The World Summit on Sustainable Development (Johannesburg, 2002) highlighted the need to promote the conservation of oceans, and the maintenance of the productivity and biodiversity of important and vulnerable marine areas, including those *beyond national jurisdiction*. Two years later, the Convention on Biological Diversity (Kuala Lumpur, 2004) called upon the utilization of the precautionary approach and ecosystem approaches when addressing the conservation of biological diversity beyond national jurisdiction, and proposed a general two-level approach for conservation in which: *"the marine and coastal protected areas network would be sitting within a framework of sustainable-management practices over the wider marine and coastal environment"*. This implies combining a site-based approach (networks of protected areas) with general restrictions that would apply to the entire area *("e.g. measures to eliminate/avoid destructive practices, consistent with international law, on scientific basis, including the application of precaution, for example, consideration on a case by case basis, of interim prohibition of destructive practices" CBD Decision VII/5-60.)*

In the Mediterranean, unique habitats of special ecological significance are found in deep-waters, such as cold-seeps, seamounts, coral reefs and brine pools. Other interesting areas deserving a particular management regime, for their ecological importance, are submarine canyons and the bathyal domain below 1000m depth. Immediate threats to these habitats are fishing (especially trawling), waste disposal and chemical pollution. In this context, WWF and IUCN adhere to the implementation of the conservation approach proposed by the CBD in the Mediterranean deep-sea, in a manner tailored to the particular features of this sea.

Why 1000 metres?

Although the 1000m isobath constitutes a somewhat arbitrary limit, scientific studies point to the non-existence of fish populations of commercial value below this depth. Interesting biological communities do still prosper at greater depths, but are extremely vulnerable to human intrusion. There are also important concentrations of juvenile shrimps, whose protection affects the sustainability of fisheries at lesser depths. Sea beds below 1000m have not yet been explored by Mediterranean fleets, and scientific evidence suggests that to maintain sustainable fishing activity, this situation should remain as such.

IUCN
The World Conservation Union

IUCN is a unique Union. Its members come from some 140 countries, including 77 States, 114 government agencies, and 800-plus NGOs. More than 10,000 internationally-recognized scientists, and experts from more than 180 countries, volunteer their services to its six global commissions. Its 1000 staff members in offices around the world are working on some 500 projects.

IUCN -The World Conservation Union's mission is *"to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable"*. The Centre for Mediterranean Cooperation was opened in 2001. Core support to its activities is provided by the *Junta de Andalucia,* and the *Ministerio de Medio Ambiente,* Spain.

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WWF

WWF is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in over 96 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity,
- ensuring that the use of renewable natural resources is sustainable,
- promoting the reduction of pollution and wasteful consumption.

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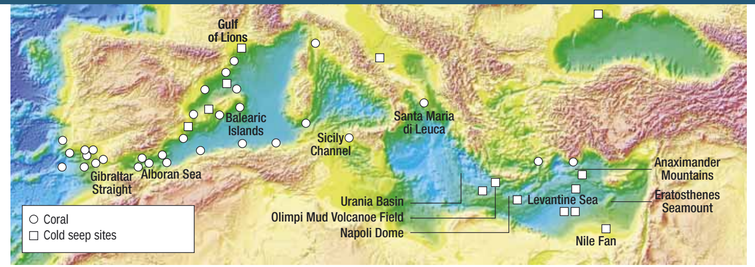

Presently known distribution of deep-sea unique biocenoses in the Mediterranean and adjacent Atlantic waters.
Crédits: *An Interactive Global Map of Sea Floor Topography Based on Satellite Altimetry & Ship Depth Soundings.* Modified. M. Miller, W.H.F. Smith, J. Kuhn, & D. T. Sandwell. NOAA Laboratory for Satellite Altimetry. http://ibis.grdl.noaa.gov/cgi-bin/bathy/bathD.pl. And Hermes project (Hotspot Ecosystem Research on the Margins of European Seas).

It is important to point out that limiting the maximum depth susceptible to be exploited by the fishery to the isobaths of 1000m in the Mediterranean would be a precautionary measure supported by sound scientific evidences, in the line recommended by Decision VII/5 adopted by CBD COP-7. Furthermore, the proposed deep-sea fishing limitation is to be considered as a restriction on potential fishing development possibilities since no regular fisheries are taking place at those depths at present. In this sense, it is important that stakeholders fully understand the rationale supporting this measure – that clearly benefits the sustainability of the fishing activity – and support the proposal as well.

Paromola cuvieri.
© M. Würtz-Artescienza, 1977.

Specifically, and considering the particular features of deep Mediterranean ecosystems, WWF and IUCN present a conservation proposal based on a comprehensive analysis of the scientific evidence available. This analysis included a wide-reaching consultation with the relevant regional specialists. The proposal, presented in detailed form in the document *"The Mediterranean deep-sea ecosystems: an overview of their diversity, structure, functioning an anthropogenic impacts, with a proposal for conservation"* is structured on two levels:

i) a general approach based on preventing an extension of fishing practices beyond 1000 m. depth as a precautionary measure, by seeking the agreement of stakeholders and implementing the CBD recommendations and

ii) a site-based approach aiming at the creation of a network of Marine Protected Areas encompassing unique habitats, such as submarine canyons, cold-seeps, brine pools, deep-water coral reefs and seamounts.

Though some directions about possible sites based on the available information are provided in the extended WWF & IUCN document, new research is continuously identifying previously unknown sites or novel habitats that would also deserve to be considered in the proposed network of deep-sea protected areas.

The two levels are complementary and should be developed in parallel, using the appropriate legal instruments for each case. These include, amongst others, the General Fisheries Commission for the Mediterranean and the Barcelona Convention, as well as coastal states' national legislative frameworks, including the new regulation on fisheries management in the Mediterranean currently under discussion by the European Union.

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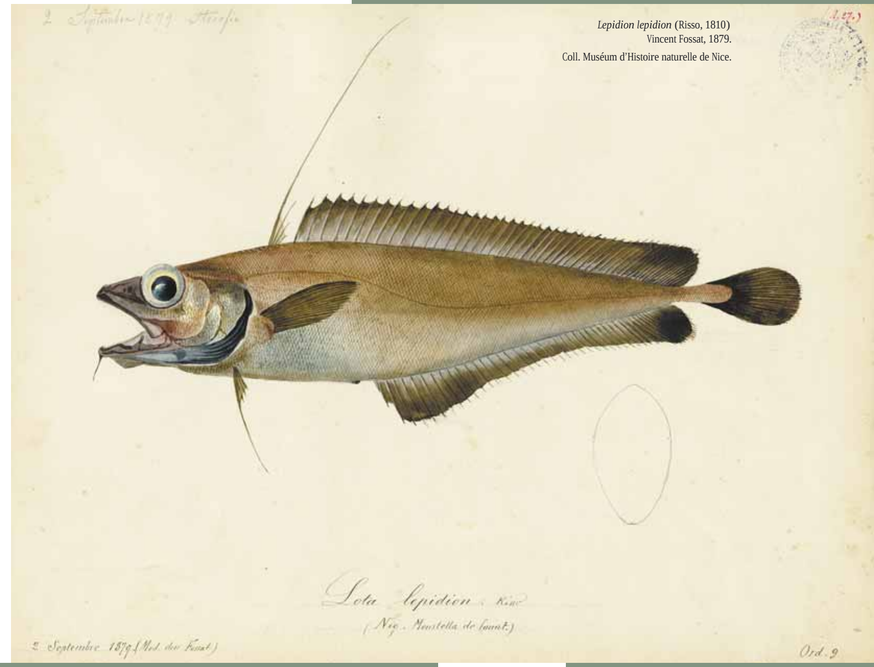
Aristeus antennatus
Albert Ier Prince de Monaco. *Camp. scient. Pénéidés pl. III.* 1908.
EL. Bouvier del, M. Borrel pinx.
Coll. Musée océanographique, Monaco.

The Mediterranean deep-sea:

highly valuable ecosystems in need of protection



Lepidion lepidion (Risso, 1810)
Vincent Fossat, 1879.
Coll. Muséum d'Histoire naturelle de Nice.

MINISTERIO DE MEDIO AMBIENTE

Core support to the activities of the IUCN Mediterranean office is provided by the *Junta de Andalucia,* and the *Ministerio de Medio Ambiente,* Spain.

JUNTA DE ANDALUCIA
CONSEJERÍA DE MEDIO AMBIENTE

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The views expressed in this publication do not necessarily reflect those of IUCN.

WWF
IUCN
The World Conservation Union

The Mediterranean Sea is a semi-enclosed basin with particular environmental characteristics, such as relatively warm deep water (around 13 ºC below 200m depth), high salinity and high oxygen content. It is composed of two basins: the oriental and the occidental, separated by the shallow Sicilia strait. Maximum depths are about 3000m to the West and 5000m to the East. The adjacent seas, as the Adriatic, are shallow. The shallow Gibraltar sill (300m.) restricts to a certain extent the exchange of deep-water fauna from the Mediterranean Sea to the Atlantic Ocean. Biological productivity (surface primary production) is especially low in the Mediterranean, resulting in low nutrient input to the deep water **[1].** Furthermore, the paleoecological history of the Mediterranean Sea involved the almost complete drying-up of the basin around 5 millions years ago. All these factors have produced deep-water assemblages that are unique to the Mediterranean (26.6% of the whole Mediterranean marine fauna are endemic) and, along with other deep water ecosystems in the world, extremely sensitive to human impact.

This general ecological setting shows, however, geographical variations at both local and large scales: there are imporant environmental differences between the western and the eastern Mediterranean, separated by the shallow Sicilian Channel. Additionally, local factors such as the presence of river runoff, submarine canyons or upwelling result in enhanced food availability at given locations (Gulf of Lions, Ebro delta, Alboran sea or the Nile delta), hotspots of biological production.

The faunal assemblages in the Mediterranean are impoverished compared to the Atlantic, with lower overall abundance and species richness, but possess high rates of endemism, especially in some faunistic groups (e.g., amphipods). Interesting faunal assemblages with high rates of endemism have been discovered in seamounts, brine pools and cold seeps, across all taxa, from Bacteria and Archaea to Metazoan groups.

In general, and for all taxa, a decrease in abundance and species richness is observed with increasing depth, and in a longitudinal gradient from west to east (about one order of magnitude). However, local geomorphological features (submarine canyons, coral reefs, mud volcanoes, trenches) are associated with increased biomass and species richness, including higher diversity and number of endemisms. These habitats are biodiversity hotspots and very fragile environments.

Deep Mediterranean soft-bottom communities' characteristics show that there is a general gradation of megafaunal assemblages (fish, large crustaceans, etc.) with depth on the continental slope. The upper slope zone is a transitional zone from the continental shelf assemblages to the typically deep sea assemblages, from ca. 200 to 500m depth. Here the biomass of fishes decreases with depth, and crustacean decapods are a dominant faunistic group. The middle slope zone (500-1200m) is characterized by low biomass of fishes and decapod crustaceans, with the important exception of high density of the commercial red shrimp species. Mediterranean deep-water fauna comprises a large amount of eurybathic species (which can live at various depths) because of the thermal stability of deep-water masses. Below 1000m depth, however, the faunal assemblages are composed of typically deep-sea species. In between 1200 and 1500m, in the lower slope zone, a secondary peak of biomass appears for typical, commercially valueless deep-sea fish species, especially in the western Mediterranean (dominated by *Alepocephalus rostratus*), as well as for red shrimp *Aristeus antennatus* (mostly juveniles). Below 1500m, the abundance and species richness of all faunistic groups decreases exponentially with depth, down to the abyssal plains.

Aristeus antennatus
Albert Ier Prince de Monaco. *Camp. scient. Pénéidés pl. III.* 1908.
EL. Bouvier del, M. Borrel pinx. Coll. Musée océanographique, Monaco.

Bathymedon longirostris, Eusirus longipes, Lepechinella manco, Rachotropis grimaldii.
© J. E. Cartes

Submarine canyons

Even in the apparently homogeneous habitat of soft (muddy) bottom communities, mesoscale variations in structure (e.g. species distribution) and functioning (food webs depending more on pelagic or benthic prey) can be found, both at temporal and spatial scales. The supply of organic matter of terrigenous origin (the advective input via, for instance, submarine canyons) is important in mainland-influenced areas. The continental slope is cut by submarine canyons **[4]** that channel organic matter input from the surface waters and continental shelves (including material of land origin such as wood) down to the abyssal plain. Submarine canyons are an important geomorphological feature, key to ecosystem functioning in the deep sea, because they are relatively richer in organic matter than surrounding areas, by accumulation. They are essential habitats in the life-cycle of some species, and higher density and recruitment rates of macrofauna and megafauna, including red shrimp *A. antennatus*, have been shown. They are also important areas of endemism (e.g., endemic hydromedusae). The influence of submarine canyons extends to the whole water column; in addition, they are important to small pelagic fish (anchovy), seabirds and cetaceans.

Cold-seeps

Special habitats in the deep Mediterranean include cold-seeps **[2],** associated to tectonic features such as mud volcanoes. Cold-seeps harbour unique ecosystems based on the oxidation of methane as the primary carbon source (i.e., not based on photosynthetic production as elsewhere on Earth), dominated by bacterial mats and communities of specialized bivalves and tubeworms. Live cold-seep biocenoses have been discovered in the Eastern Mediterranean (Mediterranean Ridge, in the Levantine sea and near the Nile delta, at depths varying from 500 to 1900 m, depending on the site), whereas new cold-seep sites have recently been located in the Western Mediterranean (around the Balearic Islands and near the Rhone delta).

Brine pools

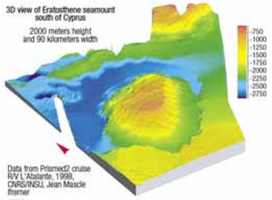
Brine pools, or Deep Hypersaline Anoxic Basins, are another unique habitat present in the Mediterranean that harbour unique faunal assemblages, adapted to withstand high salinity levels (30 PSU -Practical Salinity Units-), oxygen depletion and high concentration of methane and sulphide. Brine pools are home to specialized and poorly studied groups of extremophile Bacteria and Archaea. New groups of Prokaryotes have also been discovered in brine pools, while only a restricted assemblage of meiofauna (with some species new to science) can thrive in the extreme environmental conditions found in these habitats.

Cold-water corals

Cold-water corals form substantial reef-like structures in the Atlantic, between 300 and 800m depth, and are the object of active conservation efforts against damage by fishing, particularly trawling. In the Mediterranean, live cold-water coral reefs have been reported from very few sites, notably the recently re-discovered site in southern Italy (Santa Maria di Leuca **[5]**), where live colonies of the scleractinians *Lophelia pertusa* and *Madrepora oculata* **[6]** have been found. Cold-water coral reefs are associated with highly productive environments, and harbour high levels of diversity; they are threatened directly and indirectly by fishing.

Seamounts

Seamounts are steep-sided, submerged mountains that rise 1000m or more above the surrounding seafloor and provide unique habitats all over the world. In the Mediterranean, seamounts are found scattered around active tectonic areas, such as the Alboran Sea, the Gulf of Lions, the Ionian abyssal plain and the Levantine Sea. In the Levantine sea, the massive Eratosthenes seamount (south of Cyprus **[3-7]**) rises from the seafloor to 800m below the sea surface. Biological sampling at the top of this seamount has produced a unique biocenose, with a wide array of invertebrates, including interesting corals *(Caryophyllia calveri, Desmophyllum cristagalli)*. The biological communities of seamounts are threatened by fishing in some areas of the world (e.g. south Pacific seamounts) and these fragile communities require urgent protection.



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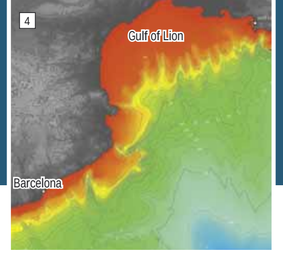
The document *"The Mediterranean deep-sea ecosystems: an overview of their diversity, structure, functioning an anthropogenic impacts, with a proposal for conservation"* can be downloaded from: www.panda.org/mediterranean - www.uicnmed.org



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1 - Chlorophyll *a* map (Monthly composite for Apr. 2000) produced by the Inland and Marine Waters Unit (JRC-EC) using SeaWiFS raw data distributed by NASA-GSFC.

2 - Cold seep. Credit: Coleman, D. and R. Ballard, 2001. A highly concentrated region of cold hydrocarbon seeps in the southeastern Mediterranean Sea. *Geo-Marine Letters* 21: 162-167. © Springer, Heidelberg.

3 - Sardou O. and Mascle J., 2003. Cartographie par sondeur multifaisceaux du Delta sous marin du Nil et des domaines voisins. Publication spéciale CIESM/Géosciences-Azur, série Carte et Atlas .

Loubrieu B. and Satra C., 2001. Cartographie par sondeur multifaisceaux de la Ride Méditerranéenne et des domaines voisins. *Comité Français de Cartographie*, n°168, pp. 15-21.

4 - Northwest Mediterranean canyons. Credit: International Hydrographic Organization Data Center for Digital Bathymetry at U. S. NOAA National Geophysical Data Center, Boulder, Colorado, U. S. A. (April, 1998).

5 & 7- Credit: *GEBCO Digital Atlas*. Modified.

6 - *Madrepora oculata*. Crédit : Angelo Tursi.

7

The deep Mediterranean biological communities are adapted to a general oligotrophic environment, with local areas of higher productivity and biodiversity hotspots. These biological communities are very sensitive to human alteration in the form of deep-sea fishing, waste disposal, chemical pollution or global warming. These perturbations have direct impacts on the communities by selectively affecting some components of the community (e.g. removal of top predators by fishing, destruction of suspension feeders such as gorgonians or coral reefs), or indirect impacts by changing the structure of a complex trophic web, modifying secondary production patterns or the far-reaching effect of climate change.

Alepocephalus rostratus Risso, 1820
Vincent Fossat, 1879.
Coll. Muséum d'Histoire naturelle de Nice.

Deep-water ecosystems are highly vulnerable to commercial exploitation, due to the low turnover rates of the species adapted to these environments, and the lack of adaptation of deep ecosystems to cope with strong external perturbations. Trawling in particular has a very important direct impact on deep-sea bottoms, as demonstrated in the south Pacific orange roughy seamount fisheries. Commercial exploitation based on deep-sea trawling has become increasingly important since the 1950's in the Mediterranean, targeting deep-water shrimp species *(Aristeus antennatus and Aristaeomorpha foliacea)* down to near 1000m in depth. Deep-sea long line fisheries, in turn, would cause deleterious impact on vulnerable populations of deep-sea assemblages, thus also threatening the structure and functioning of the deep-sea ecosystems.

Given the state of shallow water fisheries in the Mediterranean, where most stocks are fully to over-exploited, and the high economic value of deep-water shrimps, increasing pressure to fish in deep water is to be expected in the near future. A precautionary approach to fisheries management suggests the interim prohibition of fishing in waters deeper than 1000m, and the protection of unique habitats, by setting up a network of deep-sea Marine Protected Areas. The former measure, in addition, would contribute to the sustainability of current deep-sea fisheries by protecting the juvenile fraction of deep-water shrimps (the deep water shrimp market is estimated to 150 million euros per year).