CHAPTER 10/

Concluding remarks

Otero M., Mytilineou C.

The known and unknown Eastern Mediterranean Deep-Sea

The deep-sea was once regarded as vast, stable, monotonous desert-like ecosystem, with conditions too extreme for life to thrive. Building on knowledge over the years, we now know that these extreme environments are highly variable and diverse [1]. In the Eastern Mediterranean Sea, despite its ultra-oligotrophic water environment and oceanographic physical conditions, the deep-sea hosts a large diversity of ecosystems and species. It is shaped by topographically complex geomorphological structures and geological heterogeneity with submarine canyons, seeps, vents, seamounts and submarine ridges. A variety of extreme environments such as active cold seep systems, including mud volcanoes, pockmarks and brine lakes, have recently been detected on the active ridges and passive continental margins of the Eastern basin (see Chapter 2 & 5; [2]). They support the life of rare and unique species fuelled by fluid and gas emissions to the sea floor. Within each of these areas, seafloor topography, heterogeneity of sedimentary habitats, depth and water masses strongly affect the faunal communities that have developed.

The high biodiversity associated with the Eastern Mediterranean deep-sea ecosystems remain largely undescribed. The results presented in previous chapters indicate that there have been only sparse studies in most of this basin and sub-regions and large gaps in knowledge still exist, particularly in the Levantine and Libyan Sea waters where there has been considerably less sampling effort. Most of the information is concentrated on the upper continental slopes and shelf breaks and only few more recent reports have described deep-sea faunas associated with deep-straits, seamounts, canyons and slope disturbances. The review of the published and grey literature with the new analysis conducted on historical video material and by-catch data (Chapter 3 and 4), has offered an opportunity to understand the

rich biodiversity values of some of these remote locations and diverse ecosystems formed. It also shows the untapped scientific value of existing underwater videos that could be used to shine new light on deep-sea locations and retrospectively observe past baselines.

More data is certainly needed, to better quantify biodiversity in those areas, understand their present conservation status and the overlapping effects of different pressures on the same areas over time. Nonetheless, the information gathered here shows that the current accumulated knowledge has the potentiality to facilitate efforts for a comprehensive programme to ensure the conservation of these vulnerable marine ecosystems and their biodiversity in the Eastern Mediterranean.

As Mediterranean blue economies develop, and the human and climate footprints extend into the deep waters, sustainable environmental management of deep-sea ecosystems and resources will need to grow in importance. The current spectrum of human activities affecting presently or with the potential to impact the Eastern Mediterranean deep-sea ecosystems in the future is diverse and increasing. Fishing activities are expanding towards offshore and in deeper marine areas (Chapter 7 and 8), and some countries have enabled the first licenses for offshore oil and gas activities (exploration and exploitation) in the region (Chapter 9). In addition to this, the expansion of submarine cable networks (power and telecommunication) and gas pipelines have raised concerns on their impact on the marine environment and its fauna, with very limited information available. New opportunities to develop renewable energy development projects (e.g. wind park with floating turbines in the deep waters of the Aegean Sea) in marine offshore areas might surge in the near future and research with the application of effective monitoring programmes to the different on-going developments is needed.

Studies shedding light to describe the large problem of marine litter in these deep-waters are scant. The majority of the plastic waste from the coast breaks down into microplastics and disperses through the waters, before finally sinking into the deep depths. Deep-sea areas with high concentrations of macroplastics, polluted through highly urbanized gulfs (e.g. Limassol Gulf,

Waste from the coast disperses through the waters, before finally sinking into the deep depths.

Renewable energy development projects (e.g. the wind parks) in marine offshore areas need impact assessments and the application of effective monitoring programmes.

Antalya Bay and Saronic Gulf), have been described in the Eastern Mediterranean and are particularly severe in their deeper parts (Chapter 9). They have also been described in several submarine canyons and open sea areas (e.g. southwest of Lefkas Island, south of Cyprus, off Jablah in Syria). The reasons for litter accumulation in open-sea areas and on the seafloor could be related to hydrographic conditions and activities from maritime traffic. The role of submarine canyons (e.g. Lebanon coast canyons) close to the coast as organic matter corridors but also as conveying vectors for marine litter from the continental shelf into the deep abyssal seafloor is of considerable importance. The development and the implementation of appropriate policies, legal instruments and institutional arrangements as well as adequate management plans to address this problem have been recently agreed in the Mediterranean. Both strategic actions, the Regional Plan on Marine Litter Management and the Regional Plan on Urban Wastewater Treatment and Sewage Sludge Management in the Framework of Article 15 of the Land Based Sources Protocol[1] will be a key to achieve a real reduction of litter in the marine environment.

Overall, there is limited published information on the quantification of the human impacts on deep-sea ecosystems or the spatio-temporal intensity of different user industries. For some activities, the information remains dispersed among different institutions or is not available. In situ assessments of the impact of offshore activities on nearby deep-sea sediments and associated benthic and demersal fauna are rarely available. For example, information on meiofauna, the main benthic component found in significant densities in the oligotrophic deep eastern Mediterranean basins, remains very scarce and fragmented for most of its habitats (Chapter 5). This together with the limited information and monitoring effort about the nature, distribution, variability, and vulnerability of biodiversity and resources prevents the matching of information on threat intensity in specific locations. In some areas, it is already evident that economic activities of concern such as the gas leased blocks and the presence of endangered species are very close or overlap (Chapter 9; Fig.9.15a). At some deep-sea Ecologically or Biologically Significant Marine Areas (EBSAs)[2] the overlapping with potential or planned seems relatively important (Fig. 10.1; >30-50%).

1 UNEP/MED IG.25/12; IG.25/11
2 https://www.cbd.int/ebsa/

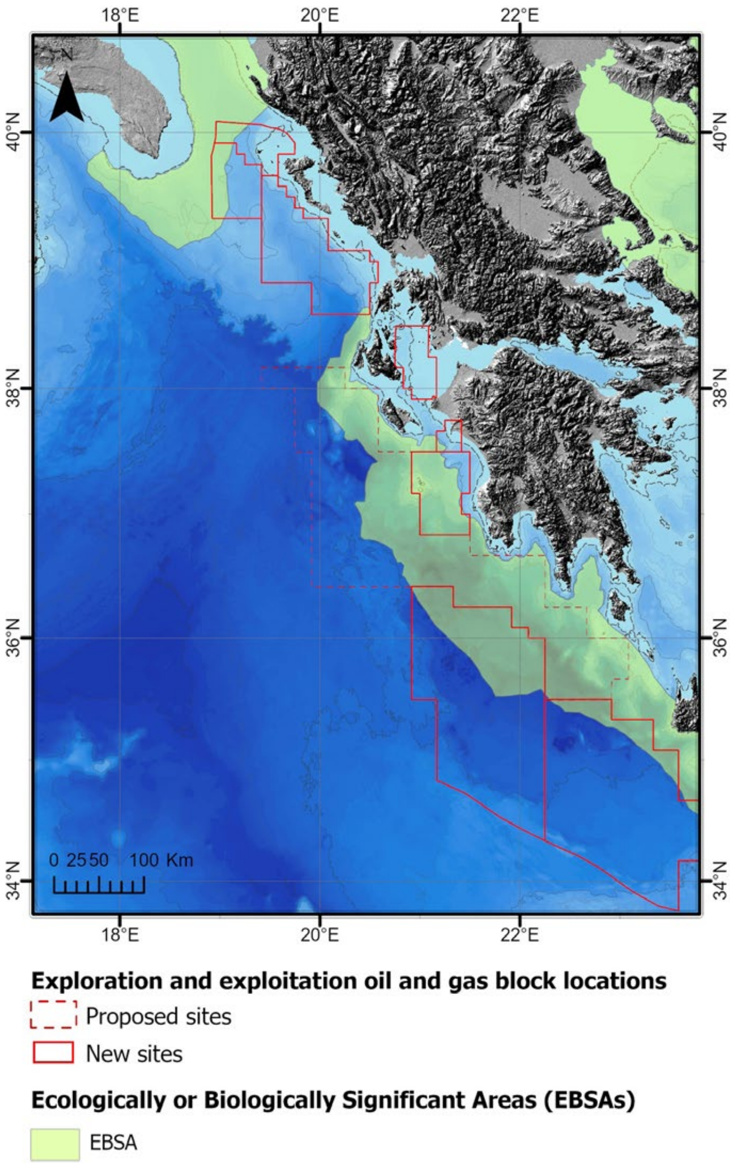


Fig. 10.1. Overlapping of the Hellenic Trench and South Adriatic Strait and Ionian Ecologically or Biologically Significant Marine Areas (EBSAs) with potential and/or planned exploitation and exploration oil and gas locations in the Eastern Ionian Sea.

Considering the current and planned expansion activities of deep-water gas exploration and exploitation in the Eastern Mediterranean, that may overlap with key biodiversity areas will pose potential further threats to the deep-sea biodiversity as well as the species using this pelagic environment (e.g. effects produced by military sonars activities on endangered species as Sperm and Cuvier's beaked whales). In the absence of dedicated surveys, alternative methodologies are needed, such as the use of data collected from platforms of opportunity and modelling techniques to predict distribution in unsurveyed areas. Moreover, a more transparent process involving stakeholders should be put in place to monitor and enhance the effective implementation of regulations concerning these activities, monitor changes and establish spatial (e.g., avoidance rules on sensitive areas and/or where endangered fauna is present), and temporal measures (e.g., restricted activities during certain periods for sensitive fauna) to mitigate risks from these activities.

Knowledge on deep-water fishing resources and fisheries in the Eastern Mediterranean is discussed in detail in Chapter 7 and Chapter 8. Deep-water fishing occurs in the upper and lower slope, submarine canyons and on many seamounts, and the overexploited status of many of the commercial Mediterranean commercially important stocks is recognised [3]. No specific information exists on the fishing effort and the corresponding fishing grounds where deep-water trawl fisheries are practiced, although it is expected to be soon available.

© ALAMY.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assessment [4] suggests that the direct exploitation of organisms (mainly through fishing) has one of the largest impacts on the marine environment. At present, scarce information is available on the extent of the fishing activities and impacts on deep seafloor communities and biodiversity in the Eastern basin. It is of concern that in some cases deep-water fishing is known to occur close to or in vulnerable ecosystems (Fig.10.2). Examples of this are areas where deep-water shrimp fishing grounds are close or coincide with fields of bamboo coral *Isidella* presence (Chapter 3, 4 and 8-Fig.8.3) on the Kephallinia seamount[5] or areas where commercial species such as *Polyprion americanus*, and *Pagellus bogaraveo* are exploited close to seamounts and banks (Chapter 7[5]). Areas around seamount features offer suitable habitats often harbouring highly productive, biodiverse and structurally complex habitats such as sponge gardens or cold-water corals. Their presence could be likely of higher relevance in the oligotrophic offshore waters of the Eastern Mediterranean.

The observed spatial patterns of some deep-water fishing activities (Chapter 8) corroborates the known deep-water fishing operations with activities near seamount ridges, canyons and slopes in the five sub-basins. As fishing vessels operating in the southern and most eastern Mediterranean areas are not equipped with VMS or AIS monitoring devices, there is very limited knowledge where deep-water trawl fishery is practiced. Identifying those deep-sea areas that are vulnerable to fishing impacts is important in conservation efforts behind Marine Protected Areas or No-Take Zones. Criteria for identifying these vulnerable marine ecosystems (VME) where fishing pressure is known to exist in the Mediterranean have started to be defined[3] and potential sites for the Eastern Mediterranean are here suggested and proposed for further investigation.

As the deep-sea ecosystems are highly sensitive to changes, it is likely their ability to recover from continuous or short-term impacts will largely depend on the different pressures on these ecosystems [6,7,8]. Therefore, a great deal more understanding of how these interactions affect the deep-sea environment is necessary in order to make sound resource management decisions in a consistent and evidence-supported manner.

There are also numerous uncertainties about how deep-sea ecosystems will respond to climate change and what this will mean for their resilience to human activities. The Mediterranean Sea is considered as one of the most responsive regions to climate change [9].

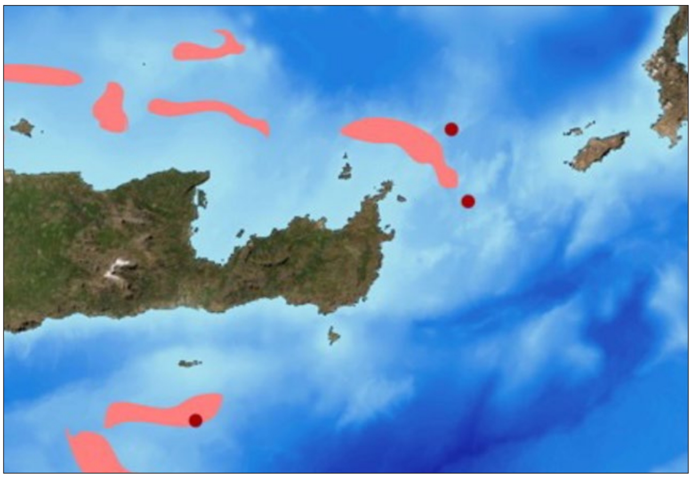
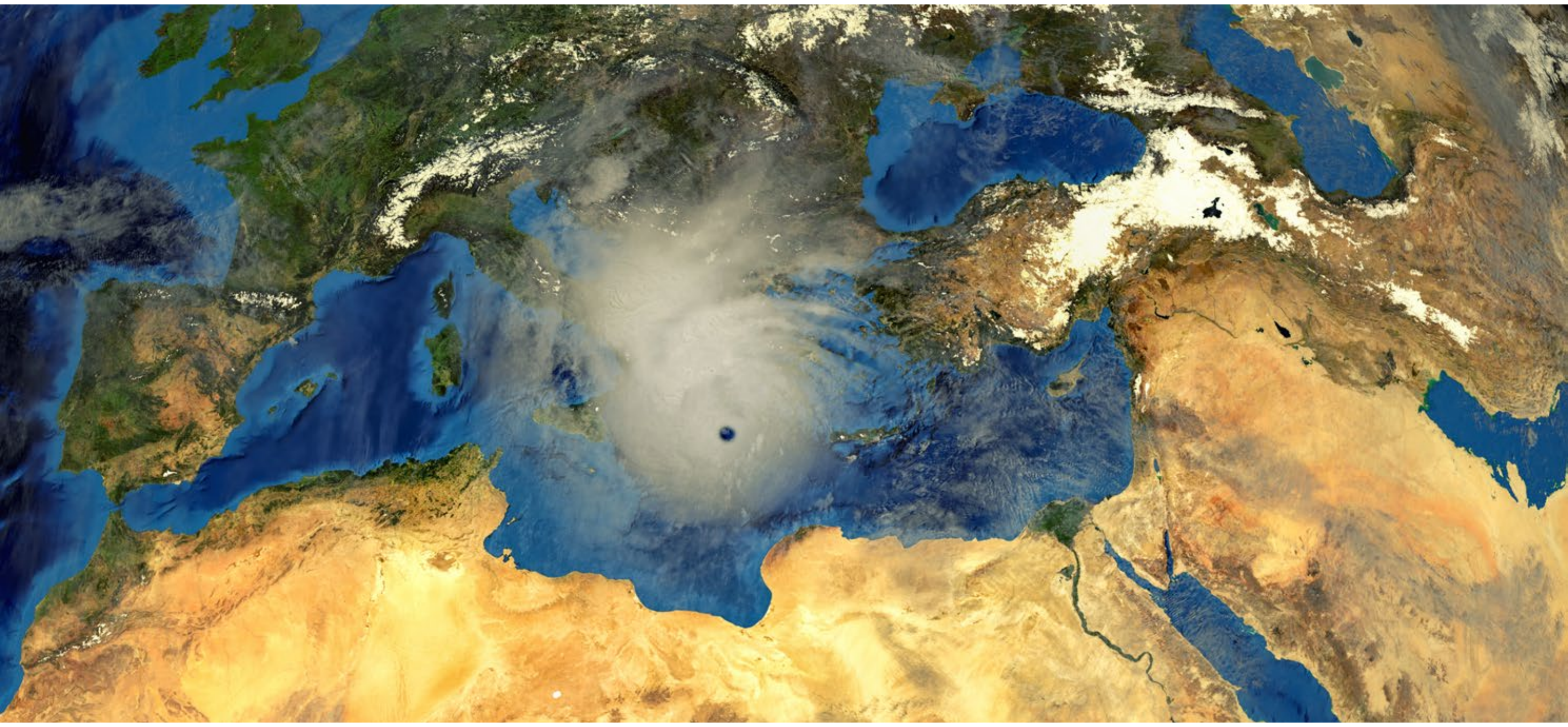


Fig 10.2. Main deep-water trawl fishing grounds in the East Crete area (2019) (Orange) with areas where the presence of cold-water corals (red dots) has been mentioned in the present work.

3 GFCM/43/2019/6; GFCM/41/2017/5



The Eastern Mediterranean basin is one of the most prominent and vulnerable climate change hotspots.

Representation of a seamount community showing potential currents and how dispersal and colonization among deep-sea benthic populatioons may occur.

Surface seawater temperatures are expected to rise between 1.8°C and 3.5°C by 2100 and the Eastern Mediterranean will be one of the hotspots where the largest changes are predicted. Ocean acidification, a consequence of higher CO_2 levels will likely impact the marine trophic chain, from its primary producers (phyto-plankton, phytobenthos and zooplankton) to deep-water corals [10] although it is less clear to what degree marine organisms might adapt to slowly changing pH over the next century. Overall, understanding how climate impacts will interact with these induced physical and chemical changes as well as pressures from other human activities occurring close to the seabed or the deep pelagic environment such as those coming from fishing and pollution will require further work. The implementation of mitigation actions in the coming years can reduce part of the impacts that are starting to be observed now and allow some restoration progress. Protection of seamount summits may provide a refuge from acidification for species that otherwise only occur in deeper more greatly affected habitats [10,11]. The present evidence also shows the role of seamounts and seamount-like structures as hotspots for some top-predators or consumers including large sharks and cetaceans (Chapter 6).

Improving the capability to monitor the present cumulative impacts, assess the vulnerabilities of deep-sea ecosystems, inform on ecosystem health and integrity, and understand socioeconomic values of these marine areas will help the success of an integrated planning of marine resource management.

The Road to protect 30% of the Mediterranean Sea

The Mediterranean countries have made strong national commitments to effectively manage their marine resources, which are embedded in regional and international efforts and commitments, such as the Convention on Biological Diversity (CBD) Biodiversity Targets (Post-2020 Global Biodiversity Framework), the United Nations Oceans Conference in support of the 2030 Agenda for Sustainable Development, the Barcelona Convention and the General Fisheries Commission for the Mediterranean (GFCM) 2030 Strategy. Moreover, they have recently increased their goals under the Post-2020 roadmap on marine protected areas (MPAs) and other effective area-based conservation measures (OECMs) in the Mediterranean.

To date, Mediterranean countries have declared the spatial protection of 8.33% of the Mediterranean Sea, almost all concentrated in the northern basin and coast al areas or as sanctuaries to reduce specific threats to some taxa (e.g. cetaceans sanctuaries). However, the present surface of MPAs has only 0.04% of waters that are in fact strongly protected with no-go, no-take or no-fishing areas [12]. The existing set of MPAs in the Eastern Mediterranean and areas designated to mitigate specific threats need to enforce their coherence, connectivity, and representativeness; and more progress has to be made in giving the deserved attention to the need of MPAs and/or FRAs designation at the open sea to protect migratory and endangered fauna as well as vulnerable biodiversity hotspots (Fig.10.3).

Mediterranean countries have committed specific goals for Protected Areas:

i) by 2030, at least 30 % of the Mediterranean Sea will be protected and conserved through a well-connected, ecologically representative and effective systems of marine and coastal protected areas (MCPAs) and other effective area-based conservation measures (OECMs), ensuring adequate geographical balance, with the focus on areas particularly important for biodiversity.

ii) by 2030, the number and coverage of MPAs with enhanced protection levels is increased, contributing to the recovery of marine ecosystems"

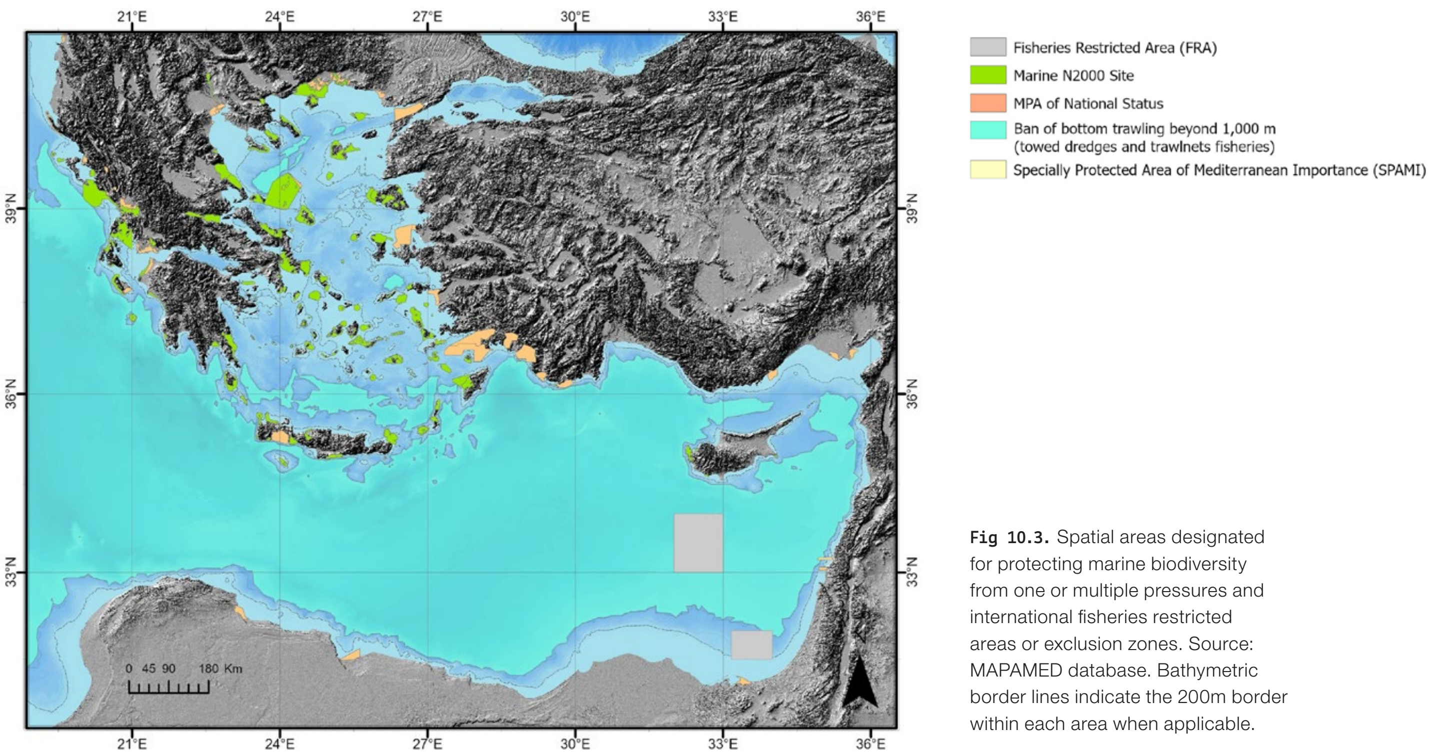


Fig 10.3. Spatial areas designated for protecting marine biodiversity from one or multiple pressures and international fisheries restricted areas or exclusion zones. Source: MAPAMED database. Bathymetric border lines indicate the 200m border within each area when applicable.

Achieving connected and ecologically representative conservation areas around the whole Mediterranean will clearly require balanced protection across ecosystems in each of the sub-basins.

As a result of the present exercise, different areas and locations can be indicated as suitable for further investigations of their ecological conditions, consultative process and the need for establishment of diverse legally and non-legally binding protection areas. They could reinforce the efforts to protect these fragile and unique ecosystems in synergy with other sectorial management measures.

Extending the CBD concept of the existing Ecologically or Biologically Significant Marine Areas (EBSAs), a number of potential biodiversity hotspots for key habitat forming fauna have been here pre-identified over the course of the present work (Fig. 10.4, see also Chapter 3 and 4). Some of these sites should be taken forward as sites requiring more recent investigation and potentially some form of protection, particularly specific areas such as in the SW of Kephallinia in the Ionian Sea, in the west and east Cretan straits (off Antikythira and off South Kasos), the Toroneos Gulf in the North Aegean, the Cyclades Plateau and the Volcanic Arc in the South Aegean, and at the Palmahim disturbance (off Israel). Historical records also showed several sites of interest in the Levantine sub-basin and off the southern coasts of Cyprus (Chapter 3).

In the North Aegean Sea, the flow of more nutrient rich Black Sea water towards the south west and the presence of geological features with low mounds (banks) and seamounts as well as the presence of other geomorphological features seem to be related to the presence of some corals and sponge grounds (Chapters 2, 3, 4). The volcanos in the Southern Aegean Sea provided a rich range of habitats in terms of hard substrate types, but also very soft sediments for a diverse benthic fauna in monospecific habitats. In the Eastern Ionian Sea, hydrological conditions associated with a variety of geomorphological formations such as seamounts, canyons or the continental shelf-break seem to be related to the higher biodiversity or abundance of benthic biodiversity in those sites (Fig. 10.5).

> “The occurrence of rocky substrates in seamounts compared to surrounding deep environments provides an environment for habitat building organisms such as corals and sponges as well as a rich associated biodiversity”

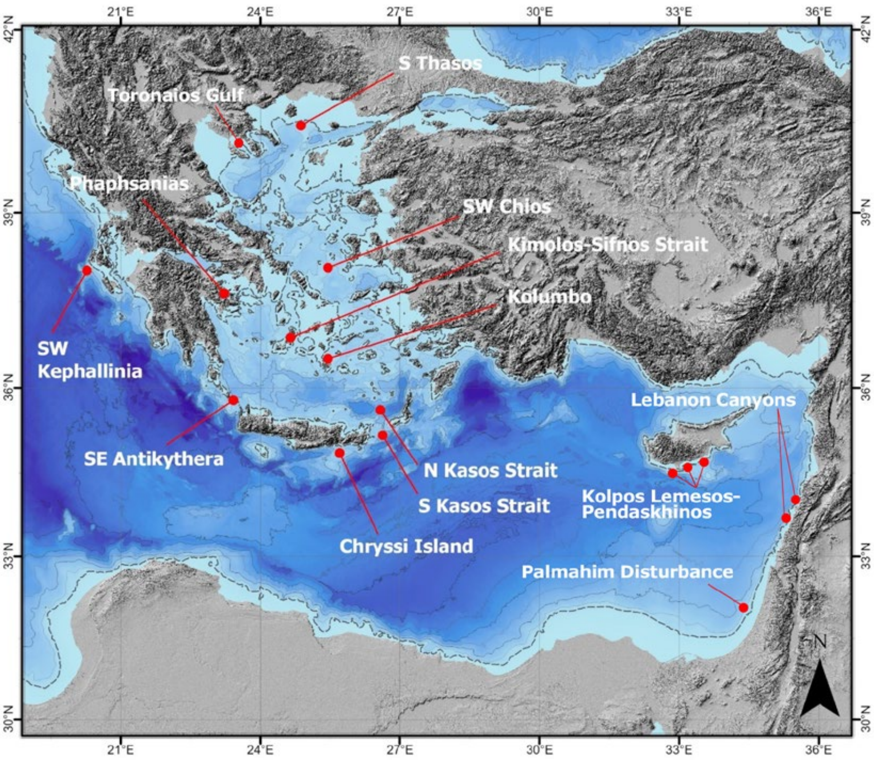


Fig. 10.4. Deep-sea hotspots of benthic biodiversity identified in this work (Chapter 3 and 4).

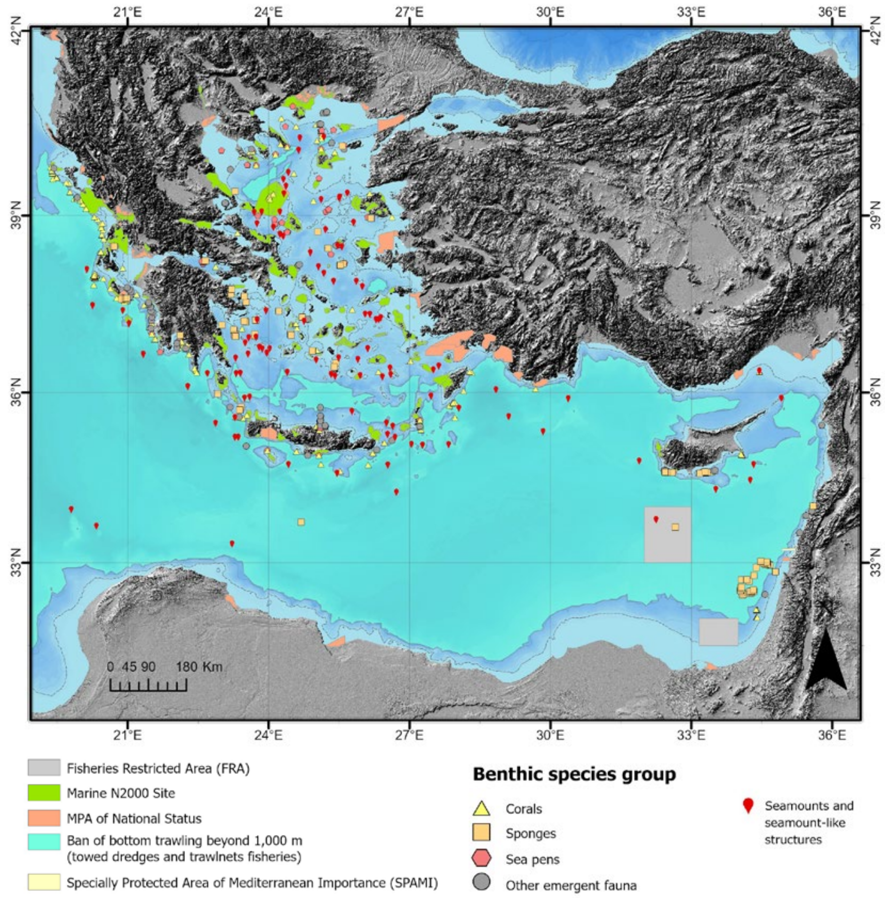


Fig 10.5. Overlapping areas of specific geomorphological features (e.g. seamounts and seamount-like structures, spatial protected areas and recorded presence of different benthic fauna (Chapter 3 & 4) with recorded presence of different benthic fauna. Similar links can be created with other geomorphological features like sea canyons.

The present results could be biased because of the sampling intensity in each area. Therefore updated information on the species and habitat distribution in these areas incorporating both detailed hydrological and biodiversity data will be required to formulate and monitor the management of the marine resources, including the establishment of MPAs or other spatial management measures.

Adding to this, efforts to mitigate the many threats posed to megafauna such as marine mammals and sharks require area-based management measures in the areas that are most important for their life processes, including feeding, reproduction, migration, and resting [13,14]. Identifying these important areas has started in the Mediterranean using a globally standardized methodology produced by IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force for marine mammals with Important Marine Mammals Areas (IMMAs) (Fig.10.6). Further recent efforts by the IUCN MMPA Task Force, IWC and ACCOBAMS are now aimed to evaluate and systematically identify areas of high risk for cetaceans [15]. The Hellenic Trench IMMA for Sperm whales and Cuvier's beaked whales is already considered potentially at risk from merchant shipping traffic [16]. A range of different management tools to keep vessels away from key areas, slow vessels speed and avoidance manoeuvres have been suggested for different situations [17]. Volunteer solutions to prevent ship strikes such as the one recently taken by the shipping and logistics MSC Group and EURONAV[4] with the re-routing of their container and cruise ships on the west coast of Greece in order to reduce the risk of collisions with sperm whales are a substantial contribution to the protection of these endangered cetaceans in the Eastern Mediterranean.

The ongoing review and identification of Critical Ceteceans Habitats (CCH) under ACCOBAMS and the dynamic identification of IMMAs considering any potential spatio-temporal shifts of cetacean populations from climate driven stressors and increasing human-derived pressures can enable the identification and establishment of a network of Marine Protected Areas (MPAs) or OECMs for cetaceans' protection in the Mediterranean.

Adopting a more integrated approach to limit multiple human pressures affecting not only cetaceans but also other endangered megafauna and key biodiversity ar-

4 "Recommended Routing Guidelines for Hellenic Trench, Greece", που δημοσιεύτηκε πρόσφατα στον ιστότοπο του διεθνούς προγράμματος Whale Guardians

POTENTIAL MEASURES TO REDUCE IMPACTS ON MARINE MAMMALS IN IMPORTANT MARINE MAMMAL AREAS (IMMAS)

- Permanent routing measures through TSS, ATBA or port approach routes
- Seasonal routing measures
- Voluntary recommended routes
- Short-term routing measurest
- Permanent speed restriction zones
- Seasonal or Dynamic speed restriction zones
- Real-time alerting tools to warn vessels of the presence of whales or aggregations that allow vessels to alter course or slow down
- Declare East Mediterranean Sea important areas for Cetaceans as "military sonars" free areas

eas (Fig 10.6) can further provide the critical elements for an integrated protected area network that ensure key ecological sites to be protected for multiple species, with some areas fully protected while others allowing the occurrence of some environmentally sustainable human activities. Numerous areas where critically endangered species have been observed, fall outside established MPAs, and overlapping knowledge of the characteristics of these areas or future prospective areas needs urgent attention for addressing existing and potential drivers and pressures that may directly or indirectly affect them (e.g. bycatch measures).

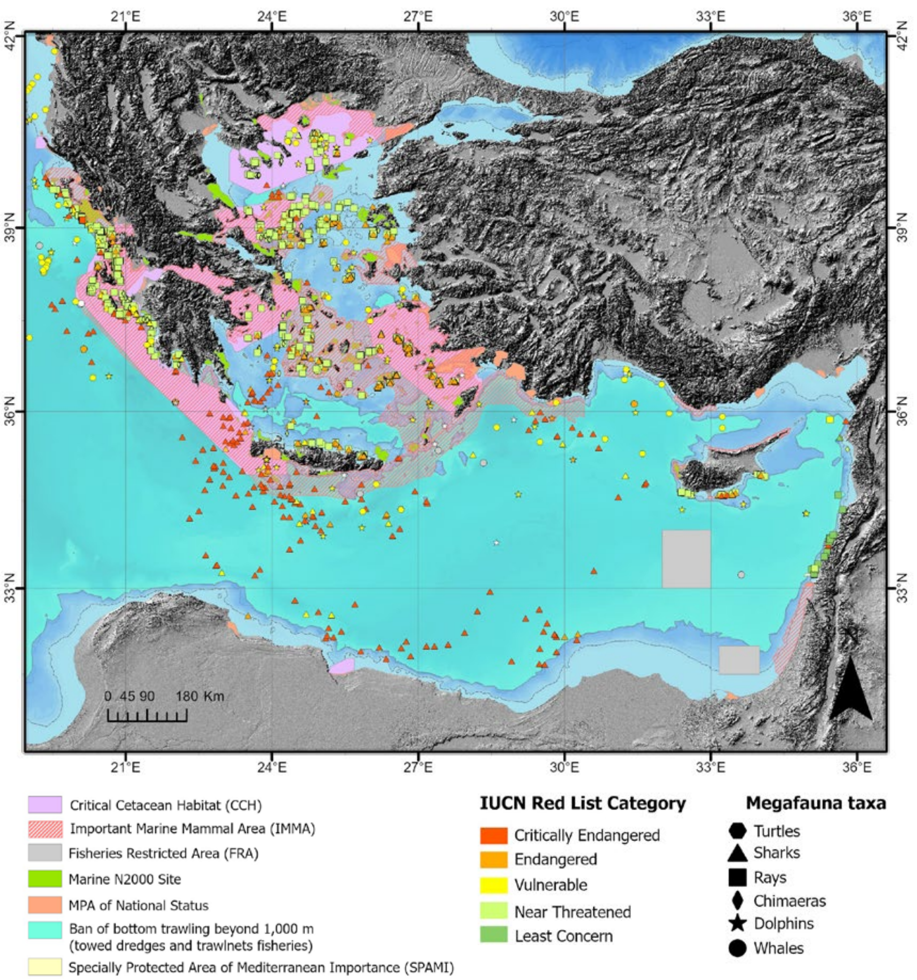


Fig. 10.6. Biodiversity Important Areas for cetaceans and permanent spatial management areas (excluding national fisheries restricted areas) in the Eastern Mediterranean with sightings of different megafauna taxa (2018, Chapter 6) and their IUCN Red list category.

In this work, it was attempted to compile the existing information on some of the most important deep-water fisheries resources in the Eastern Mediterranean to date and identify their potential Essential Fish Habitats (EFH) sites. In this analysis, five deep-water exploited species were chosen to be reviewed because of their economic importance; the two deep-water red shrimps, the giant red shrimp (*Aristaeomorpha foliacea*) and the blue red shrimp (*Aristeus antennatus*), the blackbelly rosefish (*Helicolenus dactylopterus*), the blackspot seabream (*Pagellus bogaraveo*) and the wreckfish (*Polyprion americanus*) (Chapter 7). Even though it was difficult with the available information (lack of time series data) to define the EFH boundaries for these commercial deep-sea species, initial efforts towards the definition of such areas (Table 10.1) has been made. The sites may be a result of the interaction of the ecosystem productivity, population dynamics and connectivity for some species, while for others the particular oceanographic features and/or the presence of hydrographic processes in combination with species life-cycle may drive the distribution in these sites. As with other available data, information coming from the Levantine Sea and Libyan Sea is very limited to draw inferences.

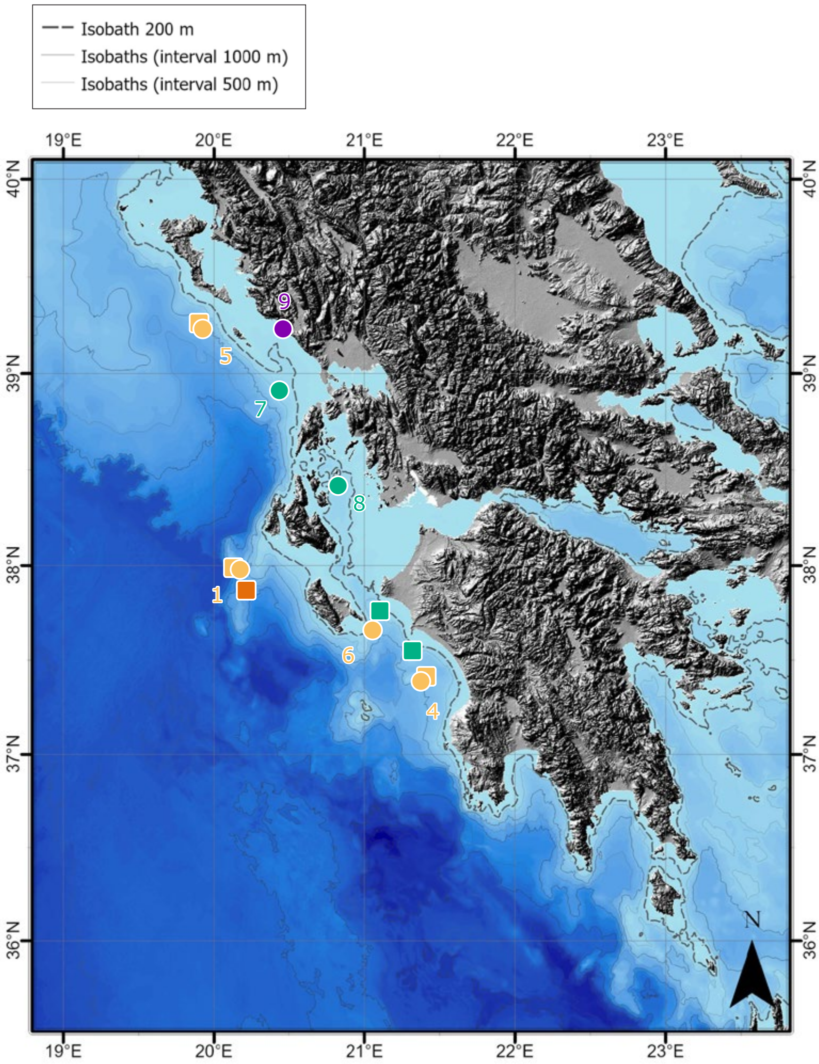
For demersal commercial species, submarine canyons and cold-water corals are observed to have a role as spawning grounds for species like the blackbelly rosefish or as recruitment areas for deep-water blue and red shrimp, a fact observed from the high abundance of juveniles in some of these geomorphological feature areas. Seamounts and seamount-like structures (e.g. banks) are reported as preferred habitats where species like adult wreckfish or blackspot seabream can occur in higher concentrations. Young individuals live on the up-per continental slope for the former species or as in the case of the blackspot seabream close to the coasts, in river deltas and closed gulfs, which are fishing grounds that are frequently exploited by both recreational and commercial fisheries, and where many times are taken indirectly as bycatch. The ecosystem-based management approach to fisheries at EFH sites including measures such as reducing fishing effort on these grounds, could provide important benefits to the sustainability of these resources while reducing juvenile mortality and therefore, the species vulnerability.

As observed in other Mediterranean areas (e.g. Pomo Pit, Santa Maria de Leuca and Bari Canyon), overlapping between Vulnerable Marine Ecosystems (VME) with some EFHs can occur. This further emphasises the important influence of structure-forming vulnerable marine benthos species for commercial species and how efforts to protect these deep-sea areas (e.g., by spatial closures to destructive fishing practises as foreseen by the Mediterranean Fisheries Regulation, and other pressures) will be key to conserve hotspots of biodiversity and ecosystem functioning in the Eastern Mediterranean deep-sea.

Wreckfish (*Polyprion americanus*) adults show a preference for habitats of seamounts and banks with cold-water coral colonies at depths between 300-800 m. Information of the species occurrence is based on a few reports and studies.

Table 10.1. List of species (common names) for which species-specific potential EFHs were indicated per sub-region.

Eastern Ionian		
Deep-water shrimps	Spawning grounds	For giant red shrimp, the Kyparissiakos (Gulf of Kyparissia), S of Kefallinia (Kefalonia) island Eastern Zakynthos, For blue and red shrimp, SW of Corfu Island, S-SW of Kefallinia (Kefalonia) island and SE of Zakynthos Island.
	Nursery grounds	For giant red shrimp, the Kyparissiakos (Gulf of Kyparissia) and SW of Corfu Island, West of Corfu Island, SW Kefallinia (Kefalonia) island, Eastern Zakynthos For blue and red shrimp, Kyparissiakos (Gulf of Kyparissia)
Blackbelly rosefish	Spawning grounds	Waters deeper than 450 m between the South-East of Zakynthos Island and the West Peloponnese and North of the Kyparissiakos (Gulf of Kyparissia)
	Nursery grounds	Between S Paxoi and NW Lefkas Islands, and off E. Ithaki Island
Wreckfish	Spawning grounds	Argostoli Ridge seamounts
Blackspot seabream	Nursery grounds	Acheron River Delta (western coast of Epirus)
North Aegean		
Blackberry rosefish	Spawning grounds	Open waters South of Chios Island
	Nursery grounds	Off West Lesvos Island
Wreckfish	Spawning grounds	Eastern coasts of Evia Island as well as Sporades islands and off the coasts of the Chalkidiki Peninsula
Blackspot seabream	Spawning grounds	Off W Limnos and off S. Sporades Islands Gökçeada Island waters, adjacent area of Saros Bay
	Nursery grounds	Deltas of the Axios Nestos and Evros Rivers and Toronaios Gulf in Chalkidiki peninsula
South Aegean		
Deep-water shrimps	Spawning grounds	For giant red shrimp, Northeast of Tilos Island, Argolikos (Argolic) Gulf For blue and red shrimp, SW of Symi island and in the Argolikos (Argolic) Gulf
	Nursery grounds	For giant red shrimp, Northeast of Tilos Island, Argolikos (Argolic) Gulf, NE of Crete Island and South of Kos and Southwest of the Symi Islands. For blue and red shrimp, NW Kalymnos Islands, NE of Crete Island and SW of Symi Island .
Blackbelly rosefish	Spawning grounds	West of Kythnos Island at 548 m and off SE Spetses Island
	Nursery grounds	North coasts of Crete Island and more specifically in the area between the Gulf of Heraklion and Dia Island; in the area E of Poros Island- Saronikos Gulf; in the Gulf of Mirabelou (off Ag. Nikolaos); in the area off E Serifos Island-Cyclades
Wreckfish	Spawning grounds	On the slope off Milos, Sifnos and Mykonos islands, during winter over depths of about 1,000 mm off North Crete
Blackspot seabream	Nursery grounds	Saronikos Gulf, Argolikos (Argolic) Gulf

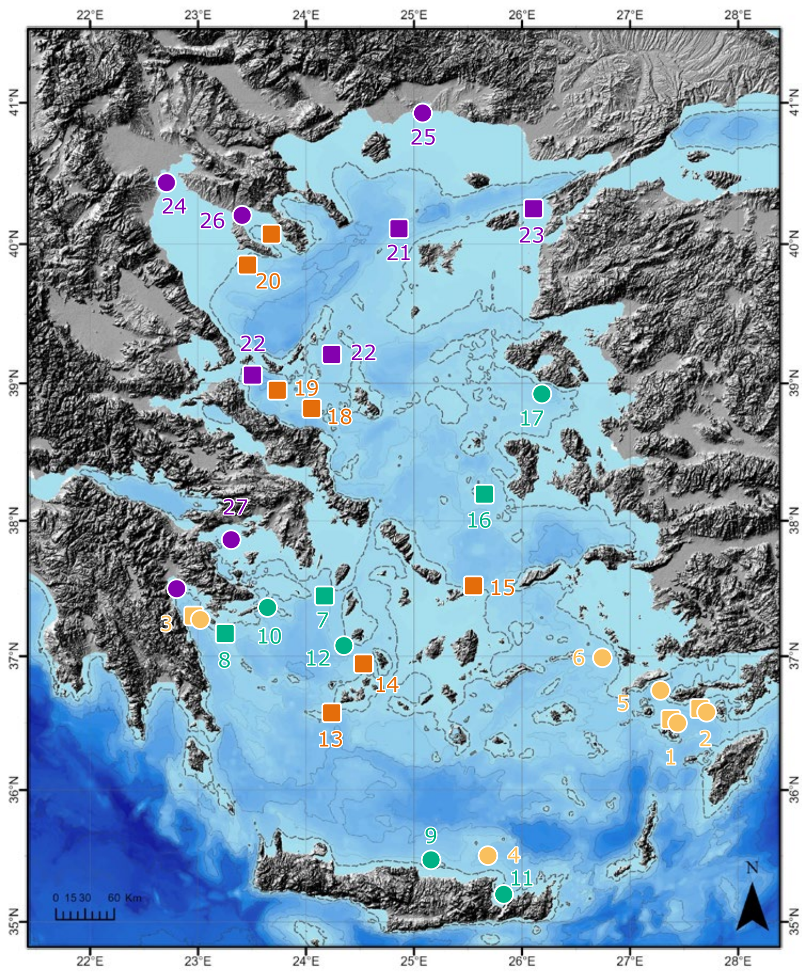


Potential Spawning Grounds
Potential Nursery grounds

Deep-water shimps
Wreckfish
Blackspot seabream
Blackbelly rosefish

1. SW of Kefallinia Island and Argostoli Ridge seamounts
4. N and S Kyparissiakos (Gulf of Kyparissia)
5. SW and W of Corfu Island
6. SE of Zakynthos Island.
7. Paxoi-Lefka islands
8. E Ithaki Island
9. Acheron River Delta

Fig. 10.7a. Species-specific potential EFHs in the Eastern Ionian Sea for the deep-water shrimps (*Aristaeomorpha foliacea*, *Aristeus antennatus*), blackbelly rosefish (*Helicolenus dactylopterus*), blackspot seabream (*Pagellus bogaraveo*) and the wreckfish (*Polyprion americanus*).



Potential Spawning Grounds
Potential Nursery grounds

Deep-water shimps
Wreckfish
Blackspot seabream
Blackbelly rosefish

1. NE Tilos Island
2. SW Symi island
3. Argolikos (Argolic) Gulf
4. NE Crete
5. SW Kos Island
6. NW Kalymnos Islands
7. W Kythnos Island
8. SE Spetses Island
9. N Crete Island (Heraklion-Dia Island)
10. E Poros Island
11. Gulf of Mirabello
12. E Serifos Island
13. Milos Island slope
14. Sifnos Island slope
15. Mikonos Island slope
16. S Chios Island
17. West Lesvos Island
18. E Evia Island
19. Sporades islands
20. Chalkidiki Peninsula
21. W Limnos (Lemnos)
22. S Sporades Islands
23. Gökçeada Island
24. Axios Nestos Delta
25. Evros Nestos Delta
26. Toronaios Gulf
27. Saronikos Gulf

Fig. 10.7b. Species-specific potential important EFHs in the North and South Aegean Sea for the deep-water shrimps (*Aristaeomorpha foliacea*, *Aristeus antennatus*), blackbelly rosefish (*Helicolenus dactylopterus*), blackspot seabream (*Pagellus bogaraveo*) and the wreckfish (*Polyprion americanus*).

> Recovery of deep-sea ecosystems requires a long time horizon and passive recovery may need as long as four decades or more [18,19]

The lack of quantitative information on juveniles and spawning grounds for deep-sea commercial species from the other Eastern Mediterranean regions, particularly the Levantine Sea, highlight the demand for more research, precautionary management measures and the close collaboration of the countries in this area.

Governance of the offshore Mediterranean environment is complicated by the presence of multi-level responsibilities, the international legally binding instrument on the conservation and sustainable use of marine biological diversity in Areas Beyond National Jurisdiction (ABNJ) under negotiation by UNCLOS umbrella as well as the lack of EEZ agreements between some countries. The construction or the use of the existing governance frameworks (e.g. under UfM, GFCM or Barcelona Convention) could facilitate coordination between multiple responsible authorities towards a shared common vision for the effective protection of the deep-sea marine environment, and the sustainable use of marine resources and space.

Despite the remoteness of the deep-sea, with new technologies and advance in modelling, there are opportunities to improve and advance the information data of this atlas. The process of knowledge building, implementation of a multi-sectoral portfolio of management measures rooted within the Ecosystem approach and Marine Spatial Planning approach with the use of precautionary principles should be the cornerstone for any management at the basin or sub-regional level for the Eastern Mediterranean maritime area. Undoubtedly, improved management measures should be put in place considering the need to target the full array of drivers of pressures that might affect different species and ecosystems. It should also document potential negative effects of the land- and sea-based pressures, reduce these threats and monitor the consequences of the existing and future management measures in the area in the long term.

We hope this publication has contributed on these efforts.

CHAPTER 10 /
REFERENCES

1. Herring, P. (2001). ***The Biology of the Deep Ocean.*** Oxford University Press. Oxford, United Kingdom.

2. IUCN. (2019). ***Thematic Report – Conservation Overview of Mediterranean Deep-Sea Biodiversity: A Strategic Assessment.*** IUCN Gland, Switzerland and Malaga, Spain. 122 pp.

3. FAO. (2020). ***The State of Mediterranean and Black Sea Fisheries.*** General Fisheries Comission for the Mediterranean. Rome, Italy.

4. IPBES (2019). ***Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.*** Díaz, S. et al. (eds.). IPBES Secretariat. Bonn, Germany. 56 pp.

5. Mytilineou Ch. et al. (2014). ***New cold water coral occurrences in the Eastern Ionian Sea: Results from experimental long line fishing.*** Deep-Sea Research II(99): 146-157

6. Dailianis, T. et al. (2018). ***Human activities and resultant pressures on key European marine habitats: an analysis of mapped resources*** Marine Policy, Vol. 98, 2018. pp: 1-10.

7. Gerovasileiou, V. et al. (2019). ***Habitat mapping in the European Seas - is it fit for purpose in the marine restoration agenda?*** Marine Policy, 106, 2019. p. 103521, doi: 10.1016/j.marpol.2019.103521

8. Danovaro, R. et al. (2020). ***Ecological variables for developing a global deep-ocean monitoring and conservation strategy.*** Nat. Ecol. Evol., 4, 2020. pp: 181-192

9. MedECC (2020). ***Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report*** Cramer, W., Guiot, J. and Marini, K. (eds.) Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France. 632 pp.

10. Maier C., Weinbauer, M. and Gattuso, J.P. (2019). ***Fate of Mediterranean Scleractinian Cold-Water Corals as a Result of Global Climate Change. A Synthesis.*** In: Orejas, C. and Jiménez, C. (2019) Mediterranean Cold-Water Corals: Past, Present and Future, 9. Springer. pp: 517-529, 2019. Coral Reefs of the World, ISBN: 978-3-319-91607-1

11. Tittensor, D.P. et al. (2010). ***Seamounts as refugia from ocean acidification for cold-water stony corals.*** Marine Ecology 31 (Suppl. 1). pp: 212–225.

12. MedPAN & SPA/RAC., (2021). ***MAPAMED- The database of Marine Protected Areas in the Mediterranean-User Manual.*** April, 2021. MedPan and SPA/RAC.

13. Agardy, T. et al. (2019). ***Looking beyond the horizon: An early warning system to keep marine mammal information relevant for conservation.*** Aquatic Conservation: Marine and Freshwater Ecosystems 29(S2): 71-83. doi: 10.1002/aqc.3072

14. IUCN. (2016). ***A Global Standard for the Identification of Key Biodiversity Areas.*** First Edition. Gland, Switzerland: IUCN.

15. IWC. (2019). ***A Joint IWC-IUCN-ACCOBAMS workshop to evaluate how the data and process used to identify Important Marine Mammal Areas (IMMAs) can assist the IWC to identify areas of high risk for ship strike.*** International Whaling Commission.

16. Frantzis, A. et al. (2019). ***Shipping routes through core habitat of endangered sperm whales along the Hellenic Trench, Greece: Can we reduce collision risks?*** PLoS ONE 14(2): e0212016. doi: 10.1371/journal.pone.0212016

17. Geijer, C.K. and Jones, P.J. (2015) ***A network approach to migratory whale conservation: are MPAs the way forward or do all roads lead to the IMO?*** Marine Policy, 51, 2015. pp: 1-12.

18. Da Ros, Z. et al. (2019). ***The deep sea: the new frontier for ecological restoration.*** Marine Policy, 108, 2019. pp:. 1039642, doi: 10.1016/j.marpol.2019.103642

19. Van Dover, C.L. et al. (2014). ***Ecological restoration in the deep sea: Desiderata.*** Marine Policy, 44, pp: 98-106.