pushing away native species by occupying their habitats and competing on existing resources (SPA/RAC-UN Environment/ MAP, 2018b). • Populations may in some cases benefit from these changes, but in other cases the impact can be negative (Ouba *et al.,* 2016).	• Expected to decrease the net calcification (high confidence) and abundance (medium confidence) of rocky intertidal and reef-associated species especially the vermetid platform building species (Badreddine et al. 2019; Hassoun, 2019; Hassoun *et al.,* 2019), and • The dissolution of calcareous species that has already been documented in tide-pool communities. The characteristic species building the platforms (*Dedropoma anguliferum, Vermetus triquetrus and Neogoniolithon brassica-florida*– and also Vermetids are vulnerable to ocean acidification around the Mediterranean by softening of their shells (Hassoun, 2014; Badreddine *et al.,* 2019).	• Increase in disease incidence among species, deterioration of spawning grounds and reduction in the survival rate and growth of different marine species (Hassoun, 2014). • Changes in population dynamics and ecosystem processes will depend on responses to changes (Hassoun, 2014; Abboud-Abi Saab and Hassoun, 2017). • Coastal water pollution may induce bloom-forming species of phytoplankton causing extensive red tides which may lead to oxygen deficiency in bottom waters (Abboud-Abi Saab and Hassoun, 2017). • The low oxygen levels especially in coastal waters will threaten different marine species dwelling in vermetid platforms (Hassoun, 2014; Abboud-Abi Saab and Hassoun, 2017).

CZ Component / Effects	Sea Surface Temperature (SST)	Sea Level Rise (SLR)	Non-Indigenous Species (NIS)	Ocean acidification	Ocean deoxygenation
Marine and coastal protected areas		• Coastal MPA's and other sensitive sites might be lost due to SLR. • SLR will add tremendous pressure on the nesting populations of marine turtles on Lebanese shores. • SLR may threaten the Monk seal (Monacchus monacchus) habitats with the potential of caves flooding especially in storms due to wave action that might reduce habitat availability. This needs to be investigated especially that the Monk Seal is listed on the IUCN Red List as an endangered species (EN) (SPA/RAC-UNEP/ MAP, 2020a). • Estuaries and similar brackish habitats considered of high productivity will be lost affecting the equilibrium and survival of species depending on such habitats.	• MPAs will face a migration of additional NIS and their possible establishment of viable populations or negatively affecting the stability of fragile coastal ecosystems and population structures (Abboud-Abi Saab and Hassoun, 2017; Badreddine, 2018; Badreddine *et al.*, 2020).	• Ocean acidification will threaten the coastal habitats especially the vermetid platforms and other habitats (e.g. coralligenous assemblages) considered as nursery and spawning grounds for marine species. • Such impact will create a disequilibrium in the existing ecosystems and therefore in the functions of conservation of MPAs (Badreddine *et al.*, 2019).	• Low oxygen levels especially in coastal waters will increase disease incidence among species, deteriorate spawning grounds and reduce the survival rate and growth of different marine species. • Such impact will create a disequilibrium in the existing ecosystems and therefore in the functions of conservation (Abboud-Abi Saab and Hassoun, 2017).

3.3.2. Oil and gas sector

The Ministry of Energy and Water (MoEW) launched the exploration and production activities for offshore petroleum resources in Lebanon under the Offshore Petroleum Resources Law (Law No. 132 dated 24/8/2010). Drilling activities started in Block 4 that is located approximately 6 km from the nearest coastline and covers an area of 1911 km^2 with water depth ranging from 320 m to 1780 m (Figure 1). The introduction of this new sector will create new challenges and pressures on the surrounding marine and coastal environments. A Strategic Environmental Assessment (SEA) for the whole sector and an EIA for Block 4 were conducted (TOTAL E&P, 2019; El Khoury *et al.,* 2020). Potential disturbance and pollution to surrounding habitats were taken into consideration in both documents and mitigation measures addressed based on experts' consultations and stakeholder meetings. In conclusion, significance of impacts on marine biodiversity increases as the level of activities increase, with more significant impacts expected to occur under the "High Development" scenario. Forwarded mitigation measures to reduce the impacts on marine biodiversity range from abiding to international guidelines (ACCOBAMS; MARPOL; Ballast Water Convention; etc.) to planning operations in non-productive seasons (TOTAL E&P, 2019; El Khoury *et al.,* 2020). On the other hand, the introduction of this sector has driven ecological research activities into deep-sea environments that otherwise would not have occurred.

4.

Current response measures

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4.1. Marine protected areas and other area based conservation measures

4.1.1. Marine protected areas:

Lebanon currently hosts three coastal MPAs officially declared by the MoE:

- PINR was established on March 9, 1992 under Law No. 121. It consists of three small islands (the Palm Island, Sanani and Ramkin) and is located 5.5 km off the coast of Tripoli-North Lebanon. The Management Committee of the reserve has fixed its opening for the public only during the summer season.
- The TCNR was established on November 5, 1992 under Law No. 708. It is located in the South of Lebanon and consists of coastal lands with sand dunes, freshwater ponds, reed beds and their adjacent Territorial waters. The Management Committee of the reserve has fixed its opening for the public only during the summer season.
- Abassieh Coast was declared as a MPA on May 8, 2020 under Law No. 170. It is located in the South of Lebanon and includes coastal sand dunes and a nesting site for marine turtles.

In order to expand the number of coastal MPAs, the MoE and IUCN, issued in 2012 the "Lebanon's Marine Protected Area Strategy" proposing a list of MPAs in order to support the conservation and management of important marine habitats and species in Lebanon (MoE/IUCN, 2012; Annex I: Coastal sites of interest in Lebanon). The strategy emphasized the need for integrating the marine environment policy into the country's policy framework and the importance of creating a "Network of MPAs" including assessment of available tools and collaboration between different stakeholders. One of the outcomes of the strategy was the assessment of key habitats according to a clear set of selection criteria and the subsequent recommendation of the following sites for declaration as MPAs:

- Nakoura.
- Sidon rocks.
- Raoucheh cliffs and caves.
- Beirut port outer platform.
- Byblos.
- Medfoun rocky area.
- Batroun Phoenician wall.
- Ras El Chakaa cliffs.
- Enfeh Peninsula.

In addition, the strategy proposed the following to be declared as MPAs:

- Five estuaries: Litani, Awally, Damour, Nahr Ibrahim and Arida.
- Four deep-water sites: Beirut Escarpment, St. Georges Canyon, Jounieh Canyon, and Sour Canyons.

Based on "Lebanon's Marine Protected Area Strategy" (MoE/IUCN, 2012), SPA/RAC has carried out in consultation with the MoE, underwater biodiversity surveys in nine of the proposed coastal MPAs in 2012-2013 and 2016 which have resulted in reports on ecological characterization in these targeted sites (RAC/SPA - UNEP/MAP, 2014; SPA/

RAC–UN Environment/MAP, 2017). Currently, a draft law submitted by the MoE to declare Ras el Chakaa as an MPA is under consideration by the Council of Ministers (CoM). In addition, another draft law for the declaration of a deep-sea nature reserve at Jounieh Canyon was finalized and will be submitted for the CoM by the MoE.

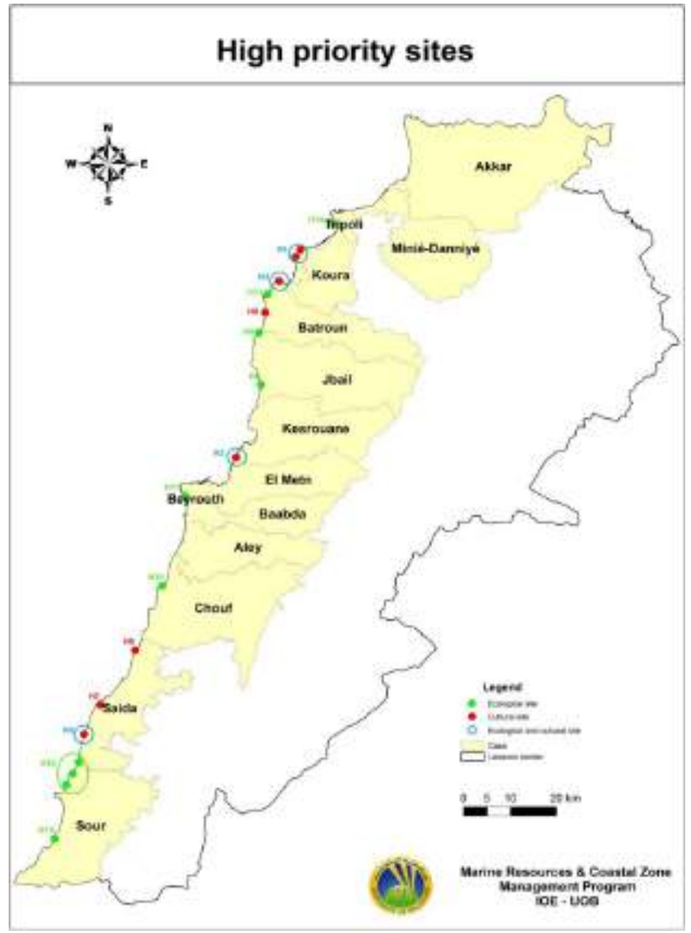
4.1.2. Coastal ecological and cultural sensitive sites:

Another initiative was undertaken in 2013 within the project entitled "Environmental Resources Monitoring in Lebanon (ERML)". The project identified coastal sensitive sites based on geographical, biological and cultural criteria and taking into consideration potential stresses and conservation measures for each site (UOB/UNEP/MoE, 2013a). Ranking of the sites was done based on criteria adopted from the Convention on Biological Diversity (CBD) and United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Centre. Sites were then classified as high, medium or low priority sites and immediate need for protection for high priority sites was recommended (Table 9; Figure 2).

Table 9

ERML High Priority sites

Code	Name	Type
H1	Ras Enfeh Salinas, wall promenade and our lady of Natour monastery	Ecological and cultural
H2	Nahr el Kelb historical site and estuary	Ecological and cultural
H3	Promontory cape and cliffs of Ras el Chakaa + Saydet El Nouriyeh Monastery	Ecological and cultural
H4	Aadloun beach and caves	Ecological and cultural
H5	The sea castle of Saida and underwater city + Sea façade + old harbour	Cultural
H6	Historical center and fishing harbour of Batroun	Cultural
H7	Ancient tell of Sarafand	Cultural
H8	Beaches in the South and North of Jbail (Jbail-Amshit)	Ecological
H9	Medfoun rocky area	Ecological
H10	Damour river estuary	Ecological
H11	Sandy beach of Ramlet el -Baida in Beirut	Ecological
H12	Qasmieh estuary Mhayleeb beach North Tyre beach (Ras-El Dine-El-Bahr)	Ecological
H13	Selaata terraces	Ecological
H14	Terraces of Al Mina	Ecological
H15	Mansouri beach	Ecological



4.1.3 Ramsar sites:

In August, 1999, the Ramsar Convention entered into force in Lebanon and three coastal sites (in addition to one terrestrial inland site) were declared Wetlands of International Importance (Annex I: Coastal sites of interest in Lebanon): 1) PINR, 2) TCNR and 3) Ras el Chakaa that consists of a coastal limestone cliff with steep slopes and marine caves and is located at 50 km North of Beirut (*https://www.ramsar.org/wetland/lebanon*).

4.1.4. Important Birds Areas (IBA):

Among the 15 IBAs declared in Lebanon, only the PINR was identified as a coastal IBA site (Annex I: Coastal sites of interest in Lebanon). This project was implemented in 2008 by A Rocha Lebanon and the SPNL under a fund by the MAVA trust (MoE/UNDP/GEF, 2014).

4.1.5. Deep-sea sensitive sites/Canyons:

Under the CBD convention, a workshop was organized in 2014 in Malaga-Spain in order to propose Ecologically and Biologically Significant Areas (EBSAs) for the Mediterranean. Within this context, Lebanon recommended the declaration of the East Levantine Canyon Area (ELCA) in order to protect these canyons and their ecosystems (UNEP/CBD/EBSA/WS, 2014; Figure 3). The justification of this proposition was that this area covers more than 1.200 km^2 of these particular and sensitive ecosystems (Section 2.2.).

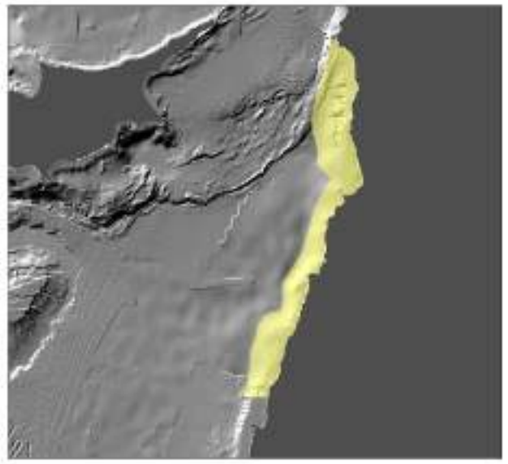


Figure 3
Proposed East Levantine Canyons Area (yellow; UNEP/CBD/EBSA/WS, 2014)

The "Towards Deep-Sea Conservation in Lebanon" Project executed by OCEANA from 2016 till 2018 in coordination with MoE and based on its request had a main objective to assist the Lebanese authorities in declaring MPAs in deep-sea areas (Aguilar *et al.,* 2018). The project executed biodiversity field surveys in 2016 in five deep-sea areas and canyons of biodiversity importance in Lebanon. The mission resulted in a scientific report summarizing the outcomes of the surveys and in a draft law for the creation of a deep-sea nature reserve at Jounieh Canyon and a management plan for this proposed MPA (SPA/RAC-UN Environment/MAP, 2018c; Section 2.3 and 4.1.1; Figure 4). Such declaration will contribute to reaching Aichi Target 11 by 2020 (at least 10% of marine and coastal waters should be protected by 2020; MoE/UNEP/GEF, 2016a), and to strengthening the natural marine biodiversity corridor in the Eastern Mediterranean basin.

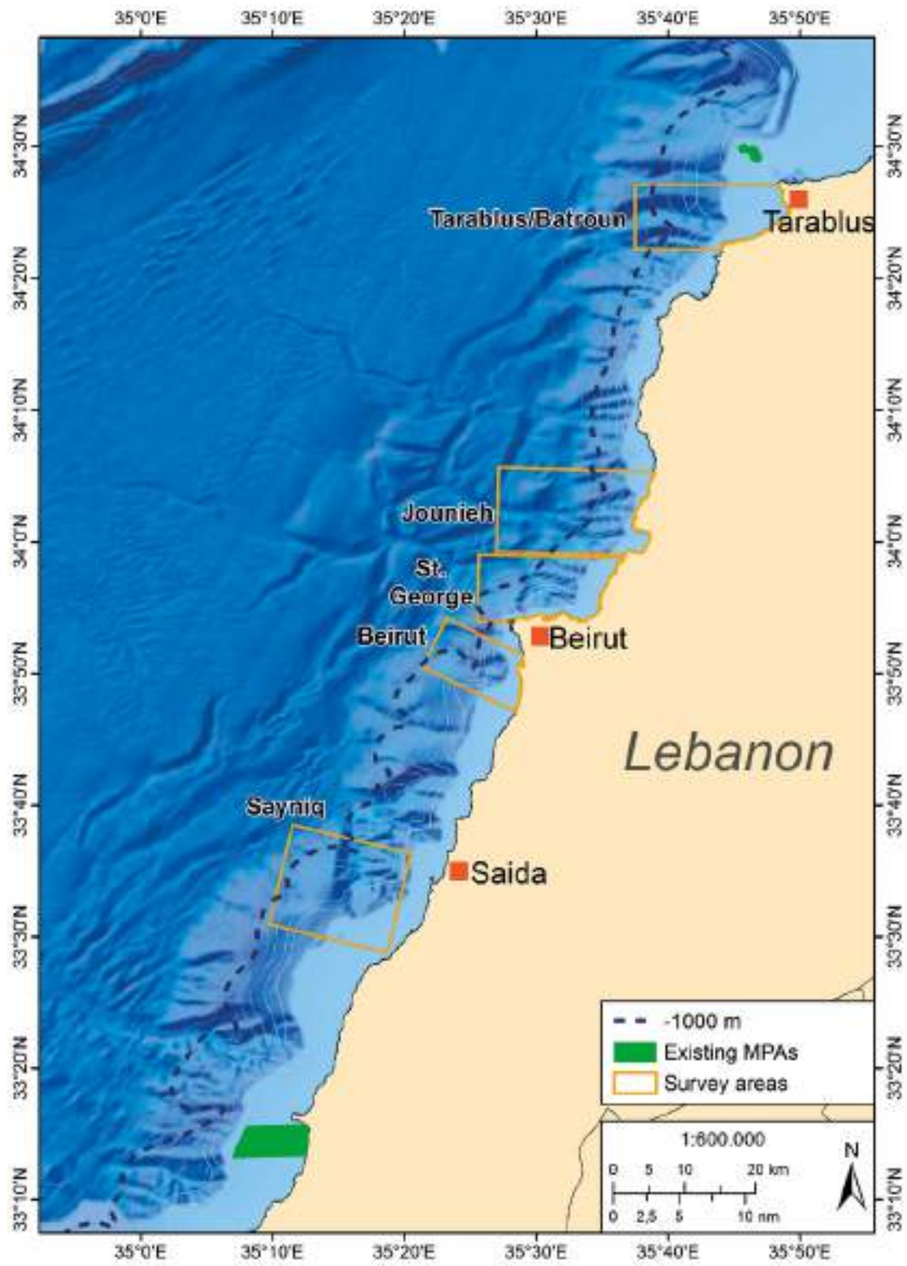


Figure 4
Surveyed canyons by "Towards Deep-Sea Conservation in Lebanon project" (Aguilar *et al.,* 2018)

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

4.2.1. Institutional actors in relation to marine and coastal zone

In Lebanon, there are several actors with different roles in marine and coastal biodiversity. They include a range of public institutions, private sector entities, cooperatives, NGOs, associations, universities and research institutions (NBSAP, MoE/UNEP/GEF, 2016b) with the main ones being as follows:

- The Ministries of: Environment, Public Works and Transport, Industry, Energy and Water, Interior and Municipalities (including local municipalities, districts and governorates), Public Health, Agriculture, Tourism, Culture, Defence.
- Office of the Minister of State for Administrative Reform.
- Lebanese Army (Navy Department).
- The Ports Authorities.
- The Council for Reconstruction and Development (CDR).
- NCMS/NCSR.
- NGOs.
- PINR and TCNR and recently the Abassieh MPA.
- Bar Association of Lebanon.
- Order of Engineers and Architects.
- Cooperatives and syndicates of related owners/workers.
- Union of Hotel Owners in Lebanon.
- Association of Lebanese Industrialists.
- Environmental consulting firms.
- Local inhabitants.
- LU.
- Universities and Research Centres.
- Independent experts and researchers.

The institutional framework shows some overlapping of responsibilities (Table 10) which sometimes slows the advancement of certain activities.

Table 10

Role of national institutions in Coastal Zone Management (CZM).

	Planning	Water resources management	Ports & marine transportation	Urban planning & zoning	Standards & legislation	Law Enforcement	Project financing & execution	Cultural heritage	Biodiversity & marine environment protection	Wastewater discharge	Awareness & guidance	Solid Waste Management	Sampling &/or monitoring	Forests	Issuing permits	Maritime Public Domain	Fisheries	Coastal resorts
MoE	X			X	X		X		X	X	X	X	X	X				X
MoPWT	X		X	X		X	X	X		X		X			X	X	X	X
Ports Authorities			X				X											
Ministry of Industry				X	X		X			X			X		X			

	Planning	Water resources management	Ports & marine transportation	Urban planning & zoning	Standards & legislation	Law Enforcement	Project financing & execution	Cultural heritage	Biodiversity & marine environment protection	Wastewater discharge	Awareness & guidance	Solid Waste Management	Sampling &/or monitoring	Forests	Issuing permits	Maritime Public Domain	Fisheries	Coastal resorts
MoEW		X					X			X			X					
Ministry of Interior and Municipalities				X		X	X			X		X	X		X	X	X	X
Municipalities	X			X		X	X	X	X	X	X	X	X	X	X	X	X	X
CDR	X	X		X			X			X		X						
MOPH					X								X		X			X
MoA	X				X	X			X		X			X			X	
MoT						X	X	X			X				X			X
Ministry of Culture							X	X										

Source: Adapted from the MoE "National Consultancy for the Identification of Legal, Policy and Institutional gaps and policy reforms drafted for marine and coastal biodiversity protection Project (2014-2015).

4.2.2. Legal text of relevance to marine and coastal biodiversity

The only framework law for protecting the natural environment is Law No. 444/2002: "Protection of the Environment Law" (or the Environment code; http://www.moe.gov.lb//). It takes into consideration the "Protection of Ecosystems" including the "Protection of the Littoral and the Marine Environment":

- Articles 29 to 34 stipulate the necessity to protect marine habitats and resources by forbidding activities harming and/or polluting marine ecosystems. The Law though does not present a list of what could be considered as harmful activities and/or products.
- Article 48 limits management of natural resources and protection of biodiversity to the creation of public gardens, nature reserves and protected areas, and the suggestion of protecting natural sites and landscapes.

Concerning CZ issues, this Law takes into consideration:

- Plans and issues/problems of shore protection.
- Actions to deal with marine pollution.
- Wetland protection including their ecological systems.
- Banning of "drainage, flooding or burning in Lebanese territorial waters of any material that can directly or indirectly impact human health and marine natural resources, or that can negatively affect seawater quality".

Because Law 444/2002 is a Framework Law, its application requires promulgation of Application Decrees that represent one of the major gaps in terms of its enforcement. Actually, it took ten years to issue two of its major application decrees: the EIA (Decree No. 8633/2012) and the SEA (Decree No. 8213/2012). EIAs and SEAs are intended to ensure the protection of the CZ (amongst other ecosystems) from possible pressures caused by new projects and plans.

In addition to Law 444/2002, other domestic laws and legal instruments related to the conservation and protection of marine and coastal biological resources are issued with several addressing specific coastal ecosystems as wetlands/estuaries, marine habitats, dunes, coastal forests, coastal landscapes and protected areas. For example, as a major achievement in recent years is the issuance of the Framework Law for Protected Areas (Law No. 130/2019) which classifies protected areas into different categories and regulates their establishment and management requirements. Within this context and in May 2020 Law No. 170 declared Abassieh as the third MPA in Lebanon.

Regarding the oil and gas sector, the GoL has issued a series of domestic laws, decrees and decisions to regulate its development with special attention to possible impacts on marine and coastal resources such as:

- The Offshore Petroleum Resources Law (Law No. 132/2010) stipulating the development of an SEA for the sector and EIAs for all plans at all stages. This Law also gives the right to the MoE, in coordination with the MoEW to oversee activities that could disturb the environment.
- Decree No. 43/2017 sets environmental requirements that should be respected by Right Holders.

A comprehensive list of all applicable laws, decrees and ministerial decisions related to the CZ and marine ecosystems and management is presented in Annex IV: Domestic Lebanese laws, decrees and decisions related to marine and CZ ecosystems.

4.2.3. Other regulations or plans, such as national plan for species

The GoL has set a list of priorities for the country to be achieved in favor of the natural environment. In addition, many strategies have been developed to protect and manage marine and coastal ecosystems:

- Under the CBD convention, Lebanon has developed its 1st National Biodiversity Strategy and Action Plan (NBSAP) in 1998 and its updated NBSAP in 2016. In the latter, 13 Priority Areas (PA) were identified. The plan also defined 18 National Targets (NT) with 91 National Actions (NA) to ensure the implementation of these targets. The updated 2016 NBSAP was developed in line with the 2010 CBD strategic plan and taking into account the 2020 Aichi Biodiversity Targets. The updated 2016 NBSAP was endorsed by the CoM in April 2018 under Decision No. 62/2018.
- In January 2019, Lebanon submitted its 6th National Report to the CBD. It included an assessment for each NT including measures taken for its application and progress. The report also presented recommendations and main challenges in terms of implementing the updated 2016 NBSAP.
- The GoL is committed to the UN Sustainable Development Goals (SDG) from Agenda 2030. Consequently, in 2017 a national committee chaired by the Prime Minister was created in order to oversee the progress in SDGs. The first Voluntary National Review in 2018 reported on achievements that have been made towards reaching the SDGs, particularly SDG 14 "Life below water". It is worth mentioning that the updated NBSAP, 2016 linked NAs and SGDs. By implementing NAs concerning marine and coastal areas, SDG 3 "Good health and well-being", SDG 11 "Sustainable cities and communities", SDG 13 "Climate action", SDG 14 "Life below water" and SDG 15 "Life on land" will be fulfilled (MoE/UNEP/GEF, 2019) for the benefit of marine ecosystems and associated habitats.

Furthermore, a new draft fishing law was prepared by the MoA taking into consideration the new challenges in fisheries management as well as the new scientific references and benchmarks for the sustainable management of marine resources and the wellbeing of fisher communities taking into account the provisions of the biodiversity related conventions ratified by Lebanon. The draft law was submitted by the MoA to the CoM and is currently continuing the administrative process towards Parliament.

Moreover, the main activities of the project "Market Policy and Legislative Development for Mainstreaming the Sustainable Management of Marine and Coastal Ecosystems in Lebanon" (2013 – ongoing), funded by the GEF, implemented by the MoE and United Nations Environment Program (UNEP) and supported by IUCN-ROWA as executing agency (MoE/UNEP/GEF) include identification of threats to marine and coastal biodiversity in Lebanon, reviewing the existing policy and legislative tools, assessing the non-compliance causes, developing recommendations for legal reforms and law enforcement mechanisms, developing capacity building programs, as well as identifying CC impacts and adaptation measures. It will also compile results of previous studies and identify the needs to fulfil the national and regional objectives and international obligations. It is therefore in line with, and complements the objectives of the completed and ongoing projects and plans. Additionally, the project will enhance stakeholder and public participation in all its activities and will create a healthy atmosphere for the conservation of marine and coastal biodiversity in Lebanon. Amongst the completed activities of the project:

- "National consultancy for the identification of legal, policy and institutional gaps and policy reforms drafted for marine and coastal biodiversity protection" (2014-2015). Through this activity, the following outputs were achieved:
  - Development of the draft national law on Integrated Coastal Zone Management (ICZM) for Lebanon in response to the ratification of the ICZM Protocol. This draft law, was submitted by the MoE to the CoM which has collected the needed comments from the concerned ministries, and is currently awaiting the submission of its latest amended draft based on these comments to the CoM to subsequently be passed by Parliament. It

contains seven sections with 26 articles in addition to a clear definition of the CZ (adapted from the ICZM Protocol to fit the geography and scale of Lebanon). Its main articles stipulate the creation of a National Council for ICZM as an independent unit headed by the Prime Minister. Once enacted, the law will reduce a large portion of conflicts experienced on the CZ as well as reduce habitat destruction and increase protective measures that will benefit biodiversity (Nader and Abou Dagher, 2016).

- Review and update the National Strategy for ICZM developed in 2003 under the Coastal Area Management Program (CAMP) project, based on available literature and publications related to the subject matter over past 11 years. To date, the strategy has not been endorsed.

- "Coastal and Marine Biodiversity Data Collection and Biodiversity Reporting" in 2015. The activity resulted in a comprehensive database of published scientific papers and reports by universities, research centers, public institutions, international agencies and individual researchers (> 800 publications collected).
- Advanced management effectiveness tracking tools for the PINR and TCNR (2018).
- Training for the development of a National Red List for marine species in Lebanon following IUCN red List methodology (2019).
- Factsheets on marine Invasive Alien Species in the marine environment of Lebanon (2019).Monitoring Protocol for Marine Invasive Alien Species (IAS) specially adopted for the Lebanese Coastal and Marine Environment (2019).
- Factsheets on the marine and coastal birds of Lebanon (2019).
- "Atlas on the distribution of the Marine and Coastal Birds of Lebanon" (MoE/IUCN/UNEP/GEF; in press). The Atlas aims at raising awareness about the threats facing marine and coastal birds, and will inform conservation experts in the country about the priority areas and keystone species that merit priority attention and protection (including 40 bird species of high concern recorded along the Lebanese shoreline and for a distance of 7 km offshore).
- Guidelines on mainstreaming biodiversity conservation in the EIA process for development projects affecting marine and coastal ecosystems in Lebanon (2020).
- Economic valuation for the PINR and TCNR (2020- in progress).
- Climate change impact on marine and coastal zone in Lebanon and identification of knowledge gaps for a full assessment on the vulnerability of marine ecosystems, with a site specific climate change adaptation analysis for Anfeh hotspot (2020- in progress).

As for MPAs, the MoE and IUCN under the "Supporting the conservation and management of important marine habitats and species in Lebanon" project (2010-2012) developed in 2012 "Lebanon's Marine Protected Area Strategy" proposing 18 sites to be declared as MPAs in order to support the conservation and management of important marine habitats and species in Lebanon (MoE/IUCN, 2012).

Additionally, the SPA/RAC and UN Environment/MAP in 2018 in coordination with MoE and based on its request developed the:

- "National Monitoring Programme for Marine Biodiversity in Lebanon" that includes two Ecological Objectives: 1) biodiversity related to habitats and species: marine mammals, marine turtles and sea birds; and 2) NIS.
- "Action Plan Concerning Species Introductions and invasive species in Lebanon". The plan includes data collection and update at national level, dissemination, capacity building for experts and awareness in addition to coordination at national, Mediterranean and international levels.

Moreover, concerning marine turtles, the SPA/RAC and UNEP/MAP in coordination with MoE published two documents: 1) the first national stranding network for sea turtles and cetaceans and a guideline protocol for monitoring the interaction between marine litter and sea turtles in Lebanon (SPA/RAC-UNEP/MAP, 2020b); and 2) the annual report on monitoring and conservation of marine turtles in Lebanon representing the results of the survey done during the 2019 sea turtle nesting season covering 22 km of Lebanese sandy beaches and allowing to find new important marine turtle nesting sites (SPA/RAC-UNEP/MAP, 2020c). The 2020 annual report is in progress.

Additional relevant strategies, draft laws and projects implemented at national level can be found in Annex V: National strategies, draft laws and projects.

4.2.4. List the relevant international Agreement to which the Country is a Party

The GoL has ratified several international agreements and treaties related to the conservation and sustainable use of marine and coastal biodiversity and ecosystems that require commitment and obligation from Lebanon (Annex VI: International agreements). Amongst these, the main ones are:

- The CBD ratified by the GoL on December 15, 1994 (by Law No. 360/1994). This convention also covers marine and coastal biodiversity.

The major breakthrough in terms of Coastal Zone Management (CZM) and marine and coastal biodiversity in Lebanon is the ratification of the ICZM Protocol by the GoL (GoL; Decree No. 639 dated 18/09/2014) that entered into force on August 31, 2017, and the ratification of the amended SPA and Biodiversity Protocol (GoL; Law No. 127 dated 30/4/2019). The ICZM Protocol acts as a main driver in CZ protection and helps contracting parties to have a common framework to implement ICZM concepts with respect to protecting areas of ecological and landscape importance and the sustainable use of natural resources (*http://www.unep.org/NairobiConvention/docs/ICZM_Protocol_Mediterranean_eng.pdf*; Section 2.1).

In 1977, Lebanon has ratified the Barcelona Convention for the Protection against Pollution in the Mediterranean Sea by Legislation Decree No. 126/1977. This regional convention

aims at preventing and abating pollution from ships, aircraft and land based sources in the Mediterranean Sea. Under this convention, Lebanon has ratified the following protocols:

- Barcelona Convention Amendments: Ratification on 22/04/2009 and entrance into force on 22/05/2009.
- Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft: Signature on 16/2/1976; Accession on 30/06/1977.
- Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency: Accession on 08/11/1977 and entrance into force on 12/02/1978.
- Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea: Accession on 03/11/2017 and entrance into force on 03/12/2017.
- LBS Protocol: signed on 17/05/1980; Ratification on 27/12/1994 and entrance into force on 26/01/1995.
- SPA Protocol: Accession on 27/12/1994 and entrance into force on 26/01/1995 and its amendment: the Protocol Concerning SPA/BD: Ratification on 30/4/2019.
- ICZM Protocol: Accession on 01/08/2017 and entrance into force on 31/08/2017.

4.3. Transboundary issues and existing, planned or needed coordination/harmonisation at subregional or regional level

In Lebanon, transboundary issues related to the marine and coastal environments are managed through national laws and ratified international agreements that bind the country in their obligations.

Ratified international treaties:

- Law No.387/1994, related to the ratification of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. This convention "controls the transboundary movements of hazardous waste and considers shipments without prior consent as illegal".
- Law No. 412/2002, related to the ratification of the Agreement on the conservation of African-Eurasian Migratory Water Birds (AEWA) (one of the agreements of the Bonn Convention).
- Law No. 571/2004, related to the ratification of the conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic-ACCOBAMS (one of the agreements of the Bonn Convention).
- The "IMO International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC)" ratified in 2005, and "The International Convention on Civil Liability for Bunker Oil Pollution Damage" (BUNKER) ratified under Law No. 141/2011, manage transboundary pollution sources including oil spills.
- Law No. 223/2012, related to the ratification of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- ICZM Protocol (ratified by Decree No. 639/2014), stipulates in Article 28 that "the Parties shall endeavour, directly or with the assistance of the Organization or the competent international organizations, bilaterally or multilaterally, to coordinate, where appropriate, their national coastal strategies, plans and programs related to contiguous CZs. Relevant domestic administrative bodies shall be associated with such coordination". Whereas Article 29 states that "within the framework of this Protocol, the Parties shall, before authorizing or approving plans, programs and projects that are likely to have a significant adverse effect on the CZs of other Parties, cooperate by means of notification, exchange of information and consultation in assessing the environmental impacts of such plans, programs and projects".
- Decree 3320/2018, related to the ratification of the Convention on Conservation of Migratory Species of Wild Animals (CMS); known as the Bonn Convention

National legislation:

- Decree No. 10289/2013 stipulates in Article 45 that "the Minister of Energy and Water shall, upon approval of the proposed petroleum activities, inform the appropriate representative of jurisdictions which may be affected by the decision, and give account of what measures have been taken to address the significant environmental effects beyond the Lebanese jurisdiction".

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

5.1.1. Pressures and community wellbeing

In general, all economic sectors along the CZ act in a way that damages their own interests through the degradation of natural resources. Industry and urbanization generate the most serious impacts on marine ecosystems as well as on other sectors, putting intense pressure on common resources. Serious air and water pollution resulting from anthropogenic behaviour, industrial activities and the transport sector represent the most important impacts. Urban development is the main prominent land consuming sector, mainly at the expense of agriculture and in several cases the maritime public domain. Significant fresh and sea water pollution in the country are consequences of urban sprawl, mainly due to the lack of proper waste management systems and the improper enforcement of applicable laws (MoE/UNEP/UNDP, 2013a).

Tourism, which exhibits common characteristics with both industry and urbanization regarding the manner it utilizes natural resources, closely follows. The high consumption of both natural and local resources is inherent to tourism. It is possible however, to restrain the extent of the consumption if measures for energy and water cutbacks are taken. Pollution can be more easily dealt with in the case of industry and urbanization. The practice of arbitrary construction of marinas, breakwaters and artificial beaches will keep on having adverse effects until it is halted. Finally, the conflicts over the restriction of public access to beaches cannot be resolved unless a coastal set back is delimited and free access is attained (MoE/UNEP/UNDP, 2013a).

Agriculture and fisheries are less disturbing activities for the other sectors; their adverse consequences mostly affect their own survival. In fact, fishery is the most vulnerable sector, bearing the undesirable effects of the activities of all other sectors while not affecting anyone else. Application of sustainable fishing methods should go hand in hand with pollution abatement measures so that fisheries are maintained and developed. Agriculture is mostly suffering from its own practices; it needs to adopt more sustainable resource management measures such as proper use of water and rational application of agrochemicals (NBSAP, MoE/UNEP/GEF, 2016a).

5.1.2. Human health

Alien species have been also recorded to affect human health especially that local coastal communities are not familiar with these NIS. Fish species like the puffer fish (*Lagocephalus sceleratus*) if consumed can affect human health by causing intoxication and fatalities due to the ingestion of Tetrodotoxin (TTX) (Khalaf *et al.,* 2014; Boustany *et al.,* 2015); the stings of the Striped catfish (*Plotosus lineatus*) causes extreme pain and requires hospitalization; as well the venomous spines of the Common lionfish *(Pterois miles)* causes intense pain, edema and erythema (Nader and El Indary, 2011; Nader *et al.,* 2012; Bariche, 2018). Also, among the main threatening species are toxic microalgae (e.g. *Ostreopsis sp.*), and the nomad jellyfish (*Rhopilema nomadica)* and the mauve-stinger (*Pelagia noctiluca*) that may affect the quality of bathing waters and

impact coastal tourism (Khalaf *et al.,* 2014; Boustany *et al.,* 2015; MoE/UNEP/GEF, 2016a; SPA/RAC-UN Environment/MAP, 2018; Badreddine *et al.,* 2020). In addition, non-native species, especially some toxic phytoplankton, can find their way into the Mediterranean and Lebanese coastal waters. To date, more than 12 toxic microalgae have been recorded especially microalgae belonging to *Ostreopsis sp*. (Abboud-Abi Saab, 2008; Abboud-Abi Saab and Hassoun, 2017).

More specifically, studies on different puffer fish species had shown a faster uptake of TTX during warmer months. Even though more investigation is needed to confirm the relation between toxicity and temperature, it can be predicted that as temperatures rise globally, and specifically in the Mediterranean which is very much affected by CC, the threats which this toxin poses might increase (De Sousa, 2011; Nader *et al.,* 2012). When this is coupled with easy migration routes and breaking of biological barriers, the need for awareness raising and prevention measures becomes paramount (Nader *et al.,* 2012).

Assessing the interaction of NIS with their surrounding ecosystems must be evaluated in depth and possible threats to human health and wellbeing should be well understood and detected. The "Action Plan Concerning Species Introductions and Invasive Species in Lebanon" (SPA/RAC-UN Environment/MAP, 2018) is a solid step towards reaching such a goal.

5.2. Critical impacts and effects on marine and coastal biodiversity

Coastal ecosystems and biodiversity are impacted unevenly among regions due to differences in vulnerability and exposure to different stresses. The main critical impacts are mainly due to CC, pollution and sea-filling. It remains to be seen whether the oil and gas sector and associated industries will be added to the list as this will depend on adherence to applicable laws and to the capacity of the GoL to enforce them.

Climate Change

Coastal systems are impacted by CC in an uneven distribution among regions due to differences in vulnerability and exposure to stresses. Global changes will translate into local impacts that require intervention and mitigation. The main negative effect of CC is expected to be manifested on the vermetid platforms and coralligenous assemblages, and through the invasion of NIS mainly from the Red Sea.

Pollution

Sources can be either land or marine based without ignoring the effects of overall air pollution that contributes not only to CC but also to the chemical composition of aquatic bodies.

Regarding land based sources of pollution, the following are to be considered:

- Solid waste: wastes carried by rivers into the CZ and chaotic dumpsites across the Lebanese territory, especially the coastal ones with a special focus on the most recent coastal dumpsites created in 2015 through sea-filling (Costa Brava and Bourj Hammoud). As already stated, the OCEANA mission reported human litter in deep-water habitats exposing the extent of the problem and need for remedial action.
- Wastewater: Major sewage treatment plants are non-operational leading to the dumping of untreated sewage directly into the sea. Knowing that industrial sites are mainly linked to the main sewer network exacerbates an already dire situation resulting in additional pollution of coastal waters.
- Agricultural run-off: Current agricultural practices are mostly traditional and unsustainable disregarding the impacts on natural resources especially soil and water. Pollution generated by this sector results from the uncontrolled use of chemicals such as fertilizers and pesticides that wash into the coastal zone.
- Visual and noise pollution: Part of coastal pollution is due to noise pollution coming from poor urban planning and the construction of coastal highways parallel to shorelines.

As for sea based sources of pollution, the maintenance of boats and ships (paints, antifouling agents, engine and hydraulic oils, etc.), and ballast waters from day-to-day shipping operations are major threats because they are steady and occur across the globe.

Habitat loss

Anthropogenic activities have added tremendous pressures on marine ecosystems through sand extraction for the real estate sector and through sea-filling for industrial, touristic and municipal purposes like dumpsites. Several ecosystems were seriously degraded such as vermetid platforms, sand dunes and river estuaries negatively affecting the viability of species (MoE/UNEP/UNDP, 2013a; Badreddine *et al.,* 2019; UNEP/MAP, 2019). Moreover, a set of data processed from the Landsat collection between 1975 and 2015 used to monitor the evolution in the built-up areas on the coastal zones in the Mediterranean showed that, for Lebanon, and within a 10 km belt from the shoreline, the percentage of built-up area increased from 9,9% in 1975 to 21.6% while within 1 km belt, the percentage increased from 24.2% in 1975 to 46,1% (UNEP/MAP, 2019). On the other hand, the "Evolution of the Lebanese Shoreline between 1962 and 2016" showed that sand and pebble beaches have retreated by 2 km^2 in 2016 compared to 1962 while more than 10 km^2 of sea-filling was added from 1962 until 2016 (Mitri et al, 2020). These changes have caused irreversible habitat losses along the Lebanese coast.

All references and publications reviewed for the purpose of this report resulted in a list of key sensitive areas on the CZ of Lebanon (Table 11). The table was adapted from the project entitled "Environmental Resources Monitoring in Lebanon (ERML) project", "Activity: Analysis of the Institutional and Legal Frameworks Related to Management and Monitoring of Coastal and Marine Areas" and updated where needed (MoE/UNEP/UNDP, 2013a).

Table 11

Conservation status of potential coastal sites in need for protection

Site Name	Location/Municipality	Conservation Status	Sources
Aarida estuary	Qleiaat.	Recommended/proposed conservation.	CDR/ECODIT/IAURIF, 1997; MoE/IUCN, 2012;
Cheikh Zennad Beach	Qleiaat.	Recommended/proposed conservation.	MoE; CDR/ECODIT/IAURIF, 1997.
Salinas and wetland of Qleiaat	Qleiaat.	Recommended/proposed conservation.	CDR/ECODIT/IAURIF, 1997.
Coastal dunes of Akkar Plain	Qleiaat. Mqeitaa. Qoubbet Chamra.	Recommended/proposed conservation.	CDR/ECODIT/IAURIF, 1997
Aarqa river estuary	Qoubbet Chamra.	National conservation.	MoE, Decision No. 188/1998.
City of Orthosia in El Bared River	Mhamrat.	N/A	
Terraces of El Mina beach	El Mina.	N/A	MoE/UNEP/UNDP, 2013a.
Canyon of Tripoli-Batroun	Tripoli-Batroun	NA	Aguilar *et al.*, 2018.
Terraces and Beach of southern Tripoli towards Qalamoun	Tripoli. Qalamoun.	National conservation.	Decree No. 3362/1972.
Ras Enfeh	Enfeh.	Proposed MPA. Declared as Hima.	MoE/IUCN, 2012; RAC/SPA - UNEP/MAP, 2012; MoE/ UNEP/UNDP, 2013a.; RAC/ SPA - UNEP/MAP, 2014. Enfeh municipal council decision
Salinas, wall promenade of Enfeh and Our Lady of Natour Monastery	Enfeh.	Declared as Hima.	MoE/UNEP/UNDP, 2013a. Enfeh municipal council decision.
Heri - Chekka beaches	Chekka. Heri.	N/A N/A	
Offshore freshwater marine springs in Chekka	Chekka.	N/A	
Promontory cape and cliffs of Ras el Chakaa and Saydet El Nouriyeh Monastery	Hamat.	Recommended/ proposed conservation - International conservation.	CDR/ECODIT/IAURIF, 1997; CDR/DAR/IAURIF, 2005; IMAC, 2009; MoE/IUCN/ AECID, 2011; MoE/IUCN, 2012; RAC/SPA - UNEP/MAP, 2012; MoE/UNEP/UNDP, 2013 a; RAC/SPA - UNEP/ MAP, 2014.
Selaata terraces	Selaata.	N/A	MoE/UNEP/UNDP, 2013a
El Jawz River estuary	Koubba/Batroun.	National conservation.	MoE, Decision No. 22/1998.
Batroun National Marine Hima at the National Centre for Marine Sciences	Batroun.	National conservation.	MoA, Decision No. 129 of 1991; MoE/IUCN, 2012; MoE/ UNEP/UNDP, 2013a; SPA/ RAC–UN Environment/MAP, 2017.
Historical Center and Fishing Harbor of Batroun	Batroun.	N/A	MoE/IUCN, 2012; MoE/ UNEP/UNDP, 2013a; SPA/ RAC–UN Environment/MAP, 2017.
Beaches of Kfaraabida	Kfaraabida.	N/A	CDR/DAR/IAURIF, 2005
Fadaous ancient tell	Kfaraabida.	None.	Recently discovered.
Medfoun rocky area	Thoum (kaemakamiyeh).	N/A	MoE/IUCN, 2012; MoE/ UNEP/UNDP, 2013a; SPA/ RAC–UN Environment/MAP, 2017
Beaches in the South and North of Jbeil (Amshit-Jbeil)	Mounsef. Aamshit. Jbeil.	Recommended/proposed conservation.	CDR/ECODIT/IAURIF, 1997; MoE/IUCN, 2012; MoE/ UNEP/UNDP, 2013a; SPA/ RAC–UN Environment/MAP, 2017.
Marine environment in front of the fishing harbor of Jbeil	Jbeil.	N/A	MoE/IUCN, 2012; MoE/ UNEP/UNDP, 2013a; SPA/ RAC–UN Environment/MAP, 2017.
Ibrahim River estuary (and archaeological sites)	Ibrahim River.	National conservation - Recommended/proposed conservation.	MoE, Decision No. 34/1997; CDR/ECODIT/IAURIF, 1997; CDR/DAR/IAURIF, 2005; MoE/IUCN, 2012.
Coastal Front Rocks and terraces of Wata Slim (Tabarja)	Tabarja-Kfaryassin.	National conservation.	MoE, Decision No. 200/1997.
Maameltein promontory	Jounieh.	N/A	
Junieh Canyon	Jounieh.		MoE/IUCN, 2012; Aguilar *et al.*, 2018.
Bay of Jounieh	Jounieh.	N/A	
Ghadir River estuary	Jounieh.	N/A	
El Kelb River estuary (and historical site)	Dbayeh.	National conservation - Recommended/proposed conservation.	MoE, Decision No. 97/1998; CDR/DAR/IAURIF, 2005; CDR/ECODIT/IAURIF, 1997; MoE/UNEP/UNDP, 2013a.
Saint Georges Canyon	Beirut.	N/A	MoE/IUCN, 2012; Aguilar *et al.*, 2018
Beirut River estuary	Beirut.	National conservation.	MoE, Decision No. 130/1998.

Site Name	Location/Municipality	Conservation Status	Sources
The rock and the small bay of Grotte aux Pigeons in Beirut and prehistoric site near the rock	Beirut.	N/A	MoE/IUCN, 2012; RAC/SPA - UNEP/MAP, 2012; MoE/ UNEP/UNDP, 2013a; RAC/ SPA - UNEP/MAP, 2014.
Ancient Persian Harbor	Beirut.	N/A	
Sandy beach of Ramlet El Bayda in Beirut	Beirut.	N/A	MoE/UNEP/UNDP, 2013a;
Sandy beaches of Jnah	Beirut.	N/A	
Sea grass meadow in front of the Airport wave breaker	Tahwitat El Ghadir/ Khaldeh.	N/A	MoE/IUCN, 2012;
Beirut Escarpment	Beirut.	N/A	MoE/IUCN, 2012; Aguilar *et al.*, 2018.
Khaldeh archaeological site	Tahwitat El Ghadir/ Khaldeh.	Private/educational area.	MoE/UNEP/MAP, 2005.
Beaches and estuary of Damour	Damour.	Private/educational area. National conservation - Recommended/proposed conservation.	CDR/ECODIT/IAURIF, 1997; UNEP/MAP/RAC-SPA, 2002a; MoE, Decision No. 29/1998; CDR/DAR/IAURIF, 2005;
Ras Saadiyat	Damour.	N/A	
Sandy beaches of Rmeileh and Jiyeh	Jiyeh. Rmeileh.	Private/educational area.	UNEP/MAP/RAC-SPA, 2002a.
Awally river estuary	Saida.	National conservation.	MoE, Decision No. 131/1998; CDR/DAR/IAURIF, 2005; MoE/IUCN, 2012.
Beaches North and South of Saida	Saida.	N/A	MoE/IUCN, 2012; UNEP/MAP, 2012; MoE/UNEP/UNDP, 2013 a; RAC/SPA - UNEP/ MAP, 2014.
Saida Zeereh	Saida.	N/A	MoE/IUCN, 2012.
Zahrani estuary	Saida.	N/A	
The sea castle and underwater city of Saida & sea façade &old harbor	Saida.	N/A	
Tell El Burak	Aadousieh/Sarafand.	Private/educational area.	MoE/UNEP/MAP, 2005.
Ancient tell of Sarafand	Sarafand.	N/A	MoE/UNEP/UNDP, 2013a.
Aadloun beach and caves	Aadloun.	None	UNEP/MAP/RAC-SPA, 2002a; MoE/UNEP/UNDP, 2013a.

Site Name	Location/Municipality	Conservation Status	Sources
Qasmieh estuary	Bereghlieh.	N/A	MoE/IUCN, 2012; MoE/ UNEP/UNDP, 2013a.
Mhayleeb beach	Bereghlieh.	None.	Personal communication with Municipality of Bereghlieh; MoE/UNEP/ UNDP, 2013a.
Tyre Canyon	Tyre.	N/A	MoE/IUCN, 2012; Aguilar *et al.*, 2018.
North Tyre beach (Ras-Siddine-El-Bahr)	Tyre.	Recommended/proposed conservation.	MoE, 1991; UNEP/MAP/ RAC-SPA, 2002a; UNEP/MAP, 2012; MoE/UNEP/UNDP, 2013a; RAC/SPA - UNEP/ MAP, 2014.
Bakbouk hot water springs	Abassieh.	Declared as MPA in 2020	MoE/UNEP/UNDP, 2013a. Law No. 170/2020 (Establishment of Abassieh Coast Nature Reserve)
Mansouri beach	Mansouri.	None-Recommended/ proposed conservation. Declared as Hima.	UNEP/MAP/RAC-SPA, 2002a; MoE; Municipality Mansouri/ Qleileh; MoE/UNEP/UNDP, 2013a. (Hima through municipal council decision)
White cliffs of Bayada	Nakoura.	Recommended/proposed conservation.	
Iskandarouna springs and beach	Nakoura.	N/A	CDR/ECODIT/IAURIF, 1997.
White cliffs and bay of Naqoura	Nakoura.	Recommended/proposed conservation. Proposed MPA	CDR/ECODIT/IAURIF, 1997; MoE/IUCN, 2012; UNEP/MAP, 2012; MoE/UNEP/UNDP, 2013a; RAC/SPA - UNEP/ MAP, 2014.
Umm El Rabb site	Nakoura.	N/A	
Umm El Amad site	Nakoura.	None	MoE/UNEP/MAP, 2005.

6.

Assessment of national priority needs and response actions

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6.1. Needs

This section reflects the needs of the country in terms of marine and coastal biodiversity. Needs could be categorized according to three different levels: 1) institutional, legal and governance level; 2) research, training and capacity building level; and 3) monitoring and scientific data level.

6.1.1. On the institutional, legal and governance level:

- Update the legal instruments that are outdated in line with scientific and technological progress.
- Efficient law enforcement.
- Increase the rate of promulgating updated draft laws.
- Revision of laws stipulating the mandates of different public institutions in order to define the role of each institution in marine and coastal ecosystems and their proper management and avoid overlaps and conflicts (SPA/RAC-UN Environment/MAP, 2018a).
- Mainstreaming marine and coastal biodiversity areas into national and sectoral development plans.
- Establish a platform for exchange of information on project planning and implementation, existing institutional channels and on data needed.
- Increase Lebanon's engagement in international agreements related to marine and coastal areas biodiversity through ensuring endorsement by all stakeholders.
- Create a system for data collection and processing, quality assurance and control, or a reporting/monitoring system.
- Increase access to data from public institutions.
- Increase consistency of data between different official sources.

6.1.2. On research, training and capacity building level:

- Avoid duplication of tasks in terms of financing similar projects or reports.
- Introduce more academic programs in fields related to marine and coastal resources management including conservation of biodiversity.
- Encourage joint research with Mediterranean countries in order to increase exchange of expertise and knowledge.
- Improve coordination between the GoL and academic and research bodies, NGOs and other relevant institutions to divide actions according to the expertise of each in order to meet national objectives.
- Raise the awareness of coastal resource users about the importance of conserving marine and coastal biological resources and the best means to achieve this conservation.
- Support technically and financially the current marine and coastal research centres and develop new ones in different regions of Lebanon.
- Involve professional NGOs in environmental monitoring and capacity building activities, as well as support their roles in lobbying and advocacy.

6.1.3. On the monitoring and scientific data level

- Storage of, sharing and access to scientific data at national level.
- Data on water quality in real-time.
- Construction of data series for waves, coastal currents, SLR, beach profiles and isostatic movement of coastal lands.
- Long-term monitoring of CC effects like SLR, SST, and acidification and deoxygenation.
- Daily time-series for marine meteorological datasets.
- Updated detailed geological and geomorphological maps for Lebanon.
- Launch long-term monitoring of sediment and organic loading from rivers including their transport and distribution.
- Act towards halting pollution from point sources already identified through legislation and other means while at the same time mapping remaining sources to reduce to the extent possible the amount of pollution entering CZs.
- Value the cost of environmental degradation of hotspots along the Lebanese coast, and optimize interventions by calculating the remedial cost to curb coastal degradation.
- Work interactively with the Central Administration of Statistics (CAS), Ministry of Social Affairs, CDR, etc. to come up with one reliable population dataset for coastal residents.
- Determine the gross domestic product (GDP) of the CZ.
- Inventory all economic assets and activities dependent on the CZ and associated resources.
- Extensive evaluation of the economic value of non-marketed goods (recreational, cultural, subsistence and natural values).
- Research on quantifying the value of coastal recreation and indirect-use values.
- Commission a study to identify and map the spawning and nursing grounds of marine organisms, especially those of commercial value.
- Monitor key species selected under the "National Monitoring Programme for Biodiversity in Lebanon" (SPA/RAC-UN Environment/MAP, 2018a) and the Deep-Sea report (Aguilar *et al.,* 2018).
- Monitor NIS species selected under the "National Action Plan on species introductions and invasive species in Lebanon" and "National Monitoring Programme for Biodiversity in Lebanon" (SPA/RAC-UN Environment/MAP, 2018a, 2018b).
- Stock assessment for exploited marine species especially in the fisheries sector.
- Identification, monitoring and conservation of sensitive species.
- Sustainability of funds for national key scientific studies and assessments.
- Regional collaboration, scientific and otherwise on common issues as NIS, fisheries, shared stocks of commercial species, and CC impact on biodiversity amongst others.
- Monitoring the health of rocky shores in general and the complex vermetid platforms and coralligenous assemblages and canyons in particular, and the viability of key species in changing climate scenarios implicated in building and preserving such ecosystems.
- Continue the monitoring of species richness of sandy beaches with focus on sea turtle nesting grounds and adaptation of turtle species to beaches affected and/or threatened by degradation and CC.
- Monitoring the impacts of CC on coastal habitats and ecosystems in general and sensitive habitats and ecosystems in particular.

6.2. Urgent actions proposed

It is most urgent on institutional, legal and governance levels to ensure the implementation of the ratified international conventions by issuing applicable decrees and by enforcing existing domestic laws concerning the protection of marine ecosystems. On the level of research, it is crucial to avoid duplication of tasks, projects and reports. Actually, the past years have seen a large amount of funds invested by different international institutions for the production of review reports on the marine environment in the absence of new substantial information that warrants the drafting of such reports. In addition, each funded project allocated a budget for a "Status Report" of the Lebanese marine and coastal areas leading to the redrafting of the same information to meet the objectives of the funding body. It is imperative that funds be directed towards filling scientific gaps, mapping of habitats, expanding knowledge of ecosystems and energy flows, and towards launching and sustaining monitoring programs for marine biodiversity and CC impacts. Furthermore, the GoL should endeavour towards meeting its obligations in terms of mainstreaming biodiversity into policy frameworks by launching and supporting targeted actions that will allow reaching such a goal.

In this context, the GoL has already set its PAs in terms of biodiversity protection through the NBSAP that was endorsed in 2018. The 6th National Report presented to the CBD in 2019 assessed the achievements made to these PAs (MoE/UNEP/GEF, 2019). Recommendations for achieving Lebanon's NTs require the following:

- Ministries and public agencies should integrate relevant NBSAP NAs into their respective action plans and policies, budgets and activities, allowing a better implementation of the NBSAP and the mainstreaming of biodiversity into different sectors.
- Scientific research projects and activities undertaken by the academic sector and NGOs should incorporate the NAs in the NBSAP to ensure support to its implementation.
- Implementing the NBSAP through a programmatic approach. This could be achieved by mobilizing national budgets leading to a more effective international community involvement in filling gaps in financial resources.

Ensure effective stakeholder coordination for the implementation of the NBSAP through the project's Steering Committee (MoE/UNEP/GEF, 2019).

7.

Funding problems and opportunities

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Funding remains the main challenge for continuous, targeted marine biodiversity studies and for the launching and sustainability of monitoring programs. There is a weakness in well-established research avenues and monitoring programs related to marine environments in Lebanon. For example, studying marine dynamics, biological interactions, impacts of pollution, sediment loading and transport and other important factors entail extensive and long-term investments (SPA/RAC-UN Environment/MAP, 2018a). Monitoring programs and research activities are not allocated any funds in the national budget and the production of new information is supported either by international funding agencies or by the academic and research institutions themselves.

In addition to the traditional research axes, several opportunities for biodiversity conservation and monitoring though have presented themselves within the oil and gas sector, the fisheries sector, and the expected impacts of CC. In the oil and gas sector, EIAs will have to be carried out and therefore will indirectly add to data sets already available for deep-sea environments, while the rising fisheries issues related to shared fish stocks and national stock management will require that species be monitored and meta-datasets generated. As for CC impacts, they have been receiving growing attention by scientists, the central government and international organizations. Increased funding will allow the production of relevant data for conservation and mitigation measures. The below list presents potential national and international donors:

- Central bank (green loans).
- Private Banks (green credits).
- Funds from Lebanese ministries to the Protected Areas Management Committees, NGO's, municipalities, consultancies, academic institutions etc.
- Public Private Infrastructure Advisory Facility (PPIAF).
- European Union (EU).
- Global Environment Facility (GEF).
- German International Cooperation (GiZ).
- United States Agency for International Development (USAID).
- Italian Agency for Development Cooperation
- The Spanish Agency for International Cooperation and Development (AECID).
- Japan International Cooperation Agency (JICA).
- Swedish International Development Cooperation Agency (SIDA).
- Norwegian Agency for Development Cooperation (Norad).
- Belgian Development Agency.
- Federal Ministry for Economic Cooperation and Development (BMZ).
- Austrian NAMA Initiative.
- Development Bank of Austria.
- Global Methane Initiative (USEPA).
- International Development Research Centre, Canada (IDRC).
- Fonds Francais pour l'Environnement Mondial (FFEM).
- International Climate Initiative of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.
- Belgian Investment Company for Developing Countries.
- Centre for International Migration and Development.

- PROPARCO (The private sector financing arm of Agence Française de Développement (AFD)
- Citibank/Citigroup Foundation.
- Critical Ecosystem Partnership Fund (CEPF).
- Heinrich Boell Foundation.
- Aga Khan Development Foundation.
- Monsanto Fund.
- The Hatoyama Initiative.
- MAVA Foundation for Nature
- Gates Foundation.

7.1. Regular national sources, potential co-financing for international funding

There is no direct funding for projects related to marine and coastal biodiversity by the GoL. Actually, funding of such projects should be ensured through a budget allocated to the MoE, but the Ministry, due to its limited national budget, largely depends on funding from international bodies to execute scientific studies. It is worth mentioning though that the Lebanese Central Treasury fund provides through the MoE yearly financial contributions to the Protected Areas Management Committees. Even though articles 8 to 11 of Law No. 444/2002 stipulate the creation of a National Environmental Fund (NEF), this has not occurred because its application decree has not been issued yet. This Law also sets the principle of "Polluter Pays" that may, through fines, ensure additional budgets to environmental protection measures. Likewise, this article has not been enabled yet.

On the other hand, the recent Protected Areas Framework Law (130/2019) allowed the collection of entrance fees from the visitors to the nature reserves as well as fees for practicing specific ecotourism activities, and states that these fees will be directly submitted to the reserves' committees to be used for improving the status of the reserves.

Moreover, other generated income like the fees of hunting permits that the MoE started to issue since 2017 on a yearly basis, are submitted directly to the Central Treasury and not redirected specifically to the MoE for environmental initiatives.

7.2. Other sources (private, public, partnership)

Other funding opportunities for research have been secured by the NCSR in Lebanon for individuals and/or research groups. In order to ensure funding, the Associated Research Unit at the NCSR necessitates collaboration between two institutions at least in submitting proposals. Awards are given after evaluation through a competitive procedure. This encourages collaboration between different institutions on research activities within the national priorities as set by the NCSR.

Furthermore, funds provided by universities to graduate students and through bilateral cooperation between national and international universities allows funding theses for marine and coastal research.

Other sources may include funding from embassies. Such funding is usually based on the policies adopted by the respective governments and the eligibility of Lebanon for such support.

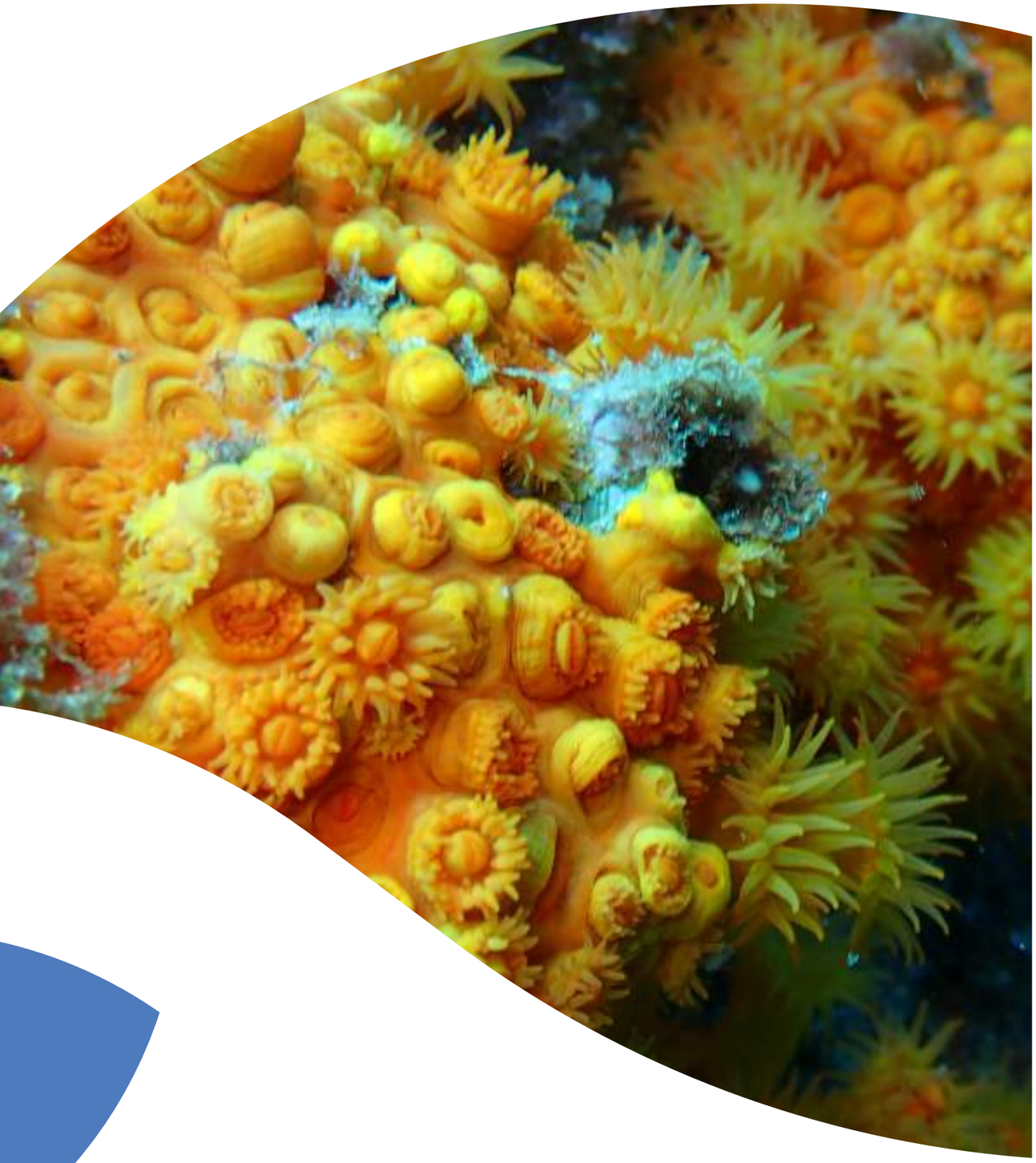
7.3. International funds, projects, programmes, national eligibility for international programmes/funds (e.g., green funds) identified.

Due to the above-mentioned constraints in local sources of funding, public institutions including the MoE, MoA, LARI, NCSR, academic institutions, NGOs, and municipalities turn to external sources of funding to achieve conservation and management goals related to marine and coastal ecosystems. Funds could be through grants, technical assistance or loans.

Some of potential international donors provide funds through other implementing institutions such as the United Nations Development Program (UNDP), United Nations Economic and Social Commission for Western Asia (ESCWA), UNEP, UNESCO, United Nations Industrial Development Organization (UNIDO) etc. while others deliver direct funds as listed above.

8.

Conclusions and recommendations



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As it can be seen, several initiatives have been launched in the past couple of decades to properly and sustainably manage marine and coastal resources while taking into consideration the well-being of coastal communities.

It is imperative that national species lists for all taxa be produced and updated regularly. In addition, coastal and deep-sea habitat mapping needs to be launched especially with the introduction of the oil and gas sector.

More importantly, national conservation plans and monitoring programs for biodiversity, NIS, CC, pollution and many other issues must be endorsed by the proper authorities and funds allocated and implementation initiated. Several plans and strategies have become outdated and need to be updated while newly developed plans and strategies need to be put on the track of execution. In many cases funds, effort and resources are spent on redundant technical reports where information is repetitive with low benefits for advancing knowledge. It is recommended that a decision be taken to direct funds towards applied research and monitoring at national level that will culminate in filling data gaps.

Also, it is essential that organizations and countries concerned with maritime transboundary issues related to biodiversity, especially NIS, launch regional discussions with the Egyptian authorities to lead on initiatives that will result in instituting measures that will prevent the migration of Indo-Pacific species into Mediterranean waters through the Suez Canal.

The GoL is invited to coordinate actions according to the expertise of academic and research bodies, national experts, professional NGOs and other relevant institutions to meet the NAs set in the NBSAP and the objectives of other relevant plans and strategies. This report has clearly shown that biodiversity conservation and the sustainable use of marine and coastal resources including the management of NIS and mitigation of CC impacts have many developed plans and strategies at national level but suffers from the absence of needed financial resources and prioritization at political level to move these plans and strategies to actual execution (priority is mostly given to critical national issues).

Lastly, biodiversity protection and propagation cannot be achieved without the proper legislative framework. The GoL is invited to accelerate the process of the endorsement of the draft legislations related to marine and coastal areas and biodiversity that it has already developed (ICZM draft law, new fisheries draft law, draft laws establishing new MPAs, etc.) and the promulgation of application decrees for all legislation related to biodiversity protection.

Nevertheless, all of this is quite challenging when placed against the background of constant political instability in Lebanon and the Middle East. Moreover, the continuing Syrian refugee crisis since 2011 and the new national crises of 2020 (the severe economic crisis, the political impasse, the COVID-19 pandemic and the consequences of the Beirut explosion in 4 August 2020) have added serious challenges for scientists and administrators alike to achieve set goals. Such a chronic, complex situation represents the main obstacle towards fulfilling national targets and objectives.

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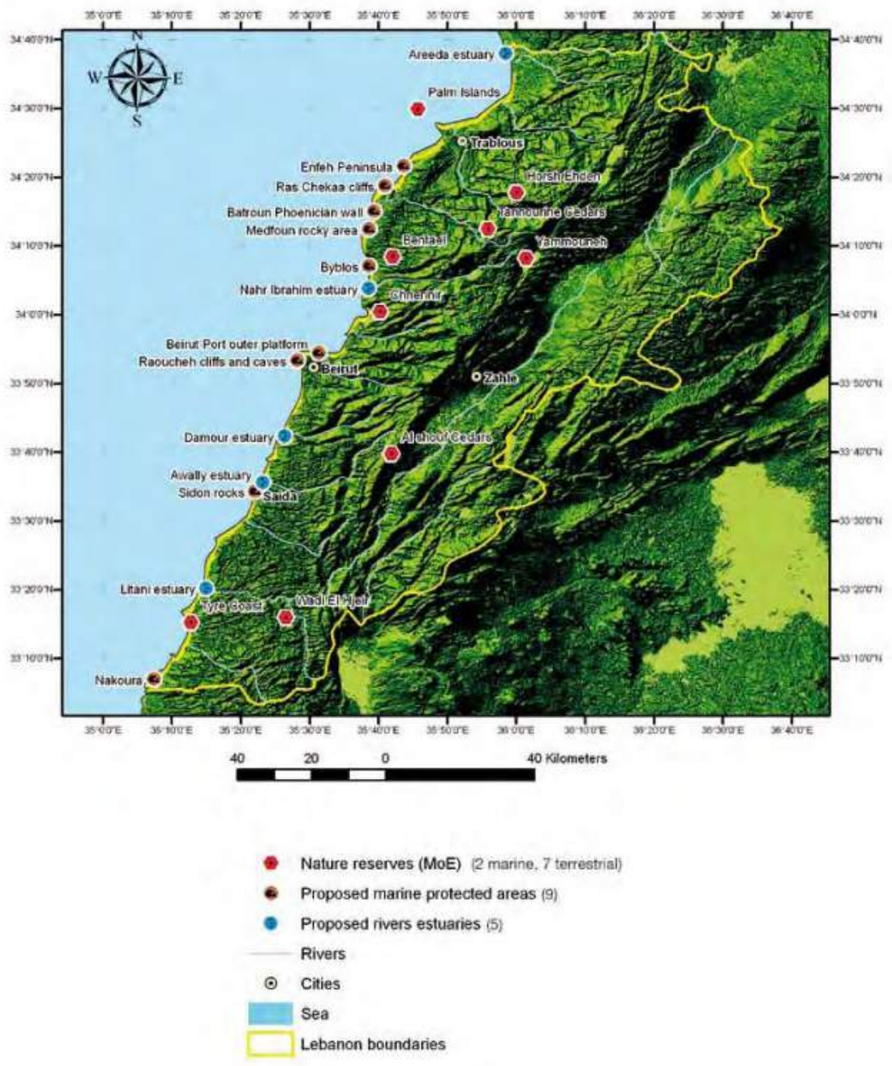
Annexes

Annex I.

Coastal sites of interest in Lebanon

Map of proposed marine protected are network



Lebanon's Marine Protected Area Strategy (MoE/IUCN, 2012)

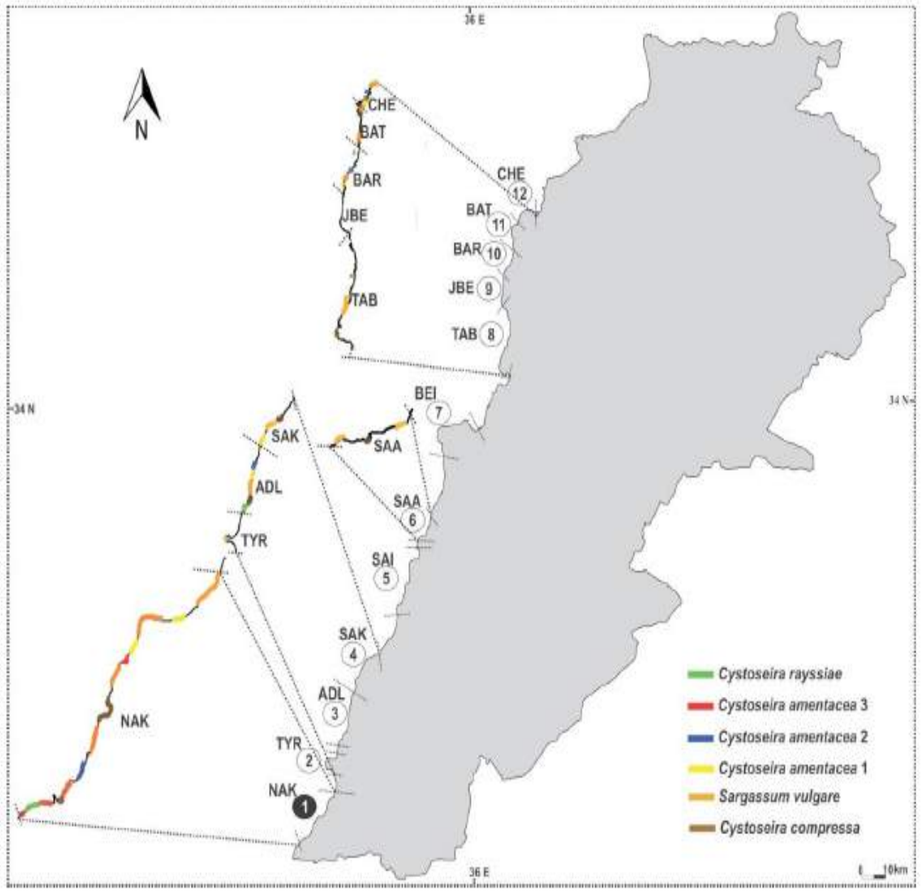
Map of other coastal sites of interest in Lebanon

Annex II.

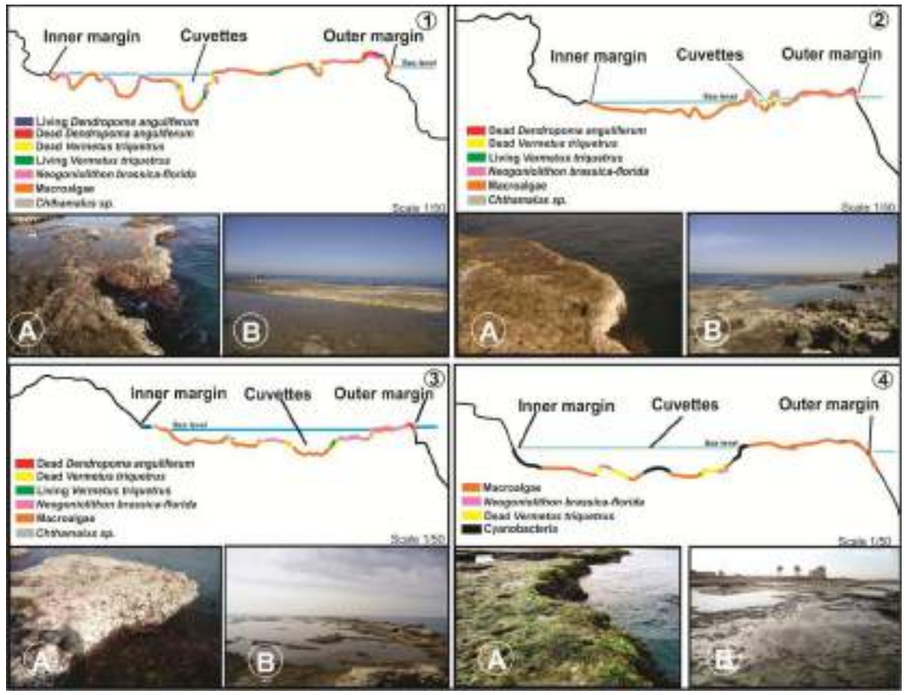
Mapping of habitats and species

Coastal habitats and species

The distribution of fucoids (*Cystoseira* and *Sargassum* species) along the Lebanese surveyed coastline (Badreddine *et al.*, 2018).

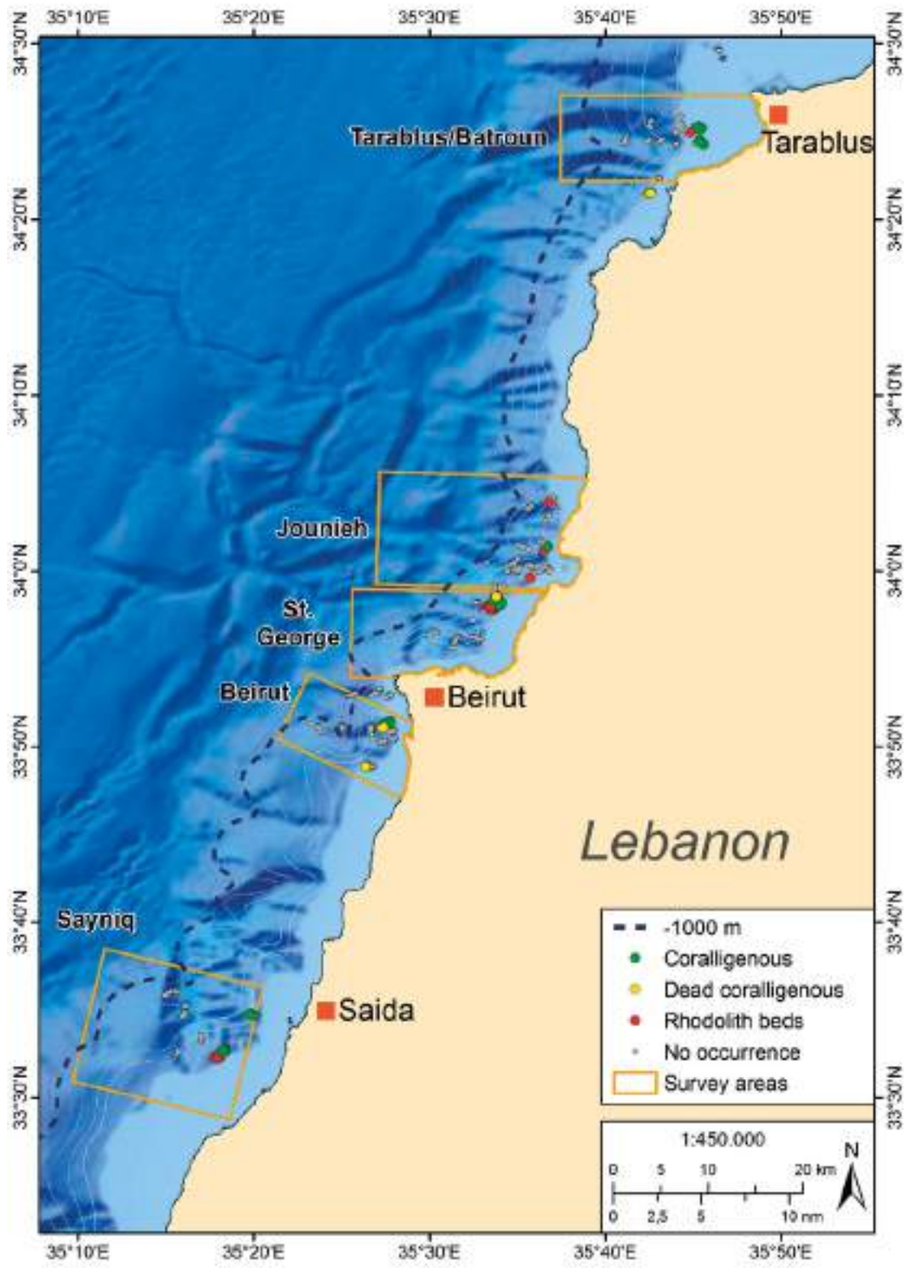


Reef topography and pictures of the outer/inner edge of the considered vermetid platforms. 1) Nakoura; 2) Tyr; 3) Batroun; 4) Tripoli; 5) Beirut. A) outer edge; B) inner edge (Badreddine *et al.*, 2019)



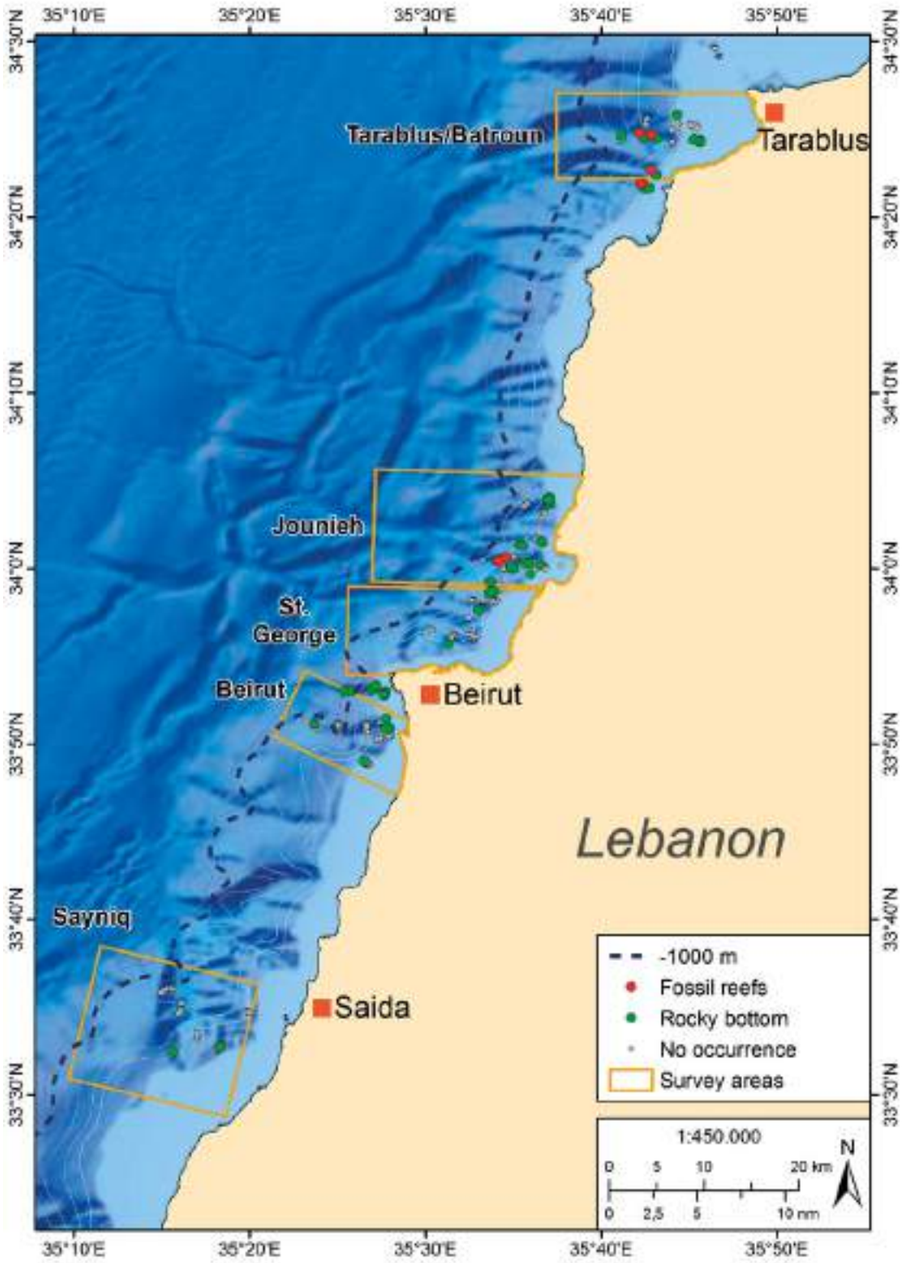
Deep-sea habitats and species

Distribution of coralligenous and rhodolith/maërl beds across sampled areas



Towards Deep-Sea Conservation in Lebanon project (Aguilar *et al.*, 2018).

Distribution of rocky bottoms and fossil reefs in surveyed areas



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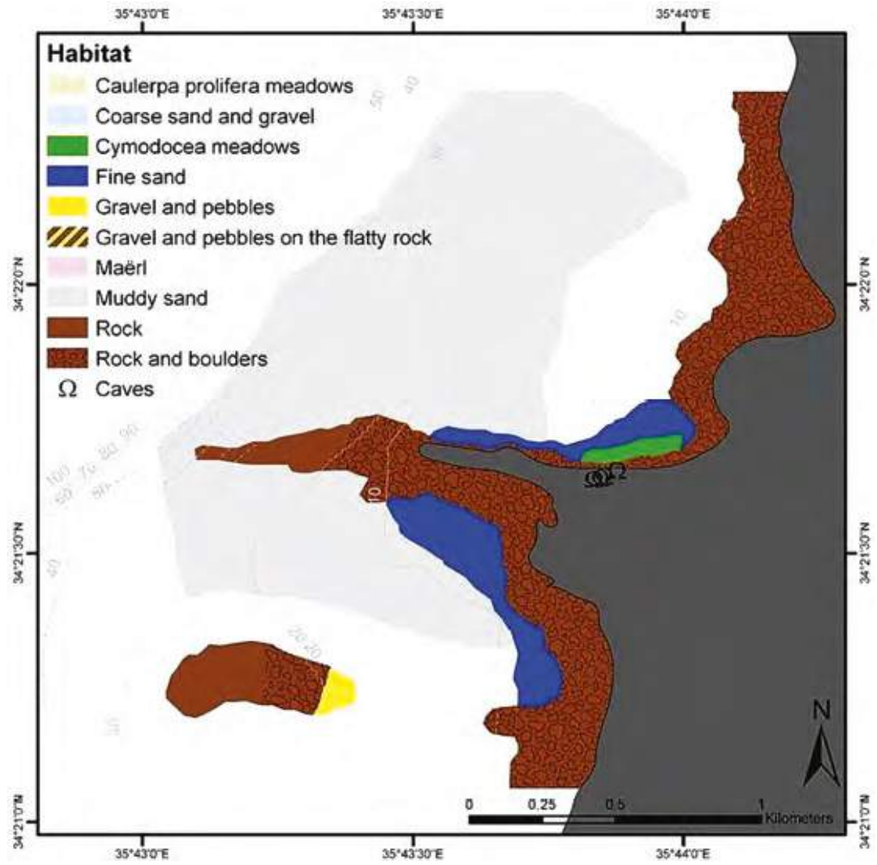
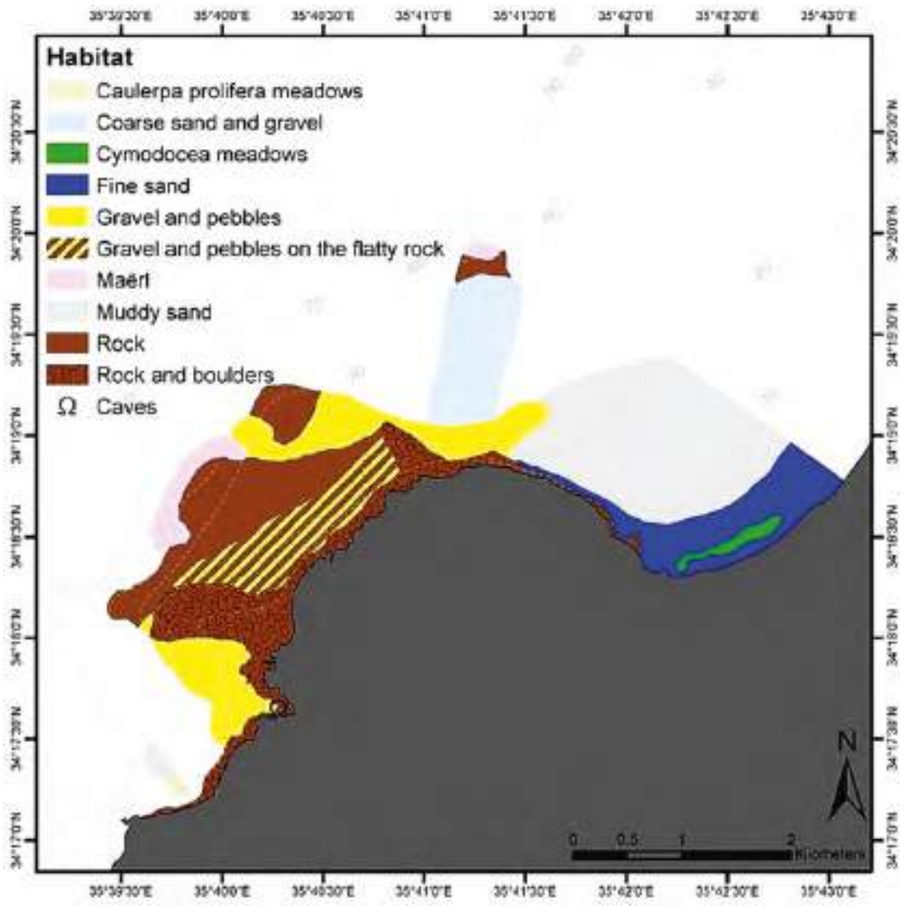
Annex III.

Bionomical Maps of Enfeh Area, Ras el Chakaa, Saida area, northern Tyre area, southern Tyre area

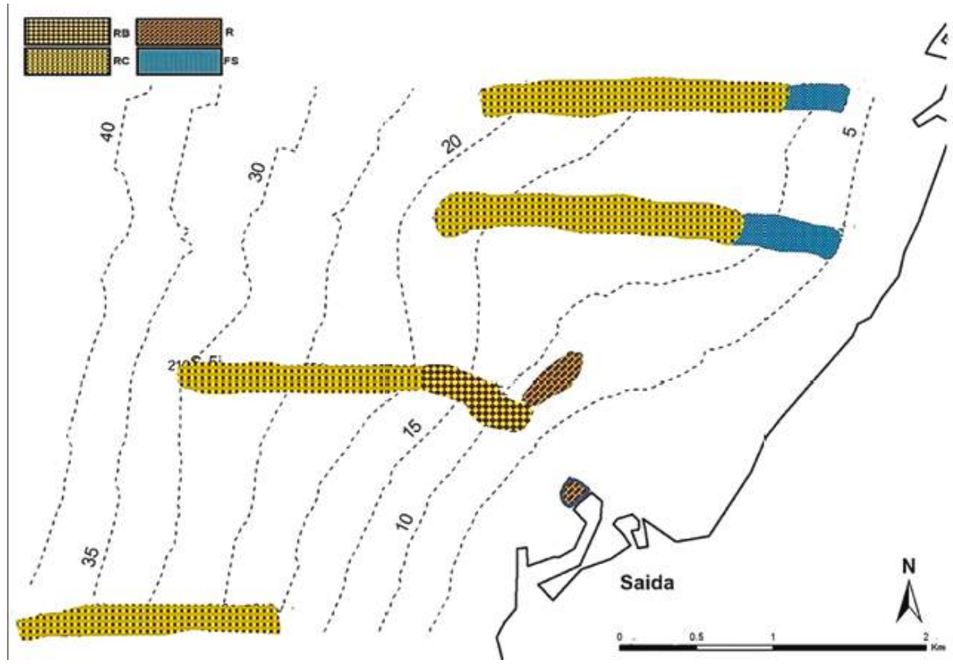
Bionomical mapping of the Enfeh area



Bionomical cartography of the Ras Chekaa area

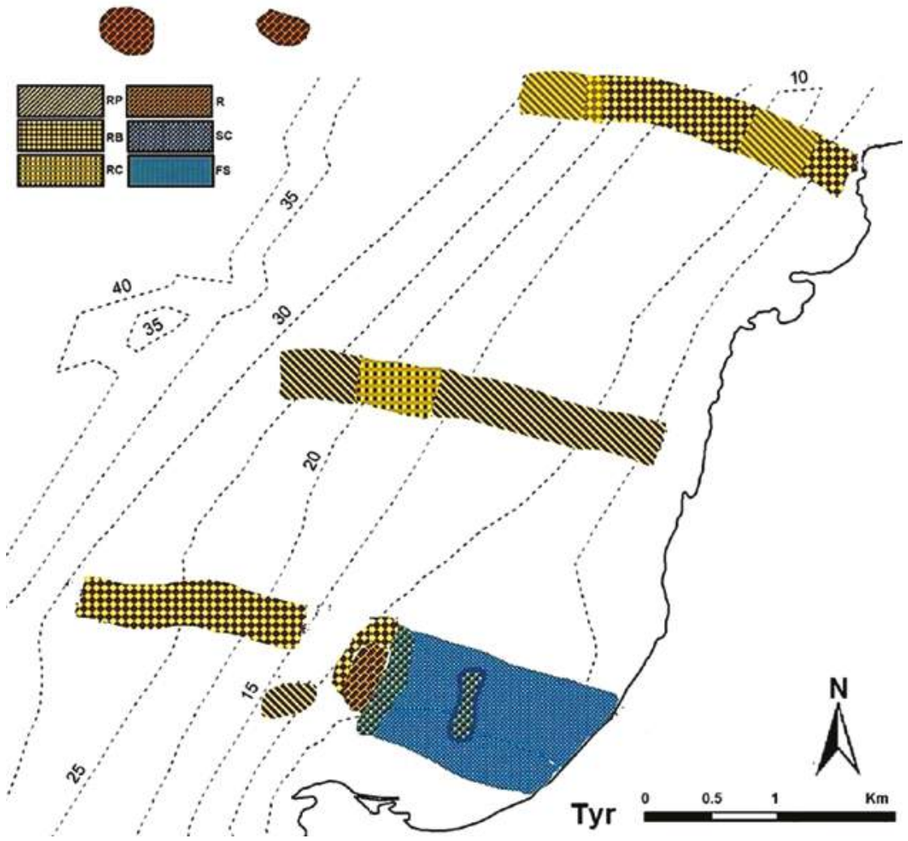


Bionomical mapping of the Saida area (hydroplane transects and plot dives)



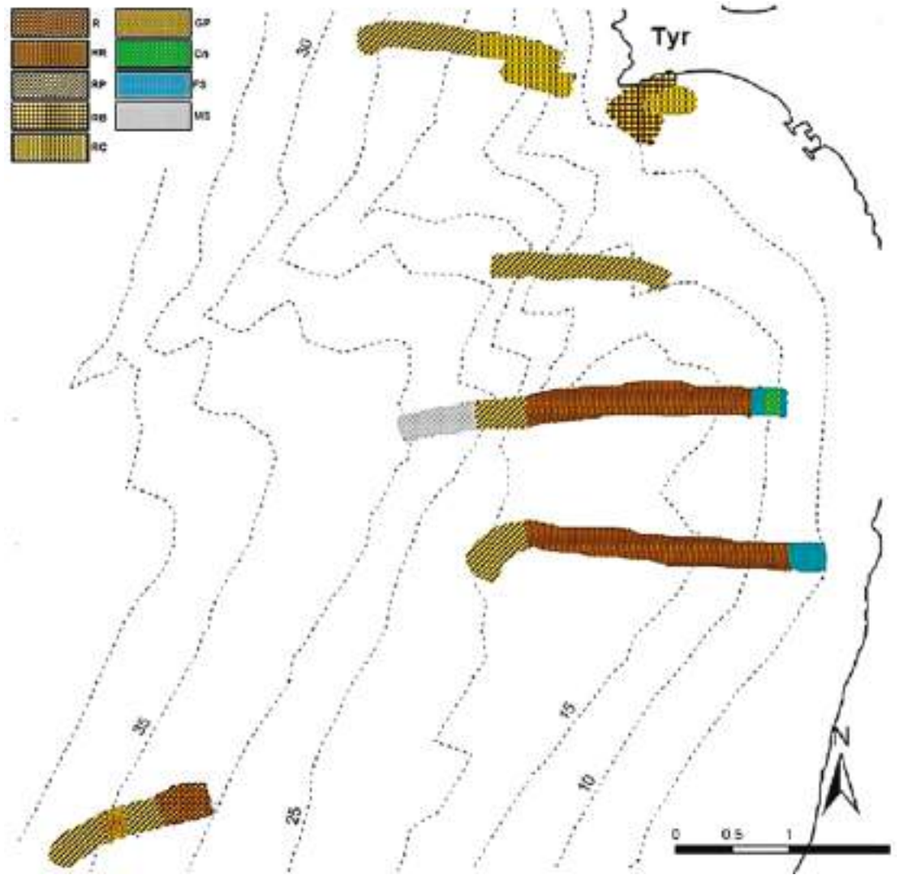
Legend:
(R) Rock;
(RB) Rock and boulders;
(RC) Rock and coarse sand-gravel channels;
(FS) Fine sand.

Bionomical mapping of the northern Tyre area (hydroplane transects and plot dives)



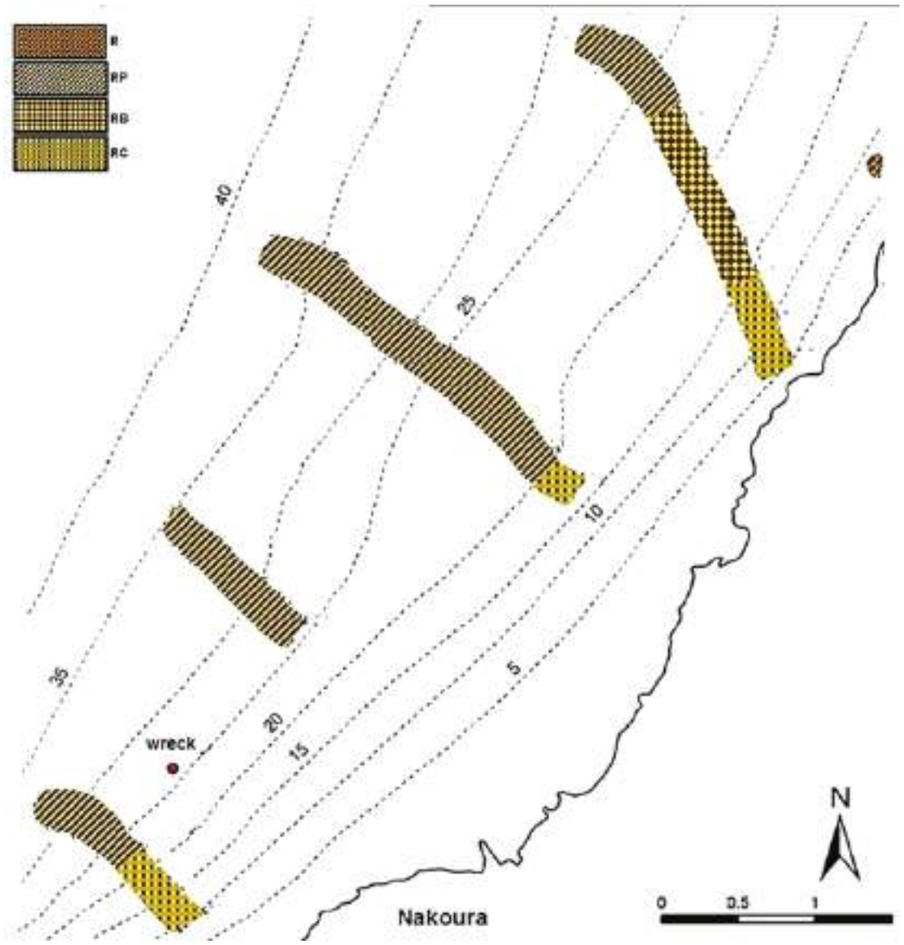
Legend:
(FS) Fine sand;
(R) Rock;
(RB) Rock and boulders;
(RC) Rock and coarse sand-gravel channels;
(RP) Rock and pebbles;
(SC) Sand and cobbles.

Bionomical mapping of the southern Tyre area (hydroplane transects and plot dives)



Legend:
(Cn) Cymodocea nodosa meadow;
(FS) Fine sand;
(GP) Gravel and pebbles;
(HR) High rocky outcrops;
(MS) Muddy sand;
(R) Rock;
(RB) Rock and boulders;
(RC) Rock and coarse sand-gravel channels;
(RP) Rock and pebbles

Bionomical mapping of the Saida area (hydroplane transects)



Legend:
(R) Rock;
(RB) Rock and boulders;
(RC) Rock and coarse sand-gravel channels;
(RP) Rock and pebbles

Annex IV.

Domestic Lebanese laws, decrees and decisions related to marine and CZ ecosystems.

Legislation	Year	Title
Laws		
Law No. 170	2020	Declaration of Abassieh as an MPA
Law No. 130	2019	Law for Protected Areas. Classification of categories of protected areas, it also regulates their establishment and management requirements.
Law No. 78	2018	Protection of air quality
Law No. 77	2018	Water Resources Law
Law No. 80	2018	Integrated Solid Waste Management Law
Law No. 28	2017	The right of access of information
Law No. 243	2012	New traffic law
Law No. 163	2011	"Law defining the maritime zones according to the Montego Bay Convention of 1982 as: interior waters, territorial waters, contiguous zone, Exclusive Economic Zone (EEZ) and continental shelf".
Law No. 132	2010	Oil and gas activities
Law No. 34	2008	Ratification of the Amendments to Barcelona Convention
Law No. 35	2008	"Law for the re-organization of the structure of the Ministry of Culture".
Law No. 571	2004	Ratification by the GoL of the agreement on conservation of Cetaceans of the black sea , Mediterranean Sea and contiguous Atlantic area ACCOBAMS
Law No. 690	2005	"Law on the Organization of the Ministry of Environment". The Law gives the MoE the prerogative to set the standards and norms for the protection of coastal zone, river beds and different water resources taking into account the protection of the environment and the conservation of its natural resources
Law No. 444	2002	Environmental Protection Law
Law No. 412	2002	Ratification by the GoL of the African-Eurasian migratory water birds agreement AEWA
Law No. 341	2001	Reduction of air pollution from transport sector and encouragement on the use of less polluting fuel
Law No.23	1999	Ratification by the GoL of the Ramsar convention on wetland of international importance specially as waterfowl habitat
Law No. 708	1998	Establishment of Tyre coast Nature Reserve in Jaftlak Ras Al Ain – Tyre Real Estate Zone
Law No. 292	1994	Protection against marine pollution
Law No. 360	1994	Ratification of the convention on biological diversity CBD
Law No. 121	1992	Establishment of two nature reserves (islands in front of Tripoli Beach)

Legislation	Year	Title
Law No. 14	1990	"Considering contracts for selling, leasing, and exploitation of the public maritime or municipal domain that are not compliant with applicable rules and regulations as absolutely invalid".
Law No. 19	1990	Ratification of the UNESCO convention on the protection of the cultural and natural heritage
Law No. 64	1988	Preservation of the environment against pollution from dangerous waste and hazardous substances
Law No. 64	1988	"Protection of the Environment from hazardous waste and products, and creation of a Higher Council for Environmental Protection presided by the Prime Minister".
Law No. 126	1977	"Ratification of the UNEP Barcelona Convention on Mediterranean Sea protection".
Law No. 7/1	1974	"Common instructions for coordinating the stoppage of contraventions on the public maritime domain".
Law of	1953	"Fines relating to the extraction of sand and gravel from the public maritime domain without a permit".
Law No. 2775	1929	Control coastal marine fishing
Law No. 372	1926	"Regulations relating to navigation, fishermen and fishing boats".
Law No. 144/S	1925	"Definition of Public Domain". The Decision strictly defines the public domain and includes the CZ in the definition. It is stated that the public domain serves for public use. Any other use of the public domain falls under the condition of obtaining the relevant permit.
Law No. 1104	1921	"The determination of the coastal zone scope and penalties related to the infringement of fishing rules".
Decrees		
Decree No. 167	2017	Providing tax exemptions on income and customs for individuals or legal entities engaged in environmental activities or importing goods to be used to avoid, reduce or eliminate pollution or to treat recycle and or reuses waste
Decree 167	2017	Application of article 20 of Law 444/2002 (tax reduction)
Decree No. 10289	2013	Petroleum activity regulations
Decree No. 8633	2012	Environmental Impact Assessment
Decree No. 8044	2012	Management Plan of Tyre's Coast's Natural reserve
Decree No. 8941	2012	Public transport incentives
Decree No. 8213	2012	"Decree that regulates the Strategic environmental assessment SEA.
Decree No. 2604	2009	Control of materials that depletes of the ozone layer
Decree No. 9765	2003	Control measures and penalties relating to industrial establishments
Decree No 8442	2002	Defined standards for gasoline and Diesel oil used in vehicles including their Sulfur content.
Decree No. 12189	1998	"Modification of the Master Plan for the southern Seaside of Byblos". The Decree sets restrictions on edifying permanent constructions on the public maritime domain with exceptions.
Decree No. 12841	1998	"Organization of fishing and leisure ports, and regulation of their use and conservation".
Decree No. 5645	1994	"The Master Plan for the southern Seaside of Byblos". The Decree sets restrictions to the construction on the coastal zone in Byblos area".
Decree No. 3899	1993	"Regulation of the extraction of sand and other materials from the public maritime domain and seabed".
Decree No. 2522	1992	"Annual fees for the temporary use of the public maritime domain". Although the Law does not forbid building on the CZ area, it sets the temporary character of any use of the public maritime domain.
Decree No. 34	1985	"Canceling Decree 144/1983 relevant to settling violations of the public maritime domain and regional water depths".
Decree No. 138	1983	"Specification of the width of the regional waters and regions where navigation is forbidden".
Decree No. 9132	1974	"Affiliating the seabed and depth of regional waters to the public maritime domain".
Decree No. 8327	1974	"Rules relating to fishing in rivers, and relevant permit fee".
Decree No. 15649	1970	"Regulation of the extraction of sand and other materials from the public maritime domain and seabed". The Decree does not set restrictions for construction on the public maritime domain. However, it imposes certain conditions to be respected in order to obtain the relevant permit.
Decree No. 5118	1969	"Regulation of beaches and pools in the city of Beirut".
Decree No. 9791	1968	"Organization of coastal monitoring activities".
Decree No. 11541	1968	"Organization of the body responsible for monitoring the coast within the Internal Security Forces".
Decree No. 4809	1966	"Regulating the Lebanese Coastal Zone".
Decree No. 4810	1966	"Regulating the occupation of the public maritime domain". The Decree sets the use of the public maritime domain as strictly given for public use. Any exception should be governed by specific rules determined in the Decree.
Decree No. 17614	1964	"The exploitation of public maritime lands".
Decree No. 17702	1964	"Regulating the coastal zone of Jounieh".
Decree No. 10121	1962	"Allowed regions and conditions for issuing permits for extracting gravel and sand from the public maritime domain".
Decree No. 11882	1948	"Enforcement of the law organizing fishing in rivers".
Decree No. 2383	1943	"Prohibiting the extraction of products from part of Beirut River".
Decisions		
CoM decision 203	2017	Establishment of Sustainable Development Goal committee
Decision MoA No. 1044/1	2014	General Conditions for the Protection of Whales and Marine Mammals.
Decion MoA No. 1045/1	2014	General conditions for Sharks fishing in Lebanon
CoM decision 41	2013	National coordination committee

Legislation	Year	Title
MoA Decision No. 346/1	2010	Regulates and identifies fishing types and equipment and bans the use of small mesh sizes and trolling nets and fishing using scuba diving equipment's
MoA Decision No. 93/1	2008	Regulates scuba diving industry including permitting procedures and safety measures and scuba diving fishing
MoEW Decision No. 14	2005	Establishment of the committee for field emergencies for energy issues and aquatic resources
MoA Dec. 88/1	2003	"Prohibition of the use of beach seines in fishing along the Lebanese coast".
MoE Decision No. 8/1	2001	National Standards for Environmental Quality related to air contaminants and liquid waste emitted from classified establishments into receiving water bodies. Amends decision 52-1/1996
CoM Decision No 9	2000	Organization of Land Public Transport sector in Lebanon and proposition of a reduction in number of public transport vehicles.
MoA Decision No. 125/1	1999	Prohibiting fishing of whales, seals and marine turtles
MoA Decision No. 43/1	1999	"Restricting the use of Sardine and "Ciaciulu" mesh to specific conditions".
MoA Decision No. 42/1	1999	"Organization of underwater fishing".
MoA Decision No. 281/1	1998	"Prohibiting sponge fishing for 5 years".
MoA Decision No. 291/1	1998	"Restricting the use of purse seine mesh to specific conditions".
MoA Decision No. 115/1	1998	"Organization of work at the Institute of Oceanography and Fisheries and defining the basis for cooperation with the National Center for Scientific Research".
MoA Decision No. 385/1	1997	Prohibits fishing activities in all estuaries all year round.
MoA Decision No. 397/1	1997	"Creation of a Fishing and Hunting Guidance Center at the Institute of Oceanography and Fisheries in Batroun- northern Lebanon".
MoA Decision No. 398/1	1997	"Creation of a Fishing and Fisheries Center at the Institute of Oceanography and Fisheries in Batroun- northern Lebanon".
MoE Decision No.52/1	1996	National Ambient Air Quality Standards (NAAQS) Determination of specifications and percentages to reduce air, water and soil pollution
MoA Decision No. 83/1	1983	"Prohibiting fishing and hunting of some animal species".
High Commissioner's Decision No. 95/L	1939	"Regulating sponge fishing".
High Commissioner's Decision Decision No.70/LR	1937	Coastal marine fishing system (Prohibit coastal marine fishing except for Lebanese ships)
High Commissioner's Decision Decision No. 166	1933	Antiquities system

Annex V.

National strategies, draft laws and projects.

National strategies:

Title	Year	Interest for marine and coastal ecosystems
Policy Paper for the Electricity Sector (Electricity Reform Paper), MoEW	2010 Updated 2019	The updated Policy Paper Has two main targets: 1) Reducing EDL's financial deficit and 2) improving the electricity supply. These will be achieved through tenders with **minimal environmental impact.**
Lebanon's 6th National Report to the Convention on Biological Diversity/ MoE	2019	Including a revision of the achievements regarding each NT (developed in the 2016 NBSAP) and their related actions in addition to recommendations and main challenges regarding the implementation of NBSAP
Nationally Determined Contribution (NDC) committee chaired by the MoE under the UNFCCC.	2018	The committee coordinates the implementation of Lebanon's NDC, reports, mainstreams, provides technical support and capacity building and identifies needs and gaps for CC mitigation.
National Monitoring Programme for Marine Biodiversity in Lebanon.	2018	Includes two Ecological Objectives: EO1. Biodiversity related to habitats and species: marine mammals, marine turtles and sea birds EO2. Non-Indigenous Species
National Action Plan Concerning Species Introductions and invasive species in Lebanon	2018	The plan includes a data collection and update at national level, dissemination, capacity building for experts and awareness in addition to coordination at national, Mediterranean and international levels.
Integrated Solid Waste Management Policy	2018	Sets the overall guiding principles and requirements for Solid waste management in Lebanon.
National Oil Spill Contingency Plan (NOSCP) in the Lebanese Waters/ MoEW	2017	The objectives of the NOSCP are in line with the International Maritime Organization (IMO) objectives for a NOSCP.
Lebanon's commitment to the UN sustainable development goals, 2030	2017	SDG 3 "Good health and well-being" SDG 11 "Sustainable cities and communities" SDG 13 "Climate action" SDG 14 "Life below water" SDG 15 "Life on land"
Lebanon's National Biodiversity Strategy and Action Plan/ MoE (NBSAP).	2016	Lebanon has submitted the first NBSAP to the CBD in 1998. The updated NBSAP submitted in 2016 including: • Selection of 13 Priority Areas. • Setting of 18 National Targets (NT) with 91 National Actions to ensure the implementation of the NTs. • Integration of the new CBD strategic goals • Integration of the 2020 Aichi Biodiversity Targets. Endorsed by the CoM in April 2018 (Decision No. 62/2018).

Title	Year	Interest for marine and coastal ecosystems
Lebanon Rural Tourism Strategy	2015	To enhance economic opportunities in Lebanese rural areas.
Ministry of Agriculture strategy 2015-2019/MoA	2014	The strategy sets three objectives, eight main courses of action including 30 components and 104 areas of intervention. Fisheries related actions include: • Improve the contribution of agriculture to the economic and social development of the country Support investment in the fisheries and aquaculture and improving sustainable management of the sector
National Water Sector Strategy	2012	Developed by the MoEW to ensure water supply, irrigation and sanitation services throughout Lebanon with commitment to environmental, economic and social sustainability.
Lebanon's Marine Protected Area Strategy/ MoE.	2012	Strategy proposes new MPAs in addition to the two existing sites and sets the MPAs management strategy.
Tyre Coast Nature Reserve management plan 2004-2009	2004-2009	Management plan for Tyre Coast Nature Reserve
Palm Islands nature reserve management plan 2000-2005	2000	Management plan for Palm Islands Nature Reserve

Draft Laws:

Draft Law	Description
ICZM draft law	Prepared by MoE and submitted to the COM
Declaration of Ras el Chakaa as an MPA	Draft law prepared by MoE and submitted to the CoM to declare Ras el Chakaa as an MPA
Declaration of Jounieh Canyon as a deep-sea nature reserve	Draft law for the declaration a deep-sea nature reserve at Jounieh Canyon
Establishment of a petroleum assets directorate, Sovereign wealth fund and Establishing a national oil company	Establishment of a petroleum assets directorate, Sovereign wealth fund and Establishing a national oil company
Draft Fishing law	Prepared by the MoA and submitted to the CoM. The draft law takes into consideration the new challenges in fisheries management as well as the new scientific references and benchmarks for the sustainable management of marine resources.
Draft NOSCP Decree. Management of Oil Spill Response in Lebanese Water	Defines requirements for the readiness, response and management of oil spills in the Lebanese Waters

Projects:

Project Name	Funding and implementing bodies	Implementation Period	Main outputs
Conservation of Marine Turtles in the Mediterranean Sea	Funded by MAVA Foundation Implemented by SPA/ RAC-UNEP/MAP in coordination with MoE	2018-2020	• Conservation of the Marine Turtles in Lebanon. Results of the 2018 and 2019 monitoring of the nesting sites of the Marine Turtles along the Lebanese coast (2020 annual report in progress)
Promoting marine biodiversity and improving fishery potential and marine ecotourism activities through the deployment of ARs off the Lebanese coast-AR2020	Funded by EU Implemented by MCR-IOE-UOB	2018-2021	• Artificial Reef deployed in July 2020 in front of Berbara, Jbeil coast
Marine Ecosystem Recovery through Artificial Reef	Funded by EU Implemented by Friends of Nature	2018-ongoing	• The Artificial Reef will be deployed offshore Jounieh.
Deployement of an Artificial Reef around the island of Al-Zireh, Saida.	Friends of Al-Zireh Island Association in collaboration with the municipality of Saida	June 2018	• Deployment of six old army tanks and four other military vehicles donated by the Lebanese Army around the island of Al-Zireh, Saida.
Enhancing socio-ecological climate change resilience of marine and coastal systems in Lebanon – CER Project	Funded by the Royal Norwegian Embassy in Beirut and implemented by IUCN ROWA through the IUCN Lebanon Project Office.	2018 – 2021 Ongoing project	This project aims to reduce the vulnerability of selected coastal towns in Lebanon, which are facing crucial sustainability issues, and improve Marine Protected Areas as Ecosystem-based Mitigation and Adaptation. Project's milestones are: • Milestone 1: Capitalising on effective measures and tools that have previously been tested and proven successful around the Mediterranean. • Milestone 2: Conduct vulnerability assessments and ecosystem mapping to protect and safeguard coastal communities. • Milestone 3: Empower stakeholders on marine management planning and change processes for effective and sustainable management of Marine ecosystems and livelihood security.
The implementation of a pilot case study on the Ecosystem Approach to Fisheries (EAF) in Lebanon http://www.faoeastmed.org/	Funded by FAO Implemented by MCR-IOE-UOB	2016	• Baseline study for the Purse Seine Sardine Fisheries (PSSF) • PSSF Management Plan.

Project Name	Funding and implementing bodies	Implementation Period	Main outputs
Evolution of the Lebanese Shoreline between 1962-2016	MCR-IOE-UOB	2015-2016	• Maps of Evolution of the Lebanese Shoreline between 1962 and 2016. (National scale and Coastal Cazas scale).
Market policy and legislative Development for mainstreaming sustainable management of marine and coastal ecosystems in Lebanon.	Funded by the GEF, Implemented by the MoE and UNEP and supported by IUCN ROWA as executing agency	2013- Ongoing project	• This project aims at creating an enabling integrated framework for sustainable management and conservation of marine and coastal biodiversity and at mainstreaming the priorities of this biodiversity into national plans, and coastal zone management plans, with particular focus on the impact of CC on marine and coastal biodiversity.
• National consultancy for the identification of legal, policy and institutional gaps and policy reforms drafted for marine and coastal biodiversity protection Project	Activity executed by MCR-IOE-UOB	2014-2015	• Updated draft law on ICZM ready to be submitted to Parliament. • Updated draft national strategy on ICZM.
• Coastal and Marine Biodiversity Data Collection and Biodiversity Reporting	Activity executed by MORES	2015	• A comprehensive database of published scientific papers and reports by universities, research centers, public institutions, international agencies and individual researchers (> 900 publications collected).
• "Atlas for Marine and Coastal Birds of Lebanon"	Activity executed by Dr. Ghassan Ramadan-Jaradi	2020	• Currently under press, the Atlas, aims at raising people awareness about the threats facing these birds, and will inform the conservation experts in the country about the priority areas and keystone species that merit priority attention and protection (including 40 bird species of high concern recorded along the Lebanese shore line and for a distance of 7 km offshore).
• Assess current climate change and to find adaptation measures to fit the situation in the CZ and the marine environment in Lebanon	Activity executed by the MCR-IOE-UOB	2020 ongoing	• Assessment of Climate Change Impact on Lebanon Coastal Zone • Identification of one marine biodiversity hotspot area (site specific adaptation analysis, comprehensive site-specific adaptation plans and prioritized actions). • Awareness handbook
• Factsheets on the marine Invasive Alien Species in the marine environment of Lebanon	Activity executed by Dr. Michel Barriche	2019	• Factsheets on the marine Invasive Alien Species

Project Name	Funding and implementing bodies	Implementation Period	Main outputs
• Monitoring Protocol for Marine Invasive Alien Species (IAS) specially adopted for Lebanese Coastal and Marine Environment	Activity executed by Dr. Michel Barriche	2019	• Monitoring Protocol for Marine IAS
• Guidelines on mainstreaming biodiversity conservation in the EIA process for development projects affecting marine and coastal ecosystems in Lebanon	Activity executed by ELARD	2020	• Guidelines on mainstreaming biodiversity conservation in the EIA process for development projects affecting marine and coastal ecosystems in Lebanon
• Economic valuation for Palm Islands and Tyre Cost Nature Reserves	Activity executed by ECODIT	2020-ongoing	• Economic valuation for PINR and TCNR
• Regional project "Towards an ecologically representative and efficiently managed network of Mediterranean Marine Protected Areas" - MedMPA Network Project	Implemented by UNEP/ MAP-SPA/RAC with the financial support of the European Union	2016-2019	• Ecological characterization of potential new Marine protected areas in Lebanon: Batroun, Medfoun and Byblos
• Regional project "Mediterranean Implementation of the Ecosystem Approach, in coherence with the European Union (EU) Marine Strategy Framework Directive (MSFD)" – EcAp MED II	Implemented by UNEP/ MAP-SPA/RAC with the financial support of the European Union and UNEP/MAP	2015-2019	• National monitoring programme for marine biodiversity in Lebanon
Towards deep-sea conservation in Lebanon project. https://www.iucn.org/regions/west-asia/projects/completed-projects/towards-deep-sea-conservation-lebanon-project	Funded by MAVA Foundation for Nature and lead by OCEANA in coordination with MoE, and in cooperation with IUCN and UNEP/ MAP-SPA/RAC as executing partners; the Lebanese MoE as key member of the Steering Committee; and ACCOBAMS, GFCM and NCSR as Supportive Partners.	2015 - 2018	• Increase the surface of MPAs in Lebanon by providing national government and regional bodies with scientific evidence and information collected in the field via at-sea research. • Scientific expedition for data collection in five canyons in Lebanese marine waters; Habitats and species identification; Mapping; Scientific report and pre-selection of MPAs; Communication strategy. • Contribute to reaching Aichi Target 11 by 2020 and strengthen the natural marine biodiversity corridor in the Eastern basin, supported by proper ecosystem-based management measures. • Preliminary management guidelines; Stakeholder workshops and meetings; Management plan for a proposed deep-sea MPA; MPA designations follow-up and advocacy.

Project Name	Funding and implementing bodies	Implementation Period	Main outputs
Sustainable Fisheries Management for Improved Livelihoods of the Coastal Fishing Community in Tyre, South Lebanon. https://www.iucn.org/regions/west-asia/projects/completed-projects/sustainable-fisheries-management-improved-livelihoods-coastal-fishing-community-tyre-South-lebanon	Funded by Drosos Foundation and implemented by IUCN ROWA and ADR.	2013-2017	Aimed at poverty reduction, sustainable fisheries management, better processing/marketing and supplementary income generation. Main outputs: • Simple and effective monitoring system covering 60% of the fishing activity. • A sustainable fisheries management plan. • An effective local governance system for the fisheries of Tyre. • Supported TCNR with equipment, tools and technical and institutional support. • Reduced blast fishing in tyre to 89%. • Created income generating activities to fishermen families and reduced fishing pressure. • Secured revolving fund for micro-credit for fishermen and their direct families.
Deployment of the first official AR in Lebanon in the Abdeh region (North Lebanon)	The Lions & Rotary Clubs, in coordination with the MoE, Ministry of Defense (MOD), MoPWT and in partnership with the MCR-IOE-UOB	2012	• AR constructed from eight derelict tanks and vehicles donated by the Lebanese Army.
Environmental Resources Monitoring in Lebanon (ERML) http://erml.moe.gov.lb/	Implemented by MoE under the management of UNEP in collaboration with UNDP.	2011-2013	• Improved Understanding, Management and Monitoring in the Coastal Zone. • Analysis of the Institutional and Legal Frameworks Related to Management and Monitoring of Coastal and Marine Areas. • Analysis of the Current Land Use and Socio-Economic Activities in the Coastal Zone.
People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast (PEGASO) http://www.pegasoproject.eu/	Funded by the EC through FP7 Implemented by a consortium of 26 Mediterranean and Black sea institutions including MCR-IOE-UOB from Lebanon.	2010-2014	• Help finding good ICZM solutions at all levels (from local to transboundary). • Assess the readiness/ preparedness of Mediterranean countries to implement the ICZM Protocol. • Assess the willingness/readiness to prepare a similar instrument for ICZM in the Black Sea. • Offer solutions for smoother implementation of the ICZM Protocol.
Supporting the conservation and management of important marine habitats and species in Lebanon"	MoE/IUCN	2010-2012	• Lebanon's Marine Protected Area Strategy/ MoE

Project Name	Funding and implementing bodies	Implementation Period	Main outputs
Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of MPAs creation and management-MedMPAnet	Implemented in the framework of the UNEP/MAP-GEF MedPartnership, with the financial support of EC, AECID and FFEM	2009-2015	• Ecological characterization of sites of interest for conservation in Lebanon (2015) • Synthesis report of the ecological characterization of the marine areas of Nakoura, Tyre and Saida in Lebanon (2015) • Synthesis report of the ecological characterization of the marine areas of Enfeh peninsula, Ras Chekaa and Raoucheh cave in Lebanon (2015)
Integrated Management of East Mediterranean Coastlines (IMAC) http://home.balamand.edu.lb/english/IMAC.asp?ID=8761	Funded by the EC through SMAPIII. Implemented by MCR-IOE-UOB.	2006-2009	• Status Report for the coast of North Lebanon. • Stakeholder analysis of the main actors in ICM in Lebanon. • Report on "Conflicting Uses of Coastal Resources". • Economic Valuation of the CZ of the Mohafaza of North Lebanon. • Assessment of the Institutional and Legal Setting. • A strategic action plan for wise use of the coastal resources of the coast of North Lebanon. • Overall awareness raising about the importance of ICM.
Strengthening the Environmental Legislation Development and Application System in Lebanon (SELDAS). http://test.moe.gov.lb/Publications/PDF%20Documents/531.pdf	Funded by EC-Life, implemented by MoE and UNESCO/Custo Chair-UOB and ELARD.	2004	• SELDAS book which includes compilation of environmental legislation till December 2003.
Improving Coastal Land Degradation Monitoring in Lebanon and Syria (CoLD)	Funded by EC-Life program Implemented by CTM-ERS/RAC, UNEP/MAP, Priority Action Program/Regional Activity Centre (PAP/RAC), Syrian General Organisation for Remote Sensing (GORS) and NCSR/NCRS	2002-2004	• Production of thematic maps: an overall erosion risk map, a detailed erosion map and the design and implementation of a population GIS. • Assessment and monitoring of degradation causes. • Identification of priority areas. • Drawing up of a "Strategy and Recommendations document
Coastal Area Management Program of the Mediterranean Action Plan (CAMP-Lebanon) http://www.pap-thecoastcentre.org/pdfs/Tourism%20FINAL%20Report.pdf	Implemented within the CAMP of the MAP of UNEP as one of its National projects.	2002-2003	• ICAM National Strategy. • Developing CZ management plans for the target municipalities. • Preparing the first ICAM Law for Lebanon.

Annex VI
International agreements

Convention title	Year	Signature/Adhesion/Ratification/ Accession by the GoL
MARINE ENVIRONMENT AND BIODIVERSITY		
Protocol Concerning SPA/BD	1995	Ratification: Law No. 127 dated 30/04/2019.
Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS)	1983	Ratification: Decree 3320 dated 29/06/2018 Entry into force 06/01/ 2019
Nagoya Protocol on Access and Benefit Sharing (ABS)	2010	Ratification: Law No. 3 dated 03/02/2017.
Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea.	2002	Accession on 03/11/2017 and entered into force on 03/12/2017
Protocol on Integrated Coastal Zone Management in the Mediterranean	2008	Ratification: Decree No. 639 dated 18/09/2014. Entered into force August 31, 2017.
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1975	Ratification: Law No. 223, dated 22/10/2012. Entered into force on 26/05/2013.
Amendments to the Barcelona Convention.	1995	Ratified by Law No. 34 dated 22/04/2009 and entered into force on 22/05/2009.
Cartagena Protocol on Biosafety to the CBD.	2000	Ratification: Law No. 31 dated 16/10/2008.
Beijing Amendment of the Montreal Protocol.	1999	Adhesion: Law No. 758 dated 11/11/2006.
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.	2004	Ratification: Law No. 728 dated 15/05/2006
Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic (ACCOBAMS).	2004	Adhesion: Law No. 571 dated 05/02/2004.
Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA).	2002	Adhesion: Law No. 412 dated 13/06/2002
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; Copenhagen	1992	Adhesion: Law No. 120 dated 03/11/1999.
Convention on Wetlands of International Importance especially as Waterfowl Habitat – Ramsar.	1999	Adhesion: Law No. 23 dated 01/03/1999.
Convention on Civil Liability for Nuclear Damage; Vienna.	1963	Adhesion: Law No. 565 dated 01/08/1996.
Convention on Assistance in Case of a Nuclear Accident; Vienna.	1986	Ratification: Law No. 575 dated 24/07/1996.
Convention on Early Notification of a Nuclear Accident; Vienna.	1986	Ratification: Law No. 566 dated 24/07/1996.
Protocol Concerning Mediterranean SPAs.	1982	Adhesion: 27/12/1994. Entered into force: 26/01/1995.
Protocol for the Protection of the Mediterranean Sea against Pollution from LBS; Athens	1980	Adhesion: 17/05/1980; Accession: 27/12/1994.
United Nations Convention to Combat Desertification; Paris.	1994	Ratification: Law No. 469 dated 21/12/1994.
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Basel.	1989	Ratification: Law No. 387 dated 21/12/1994
Convention on Biological Diversity; Rio de Janeiro.	1992	Ratification: Law No. 360 dated 11/08/1994.
United Nations Framework Convention on Climate Change; Rio de Janeiro.	1992	Ratification: Law No. 359 dated 11/08/1994.
Convention on the Law of the Sea (UNCLOS) adopted in Montego Bay (Jamaica)	1982	Adhesion: 22/02/1994, Law No. 295.
International Convention for the Prevention of Pollution from Ships; London.	1973	Adhesion: 24/11/1993.
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; London.	1990	Adhesion: Law No. 253 dated 31/03/1993.
Convention for the Protection of the Mediterranean Sea against Pollution; Barcelona Convention.	1976	Signature: 16/02/1976; Accession: 30/06/1977 by Decree-Law No. 126.
Convention on the Prohibition of Military or any other hostile use of Environmental Modification Techniques; Geneva.	1976	Signature: 18/5/1977- Not ratified.
Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency; Barcelona.	1976	Signature: 16/02/1976; Accession: 30/06/1977 Decree-Law No. 126.
Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft; Barcelona.	1976	Signature: 16/2/1976; Accession: 30/06/1977 Decree-Law No.126.

Convention title	Year	Signature/Adhesion/Ratification/ Accession by the GoL
International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties.	1969	Ratification: 12/10/1974, Decree No. 9226.
Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Seabed and the Ocean floor and in the Subsoil.	1971	Ratification: 7/10/1974, Decree No. 9133.
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. London, Mexico city, Moscow, Washington.	1972	Signature: 15/05/1973. Not ratified.
International Convention on Civil Liability for Oil Pollution Damage.	1969	Ratification: 12/10/1973, Law No. 28/73.
International Convention for the Prevention of Pollution of the Sea by Oil.	1954	Adhesion: 16/11/1966, Law No. 68/66
Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and in Underwater.	1963	Ratification: 30/12/1964, Law No. 59/64.
CULTURAL AND NATURAL HERITAGE		
UNESCO Convention on the Protection of Cultural & Natural Heritage.	1972	Adhesion: Law No. 19 dated 30/10/1990.
CLIMATE CHANGE		
Paris Agreement for Climate Change	2019	Ratification: Law No. 115
Establishment of SDG committee	2017	CoM decision No. 203
National coordination committee	2013	CoM decision No. 41
Kyoto Protocol	2005	Ratification: Law No. 738 dated 15/05/2006.
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; Copenhagen.	1992	Adhesion: Law No. 120 dated 03/11/1999.
United Nations Framework Convention on Climate Change UNFCCC.	1992	Ratification: Law No. 359 dated 11/08/1994.
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; London.	1990	Adhesion: Law No. 253 dated 31/03/1993.
Montreal Protocol on Substances that deplete the ozone layer.	1987	Adhesion: Law No. 253 dated 31/03/1993.
Vienna Convention for the Protection of the ozone layer; Vienna.	1985	Adhesion: Law No. 253 dated 30/03/1993.

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

Specially Protected Areas

Monitoring

Mediterranean Monk Seal

Cartilaginous fishes
(Chondrichtyans)

Coralligenous and other calcareous bio-concretions

Marine vegetation

Marine and coastal bird species

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

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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MAVA FONDATION POUR LA NATURE

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