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ACTION PLAN FOR THE CONSERVATION OF HABITATS AND SPECIES ASSOCIATED WITH SEAMOUNTS, UNDER WATER CAVES AND CANYONS, APHOTIC HARD BEDS AND CHEMO-SYNTHETIC PHENOMENA IN THE MEDITERRANEAN SEA

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ACTION PLAN FOR THE CONSERVATION OF HABITATS AND SPECIES ASSOCIATED WITH SEAMOUNTS, UNDERWATER CAVES AND CANYONS, APHOTIC HARD BEDS AND CHEMO-SYNTHETIC PHENOMENA INTHE MEDITERRANEAN SEA

Dark Habitats Action Plan

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1. FOREWORD

The Action Plan for the conservation of habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemosynthetic phenomena in the Mediterranean Sea follows a series of eight Action plans adopted by the Mediterranean countries within the framework of the Barcelona Convention, devoted to the conservation of species or groups of species. These Action plans are:

- Action Plan for the management of the monk seal
- Action Plan for the conservation of marine turtles
- Action Plan for the conservation of cetaceans
- Action Plan for the conservation of marine vegetation
- Action Plan for the conservation of bird species registered in Annex II of the SPA/BD Protocol
- Action Plan for the conservation of cartilaginous fishes (Chondrichtyans) in the Mediterranean Sea
- Action Plan concerning species introduction and invasive species
- Action Plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea

Dark Habitats are considered fragile and sensitive habitats requiring protection (Directive 92/43/EEC) They constitute veritable reservoirs of biodiversity that, therefore, must be protected and need further attention.

This draft Action plan was the result of a Meeting of the ad hoc group of Mediterranean experts, nominated in consultation with the Contracting Parties and relevant partner organizations (Marseilles - France, May 2013). It was reviewed and adopted by the Eleventh Meeting of Focal Points for SPAs (Rabat - Morocco, 2 – 5 July 2013).

The Action Plan was adopted in the Eighteenth Ordinary Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols (Istanbul - Turkey, 3-6 December 2013). The document of the Action Plan was first published in 2015 under the reference: UNEP-MAP-RAC/SPA, 2015. Action Plan for the conservation of habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena in the Mediterranean Sea. Dark Habitats Action Plan. Ed. RAC/SPA, Tunis: 17 pp.

This document is the draft update of the Action Plan for the conservation of habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena in the Mediterranean Sea as requested by the contracting Parties in their decision IG.24/07 (CoP 21- Naples -Italy, 2-5 December 2019).

2. PRESENTATION

Dark habitats are those where either no sunlight arrives or where the light that does arrive is insufficient for the development of plant or algal assemblages. These are known as the aphotic and the disphotic or twilight zones. They are distributed throughout the Mediterranean basin and include both shallow marine dark caves[1] and deep-sea habitats (usually at depths below 150-200 m, Figure 1). However, inventorying and monitoring initiatives focusing on marine caves should consider the cave habitat as a whole. Therefore, this document covers both semi-dark and dark caves. Diverse geomorphological structures such as underwater caves, canyons, slopes, isolated rocks, seamounts, abyssal plains and areas presenting chemosynthetic phenomena, can characterise the dark habitats and can support sensitive habitats and assemblages that are of unique scientific and conservation interest and require special protection.

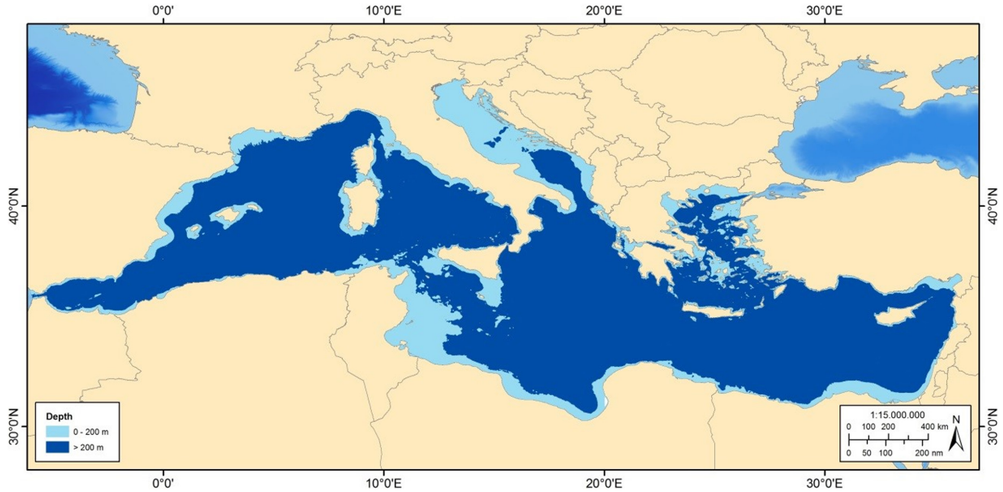

Figure 1

Deep-sea areas in the Mediterranean Sea below 200 m depth (from SPA/RAC-UN Environment/MAP & OCEANA, 2017; compiled by the authors based on data available from different sources)

[1] Semi-dark cave communities have been integrated into the Action Plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea (UNEP-MAP-RAC/SPA, 2008)

3. STATE OF KNOWLEDGE

3.1. Distribution

3.1.1. Marine caves

To date approximately 3,000 marine caves have been recorded in the Mediterranean Sea (see Figure 2) (Giakoumi ***et al.***, 2013; SPA/RAC-UNEP/MAP, 2020). Most of these caves are located in the North Mediterranean, which encompasses a higher percentage of rocky coasts and has been more extensively studied for this particular habitat. Specifically, the highest numbers of known caves are in the Eastern Adriatic, Aegean, Tyrrhenian, Provencal and Ionian coasts, where they are sometimes densely concentrated on islands and rocky peninsulas (SPA/RAC-UNEP/MAP, 2020). Mapping initiatives have taken place in Italy (Cicogna *et al.*, 2003), Corsica (CREOCEAN-DREAL, 2010), Croatia (Surić *et al.*, 2010) and Greece (Gerovasileiou *et al.*, 2015; Sini *et al.*, 2017). Expeditions in the framework of the research projects MedKeyHabitats, MedMPAnet and LIFE BaHAR for N2K provided information on the distribution of marine caves in Algeria (PNUE/PAM-CAR/ASP, 2016a), Lebanon (SPA/RAC-UN Environment/MAP, 2017), Montenegro (UNEPMAP-RAC/SPA, 2016a, b), Morocco (Espinosa ***et al.***, 2015; PNUE/PAM-CAR/ASP, 2016b), Malta and Gozo (Evans *et al.*, 2016; Borg *et al.*, 2017). The latter studies also extended the bathymetric distribution of the marine cave habitat to the deep sea (between 205 and 795 m). Numerous marine caves from the coasts of Turkey were also described in a recent publication (Öztürk, 2019). However, given the logistic difficulties in the inventorying of underwater caves, and especially the submerged ones, their number is assumed to be much higher than we know (SPA/RAC-UNEP/MAP & OCEANA, 2017). Mapping efforts are required in order to fill current distribution gaps in the Eastern and Southern Mediterranean regions, and in deeper waters.

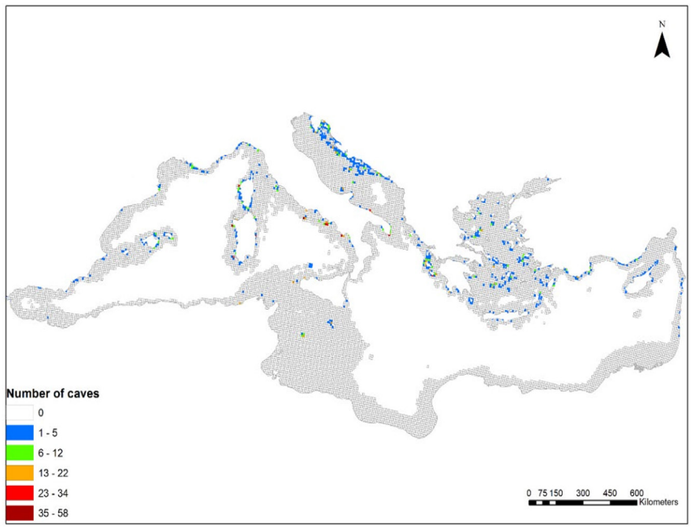

Figure 2

Distribution of marine caves in the Mediterranean Sea. Different colours indicate the number of caves recorded in cells of 10x10 km (from Giakoumi *et al.*, 2013)

3.1.2. Deep sea

Geomorphologic structures such as canyons (Figure 3), seamounts (Figure 4) and rocky aphotic escarpments may be localized by the acquisition and study of high-resolution geomorphologic seafloor data. Spatial information on deep-sea geomorphologic structures such as canyons have been compiled at the Mediterranean scale (Würtz, 2012) and have been updated (Harris & Macmillan-Lawler, 2015). The distribution of seamounts and seamount-like structures have also been mapped in the Mediterranean (Würtz & Rovere, 2015).

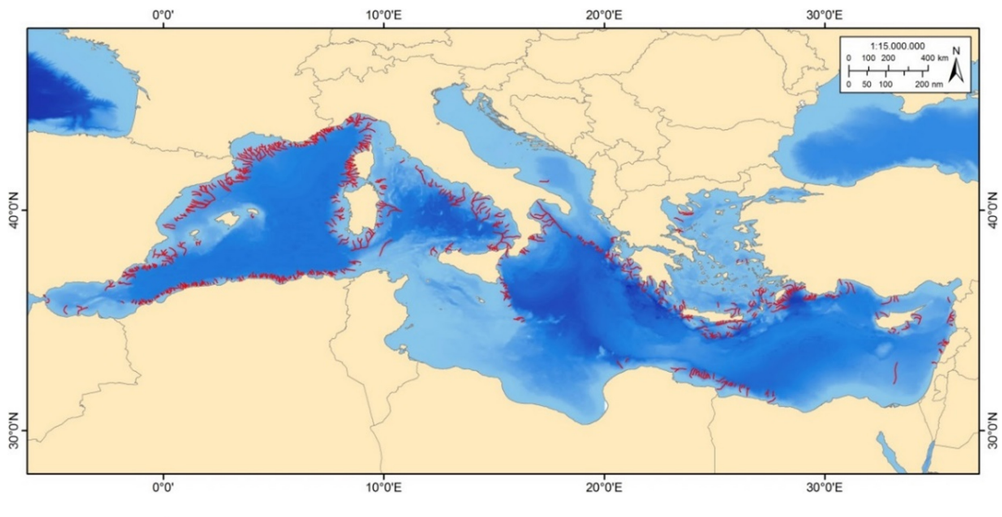

Figure 3

Distribution of Mediterranean submarine canyons (from SPA/RAC-UN Environment/MAP & OCEANA, 2017; compiled by the authors based on data available from different sources)

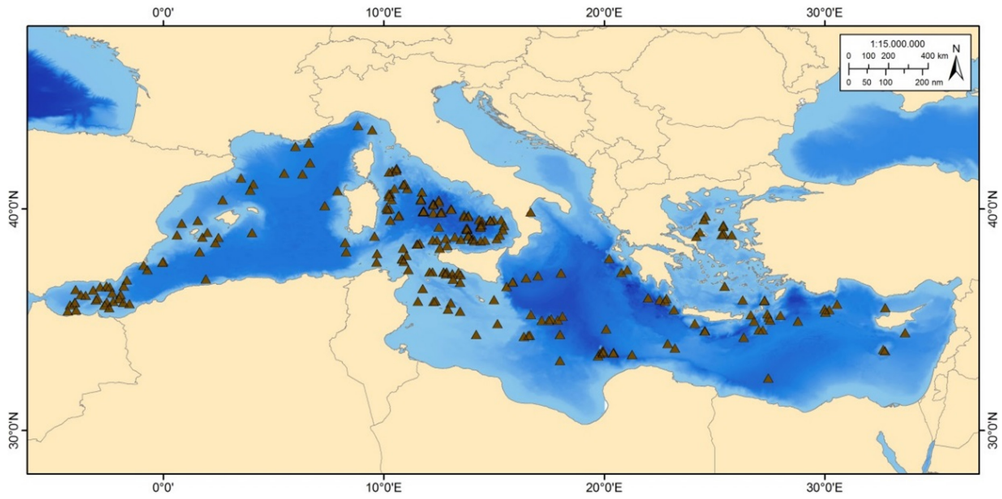

Figure 4

Distribution of Mediterranean seamounts (from SPA/RAC-UN Environment/MAP & OCEANA, 2017; compiled by the authors based on data available from different sources)

These structures offer heterogeneous habitats that enhance biodiversity and are considered as hotspots of biodiversity (Danovaro *et al.*, 2010; Würtz & Rovere, 2015). They may harbour slow growing, long-living species, constitutive of sponge aggregations, coral forests and Cold-Water Corals (CWCs) that are considered as Vulnerable Marine Ecosystems (VMEs), according to *The International Guidelines for the Management of Deep-sea* Fisheries in the High Seas (FAO, 2009). Areas with chemosynthetic phenomena (e.g. cold seeps, mud volcanoes, hydrothermal fields, pockmarks, brine pools) (Figure 5), represent rare and fragile morphological structures and shelter unique ecosystems and species (e.g. Angeletti *et al.*, 2015; Esposito *et al.*, 2015; Beccari *et al.*, 2020).

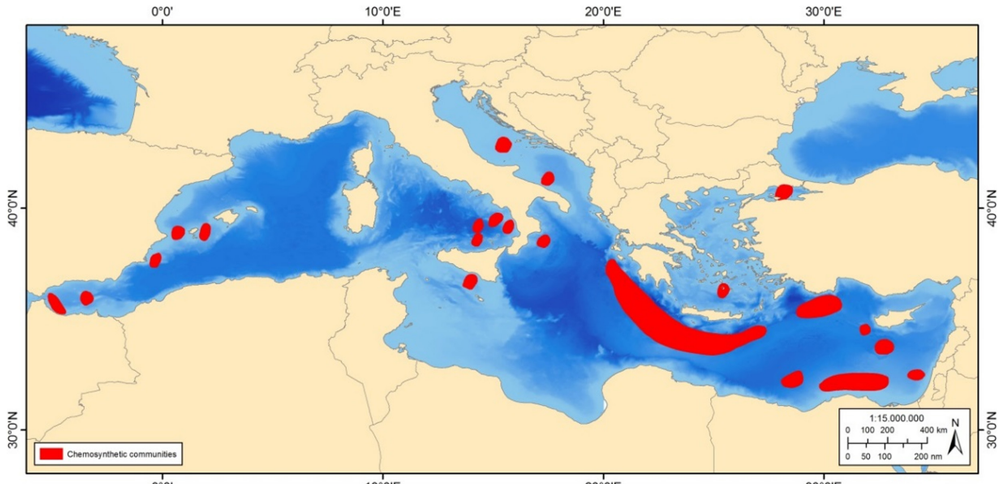

Figure 5

Identified areas with chemosynthetic assemblages (from SPA/RAC-UN Environment/MAP & OCEANA, 2017; compiled by the authors based on data available from different sources)

Recent exploration has uncovered unique deep-sea communities on the Israeli continental shelf at the "Palmahim Disturbance". Vast coral gardens are distributed along the margins of the Palmahim disturbance, CWC assemblages grow in the compact sediments around the coral gardens and cold seep communities thrive in the deeper western zones of the site (Basso *et al.*, 2020) Recently, brine seepage and brine pools were documented in the north-west part of the proposed FRA[3], with dense chemosynthetic tube-worm cover, and their vicinity appears to function as a reproduction hotspot for blackmouth catshark (*Galeus melastomus*), with numerous eggs laid on the benthos. These benthic habitats form important deep-sea ecosystems, which are extremely rare in the eastern Mediterranean.

The distribution of one of the most emblematic and fragile Mediterranean deep-sea assemblages, the CWCs, has been mapped at the Mediterranean scale (see Figure 6 from Chimienti *et al.*, 2019).

Figure 6

Distribution of the Cold-Water Corals (CWCs) in the Mediterranean (Chimienti *et al.*, 2019)

A recent book reviews the cold and deep coral habitats known to date in the Mediterranean Basin (see Orejas & Jiménez, 2019). The known distribution of the black coral *Leiopathes glaberrima* (Massi *et al.*, 2018) as well as the scleractinian *Dendrophyllia cornigera* (Castellan *et al.*, 2019) have also been published at the Mediterranean scale. These species are present in the Alboran, Ligurian and Tyrrhenian Sea, the Algero-Provençal Basin, the Sicily Channel, the Ionian Sea, the Southern Adriatic, the Aegean Sea and the North Levantine (near Rhodes Island).

The spatial distributions of some other deep-sea benthic species have been published but they are limited to an area or a country (e.g. distribution of the bamboo coral Isidella *elongata* in the Aegean Sea (Gerovasileiou *et al.*, 2019), 130 taxa from the French Mediterranean canyons and shelf brake (Fourt *et al.*, 2017)).

The inventory of Mediterranean canyons, seamounts and areas with chemosynthetic phenomena is still not complete (Harris & Macmillan-Lawler, 2015; Würtz & Rovere, 2015), the distribution knowledge of associated assemblages and ecosystems presents therefore even larger gaps. Only part of the Mediterranean deep-sea habitats has been explored mainly in the north-western sector. To be in capacity of building a coherent Mediterranean network of protected deep-sea marine habitats, efforts are still needed to acquire basic data on their spatial and bathymetric distribution in the Mediterranean Sea.

[2] See https://www.sciencedirect.com/science/article/abs/pii/S0967064519300244?via%3Dihub
[3] See http://mafish.org.il/wp-content/uploads/2021/05/FRA-Proposal-Palmahim-Disturbance-SPNI-revised-310521-.pdf

3.2. Composition

3.2.1. Marine caves

Marine caves are acknowledged “biodiversity reservoirs” and “refuge habitats” of great conservation value, as they harbour a rich biodiversity (32-71% of the Mediterranean sponge, anthozoan, bryozoan, tardigrade and brachiopod fauna) that includes several rare, exclusive, endangered, protected, as well as deep-sea species (Harmelin *et al.*, 1985; Gerovasileiou & Voultsiadou, 2012; Gerovasileiou *et al.*, 2015; Ouerghi *et al.*, 2019; SPA/RAC-UNEP/MAP, 2020). A total of 2,369 taxa has been reported from ca. 350 marine caves in 15 Mediterranean countries (Gerovasileiou & Voultsiadou, 2014; Gerovasileiou & Bianchi, 2021). Studies in Mediterranean marine caves are continuously bringing to light new species, several of which have not been yet reported from other habitats, and thus can be considered as cave-exclusive sensu lato (Gerovasileiou & Voultsiadou, 2012). However, the majority of species found in marine caves are cryptobiotic or crevicular and deep-water species which secondarily colonize caves, originating from external dim-light and dark environments (e.g. coralligenous beds, circalittoral bottoms and deep-water habitats) (Gerovasileiou & Bianchi, 2021). Therefore, marine dark caves have been characterized as “natural laboratories” or “deep-sea mesocosms” in the littoral zone because they provide direct human access to bathyal-like conditions (Harmelin & Vacelet, 1997).

3.2.2. Deep sea

Remotely Operated underwater Vehicles (ROVs) have enabled a better exploration and understanding especially of rocky substrates. Extensive areas can be covered by photographs and video-footages allowing researchers to describe habitats and mega-benthic species composing the assemblages. ROVs, but also landers and dropping cameras can reveal precious information on the habitus, coloration and behaviour of species (Bo *et al.*, 2020). Many explorations of deep-sea habitats, based on images and videos, allow qualitative/quantitative analysis of mega-benthic assemblages and description of the associated megafauna. Nevertheless, sampling is often necessary to assert species identifications and determine composition of small (not identifiable on images) species.

Recent publications have focused on the emblematic ecological role of CWC assemblages, describing their composition and function (Orejas & Jiménez, 2019). Other deep-sea anthozoan assemblages, described as gardens or forests because of their three-dimensional development, show a rich biodiversity (e.g. Bo *et al.*, 2015; Ingrassia *et al.*, 2016). In parallel, the composition of sponge aggregations has been studied in the western Mediterranean (see Maldonado *et al.*, 2015; Santín *et al.*, 2018).

Furthermore, ecosystem functioning and relations between deep-sea benthic and vagile species are more and more investigated. Publications suggest that fish are very abundant in CWC assemblages and canyons (D’Onghia *et al.*, 2015; Capezzuto *et al.*, 2018a, b). Besides, the nursery function of coral forests appears to be important as they are described as spawning areas for fish and sharks (see Cau *et al.*, 2017).

To better understand the sensitivity of CWC communities to climate change impacts, relations between bacteria and CWC are also being investigated (Meistertzheim *et al.*, 2016).

New species of the Mediterranean deep-sea are regularly described (e.g. Boury-Esnault *et al.*, 2015, 2017; López-González *et al.*, 2015; Fernandez-Leborans *et al.*, 2017; Bo *et al.*, 2020) but difficulty in collecting samples limits their identifications. Many species of the deep-sea assemblages are still to be discovered and their population dynamics and interrelations need more systematic and rigorous investigation.

4. MAIN THREATS

4.1. For marine caves

Considering marine caves as a whole (semi-dark and dark parts), they are fragile ecosystems with low resilience (Harmelin *et al.*, 1985; Rastorgueff *et al.*, 2015) that are vulnerable to seawater warming, unregulated visits by SCUBA divers and tourist boats (e.g. mechanical damages by unintentional contact, sediment resuspension and accumulation of exhaled air bubbles), red coral harvesting, spearfishing, urbanization and building of coastal structures, waste outflows, littering and non-indigenous species (Chevaldonné & Lejeusne, 2003; Parravicini *et al.*, 2010; Di Franco *et al.*, 2010; Guarnieri *et al.*, 2012; Giakoumi *et al.*, *et al.*, 2013; Rastorgueff *et al.*, 2015; Gerovasileiou *et al.*, 2016; Nepote *et al.*, 2017; SPA/RAC-UNEP/MAP, 2020).

Climate change effects (e.g. heat waves and temperature anomalies) and local disturbances caused by coastal interventions and constructions (e.g. extension of harbours and beach nourishments) have proved to generate structural and functional homogenization of marine cave communities, such as the decrease of structural complexity and parallel increase of turf and sediment (Nepote *et al.*, 2017; Montefalcone *et al.*, 2018; Sempere-Valverde *et al.*, 2019). Marine pollution and littering constitute additional threats especially in semi-submerged caves where litter often accumulate on internal beaches, drifted by wave action (Mačić *et al.*, 2018) or dark cave zones where the lack of water movement may also favour the entrapment of litter (Gerovasileiou & Bianchi, 2021).

An additional threat to Mediterranean marine cave communities involves the continuous spreading of non-indigenous species (NIS), especially in the south-eastern Mediterranean Sea (Gerovasileiou *et al.*, 2016; Öztürk, 2019). NIS are mainly observed at the entrance and semi-dark zones of shallow and semi-submerged caves and less frequently in dark zones. However, their impact on cave communities is unknown and should be urgently monitored, especially in marine caves of the Levantine and Aegean ecoregions.

4.2. For Mediterranean deep sea

4.2.1. Trawling

The most important threats perhaps for deep-sea habitats are the direct and indirect impacts of trawling activities. In canyons, soft bottom corals undergo direct destruction by trawling activities (Petović *et al.*, 2016; Lauria *et al.*, 2017; Pierdomenico *et al.*, 2018). *Isidella elongata*, the only Mediterranean Anthozoan considered as Critically Endangered (Otero *et al.*, 2017), is directly threatened by trawling impacts (Pierdomenico *et al.*, 2018). CWC assemblages represent a threat for bottom trawling and since the adoption of electronic maps and GPS navigation systems allowing trawlers to navigate precisely, these areas are generally avoided

although the present direct trawling impact by destruction of the vulnerable structures of the main builders, is not excluded. Until the mid-1990s, when the GPS systems were not available on trawling boats and scientific knowledge on the CWC areas was minimal, trawlers hit most CWC areas causing severe damage (Tunesi *et al.*, 2001).

Trawling also impacts indirectly canyon habitats and CWC assemblages by increasing water turbidity and sediment resuspension and deposit (Puig *et al.*, 2015; Paradis *et al.*, 2017; Arjona-Camas *et al.*, 2019; Lastras *et al.*, 2016; 2019). Thus, recent studies have shown that as well as displacing sediments, trawling affects the morphology of the seabed, as is known by high-resolution relief maps of seabed, causing damage comparable to that caused by ploughing farmland (Puig *et al.*, 2012). Also, discards of vulnerable by-caught species from deep-sea trawling are not negligible (Gorelli *et al.*, 2016).

In the Mediterranean Sea, the General Fisheries Commission for the Mediterranean (GFCM), led by the precautionary principal, banned bottom trawling activities in depths over 1000 m since 2005. However, CWC dwell also shallower than 1000 m depth, highlighting the ineffectiveness of this restriction for a large part of these vulnerable ecosystems. Therefore, the deep-sea habitats between 200 and 1000 m depth, especially along canyons, stay threatened and vulnerable to bottom trawling. To address this issue, in certain areas, GFCM has adopted Fisheries Restricted Areas (FRAs), ecosystem based spatial management measures that restrict fishing activities with a total closure to bottom trawling. FRAs ensure the protection of deep-sea sensitive habitats such as VMEs (it is the case of the *Lophelia* reef off Capo Santa Maria di Leuca in 2006; the Eratosthenes seamount in 2006; an area in the Nile delta with cold hydrocarbon seeps since 2006) and essential fish habitats (it is the case of the Eastern Gulf of Lion area in 2009; the three areas in the Strait of Sicily in 2016; and the Jabuka/Pomo Pit in the Adriatic in 2018).

4.2.2. Other fishing activities

Practically every recent publication based on mega-benthic deep-sea observations mentions visible anthropogenic impacts with a high number of derelict fishing gear either on CWC assemblages, or on other coral assemblages (Angiolillo & Canese 2018; Capezzuto *et al.*, 2018a; Chimienti *et al.*, 2019; Giusti *et al.*, 2019; Angiolillo & Fortibuoni, 2020). Presence and impact of lost fishing nets and longlines are especially noticeable on deep-sea habitats that are close to the coast because more accessible to artisanal and recreational fishing activities.

4.2.3. Industrial discharges and marine litter

Impacts of terrestrial human activities such as industrial discharges (Bouchoucha *et al.*, 2019; Fontanier *et al.*, 2020), dumping (Taviani *et al.*, 2019), marine litter (Pierdomenico *et al.*, 2019; Angiolillo & Fortibuoni, 2020) and transfer of pollutants to the deep-sea (Sanchez-Vidal *et al.*, 2015) represent important pressures on deep-sea habitats and species.

Because of their geomorphology and the oceanographic currents occurring around submarine canyons, these structures tend to funnel, collect and accumulate litter at the base or in depression. This is particularly true for canyons that are close to the coast. The Mediterranean holds the submarine canyons with the highest concentration of plastic in Europe (Aguilar *et al.*, 2020; Canals *et al.*, 2021). The other deep-sea geomorphological structures undergo the impact of marine litter as well (see Aguilar *et al.*, 2020).

4.2.4. Climate change

Although poorly known, climate change impacts cumulated to the previous threats, could drive important changes in Mediterranean deep-sea ecosystem structures (Sweetman *et al.*, 2017). The impacts of acidification combined to the increase of the sea temperature on reef building deep species such as scleractinian CWCs is not yet well known but the development of these species seems altered (see Maier *et al.*, 2012; Hennige *et al.*, 2014; Rodolfo-Metalpa *et al.*, 2015; Gómez *et al.*, 2018).

Benthic non-indigenous species (NIS) have rather rarely been reported in deep-sea habitats (Galil *et al.*, 2019) and for the moment they do not represent the most important threat. Nonetheless, the rise of sea temperature attributed to climate changes occurs also in deep-sea and could contribute significantly to expand the bathymetric distribution of actual shallow NIS (see e.g. Innocenti *et al.*, 2017).

4.2.5. Other threats that could develop in the future.

Offshore oil and gas developments (exploration, offshore infrastructures, drilling operations and transport by pipelines and/or tankers) represent a direct and increasing threat for deep-sea ecosystems, especially for benthic habitats (Cordes *et al.*, 2016). Discoveries of new hydrocarbon resources in the Mediterranean will probably lead to an increasing number of drilling licences as well as the development of pipelines crossing deep-sea benthic habitats and increasing tanker traffic in the Mediterranean.

Marine noise pollution (MNP) can be a side effects of such explorations and developments but can also originate from many other anthropogenic activities (e.g. maritime traffic, military activities). MNP have considerably increased since the second world war (Frisk, 2012) and can interfere with behaviour and vital processes of marine mammals (e.g. Erbe *et al.*, 2018) but also have various impacts on deep-sea fauna including invertebrates (see Di Franco *et al.*, 2020).

5. OBJECTIVES OF THE ACTION PLAN

The objectives of the Action Plan are to:

- develop and improve knowledge about dark habitats and their assemblages (e. g. distribution, species richness, composition, functioning, and ecology).
- conserve the habitats' integrity, functionality (favourable state of conservation) by maintaining the main ecosystem services (e .g. carbon sink, halieutic recruitment and production, biogeochemical cycles) and their interest in terms of biodiversity (e.g. specific diversity, genetics);
- encourage the natural restoration of degraded habitats (e. g. reduction of anthropogenic impacts).

6. ACTIONS REQUIRED TO ATTAIN THE OBJECTIVES OF THE ACTION PLAN

6.1. Improving inventories, location and characterisation

During recent decades, interest and concern for dark habitats has increased, and knowledge has been improved by newly available exploration technologies (see SPA/RAC-UN Environment/MAP & OCEANA, 2017). However, this knowledge is often scattered, even at national level, and spatially uneven throughout the Mediterranean. Efforts are made by the scientific community, international and national bodies to acquire information on the distribution and composition of marine caves and deep-sea benthic habitats. Still, the difficulty of access and the high cost of deep-sea scientific campaigns explain the large knowledge gaps on the distribution, biodiversity, ecosystem functioning, dynamics and ecological status of the various types of dark habitats and their assemblages. Yet, this information is vital for the implementation of an optimal management strategy on these ecosystems.

The following actions could help improve the lack of knowledge for all dark habitats:

- Aggregate the available knowledge, taking into account not only national and regional data (e.g. SPA/RAC, GFCM, IUCN, OCEANA, WCMC) but also scientific works. The information should be integrated within a geographical information system (GIS) and could be shared via online consultation.
- Identify geographical areas of interest presenting important knowledge gaps and enhance national capacities and international cooperation for investigation campaigns.
- Set up a database of people-resources in identified fields (i.e. caves, deep-sea populations), of institutes and bodies working in this field and of the available means of investigation.
- Quantify the actual or potential pressures (e. g. commercial and recreational fishing, leisure activities and diving, undersea prospecting). New knowledge must be acquired in areas of regional interest to promote a multidisciplinary approach and enhance international cooperation over these sites. Such joint action will permit the exchange of experience and the setting up of shared management strategies (building guidelines).
- Maintain regular theme-based workshops that bring together experts on dark habitats (biodiversity, methodology, monitoring, threats, conservation etc.).

6.2. Building-up management measures

Management procedures involve enacting laws aimed at regulating human activities likely to affect dark habitats and permit their long-term conservation.

6.2.1. Legislation

At national level, endangered and threatened species and populations of dark habitats should be identified in order to update corresponding national species lists. They can then be considered as protected species as defined in Article 11 of the Protocol on Specially Protected Areas and Biological Diversity (SPA/BD Protocol, 1995). Special consideration should be given to species of Vulnerable Marine Ecosystems (VMEs)[4]. The regulations on impact studies must be strengthened to make compulsory the assessment of impacts on species and assemblages of dark habitats. The regulations should pay particular attention in the event of coastal development, the prospecting and exploiting of natural resources and the discharge and dumping of materials at sea.

Insofar as regulatory procedures already exist at international level to restrict or ban certain human activities, further actions are required in order to have them applied and develop new propositions. This is particularly so for the setting up of Fisheries Restricted Areas (FRA) as adopted in the context of the mandate of the General Commission on Mediterranean Fisheries, including the ban on trawling, in the Mediterranean, at depths of over 1,000 meters down (FAO-GFCM, 2006; GFCM, 2019). The Mediterranean states are invited to use and enhance, all means already available to ensure better conservation of dark habitats.

6.2.2. Setting Marine Protected Areas

Numerous Mediterranean MPAs encompass marine caves and in several cases, coastal areas with marine caves have been suggested for protection. Nevertheless, their number in MPAs remains unknown and - despite the establishment of new MPAs, EU environmental legislation and the Dark Habitats Action Plan - in most cases there is a lack of specific regulations or management plans for their protection, monitoring and restoration. Further specific regulations are needed for dark habitats within MPAs, especially marine caves.

Mediterranean deep-sea habitats are still poorly represented in MPAs partly due to the fact that these habitats are often distant from the coast and difficult to access, therefore their effective protection represents a real challenge. Adding to the difficulty of access, is the fact that deep-sea habitats are often areas beyond national jurisdiction (ABNJ).

Designation of Marine Protected Areas intended to permit more efficient conservation of these assemblages must be based on the identification of sites on the basis of the criteria such as uniqueness or rarity, particular importance for species biological stages, importance for threatened, endangered or declining habitats or species, vulnerability and reduced recuperative capacity after disturbance, biological productivity, biodiversity and naturalness as adopted in 2009 by the Contracting Parties (UNEP-MAP-RAC/SPA, 2009). At the Mediterranean level, the selection of sites to be protected must also be based on the ecosystem approach and take in consideration the patchy distribution of these habitats, as the only way to ensure a coherent and efficient network of MPAs for a sustainable management of the various types of dark habitats.

[4] See report of GFCM Working Group on Vulnerable Marine Ecosystems (WGVME), Malaga, Spain, 3-5 April 2017

6.2.3. Other management measures

Measures should be identified to reduce the pressures that hang over assemblages of dark habitats and to implement them. In the light of the precautionary principle, particular attention should be paid to the impacts that could arise as a result of the seawater temperature rise, acidification and/or fertilization of the oceans and the setting up of new emergent fisheries (border areas).

MPAs which host dark habitats (e.g. dark marine caves) should update their management plans to include measures adapted to their conservation.

Procedures aimed at assessing the efficiency of these measures, as a whole, should be defined in consultation with the organisations concerned by the management of these assemblages (e.g. international conventions, GFCM, IUCN, NGOs) to promote sustainable, adaptable and concerted management.

In sites that have not yet been studied, a state of reference ('zero state') is a necessary precondition for setting up a monitoring system for these assemblages. For the sites for which data already exists, monitoring procedures should be started.

6.3. Strengthening national plans

To give greater efficiency to the measures for setting up the present Action Plan, the Mediterranean countries are invited to build-up national plans for the protection of dark habitats. Each national plan should propose appropriate legislative measures, particularly as regards impact studies for coastal development and check the activities that can affect these assemblages.

The national plan should be elaborated on the basis of the available scientific data and should include programmes for:

- gathering and continuous updating of data,
- training and updating of specialists,
- education and awareness for the public, actors and decision makers, and
- conservation of dark habitats and their assemblages that are significant for the marine environment in the Mediterranean Sea.

These national plans must be brought to the attention of all the concerned actors and as far as possible ensure coordination with other permanent national plans (e.g. emergency plan against accidental pollution).

6.4. Establishing monitoring plans

Recent technological advances have enhanced the possibilities of studying and monitoring deep-sea habitats by acoustic, visual or sampling methods. These methods must be combined to obtain the most cost-efficient monitoring of deep-sea habitats to reach the most accurate state of conservation. Plans for monitoring dark habitats and associated assemblages should be communicated at a Mediterranean scale to encourage transboundary exchanges, regional coherence, sharing effort and means of investigations (see Deep-sea exploration in France, Monaco and Italy in the framework of the international agreement Ramoge - Daniel *et al.*, 2019).

The Guidelines for inventorying and monitoring of Dark Habitats in the Mediterranean Sea (SPA/RA-CUN Environment/MAP & OCEANA, 2017) details the methodologies and the IMAP common indicators selected for monitoring dark habitats. Monitoring of dark habitats should be based on these guidelines. Nevertheless, the absence of long time series depicting the past ecological status of dark habitats (e.g. marine caves) is a major impediment to the monitoring and evaluation of impacts and changes in their ecological status.

6.5. Enhancing transboundary exchanges

In the light of the geographical distribution of many types of dark habitats in areas beyond national jurisdiction (ABNJ), and the difficulties of reaching them (bathymetric range, lack of knowledge, scientific means required and cost of study), it is important to:

- encourage the establishment of international cooperation to create synergies between the various actors (decision makers, scientists, socio-professionals) and set up shared management.
- organise training courses and encourage the exchange of cross-border experience so as to enhance national capacities in the field.

6.6. Developing public awareness and information

Information and awareness programmes to make dark habitats, their vulnerability and the interest in conservation better known should be crafted and continued for decision-makers, but also users such as SCUBA divers, fishers and mine operators. Communication on these habitats should also be encouraged for the wider public. The participation of NGOs in these programmes should be encouraged

7. REGIONAL COORDINATION AND IMPLEMENTATION

Regional coordination of the implementation of the present Action Plan will be handled by the Secretariat of the Mediterranean Action Plan (MAP) via the Regional Activity Centre for Specially Protected Areas. The coordinating structure's main functions are:

i) gathering, summarizing and circulating knowledge at Mediterranean level and permitting this to be integrated within the available instruments (e.g. Standard Data-Entry Form - SDF);

ii) setting up and updating databases on people/resources, laboratories involved, and investigation means available;

iii) helping states identify and assess the pressures on the various types of dark habitats and their assemblages at national and regional level;

iv) promoting studies on dark habitats and making inventories of species in order to better figure out the way they function and better assess the ecosystem services they provide;

v) promote cross-border cooperation;

vi) back the setting up of monitoring networks for dark habitats;

vii) organise meetings of experts and training courses on dark habitats and their

biodiversity;

viii) prepare reports on how implementation of the Action Plan is progressing, for submission to the Meeting of National Focal Points for SPAs and meetings of the Contracting Parties;

ix) establish a work programme for implementing the Action Plan over a five-year period, which will be submitted to the Contracting Parties for adoption.

At the end of this period, if necessary, after assessment and updating, it can be repeated. Implementing the present Action Plan is the responsibility of the national authorities of the Contracting Parties. At each of their meetings, the National Focal Points for SPAs shall assess how far the Action Plan is being implemented on the basis of national reports on the subject and a report made by RAC/SPA on implementation at regional level.

In the light of this assessment, the Meeting of National Focal Points for SPAs will suggest recommendations to be submitted to the Contracting Parties. If necessary, the Meeting of Focal Points will also suggest adjustments to the schedule that appears in the Appendix to the Action Plan.

8. PARTICIPATION IN THE IMPLEMENTATION

Supplementary work done by other international and/or non-governmental organisations, aiming at the same objectives, should be encouraged, encouraging their coordination and avoiding duplication of effort. At their ordinary meetings, the Contracting Parties could, at the suggestion of the Meeting of National Focal Points for SPAs, in order to encourage and reward implementation of the Action Plan, grant the title of 'Action Plan Partner' to any structure that may so request.

This label will be granted on the evidence of proven involvement in the implementing of the present Action Plan attested by concrete actions (e.g. conservation, management, research, awareness etc.).

The label can be extended at the same time as the multi- annual work programme on the grounds of an assessment of actions carried out during that period.

Actions	Time	Who
Making a summary of knowledge of dark habitats and their distribution around the Mediterranean in the form of a geo-referenced information system	As soon as possible and continuously	SPA/RAC & Contracting Parties
Setting up a database of people/resources and means of investigation available	As soon as possible and continuously	SPA/RAC
Identify and assess proven pressures on each of the various types of dark habitats	Year 1 and 2	SPA/RAC, Partners and Contracting Parties
Gathering data and information on research activities	Continuously	SPA/RAC & Contracting Parties
Revise the reference list of types of marine habitats for the selection of sites for inclusion in the national inventories of natural sites of conservation interest, in order to take into account dark habitats	Year 1 and 2	Contracting Parties
Revise the list of endangered or threatened species in order to take account of species and assemblages of dark habitats	Year 1 and 2	SPA/RAC & Contracting Parties
Promote the identifying of areas of interest for the conservation of dark habitats in the Mediterranean and carry out concerted actions in national and/or cross-border sites	Year 1 and 2	SPA/RAC & Contracting Parties
Implement and/or extend MPAs to include already identified sites of interest that host dark habitats at a national level and in areas beyond national jurisdiction (ABNJ)	As soon as possible and continuously	SPA/RAC & Contracting Parties
Introduce national legislation to reduce negative impacts on dark habitats and associated assemblages (including impact studies procedures)	On adoption	Contracting Parties
Regularly hold theme-based workshops (in coordination with those of the'Coralligenous' AP)	Every three years	SPA/RAC
Update guidelines suited to the inventorying and monitoring of dark habitats and associated assemblages	Every three years	SPA/RAC and Partners
Implement monitoring systems	As soon as possible	SPA/RAC & Contracting Parties
Develop detailed guidelines for effective management measures of dark habitats	Year 1 and 2	SPA/RAC, Partners and Contracting Parties
Enhance cooperation actions with concerned organisations and in particular with GFCM	Continuously	SPA/RAC
Step up awareness and information about dark habitats and associated assemblages with the various actors	Continuously	SPA/RAC, Partners and Contracting Parties
Enhance national capacities and improve skills in taxonomy and monitoring methods	As needed	SPA/RAC

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SPA/RAC WORKING AREAS

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

POST-2020 SAPBIO

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

SPAMI

Specially Protected Areas of **Mediterranean Importance**

Marine turtles

Cetaceans

Specially Protected Areas

Monitoring

Mediterranean Monk Seal

Cartilaginous fishes
(Chondrichtyans)

Coralligenous and other calcareous bio-concretions

Marine vegetation

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

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

Species introduction and invasive species

UN environment programme
Mediterranean Action Plan
Barcelona Convention
SPA/RAC
The Mediterranean Biodiversity Centre

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