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

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The present publication has been prepared as Israel Conservation of Mediterranean marine and coastal biodiversity by 2030 and beyond. It has been prepared by Dr. Dori Edelist, Marine Ecologist from the University of Haifa as National consultant, with observations from Dr. Simon Nemtzov of the INPA, National SAPBIO Correspondent and Focal Point for SPAs.

For bibliographic purposes, this document may be cited as:
UNEP/MAP-SPA/RAC, 2021. Israel marine and coastal biodiversity conservation for 2030 and beyond. By D. Edelist. Ed. SPA/RAC, Tunis: 101 pp + Annexes.

Cover photo
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This publication has been prepared with the financial support of the MAVA foundation

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

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

POST-2020 SAP BIO

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

List of Acronyms

BAT	Best Available Technology
BP	Bacterial Production
CC	Climate Change
EBFM	Ecosystem Based Fisheries Management
FRA	Fishery Restricted Area
GHG	Green House Gasses
IDF	Israel Defense Forces
INPA	Israel Nature and Parks Authority
IOLR	Israel Oceanographic & Limnological Research Institute
MCS	Monitoring, Control and Surveillance
MOAG	Ministry of Agriculture
MOEP	Ministry of Environmental Protection
MOE	Ministry of Energy
MPA	Marine Protected Area
NAP	National Action Plan
NIS	Non-Indigenous Species
NTZ	No Take Zone
PCBs	Polychlorinated Biphenyls
PP	Primary Productivity
SPA/BD	Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region
SAPBIO	Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region
SPNI	Society for Protection of Nature in Israel
t*y-1	Tons per year
µgL-1	Microgram per liter
WWTP	Waste-Water Treatment Plant

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Executive Summary

The Israeli Mediterranean is located in the Levant and thus constitutes a diverse set of marine ecosystems under rapid environmental change. These ecosystems are not characterized by endemic species (endemism is rare in the Levant), high productivity (the Levant is oligotrophic) nor extensive maerl beds or seagrass meadows (there are none); rather, the Israeli Levant serves as home to thousands of marine species, and there is indication that many others are yet undiscovered. Several high-profile vulnerable species (for example marine mammals, nesting sea turtles and spawning guitarfish) and some habitats such as abrasion platforms, deep-water habitats and mesophotic reefs. cold seeps, and sponge beds are worthy of particular conservation attention. Importantly, the Levant is also the most bio-invaded marine ecosystem on the planet and is under intense climate change.

The present document describes the main natural resources in the Israeli Mediterranean and the sustainable management efforts proposed and made to protect them. It compiles important information for the analysis of the status of marine and coastal biodiversity and for the identification of national priorities.

As an elaboration of the Post-2020 Strategic Action Programme for Biodiversity (SAP-BIO), in preparation of this report the author was asked to consult with "institutions in charge of conservation and management of marine and coastal biodiversity, species and habitats, MPA planning and management, marine living resource management, as well as marine research institutions, national focal points and NGOs". Due to COVID-19 limitations, this draft of the national report arises from an online consultation process with these stakeholders.

Availability and problems of actual information and knowledge: Israel has taken considerable steps over the past decade to address several of the main challenges and information gaps that existed on the national level. These include mapping of the seafloor and habitats within its EEZ, identification of the sources and hotspots of marine pollution and their subsequent reduction, as well as identification of sensitive habitats and steps to conserve them. Programs are promoted for the quantification and identification of conservation needs for protected species and the main knowledge gaps were identified. While plenty of information has been accumulated over the years, there are still some knowledge gaps that need to be covered and factored into the decision-making process. The information also has to be further consolidated to provide a working understanding of marine ecosystems.

For example, information gaps exist for solid waste and urban runoff, understanding the combined impacts of climate change and marine bioinvasion, marine pollution and impacts from shipping, the military and the oil and gas industry, improving fisheries science and factoring it into decision making. Little is known about groundwater pollution discharged into the sea, or about bacterial water quality in effluents and urban runoff, which are not monitored. These issues are more than information gaps – these are also the main conservation challenges to which Israel needs to improve its response.

Level and quality of national response activities: The level of national response activities in Israel varies across different pressure sources. It may be considered as insufficient on issues like solid waste or climate, but high and at times, extremely high, for example with regards to eutrophication, land-based pollution, MPA planning and deployment and protection of vulnerable species, for example:

- Many major pollution hotspots were identified and reduced or shut down, including the Bay of Haifa, where stern regulation led to a drastic reduction of pollution from land-based sources, the shutting down of the Shafdan municipal sludge disposal site for control of eutrophication. Almost all Israeli citizens today are connected to a sewer system that leads to a WWTP where most water is treated to a tertiary level; such that Israel is the countryi with the highest percent of reuse of its municipal waste water in the world.
- MPA network deployment – The total area planned for conservation according to the Israel Planning Administration (2020) MSP is 876 km^2, covering 21.6% of the territorial waters. These include 8.6% designated as areas with high levels of protection (i.e. Marine Reserves), 8.7% is planned as "special areas" for which the level of protection will be determined in the future, and 4.2% additional rocky areas with partial protection. An additional area of 30 km^2 in the EEZ was planned as search area for deep-water MPAs with 560 km^2 in the EEZ, planned as "special areas" for future consideration. This network of representative, connective MPAs was planned and is being deployed to protect habitats and species identified as vulnerable.
- Fisheries management: A new fishery reform and regulations were promulgated in 2016. Conservation-wise, this reform is revolutionary in Israeli terms and in some ways even in global terms (i.e., enforcement of a complete ban on the fishing and sale of all cartilaginous fish species). Reduction of fishing pressure, adoption of spatial and temporal measures and protection of vulnerable habitats aim for a high level of protection for many marine species. The reform was not fully accepted by the fishing sector. Both fishers and some scientists are concerned that socio-economic issues such as access of fishermen to fish were not sufficiently addressed. Political pressure is being applied by fishers in order to abort or weaken the reform, and there is contrary pressure from environmental NGOs to make it even more stringent. It is, however, widely agreed by both sides that prior to the 2016 reform, that the fisheries were not satisfactorily managed to safeguard biodiversity and fish stocks.

Critical conservation issues, gaps, priority needs and response actions: While a comprehensive process of prioritization with all stakeholders is beyond the scope of the present report, some needs emerged as most critical:

- A need to perform a comprehensive mapping of the extent, sources and ecosystem impacts of solid waste, mainly micro and macro plastics. Need for a national plastic and litter reduction program. The right way forward is detailed in the NAP (MOEP, 2016a) and needs to be acted upon.
- Form a national program and legislation to deal with the challenges posed by invasive species and encourage a regional and pan-Mediterranean plan. This must include addressing bioinvasion vectors and the reduction of stressors that encourage the establishment of invasive species such as pollution, habitat degradation and

overexploitation of indigenous fauna. Sustainable fisheries management and culling of some of the worst invasive species should be considered in this context.

- Address and prepare national and regional plans for climate change preparedness and adaptation and incorporate these into MSP and other plans.
- Complete the MSP process and pass the law to legally declare Israel's EEZ.
- Address and resolve regional issues such as bioinvasions via the Suez Canal, damming of the Nile, land-based pollution from the Gaza Strip, regional fisheries regulations and international ballast water regulation and compliance.
- Reduce pollutant loads from urban drainage systems in both source and effluent.
- Regulate and reduce pollution and emissions in identified hotspots and sensitive sites.
- Monitor and assess the long-term effects of large-scale desalination.
- Evaluate the efficacy of the new fishery regulations and develop an Ecosystem-Based Fishery Management framework.
- There is a need to establish environmental legislation in the Israeli EEZ.
- Need to continue to evaluate the function and efficacy of MPAs.
- A need to map and reduce marine pollution including noise and light pollution from shipping, the oil and gas industry, military operations and marine construction.
- A need for conservation of sandy beach habitats and shoreline cliffs, mainly from the erosion aspect and also develop a conservation strategy for the newly-returning vermetid reefs.

Key funding challenges: The total amount of funding of marine research and marine conservation efforts has never been estimated or individually mapped for Israel. No streamlined workplan is installed for allocation of government funds in ways proportional to national needs. These gaps pose a challenge to both conservation efforts and research and should be resolved.

Key transboundary issues :

- Control of bioinvasion vectors such as ballast waters and transoceanic canals (i.e. the Suez Canal)
- Collaborative work on climate change
- Adopt regional plans for control and reduction of pollution sources, particularly solid waste
- Improved collaborative conservation efforts concerning migratory species
- Transboundary collaboration on MPA networks
- Improved scientific collaboration and study of regional change including collaboration on monitoring
- Harmonization and standardization of fisheries management efforts
- Continued regional collaboration in the control and prevention of pollution.

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1.4. Quality and comprehensiveness of available information documents

Several recent comprehensive bodies of knowledge provide a much better understanding of Israeli Mediterranean marine ecosystems and pressures today than a decade ago. Improved bathymetry enables us to identify critical habitats (SEA, 2016), monitoring is in line with EcAp standards and provides an updating picture of the biota (Herut *et al*. 2017), and mapping of pollutions sources and data gaps (MOEP, 2016a,b) enables us to propose solutions. Academic research fills some of the remaining gaps (e.g., Idan *et al*. 2018; Corrales *et al*. 2018; Edelist *et al*. 2020). The legal framework exists for many identified challenges and Israel is party to most of the important international agreements. Nevertheless, serious challenges and obstacles to sustainability remain.

CBD (Convention on Biological Diversity): The Convention on Biological Diversity (CBD) is an outcome of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. It was adopted by Israel at that conference, along with the UNFCCC and the UNCCD. The CBD entered into force on December 29, 1993. Israel ratified it in 1995.

Barcelona Convention and Mediterranean Action Plan (MAP): Israel ratified the original Barcelona Convention in 1978. Table 13 in Appendix III lists the state of adoption of the various protocols. In September 2005 Israel ratified the amended Barcelona convention,

which entered into force in Israel on October 29, 2005. The NAP is carried out according to EcAp principles (MOEP, 2016a) and identifies four main information gaps regarding marine pollution:

1. **Solid Waste** – A need to perform a comprehensive mapping of the extent, sources and ecosystem impacts of the problem.

2. **Municipal Runoff** – A need to map the extent, type and volume of pollutant loads from urban drainage systems, a need for defining standards and pollution reduction measures in both sources and effluents.

3. **Coastal Streams** – A need for continued and improved resolution and assessment of the sources of nutrient and pollutant loads.

4. **Pollution Hotspots** – A need to define a workplan for promoting the regulation and reduction of emissions in the identified hotspots (Appendix II) and sensitive sites (Appendix IV).

Information gaps identified by the **NAP** (MOEP, 2016a) can be found in Table 4 in Chapter 5.1. Importantly, the NAP mainly considers pollution while other important conservation aspects are not fully addressed by this document

The EU Marine Strategy Framework Directive (2008/56/EC) (**MSFD**) is one of several legal instruments existing worldwide that have been adopted to protect the marine environment (Crise *et al*. 2015). The MSFD requires that all EU Member States take measures to maintain or achieve Good Environmental Status (GES) in their seas by 2020. The comprehensiveness of data on a global basis is described by Crise *et al*. (2015) and highlights the low availability of information on open sea ecosystems compared to better studied coastal systems, the low data availability on NIS, marine litter, noise other marine energy and marine food webs. The situation in Israel is similar, perhaps with the exception of the relative multitude of knowledge on NIS and paucity of knowledge on commercially exploited fish and shellfish. Directive 2014/89/EU establishes a framework for maritime spatial planning and endorses promotion of regional and transboundary environmental governance solutions.

The UN Sustainable Development Goal (SDG) 14 - Life below water, aims to conserve and sustainably use the oceans, seas and marine resources. This SDG has set 10 ocean conservation targets and indicators (Appendix VI). The targets of SDG 14 are listed in Table 13 in Appendix VI, with an expert assessment of Israel's main gaps for each target according to its indicators.

CMS - Convention on Migratory Species. The CMS (or Bonn Convention) aims to conserve terrestrial, aquatic and avian migratory species and their habitats, on a global scale. It also seeks to promote international cooperation in research and to advance international agreements on the protection of endangered wild migrating animals. Israel ratified the CMS on May 17, 1983, the day it entered into force. Israel is a signatory on two CMS Agreements. on African-Eurasian waterbirds (including marine birds) and on European bats, and one MoU on raptors. (http://www.sviva.gov.il/English/env_topics/InternationalCooperation/IntlConventions/Pages/CMS.aspx).

ACCOBAMS (the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area) is a binding conservation treaty under the Convention on Migratory Species, based on international cooperation. Its purpose is to reduce threats to cetaceans (whales and dolphins). The Mediterranean marine space of Israel was announced by the IUCN as an important marine mammal area (IMMA) for the bottlenose and common dolphins. Nevertheless, Israel has signed but not ratified the ACCOBAMS agreement. While Israel sends experts and national focal points to ACCOBAMS meetings, the country has yet to join as a full member.

GFCM (General Fisheries Commission for the Mediterranean) is the regional fisheries management organization administered by FAO. Israel is one of the original contracting parties to join GFCM in 1952. Unfortunately, over the past three decades, Israel stopped being an active member and generally did not contribute data of its fishing fleet or national catch in an organized, survey-based manner. In 2020 Israel has started again to fulfil its reporting obligations and is now set to participate in GFCM as an active member.

2.

Marine and coastal ecosystem status

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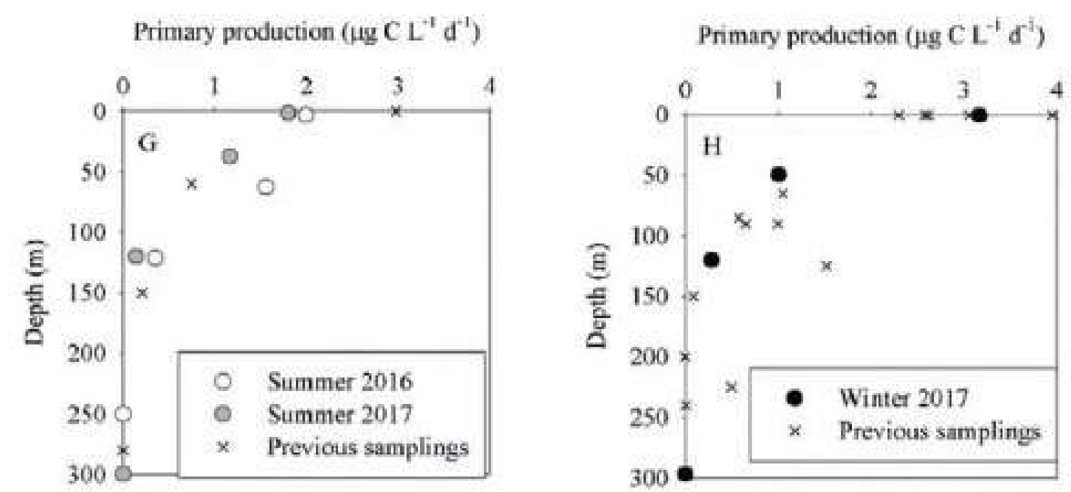
2.1. Biological characteristics

2.1.1 Description of water column biological communities

Phytoplankton: The paucity of nutrients in the Levantine photic zone causes Cyanobacteria and heterotrophic bacteria to dominate Israeli assemblages, while Eukaryotic algae are sparse (Herut *et al*. 2017). Overall, since 2015, BP has exceeded PP, suggesting rapid processing of nutrients in microbial heterotrophic processes (Herut *et al*. 2017). Phytoplankton populations are monitored annually in 14 stations along the Israeli coast, mainly in the mouths of coastal rivers in four depths from 6 to 30 m. Picophytoplankton, Cyanobacteria, Dynoflagelates, Ciliates and Diatoms are spatially monitored routinely (monthly). Ultraphytoplankton heterotrophic bacteria are similarly monitored along the coast and at high resolution in a single station (Haifa). Total Chl-a concentrations were generally low, with values of $0.1\mu gL^{-1}$ to $1.7\mu gL^{-1}$ (Herut *et al*. 2017). Cyanobacteria of the genus *Synechococcus* (of two main species) were by the most common Ultra-phytoplanktonic species observed, with microalgae <5µm second. Small eukaryotic phytoplankton were generally fewer (200-6000 cells per ml) and while their dispersal matched chl-a concentrations it differed from *Synechococcus* locations (the latter showed marked spatial hetrogenity). Heterotrophic bacteria were commoner by an order of magnitude (90000-870000 cells per ml) all along the coast, with higher concentrations in the north. Coastal samples generally contained higher concentrations than offshore stations, but even coastal values were low compared with other Mediterranean measurements (e.g., Šantić *et al*. 2013). The highest PP values were $9^{-1}2$ μg C L^{-1} D^{-1} and the lowest were 1.2 μg C L^{-1} D^{-1}. Levels of BP were higher than PP (unlike open sea measurements) and totaled 2.5 - 21 μg C L^{-1} D^{-1} (Figure 1, Herut *et al*. 2017). Spatially, BP values generally correlated well with PP values. In the high-resolution Haifa (Shiqmona) measurements, Chlorophyl values were similarly low (Figure 2, Figure 3) with 0.16 μg L^{-1} (summer) to 0.45 μg L^{-1} (winter). Similarly, winter values of phytoplankton biomass were highest with the most prominent species being *Synechococcus and Prochlorococcus*. Eukaryotic algae were an order of magnitude less common.

Figure 1

Vertical (depth in m) distribution of Primary Production (top) and Bacterial Production (bottom) in the winter (right) and summer (left) in an offshore station. Source: Herut *et al*. 2017



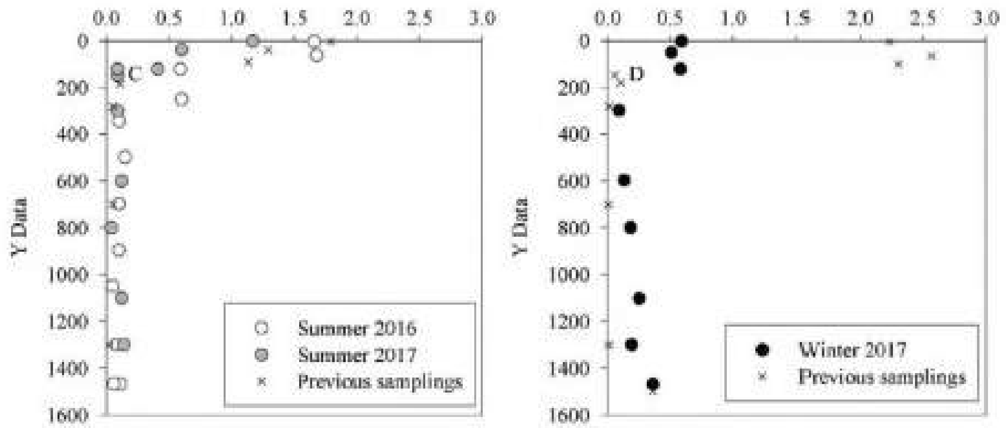


Figure 2

Spatial distribution of Chlorophyll (left), Piko-phytoplankton (Synechococcus), nano eukaryotes and heterotrophic bacteria (cells/mL) in surface waters (Water depths 6-30m) along the Israeli coast in Aug 2016. (Source: Herut *et al*. 2017). A table consisting of the counts of >200 species may also be found in Herut *et al*. 2017.

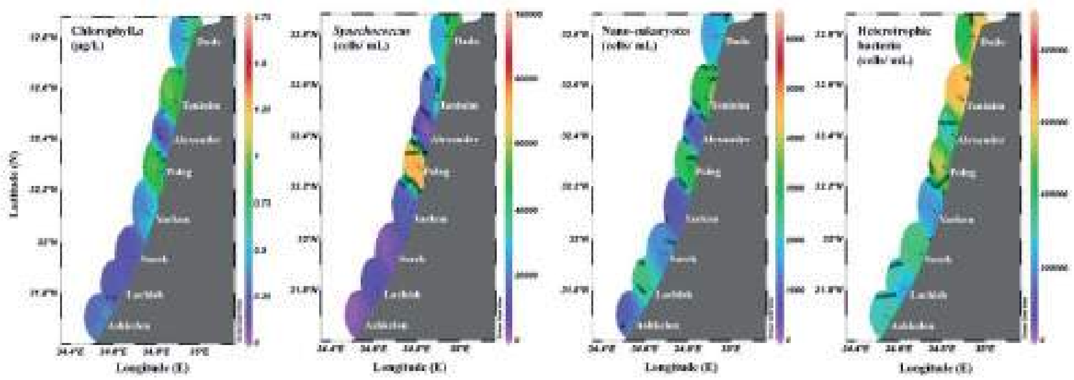


Figure 3

Primary (left) and Bacterial (right) Productivity values along the Israeli coast in Aug. 2016 (Source: Herut *et al.* 2017). Note that 2016 was characterized by particularly high productivity compared with average years.

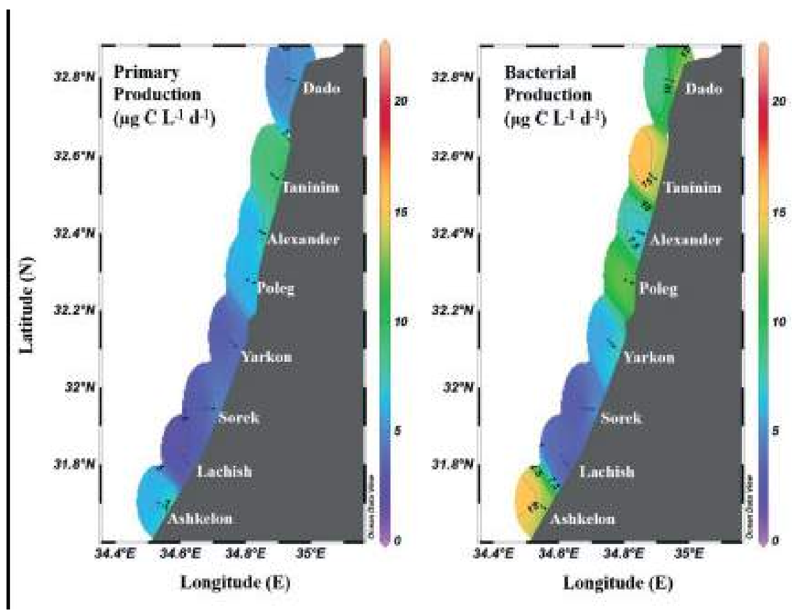
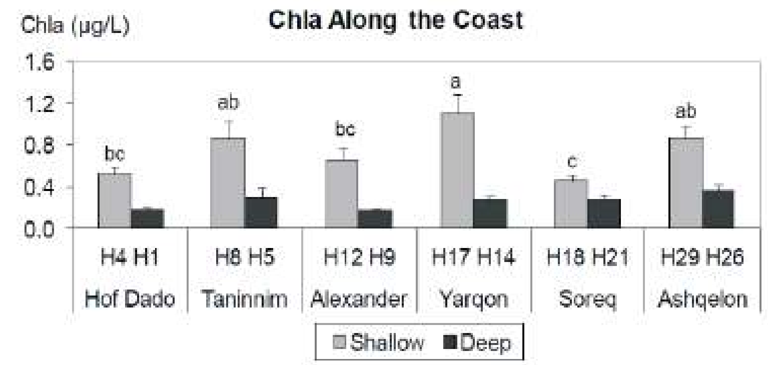
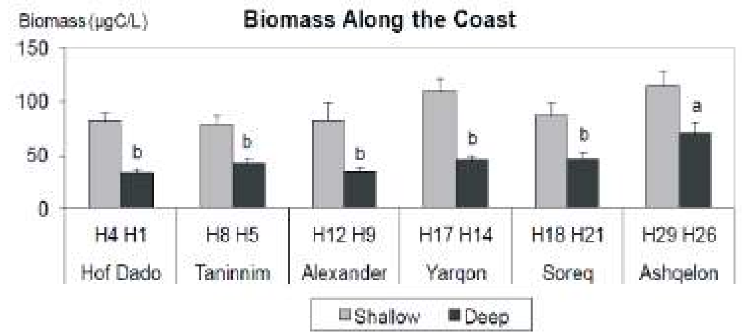


Figure 4

Total biomass and mean Chl.a concentrations on the Israeli shelf in shallow waters and in deep waters (6 m) in 2003-2016 (source: Herut *et al.* 2017)



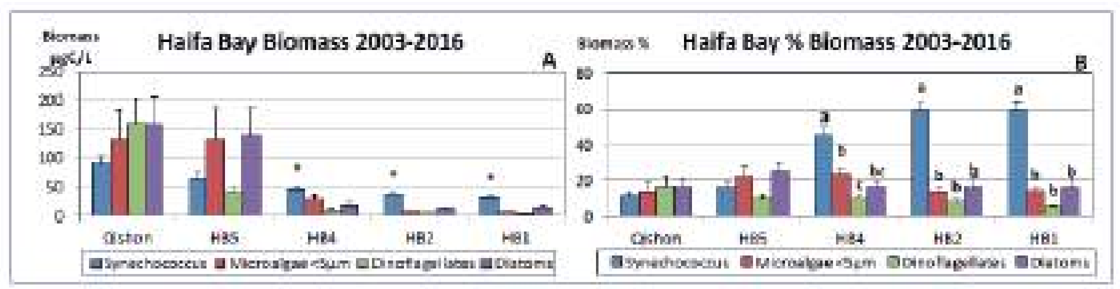


Productivity can thus be considered to occur mainly in inshore waters and in is limited in waters >30 m (roughly more than 3km from shore) along the Israeli coast.

The Bay of Haifa and particularly the inner bay at the effluent of the Kishon River, has been known for decades as a major area of eutrophication (Figure 5). Algal biomass is typically highest in the river mouth and is comprised of mainly of *Synechococcus* spp. And diatoms as well as some other groups and typically decreases with distance into the outer bay. The most prominent diatoms on the bay are *Thalassiosira pseudonnana*, *Pseudonitzschia* sp. And Amphora sp. (in offshore stations). The most prominent Dinoflagellates in the bay were *Protoperidinium* sp., *Scripsiella* sp. and *Oxyphysis oxytoxoides*. Flagellates of the group *Cryptophyceae* were common in the shallows and at the Kishon river mouth while ciliates of the genus *Zoothamnium* were common in the westernmost station in Haifa Bay.

Figure 5

Haifa Bay stations – average microplankton biomass (Qishon river is inshore and HB1 is the deepest offshore station) in 2003-16 (source: Herut *et al*. 2017).



Zooplankton represents one of the greatest knowledge gaps in biological data in the Israeli Mediterranean, but this gap is rapidly closing in recent years. Zooplankton that graze on the scant phytoplankton in the oligotrophic Levant are typically as poor as the resource they rely on. Recent and inclusive studies are surprisingly scarce. In the 1960s, Zooplankton communities used to form two annual peaks, in April-May and December with an additional large peak in late summer triggered by Nile floods. During these peaks in inshore waters, the great bulk of the population was copepods (up to 85% of the specimens and 940 ind./m^3), mostly calanoids. Additional taxa included Chaetognaths, Pteropods and larval stages of decapods. In offshore waters Pterapods and Cladocerans dominated pelagic assemblages alongside the copepods (Kimor and Wood, 1975). Calanoid copepods dominate both nearshore and offshore waters, while high abundance of cladocerans and pteropods swarms are typical to the summer as the hatching of their resting eggs is temperature dependent (cladocerans) or the formation of aggregations (pteropods). Nevertheless, they are not considered the dominant groups in offshore waters throughout the year. There a complete absence of knowledge on the temporal dynamics of the whole zooplanktonic community, demersal zooplankton interactions with the benthos (and generally benthic-pelagic coupling). Initial recent endeavors to close this gap are underway in IOLR.

The Levant is also a hub of huge swarms of jellyfish populations and this phenomenon seems to be on the rise due to bioinvasion, particularly since the arrival of a single dominant species in the late 1970s. Rhopilema nomadica, one of the worst 100 invasive species in the Mediterranean (Streftaris and Zenetos, 2006) swarms the Levantive coast in huge masses almost every summer and often in winters too (Edelist *et al*. 2019). Stinging bathers and plugging intake pipes of desalination and power plants, jellyfish exert a heavy toll on the economy and as marine predators that often inhabit the entire water column of the continental shelf, have far reaching and not yet fully known repercussions for the entire ecosystem. The indigenous jellyfish Rhizostoma pulmo is still frequent, typically arriving in conjunction with R. nomadica swarms. Other dominant NIS of gelatinous plankton swarming the Levantine shelf include voracious predators like the comb-jellies Mnemiopsis Lleidyi and Beroe ovata which arrived from the Black Sea in 2009 and 2012 respectively. A comprehensive list of jellyfish species in the Israeli Mediterranean can be found in table 8 in Appendix I. It also includes new species previously unknown to science and first discovered in Israel such as Marivagia stellate and Chrysaora pseudoocelata.

2.1.2. Information on invertebrate bottom fauna, macroalgae and angiosperms: species

composition, biomass and annual/seasonal variability

Marine angiosperms are all but absent from Israeli Mediterranean waters, with no known Posidonia oceanica, some minor records of nonindigenous Halophila stipulacea and minor beds of Cymodocea nodosa estimated as "no more than a few hundred square meters" by Lipkin *et al*. (2003).

Macroalgae: The checklist of algae for the Mediterranean coast of Israel includes more than 300 species of red (Rhodophyta), brown (Phaeophyta), and green (Chlorophyta) marine macroalgae found primarily in the intertidal zone, with at least one

endemic species (*Treptacantha rayssiae*, Phaeophyta) described for this area (Einav and Israel, 2008). The list includes more than 115 species of seaweed species that migrated from the Indo-Pacific through the Suez Canal, a process that constantly reshapes the fauna and flora of the Israeli Mediterranean and their biodiversity.

One main Lessepsian feature that completely reshapes the algal biomass and distribution is over-grazing by invasive rabbitfishes (mostly *Siganus rivulatus* and to a lesser degree *Siganus luridus*). Israeli reefs are currently dominated by turf-forming algae, with canopy algae beds very rare. Reefs contain a high ratio of invading algae and sustain low numbers of top predators. The once lush canopy is replaced by turf barrens that are the dominant substrate cover today, while cover of native brown algae canopy (e.g., Figure 6) is limited to small patches occurring only during winter and spring. The exception is the Rosh Hanikra marine reserve, where recent surveys show both high density of top predators and relatively high coverage of canopy algae (Rilov *et al*. 2018).

Figure 6
Characteristic seaweed communities from the Israeli Mediterranean Sea. Source: Alvaro *et al.* 2019

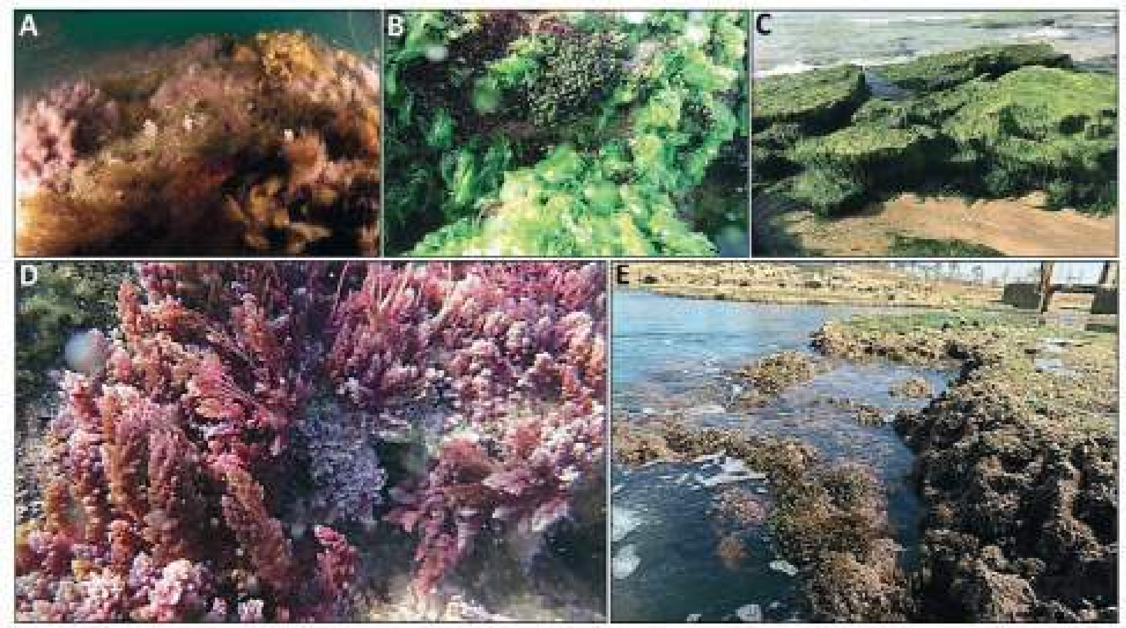


Figure 1: Characteristic seaweed communities from the Israeli Mediterranean Sea.
(A) An assemblage of macroalgae at 10 m depth in Haifa Bay composed of *Jania rubens*, *Padina* spp., *Lobophora schneideri*, *Dictyota* spp. and others (photo credit: G. Rilov). (B) Intertidal *Valonia utricularis* and *Ulva* spp. (C) Abrasion platforms in the intertidal covered by *Ulva* spp. during March 2019 in Hertzlyia. (D) Populations of *Asparagopsis taxiformis* thriving in intertidal rock pools in Rosh Hanikra. (E) Algal diversity during high growth season on the intertidal shores of Atlit in February 2018.

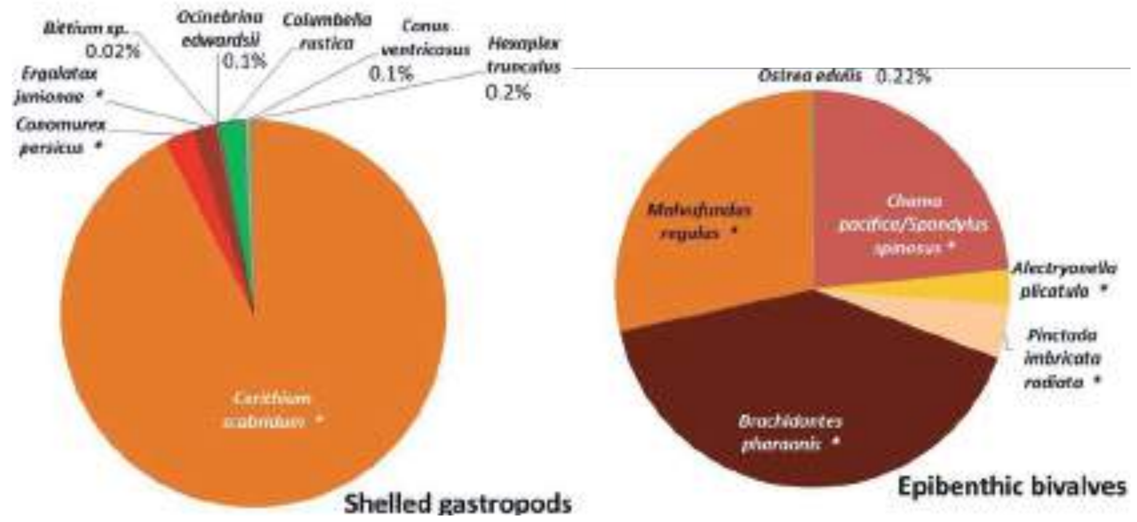
On Vermetid reefs (Abrasion platforms), *Ulva* spp., *Laurencia* spp., Ectocarpus, *Jania rubens*, and turf are the main macroalgal species (Appendix I). There is very strong algal seasonality with winter and spring having the highest diversity. Warm affinity species are becoming more dominant, probably due to Climate Change (Rilov *et al*. 2020). Turf occurs on almost all shallow rocky reefs year-round with a biomass that exceeds the second most abundant taxa by more than an order of magnitude (Rilov *et al*. 2017). Two red crustose algae (CCA of the genus *Peyssonnelia*) were also very abundant in rocky reef surveys. One red alga, *Chondracanthus acicularis*, was abundant in autumn but less abundant in the spring. In subtidal reefs the invasive alga *Galaxaura rugosa* occurred on 29% and 58% of the rocks in the autumn and spring, respectively, and its mean biomass increased 30-fold in the spring. Canopy forming Erect brown algal species (e.g., *Dictyota*, *Dictyopteris* and *Halopteris* spp., *Fucales*, *Cystoseira* and *Sargassum* spp.) were found only in very few transects in the shallow waters of the Carmel Head, as well as inside the Achziv-Rosh Hanikra marine reserve and most native shallow algal species are highly seasonal and bloom for a short time during spring (Rilov *et al*. 2017).

Infauna of the soft shallow sediment was sampled in 14 stations along the Israeli coast and in Haifa Bay. It consists mainly of polychaetae worms (Spionidae – by far the commonest taxa overall), crustaceans (Ostracoda and Tanaidacea) and nematodes, as well as mollusks and echinoderms. More than 120 infaunal taxa are listed in these sediments in Herut *et al*. 2016. Worms consisted of 22 families and 31.5% of all specimens. The three major Polychaetae families – Capitellidae, Sillidae and Spionidae) are the commonest taxa. Capitellidae specifically are used as a biomarker for organic pollution. Spioniids are by far the commonest and mostly inhabit undisturbed sediments. Nematodes inhabit mostly the northern stations and particularly Haifa Bay stations. Crustaceans consisted of 37 taxa and 53% of specimens. There were 47 taxa of mollusks representing 5.1% of all sampled specimens and including *Donax semistratus*, known to thrive in polluted areas. Even in infaunal assemblages, Lessepsian migration is evident, particularly in Mollusks, where taxa are identified to the species level. For example, in the Bay of Haifa out of 68 mollusk species, the Indo-Pacific *Finella pupoides* constituted 65% of all specimens (Herut *et al*. 2017). There are indications that in the mesophotic zone, many cryptic species of infauna and epifauna have yet to be discovered (Albano *et al*. 2020).

Epifauna in Israel includes mainly crustaceans, mollusks and fish. Benthic species may include cnidarians and echinoderms as well. Rilov (2016) has found that on shallow rocky reefs, almost all mollusks, including bivavles and gastropods, are of nonindigenous origin (Figure 7) and many indigenous mollusk species have disappeared altogether (Appendix I). Indeed, the Bivalves *Chama pacifica and Spondylus spinossus* today cover most medium depth reefs and *Brachiodontes pharonis* is by far the commonest bivalve on shallow and intertidal reefs and covers a significant proportion of abrasion platform as well (appendix I). It did suffer mass mortality in the summer 2016 and is now slowly recovering and this is common in such boom and bust communities (Rilov *et al* 2020). In another example, *Cerithium scabridum* was by far the commonest gastropod on shallow reefs and NIS generally dominated the assemblage (Figure 7).

Figure 7

Rocky reef mollusk species recorded in SCUBA diving surveys along the Israeli coast. Warm colors (red, brown, orange, yellow) represent Lessepsian Migrants. Source: Rilov *et al.* (2018)

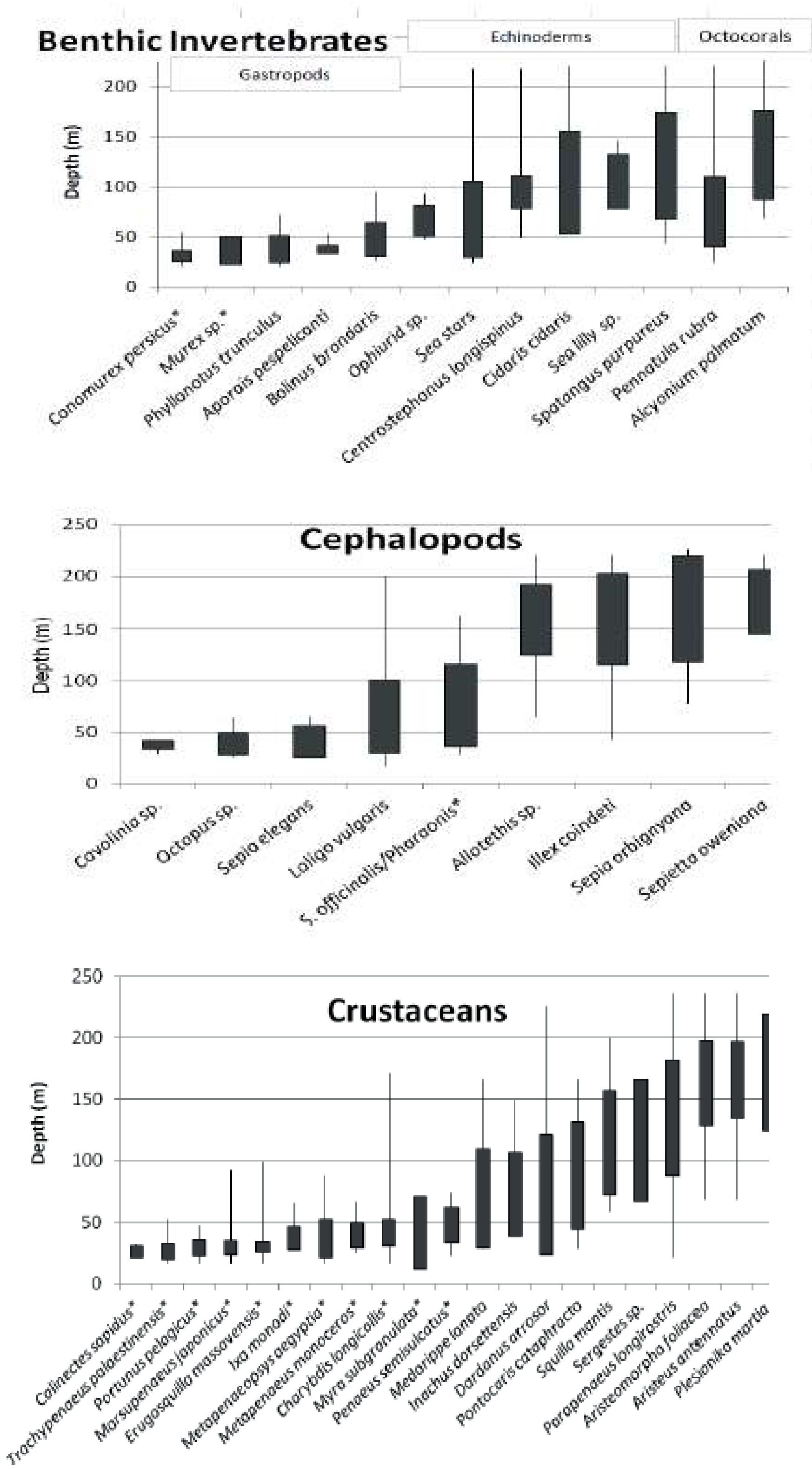


This tremendous explosion of nonindigenous life has also seen the displacement and often disappearance of indigenous species. For example, the red-mouthed rock shell *Stramonita haemastoma* (Linnaeus, 1767) that was a common species in the shallows was extirpated (Rilov, 2016). Other important species in sharp decline were reef-building gastropods of the species *Dendropoma cristatum* that, along with confamilial *Vermetus triquetrus* shaped the unique Levantine abrasion platform habitat. *D. petraeun* are among species extirpated most probably by a combination of factors that include climate change (Rilov, 2016). Importantly, in 2013 small (10cm) patches of *D. cristatum* started appearing in some platforms in Northern Israel and by 2016 reached 1% cover of certain platforms, indicating alternating decline and resurgence (Herut *et al*. 2017; Rilov *et al*. 2020). The purple sea urchin *Paracentrotus lividus*, once common in shallow rocky reefs, was shown to be intolerant of the warming conditions and as a result of CC combined with NIS (rabbitfishes outcompeting them for algal biomass as food) have nearly disappeared from Israeli shallow water (Yeruham *et al*. 2020).

On soft bottoms, epifauna is typically sampled by bottom trawl (Table 6 in Appendix I) and is layered according to depth (Figure 8) and seabed type (sand to 30 m and mud above 30 m). In 266 trawl hauls conducted in 2008-11, Edelist (2013) has shown how the distribution of both fish and invertebrates varies with depth - the main species of benthic invertebrates are shown below and in Table 6 by Herut *et al.* (2017). Here too, the known singularity compared with other Mediterranean coastal waters, is the strong presence of Lessepsian migrants in the shallows, particularly that of crustaceans on the continental shelf, which in waters below 50m are almost all nonindigenous.

Figure 8

Soft bottom invertebrates: Bathymetric distribution of the commonest demersal invertebrates over soft bottoms in 266 trawl hauls in 2008-11. Hairlines represent minimum and maximum depths and thick bars represent one standard deviation from the mean depth. * = Lessepsian migrant species. Source: Edelist (2013). Additional taxa from more recent surveyed can be found in Table 6 in Appendix I.



Lessepsian domination of shallow strata is also evident in soft sediments, where the shallows are overrun by NIS mollusks such as *Conomurex persicus* (>75% of all shallow water mollusks in Edelist, 2013 – annex 1). This species Is also very abundant in shallow rocky reefs (Rilov *et al*. 2017). In deeper waters (above 50m) indigenous benthic species dominate, including motile indigenous cnidarians such as *Pennatula rubra* and *Alcyonium palmatum* (both were also the commonest sessile invertebrates in Herut *et al*. 2017) gastropods such as *Hexaplex trunculus* and *Bolinus brandaris* and indigenous crustaceans replacing migrants in the deeper assemblage. The commonest mobile mollusks in trawl catches were by far *Loligo vulgaris*, with *Octopus vulgaris* and *Sepia officinalis/pharonis* (and in deeper waters *Sepia orbygnyana*) an order of magnitude less abundant. In deeper starta beyond 150m, *Illex coindetti* was the dominant squid. Among shallow (<50 m) crustaceans, *Charybdis longicollis, Erugosquilla massavensis*, *portunus pelagicus* and *Marsupenaeus japonicus* are the commonest species, the latter two being a boon for fishers as highly valuable commercial species. Many other NIS of crustaceans abound in the shallows. In deeper strata of 100-150m, the main crustaceans are the indigenous rose shrimp *Penaeus longirostris* and in even deeper grounds, the red shrimp *Aristeus antennatus* and *Aristeomorpha foliacea* dominate assemblages. The Levant is unique also in the relative paucity of echinoderms and this is evident in trawl surveys, in which they are two orders of magnitude less abundant than crustaceans or mollusks and three orders of magnitude less abundant than fish (in both Edelist 2013 and Herut *et al*. 2017). The commonest echinoderms are Astropectens and some ophiurids (in both Edelist 2013 and Herut *et al*. 2017), with sea urchins, sea lilies and sea cucumbers altogether missing from the assemblage.

Fishes are the most studied taxonomic group in the Israeli Mediterranean. Approximately 300 species of indigenous bony fish and 80 species of cartilaginous fish are listed in Israeli Mediterranean waters and they are supplemented by approximately 100 non-native fish species. Almost all fish NIS are bony fishes, almost all are of Indo-Pacific origin (Lessepsian migrants). Migrants today dominate the Israeli shallow shelf (until 50 m) ichthyofauna alongside indigenous species and the commonest soft bottom migrants (e.g., *Saurida lessepsianus, Nemipterus randalli, Upeneus moluccensis*) can be found even beyond 100 m depth. The most problematic NIS from a human perspective are poisonous species (four species of invasive pufferfish) and venomous species (e.g., *Plotosus lineatus, Pterois miles, Synancia verrucosa*).

Either as a result of overexploitation, displacement by NIS or other pressures, the abundance of several indigenous species such as *Dentex macrophthalmus, Mullus barbatus, Mullus surmuletus, Merluccius merluccius Trachinus draco* and *Uranuscopus scaber* has declined dramatically between 1990 and 2011 (Edelist *et al*. 2013).

A comprehensive list of soft stratum fishes can be found in Appendix I. On shallow rocky reefs, the most prominent species are *Diplodus* spp., Mugilidae and *Siganus* spp., the latter are invasive bioengineering species that completely altered the Levantine reefs, turning them from lush canopy to turf (Rilov *et al*. 2017).

Predators also abound on some reefs, the most prominent of which are groupers such as *Mycteroperca rubra* and *Epinephelus marginatus*. Since 2016 grouper and drum fishing was banned for 60-70 days every year in order to protect them during reproduction season. A complete three months moratorium of all fishing as suggested by SPNI has not yet been implemented and so far, recreational and artisanal moratoria have lasted

30 days, and bottom trawling bans are 60 days long. In the upper water column inshore schooling species such as sardines (mainly *Sardinella aurita*), mackerels and barracudas have their seasonal runs and in offshore waters beyond the continental shelf edge tuna and swordfish run every spring. Native herbivores (e.g., *S. salpa*) are now rare outside reserves.

There is no known fish endemism in the Levant, and as it is the warmest saltiest most oligotrophic part of the Mediterranean, species richness is lower than in its western and northern reaches.

There is a large occurrence of cartilaginous fishes in Israel in all seasons, but unique aggregations of sharks and rays occur during winter in the vicinity of warm-water effluents of coastal power plants (Barash *et al*. 2018). All cartilaginous fishes are fully protected in Israel and there is little illegal fishing of them, especially since the INPA took over enforcement of fishing regulations in 2017. Guitarfish have been overfished in most places around the Mediterranean, yet they are abundant In Israel where they reproduce and are protected. Large migrations of Devil rays can also be viewed in Israeli offshore waters during Feb-March (Abudaya *et al*. 2018).

Annex II of the SAP/BD Protocol: As mentioned above, no seagrasses are present and few red, green and brown algae of the protocol species exist in Israel. Among Porifera, *Axinella* sp. as well as some other key species are present on shallow and mesophotic sandstone rocky reefs (50-120 m). Some cnidarians (e.g., Madrepora, Cladocora and Antipathes species) are sparsely found on the small rocky patches of the continental slope (200-800m), mostly in Palmachim Disturbance in southern Israel. Among mollusks, as mentioned above, *D. petraeum* has become rare and *Tonna galea* shells found today are all empty. Among crustaceans, *Ocypode cursor* exists on sandy beaches (Nemtzov, 2020) but has seen its sandy habitat shrink considerably, mainly due to coastal construction of marinas, ports, promenades etc. Cartilaginous fish, as mentioned above, are protected since 2005 and not fished at all since 2018, and therefore Israel is a sanctuary for all species of sharks and rays. Most prominent of which in the shallows are guitarfish *Rhinobatos rhinobatos* and *R. cemiculus* which abound in great numbers along the coast (mostly the former). Among reptiles, *Caretta caretta* are prevalent in Israel and over a hundred females lay eggs in the sand every year, while *C. mydas* is by far less abundant. For more than three decades, eggs are transferred by INPA to protected facilities that facilitate high survival rates.

2.1.3 Information on vertebrates other than fish

Sea birds: True Seabirds are most common in Israel during winter. Typically, mostly seagulls, sterns and cormorants are observed along the coast, but during winter storms, in offshore waters or trailing in the wake of bottom trawlers, Shearwaters, petrels and other true seabirds may be observed. Breeding colonies, mostly of sterns, can be found in the few small islands along the Israeli coast. A comprehensive list of seabirds of conservation concern is presented in Table 5 in Appendix I. It includes species such as *Puffinus yelkouan* (CMS Annex II) *Stercorarius parasiticus*, *Calonectris diomedea*, *Ardenna grisea, Oceanodroma leucorhoa, Morus bassanus* and others. See Appendix I for a complete list. Among these, *P. yelkouan* is a prominent species of concern; however, no qualitative assessment of seabirds has been conducted in Israel and data are extremely limited.

Marine Mammals: Kerem *et al*. (2012) have provided the first species list for Cetaceans of the region, based on observations from 1993-2009 (Table 7 in Appendix I). Species with a 'regular' status included the common bottlenose dolphin, striped dolphin, common dolphin, Risso's dolphin and rough-toothed dolphin, as well as Cuvier's beaked whale; 'visitors' included false killer whale, sperm whale, minke whale and fin whale; Indo-Pacific humpback dolphin, humpback whale and killer whale were designated as 'vagrants'. Indeed, despite its profound oligotrophic nature, the diversity of cetacean species in the Levantine basin was found to equal that of the western basin (Kerem *et al*. 2012). Additionally, and importantly, the Mediterranean Monk Seal *Monachus monachus* is a rare visitor to the coast of Northern Israel with recent sightings in 2010, 2013, 2014, 2016, 2018 and 2020. Most of these species appear in Annex II of the SPA/BD Protocol.

Sea turtles: A well-documented decline in sea turtle populations over the 20th century prompted a conservation project to protect sea turtles in Israel (Levi *et al*. 2015). They are still threatened by shipping, offshore energy, military or other risk factors, and are still bycaught in fisher's nets, but are not directly targeted in Israel since the 1970s. Moreover, while it was previously estimated that 3000 sea turtles die from bycatch in fishing gear in the country every year (Levi *et al*. 2015), such values are expected to go down following the fisheries reform that since 2017 has lowered both overall fishing and trawling pressure and specifically fishing in the areas (shallows) and times (spring-summer) when turtles reproduce. *Chelonia midas* are an order of magnitude rarer than *Caretta caretta* but can also be found along the Israeli coast.

The National Sea Turtle Rescue Center at Mikhmoret was established in 1999 by the INPA. Injured sea turtles are temporarily housed at the center for medical treatment and rehabilitation and are released to the sea when they recover. Since its inception, the center has treated some 700 sea turtles.

While *C. caretta* global status was recently reclassified by IUCN from Endangered to Vulnerable (and in the Mediterranean to "Least Concern"), the status of *C. midas* remains "Endangered". A rehabilitation project by INPA for *C. midas* is underway, where Green turtles hatched from eggs are grown in tanks as a reproductive mating stock for generation of future offspring to be released to the ocean. Rare observations of *Dermochelys coriacea* do occur and several specimens were also washed ashore or bycaught in fishing nets.

2.1.4 Inventory of the occurrence and abundance of non-indigenous, including invasive species

Hundreds of taxa of nonindigenous origin were recorded on the Israeli continental shelf in recent decades and Edelist *et al*. (2013) dubbed the Levant as the most bio-invaded marine ecosystem in the world. Theirs and many other studies indicate that bioinvasion is still ongoing and still accelerating. As the Suez Canal is the main vector for their transportation, almost all NIS are shallow water species. Most of them are present year-round although all have some seasonality and established species typically enter some dynamic equilibrium after initial population explosions. Some of the NIS (the main ones described below) have dramatic deleterious impacts on indigenous biodiversity. Prominent invaders are listed below:

Fish:

- Ecosystem altering Rabbitfish (*Siganus rivulatus & S. luridus*)
- Poisonous Pufferfish (*Lagocephalus* spp., mainly *L. sceleratus*).
- Venomous fish like the Catfish (*Plotosus lineatus*), Lionfish (*Pterois miles*), Stonefish (*Synanceia verrucose*) and the Reticulate whipray (*Himantura uarnak)*

Mollusks:

- The extremely common gastropods *Conomurex persicus*, *Cerithium scabridum* and *Murex forskoehlii.*
- The habitat-engineering bivalves *Chama pacifica*, *Spondylus spinosus* and *Brachiodontes pharonis*.

Crustaceans:

- Brachyura: Blue crab *(Callinectes sapidus), Matuta victor,* Rosy egg crab *(Atergatis roseus),* the swimming crabs *Charybdis longicollis* and *Portunus segnis* – all dominating the shallow crustacean faunal assemblages.
- The mantis shrimp *Erugosquilla massavensis*.

Foraminifera:

- *Amphistegina lobifera* and *Sorites orbiculus*

Algae:

- Chlorophyta: *Codium parvulum,* several species of the genus *Caulerpa spp.*, such as *C. racemosa* and *C. mexicana,* however, these species are in low abundances in the Israeli Mediterranean coast
- Rhodophyta: *Galaxaura rugosa*
- Phaeophyceae: *Dictyota acutiloba, Lobophora schneideri* and the poisonous algae *Stypopodium zonala*

Jellyfish:

- Scyphozoa: *Rhopilema nomadica, Phyllorhiza punctate*
- Ctenophora: *Mnemiopsis leidyi, Beroe ovata*

2.1.5 Information on species of commercial interest for fishing (fish, mollusk and shellfish): identified populations, their abundance, spatial distribution and age/size mainly encountered in the country

The annual national commercial catch increased from about 2,500 tons in the late 1940s and 1950s to a record annual average of 4,153 $t*y^{-1}$ in the 1980s. In 1990s and 2000s, the annual catch has dropped to around 3000 $t*y^{-1}$ and then in the 2010s to around 2,000 $t*y^{-1}$ (Edelist *et al*. 2019). Over these years fishing became less profitable and the fleet has shrunk, mainly due to increased costs, but also due to a multitude of economic, geopolitical, ecological and other factors, including overexploitation (mostly in the inshore section). The replacement of indigenous fauna by Lessepsian migrants – nonindigenous organisms (including >100 species of fish) of mainly Indo-Pacific origin is a major factor reshaping fisheries. Bottom trawls rely heavily on Lessepsian migrants such as the threadfin bream *Nemipterus randali*, the goldband goatfish *Upeneus moluccensis*, the brushtooth lizardfish *Saurida lessepsianus* and the Kuruma prawn *Marsupenaeus japonicus* – all of which have displaced indigenous species and all are also in the top 10 most common trawl fish caught in the Indian Ocean.

In recent years, conservation has become a major player in shaping Israel's fishing policy, pushing for an extensive fisheries reform that became official in December 2016. The reform has resulted in a further reduction in fishing effort, seeing national commercial catch decline to $1300^{-1}600$ $t*y^{-1}$ (Edelist *et al*., 2019).

As requested for the present report, I estimate here from personal information the catch and revenue of the main species of interest for artisanal Israeli fleets in 2019. Lessepsian Migrants shown in red:

Main species of interest to the artisanal sector	Tonnes / y	Revenue ('000 € y)
Euthynnus alleterratus	120	300
Scomberomorus commerson	80	800
Epinephelinae	60	1350
Pagrus spp.	50	875
Sphyraena chrysotaenia	30	190
Seriola dumerili	30	340
Sciaenidae	30	340
Mugilidae	20	150
Potunus pelagicus	20	100
Diplodus spp.	20	150
Thunnus thynnus	15	280

It should be noted that these revenues are from artisanal fishing only and do not include bottom trawling, which is responsible for more than half of the national catch.

Annex III of the SAP/BD Protocol: As far as I could determine, Israel is the first and only country in the Mediterranean today to ban extraction of all cartilaginous fish species, and they are all protected by law. *Carcharinus plumbeus* and *C. obscurus* are the most prominent species inshore among them, with *C. granulosus* and *M. mustelus* common in deeper strata. The three relevant benthic bony fish species – *Epinephelus marginatus, Umbrina cirrosa* and *Sciaena umbra* are managed under a minimum size limit (40cm), a seasonal fishing ban during spawning season and a daily catch limit for recreational fishers (*E. marginatus* was recently reclassified by IUCN from EN to VU on a global scale, but the assessment of the Mediterranean population remains EN). The two pelagic species – *Xiphias gladius* and *Thunnus thynnus* are fished in small amounts (<20t per year) by pelagic longliners 8-30 NM from shore during 3 months in the spring season (which is spawning season for *T. thynnus*). *Alosa fallax fallax* does not occur in the Israeli Mediterranean and there are no significant marine populations of *Anguilla anguilla* in Israel. There is no commercial extraction of Porifera or Cnidaria in Israel (*Corralium rubrum* is wholly absent from the Levant) and all Porifera and Coelenterates (except jellyfish) are protected. As mentioned above, *P. lividus* has seen a tremendous decline in its populations. *Scyllarides latus* is the only prominent lobster and its extraction is today forbidden and enforced.

2.2. Main Habitat types

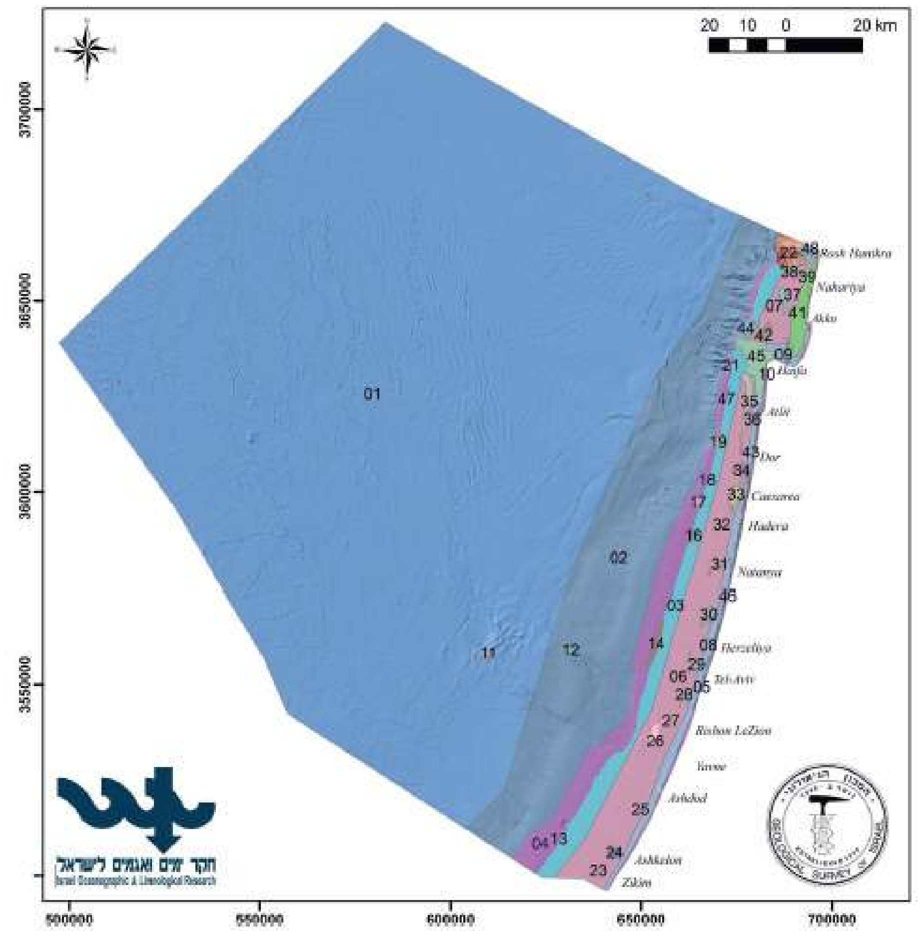
The Mediterranean's Levant Basin is a geologically active area, meaning that its unique geomorphologic phenomena also constitute special habitats, such as underwater ridges, trenches, and canyons, deep sea plateaus, submarine landslides, hydrothermal vents and more (Technion Israel Marine Plan Integrating Team. 2015). The Israeli Mediterranean is warm, salty and highly oligotrophic, yet diverse. In the shallows, its unique location in a transition area between tropical and temperate zones allows a large and growing part of this diversity to be attributed to NIS. A sharply descending gradient in the abundance of invertebrate and vertebrate species may be observed when moving away from the richer continental shelf to the slope and plateaus. The eastern basin is by nature the least species-rich, apparently due to higher temperature and salinity and lack of nutrients. Israeli habitats are constituted of large areas of soft substrate and some limited hard substrate habitats, including some that are globally unique, such as vermetid

abrasion platforms, underwater Eolianite or sandstone ridges (kurkar ridges), methane seeps and deep-water corals.

The 2019 Barcelona Convention "Classification of Benthic Marine Habitat Types for the Mediterranean Region and Reference List of Marine and Coastal Habitat Types in the Mediterranean" was used as a habitat reference tool for classifying habitats and may be viewed in Table 12 in Appendix V. There are no confirmed maerl-beds or seagrass (*Possidonia oceanica*) meadows in Israel, but several valuable habitats have been identified and mapped (Figure 9) and these are described below.

Figure 9

Forty-eight marine habitats, as defined in an early draft of the Strategic Environmental Assessment survey conducted by IOLR in 2015 (Source: SEA, 2015).



2.3. Singular habitats in the country

Vermetid Reefs: Approximately 33.4km out of the 190km Israeli coast (17.5%) is lined with abrasion platforms (Edelist and Rilov, 2017 and see table 9 in Appendix I for a full list. These biogenic calcareous reefs can be found mainly along the northern coastline of Israel and are considered as a biodiversity hotspot under substantial thermal stress (Rilov *et al*. 2020). Many vermetid reefs are protected as they are in marine protected areas.

Coraligenous habitats: While not exactly similar to the coralline algae encrusted reefs of the Central, Northern and Western Mediterranean, submerged sandstone ridges create most rocky reefs on the continental shelf. These rocky formations have a high structural complexity, and they are covered with invertebrates and teeming with marine life.

Mezophotic Sponge Gardens: At the shelf break, several submerged reefs have been recently identified as unique habitats with a diverse and unique sponge community (Idan *et al*. 2018). These deeper (100 m) reefs are home to 63 species of sponges, 14 of them new to the Levant, with a sponge cover percentage of 35% (Idan *et al*. 2018).

Deepwater Corals: These corals were discovered recently at depths of 500-900 m mainly offshore of Tel Aviv, on the rocky slopes of a mudslide called the Palmachim Disturbance. These branching coral colonies create a complex habitat that is extremely rare in the deep seabed of the South-Eastern Mediterranean, which is mostly comprised of uniform soft bottom. The closest known deepwater corals can be found in Eratosthenes Seamount, near Cyprus. These gardens host a comparatively high diversity of fish and invertebrate species. The deep Israeli slope and plains are not inhabited by deep sea echinoderms and several other species typical for the deep sea in the Central, Northern and Western Mediterranean.

Cold methane seeps: Cold methane seeps and pockmarks can be found in the deeper areas of the Palmachim Disturbance (1000-1200 m) and elsewhere on the deep slope. A rich and unique ecosystem (compared to the uniform deep substrate) evolved around chemo-synthetic bacteria that oxidize methane and create end-products like sulphides. While some organisms (such as gastropods or echinoids) in this habitat feed directly on the bacterial mat, others (such as tube worms or bivalves) host the bacteria as symbionts and utilize their products.

Rodolith beds: Rodoliths may be found in several locations on the Israeli shelf, but they are not common. One particular area with gravel bottoms which needs further research and may be the closest to a Rodolith bed in Israel is area 42 in Figure 9 above, North of the submerged Carmel rocky ridge.

Achziv canyon: This canyon is part of the East Levantine Canyons Area (ELCA), declared as an Ecologically or Biologically Significant Marine Area (EBSA) by the CBD (https://chm.cbd.int/database/record?documentID=204120). It is a system of deep canyons located all along the Lebanese, Syrian and Israeli coastline. Hydrothermal vents and submarine freshwater springs have been found in some of the Lebanese and Syrian canyons (Bakalowicz, 2014) but until today have not been observed in Achziv.

Mount Carmel extension into the sea: A geological rocky area extending to 300 m depth. See: Ben-Gai, Y., and Ben-Avraham (1995) Tectonic processes in offshore northern Israel and the evolution of the Carmel structure, Marine and Petroleum. Geology, Vol. 12, No. 5, pp. 533-548.

2.4. Transboundary issues

Israel has a small coastline of less than 200 km and its shelf occupies a relatively small part of the Levant (GFCM's GSA 27). As many marine animals migrate over large expanses of sea and do not recognize national borders, many migrating species merely pass through Israel on their way from and to other regions. Different standards of protection of migratory species are applied in different nation/states and their harmonization may aid in conservation of marine fauna. Some invasive and nuisance species (e.g., jellyfish) also represent issues that should be dealt with from a regional perspective. See chapter 4.3 for more on transboundary issues.

3. Pressures and impacts

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3.1. Biological disturbance

3.1.1 Invasive Species

The large prevalence of NIS on the Israel continental shelf is described above in Chapter 2. An invasive species may be defined as a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health (US National Park Service Executive Order 13751). NIS and invasives among them in the Levant are chiefly of tropical origin and immigrate to the Mediterranean Sea via the Suez Canal (Lessepsian migrants). The Suez Canal is one of the main vectors of change in this rapidly changing sea. Until now, at least 384 multicellular species were introduced via the Suez Canal and established viable populations and most of them can be found in the Israeli Mediterranean waters (Galil *et al*. 2018). This mass migration has led to vast changes in biodiversity patterns in an unprecedented rate (VergŽs *et al*. 2014). This community shift is accelerated in recent decades due to higher invasion rate and increased proliferation of "veteran" invaders (Rilov *et al*. 2017). This acceleration is also attributed to enlargement of the Suez Canal (completed in 2015) and also due to long term climatic changes: Sea water temperature rise ($0.12°C*y^{-1}$ over the last 30 years *sensu* Ozer *et al*. 2017) benefits tropical invaders – due to their susceptibility of to the cold waters in the temperate Mediterranean during the winter, the survival of tropical NIS depends greatly on the intensity of low temperature events, which may serve as bottle necks (Yeruham *et al*. 2019). Increase in water temperature gradually removes this barrier and indirectly facilitates bioinvasion. Additionally, removal and displacement of indigenous species as a result of exploitation, pollution, habitat destruction, climate change etc. may also assist in NIS establishment and proliferation (Rilov *et al*. 2017). Below are some noteworthy examples for the outcomes of bioinvasion in the Israeli Mediterranean.

3.1.1.1 Habitat alteration

Algal overgrazing and barren formations: The rabbitfish *Siganus rivulatus* and *S. luridus* were first recorded in the Mediterranean in 1924 and 1955, respectively, and since then they have become very abundant. Along the Israeli coast they comprise 95% of the herbivorous fish and one third of the total fish biomass in rocky habitats (Galil, 2007). Their invasion had a tremendous impact: Surveys along the Israeli coast indicated that native habitat forming algal biomass and diversity exhibit low cover, and many algal species have nearly disappeared, with barren turf grounds dominating almost all of the shallow subtidal reefs (Rilov *et al*. 2017). The link between this phenomenon to siganid activity was shown in experiments conducted in Israel (Yeruham *et al*. 2020). Besides the algae which are consumed directly by the siganids, numerous other organisms which depend on algae for shelter and food have declined, such as sea urchins, which became extremely rare in the last couple of decades (Yeruham *et al*. 2020). A handful of studies examined other repercussions of the rabbitfish invasion and the disappearance of such an important habitat was shown by Peleg *et al*. (2020) to cause ecosystem function modifications. Rabbitfish population explosion and concomitant overgrazing, was also suggested to be related to decline in predatory fish (Rilov *et al*., 2018).

Reef modifications: the Indo-Pacific bivalves *Chama pacifica and Spondylus spinosos* are rock cemented species, thus part of the shell remains attached to the substrate when the animal dies. Due to their extended abundance (25% of the epibenthic bivalve assemblages in northern Israel) they form multi-layered structures that considerably add to the complexity of the reefs and probably alter their function. It is important to point out that these two species were first recorded during the 1990's (Rilov *et al*. 2017) and, aided by siganids, bring about a transformation of Levnatine reefs from canopy algae-dominated to a turf-covered (Peleg *et al*. 2020) filter feeder-dominated community.

3.1.1.2 Changes in distribution patterns: Extreme displacements and exclusions

Exclusion and displacement of native species by NIS in the Israeli Mediterranean was shown in quite a few studies, for example:

- The native penaeid prawn, *Melicertus kerathurus*, was completely overrun by three species of Indo-Pacific prawns which occupy the same habitat, and today it is very rare.
- In marinas and ports, invasives such as *Styela plicata* cause damage to anchorage systems and compete and displace indigenous species (Novak *et al*. 2017).
- The native red mullets, *Mullus barbatus* and *M. surmuletus* were excluded into deeper waters by the Erythrean goldband goatfish, *Upeneus moluccensis,* that lives in the same habitat and has similar food preferences (Golani, 1994).
- In the intertidal zone, the mussel *Mytilaster minimus,* which use to form vast beds on rocky shores was outcompeted by the invasive *Brachidontes pharaonis.* This species was one of the first to make a successful migration via the Suez Canal, first recorded in the Mediterranean in 1876. Surveys conducted a century later show it was still infrequent: "250 times rarer than the native mytilid *Mytilaster minimus*". However, a rapid turn occurred during the 1990's, with a sharp rise in *B. pharaoinis* densities, and decline, to a near disappearance of *M. minimus* (Rilov *et al*., 2004) .
- In some areas, mainly along the northern Israeli coast, invasive algae such as *Galaxaura rugosa* replace native algae species, possibly due to their lower palatability to the Iinvasive herbivores (*S. rivulatus* and *S. luridus*). The introduced algae usually do not form dense meadows as their native counterpart does (although recently some observations in northern Israel indicate they may do so), and the habitat they create is described by researchers as shrubbery (Figure 10) (Garval 2015, Peleg *et al*. 2020).

Figure 10

The three shallow southeastern Mediterranean reef habitattypes during spring 2016: (a) Algal forest; (b) Turf; and (c) Tropical shrubs. Source: Peleg *et al*. 2020.

3.1.1.3 Damage to fisheries

- Damage to fishing equipment: Several species of *Legacephalus* spp., mainly *L. sceleratus*, have invaded and proliferated in the Israeli Mediterranean. These opportunistic carnivores are causing severe damage to fishing equipment, such as nets and long lines, and also scavenge on tangled fish. Similar impact is exerted by the invasive stinging jellyfish *Rhopilema nomadica*, that creates dense swarms and is often captured in fishing nets (See more below).
- Damage to fishers: The invasive striped eel catfish quickly became very abundant after its first observation in the Israeli Mediterranean in 2001. While the ecological impact of this invasion is unknown (it feeds on zooplankton and small invertebrates), it has a strong negative impact on fisheries: this species (which has no commercial value) is captured in very large numbers and due to its venomous spines makes catch sorting complicated and potentially dangerous to fishers, thus reducing profitability and adding severe hazard to this occupation (Bentur *et al*. 2018).
- Overpredation: The lionfish *Pterois spp.,* have caused severe impact on fish populations via overpredation in areas in which it invaded and proliferated, such as the Caribbean Sea. Lionfish numbers remained relatively low in the Israeli Mediterranean until recently. However, over the past few years its abundance is on the rise, which raises many concerns regarding prey species – small reef fish, as well as juveniles of many larger species. It also competes with and probably displaces indigenous predators such as groupers. INPA thus took some measures, such as enabling the extraction of this species from no-take marine reserves by recreational divers, and allowing the fishing of this species using scuba diving equipment, even though fishing while scuba diving is forbidden through the entire Israeli Mediterranean (Stern and Rothman 2018).
- Parasitism: Among migrants there is also a large proportion of parasites, with high presence of crustacean parasitic copepods and barnacles (Galil *et al*. 2007).

3.1.1.4 Implication for infrastructure, tourism, and human welfare:

Summer blooms of stinging jellyfish *Rhopilema nomadica*: Consequences of *R. nomadica* blooms to humans are extensive: clogging of water intake pipes of power and desalination plants, damage to fishing gear, interference with fishing activity and disruption to coastal recreational activities. The multitude of factors affecting (and affected by) their density and distribution merit long term monitoring of their populations. Recently some monitoring by Citizen Science (Edelist *et al*. 2020) is helping to fill this gap. While swarms may be seen in the Israeli Mediterranean throughout the year, during summer months this large stinging jellyfish creates enormous and dense swarms that stretch over thousands of km. The arrival of the swarms during peak bathing season in June-July reduces visitor numbers to the beaches dramatically (Ghermandy *et al*. 2015) and also clogs the intakes of coastal desalination plants and cooling water for power plants. *R. nomadica* has an unquantified but overwhelming ecological impact. These planktivorous animals consume huge amounts of prey in this ultra-oligotrophic environment and recent studies (e.g., Kuplik *et al*. 2020) have begun to shed some light on such impacts.

3.1.2 Impacts of fisheries on the marine environment and recent steps undertaken to reduce them

Fishing impacts target species, bycatch and marine habitats in all coastal countries. In Israel, adverse effects of fishing have been extensively described by SPNI (2020) and INPA (2018). Sustainable fishing is hard to achieve but possible, and fishing may even play a role in conservation such as when culling NIS (Kleitou *et al*., 2020).

Israel has a small continental shelf and the fishery is equally small - Israeli fishers today land less than 2,000 $t{*}y^{-1}$ - about half the catch of neighboring Gaza Strip and Lebanon (SOMFI, 2018), about 5% of Egyptian catches and about half of Israel's peak catches in the peak years of fishing in the 1980s and 1990s, when commercial catches often exceeded 4,000 tons per year. This decline in catch is mainly a result of a decline in fishing effort that occurred due to various geopolitical, socio-economic and physio-chemical reasons such as bioinvasion, pollution, fuel and labor prices, low profitability and fish prices, better job options, imports, and quite possibly a certain degree of overexploitation of some local populations as well (Edelist, 2013). If we stop eating seafood, we will have one less incentive to safeguard our seas from pollution, and for this and other reasons, fishing merits the extended attention it attracts. In recent years, the main reason for catch and effort declines is a new fisheries reform that included effort reduction measures such as vessel buy-out and seasonal and spatial moratoria. This new set of regulations followed an advocacy and litigation campaign by SPNI that

led to the Ministry of Agriculture's changing the fisheries management paradigm from maximizing the catch and protecting fishermen to decreasing fishing pressure and protecting fish stocks and the environment. Intensive fishing can overexploit target species and often exploits juveniles. It may alter habitats and entail bycatch of non-target species, including vulnerable and threatened species. These impacts all take place in Israel; however, the full extent to which these and other impacts are occurring is debated, unknown and understudied.

Israel has embarked on the fisheries reform and in Dec. 2016, new fishing regulations (MOAG and INPA, 2017) were announced. Since 2017 they were partially applied and since May 2018 are officially enforced by a newly formed INPA marine unit. This reform is under constant criticism by both the environmental sector and the fishing sector, the former claiming it is not stringent enough while the latter claims it is too stringent and economically and socially unjust. The main regulations and measures in the reform include:

- Minimum Landing Sizes were set for most commercial species.
- A daily maximum of 5 kg or two large fishes was set for recreational fishers.
- Spearfishing and recreational fishing activity from a boat requires a fishing license. Spearfishing with SCUBA gear is forbidden.
- Seasonal ban on fishing of all groupers (Epinephelinae) and drums (Sciaenidae) in the Spring of 60-90 days.
- A spawning season ban on all artisanal and recreational vessel-based fishing every Spring (set to 60-90 days in regulations and thus far implemented for ~30 days each year).

- All commercial artisanal fishers must be licensed for personal use and all vessels must be licensed, and all fishers must maintain proper book-keeping with the tax authorities.
- Minimum mesh size was set as 30 mm (stretched mesh) for artisanal fishers and gillnets and longlines are limited by maximum gear size regulations.
- A 500 m minimum distance from shore was set for purse seines and a minimum mesh size of 20 mm.
- Bottom trawling is banned in the entire northern third of Israel (north of Dor), banned shallower than 30\40 m in the south and banned on or near rocky reefs (Figure 16 in appendix IV) – together these exclude trawlers from almost half of the fishing fields. A trawling moratorium of up to 90 days was set for the summer recruitment season (so far implemented as 60 days) and the minimum trawl net mesh size was enlarged to 48 mm at the codend.
- Additionally, several trawlers were scrapped in a vessel buyout program and only 16 remain active today.
- On top of these new regulations, all fishing (except shore-based angling) is currently forbidden in all marine nature reserves.
- Landing or sale of all cartilaginous fishes is prohibited. Lobsters are also protected and so are a number of other species. This is, in fact, not a part of the fishery reform and emanates from the List of Protected Species from 2005 that was updated in 2019.

Most declines were observed in migrating and pelagic species that in the past represented a substantial part of the catch as only seven purse seiners are active in Israel today. There is no beam, dredge or rockhopper trawling in Israel, although a single vessel used rockhopper gear from 2008 to 2015 before being bought out. So long as there is no trawling on or near rocky reefs (which is now banned by the new reform), soft sediment habitat disturbance levels are predominately short to medium-term impacts (Edelist, 2013). Artisanal fishing methods such as gillnetting and longlining were assessed for effort and have shown low effort (Belmaker *et al*. 2018), declines in landed catch and probably also in total catch, particularly of some high prized local demersal rocky reef species such as groupers.

Commercial catch: Landings in the years following the reform are in the order of 1,300-1,600 $t{*}y^{-1}$. It is estimated here that about half of this catch is landed by trawl fishing (650-900 t) and the rest is comprised mainly of artisanal entangling nets (400-550) $t{*}y^{-1}$ and longlines ($80^{-1}00$ $t{*}y^{-1}$), with the once booming purse seine industry reduced to less than a tenth of the catch ($80^{-1}20$ $t{*}y^{-1}$), mainly due to imports, damming of the Nile, low prices for pelagic fishes, periodic closure of exports to the Gaza Strip and other ex-fishery factors (Edelist, 2013).

Recreational catch: recreational landings were recently assessed (Frid, 2018) and found to be a substantial part of the total catch, amounting to 147-203 $t{*}y^{-1}$ for fishing from shore with pole and line and 70-588 $t{*}y^{-1}$ for speargun or fishing from boat. The latter range is particularly wide and needs to be narrowed with better data, as the upper figures are probably overestimated. Despite the paucity of information, it is clear that recreational fishing accounts for a substantial proportion of the catch in Israel.

Bycatch of vulnerable species: It was previously estimated that 1,315 sea turtles were caught and discarded annually by trawlers in Israel, with unknown survival rates (Levi *et al*. 2015). Following the reform (summer trawl ban, 40 m minimum, vessel decommissioning etc.) this figure is expected to be reduced. A slightly larger number of turtles (1,801) were estimated to be caught by artisanal fishers (Levi *et al*. 2015) and this figure has probably declined as well due to spring spawning season moratoria on artisanal fishers. All sharks and rays are discarded with unknown survival rates. Dolphins are extremely rarely caught, no more than 1-2 animals per year. In total, bottom trawlers in Israel have a discard rate of slightly less than 50% of the biomass, which is typical for the Mediterranean (Edelist, 2013). Most of the discarded catch is comprised of non-target species, but a substantial portion is juveniles of commercial species. Other fishing methods have considerably lower discard rates.

Author's Recommendations: The new fisheries reform regulations of 2016 and new MPAs (even though not all are yet approved), rank Israel in the top of Mediterranean nations so far as marine conservation goes. SPNI (2020) has recently proposed a long-term masterplan for management of Israeli fisheries that expands it even further. This plan is mostly based on conservation-driven advocacy and promotion of the precautionary principle rather than principles of EcAp and EBFM, but it does contain some fundamental management amendments. It calls for more science-based decision making, improved MCS and an economic safety net for commercial fishers. It also calls for more effort reduction on top of the new regulations, including a complete cessation of all bottom trawling, longer inshore moratoria and more spatial, species and gear limitations. While fishers and some scientists feel that the effectiveness of the 2016 regulations should be evaluated before acting upon these calls in unison. INPA and the national MSP process (2020) support them. It is understandable that an environmental NGO will propose a program that is more conservation-oriented, but such a masterplan needs to be established by the government to balance conservation with fishers' specific vulnerabilities and risks (FAO, 2020; Uffman *et al*. 2020; UN SDGs - Table 13). Small-scale fishers' access to social protection systems has been somewhat improved in Israel by mandatory licensing and book-keeping, but still merits attention.

Here are some additional fisheries issues that merit attention: 1) Recreational fishing licensing needs to be completed. 2) Data collection needs to be improved for both recreational and commercial catches 3) Surveillance technology to track vessels using Automatic Identification Systems or Vessel Monitoring Systems should be employed and regulated. 4) Illegal, Unreported and Unregulated fishing needs to be phased out 5) The lists of protected species and Minimum Landing Sizes need updating. 6) Fishers should be consulted in the regulation process to promote collaborative management and conservation efforts and reduce IUU. 7) Fishing must be banned in contaminated areas; particularly where high mercury levels are recorded (e.g., southern Acre in the bay of Haifa – Herut *et al*. 2017). 8) Science-based analysis should assess the potential impact of climate change on fishing as warming affects reproduction, size and distribution of both native and NIS fauna (Givan *et al*. 2018).

INPA comments on author's recommendations, above:

The fishers have an organized and vocal lobby and their wants and need have been heard. The Israeli Supreme Court has ruled on a number of appeals by the fishers and has consistently found that the reform was enacted following a proper weighing of all points of view.

The reform will actually help the fishers in the long term and therefore short-term benefits should not be used to determine the future of the ecosystem. In fact, one of the main goals of the fishery reform is to conserve fish stocks by ensuring the future health of the ecosystem that produces the very fish that the fishers depend on.

3.1.3. Aquaculture

The Israeli coast is relatively straight. With no significant bays or protected waters other than port breakwaters, therefore winter storms pose a constant threat to structures and dictate use of submersible offshore fish cages. Currently most Mediterranean aquaculture is still protected by the Ashdod port breakwater and only two farms operate in the open sea, on an area of 14km2 offshore Ashdod and ~1km2 offshore Mikhmoret. Together, all Mediterranean farms produce roughly 2,000-3,000 $t{*}y^{-1}$ of a single species – *Sparus aurata*. Plans to widen Israeli offshore aquaculture to 100,000 tons from a 100 km2 area have been proposed and recently 30 km2 were approved. Impacts of aquaculture on the oligotrophic waters of the Eastern Mediterranean are claimed by some models to be mainly local and that farms are not expected to exceed ecosystem carrying capacity (Grossowicz *et al*. 2017). Nevertheless, this amount of nutrients is nearly double the discharges by coastal streams and should not be considered lightly. Mariculture farms function as floating artificial reefs – providing settlement substrates for fouling communities and functioning as feeding stations with uneaten pellets, dead fish and fish fecal matter creating local enrichment halos attracting predators such as sharks, tuna and dolphins. Improved sanitation and optimized feeding procedures are key to keeping top-predator interactions to a minimum. As with any marine structure and activity, lost gear and netting (mainly due to storms) may endanger marine wildlife. Other impacts include antibiotics leaching into the environment and escapees which might alter the genetic makeshift of local populations or spread disease; however, considering the single-species makeshift, low natural abundance of *S. aurata* in the Levant and its tendency to rush to the shallows when escaping (right into high fishing pressure) and the low antibiotic inputs in open sea cages, these impacts may be considered as secondary. As most aquaculture in Israel is planned to be located offshore, additional effects include local eutrophication, light and noise pollution in previously undisturbed sites. Offshore light pollution might also affect sea turtles and migratory birds.

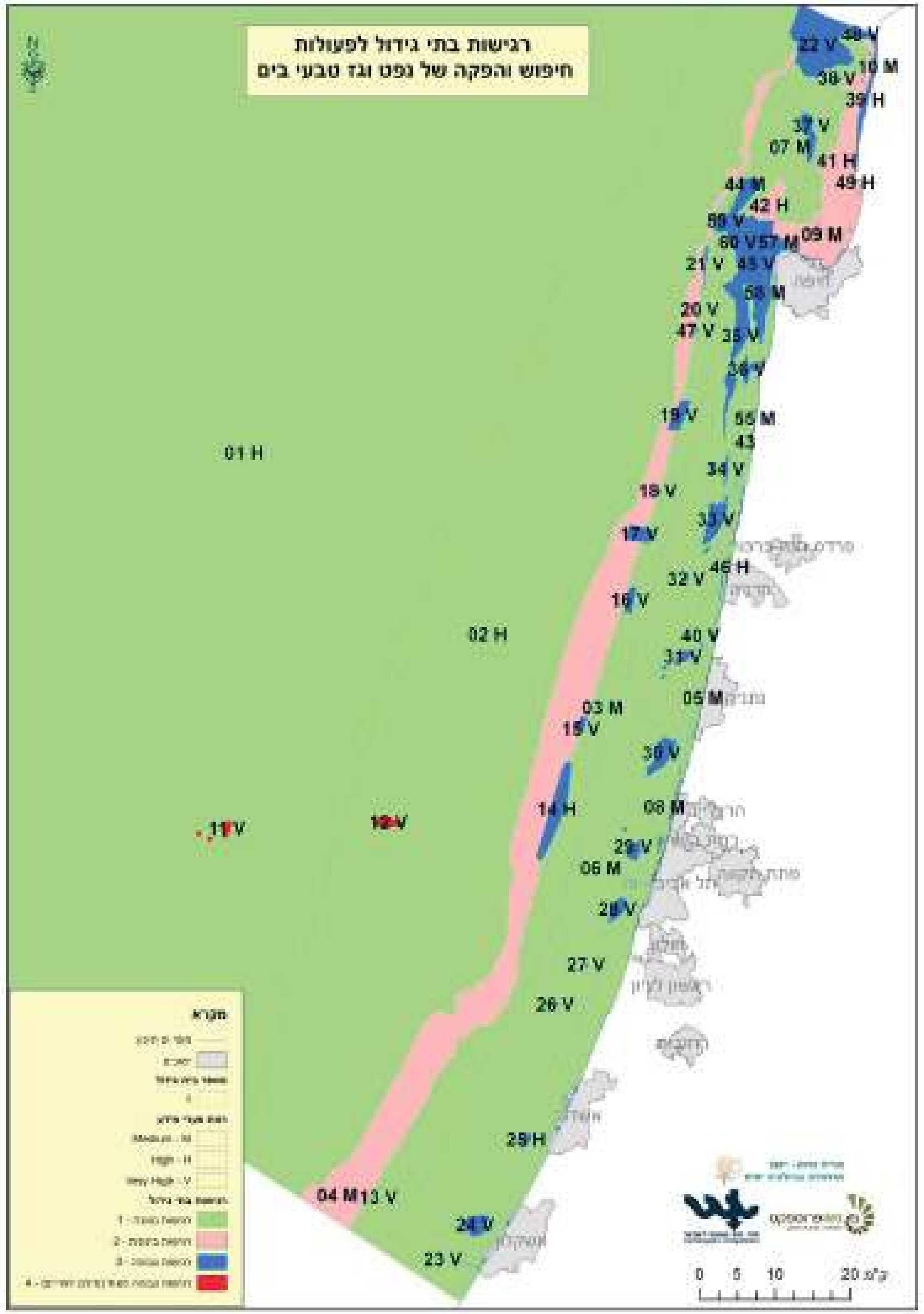
3.2. Vulnerable marine ecosystems

In light of the recent natural gas discoveries in the Israeli EEZ, the Israeli Ministry of Energy has initiated over the past decade a large scale Strategic Environmental Assessment (SEA), mapping and evaluating habitats in the entire Israeli EEZ, in order to assess potential environmental conflicts (SEA, 2016). There is also a need to establish environmental legislation in the Israeli EEZ.

Over 60 distinct habitats have been identified, mapped and classified according to their environmental sensitivity – vulnerability to anthropogenic stress vectors (mainly those which that are caused by oil search and extraction activities), and the ability of the habitat to recover. This was done on a scale between 1-4 (4 being the highest sensitivity level – see Figure 11).

Figure 11

Habitat sensitivity to oil and gas search and production activities, Source: SEA, 2016



The regulations for drilling are according to the sensitivity level, with the strictest regulations in the case of proximity to habitats with sensitivity level of 3 or 4. Habitats classified as most vulnerable (level 4) usually include unique species that have a very long recovery rate such as deep sea corals. Also included were coastal abrasion platforms and cold methane seeps at depths of 1000-1200 m and deep-sea corals in 500-900 m – both can be found in the Palmachim Disturbance. This habitat was recently proposed by SPNI as a MPA and FRA, as it was classified as sensitive by the SEA (2016).

Habitats in sensitivity level 3 included mainly the calcareous and sandstone reefs (in both shallow and deep waters). It is important to point out that not all calcareous reefs are classified in this sensitivity (some are in level 2), and this was assessed according to the species assemblage surveyed in each site (SEA, 2016). This assessment was very lacking in terms of megafauna of each site and habitat mapping needs to be improved by auxiliary biological habitat research (e.g., Edelist, 2013; Idan *et al.* 2018; Rilov, 2016) and high-resolution bathymetric surveys.

Other sensitive areas identified by MOEP (2016b) are wetlands and river mouths. Although these are small, they are thoroughly assessed and surveyed seasonally and were similarly allocated four levels of sensitivity (albeit to different factors) as shown if Table1.

Table 1.

Sensitive coastal habitats in Israel, as identified by MOEP (2016b), correlating mainly to river mouths and wetlands.

Site	Alexander	Naaman	Taninim	Hadera	Lakhish	Soreq	Kishon	Yarkon + Ayalon
Public health Seamount FRA								
Population	4	4	4	4	4	4	4	4
Wastewater treatment	3	3	3	2	2	2	2	2
Drinking water quality	2	2	2	2	2	2	2	2
Bathing water quality	2	2	2	1	2	2	2	2
Environmental Status and Pressures								
Organic matter	3	3	2	3	2	3	3	3
Nutrients and biological status	3	3	2	3	3	3	3	3
Contaminants	2	2	2	2	2	2	2	2
Marine litter	1	1	1	1	1	1	1	1
Economics								
Economic activities and ecosystem services underpinning them	2	2	2	2	2	2	3	3
Trans-boundary Effects								
Transboundary effects	1	1	1	1	1	1	1	1
Total Score	80	80	74	72	73	76	80	80
Class	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)

3.3. Emerging issues such as climatic change effects and open sea including deep-sea ecosystem concerns

3.3.1. Climate change

The South-Eastern Mediterranean is highly impacted by climate change. Since the early 1980's sea water temperature has risen by more than 3 degrees, making it one of the fastest-warming marine areas in the world (second only to polar regions). This trend is occurring in all water layers, not just surface waters (Sisma-Ventura *et al*. 2014, Ozer *et al*. 2017) and might act in synergy with regional phenomena such as the Eastern Mediterranean Transient - warming of Levantine deepwater as a result of convection and sinking in the Aegean Sea instead of the Adriatic Sea (Beuvier *et al*. 2010). Warming has a strong impact on the local biota and is considered to play a key role in the recent ecological alterations that are ongoing in the area. Although the Israeli Mediterranean (much like the rest of the sea) is highly impacted by several anthropogenic stressors (such as overfishing, habitat destruction, and NIS invasions due to anthropogenic factors), and it is difficult to associate between the various biodiversity changes to the each of the different stressors, some recent studies demonstrate the significant influence warming has on the local communities. For many species (mainly of those of North-Atlantic origin), the South-Eastern Mediterranean represent the warmest distributional edge of their distribution range, and further warming may have severe consequences at the population level for them. Sharp declines in populations, to near extinction, of species such as sea urchins (*Paracentrotus lividus* & *Arbacia lixula*) and gastropods (*Stramonita haemastoma* & *Dendropoma cristatum*) was suggested to be associated with this rapid, recent warming (Rilov, 2016). In deep water hake (*Merluccius merluccius*) declines may be associated with this change (Edelist, 2013) and in the ultra-shallows, *P. lividus* population collapse appears to be linked to the elevated peak summer temperature in the last couple of decades, reaching usually to around 31 C. It was experimentally demonstrated how current temperature is well above the thermal tolerance range of this species, which exhibits high mortality rates in these high temperatures (Yeruham *et al*. 2015; Rilov 2016). Temperature rise also changes the biota in indirect and non-lethal ways, as thermophilic species (both local and invasive) benefit from it. This advantage leads to their proliferation at the expense of thermophobic species, as well as higher NIS establishment rates and expansion of tropical NIS (Givan *et al*. 2018, Yeruham *et al*. 2019, Gamliel *et al*. 2020).

Another aspect of climatic changes affecting the Israeli Mediterranean is pattern alterations of extreme weather events. Between October and May, atmospheric conditions can generate strong, dry, easterly winds combined with high barometric pressure and these push the very nearshore water level down so that even during high tide, intertidal habitats including abrasion platforms (see chapter 2.2) remain exposed to air for prolonged periods of time – several days to weeks. This phenomenon, also known as PDE (prolonged desiccation event) is intensifying in recent years, as the frequency and length of these events are increasing. This has a tremendous impact on the intertidal community – both flora and fauna: PDEs leads to mass bleaching of algae (mainly fleshy and erect algae) in the mid and lower intertidal zones and declines in populations of associated invertebrates (Zamir *et al*. 2018)

Climate change may also reduce nutrient availability in this already ultra-oligotrophic sea (Sisma-Ventura *et al*. 2014). Rising water temperature might increase stratification and reduce nutrient influx from deep waters towards the surface, further reducing overall productivity (Richardson 2008). Sea level rise might have dire impacts on the ecology and diversity of vermetid reefs. In addition, continued global desertification and reduction in precipitation overland may reduce available nutrients, especially in coastal habitats (synergistically operating with oligotrophication factors such as damming and river drying). It remains to be investigated whether these vectors of change are responsible for the recent decline in small pelagic fish catch (mainly sardines and mackerels) in Israeli coastal waters.

3.3.2. Solid Waste

Plastic pollution is disturbingly high along the Israeli Mediterranean coastal waters: Recent surveys show plastic particles concentration in surface waters in this area is 1-2 orders of magnitude higher than abundances reported in other parts of the world. Average plastic particle concentration of 7.7 particles per m3 was found in Israeli surface waters, and maximal measured concentration was 324 particles per m^3 (van der Hal *et al*. 2017). It is important to point out that pollution and microplastics are a transboundary problem. Some of it originates outside of Israel and maybe (rarely) even outside the Levant.

3.3.3. Deep Sea

Only a decade ago, deep sea conservation in the Israeli Mediterranean was fairly neglected, receiving little attention from NGOs, regulators, and scientists. This has changed due to recent discoveries of large hydrocarbon reservoirs in the SE Mediterranean which led to several large-scale extraction and production operations. These activities have considerable environmental consequences, mainly in the case of malfunction (such as hydrocarbons spill or leak), but also from its regular operations as a result of noise and light pollution, dumping of drill cuttings (soaked in water based drilling muds), emissions such as production water, altered habitat complexity or the additional hard substrate provided by the submerged infrastructure (Cordes *et al*. 2016). With the risks came regulation, research, monitoring and mapping (SEA, 2016) and some regulatory measures are now taken to protect the unique habitats of deep-water corals and cold methane seeps that were found in surveys. However there is a lack of environmental legislation regarding the EEZ. Most regulation in the EEZ is done predominately by the Ministry on Energy, while the Ministry of Environmental Protection acts only as a consultant. More information regarding these habitats and the measures taken in order to reduce anthropogenic impact on them can be found in chapters 2.3 and 5.

4. Current response measures

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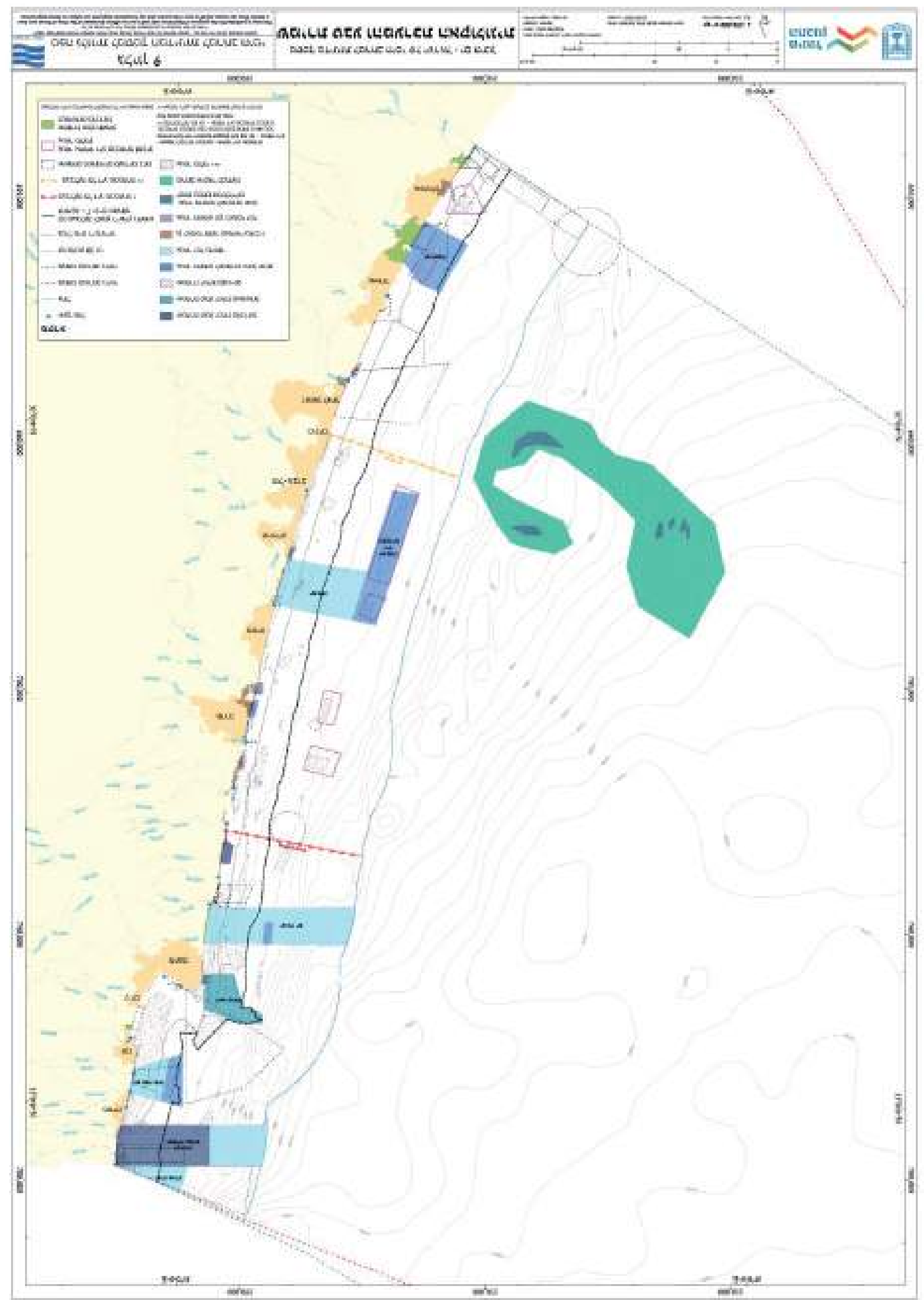
4.1. Marine protected areas and other area based conservation measures

4.1.1. Marine and Coastal Protected Areas

Several large Marine Protected Areas have been proposed (i.e., in advanced planning stages), deposited (plan is opened for public and stakeholder feedback), or officially declared in recent years in Israeli territorial waters and the EEZ (Figure 12).

Figure 12

Marine conservation areas in the Israeli Mediterranean Marine reserves (dark blue), special areas for future consideration (light blue), rocky areas excluding bottom trawlers (purple outline) and proposed search area for reserves in the EEZ (turquoise)



These large reserves shown in Figure 12 constitute about 8.6% of Israel's territorial waters, yet this is almost unparalleled in the Mediterranean today on such a proportion of a national continental shelf. As only 0.23% of the Mediterranean Sea today receives high protection levels (Claudet *et al*. 2020), deployment in this magnitude and sound management will surely make Israel a Mediterranean conservation leader.

While some of these MPAs are set to protect special regions of concern and focus on rocky reefs (e.g., Achziv Canyon, Tel-Aviv Sponge Reefs, Rosh-Carmel Promontory), other areas are set on soft bottom habitats of sand and mud (Ivtach and parts of Poleg and Neve Yam) under the principles of connectivity and representativity or for conservation of vulnerable species. Deepwater habitats in Palmachim Disturbance in the Israeli EEZ are also proposed for conservation (Figure 12). Another area worthy of conservation that was left out of the Rosh Carmel reserve is the rich shallow algal reef of Bat-Galim in Haifa which is also a haven for sea turtles and other vulnerable species and grassroots community organizations are now calling for its protection.

In addition to these spatial measures, the Ministry of Energy restricts hydrocarbon extraction activities around sensitive habitats (such as cold methane seeps and deep water corals) and these habitats have a safety buffer zone of 1000 m for drilling activities, and 150 m for pipeline installations (SEA, 2016). Areas other than MPAs that exclude fishing include the new fisheries regulations (MOAG and INPA, 2017 – see chapter 3.1.2), aquaculture sites, hydrocarbon infrastructure (500 m from pipelines, 3nm from platforms), borders and Israeli military zones.

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

4.2.1. Stakeholders

The most important institutional actors in relation to marine and coastal biodiversity include mainly government, the private sector, academy, and NGOs (Table 2).

Table 2.
Institutional actors and contact points in Israel

Type	Institutional Actor	Relevant areas of interest or responsibility	Focal Points
Government	Ministry of Environmental Protection	Marine Environment	Rani Amir, Dror Zurel, Fred Arzuan
Government	Ministry of Energy	Oil & Gas, Energy production	Ilan Nissim, Dorit Hochner
Government	Ministry of Transportation	Administration of Shipping and Ports	
Government	Ports Authority	Shipping and port activities and development	Yaron Shvartz Roni Zissu
Government	Ministry of Agriculture	Fisheries, Mariculture	Nir Froyman
Government	Ministry of Finance	Funding of marine projects and activities	
Government	Ministry of Tourism	Tourism and recreational activities	
Government	Ministry of Foreign Affairs	Transboundary issues	Eldad Golan
Government	Ministry of Defense / Israel Defense Forces	Military and paramilitary actions, closed areas	
Government	Ministry of Science and Technology	Research Funding	
Government	Ministry of Interior Affairs	Bathing beaches	Miri Tamir
Government	Planning Administration	Marine Spatial Planning	Ronit Mazar
Government	Water Authority	Desalination, Sewage,	Olga Slepner
Government	Health Ministry	Bathing Beaches, sewage effluent	
Government	INPA	Conservation, Enforcement, Research & Education, Tourism, Bathing beaches	Ruthy Yahel, Simon Nemtzov
Academy/ Govt	IOLR	National Monitoring Plan, Research & Education	Barak Herut
Academy/ Govt	Geological Institute	Geophysics, mineral resources	Oded Katz
NGO	Israel Diving Federation	Education, Training	Boaz Mayzel
NGO	SPNI	Conservation, Education	Alon Rothschild
NGO	Zalul	Conservation	Yuval Arbel
NGO	Ecoocean	Conservation, Education	Assaf Ariel
NGO	Adam, Teva Vadin	Conservation	Amit Bracha
NGO	IMMRAC	Cetacean Conservation, Research	Oz Goffman
NGO	Delphis	Cetacean Conservation, Education	Mia Elasar
NGO	Greenpeace (Israel)	Conservation	
Private	Israel Electric Company	Research & Monitoring	Kfir Avramzon
Private	Private sector and Industry	Any commercial activity	
Private	Oil & Gas sector	Search, drilling, production and sale of O&G	Noble, Delek, Energian
Private	Shipping sector	Shipping lanes, ports, free passage	Haifa, Ashdod
Private	Desalination companies	Desalination plants	
Private	Fisheries sector	Marine and coastal fishing	Gil Sassover, Sami et Ali
Academy	University of Haifa	Marine research, education, some monitoring	Sharon Liper, Aviad Scheinin

Type	Institutional Actor	Relevant areas of interest or responsibility	Focal Points
Academy	Tel-Aviv University	Marine research, education, some monitoring	Jonathan Belmaker
Academy	Weizman Institute	Marine research & education	Aldo Shemesh
Academy	Ruppin - Marine Faculty	Marine Research & education	Abraham Hefetz
Academy	Hebrew University	Marine Research & education	Daniel Golani
Academy	Technion Institute	Marine planning & education	Shamay Assif, Michelle Portman
local authorities	Municipalities and local authorities	Municipal wastes and coastal development, bathing beaches	

4.2.2. Legal texts of relevance

Texts of relevance to marine and coastal biodiversity (conservation, management of uses such as fisheries, tourism, etc), regulations or plans and international Agreements to which Israel is (or should be) a party to are listed below: A comprehensive list of conventions and protocols to which Israel is a signatory party may be found in Appendix III.

Israel is one of the few Mediterranean coastal states who are not a party to the 1982 UN Convention on the Law of the Sea (UNCLOS). Israel follows UNCLOS guidelines, but not all requirements of the treaty have been incorporated into Israeli maritime laws (Teff-Seker *et al*. 2018). Similarly, Israel has not signed all the protocols of some of the other conventions that it did ratify.

As part of the Legal Framework for Marine Pollution Prevention in Israel, MOEP administers the following laws and regulations relating to the marine environment:

- The prevention of seawater pollution by Oil Ordinance, 1980, provides the legal basis for controlling marine oil pollution. The Ordinance forbids discharge of oil or oily water into Israel's territorial and inland waters by any shore installation or vessel and makes any such act a criminal offense - the law is also in force on Israeli ships in international waters. The law provides the MCED inspectors to conduct inspections and investigations in order to prevent violations of the ordinance or its regulations. Other salient features of the ordinance and its regulations include the obligation to keep oil record books on vessels; measures to be taken in case of discharge of oil; maximum fines for oil spillage; and liability for cleanup costs. Fines may be as high as $40,000, and violators may be sentence up to one-year imprisonment. An effort is now being taken to increase fines.
- Regulations promulgated within the framework or the law requires Israeli harbors to provide adequate reception facilities for oily wastes and require vessels to use these facilities. The MCED inspectors for the Mediterranean Sea and the Gulf of Aqaba strictly enforce these regulations. This law Complies with Annex 1 of the MARPOL 73/78 Convention.
- Other regulations under the ordinance provide for the operation of "Marine Pollution Prevention Fund". The fund concentrates the financial resources for preventing

and combating marine and coastal pollution. It is comprised of money from fees imposed on all ships calling at Israeli ports and oil terminals and from fines on violators of the marine pollution prevention laws - thus implementing the "polluter pay" principle. The fund is utilized for MCED operations 4 such as the purchase of equipment, law enforcement, shore cleanup, and more.

- Regulations concerning the Loading and Discharging of Oil under the Ports Ordinance, 1971. These regulations control all procedures for safe loading and discharging of oil and contain specific instructions regarding hazardous materials. Entry into territorial waters and ports; vessel operations during their stay in terminal; measures for fire prevention and firefighting; fit conditions of oil terminal; transfer of oil from road tankers; and other regulations aimed at ensuring environmentally safe and sound practices. Some of the regulations are supervised and enforced by the Ministry of Transport; however, the MCED inspectors of the Ministry of the Environment administer the regulations concerning environmental issues.
- The Prevention of Sea Pollution (Dumping of Waste) Law, 1983, controls dumping of waste at sea. The law complies with the Dumping protocol of the 1976 Barcelona Convention- The law prohibits the dumping of any waste from vessels and aircraft into the sea, except under a permit which may be issued by a special committee. A court convicting an offender under this law may require, in addition to the fine levied, payment of expenses for cleanup operations. The regulations under the law include lists of substances, which may or may not be dumped at sea, and conditions for the issue of permits.
- The Prevention of Sea Pollution from Land-Based Sources law - 1988, which entered into force in 1990, deals with the major source of marine pollution. Under the law, industrial and municipal wastewater discharge into the sea is prohibited or eventually regulated through a strict permit 5 system. As in the Dumping of waste law, courts may impose severe fines and even Imprisonment on the offender. MCED inspectors, together with regional professional wastewater inspectors, enforce the law by carrying out investigations whenever a violation occurs. Regulations under this law include terms and conditions for issuing permits, and lists of substances, which may or may not be discharged into the sea. The law complies with the Land-Based Sources Protocol of the 1976 Barcelona Convention. Although it will probably take additional 2-3 years to regulate all industrial emissions to the marine environment it can be assumed that inspection and law enforcement will result in a significant decrease in marine pollution along the coasts.
- The Cleanliness Law – 1984, is implemented through the inspectors, the police, and voluntary specially designated "Cleanliness Trustees." The law prohibits the disposal of any material in public areas, which also applies to any litter left on the beach or thrown overboard from a vessel into the sea within Israel's territorial waters. In regard to vessels, the law holds the skipper and the owner of the vessel responsible for violations, and fines are imposed against them. Funds collected from fines and penalties is deposited in a "Cleanliness Fund," and is used for specific projects such as beach cleanup campaigns research on recycling, and environmental education.

- In order to protect endangered species and areas at risk, INPA enforces mainly these two laws: The Wildlife Protection Law, 1955 and the National Parks, Nature Reserves, and Memorial Sites Law, 1998. These laws also serve as Israel's implementation tool for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All the species listed in the CITES Appendices were declared as protected species since 2004 and updated in 2019. The List of Species protected by law (2005) has also been updated in 2019 and it includes hundreds of Mediterranean marine species. Most prominent among them are all marine mammals, reptiles, sea birds and cartilaginous fishes. Among bony fish, 15 families are protected. Other groups protected fully in the list include all coelenterates, sponges, echinoderms and mollusks (except cephalopods). The law also prohibits any harm to wildlife inside the marine protected areas.

The Law for Protection of the Coastal Environment (Law 5764-2004) also has provisions of relevance for biodiversity conservation, aiming at preventing damage to the marine environment (Territorial waters) and the coast (300 m inland) considered by this Law as one integral unit.

- The Fishing and Aquaculture Department operates within the framework of the Ministry of Agriculture and Rural Development and under its authority, according to the Fishing Ordinance of 1937 enacted even before the State of Israel was declared in 1948. The department is engaged in a wide selection of activities, including managing Mediterranean fisheries and reporting to GFCM. The MoAg issues individual and vessel fishing permits and supervises regulates and updates the Fishing Ordinance. It is also tasked with preventing the invasion of harmful fish species, conducting fishing and aquaculture monitoring and research, as well as export and import permits.

4.2.3. Integrated Coastal Zone Management

In 1996, under the auspices of UNEP's Mediterranean Action Plan, the concept of Integrated Coastal Zone Management (ICZM) was inaugurated. Between 1997 and 2000, reports were prepared on coastal zone management, coastal sand management, impacts of marine structures, public access to the coast, beach and cliff protection and pollution prevention. Israel then passed the Law for the Protection of the Coastal Environment, 2004. The stated aims of the law are to protect the coastal environment and its natural treasures, to reduce and prevent coastal damage, to preserve the coastal environment and the coastal sand for the benefit and enjoyment of present and future generations, and to establish principles for the sustainable management, development and use of the coastline.

4.2.4. Mediterranean Action Plan

Israel is one of the Contracting Parties of the Mediterranean Action Plan (MAP). In 1976, the MAP Parties adopted the Barcelona Convention, aimed at protecting the Mediterranean Sea against pollution. Over the years, MAP's mandate has widened to include integrated coastal zone planning and management. Israel has been involved in many of the main MAP activities, such as Coastal Areas Management Programme (CAMP), LIFE Tri-lateral Agreement, GIS Info RAC, SAP-MED National Action Plan and a turtle protection program. Current MAP-related activities in Israel include: Marine litter prevention (for example, the MoEP's Clean Coast Program), Ecosystem Approach (EcAp) implementation plan, focused on improving the way human activities are managed for the protection of the marine environment, promotion of more sustainable consumption and production practices that would mitigate the negative impact on the Mediterranean, coordinating oil spill contingency plans with MAP members and Working to protect the sea from marine pollution caused by offshore gas and oil drilling.

4.2.5. National Outline Plans

There are four National Outline Plans (NOP) that relate to coastal zone management:

The National Outline Plan for the Mediterranean Coast (NOP 13): This plan, approved in 1983, was based on two underlying principles: preference to recreational activity on the coast and land use as a function of the carrying capacity of the coastline. The plan allocates land along the coastal strip to be managed, preserved, developed, and used for: swimming, recreation and sport; tourist facilities; protection of antiquities, nature reserves, national parks, forests and coastal reserves; ports and other essential uses which require a coastal location. It includes a clause prohibiting development within 100 meters of the coastline and requires detailed environmental assessments as prerequisites for all coastal plans. The NOP also allocates sites for ports and marinas.

The National Outline Plan for Ports and Marinas (NOP 13B): This NOP was commissioned by the National Planning and Building Board to regulate use of marine and land areas for seaports, which include ports for tourism and sport activities. It deals with distribution of marinas, scope and type of development in the hinterland of marinas, anchorage spaces, and allocation of coastal and marine areas based on the number of vessels. This is currently an ongoing plan and is not yet approved and is opposed by most environmental bodies.

The National Outline Plan for the Resource Management of the Mediterranean Coastline for Tourism and Recreation (NOP 13C): This NOP was commissioned by the National Planning and Building Board to help provide a comprehensive long-term guide to planning policy. Suitability for tourist and recreation development was assessed on the basis of geological, vegetation, landscape and archaeological surveys, and levels of development were defined for each site along the Mediterranean coastline in relation to resource sensitivity.

The National Outline Plan for Tourism (NOP 12): This plan was approved by the government in 1983. It determined, inter alia, coasts designated for extensive development, recreation villages, numbers of hotel rooms, and spaces in bathing beaches based on a population forecast of five million residents. An amendment to the NOP was prepared in the 1994. Prepared by the Tourism and Interior Ministries, in close cooperation with green organizations, the amendment incorporates many of the principles of the coastal NOP. It recognizes the importance of maintaining sufficient land reserves for tourist accommodation and services, in the face of development pressures, in order to help realize the country's long-term tourism potential.

4.2.5. Marine Spatial Planning

Two separate processes to plan the spatial management of the Mediterranean waters of Israel have been carried out in recent years. The first was an academic approach by a group spearheaded by the Technion Institute (2015) and the second was a governmental approach by the Israel Planning Administration (2018). Both teams considered a wide array of Mediterranean stakeholders, their needs and impacts on each other and on the environment. Both teams and documents call for enhanced conservation of the marine environment by adopting an Ecosystem Based Management approach, alongside sustainable development of various endeavors, with marine reserves as the main spatial tools. Both documents also call for extension of MPAs into the Israeli EEZ in order to protect sensitive deep-water habitats and adoption of the maritime areas law as a legislative tool for the EEZ. Some researchers (e.g., Galil *et al*. 2017, Corrales *et al*. 2017) have challenged the premise of MPA function in such a heavily bio-invaded ecosystem. An alternative take on conservation by some researchers (Galil *et al*. 2017) insists that no take zones in such a heavily invaded ecosystem merely supports more bioinvasion. It is thus particularly important to clearly define reserve goals in this region, monitor effectiveness in reaching them and think outside the conventional MPA box including also OECM (other effective conservation measures). Because invaders are here to stay, we need to know their functions in the system and incorporate this understanding into the Ecosystem Based Management proposed in the MSP (2020). According to INPA, marine reserves are effective based on recent reports that show that for now they are the best way to protect the marine benthic biodiversity and commercial species of fish.

4.2.6. Climate Change

In April 2016, the Israeli Cabinet approved a national plan to reduce GHG emissions and increase national energy efficiency. The plan will ensure implementation of Israel's per capita GHG reduction target of 26% below 2005 per capita emissions level. Israel submitted this target to the UN Framework Convention on Climate Change in Sept. 2015. The program is being led by the Ministries of Environmental Protection, Energy, Finance, and Economy. It should be noted that in 2020 MOE has announced a new plan that seeks to increase national reliance on renewable energy (mainly solar) to 30% (instead of 17% on the original program) and, with increasing reliance on natural gas instead of coal, thus reduce GHG emissions per capita by ~50%.

4.3. Transboundary issues and existing, planned or needed coordination / harmonization at sub-regional or regional level

Regional scientific collaboration: Significant breakthroughs in the research, monitoring and management of marine ecosystems can be capitalized on by regional standardization, harmonization and sharing of the underlying science. This is particularly challenging in an area fraught with conflict such as the Levant.

Suez Canal: The single most important manmade factor reshaping biota of the Levantine basin (and, arguably, the entire Mediterranean Sea) today is the opening and expansion of the Suez Canal. Various methods of segregation, filtration and regulation were proposed in the past (Galil *et al*. 2015), most recently that brine from the new desalination plants be used to recreate hypersaline barriers in the canal (Guy-Haim and Peleg, 2019). While eradication of NIS marine species is unfeasible, this is an opportunity to somewhat control the process or at least slow it down in order to protect indigenous Mediterranean biota. There is need to plan and implement a monitoring program of Suez Canal and Red Sea waters to alert and identify NIS passage mechanisms and possible solutions.

Protected areas: Planned and deployed MPAs should be integrated into a regional array of MPAs in order to ensure connectivity, facilitate monitoring and research and increase their effectiveness.

Pollution: Solid and liquid waste drift across borders and pollute beaches and ecosystems far from their origin. As such, they should be reduced in both national and international initiatives. As the national response capability for major marine pollution incidents, particularly oil spills, is modest, international agreements and regional assistance centers (e.g., REMPEC) should be encouraged and maintained. Climate Change: It is pivotal that all countries streamline their efforts to promote clean renewable energy that decreases GHG emissions to the lowest possible level in order to minimize the effects of climate change. It is also pivotal to provide regional and international frameworks that facilitate response and preparation for upcoming changes. We also need to develop coordinated monitoring programs that address the various aspects of climate change trends and impacts, including sea level change, warming, acidification, salination and affected ecological parameters.

Fish stocks: Regional cooperation on fishery regulations and monitoring of fish populations and takes, could serve to enhance fish stocks on a regional basis.

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

Pressures on the Israeli marine environment are of a diverse nature. The primary pressure and biotic changes that the Levant is undergoing are mainly due to a combination of climate change and a massive marine bioinvasion process via the Suez Canal, as described in section 3.1. Other main pressures include mainly pollution (see below), exploitation mainly by fisheries (see 3.1.2) and the oil & gas sector, and habitat destruction.

Pollution Hotspots: The guidelines for identification of prioritized hot spot pollution sources (MOEP, 2016a) present a list of criteria referring to: 1) Densely populated areas - Ashkelon, Ashdod, Greater Tel-Aviv, Netanya, Haifa, Acco (Acre), and Nahariya are all densely populated coastal cities, 2) Coastal industry – Large Industrial concentrations exist mainly in Haifa Bay, but also in Ashdod and there are coastal power plants in Hadera and Ashkelon as well, 3) Big ports – Both Haifa and Ashdod ports have been significantly expanded in recent years, and both represent significant hazards, especially the threat of oil spills, 4) dredge material dump sites – The 'Alpha' site located in 1300 m depth 45 km from shore is the largest dump site, mainly for dredging byproducts contaminated by mercury, lead, organotins and PCBs. Landfill solutions were previously evaluated and discarded and should be reevaluated. This site is regularly monitored, and the diameter of contamination is far wider than the dumping point itself (up to 130km^2). Other old sites (e.g., Epsilon site) are rarely used for dumping of dredging materials, and these are typically less polluted, 5) Oil/gas exploration and production – main emissions from this sector include various chemicals during routine operations, from drilling muds and cuttings to formation and production water (Astrahan *et al*. 2017). A large spill might entail condensate or even oil spill due to accidents, and risks for their occurrence must be reduced to the lowest possible extent at all cost, 6) exploitation and mining sites – Probably the only sector on this list that is not relevant (yet) to Israel, 7) Big aquaculture areas – Most Israeli mariculture is located Inside Ashdod port (see more in chapter 3.1), 8) Large river discharges – See table 3, and 9) Historical pollution sites (e.g., old munitions dump sites, Shafdan or the Electrochemical Industries mercury pollution site south of Acco). With the exception of mining, all of these sources may be identified in Israel, and a list of 25 such sites was prepared by MOEP (2016a). Here are some of the main sites, assessed for different impacts:

Table 3.

Pollution hotspots in Israel (hotspots shown in red), as ranked and defined in MOEP (2016a).

Site	Ashdod Port	Coastal Power Plants	Gad Granot & Rahav Desalination Plant (Mekorot)	Agan	Ashdod Refineries	Shafdan WWTP	Reading Sewage Pumping Station	Site Alpha & Epsilon	EIL
Public health									
Population	4	4	4	4	4	4	4	1	4
Wastewater treatment	1	2	2	4	2	4	3	4	4
Drinking water quality	1	1	1	3	3	2	1	1	4
Bathing water quality	1	1	1	2	1	2	2	1	2
Environmental Status and Pressures									
Organic matter	2	1	2	2	1	4	3	1	1
Nutrients and biological status	3	2	3	2	1	4	3	1	1
Contaminants	2	2	2	4	1	4	1	4	4
Marine litter	1	1	1	1	1	1	1	1	1
Economics									
Economic activities and ecosystem services underpinning them	2	2	1	3	2	2	2	2	4
Trans-boundary Effects									
Transboundary effects	1	1	1	1	1	1	1	2	1
Total Score	61	59	61	92	61	96	73	59	59
Class	SENSITIVE (C)	SENSITIVE (C)	SENSITIVE (C)	HOT SPOT (B)	SENSITIVE (C)	HOT SPOT (B)	SENSITIVE (C)	SENSITIVE (C)	HOT SPOT (B)

Steps taken to decrease pollution: The NAP (MOEP, 2016a) compares changes in discharged pollutant loads from the years 2004, 2008, and 2012 (updated to 2014) that shows declines in discharge of many pollutants by >90% over the past 15 years (Appendix II). MOEP (2012) summarized these changes as: 1) Municipal sewage treatment – development of a comprehensive sewage collection and treatment infrastructure that resulted in a significant reduction in wastewater discharged in the streams or directly into the sea. 2) Industry – increased regulation and monitoring through MoEP permits for direct marine and streams discharge. Additionally, the approved emission loads were drastically reduced. 3) Air quality – the Israeli Clean Air Law was implemented and the framework concept of Best Available Techniques (BAT) was applied. 4) Methodology and availability of data – the current report is characterized by better data availability, which can be attributed to the introduction of the MIFLAS PRTR system in 2012 (under the newly legislated Israeli PRTR Law) and the consequent availability of liquid and atmospheric emission data for all major industrial sectors. These data facilitate a more comprehensive and accurate assessment than in previous years. 5) Shafdan activated sludge – The sludge discharged from the Shafdan (Tel Aviv Metropolitan WWTP) still constituted a major portion of the total amount of polluting substances being discharged into the Mediterranean in the 2012 inventory, however by 2016, the marine discharge of sludge from the Shafdan WWTP was completely stopped (Herut *et al*. 2017) and it now only emits ballast water. This is of major importance since Shafdan was responsible for 82% of heavy metals and >90% of Nitrogen, ToC, Phosphorous, oil and grease inputs before its closure.

Additional steps taken to reduce eutrophication include (MOEP, 2016a): All agglomerations of more than 2000 inhabitants now collect and treat their urban wastewater before discharging them into the environment. Industrial Food Plants are limited to COD 160 mg/l or TOC 55 mg/l and BOD 30 mg/l. All coastal cities and urban agglomerations are connected to a sewer system. Wastewater from industrial installations which are sources of organic matter, nutrients and suspended solids are generally environmentally disposed. Urban sewage and wastewater treatment plants mostly prevent run-off and riverine inputs of litter. Emission limit values (ELV) are adopted and enforced for BOD in municipal wastewater treatment plants. Reuse of treated effluents for the conservation of water resources is executed to an extremely high extent. Nutrient inputs from agriculture and aquaculture practices into areas where these inputs are likely to cause pollution are reduced and regulated.

Ecological Objectives: The Barcelona Convention adopted a list of 11 Ecological Objectives (EO) and associated GES targets in decision IG 21/5 of the 18th Conference of the Parties. The National Action Plan (MOEP, 2016a) focuses on three of these – EO5 (eutrophication), EO9 (pollutants) and EO 10 (solid waste). The latter is more diffuse and more difficult to address as population and consumption are increasing, thus micro and micro plastics and other marine litter remain a main concern. There is still much work to be done, but regarding liquid pollution (see table 12 in appendix II) and eutrophication (above), Israel has fared well so far, dramatically reducing the amounts of nutrients and pollutants entering the Mediterranean. In addition, as specified in UN Environment/MAP-SPA/RAC (2019), and as evidenced in the present document (Chapters 2 and 3 respectively), both EO1 (biodiversity) and EO2 (NIS) are extensively monitored in Israel. The EcAp process concerning biodiversity and NIS monitoring under IMAP is covered by the national monitoring Program for marine biodiversity in Israel, which provides important elements, including population indices such as distribution ranges, abundance, age/size structure, species composition, sex ratio, reproductive indices and mortality rates for both selected indigenous populations such as marine mammals, sea turtles, cartilaginous fishes (EO1) and trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in high risk areas (EO2) (UN Environment/MAP-SPA/RAC, 2019).

Main remaining gaps for pollution (EO 5, 9 and 10) are listed in table 4.

Table 4.

Gaps identified by MOEP (2016a) regarding Marine Pollution (Midterm Baseline Fact Sheet A – legally binding obligations).

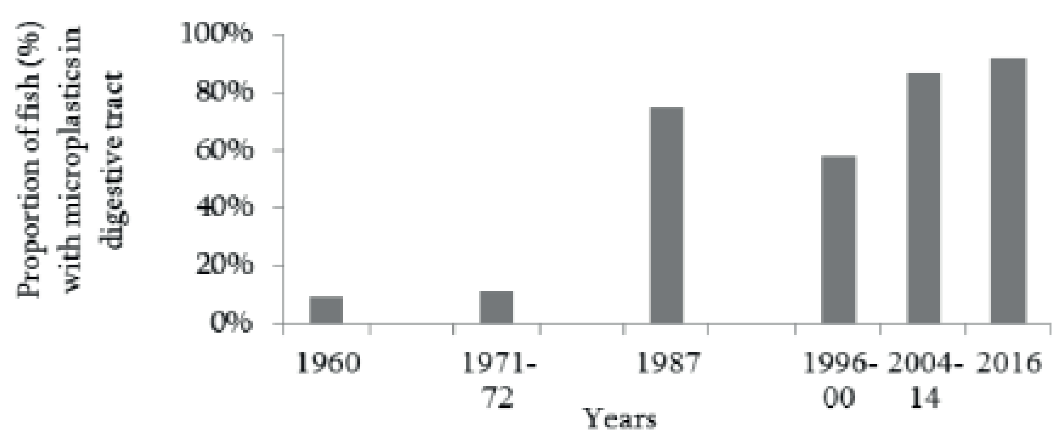
Topic	Identified gaps**
Industry BAT	Completion of BAT implementation in all sections of industry
POPs	Completion of policymaking process and enforcement measures
POP stockpiles	Rehabilitation\management of remaining sites
Pesticides and PCBs	Monitoring is insufficient
Organomercuric, organolead, organotin	Further reduction in mercury emissions and losses
PAHs	No constant monitoring and therefore lack of data
Mercury, cadmiun and lead	No regular air monitoring of mercury. Mercury leach from the site of the closed EIL factory (identified as a hotspot)
Mercury ELVs	Completion of integrated regulation measures and update of business permits
Sites contaminated with mercury	The EIL factory was closed in 2004 but old stockpiles of mercury are apparently still leaking into the bay waters
Wastewater reuse and BOD	Not all WWTPs have been upgraded to tertiary level of treatment
Priority pollutant monitoring	Extra monitoring criteria (e.g. marine litter) in the NAP
Industrial BOD, SS, Zinc, copper and chrome	BAT not yet implemented in all industrial sectors
rain waters and municipal wastewaters	Not all sewage collection infrastructure is separated from runoff collection. Industrial runoff not separated from municipal runoff
Permanent water quality register in rivers	Streams monitoring is performed only twice annually and includes only several parameters
Litter from runoff	Lack of data concerning the amounts of litter from urban drains and streams
Reduction of point source nutrient loads	In practice, some of the point sources do not fulfil the Inbar requirement and are treated as exceptions
Reduction of diffuse source nutrient loads	Lack of data. No clear policy
Reduction of fishpond contaminant loads	Ordinances for fishpond wastewater quality have not been adopted yet
Urban runoff treatment	No legislation. No clear policy
Rehabilitate coastal streams	Completion of the rehabilitation of all coastal streams
Marine litter data bank	Insufficient data of amounts and sources. No measures taken
Marine litter impact control	No measures taken. No operational plan for reducing litter. Beach litter is still prevalent in some beaches
Reduction of plastic litter	Continued reduction in plastic use and disposal
Urban solid waste management	In practice, 80% of waste is sent to landfills and only 20% recycled
Illegal dumping and littering	Beach litter is still prevalent in some beaches
Litter monitoring program	No waste monitoring in the National Monitoring Program
Marine litter removal	Hotspots were not identified
Public awareness and education of littering	No public education activities concerning non beach related sources of marine litter

Topic	Identified gaps**
Dredging activities	Possible adverse effects of dumping site on marine environment
Close illegal solid waste dump sites	Done, but rehabilitation was not fully completed
Mercury in wastes	Implementation still incomplete but will meet 2025 targets
Cooperation to address trans-boundary marine litter	No measures taken
Eutrophication	No legal status for the proposed standards. No change in stream nutrient levels
Human health and water quality in bathing waters	No monitoring in unregulated beaches. Lack of real time information
Contaminants in biota, sediment or water	Mercury in Haifa Bay, TBT in ports and marinas
acute pollution events	Sewage overflow during heavy rain. Emergency infrastructure in all industrial facilities

Solid waste and plastics: Both point sources (rivers – see Appendix II) and dispersed sources (mainly the public in the bathing season) are responsible for marine litter (Pasternak *et al*. 2017). A recent study has found that average debris density in bathing beaches was around 10 items per 100 m2 and 90% of the items were plastics (Pasternak *et al*. 2017). Top debris categories were food wrappers, and disposables, plastic bags and cigarette butts. A huge and increasing amount of solid waste finds its way into the Mediterranean each year and sources and characteristics in Israel were recently studied, mainly from the macro and micro plastics perspectives e.g., Pasternak *et al*. 2017 and van der Hal *et al*. 2017. The latter study found a mean abundance exceeding 7.68 ± 2.38 particles/m3 in coastal waters, which is 1-2 orders of magnitude higher than abundances reported in other parts of the world. It is therefore no surprise that microplastics are being ingested in alarmingly growing proportions by fishes in the Israeli Mediterranean (Figure 11) and probably also by other marine organisms too.

Figure 13.

Proportion (%) of fish with microplastic particles in their digestive tracts, from 1960 to 2016. Source: van der Hal *et al*. 2020



A national "clean coast" program was initiated by MOEP and its funding must be urgently increased and assured for the long-term. Properly educating the public on the environmental implications of solid waste in coastal and marine ecosystems is urgently needed. Proper regulation and stern enforcement of the cleanliness law are of similar importance and urgency. As some transboundary waste washes onto beaches, this is clearly a regionally and global issue of concern.

Marine sources of solid waste may also be significant. Shipping debris, construction and the oil & gas sector may be sources of plastics as well as aquaculture. Fishing itself may also be a main concern as a source of plastics: indeed, there is no use of drift nets in Israel, but fishing gear may get lost and ghost nets and derelict longlines may be found on shelf reefs. Nearshore reefs are often strewn with derelict fishing gear. While many fishers are environmentally aware and responsible users of the sea and beach; cleanliness awareness of fishers is pivotal. It should be noted that bottom trawlers, although they might lose gear too, do collect large amounts of debris and plastics from the deep shelf during routine fishing operations.

The severe plastic pollution problem also may pose a serious health threat: microplastics are often consumed by marine animals, some of them have commercial value and are consumed by humans. For example, plastic particles were found in nearly all of rabbitfish examined over the past few years (van der Hal *et al*. 2018). This study also compared levels of plastic pollution over the last 60 years, by checking particles in preserved rabbitfish stored at the National Zoological Collections at the Tel Aviv University and the Hebrew University in Jerusalem, showing a dramatic increase during the 1980's from ~10% occurrence rate in fish collected prior to that time to 60-100% after it – see Figure 11 (van der Hal *et al*. 2018). It was also experimentally shown that these fish uptake pollutants such as volatile organic compounds such as PCBs which plastic particles adsorb over time. These compounds accumulate in various tissues and potentially increase their toxicity (van der Hal *et al*. 2020)

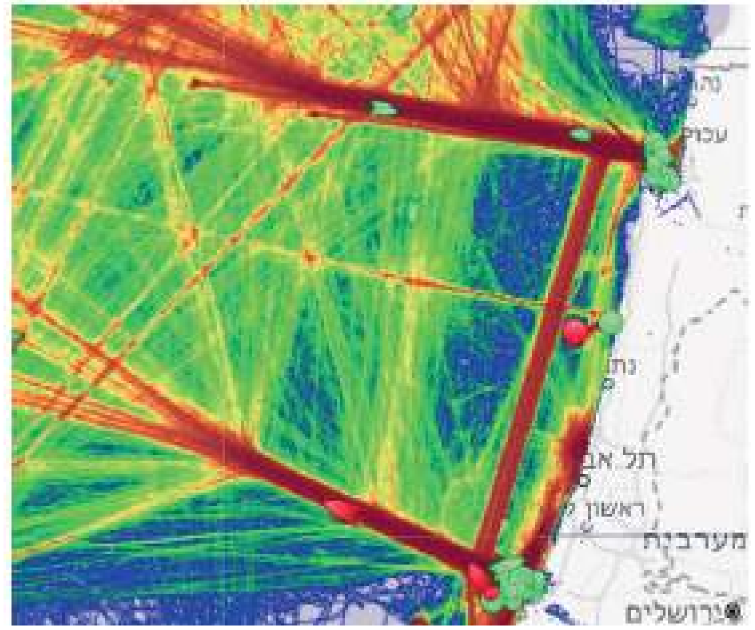
Shipping routinely emits various liquid and gaseous pollutants affecting the marine environment in various ways. Additionally, main concerns are always shipping accidents involving large scale oil pollution events which are potentially catastrophic with long-term impacts for the sea and beaches. Routine emissions also include ballast waters, which alongside hull fouling provide a substantial vector of bioinvasion and need to be monitored and accounted for.

Noise and light pollution by ships and ports also have a considerable impact on marine ecosystems and many vulnerable species including marine mammals, sea turtles and others. This is particularly true in the crowded shipping lanes of the Mediterranean. Two large shipping ports exist in Israel – Haifa and Ashdod (Figure 13), and shipping lanes also extend to the energy related ports of Hadera and Ashkelon. Ports and anchorage areas are disturbed habitats due to emissions, the dragging of anchors and intense turbidity.

Data on ship collision with marine mammals and sea turtles in the crowded sea lanes are not available; but can be assumed to be non-trivial.

Figure 14.

Heat map of vessel density in the Israeli EEZ in 2017, overlaid with cargo vessels (green dots) and tankers, as observed in 17.8.2020. Source: www.marinetraffic.com



Military activities: Another pressure source, is the Israeli military, mainly the Navy. Most operations are secretive. Military operations need to be monitored for environmental impacts, perhaps through consultation with marine biologists, to reduce deleterious impacts to the greatest possible extent.

Hydrocarbons: Significant hydrocarbon reservoirs (mainly natural gas and condensate but also oil) were discovered in the last 15 years in the Israeli EEZ. Production is increasing at a rapid rate, and this industry is expected to grow in the next few decades. This trend is raising considerable concerns regarding the potential environmental threats emanating from this industry. Every step in the hydrocarbon production process – search and exploration, seismic surveys, drilling and extraction, production and transportation pose some risk to local marine life, not just from oil leaks but also from noise and light pollution.

Deep sea habitats, such as cold methane seeps and deep-water coral gardens, are particularly vulnerable as they are rare and extremely sensitive to anthropogenic impacts and have an extremely long recovery rate. On the shelf, a large spill may harbor severe implications for most biota that comes in contact with oil.

While Israel is not prepared to handle a large oil spill by itself, a series of international agreements as well as the Regional Marine Pollution Emergency Response Center for the Mediterranean Sea (REMPEC) help build and back-up the national response capability for major marine pollution incidents. Three production platforms are deployed in the Israeli EEZ today and side effects of their existence is that they serve along with the pipelines and other subsea infrastructure act as artificial reefs providing habitat to biota that includes both indigenous species and NIS, and they are also sources of noise and light pollution.

Desalination and power plant effluents: There are currently four power plants on the Mediterranean coast - two large coal plants and two natural gas plants, and their marine emissions share similar characteristics, rating them among the highest levels of pollution in all four sites (MOEP, 2016a). These power plants use seawater for cooling and also act as a discharge terminal for cooling water originating in inland facilities. Additionally, some of the pollutants released into the atmosphere in the process of combustion, eventually reaches Mediterranean waters.

The Barcelona Convention SAP requires the gradual cessation of all PAH discharges, prior to a 2025 deadline, is achieved by gradually adopting cleaner burning fuel in the power plants (MOEP, 2016). In the coal plants, ash may be found around the piles of the coal unloading jetties.

Israel has also recently constructed five large desalination plants emitting warm briny effluent that also carries some heavy metals (MOEP, 2016). The impacts of effluents of both warm waters and brine may be considered to be local, but long-term effects are largely unknown. Two more desalination plants are in advanced planning stages. It was shown by Wood *et al* (2020) that desalination brine plumes from multiple sources along the Israeli coast might increase near-bottom stratification, essentially decoupling the benthic-pelagic nutrient cycle in coastal waters. Large amounts of sharks and rays are attracted to the warm effluents during winter (see Chapter 2).

Fishing: Fishing is one of the main factors impacting marine biodiversity both globally and locally (SPNI, 2020). The extensive adverse results of overexploitation, bycatch and habitat destruction are documented in Israel, but many of these have only recently been addressed. As stated above, until 2016 Israel's fisheries were not managed sustainably, or in an ecosystem based manner. There is a current attempt to address this issue by the 2016 reform (see 3.1.2 above). Many of the impacts of fishing are today moderated by the reform's stringent regulation as fishing pressure has significantly declined. For example, bycatch of protected species and a reduction in discards are evident following gear and spatial limitations and seasonal moratoria in the trawl fleet (Edelist, 2020).

5.2. Critical impacts and effects on marine and coastal biodiversity

Main identified trends reported to CBD (MOEP, 2016b) include local trends such as sandy and rocky habitat destruction, migrant species and overexploitation on the shelf, pollution of liquid and gaseous waste (Figure 17 in Appendix II) as well as solid (mainly plastic) waste, industrial pollutants, underwater noise, hormones, thermal pollution, oil and desalination effluents.

Large scale regional changes are caused by the Nile River and the Aswan Dam, coastal rivers, Suez Canal, atmospheric pollutants, metals, fertilizers, climate change, increase in acidity, warming, and exploitation of oil and gas resources (MOEP, 2016b).

Wetlands in Israel are small and many are concentrated in river mouths, where the most important impacts include: 1) land-based upstream pollution sources contaminate estuaries and riverbanks (see Appendix II, IV), 2) coastal development reshapes and impacts sand inputs and connectivity with the sea, 3) exploitation of mullet juveniles affects stream functionality and biodiversity. 4) Solid waste from beachgoers that is often harder to access and clean than in open coasts.

Important beaches and rocky coasts: All beaches are important, albeit for different reasons – sandy beaches serve the public as bathing beaches and sea turtle nesting sites, while rocky beaches contain more biodiversity. The character of Israel's sandy beaches has changed ever since the construction of the Aswan Dam on the Nile River in the 1960's. Ongoing erosion of the sandy beaches and sea cliffs of sandy beaches needs to be reduced by 'building with nature' principles (Israel Planning Administration, 2018) where the sandy habitat is reclaimed for conservation of sea turtles and ghost crabs (*Ocypode cursor*). Rocky beaches are home to many intertidal species as described in chapter II. Many of these rocky beaches are protected by Nature Reserves, such as Rosh-Haniqra and Achziv, Shikmona, Dor-Habonim, Maagan Mikhael islets, Gdor and Palmachim (Figure 12).

Both rocky and sandy beaches are overrun by NIS, mostly of Indo-Pacific origin, displacing and sometimes completely replacing indigenous biodiversity. Similarly, both rocky and sandy beaches receive large amounts of solid waste, most of it is macro, micro and nano plastics, the source of most of which is beachgoers in the bathing season. Despite great improvements over the past three decades, liquid discharges from drainage and point sources remain a source of contaminants for nearby beaches.

Offshore and Deepwater Habitats: These include shallow sandy (< 30 m depth) and deeper muddy (> 30 m) habitats, rocky habitats, midwater pelagic habitats and the pleuston at the water surface. Soft bottoms to 30 m are shifting habitats in constant flux. Deeper muddy habitats are more stable, and both experience a great deal of depth dependent faunal zonation and thus impacts depend mostly on distance from shore. In Dec. 2016, bottom trawling (the main impacting fishery sector on soft bottoms) was banned north of Dor and shallower than 25\40 m (as opposed to 15 m before), and a two-month recruitment season moratorium was set. Benthic shelf habitats, both soft and hard substrates are also deeply impacted from NIS bioinvasion. Rocky reefs, mostly located in the north of Israel, cover roughly a fifth of the shallows (>30 m) and a tenth of the total shelf. They differ significantly from one another, and thus experience varying degrees of impact from different sources. Shelf reefs are inhabited by some indigenous flag species such as groupers, which are targeted by local fisheries, have experienced some level of overexploitation and are now protected by new fisheries regulations.

Notable among deeper reefs are the "Sponge gardens" at 95-125 m on the deep kurkar ridges west of Herzliya and Haifa, found to contain high biodiversity of sessile invertebrates. They are impacted mostly by fishing, and as trawling has been recently banned around reefs, longlining remains the main impacting factor.

Deepwater corals are sparsely found on the rare rocky reefs of the almost entirely soft bottom of strata below 500 m, especially in the Palmachim Disturbance area. Despite the fact that Israeli bottom trawlers rarely (if ever) fish in such depths, these reefs mandate some form of protection. The entire Mediterranean Sea below 1000 m is declared as an FRA by the GFCM. Deepwater biodiversity is also greatly impacted by regional changes such as the Eastern Mediterranean Transient (Appendix I). Additional

significant factors impacting these include the Oil & Gas industry, shipping, marine construction, and military operations.

Species at high risk: All the species listed in the CITES Appendices were declared as protected species in Israel and the list was last updated in 2019. The species in the highest risk of extinction by far is the Mediterranean monk seal *Monachus monachus,* which pays only rare visits to the Israeli coast as it lacks the undisturbed caves in which it reproduces. Therefore, like other vertebrates at high risk (marine mammals, birds, reptiles, sharks), the main conservation measures are holistic and include reduction of pollution (including noise and light pollution), prevention of habitat destruction, declaration of large MPAs and, when possible, promotion of breeding projects (e.g., INPA's *Chelonia mydas* program). The Ministry of Environmental Protection is considering adding the dusky grouper *E. marginatus* and the gold blotch grouper *E. costae* to the protected species list because INPA monitoring results suggest they are adversely affected by fishing pressure. Fishers oppose this declaration and insist grouper conservation is already addressed by other regulations within the fisheries reform (spawning season ban, size and quota limitations).

Multiple studies show the impacts of noise on the hearing, behavior and survival of marine mammals, sea turtles and various other marine species (Ketten, 2008). Prominent noise pollution sources like shipping, sonars, pile driving, explosions and seismic surveys need to meet regulations set to limit the received acoustic power absorbed by marine species.

Fisheries resources: Valuable fish stocks are in constant flux and experience acute seasonal, annual and decadal changes due to both natural and manmade drivers. The fishing capacity and the fishing effort exerted by the small Israeli fleet were reduced significantly by the fisheries reform and once nature reserves will be implemented, the probability of overexploitation will be further reduced. A holistic EBFM program needs to be developed for Israel, that would allow both fish and fishers to flourish. Until then, the same kind of generic protection measures taken for species at high risk may be employed, i.e. reduction of pollution, curbing bioinvasion and protecting habitats. An Israeli expert panel recently concluded that these options should be implemented before any efforts of stock enhancement are attempted (van Rijn *et al.* 2017).

6. Assessment of national priority needs and response actions

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In the author's opinion, supported by the consultation process, the most significant factor impacting biodiversity on all shelf habitats is Lessepsian migration coupled with climate change. This is followed by other important factors, namely overexploitation, plastic and other forms of pollution, and habitat destruction.

6.1. Needs

Introduction: No single comprehensive assessment of Israel's national priorities and needs for marine conservation has been conducted thus far. The following is the author's personal recommendations based on his experience and knowledge. These were reviewed by prominent marine scientists and stakeholders in the current consultations process and comments were integrated to form the following list (which is no partucuar order).

Invasive species: This environmental issue is comparably under-managed in the Mediterranean and specifically in Israel, especially in light of the scale of this migration in Levantine shores. The main ways of reducing invasion pressure are transboundary issues involving the main vectors - the shipping industry, particularly ballast water discharge management, and of course the Suez Canal itself. It was recently proposed that brine from the new desalination plants be used to recreate hypersaline barriers in the canal (Guy-Haim and Peleg, 2019). Permission has been given to fish certain invaders such as lionfish in forbidden methods (e.g., scuba diving) and places (e.g., marine reserves).

Culling in the future can be applied for rabbitfish or other selected species. Fishers can play a key part in this process. The relative abundance of invasive herbivorous rabbitfish inside the only no take MPA in Israel was found to be lower than in adjacent, unprotected areas (Rilov *et al*. 2017). This example supports the prevailing regulation in Israel that bans all fishing activities in marine reserves. On the other hand, several researchers (e.g., Galil *et al*. 2017; Corrales *et al*. 2018) have argued that reserves cannot effectively protect only indigenous species and the impacts of bioinvasion and climate change may reduce their efficacy. Others (e.g., Kleitou *et al*. 2020) advocate extraction of NIS as an integral part of the regional fisheries management approach or warned that the exclusion of fishing operations that rely mainly on NIS (e.g., bottom trawling) from certain marine areas might increase their prevalence on the Levantine shelf.

Eutrophication: Israel has taken many significant steps to avoid eutrophication, despite its location in the ultra-oligotrophic Levantine Mediterranean. To a large extent (and in addition to damming of the Nile in Egypt), these actions have brought about further oligotrophication of coastal waters. While prevention of eutrophication is in line with policies of environmental protection and public health, the ramifications of deprivation of nutrients from an already nutrient deprived marine environment are unclear and need to be studied and modeled. Separate collection of rain waters and municipal wastewaters needs to be improved considerably. Several upstream riverine and coastal pollution sources still need better management, particularly where transboundary collaboration with the Palestinian Authority is required.

Marine Contaminants: To deal with marine contaminants (EO9), Israel has applied and adopted several main measures (MOEP, 2016a): Hazardous wastes need to be disposed of in a safe and environmentally sound manner. Application of BAT and BEPs for environmentally sound management of POPs needs to be buttressed. Concentration of priority contaminants in biota, sediment or water needs to be kept within acceptable limits. Emission discharges and losses of PAHs, mercury cadmium and lead need to be phased out. Releases of mercury to the sea need to be ceased. Mercury still poses a challenge in Acco, as contaminated land and groundwater leach into the Bay of Haifa (Shoham-Frider *et al*. 2020). Pollution by zinc, copper, and chrome, as well as organomercuric, organohalogen, organolead and organotin and radioactive compounds must be minimized. Pharmaceuticals like carbomazepine that do not degrade during the sewage treatment process must also be addressed. Pesticides and PCBs should be phased out and so are inputs of hexachlorobenzene, dioxins and furans. Criteria and standards for bathing waters in the Mediterranean region are currently based on Intestinal enterococci, and are applied and checked daily in all bathing beaches during the bathing season. Other contaminants are not regularly checked in bathing beaches and this can be improved. Desalination and power plant pollutants include chlorine, antiscalants, strong acids and bases, nitrates. Eutrophication and CO2 can also be considered contaminants – all of these contribute to acidification, which is a major environmental concern.

The international collaboration for preparedness of response to oil pollution (RMPEC) must be maintained and fortified.

Importantly, the long-term impacts of emerging factors such as light and noise pollution, warm water effluent and desalination brine effluent need to be monitored and modeled. Generally, there is a need to comprehensively map light and acoustic pollution near shipping routes, ports, cities and in MPAs.

Molecular monitoring capacities are being built in Israel, but need to be propped up, including genotoxicity, which can be integrated as a monitoring tool of biological impacts. Similarly, DNA barcoding is an important tool that has a tremendous potential in monitoring and research. Barcoding is pivotal in highly bioinvaded areas as it shows how many and which species are present in an ecosystem, helping us understand and conserve diversity.

Solid waste and marine litter: Recommended measures to combat marine litter in Israel in line with EO9 of the Barcelona Convention include (MOEP, 2016a): Urban solid waste management should be based on reduction at source with the following waste hierarchy: prevention, re-use, recycling, recovery, and environmentally sound disposal. Environmentally suitable and economically feasible systems of collection and disposal of urban solid waste in cities of more than 100,000 inhabitants, adequate urban sewer and wastewater treatment plants that prevent run-off and riverine inputs of litter, application of cost effective measures to prevent any marine littering from dredging activities, preventive measures to minimize inputs of plastic in the marine environment, measures to combat illegal dumping including littering on beaches and illegal sewage disposal in coastal zones and rivers, programmes on regular removal and sound disposal of accumulations/hotspots of marine litter, adequate waste reducing/reusing/ recycling measures in order to reduce the fraction of plastic packaging waste that goes to landfill or incineration, closure of illegal solid waste dump sites, removal of existing accumulated litter from protected areas and litter impacting endangered species.

Fisheries Management and Marine Protected Areas: Israel has recently taken extensive new measures to conserve fishery resources and the marine environment. The new measures taken (both from a fishery and a conservation standpoint) should be monitored, and their efficacy in protecting wildlife should be assessed. Moreover, these issues should be integrated (thus far they have been regulated separately) to ensure other uses of the marine environment, including fisheries, should be done sustainably and balanced with conservation efforts. Well planned monitoring of MPAs would also help distinguish between fishing impacts and those of climate change and bioinvasions (Rilov *et al* 2020, Ecological Applications). See chapter 3.1 for additional recommendations and needs.

Training and capacity building: Large entities engaged in large scale marine operations such as the energy sector, the navy and the shipping industry, should be trained and enabled to be auxiliary response mechanisms for marine conservation. Professionals are required in many fields relevant to improved conservation of Mediterranean ecosystems, for example: Engineers that understand and address the environmental impacts of marine industrial sectors (shipping, marine construction, desalination, hydrocarbons), educators who understand and can effectively convey the threats of solid waste to children and to the wider public, fisheries scientists to perform stock assessment for key species. International workshops and collaborative efforts to improve scientific and management capacities are welcome, but should target direct and immediate needs, rather than general development-oriented themes (e.g., "blue economy" or "blue growth"). The taxonomy crisis, i.e., the worldwide shortage in taxonomic knowledge resulting from the gradual disparagement of taxonomy as a scientific profession along with the rise of molecular biology, and the inevitable retirement and death of professional taxonomists requires special attention. Molecular barcoding can indeed help, but must rely on a solid morphological taxonomy.

6.2. Urgent actions proposed

The urgency of actions needed is somewhat subjective, and thus should be weighted and prioritized by a holistic process, for example Marine Spatial Planning (e.g., Technion Israel Marine Plan Integrating Team 2015, Israel Planning Administration, 2018, 2020). These exceed the scope of the present report and here are the most urgent actions, following consultation with several notable national experts in no particular order:

- Form a national plan to reduce solid waste, with an emphasis on macro and microplastics. Reinforce the clean coast program, promote plans to educate the public, ban and phase out the use of disposable plastics in beaches.

- Keep reducing pollution from land-based emission sources and define a workplan - map the extent, type and volume of pollutant loads from all sources especially urban drainage systems, define standards and pollution reduction measures in both sources and effluents.

- Apply and extend the national programs for reducing GHG emissions and dealing with the consequences of climate change. Monitor acidification by implementing state of the art continuous measurements (pH and CO2).

- Monitor, regulate and control pollution from shipping and the oil & gas industry, including marine noise.

- Continue to monitor and evaluate the function and efficacy of Marine Protected Areas. Update the management policies within the MPA's if needed.

- Monitor and evaluate the function and efficacy of the new fisheries reform. One recommended measure would be bottom trawl surveys, as preformed in other parts of the Mediterranean such as the MEDITS survey (Merigot *et al*. 2019). This would facilitate, for the first time, an extensive, scientifically rigorous comparison of the Israeli (and Levantine) shelf fauna to other Mediterranean ecosystems.

- Promote solutions for regional and transboundary issues, especially concerning bioinvasion (the largest driver of biotic change in the Levant), oil pollution preparedness and solid waste.

- Form a national plan and directed legislation regarding invasive species mitigation and control.

- Improve Integrated Coastal Zone Management of the MSP to address coastal urbanization governance, stakeholder participation, information management, and ecosystems needs.

- Follow through the MSP to establishing a joint inter-ministerial steering committee that will be able to examine all current and future plans and needs for development and exploitation and integrate them with plans regarding protection, conservation, and mitigation to reduce biodiversity loss.

7. Funding problems and opportunities

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The amount and source/distribution of money spent on conservation actions and environmental marine research in Israel has never been thoroughly assessed or mapped. There is a need to map the various stakeholders with interest in the Mediterranean Sea and prioritize them towards more effective conservation and research processes. The following is thus a partial list of funding sources in Israel.

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

The main funding sources for marine environmental research and monitoring include: Government ministries: MOEP and MOE fund the Strategic Action Plan to address pollution (MOEP 2016a), the national Marine Monitoring Program as well as some of IOLR's activity. MOEP supports conservation through other devices as well and additionally administers the Maintenance of Cleanliness Fund (MCF), established by the Cleanliness Law, 1984. The MCF holds funds collected from various environment-related fees and fines that are earmarked for environmental protection activities. This fund is a terrific opportunity to support research and monitoring as well as concrete conservation actions at sea, as in 2019 its assets amounted to more than 2 Billion Shekels (MOEP, 2020); however, in 2019 it spent only 82,000 Shekels on research related to cleanliness (on land and sea). The MCF needs to be sourced to a greater extent for actively cleaning beaches (the main source of solid waste), buttressing the Clean Coast program, enforcing the cleanliness law in beaches and educating the public on the importance of keeping beaches and the sea free of solid waste.

The Ministry of Agriculture funds fisheries-dependent and independent surveys in ports and at sea for monitoring fisheries catch and effort, and this funding must be increased to facilitate proper surveys and stock assessments or to understand benefits (or lack of) emanating from the fisheries reform. As other bodies in Israel (National Monitoring Plan, INPA, academy, NGOs) are now performing their own fishery-related surveys, harmonization and coordination of these efforts is an important opportunity for mutual funding.

The Ministry of Science has declared the sea as one of its 5 priority fields for education and research. The Ministry's Innovation Authority supports technological ventures and offers the know-how, experience, funding, policy support, governmental backing and international collaboration opportunities for startups and R&D projects mainly on land but also in the marine realm. While not necessarily conservation-oriented, ample support exists in Israel today for technological startups. Technology can and should be tapped to solve conservation issues and several platforms in the marine realm may fit this model

The Israel Science Foundation (ISF) supports excellence in basic research across all fields of knowledge and many marine researchers and institutions often tap this source for funding their research. The vast majority of the ISF funding is provided by the Council of Higher Education, through its sub-committee, the Planning and Budgeting Committee (the "Vatat").

7.2. Other sources (private, public, partnership)

The private sector supports little research and conservation actions in the marine realm in Israel. Shipping and ports, oil & gas industry, desalination plants and coastal power plants, all of which are among the main polluters, mainly perform the minimum monitoring required by law rather than practice meaningful corporate responsibility and support of conservation efforts. This should be viewed as an opportunity and big businesses must be approached for funding conservation actions in the marine realm and embraced as main partners, as they can provide ample access, platforms and funding for marine research and conservation.

Yad Hanadiv - Since 2013 this Israeli philanthropic fund has been pursuing a strategic initiative to promote conservation of the ecosystem in the Mediterranean Sea, mainly through support of MPA establishment and the SPNI fisheries campaign and formation of community support by citizens in "marine communities", as well as a wide array of other marine conservation and research projects in the Mediterranean.

Academic institutes are often supported by philanthropy. For example, The Leon H Charney School of Maritime Sciences in the University of Haifa is supported by funding from the Charney, Strauss, Hatter and Helmsley funds.

SPNI – the largest environmental NGO in Israel has turned towards the sea in the past decade and was instrumental in advocating a conservation-oriented line and pushing for the fisheries reform mentioned above. This NGO is supported mostly by private philanthropic and some government funding (for education).

Other than SPNI, main Israeli NGOs acting in the Mediterranean today include Ecoocean and Zalul, both funded mainly by philanthropy and some government funding for education.

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

The EU's Horizon 2020 program has funded much needed research through its various grants and mechanisms (ERC, Marie Curie, EIC, COST, VECTORS, ASSEMBLE etc.). As Israel is active in many EU projects, its replacement, Horizon Europe, is set to undertake its place as a main financier of both academic research and sustainable development, as well as support for conservation driven innovation in the marine realm, as one of its 5 missions is "Healthy oceans, seas, coastal and inland waters".

BSF (Binational Science Fund) is a U.S.-Israel Grant program. It funds both U.S. and Israeli scientists who wish to work together. Total annual expenditure in this program is around 16M USD. The U.S. National Science Foundation (NSF), also funds collaborative U.S.-Israeli scientific research such as BSF-NSF joint program in ocean sciences. The financial support for the Israeli scientists in this program is from annual allocations from the Israeli Committee for Planning and Budgeting (CPB).

MOST-BMBF – Israeli Ministry of Science and Technology (MOST) and the Federal Ministry of Education and Research (BMBF) is a fund for German-Israeli Cooperation in Sciences, funding joint scientific research projects up to 750,000 € via bilateral cooperation.

8. Conclusions and recommendations

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CONCLUSIONS

Here are some specific challenges in the Israeli Mediterranean and possible solutions:

Problem	Proposed solutions and responses
Plastics	High fines for littering, bans on disposable plastics, educate the public to consume less and avoid littering, promote WWTP engineering for capture of microplastics, increase funding for cleanup activities.
Protected areas	Declare large MPA's in the Israeli territorial waters and EEZ, and manage them to benefit both the environment and human interests
Habitat destruction	Prioritize habitats according to the different threats and sensitivities (as done for oil &gas activity in the SEA) and act to safeguard them in MPA management plans.
Climate change	Educate the public to consume less, set high GHG emission targets and pursue them with renewable energy. Prepare adaptation plans.
Bioinvasion	Act boldly to curb bioinvasion, for example by recreating high salinity barriers in the Suez Canal and enact national legislation to curb bio-invasions. Study ecological and economic impacts of bioinvasion to identify practical solutions.
Oil pollution	Use advanced technology to improve safety of shipping and safety of oil and gas search, extraction, production, and transport. Apply stern regulation ensuring the use of BAT
Endangered species	Reduce marine explosions and noise by engaging with thehydrocarbon industry and shipping. Reduce bycatch in all fishing methods by technological means as well as seasonal and spatial moratoria. Adopt species restoration programs (as for C. mydas) for the most endangered species
Pollution in fish	Ban fishing in polluted areas (e.g. Southern Acre beaches) until they are cleared from heavy metals.
Overfishing	Set viable goals and indicators. Revise, monitor and implement the fishery reform according to EBFM and EcAp principles and in line with GFCM recommendations
Conserve shallow sandy hab-itats	'build with nature' (smart breakwaters, groins and novel coastal engineering methods) instead of erecting ever higher embankments and seawalls to reclaim lost beaches
Fishery resources	Alongside conservation efforts, develop environmentally-friendly fishing technologies and incentivize markets for local sustainably fished seafood

Annexe I

Abundance tables for taxa described in the document

Table 5.
Bird species listed in Annex II of the Barcelona Convention – sentinel species of the Mediterranean region (Adapted from UNEP MAP RAC/SPA - Sultana 2007, with comments on Israeli distribution fromwww.israbiding.com/checklist)

Species	Population Characteristics	Main Threats
Cory's Shearwater (*Calonectris diomedea*) **LC**	The nominate subspecies Calonectris d. diomedea is restricted to the Mediterranean. It breeds in sea-cliffs, and on rocky islands and islets. The population has been estimated at less than 76,000 pairs, but surveys in the eastern Mediterranean are lacking. **Fairly rare passing migrant in Israel**	Introduced mammals; illegal hunting; taking of eggs and chicks; bycatch; development near colonies and disturbance, and possibly oil spills and chemical pollution of the sea
Balearics Shearwater (*Puffinus mauretanicus*) **CE** and Levantine Shearwater (*Puffinus yelkouan*) **NT**	The two subspecies of the endemic Mediterranean Shearwater have recently been given separate specific status. Both are pelagic species breeding on rocky islands of the central and western Mediterranean. The population of the Balearic Shearwater has been estimated at about 1,750 pairs and Levantine Shearwater at probably less than 16,500 pairs. The Balearic Shearwater is classed as a critically threatened species because of an extreme decline rate of over 7% annually. P. yelkouan is a fairly rare to fairly common passing migrant in Israel, while *P. mauretanicus has only been recorded twice in Israel.*	Lack of food resources; lack of protection of breeding colonies; predation by introduced mammals; illegal exploitation for human consumption; disturbance; some mortality from bycatch; and possibly oil spills and chemical pollution of the sea.
European Storm Petrel (*Hydrobates pelagicus*) **LC**	Pelagic species breeding in small to very large colonies mainly on islets and in caves. Subspecies melitensis is endemic to the Mediterranean. Important breeding colonies are found in Malta, Sardinia, and Sicily. A general population decline in has been recorded. **Only 5 records in Israel, the last in 1986**	Loss of habitat; disturbance; predation by Rattus sp. and Yellow-legged Gull Larus michahellis; possibly oil spills and chemical pollution of the sea.
Shag (*Phalacrocorax aristotelis*) **LC**	The Mediterranean subspecies is endemic to the central and western Mediterranean, breeding along the coast on rocky islands and islets. The Mediterranean population numbers less than 10,000 pairs. **Extremely rare in Israel (a single record in 2005)**	Human disturbance; oil pollution; habitat loss; mortality from bycatch; Seine net fishing and longline hauling close to colonies and moulting areas
Pygmy Cormorant (*Phalacrocorax pygmeus*) **LC**	Main breeding Mediterranean populations of this globally threatened species are in the eastern and central basin. Restricted to lowland freshwater and brackish habitats, it frequents coastal lagoons, rivers, and riparian forests. Mediterranean population probably numbers less than 2,500 pairs. **A fairly common resident breeding species in Israel**	Degradation and loss of wetland habitat; persecution by fishermen; disturbance and hunting; destruction of breeding colonies
White Pelican (*Pelecanus onocrotalus*) **LC**	Breeds in Turkey and Greece and nests on the ground in large reedbeds, bare earth, or rocky islands, in isolation from the mainland to be safe from mammalian predators. **Seasonally common to fairly rare in Israel**	Habitat loss and destruction; depletion of fish stocks; persecution and disturbance; pollution, flooding; disease; collision with powerlines
Dalmatian Pelican (*Pelecanus crispus*) **VU**	Vulnerable and globally threatened. In the Mediterranean, small populations (totaling 1,000 pairs) breed mainly in Albania, Greece, and Turkey. Breeds on inland and coastal wetlands and nests on floating islands of reeds and on bare ground on islands. Up to about 3,000 birds winter in the eastern basin. **Native but only 8 records (last in 2004)**.	Wetland drainage; loss of breeding sites; hunting; collisions with powerlines; persecution by fishermen; contamination by pesticides and heavy metal residues

Greater Flamingo (*Phoenicopterus rubber*) **LC**	Breeds in wetlands free from human disturbance, mainly in the north Mediterranean. Non breeding populations also occur in Greece and Cyprus. Wintering, non-breeding, f**airly rare passing migrant in Israel**	Urban development; habitat loss for tourism development; disturbance; hunting
Eleonoras Falcon (*Falco eleonorae*) **LC**	Breeds in colonies along the coast or on rocky, often uninhabited islands. Total world population is estimated at 6,200 pairs. The Aegean islands and Crete hold about 70% of this population and also found in Spain, Italy, and Tunisia. **Fairly rare passing migrant in Israel.**	Predation by cats and rats; human disturbance in colonies; habitat degradation; taking of eggs and young; hunting.
Slender-billed Curlew (*Numenius tenuirostris*) **CR**	Globally threatened, once described as common in the Mediterranean, it is now one of the rarest and least known species. Migrates from Siberia across eastern and southern Europe to winter in North Africa. On passage, occurs in salt marshes, saltpans, brackish lagoons, dry fishponds and freshwater marshes. **Only 1 record (1917) in Israel**.	Habitat loss in passage and wintering areas. Other factors unknown
Audouin's Gull (*Larus audouini*) **NT**	Endemic to the Mediterranean. Main breeding populations occur in coastal and island sites in Spain and in Corsica. Other colonies occur in Greece, Turkey, Tunisia, and Sardinia. It was close to extinction in the 1970s, but better enforcement of protection measures has resulted in an increase in the breeding population. **4 records in Israel since 1985**	Habitat loss at breeding sites; competition with Yellow-legged Gull; egg collection; human disturbance; depletion of food resources; chemical pollution and spills.
Lesser Crested Tern (*Sterna bengalensis*) **LC**	A small localized population (breeding population probably less than 4,000 pairs) of the endemic subspecies Sterna bengalensis emigrata breeds on two Libyan offshore islands and occasionally in France, Greece, Italy and Spain. N**on-breeding frequent summer visitor in Israel**	Habitat loss; disturbance; predation; colony destruction.
Sandwich Tern (*Sterna sandvicensis*) **LC**	Probably less than 3,000 Mediterranean pairs nest in colonies mainly in river deltas, sandbanks and salinas. Migrates from elsewhere into the Mediterranean for wintering. F**airly rare to Fairly common in Israel**	Coastal development; disturbance by humans and animals; predation.
Little Tern (*Sterna albifrons*) **LC**	Mediterranean population mainly along southern coastline and western basin, where the actual size is unknown. Quantitative data from the Adriatic and Eastern Mediterranean countries are lacking. Breeds in rivers and deltas, estuaries, lagoons, and salinas. F**airly rare, summer visitor in Israel**.	Occasional disturbance by fishermen; probably predation by Yellow-legged Gull Larus michahellis; and possibly oil pollution and toxic chemicals

Table 6.

Abundance of soft bottom biota: number of specimens caught in 266 trawl hauls on the Israeli shelf and upper slope in 2008-11 (source: Edelist, 2013)

Family	Species	n
	Cephalopods	**3769**
Loliginidae	*Allotethis spp.*	38
Ommastrephidae	*Illex coindeti*	141
Loliginidae	*Loligo vulgaris*	2970
Octopodidae	*Octopus sp.*	193
Sepiidae	*Sepia elegans*	53
Sepiidae	*Sepia officinalis/Pharaonis*	65
Sepiidae	*Sepia orbignyana*	293
Sepiidae	*Sepietta oweniana*	16

Family	Species	n
	Cartilaginous Fish	**154**
Carcharinidae	*Carcharinus obscurus*	1
Dasyatidae	*Dasyatis pastinaca*	10
Dasyatidae	*Dasyatis tortonesei*	3
Rajidae	*Dipturus oxyrinchus*	2
Gymnuridae	*Gymnura altavela*	2
Dasyatidae	*Hymantura uaranak*	1
Triakidae	*Mustelus mustelus*	2
Myliobatidae	*Myliobatis aquila*	2
Myliobatidae	*Pteromylaeus bovinus*	4
Rajidae	*Raja clavata*	28
Rajidae	*Raja miraletus*	70
Rhinobatidae	*Rhinobatos rhinobatos*	18
Squalidae	*Squalus blainvillei*	
Dasyatidae	*Taeniura grabata*	1
Torpedinidae	*Torpedo marmorata*	4
Torpedinidae	*Torpedo nobiliana*	4
Torpedinidae	Torpedo torpedo	16
	Crustaceans	**44613**
Alpheidae	*Alpheus sp.*	8
Aristeidae	*Aristeomorpha foliacea*	1831
Aristeidae	*Aristeus antennatus*	1113
Calappidae	*Calappa granulata*	2
Portunidae	*Calinectes sapidus*	7
Portunidae	*Charybdis longicollis*	12324
Diogenidae	*Dardanus arrosor*	20
Squillidae	*Erugosquilla massavensis*	2735
Goneplacidae	*Eucrate crenata*	2
Majidae	*Hyastenus hilgendorfi*	1
Inachidae	*Inachus dorsettensis*	7
Leucosiidae	*Ixa monodi*	60
Latreilliidae	*Latreilla elegans*	77
Pisinae	*Lissa chiraga*	3
Penaeidae	*Marsupenaeus japonicus*	3779
Dorippidae	*Medorippe lanata*	106
Penaeidae	*Metapenaeopsis aegyptia*	2329
Penaeidae	*Metapenaeus monoceros*	22
Leucosiidae	*Myra subgranulata*	29
Paguridae	*Pagurus sp.*	3
Penaeidae	*Parapenaeus longirostris*	19401
Prthenopidae	*Parthenope angulifrons*	1
Penaeidae	*Penaeus semisulcatus*	20
Crangonidae	*Pontocaris cataphracta*	179
Portunidae	*Portunus pelagicus*	128
Sergestidae	*Sergestes sp.*	14

Family	Species	n
	Crustaceans	**44613**
Squillidae	*Squilla mantis*	35
Penaeidae	*Trachypenaeus palaestinensis*	339
Pandalidae	*Plesionika martia*	38
	Bony Fish	**78573**
Carangidae	*Alectis alexandrinus*	8
Carangidae	*Alepes djedaba*	129
Anguillidae	*Anguilla anguilla*	
Anthiinae	*Anthias anthias*	1
Apogonidae	*Apogon fasciatus*	1101
Apogonidae	*Apogon imberbis*	4
Apogonidae	*Apogon pharonis*	30
Apogonidae	*Apogon queketti*	2
Apogonidae	*Apogon smithi*	1873
Argentinidae	*Argentina sphyraena*	14
Sciaenidae	*Argyrosomus regius*	
Congridae	*Ariosoma balearicum*	55
Bothidae	*Arnoglossus spp.*	291
Triglidae	*Aspitrigla cuculus*	1
Atherinidae	*Atherina boyeri*	12
Atherinidae	*Atherinomorus lacunosus*	25
Balistidae	*Balistes capriscus*	35
Blenniidae	*Blennius ocelatus*	4
Sparidae	*Boops boops*	3330
Bothidae	*Bothus podas*	393
Bregmascerotidae	*Bregmaceros Atlanticus*	22
Soleidae	*Buglossidium luteum*	1
Callionymidae	*Callionymus filamentosus*	3011
Callionymidae	*Callionymus risso*	2
Caproidae	*Capros aper*	30
Carangidae	*Caranx crysos*	45
Carangidae	*Caranx rhonchus*	
Exocoetidae	*Cheilopogon heterurus*	3
Chlorophthalmidae	*Chlorophthalmus agassizii*	287
Citharidae	*Citharus linguatula*	972
Macrouridae	*Coelorhynchus Coelorhynchus*	13
Congridae	*Conger conger*	52
Cynoglossidae	*Cynoglossus sinusarabici*	122
Dactylopteridae	*Dactylopterus volitans*	3
Ophichthidae	*Dalophis imberbis*	2
Carangidae	*Decapterus russelli*	1760
Gobiidae	*Deltentosteus quadrimaculatus*	3
Sparidae	*Dentex dentex*	
Sparidae	*Dentex gibbosus*	6
Sparidae	*Dentex macrophtalmus*	1326

Family	Species	n
	Bony Fish	**78573**
Sparidae	*Dentex maroccanus*	358
Myctophidae	*Diaphus rafinesquei*	2
Moronidae	*Dicentrarchus punctatus*	
Sparidae	*Diplodus annularis*	21
Sparidae	*Diplodus cervinus*	9
Sparidae	*Diplodus puntazzo*	3
Sparidae	*Diplodus sargus*	50
Sparidae	*Diplodus vulgaris*	22
Clupeidae	*Dussumieria elopsoides*	437
Ophichthidae	*Echelus myrus*	52
Echeneididae	*Echeneis naucrates*	19
Engraulidae	*Engraulis encrasicolus*	3526
Serranidae	*Epinephelus aeneus*	14
Serranidae	*Epinephelus costae*	
Serranidae	*Epinephelus haifensis*	1
Clupeidae	*Etrumeus teres*	850
Scombridae	*Euthynnus alletteratus*	1
Triglidae	*Eutrigla gurnardus*	
Nettastomatidae	*Facciolella oxyrhyncha*	3
Fistularidae	*Fistularia commersoni*	172
Congridae	*Gnatholepis mystax*	
Gobiidae	*Gobius niger*	6
Scorpaenidae	*Helicolenus dactylopterus*	26
Hemiramphidae	*Hemiramphus far*	
Clupeidae	*Herklotsichthys punctatus*	5
Syngnathidae	*Hippocampus guttulatus*	1
Syngnathidae	*Hippocampus Hippocampus*	2
Trachichthyidae	*Hoplostethus mediterraneus*	
Hemiramphidae	*Hyporamphus affinis*	
Tetraodontidae	*Lagocephalus sceleratus*	45
Tetraodontidae	*Lagocephalus spadiceus*	384
Tetraodontidae	*Lagocephalus suezensis*	2113
Leiognathidae	*Leiognathus kluzingeri*	10353
Trichiuridae	*Lepidopus caudatus*	13
Scophthalmidae	*Lepidorhombus whiffiagonis*	
Triglidae	*Lepidotrigla cavillone*	723
Triglidae	*Lepidotrigla dieuzeidei*	7
Gobiidae	*Lesueurigobius suerii*	10
Sparidae	*Lithognathus mormyrus*	382
Mugilidae	*Liza aurata*	
Mugilidae	*Liza ramada*	
Lophiidae	*Lophius budegassa*	3
Macrorhamphosidae	*Macroramphosus scolopax*	592
Merlucciidae	*Merluccius merluccius*	178

Family	Species	n
	Bony Fish	**78573**
Soleidae	*Microchirus ocellatus*	16
Soleidae	*Microchirus varigates*	
Soleidae	*Monochirus hispidus*	3
Mugilidae	*Mugil cephalus*	
Mullidae	*Mullus barbatus*	877
Mullidae	*Mullus surmuletus*	300
Muraenidae	*Muraena helena*	2
Nemipteridae	*Nemipterus randalli*	4225
Sparidae	*Oblada melanura*	10
Ophidiidae	*Ophiodon barbatum*	91
Gobiidae	*Oxyurichthys papuensis*	66
Sparidae	*Pagellus acarne*	3605
Sparidae	*Pagellus bogaraveo*	191
Sparidae	*Pagellus erythrinus*	4795
Sparidae	*Pagrus auriga*	3
Sparidae	*Pagrus coeruleostictus*	198
Sparidae	*Pagrus pagrus*	10
Heterechelyidae	*Panturichthys fowleri*	
Blenniidae	*Parablennius tentacularis*	1
Pempheridae	*Pempheris vanicolensis*	3
Gadidae	*Phycis blennoides*	3
Gadidae	*Phycis phycis*	3
Plotosidae	*Plotosus lineatus*	7506
Haemulidea	*Pomadasys incisus*	19
Haemulidea	*Pomadasys stridens*	92
Pomatomidae	*Pomatomus saltator*	3
Carangidae	*Pseudocaranx dentex*	1
Labridae	*Pteragogus pelycus*	16
Clupeidae	*Sardina pilchardus*	578
Clupeidae	*Sardinella aurita*	457
Clupeidae	*Sardinella maderensis*	2
Holocentridae	*Sargocentron rubrum*	59
Synodontidae	*Saurida undosquamis*	1801
Sciaenidae	*Sciaena umbra*	1
Scombridae	*Scomber japonicus*	1297
Scombridae	*Scomberomorus commerson*	37
Scorpaenidae	*Scorpaena elongata*	11
Scorpaenidae	*Scorpaena mederensis*	4
Scorpaenidae	*Scorpaena notata*	16
Scorpaenidae	*Scorpaena porcus*	3
Scorpaenidae	*Scorpaena scrofa*	3
Carangidae	*Seriola dumerili*	64
Serranidae	*Serranus cabrilla*	114
Serranidae	*Serranus hepatus*	556

Family	Species	n
	Bony Fish	**78573**
Siganidae	*Siganus luridus*	
Siganidae	*Siganus rivulatus*	47
Sillaginidae	*Sillago sihama*	132
Soleidae	*Solea solea*	5
Soleidae	*Solea sp.*	
Scaridae	*Sparisoma cretense*	1
Sparidae	*Sparus aurata*	17
Tetraodontidae	*Sphoeroides pachygaster*	8
Sphyraenidae	*Sphyraena chrysotaenia*	154
Sphyraenidae	*Sphyraena sphyraena*	88
Sphyraenidae	*Sphyraena viridensis*	1
Centracanthidae	*spicara flexuosa*	2447
Centracanthidae	*Spicara maena*	449
Centracanthidae	*Spicara smaris*	1481
Sparidae	*Spondyliosoma cantharus*	1
Monacanthidae	*Stephanolepis diaspros*	390
Cynoglossidae	*Symphurus nigrescens*	
Synodontidae	*Synodus saurus*	62
Terapontidae	*Terapon puta*	1
Tetraodontidae	*Torquigener flavimaculosus*	9
Trachinidae	*Trachinus araneus*	
Trachinidae	*Trachinus draco*	4
Trachinidae	*Trachinus radiatus*	
Carangidae	*Trachurus indicus*	424
Carangidae	*Trachurus mediterraneus*	848
Carangidae	*Trachurus picturatus*	1
Carangidae	*Trachurus trachurus*	1536
Trichiuridae	*Trichiurus lepturus*	12
Triglidae	*Trigla lucerna*	4
Triglidae	*Trigla lyra*	5
Triglidae	*Trigloporus lastoviza*	88
Mullidae	*Upeneus moluccensis*	6841
Mullidae	*Upeneus pori*	1060
Uranoscopidae	*Uranoscopus scaber*	13
Labridae	*Xyrichthys novacula*	15
Zeidae	*Zeus faber*	19

Figure 15.

Cover % of the commonest taxa on abrasion platforms. Source: Herut et al. 2017.

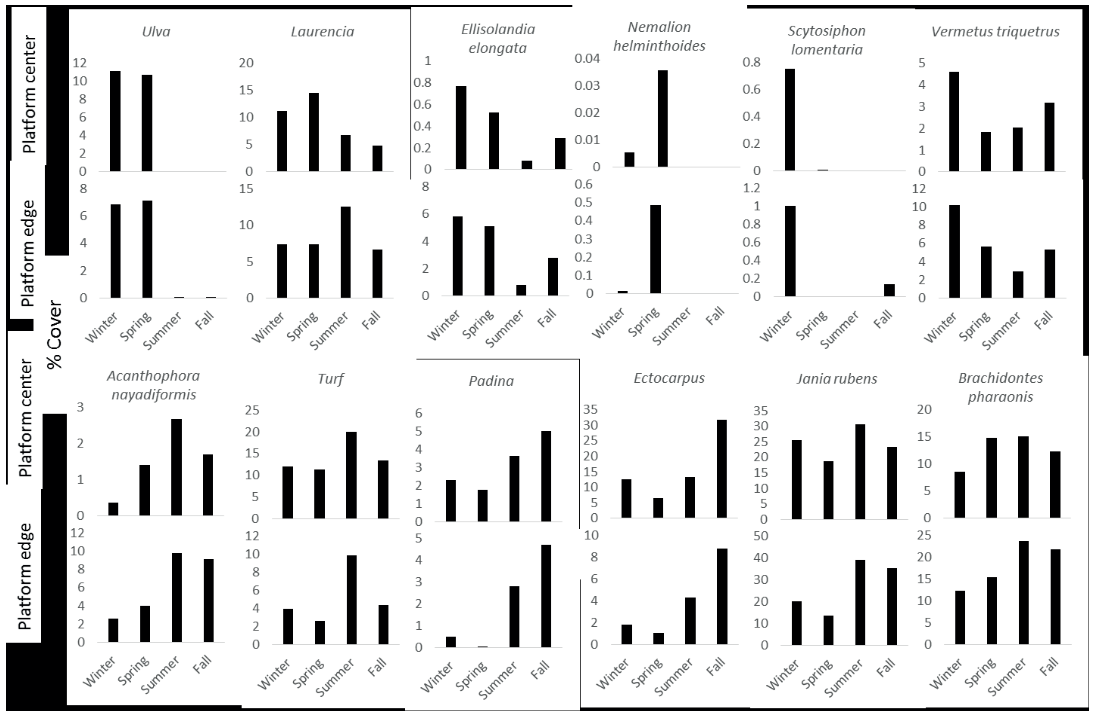


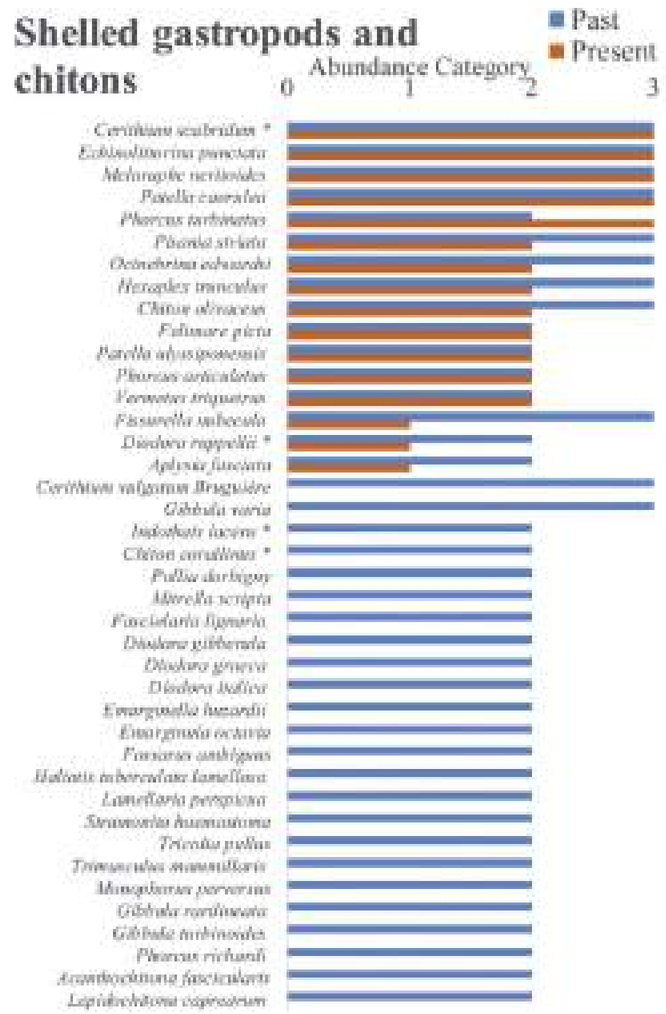
Table 7.

Status of Cetacean Species along the Israeli coast as assigned by Kerem et al. (2012)

Species	Mediterranean	LB
Tursiops truncatus	Regular	Regular
Stenella coeruleoalba	Regular	Regular
Delphinus delphis	Regular	Regular
Grampus griseus	Regular	Regular
Ziphius cavirostris	Regular	Regular
Balaenoptera physalus	Regular	Visitor
Physeter macrocephalus	Regular	Visitor
Globicephala melas	Regular	Absent
Steno bredanensis	Regular	Regular
Balaenoptera acutorostrata	Visitor	Visitor
Pseudorca crassidens	Visitor	Visitor
Megaptera novaeangliae	Visitor	Vagrant
Orcinus orca	Visitor	Vagrant
Sousa chinensis	Alien vagrant	Vagrant

Figure 16.

Past and present abundance categories of hard substrate (rocky reef) shelled gastropods and bivalves based on Levant taxonomic literature and present survey data. 0 = not found, 1 = rare, not common, 2 = common, 3 = very common. Species marked with asterisks are non-indigenous.



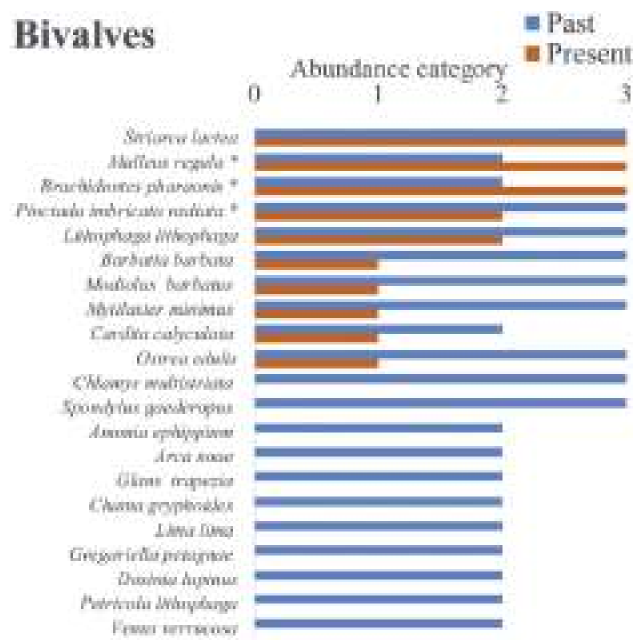


Table 8.

Common gelatinous zooplankton species along the Israeli Mediterranean coast. Source: www.meduzot.co.il

Phylum	Class	Order	Species	Abundance
Cnidaria	Scyphozoa	Rhizostomeae	Rhopilema nomadica	Very Common
	Scyphozoa	Rhizostomeae	Rhizostoma pulmo	Common
	Scyphozoa	Rhizostomeae	Phyllorhiza punctata	Common
	Scyphozoa	Semaeostomeae	Aurelia aurita	Medium
	Scyphozoa	Rhizostomeae	Cotylorhiza tuberculata	Rare
	Scyphozoa	Rhizostomeae	Cassiopea andromeda	Rare
	Scyphozoa	Rhizostomeae	Marivagia stellata	Medium
	Scyphozoa	Semaeostomeae	Pelagia noctiluca	Rare
	Scyphozoa	Rhizostomeae	Cotylorhiza erythraea	Medium
	Scyphozoa	Semaeostomeae	Chrisaora pseudoocellata	Rare but New
	Scyphozoa	Semaeostomeae	Discomedusa lobata	Medium
	Hydrozoa	Anthoathecata	Porpita porpita	Medium
	Hydrozoa	Anthoathecata	Velella velella	Rare
	Hydrozoa	Leptothecata	Aequorea spp.	Medium
Ctenophora	Nuda	Beroida	Beroe ovata	Very Common
	Tentaculata	Lobata	Mnemiopsis Leidyi	Very Common
	Tentaculata	Cestida	Cestus veneris	Rare
	Tentaculata	Lobata	Leucothea sp.	Rare

Figure 17.

Commercial species caught along the Israeli Mediterranean coast in 2009 by fishing method. Note that a fisheries reform in 2016 has altered this composition considerably: 1) Today the total catch is about 40% lower. 2) Cartilaginous fishes are not commercially caught any more. 3) M. japonicus catch today is less than a quarter 2009 values, as trawlers are excluded from habitat shallower than 40 m.

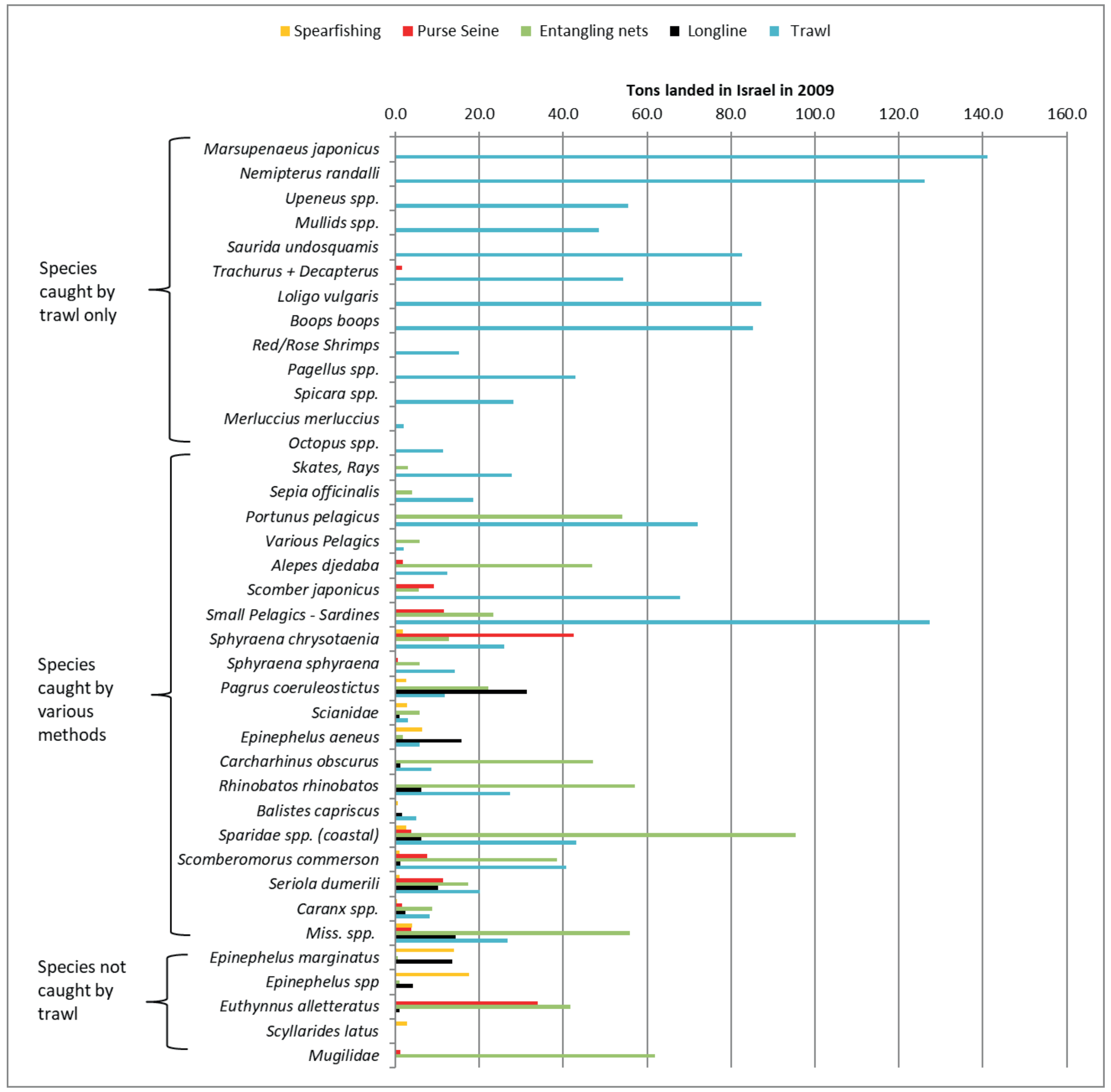


Table 9.
Abrasion Platform location and shoreline length (in km) along the Israeli coast, from north to south. Source: Edelist and Rilov (2017).

Location	Shoreline Km
Rosh Haniqra	1.3
Achziv	3
Shavey Zion	1.5
Acco	3.5
Shiqmona	1.5
Atlit	3.5
Dor-Neve Yam	0.5
Nachsholim-Dor	5
Maagan Michael	0.7
Jisr A Zarqa	0.7
Caesarea	0.7
Sdot-Yam	2.5
Olga	1
Gdor	1
Michmoret	2
Jaffa-Bat Yam	4
Palmachim	1
Total	33.4

Annexe II.

Marine Pollution and threats to the Mediterranean marine environment

Figure 18.
Sources of direct discharge of pollution into the Mediterranean Sea through the drainage basin (left) and gaseous airborne depositions into the Mediterranean (right). Source: MOEP (2012)

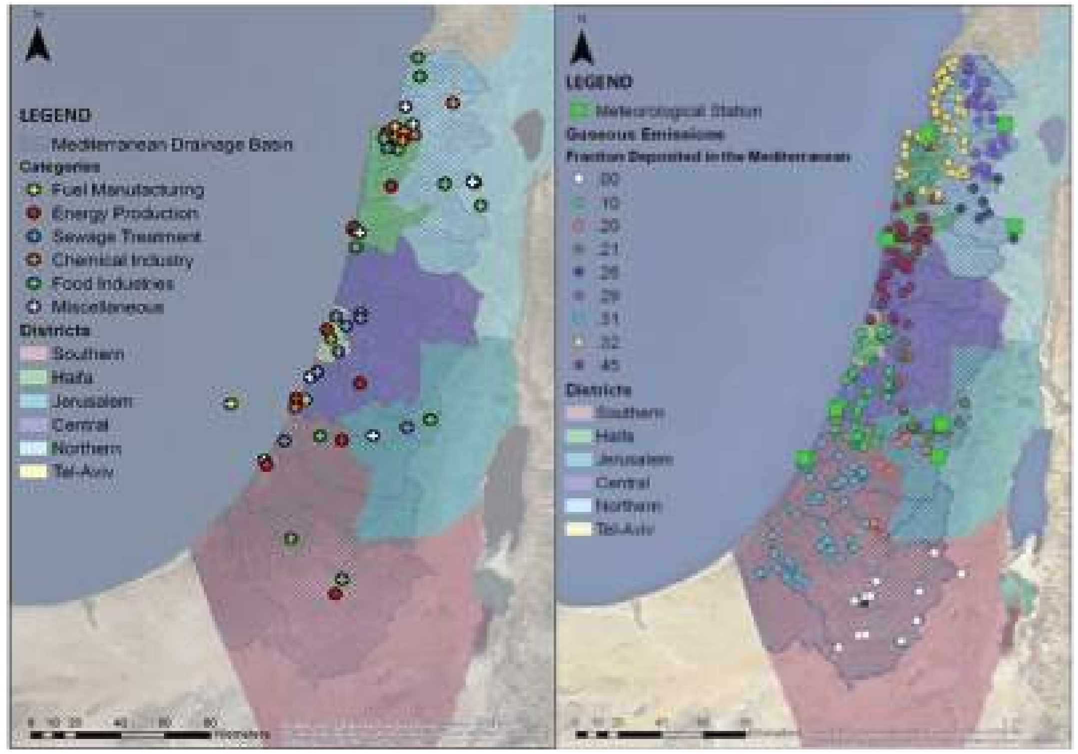


Table 10.
Trends in parameters of pollutants entering the Mediterranean between 2004 and 2012 (before Shafdan closure in 2016)

Group of Pollutants / Pollutant	2004		2008		2012		% change from 2008	
	Liquid	Air	Liquid	Air	Liquid	Air	Liquid	Air
TOC [ton]	33,000		39,301		33,442		-15%	
N [ton]	7,711		7,299		4,887		-33%	
P [ton]	1,179		2,275		2,834		25%	
BOD [ton]	19,530		31,556		29,602		-6%	
Oil and Grease [ton]	5,661		3,348		3,435		3%	
Hydrocarbons [Kg]	3,053,475	348,041	7,443,830	242,080,800	5,829	32,692	-100%	-100%
PAH [Kg]		176		2,441		625		-74%
Heavy Metals [Kg]	46,780	27,615	18,209	29,633	9,918	3,150	-46%	-89%
As [Kg]	79	1,542	42	1,606	23	31	-45%	-98%
Cd [Kg]	1,000	270	127	289	47	23	-63%	-92%
Cr [Kg]	2,775	1,301	1,584	1,063	1,279	440	-19%	-59%
Cu [Kg]	35,000	431	10,238	425	6,509	91	-36%	-78%
Hg [Kg]		545	74	958	45	76	-40%	-92%
Ni [Kg]	6,000	21,448	2,737	21,780	1,264	2,278	-54%	-90%
Pb [Kg]	5	2,078	3,407	3,512	752	209	-78%	-94%
No. Records	30	52	30	52	68	431	127%	729%

Table 2 : Pollutant loads entering the Mediterranean through coastal streams during 2012

Administrative Zone	Stream	Total Phosphorus (ton/year)	Total Nitrogen (ton/year)	BOD (ton/year)	TOC (ton/year)	Flow (MCM/year)
Northern	Naaman[1]	6.7	142	153	171	16.5[2]
Haifa	Kishon	14	350	174	211	24.8
	Taninim	2.3	25	6.7	75	4.61[4]
	Hadera	23	126	193	224	12.4[illegible]
Central	Alexander	39	444	107	412	13.1
	Soreq	43	284	575	639	22.1
Tel Aviv	Yarkon[5]	37	313	330	313	33.7
Southern	Lakhish	20	64	242	240[6]	16.1
	Besor[7]	0.2	4.4	1.2	30	2.4

Annexe III.
Conventions, Treaties and Protocols

List of conventions, treaties and protocols signed and ratified by Israel (Source: MOEP website)

Biodiversity, Nature, Heritage related

1. Convention on Biological Diversity (CBD), 1992
2. Convention on Migratory Species (CMS), 1979
3. Convention on International Trade of Endangered Species (CITES), 1973
4. World Heritage Convention, 1972
5. Convention on Wetlands of International Importance (Ramsar Convention), 1971
6. International Union of New Plant Varieties (UPOV), 1961
7. International Convention for the Regulation of Whaling, 1946
8. African Eurasian Waterbird Agreement -1985
9. Raptors MOU - 2015

Climate and Air Quality

10. Kiev Protocol on Pollutant Release and Transfer Registers, 2009
11. UN Framework Convention on Climate Change (UNFCCC), 1994
12. Vienna Convention for the Protection of the Ozone Layer, 1985

Hazardous Materials

13. Minamata Convention on Mercury, 2013
14. Stockholm Convention on Persistent Organic Pollutants, 2001
15. Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, 1998
16. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989
17. Convention Concerning Protection against Hazards of Poisoning Arising from Benzene (Benzene Convention), 1971

Marine and Coastal Environment

18. International Convention on the Civil Liability for Oil Pollution Damage (CLC), 1992
19. International Convention on Oil Pollution Preparedness, Response and Coop (OPRC), 1990
20. Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona), 1976
21. International Convention for the Prevention of Pollution from Ships (MARPOL), 1973
22. International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund), 1971

The UN identifies several important national zoning laws (https://www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/ISR.htm), including Submarine Areas Law of 10 February l953, Territorial Waters (Amendment) Law, 5750-1990 of 5 February 1990 and Territorial Waters Law, 5717/1956, as amended by the Territorial Waters (Amendment) Law, 5750-1990, of 5 February 1990. Regarding Piracy, the UN has identified the following legislation as relevant: Penal Law 1977; Maritime Law 2008; and Prohibition on Money Laundering Law 2000.

Table 11.

Barcelona Convention protocol – state of adoption and ratification in Israel

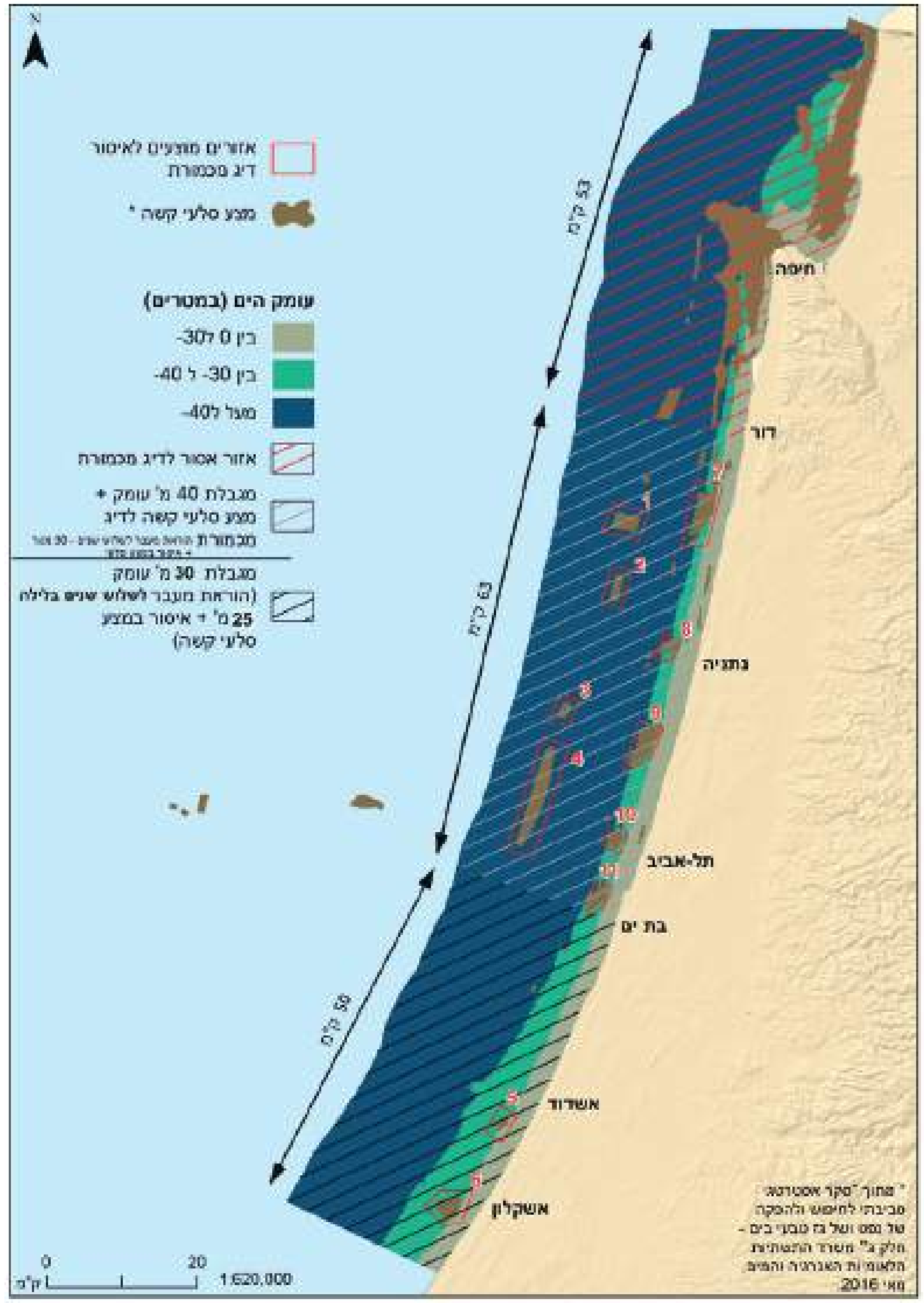
Original Protocol	Adopted/ Entered into Force	Ratified/ Entered into Force in Israel	Revised/Replaced	Ratified/ Entered into force in Israel
Protocol for the Prevention of Pollution in the Mediterranean Sea by Dumping from Ships and Aircraft	Adopted 1976; Entered into force 1978	Ratified by Israel March 1, 1984. Entered into force April 1984.	In 1995 the Protocol was amended and recorded as the Protocol for the Prevention and Elimination of Pollution in the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea. The new Protocol is not yet in force.	Israel has not ratified the amended Protocol
Protocol Concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in Cases of Emergency	Adopted 2002; Entered into force 2004	Ratified by Israel on March 3, 1978. Protocol entered into force in Israel in April 1978	In 2002, the Protocol was amended. The new Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea entered into force in 2004.	Israel has not ratified the new Protocol
Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources	Adopted 1980; Entered into force 1983.	Ratified by Israel Feb. 21, 1991. Entered into force in Israel March 1991.	In 1996, the Protocol was amended. The new Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities entered into force in 2008.	Israel ratified the amended Protocol on June 19, 2009. It entered into force in Israel in July 2009
Protocol concerning Mediterranean Specially Protected Areas (SPA)	Adopted 1982; Entered into force 1986	Ratified by Israel Oct. 28, 1987. Entered into force in Israel November 1987.	In 1995, the Protocol was amended. The new Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean entered into force in 1999.	Israel has not ratified the new Protocol.
Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil	Adopted 1994; Entered into force 2011	Israel has not ratified this Protocol.	Not Applicable	Not Applicable
Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal	Adopted 1996; Entered into force 2008.	Israel has not ratified this Protocol.	Not Applicable	Not Applicable
Protocol on Integrated Coastal Zone Management in the Mediterranean	Adopted 2008; Entered into force 2011	Ratified by Israel Feb. 4, 2016.	Not Applicable	Not Applicable

Annexe IV.

Spatial Fishing Regulations

Figure 19.

No Trawling Zones in Israel (red crossbars and polygons, turquoise and grey zones). Source: INPA, 2017.



Annexe V.
Identified habitat types according to SPA/RAC – Tunis, 2017

Table 12.

List of marine habitat types identified in Israel by the author and classified according to the reference list provided by UNEP/MAP, SPA/RAC - Tunis, 2017.

MA1.5 Mediterranean littoral rock MA1.51 Supralittoral rock
MA1.54 Lower mediolittoral rock
MA2.55 Biogenic reef assemblages of the lower mediolittoral rock MA2.551 Vermetid reefs (Dendropoma spp.) MA2.552 Platforms with coralline algae (Lithophyllum concretions)
MA5.5 Mediterranean littoral sand MA5.51 Supralittoral sands
MA5.52 Mediolittoral sands
MB1.5 Mediterranean infralittoral rock MB1.51 Infralittoral algae
MB1.51K with Sargassum vulgare with Cystoseira spp
Sheltered, shaded, upper infralittoral rock MB1.51Y Coralligenous (in enclave)
Infralittoral rocky outcrops ("tègnue") with Ulva spp.
MB2.5 Mediterranean infralittoral biogenic habitat MB2.51 Biogenic reef assemblages of the infralittoral algae biocoenosis MB2.511 with Dendropoma spp.
MC1.5 Mediterranean circalittoral rock MC1.515 with Sargassum spp., Cystoseira spp.
MC1.5 Mediterranean circalittoral rock MC1.519 - Invertebrate-dominated coralligenous bioconstructions with Erythraean aliens
MC1.52 Shelf edge rock with macroscopic vegetation Circalittoral rock with coralligenous outcrops dominated by Axinellida with alcyonarians
MC1.53 Semi-dark caves and overhangs Walls of infralittoral and circalittoral caves and tunnels
MC2.5 Mediterranean circalittoral biogenic habitat MC2.51 Coralligenous platforms
MC3.5 Mediterranean circalittoral coarse sediment with Pennatulaceans (Pennatula, Pteroides, Virgularia) and Alcyonium palmatum
MC3.52 Coastal detritic bottoms with rhodoliths
MC4.5 Mediterranean circalittoral mixed sediment MC4.51 Muddy detritic bottoms with Alcyonium palmatum and Pennatula rubra
MD1.5 Mediterranean offshore circalittoral rock MD1.51 Offshore circalittoral rock
Circalittoral rocks with Paralcyonium spinulosum and/or Alcyonium palmatum
Circalittoral rock covered by sediments, with Cerianthus sp
MD4.5 Mediterranean offshore circalittoral mixed sediment
MD6.5 Mediterranean offshore circalittoral mud MD6.51 Coastal terrigenous muds
ME1.5 Mediterranean upper bathyal rock ME1.51 Upper bathyal rock. Bathyal rocks with Scleractinia and Alcyonacea. Bathyal rocks with Antipatharia. Bathyal rock with Viminella flagellum
ME3.5 Mediterranean upper bathyal coarse sediment Bathyal coarse sediment with Alcyonacea
Bathyal muds with Alcyonacea ME6.515 Bathyal muds with Isidella elongata
ME6.5 Mediterranean upper bathyal muds. Bathyal muds with Pennatulacea, Alcyonacea and Crustacea Decapoda
MG6.1 Mediterranean abyssal mud Cold seeps and hydrothermal vents Methane seeps

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**

Marine turtles

Cetaceans

Mediterranean Monk Seal

Cartilaginous fishes
(Chondrichtyans)

Marine and coastal bird species
Listed in Annex II of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean

SPAMI

Specially Protected Areas of **Mediterranean Importance**

Specially Protected Areas

Monitoring

Coralligenous and other calcareous bio-concretions

Marine vegetation

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

Species introduction and invasive species

POST-2020

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and **Sustainable Management**
of **Natural Resources**
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UN environment programme | Mediterranean Action Plan Barcelona Convention | SPA / RAC *The Mediterranean Biodiversity Centre*

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This publication has been prepared
with the financial support of the MAVA foundation