Options for Delivering Ecosystem-based Marine Management

The Mediterranean Sea: Additional information on status of threatened ecological characteristics relevant to the Marine Strategy Framework Directive

September 2011

ODEMM Partners

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This work was supported by the European Commission's 7th framework project 'Options for Delivering Ecosystem-Based Marine Management' (ODEMM, Theme ENV.2009.2.2.1.1)

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Introduction

The Mediterranean, historically at the crossroads of people, biota and maritime routes, a recognised global biodiversity hotspot, a world tourist destination and key shipping highway, remains both a coveted asset and a heterogeneous mosaic of pressures. Though much of the basin is unmanaged and open to threats, it is still a mystery in terms of knowledge about ecological processes, species distribution, the condition of its ecosystems and the drivers for biodiversity loss (Notarbartolo di Sciara & Agardy 2009). Recent reviews of the Mediterranean Biodiversity Knowledge reported on some of the known drivers of biodiversity loss as well as highlighting areas where our understanding is limited and the significant regional differences in data coverage that occur in the region (Coll et al 2010, Danovaro et al 2010, UNEP/MAP-Plan Blue 2009, UNEP/MAP-RAC/SPA 2010).

The Mediterranean Sea includes 7% of the world's marine species (approx 17,000 marine species) for an area that represents less than 1% the world's ocean surface (UNEP/MAP-Plan Bleu, 2009). Many of the ecological characteristics in the Mediterranean Sea are under threat (see summary information for GES Descriptors above), with over 20% of the known species under threat, and will likely increase given that currently undescribed species will be added in the future and a large proportion of species are either not assessed or assessed as Data Deficient (an issue in itself). This includes emblematic species of conservation concern, such as, the world's most endangered pinniped, the critically endangered Mediterranean monk seal, sea turtles, several whales, dolphins, sharks, skates and rays at risk of extinction or threatened, and the overexploited bluefin tuna (Cuttelod et al 2008, UNEP/MAP-Plan Bleu, 2009).

There are several unique habitats at various levels of risk, including the seagrass meadows of the endemic *Posidonia oceanica* (an important indicator of human impacts and a host of crucial ecosystem services), vermetid reefs, coralligenic concretions, maerl beds, seamounts and deep sea coral reefs. As a tool to protect its marine environment and biota, 800 marine and coastal protected areas have been established in the Mediterranean so far. The current network is however not representative and excluding the Pelagos Sanctuary (87,000 km2 the only high- sea MPA) coastal MPAs cover only 0.4% of the Mediterranean Sea (Abdulla et al 2009).

Past and recent human activities and economic development in the Mediterranean impact the environment, particularly coastal ecosystems. Apart from carbon sequestration and renewable energy, 18 of the 20 sectors identified in ODEMM are present in the region. Main and emergent threats include loss and habitat degradation (through urbanization, industrialization, coastal infrastructure, shipping and tourism), pollution (including litter), harmful algal blooms, invasive species, overexploitation of marine resources, fisheries related impacts (unsustainable fishing practices, by-catches and discards, illegal fishing) as well as climate change (Coll et al 2010, Costello et al 2010, UNEP/MAP-Plan Blue, 2009, UNEP 2010). Significant increases in pressures are expected through further increases in coastal population and tourism, coastal power plants, desalination plants and industrial complexes as well as significant additional increases in maritime traffic (contributing to alien species introductions and noise, POP and oil pollution), aquaculture and renewable energy.

Of particular economic, social and political interest and importance within the Mediterranean region, is the sector of Shipping. Maritime traffic in the Mediterranean Sea accounts for 15% of global shipping activity (REMPEC 2008). This is because the Mediterranean is considered a major transit route between non-Mediterranean ports. The increase in seaborne shipping activities is reflected by the growth in cargo volume and ship sizes (REMPEC 2008). The introduction of the Motorways of the Sea model by the European Council (EC 2004) will support future growth within this sector, through new specific businesses, such as shipbuilding, cargo transport and logistics The new model is to increase the European maritime logistic chain in an attempt to reduce road traffic and congestion due to increasing use of heavy good vehicles (EC 2004). Although the introduction of this model will support economic and social development of the Mediterranean Sea region, it will come at a cost to the marine environment.

A Mediterranean Sea Sustainable Development progress report revealed that Member and non-Member States are not considered to be within an acceptable index range to support sustainable development (UNEP 2011). Of all countries surrounding the Mediterranean Sea, only four states (EU non-Member states) have ecological footprints deemed to be adequate by UNEP Ecological Footprint Index (UNEP 2011). These high ecological footprints are closely coupled with economic activities. Based on the World Bank economic classifications, countries within the Mediterranean Sea region belong to one of two economic groupings. The first group consists of middle-income countries, with low Human Development Index (HDI) and ecological footprints, and includes: southern and eastern Mediterranean states, and Balkan countries (UNEP 2011). The second group comprises high income countries with high HDI and ecological footprints, and is represented by EU Mediterranean states and Israel (UNEP 2011).

The socio-economic division between these two groups will create political issues in implementing a regional approach to achieving GES for the MSFD Descriptors. Some Mediterranean Sea states will not have the financial and institutional capacity to implement strategies to meet the objectives of the MSFD. This challenge is coupled with the promotion of economic and social reforms to increase development in a sustainable manner. Presently, the environmental capacity in the Mediterranean Sea region is consumed faster than it is renewed (UNEP 2011), indicating marine ecosystems are at threat. These issues will pose difficulties for the Mediterranean region to meet its own sustainable development and environmental strategies.

Availability of Information: Regional Summary

A large body of work describing the marine ecosystem and its ecological characteristics of the Mediterranean Sea is available. The Mediterranean Ecological Vision (Decision IG 17/6, Barcelona Convention 2008) for “a healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations” is the first step towards the development and application of the Ecosystem Approach in the region. Twenty-one states have a coastline on the Mediterranean Sea, but only seven are Member States of the EU (Spain, France, Italy, Greece, Cyprus, Slovenia and Malta). Non- member states have no obligation to maintain the environment in a manner described in several EU directives (e.g. Habitats Directive, WFD or MSFD) and thus, the absence of a coordinated effort toward the objectives of those directives may lead to difficulties in the achievement of those goals. However, since 1975, The United Nations Environment Programme (UNEP) has played a key role in coordinating a Mediterranean-wide regional sea programme. The Mediterranean Action Plan (MAP) was the first ever plan adopted as a Regional Seas Programme under UNEP’s umbrella and was initially adopted by 16 Mediterranean countries and the European Community. Today, this has been extended to involve all 21 countries that border the Mediterranean Sea. There are five objectives of the MAP: (1) to assess and control marine pollution, (2) to assist in the formulation of national environmental policies, (3) to improve the ability of governments to identify better options for alternative patterns of development, (4) to optimise the choices for allocation of resources, and (5) to incorporate integrated coastal zone planning and management as a tool to support the environmental, social and economic objectives of the programme.

The roadmap to the application of the Ecosystem Approach (and the wider implementation of MSFD) includes seven steps. Step 3 is on-going and its aims include the “identification of important ecosystem properties and assessment of ecological status and pressures. Step 4 aims at the “development of a set of ecological objectives corresponding to the Vision and Strategic goals”. Currently UNEP MAP is finalizing the assessment report that covers pollution and biodiversity, physicochemical and oceanographic parameters. Six MAP Regional Activity Centres (RACs) are based in Mediterranean countries, each offering its own environmental and developmental expertise for the benefit of the Mediterranean community in the implementation of MAP activities. The Regional Activity Centre for Specially Protected Areas (RAC/SPA) launched The Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean (SAP BIO) in 2003. Chapter 1 of SAPBIO 2003 was the “I. MEDITERRANEAN MARINE AND COASTAL BIODIVERSITY: Status, Threats and Trends” i.e. the region’s assessment at national and regional level. SAPBIO is currently under review with new targets and objectives are expected in 2011.

Table 1. A Summary of Areas of Concern, Risks to GES, and Confidence in Risk Assessment of GES Descriptors in the Mediterranean Sea. Each GES Descriptor is described by one or more components: ecological characteristics, pressure and/or impacts information (in Chapter 2 of Deliverable 1). The components used to evaluate each descriptor are shown in more detail in the following summary tables and outline the availability of information and criteria used to assess current status and trends of components in each Regional Sea. * indicates a pressure assessment approach was used, either in part or in its entirety, to evaluate the descriptor. Risk assessment criteria and confidence assessment definitions are described in Chapter 3 and Annex V of Deliverable 1 (www.liv.ac.uk/odemm/outputs).

GES Descriptor	Problems	Areas of Concern	Risks to GES	Risk Confidence
1a. Plankton	Yes	Alterations in the dominance of plankton species are on-going, but no notable or maintained changes are occurring.	Moderate	Moderate
1b. Fish	Yes	30 species of cartilaginous fish in the Mediterranean Sea are current threatened with as many as 73% of bony fish outside safe biological limits. Trends indicate a decline in the abundance of many species	Moderate	Moderate
1c. Marine Mammals & reptiles	Yes	Several species of marine mammal and reptiles are currently threatened (IUCN criteria) with rates of decline in abundance and distributional range suggesting those species may be lost within the next 10 years	High	High
1d. Seabirds	Yes	60% of Annex II SPA-BD species (Barcelona Convention) are listed as threatened or endangered shown by reducing population (breeding) sizes, however, these species are not currently expected to be lost	Moderate	Moderate
1e. Predominant Habitats	Yes	Nearly all predominant habitat types in the Mediterranean are declining or exhibiting some degree of degradation with many in poor, endangered or unfavourable status	Moderate	Moderate
2. Non-indigenous species (NIS)*	Yes	There are a considerable number of invasive species in the Mediterranean that have resulted in widespread negative impacts on native species. Introductions continue to occur as a result of shipping, mariculture and entry via the Suez canal	High	High
3. Commercial fish and shellfish	Yes	More than 25% are exploited beyond sustainable levels, with most key pelagic and demersal species over-exploited and at high risk of stock collapse. Contributing factors include unregulated fishing practices, lack of enforcement, illegal gears and fishing and absence of management or protection measures	High	Moderate
4. Food webs	Yes	The prevalence of invasive jellyfish species and structure of top predators suggests that the Mediterranean food web is in an advanced state of degradation	High	Moderate
5. Eutrophication*	Yes	Algal blooms, hypoxia, eutrophication hot spots coupled with local oxygen deficiencies are of some concern, but due to low nutrient inputs and given the large area of the basin, eutrophication is a problem limited to sheltered marine waters such as harbours or bays and not expected to be of concern in the next two decades	Moderate	High
6. Seafloor Integrity*	Yes	Human activities such as agriculture, coastal infrastructure, fishing, navigational dredging, non-renewable energy (oil & gas), shipping, and tourism and recreation contribute widespread and persistent pressures that have detrimental effects on several aspects of the Mediterranean Sea ecosystem	High	Moderate
7. Hydrographic conditions*	Yes	Increases in sea surface and bottom temperatures indicate warming sea in conjunction with continued ocean acidification and increases in pCO_2	Not assessed	Not assessed
8. Contaminants	Yes	Heavy concentrations of some heavy metals are present in the region and concentrations continue to rise from transport introductions, however, other contaminants are declining e.g. Pb and PAHs.	Moderate	High
9. Fish and Shellfish Contamination	Yes	Concentrations of Mercury currently exceed benchmark dose limits (BMDL) and some heavy metals are high in concentration, but they occur from natural sources	Low	Moderate
10. Marine Litter*	Yes	More than 111 species of seabird and several species of marine mammals and reptiles have been reported to ingest marine debris. Although the amount of litter (number of items and mass) has reduced, shoreline and recreational activities continue to discard large volumes of litter in to the marine environment	High	High
11. Energy (Underwater noise)*	Yes	Trends indicate an increase in shipping activity leading to an increase in underwater noise throughout the region	High	Moderate
12. Habitats Directive Habitats	Yes	35% of habitats are in unfavourable status under at least one assessment criterion and over 40% declining in some aspect (e.g. range, area, structure and function, or future prospects). There is considerable uncertainty of the status of many habitats.	High	High
12. Habitats Directive Species	Yes	>50% of species are in unfavourable condition, with many species exhibiting declines across all assessment criteria (range, population size, habitat, and future prospects).	High	High

TOPOGRAPHY & BATHYMETRY

The Mediterranean is a semi-enclosed sea almost entirely landlocked between Europe, Africa and Asia (Notarbartolo di Sciara & Agardy 2009). The total length of the basin is 3.860km and the maximum width is 1.600km (figure 1). The total area covered by the basin is about 2.536.000km^2 and the total volume is about 3.750.000km^3 (Würtz, 2010). Mediterranean coastline has been estimated at approximate 46.000 km (IUCN, 2007).

The Mediterranean Sea is connected to the Atlantic through the Strait of Gibraltar (a 14km wide at its narrowest point corridor with 600 m mean depth) (Notarbartolo di Sciara & Agardy 2009) and to the Sea of Marmara and the Black Sea through the shallow Strait of Dardanelles (maximum width 7km and average depth 55m, CEPF 2010). The connection with the Red Sea occurs through the man-made Suez Channel, which has become a significant corridor for biological dispersion (Notarbartolo di Sciara & Agardy 2009).

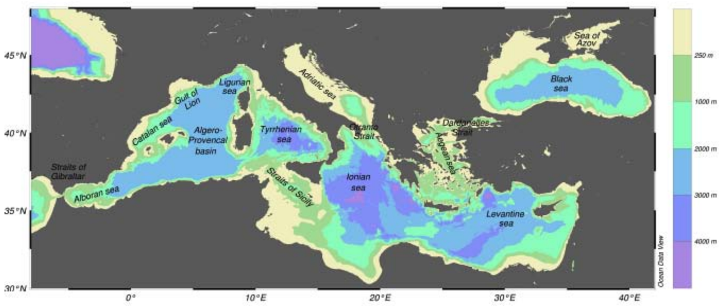

Figure 1. Major seas, straits and topography of the Mediterranean. From: Siokou-Frangou et al. 2010.

In the Strait of Sicily, a shallow ridge at 400m depth (Würtz, 2010) separates the island of Sicily from the coast of Tunisia and divides the sea into two main subregions: the western (area = 0.85 million km^2) and the eastern (area= 1.65 million km^2; Coll et al., 2010), acting as a geographical and hydrological frontier (Zenetos et al., 2002).

The Mediterranean has average depth of 1.450m and thus it is considered to be a shallow basin compared to average depth of oceans (about 3.850m; Danovaro et al., 2010). Still, there are areas in Mediterranean exceeding 4.000m depth and a large part of the Mediterranean basin can be classified as deep sea (Notarbartolo di Sciara & Agardy 2009; Coll et al. 2010 and Figs 2 & 3 below). The mean depth of the western basin is estimated to be 1.612m, and the deepest sounding ever recorded is 3.733m (Würtz, 2010). In the eastern Mediterranean the maximum depth is 5.121m (Danovaro et al., 2010), found in a narrow basin located off the shores of southwest Greece within the Hellenic Trench (CEPF, 2010), which is the deepest point in the entire basin (Danovaro et al., 2010). The shallowest part of Mediterranean Sea is the northern Adriatic, the depth of which does not exceed 50m (CEPF, 2010). The steepest slope observed is situated close to the island of Sapienza, near Navarino, where a depth of 4.978m is reached only 10 miles from land (see Table 2 below, from Würtz, 2010).

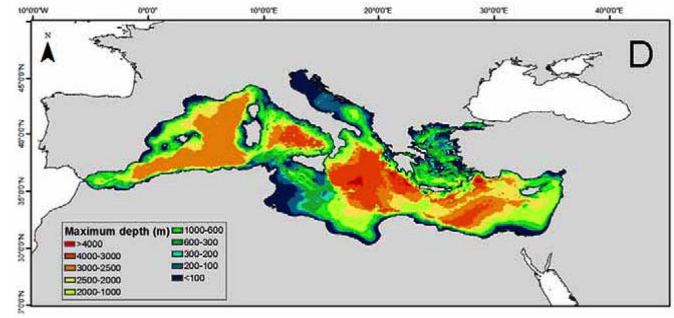

Figure 2. Maximum average depth (m) (NOAA). From Coll et al. 2010.

Table 2. Depth zones by area of coverage and volume of Mediterranean (km^3) along with the mean depth in Mediterranean sub- basins. From: Würtz, 2010

Depth zone (m)	Area (Km$^{2)}$
0 - 200	578,000
200 - 1000	720,000
1000 - 2000	230,000
2000 - 3500	951,000
Over 3500	57,000
Total	2,536,000

	Basin Volume (Km^3)	Mean Depth (m)
Western Mediterranean	1,357,000	1612
Sicilian-Ionian basin	1,243,000	1620
Levantine	1,117,000	1451
Adriatic Sea	33,000	243
Total	3,750,000	

Mediterranean has a narrow shelf and in the north is mostly bordered by mountain chains sloping steeply into the sea, resulting in a narrow littoral zone and small drainage basin (Zenetos et al., 2002). Shelves in the south are mainly narrow and steep with the exception of the Gulf of Gabe´s, while those in the north are wider. Moreover, in contrast to the flat western Mediterranean basin (west of Sardinia and Corsica), the Tyrrhenian, Ionian, Levantine and Aegean seas are characterised by alternating deep depressions and morphological highs, submarine valleys and steep slopes (CEPF, 2010). Along the coastal areas, rocky shores —both hard and soft— predominate, with cliffs over 150 m high occurring in Spain and Croatia. These are only occasionally interrupted by sandy beaches of limited length, associated with relatively narrow valleys cutting through the mountains or with small coastal plains surrounded landwards by mountainous areas (CEPF, 2010).

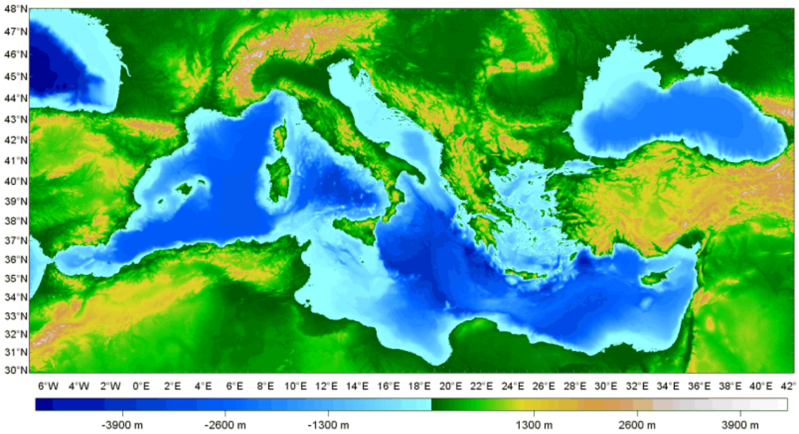

Figure 3. Bathymetric map. http://www-3.unipv.it/cibra/edu_Mediterraneo_uk

Much of the Mediterranean seabed is covered in blue mud, often presenting a yellow upper layer, which contains a considerable proportion of lime carbonate (calcium carbonate, $CaCO_3$). This portion of carbonate mainly originates from shells of pelagic Foraminifera (Würtz, 2010).

From the few big rivers flowing out into the Mediterranean Sea, the biggest in length is Nile in Egypt of which its catchment basin extends several thousands of kilometres into the northeastern part of the African continent. The Rhone itself rises in the central Alps in Switzerland and flows to the Gulf of the Lion in the western Mediterranean Sea. The river Po drains the southern flanks of the Alps and plains to the northern Adriatic Sea, and finally the Evros River plains to the North Aegean Sea (CEPF, 2010).

The Mediterranean pelagic realm has a highly variable four-dimensional structure (Würtz, 2010 and Fig 4) and water circulation is highly complex (Danovaro et al., 2010).

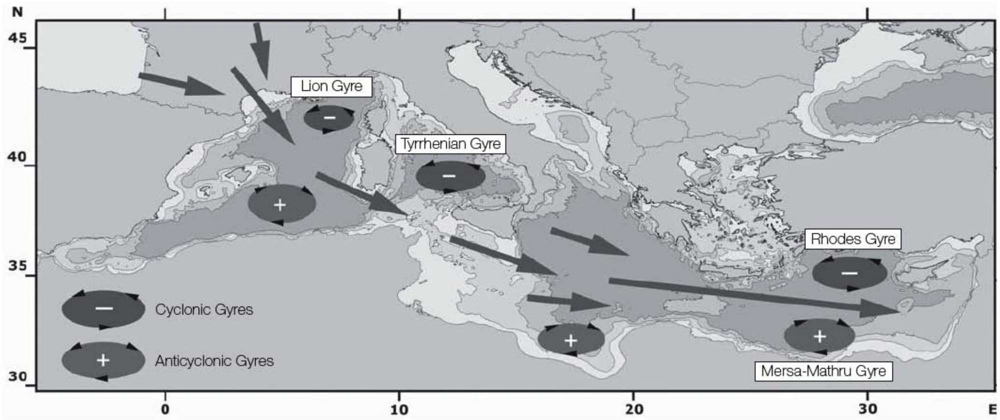

Figure 4. Gyres and eddies generated by wind stress along the longitudinal axis of the Mediterranean Sea. From: Würtz, 2010.

Large areas of the Mediterranean Sea are still without detailed swath bathymetry and/or habitat map data (Figure 5 CIESM & 6 EUSeaMap project contract MARE/2008/07).

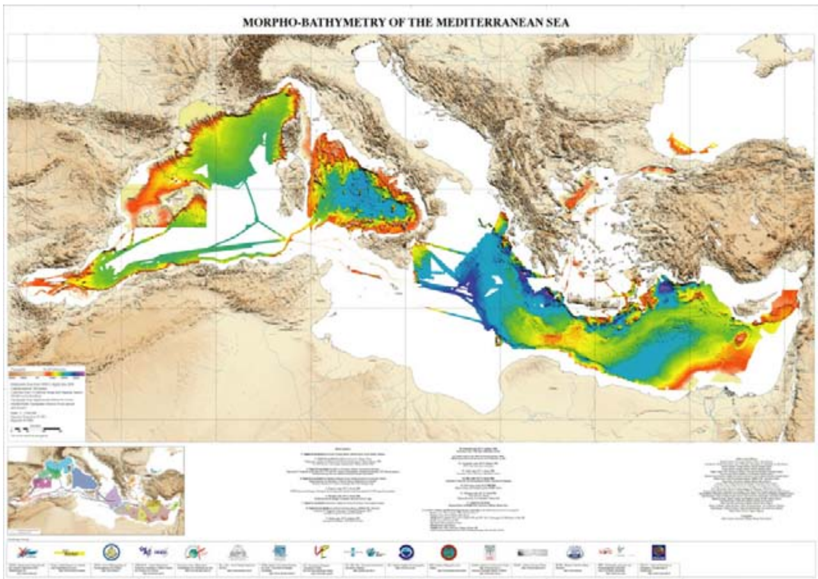

Figure 5. Swath bathymetry of the Mediterranean, http://www.ciesm.org/marine/morphomap.htm

Figure 6. EUSeaMap portal for modeled European seabed habitats showing only Western Mediterranean coverage so far under DG MARE contract MARE/2008/07 (although a new DG MARE project, expected to start before the end of 2011, is looking to address some gaps), http://jncc.defra.gov.uk/page-5040, https://webgate.ec.europa.eu/maritimeforum/system/files/20101215_FinalReport_EUSeaMap_v2.0.pdf

Maps: Structural features of bottom topography in the Mediterranean basin

The Mediterranean basin contains, over relatively limited spatial scales, a number of habitats that can represent potential ‘‘hot spots’’ of biodiversity. A tentative, possibly not exhaustive list of these systems includes (a) open slope systems, (b) submarine canyons, (c) deep basins, (d) seamounts, (e) deep-water coral systems, (f) cold seeps and carbonate mounds, (g) hydrothermal vents, and (h) permanent anoxic systems (Danovaro et al. 2010, figures 7-10). The Eratosthenes Seamount is an impressive geological structure in the Levantine Sea, the biology of which is practically unknown (Danovaro et al., 2010). Several submarine canyons cross the continental slope of the Western and Central Mediterranean. They represent hot spots of species diversity and endemism and are preferential areas for the recruitment of megafaunal species (Danovaro et al., 2010). So far, a total of 14 coral bank areas have been censused in the Mediterranean, although only a few of them have been examined by ROV dives. These include the areas from the Gibraltar sill to the Gulf of Lions canyons, from the Ligurian Sea to the Sicilian Channel, and from the Apulian margin to the trough off Tassos in the Aegean Sea. The depth distribution of the corals ranges from 150m (Strait of Gibraltar) to 1.100m (Santa Maria di Leuca) (Danovaro et al., 2010). Most hydrothermal vents in the Mediterranean with described biological assemblages occur in shallow depths of less than 100m (Danovaro et al., 2010). Numerous deep hypersaline anoxic basins (DHABs) have been discovered in the Eastern Mediterranean Sea, the Red Sea, and the Gulf of Mexico. The six DHABs of the Eastern Mediterranean (L'Atalante, Urania, Bannock, Discovery, Tyro, and La Medee) are located on the Mediterranean Ridge. The Mediterranean DHABs lie at depths ranging from 3,200 m to 3,600 m and contain brine. Brines enclosed in these basins are characterized by high abundances, which hamper the mixing with overlying oxic seawater and result in a sharp chemocline and anoxic conditions. The combination of nearly saturated salt concentration and corresponding high density and high hydrostatic pressure, absence of light, anoxia, and a sharp chemocline makes these basins some of the most extreme habitats on earth (Danovaro et al. 2010).

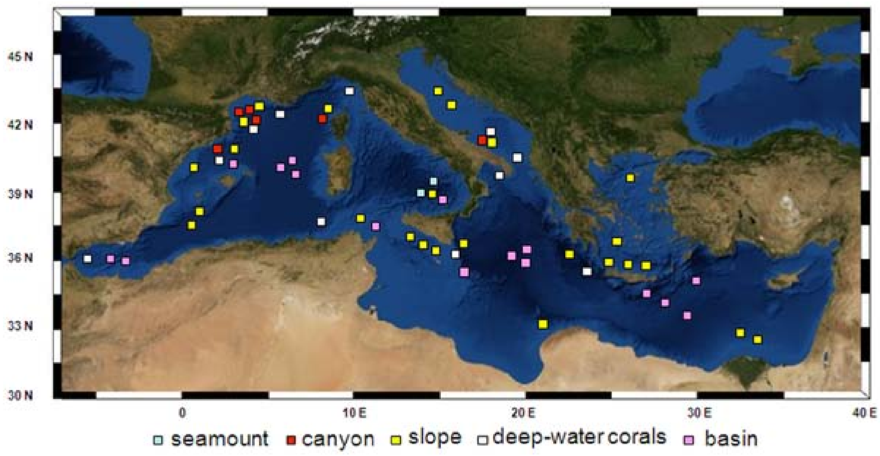

Figure 7. Investigated areas in the Mediterranean basin. Areas include slopes, seamounts, canyons, deep-water corals, and basin. From: Danovaro et al. 2010.

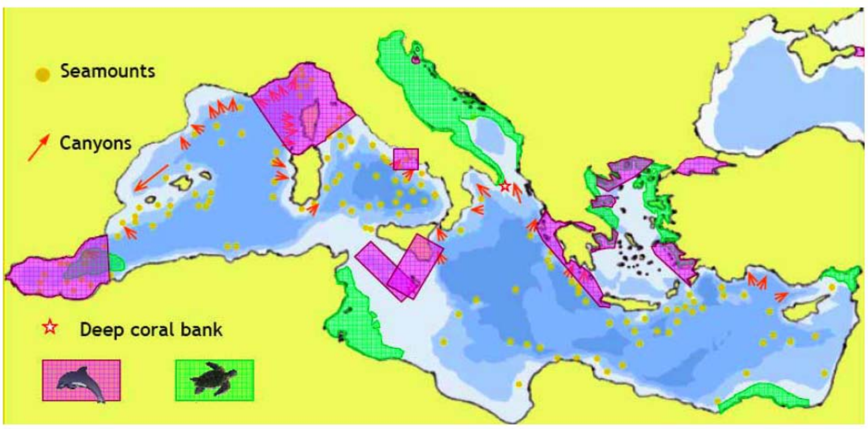

Figure 8. Major seamounts and canyons in the Mediterranean Sea (Pergent 2008). From: Notarbartolo di Sciara & Agardy 2009

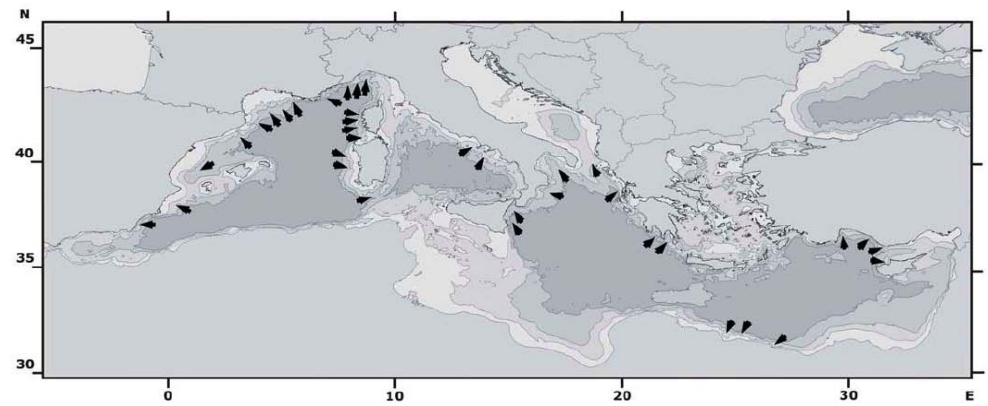

Figure 9. Approximate seamount positions in the Mediterranean Sea. From: Würtz, M. 2010

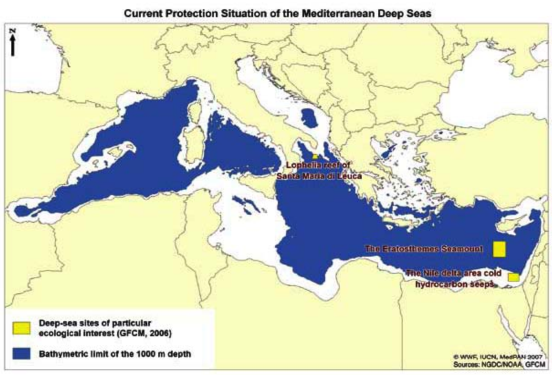

Figure 10. Deep-sea sites of particular ecological interest and bathymetric limit of the 1000m depth. From Abdulla et al. 2008.

TEMPERATURE

In the Mediterranean the climate is characterized by hot, dry summers and cool, humid winters (sub tropical-temperate climate; Coll et al., 2010). Sea surface temperature (SST) shows a high seasonality and increases from the north to the south and from the west to the east (Figure 11) (Coll et al., 2010).

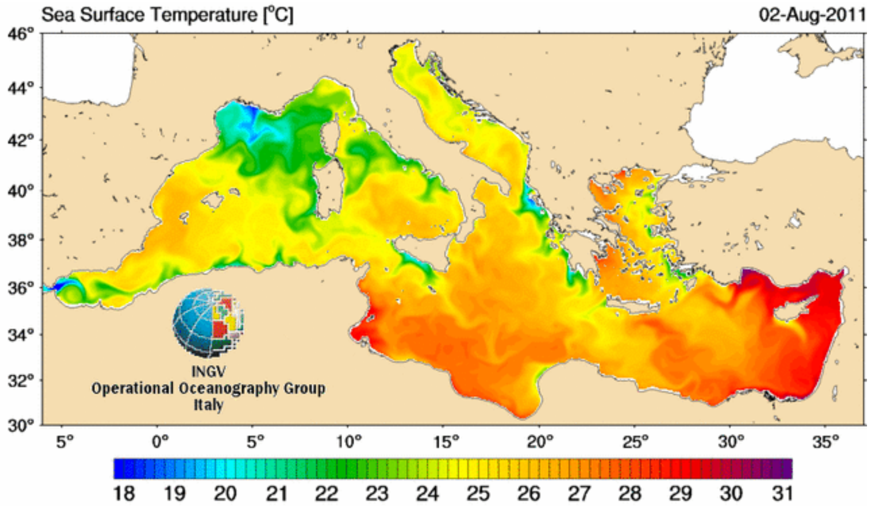

Figure 11. SST, http://gnoo.bo.ingv.it/mfs/B4G_indicators/SST.htm

The mean surface temperature of Mediterranean waters ranges from over 21° C (eastern basin) to an average of 15.5° C (coast of the Gulf of Lion in the western basin). In early 1980s the warmest area of the Mediterranean was the Levantine Basin, with a mean SST of 21.8°C, and the coolest areas were the Gulf of Lions and the Ligurian Sea, with a mean SST of 16.9°C (Coll et al. 2010). The 18°C isothermal line runs from Gibraltar to the north of Sardinia, passing through the Strait of Messina up to the Gulf of Corinth. Below 200-500 m, temperature remains practically uniform down to the bottom, between 13.5-15.5° C in the eastern basin and 12.7-13.5° C in the western basin (Coll et al 2010, Würtz 2010). This high homothermy, the relatively high and high minimum temperatures (~13°C) and the high salinities (37.5–39.5 psu) characterize the deep sea of the Mediterranean (Coll et al 2010, Danovaro et al 2010).

The 15°C isotherm, whose one-century climatological mean crosses the Straits of Sicily, may have moved northward in recent times (Coll et al 2010). According to EEA the SST changes in the European regional seas are stronger than in the global oceans with the Baltic Sea and the North Sea showing higher rates than the Black Sea and the Mediterranean Sea (http://www.eea.europa.eu/publications/eea_report_2008_4/pp76-110CC2008_ch5-4to6_Water_quantity_and_quality.pdf). Warming rates in the Western and Eastern Mediterranean are not the same, but the average increase in sea surface temperature (SST) between 1982 and 2003 has been 2.2 - 2.6 °C (EEA 2007, UNEP/MAP-Plan Bleu, 2009). In addition climate models predict that by 2041–2060, the major part of the Mediterranean will become warmer except the northern Adriatic, which is expected to become cooler while by the end of the century, the Mediterranean could be warmer by 3.1°C, with the Gulf of Lions and the northern Adriatic being the last cool enclaves, with a mean SST of 18°C (Coll et al 2010).

<u>Maps: SST in the Mediterranean basin</u>

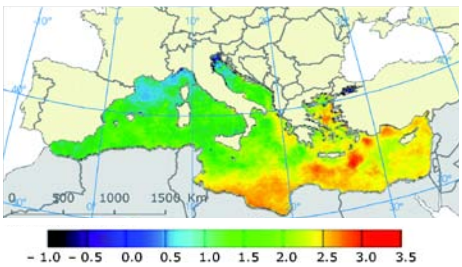

Figure 12. Total SST changes in the Mediterranean Sea (°C) 1982-2003, www.eea.europa.eu/data-and-maps/figures/total-sea-surface-temperature-changes-in-the-mediterranean-sea-oc-1982-2003

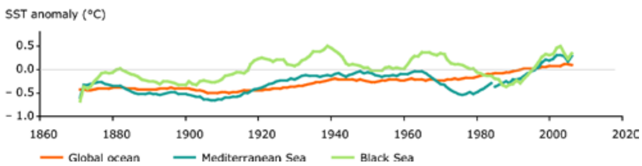

Figure 13. SST anomaly for period 1870-2006. From: www.eea.europa.eu/data-and-maps/figures/sea-surface-temperature-anomaly-for-period-1870-2006

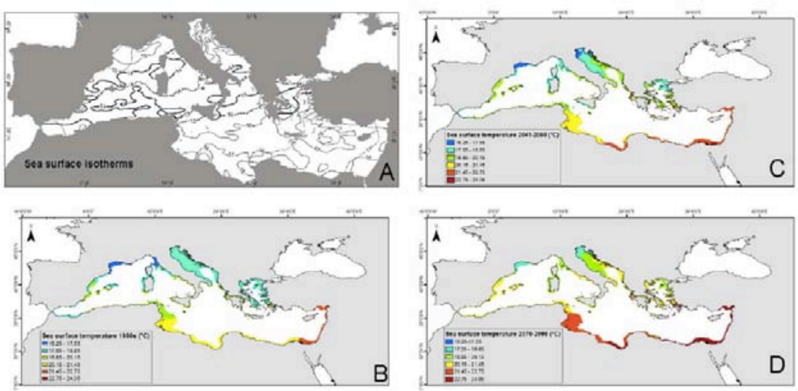

Figure 11. Past changes in seawater temperature and future projections in the Mediterranean Sea. (A) recent northward shifting of February sea surface isotherms (°C) in the Mediterranean Sea (broken lines are the one-century climatological means, solid lines the means for 1985–2006: the 14°C and the 15°C "dividers" are highlighted by a thicker tract. Data compiled from MEDATLAS, GOS-MED, NOAA-AVHRR data and various other sources. Seawater surface temperature on the continental shelves is shown (B) during the 1980s (according to the NOAA data), (C) by 2041–2060, and (D) by 2070–2099 [according to the OPAMED8 model based on the A2 IPCC scenario, 120]. The size of the cell is 0.1×0.1 degree. doi:10.1371/journal.pone.0011842.g011

Figure 14. Past and projected SST changes in the Mediterranean Sea, after Coll et al. 2010

SALINITY

The Mediterranean is a 'concentration basin' with a negative hydrological balance with evaporation exceeding precipitation and river runoff (Notarbartolo di Sciara & Agardy, 2009) and a site of water mass formation processes, which can be studied experimentally because of their easy accessibility (Bergamasco & Malanotte-Rizzoli, 2010). The sea surface salinity of the Mediterranean increases eastwards (Figure 15 & 16 spatial and vertical distribution) from about 36‰ in Gibraltar to 37.6‰ east of Sardinia and 39‰ and upwards in the eastern basin (Coll et al. 2010, Würtz 2010).

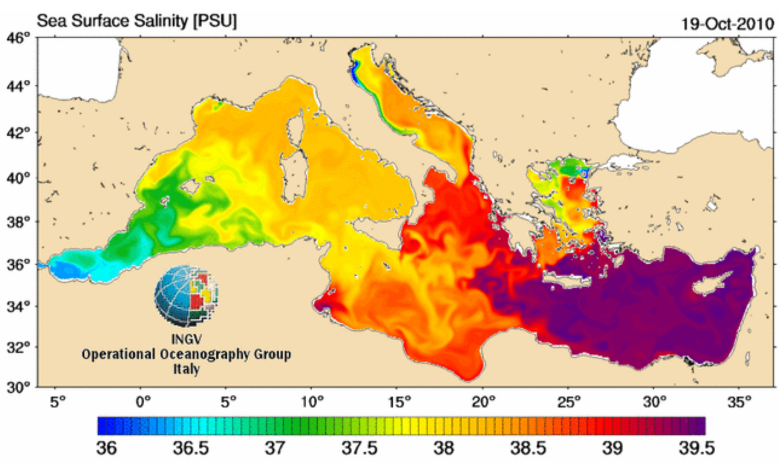

Figure 15. SST (19-10-2010), http://gnoo.bo.ingv.it/mfs/B4G_indicators/SSS.htm

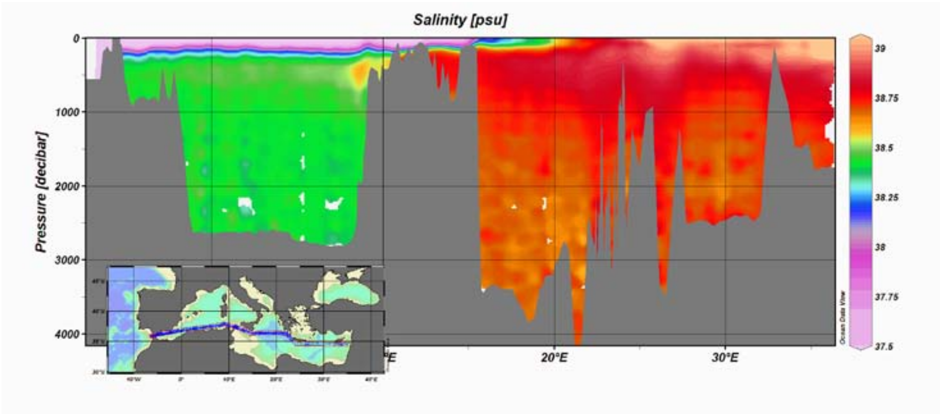

Figure 16. Vertical salinity distribution in the Mediterranean Sea. From: http://odv.awi.de/fileadmin /user_upload/odv/data/MedatlasII/MedatlasII_Btl_Salinity-ZonalSection-AllMed.gif

Long term changes and decadal trends are being studied out by many teams/projects including the Mediterranean Forecasting System at http://gnoo.bo.ingv.it/mfs (Fig 17) and the CIESM Hydro-Changes program with recent results available from http://www.ciesm.org/marine/programs/hydrochanges.htm.

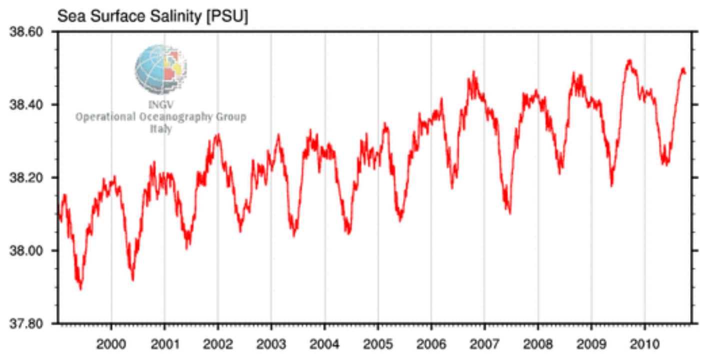

Figure 17. Mediterranean SSS (1999-2010), from: http://gnoo.bo.ingv.it/mfs/B4G_indicators/SSS.htm

Water circulation is highly complex. The surface waters come from the Atlantic and turn into intermediate waters in the Eastern Mediterranean. Low-salinity Atlantic waters enter the Mediterranean, while denser deep- Mediterranean waters flow beneath the Atlantic waters in the opposite direction into the Atlantic Ocean. Mesoscale variability is extremely evident in the Mediterranean and is responsible for the creation of small gyres (eddies) that have implications for the primary productivity and the flux of organic matter settling to the seafloor (Danovaro et al. 2010). A recent historical review of experimental investigations on the circulation of the Mediterranean Sea summarizes existing knowledge and major experiments that led to the discovery of the sub-basin scale circulation and its mesoscale features (Bergamasco & Malanotte-Rizzoli 2010).

OXYGEN/NUTRIENTS

The Mediterranean is one of the most oligotrophic seas, due to high oxygen and low nutrient concentrations, with oligotrophy increasing along both the west-east and north-south axes (Danovaro et al. 2010; Zenetos et al. 2002). The deep layers are efficiently oxygenated while regularly formed independently in the western and eastern sub-basins (Siokou-Frangou et al., 2010). Oxygen levels in Mediterranean are almost saturated in the surface layer (6 ml/l in winter and 4.8 ml/l in summer). In the deep water the oxygen concentration is around 4.5 ml/l in the western and 4.2 ml/l in the eastern basin (Zenetos et al, 2002).

Local oxygen deficiencies are always connected with eutrophication sources, mostly discharges of raw or treated urban or agricultural effluents (Notarbartolo di Sciara & Agardy, 2009). During the summer, owing to the strong stratification of surface waters, eutrophication is more acute when ambient nutrient concentrations are low and oxygen transport through the thermocline is strongly reduced. Winter mixing allows for the required vertical transport of oxygen to keep the deep waters and the sediments oxidized all over the Mediterranean Sea (Notarbartolo di Sciara & Agardy, 2009) and the water column is more homogeneous (Danovaro et al., 2010). Oxygen depletion risk (Fig 18) is low although areas of concern do exist (e.g. Adriatic sea).

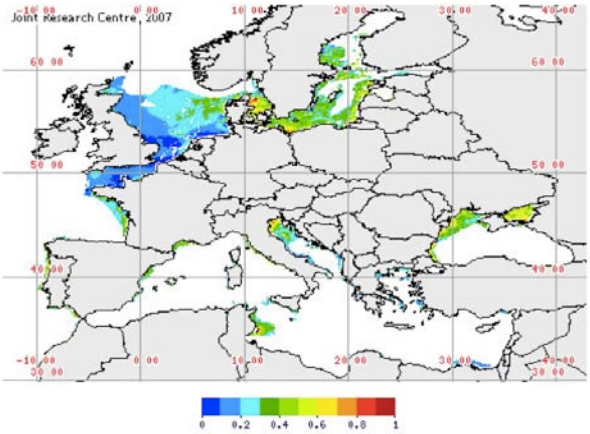

Figure 18. Oxygen depletion Risk. Monthly map (April) of the Oxygen depletion Risk (OXYRISK) index for European seas (<100m water depth) from 10-years climatology (1998-2008). The index ranges from 0 to 1 and reflects the probability (high is red) of bottom hypoxia considering the physical processes at depth (from hydrodynamic model) and the biomass production in the upper layers as derived from satellite data. From: http://ies.jrc.ec.europa.eu/index.php?page=67, http://emis.jrc.ec.europa.eu/ 1_1_def_eutro.php

Nutrient availability is low, especially for phosphorous (N:P up to 60), though this limitation may be buffered by inputs from highly populated coasts and from the atmo- sphere. Phytoplankton biomass, as chl a, generally displays low values (less than 0.2 μg chl a l^{-1}) (Figure 2) over large areas and primary production reveals a west-east decreasing trend ranging between 59 and 150 g C m2 y $^{-1}$ (in situ measurements) (Siokou-Frangou et al. 2010). Eutrophication, a very common problem in the sheltered marine water bodies such as harbours and semi-enclosed bays, is reported as worsening (EEA 2006, UNEP 2010), with hot spot areas and increased HABs events, however due to low nutrient inputs and its large area, the basin will not be seriously threatened by eutrophic pressures over the next 2 decades, and the Outlook for the Mediterranean Sea is recorded as Moderate (UNEP 2010). The recurrent, increasing localized blooms at the various hotspots, appearing in the chl anomalies, are linked to air–sea interactions in pelagic domain (Lion Gyre and Rhodes Gyre), to increased nutrient availability and low water renewal in coastal areas (e.g. beaches or marinas) or to the combination of specific geographical and meteorological conditions (e.g. enclosed bays during summer) and with little or no connection to regional events (Barale et al 2008).

pH/pCO

Research on ocean acidification impacts in the Mediterranean is quite recent (see http://medsea-project.eu/ for a new targeted EU FP7 Project), existing results are summarized in CIESM (2008) review and Rivaro et al. (2010), a recent study about the carbonate properties of the water column in the Mediterranean Sea. The results of this study showed that total alkalinity varied linearly with salinity in the Mediterranean Sea with the highest values seen in the Eastern basin, both in the surface and in the deep layers, and confirmed the concentrating behavior of the Mediterranean Sea. The Mediterranean pH exhibited high and variable values in the surface layer and an increasing gradient from the western to the eastern Mediterranean (Rivaro et al., 2010). In addition to historical last century reduction of seawater pH, further reductions are predicted globally by all future carbon emission IPCC scenarios (CIESM, 2008).

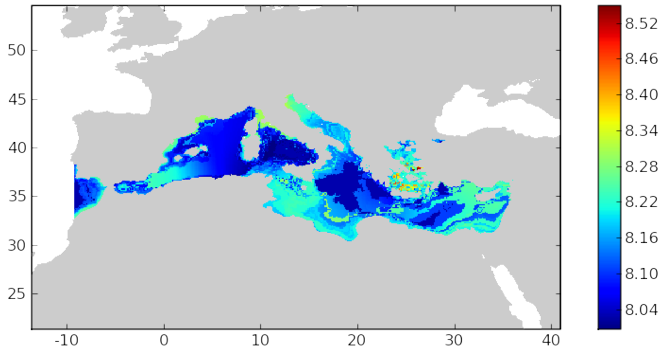

Figure 19. pH concentrations in Mediterranean sea (26 Oct 2010). From: www.seadatanet.org/products

An increase of pCO_2 from Gibraltar to Levantine Basin is also seen, positively co-varying with surface temperature (Rivaro et al. 2010). Their results show that the entire water column has already been invaded by the anthropogenic CO_2 throughout the Mediterranean Sea with generally higher concentrations of anthropogenic CO_2 in the intermediate and deep layers than those measured in the Atlantic waters. The Mediterranean Sea is one of the few places in the world where deep convection and water mass formation takes place that can represent, in selected areas and seasons, a strong marine sequestration of anthropogenic CO_2 (Rivaro et al. 2010)

PREDOMINANT HABITATS

1. Mediterranean Habitat (and research) specificities

Most of Mediterranean habitat research has been focusing on priority, endangered, threatened and in need of conservation marine habitats. The most typical such example is the *Posidonia* meadows, which is an Annex I Habitat Directive/NATURA 2000 habitat (code: 1120, title: *Posidonia* beds), a species listed in the Annex II List of Endangered or Threatened Species of the SPA/BD Protocol under the Barcelona Convention and a EUNIS level-5 habitat A5.535 *Posidonia* beds. UNEP (2002) is a classic regional resource for interpreting marine habitat types.

Most of the recent habitat reviews/assessments (see below) recognize the lack of habitat data at grosser scales (e.g. EUNIS level 3 or 4) and at sea basin scales (Mangos et al. 2010). The on-going 7FP Project MESMA: Monitoring and Evaluation of Spatially Managed Areas (www.mesma.org) has recently put together A catalogue of European seabed biotopes (MESMA 2010) with special emphasis given on fully marine Mediterranean, Black Sea (Pontic), and deep-sea biotopes (EUNIS level 4), for which little or no information was included in the original EUNIS database. Even widely perceived important habitats such as Posidonia or coralligenous/maerl habitat (EUNIS level 5 habitats) have not yet been mapped fully in all the EU Member States (see EUSeaMap - Mapping European seabed habitats http://jncc.defra.gov.uk/page-5020 and forthcoming EU Project MAREA).

In addition to the requirements of the Habitats Directive (achieved at varying degrees) larger scale habitat (diving, ROVs, sonar) and geological and/or special habitat type mapping (e.g. canyons, coral reefs, cold seeps, CoralFISH http://eu-fp7-coralfish.net/ and HERMES http://www.eu-hermes.net/ and HERMIONE EU projects http://www.eu-hermione.net/, and http://eu.oceana.org/sites/default/files/reports/First_Mediterranean_symposium_Tunisia.pdf & http://na.oceana.org/sites/default/files/o/fileadmin/oceana/uploads/europe/reports/OCEANA_habitats_in_danger.pdf for OCEANA expeditions) is carried out mostly in the Western Mediterranean (see for example although the Central (e.g. Malta, BIOMAERL & maerl mapping) and Eastern parts are not excluded (e.g. see Greece: HERMES & CoralFISH projects, and Croatia a candidate EU country: national project mapping marine habitats in anticipation of Habitats Directive requirements). COUNCIL REGULATION (21 1967/2006 EC) of December 2006 concerning management measures of the sustainable exploitation of fishery resources in the Mediterranean Sea, prohibits fishing with trawl nets, dredges, purse seines, boat seines, shore seines or similar nets above seagrass beds of, in particular, Posidonia oceanica or other marine phanerogams, or above coralligenous habitats and mäerl beds and calls Member States to take appropriate steps to ensure the collection of scientific information with a view to the identification and mapping of habitats to be protected. However, all the MS have not yet implemented this regulation. Much larger knowledge and mapping gaps are expected in Mediterranean riparian countries where only a very small part of the coastline has been inventoried.

Most of Mediterranean marine benthic research has been focusing on soft substrata and shelf sediments and despite the size/extent of Mediterranean deep-sea its benthic fauna has only received attention in the last 20yrs and is still understudied.

2. Recent Mediterranean reviews and research

A number of extensive resent Mediterranean reviews (Airoldi & Beck 2007, Coll et al. 2010, Danovaro et al. 2010, Mangos 2010, Oceana 2006, UNEP/MAP-PlanBlue 2009) and the on-going EU project MESMA (www.mesma.org) summarize the state of knowledge, temporal and spatial biodiversity trends and threats along with spatial identification of conservation hot spots and endangered seas. Extracts from these 7 sources are presented in the section below.

2.1. Mangos et al. 2010.

In order to better understand and protect them, the Mediterranean marine ecosystems were classified. The Regional Activity Centre for Specially Protected Areas (RAC/SPA) thus drew up a reference list identifying 27 major types of benthic habitats in order to assist the Mediterranean states with their inventories of natural sites of conservation interest. This list draws to some extent on the one drawn up by EUNIS, the European Nature Information System. This system with its 4-level hierarchy ranks marine (A) and coastal (B) ecosystems at the very top. On the next level down, the marine ecosystems comprise 8 sub-classes, 7 of which apply to the Mediterranean, and with the categories depending on depth (coastal, infra, circalittoral, deep sea and the water column) and the nature of the substrate (soft or rocky). Some specifically Mediterranean marine ecosystems are on levels 3 and 4, which would give a total of twenty classes or so. It was felt that the gaps in knowledge did not permit this level of detail. Following a bibliographic study and scientific opinion, a compromise was reached between the knowledge available and those categories of ecosystem which are most characteristic of Mediterranean biodiversity and most subject to relations with human activity. This gave rise to the following classification, with an initial assessment of the area involved throughout the Mediterranean: from the coastline to the 100 m isobaths: Posidonia meadows (35,000 km2), corallogenic formations (108,500 km2), rocky seabed with photophilic algae (108,500 km2), seabed with a soft substrate (217,000 km2) and Beyond the 100 m isobaths: open seas, including both pelagic and benthic ecosystems, for the rest of the basin (i.e. around 2,066,000 km^2).

Five species of magnoliophytes are found in the Mediterranean (*Cymodocea nodosa*, *Halophila stipulacea*, *Posidonia oceanica, Zostera marina* and *Zostera noltii*), which form vast underwater meadows at a depth of between 0 and 50 metres in the open seas and in the brackish and saltwater coastal lagoons. Amongst these species, *Posidonia oceanica*, a species endemic to the Mediterranean, plays a key role, often compared to that of the forests. The *Posidonia* meadows comprise the leading Mediterranean ecosystem in terms of biodiversity, since they support a quarter of its recorded marine species over an area estimated to cover almost 1.5% of the seabed. A spawning ground and nursery for many commercial species and the source of major primary production, the beds constitute one of the Mediterranean's sensitive habitats for preserving sustainable non- industrial fishing. Playing an important role in oxygenating the water, they trap and fix sediment (like beach-grasses on the dunes). By protecting the beaches against erosion (by reducing hydro-dynamism and by trapping sediment in the matte) and by encouraging water transparency, they are the guarantors of seaside tourism and provide an effective tool for monitoring the quality of coastal waters. Finally, together with rhizomes their roots- which grow in the substrate- form the duff, which traps carbon at length, thus being instrumental in the sea's absorption of man-made CO2.

The corallogenic reefs are the Mediterranean equivalent of the inter-tropical coral formations, albeit not as spectacular and not having the same structure. Corallogenic concretions are built up through the accumulation of calcareous algae (mainly corallinales of the *Mesophyllum* and *Pseudolithophyllum* type), which grow in poor light conditions. Such concretions, which are common throughout the basin with the exception of the Israeli and Lebanese coasts, are mainly to be found at a depth of between 40 and 120 m, but also closer to the surface in caves, on the vertical walls and in poorly lit spots. They provide a home for a vast range of sessile invertebrates (bryozoans, gorgonians, sponges) and comprise the second Mediterranean ecosystem in terms of biodiversity, with over 1,700 species, a high percentage of which are endemic. The species associated with the corallogenic reefs comprise 75% invertebrates, 19% macrophyte algae and one hundred or so fish species31. A large number of the species present are of commercial interest and their traditional exploitation dates way back in history (e.g. sponges, red coral). The concretions also host many small sharks.

The Mediterranean deep-sea ecosystems have only recently started to be studied on a systematic basis (WWF/IUCN, 2004). Albeit relatively poor when compared with ecosystems in the Atlantic ocean, given the particular paleoecology and the marked oligotrophic nature of the Mediterranean sea, the Mediterranean deep-sea biological communities present a markedly endemic nature and some remarkable points of biodiversity, such as canyons, deep-water corals, seamounts or deep saltwater lakes, which house a unique fauna of which little is yet known. These particular ecosystems are exceedingly fragile, sensitive to macro-waste and chemical pollutants and are undergoing procedures to protect them, from certain types of fishing in particular}.

2.2. UNEP/MAP-PlanBlue 2009

The coastal zones (between 0 and 100 m) support some major ecosystems. Thus, within the framework of the instruments established by SPA/RAC to assist the Mediterranean states in drawing up their inventories of sites of conservation interest, a reference list has been established, which identifies 27 major types of benthic habitat, the main ones of which are the magnoliophyte beds and the coral concretions. With the exception of Posidonia beds & corallogenic reefs, the information available is extremely patchy and varies widely from one sector of the Mediterranean basin to the next. Looking at the Posidonia beds alone, which for two decades have benefited from numerous specific study programmes and have been the subject of over 1,000 publications indexed in international data bases ("Web of Science"), it has to be said that, in spite of a well-known theoretical spread and an area estimated at 35,000 km2, in some Mediterranean states only a tiny stretch of coastline has been inventoried (see Figure 1: Malta & Croatia >90%, Spain & Italy 60-70%, Greece & Tunisia 20-30%, Libya <10%). At regional level, at least for the eastern basin and the southern portion of the western basin, knowledge is clearly lacking. This is linked both to the fact that *in situ* investigation techniques (e.g. scuba, ROVs, observation submarines...) are relatively recent as well as to the technical difficulties and high cost of their implementation. This state of affairs, which was highlighted by the states in 2003 is still on-going and makes it difficult to assess the "resource" with any accuracy (geographic distribution, vitality), though such an assessment should be the first step in any management process.

2.3. MESMA 2010

The seas around Europe are home to an exceptionally wide range of marine habitats and their associated biodiversity. To achieve sustainable management and to conserve marine biodiversity, access to information about seabed biotic and abiotic characteristics is a prerequisite. Such information includes the distribution of seabed habitats and their associated communities, their current state and future trends, goods and services provided, and their vulnerability and impacts as a result of human activities. The relative value of the various aspects of the benthic marine environment is an important basis for the spatial management of marine areas and such assessments will thus play a key role in MESMA as a means of identifying priority biotopes of high value that are particularly vulnerable to anthropogenic effects and therefore in need of protection.

In this catalogue, existing information was compiled (as factsheets) and analysed for the majority of European seabed biotopes as proposed and classified by the European Nature Information System (EUNIS) (http://eunis.eea.europa.eu). The EUNIS database provides a comprehensive pan-European approach that covers all types of habitats (from natural to artificial, from terrestrial to freshwater and marine). However, for many of these sub-categories either no information or very limited data has so far been provided. Hence, building upon EUNIS, we greatly extended the available information in order to fulfill the needs of MESMA. Within the MESMA perspective, this report focuses specifically on sublittoral, fully marine EUNIS habitat types at level-4 and beyond (i.e. EUNIS A1 and A2 habitats are excluded). Habitat types at EUNIS level-4 are hereby defined as biotopes. Special emphasis was given on the Mediterranean, Black Sea (Pontic), and deep-sea biotopes, for which little or no information was included in the original EUNIS database. In total, 67 biotopes at EUNIS level-4 were compiled, 6 of which are newly inserted for the Black Sea. Furthermore, 27 new sub-biotopes were inserted and described, 16 of which at EUNIS level-5, and 11 more at EUNIS level-6.

2.4. Coll et al. 2010

The recent marine biota in the Mediterranean Sea is primarily derived from the Atlantic Ocean, but the wide range of climate and hydrology have contributed to the co-occurrence and survival of both temperate and subtropical organisms [18,19]. High percentages of Mediterranean marine species are endemic [16,20]. This sea has as well its own set of emblematic species of conservation concern, such as sea turtles, several cetaceans, and the critically endangered Mediterranean monk seal (*Monachus monachus*). It is the main spawning grounds of the eastern Atlantic bluefin tuna (*Thunnus thynnus*) [e.g., 21–25]. There are several unique and endangered habitats, including the seagrass meadows of the endemic *Posidonia oceanica*, vermetid reefs built by the endemic gastropod *Dendropoma petraeum*, coralligenous assemblages [e.g., 26–29], and deep-sea and pelagic habitats that support unique species and ecosystems [e.g., 30–32]. Many sensitive habitats exist within the coastal ecosystems. There are 150 wetlands of international importance for marine and migrating birds, and some 5,000 islands and islets [33–35].

In addition, the invasion of alien species is a crucial factor that will continue to change the biodiversity of the Mediterranean, mainly in its eastern basin that can spread rapidly northwards and westwards due to the warming of the Mediterranean Sea. Spatial patterns showed a general decrease in biodiversity from northwestern to southeastern regions following a gradient of production, with some exceptions and caution due to gaps in our knowledge of the biota along the southern and eastern rims.

2.5. Danovaro et al. 2010

Deep-sea ecosystems represent the largest biome of the global biosphere, but knowledge of their biodiversity is still scant. Traditionally the Mediterranean Sea is one of the most intensively investigated areas of the world in both terrestrial and coastal marine biodiversity, but it lags other regions of the world in studies of its deep-sea fauna. The Mediterranean basin has been proposed as a hot spot of terrestrial and coastal marine biodiversity but has been supposed to be impoverished of deep-sea species richness. We summarized all available information on benthic biodiversity (Prokaryotes, Foraminifera, Meiofauna, Macrofauna, and Megafauna) in different deep- sea ecosystems of the Mediterranean Sea (200 to more than 4000 m depth), including open slopes, deep basins, canyons, cold seeps, seamounts, deep-water corals and deep-hypersaline anoxic basins and analyzed overall longitudinal and bathymetric patterns. We show that in contrast to what was expected from the sharp decrease in organic carbon fluxes and reduced faunal abundance, the deep-sea biodiversity of both the eastern and the western basins of the Mediterranean Sea is similarly high.} {Some information is also given for parts of EUNIS level 3 and 4 habitats A6.6 – A6.9 such as seamounts, deep-water corals, cold seeps and hydrothermal vents.

2.6. OCEANA 2006, Habitats in danger

List of identified habitat types includes 17 habitats: Seamounts, Constructive gases, Caves, caverns and overhangs, Pelagic environments, Marine deserts, Coral reefs, Gorgonian gardens, Sponge fields, Mollusc reefs, Worm reefs, Crustacean reefs, Seagrass meadows, Green algae meadows, Red algae concretions, Kelp forest, Fucoid beds, Other identified habitat (such as understories of brown algae and mixed meadows of photophilic algae and/or carpets of mixed algae found in the Mediterranen). Publication gives information on distribution (if/to the extent that it is known), associated species, relation to other habitats of community interest (e.g. Habitats Directive, Barcelona Convention, EUNIS scheme) and degree of vulnerability (threatened, listed etc). It should be pointed out that the lack of protection of certain types of seabed is one of the most serious shortcomings of the Habitats Directive. As an example, it is important to note that the Directive does not include corals in its annexes of priority habitats, nor any of their characteristic Anthozoa species. Other habitats that should be defined as priority habitats are deep-sea coral reefs, maërl beds, laminarian forests (also known as kelp forests), *Cystoseira* communities and seagrass meadows. The only marine habitats currently defined as priority habitats by the Habitats Directive are 1120, *Posidonia oceanica*, and 1150, coastal lagoons.

2.7. Airoldi & Beck 2007

Over the centuries, land reclamation, coastal development, overfishing and pollution have nearly eliminated European wetlands, seagrass meadows, shellfish beds, biogenic reefs and other productive and diverse coastal habitats. It is estimated that every day between 1960 and 1995, a kilometre of European coastline was developed. Most countries have estimated losses of coastal wetlands and seagrasses exceeding 50% of the original area. Conspicuous declines, sometimes to virtual local disappearance of kelps and other complex macroalgae, have been observed in several countries. A few dominant threats have led to these losses over time. The greatest impacts to wetlands have consistently been land claim and coastal development. The greatest impacts to seagrasses and macroalgae are presently associated with degraded water quality while in the past there have been more effects from destructive fishing and diseases. Coastal development remains an important threat to seagrasses. For biogenic habitats, such as oyster reefs and maerls, some of the greatest impacts have been from destructive fishing and overexploitation with additional impacts of disease, particularly to native oysters. Coastal development and defence have had the greatest known impacts on soft-sediment habitats with a high likelihood that trawling has affected vast areas. Most habitat loss estimates refer to a relatively short time span primarily within the last century. However, in some regions, most estuarine and near-shore coastal habitats were already severely degraded or driven to virtual extinction well before 1900. Nowadays less than 15% of the European coastline is considered in 'good' condition.

COMMERCIAL FISH & SHELLFISH

In addition to assemblage and species information (for 4 demersal and 2 pelagic fish and 3 crustacean commercial species) presented in the status and trends ODEMM background document, findings/conclusions from 3 major regional resources are presented here (Piet et al 2010, EEA & CSI 032 and www.seaaroundus.org)

Status of marine fish stocks (EEA CSI 032) (source: www.eea.europa.eu):

- Reports on status of fish stocks are sporadic and irregularly updated. Many assessments that cover wider areas are based on preliminary results. Nevertheless, the percentage of stocks outside SBL ranges from 44% to 78%, with the Adriatic Sea being in the worst condition.
- Demersal stocks remain outside safe biological limits. Small pelagic stocks in the same area exhibit large-scale fluctuations, but are generally not fully exploited, except for anchovy and pilchard in the Southern Alboran and Cretan Seas.
- According to the latest assessment by the International Commission for the Conservation of Atlantic Tunas (ICCAT 2009) swordfish is now considered overexploited.
- Strong concern still remains about the over-exploitation or even risk of stock collapse of bluefin tuna. Uncertainties of stock assessment and a lack of documented reporting (including by EU Member States) still affect the management of this highly migratory species. Bluefin tuna catches continue to exceed the sustainable level.

Stock assessments (source: TG3 Report by Piet et al 2010):

Following an EC STECF request to define the status of the main Mediterranean stocks and evaluate the exploitation levels and the sustainability of the stocks, a Mediterranean stock assessment Sub-group was created and became operational in 2006. Up to now, most of the demersal stock assessments available for the region are from the western Mediterranean; In general these assessments suggest that fishing mortality should be reduced significantly, sometimes by a large amount, as some of these stocks may be approaching a critical state. This suggests that probably fishing mortality should also be reduced in many other areas of the Mediterranean. While the wording "significantly" cannot always be quantified, the "reference direction" to follow for the Mediterranean demersal fisheries is clear: fishing mortality should be decreased.

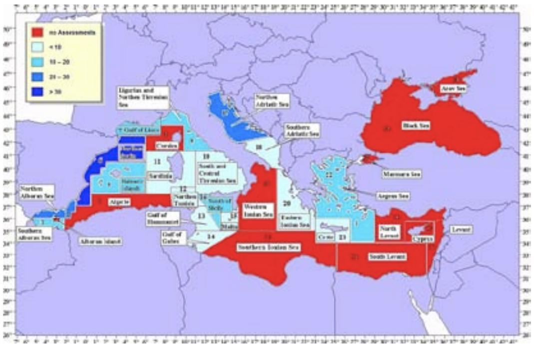

Figure 20. Red: no assessments, very light blue: <10 assessments, light blue: 10-20, sky blue: 20-30, dark blue: > 30 assessments presented to SAC/GFCM between 2001-2008 (including same species over time), source: TG3 Report by Piet et al 2010

Monitoring programs (Source: TG3 Report by Piet et al 2010)

The MEDITS surveys (Mediterranean International Trawl Survey) monitor the demersal resources in the Mediterranean by collecting abundance data and biological parameters of fish, crustaceans and cephalopods species. The hauls are positioned following a depth stratified sampling scheme with random drawing of the positions within each stratum (10 – 49 m, 50 - 99 m, 100 - 199 m, 200 - 499 m, 500 - 800 m). The series began in 1994 and is carried out with one yearly survey during the May-July period. The fully standardized MEDITS survey covers shelves and upper slopes of 17 GFCM-GSAs. Results from the MEDITS surveys are available at http://www.ifremer.fr/Medits_indices (indices: Log(N), W, Wbar, Lbar, L 0.05, L0.25, L0.75, L0.95, and Lvar).

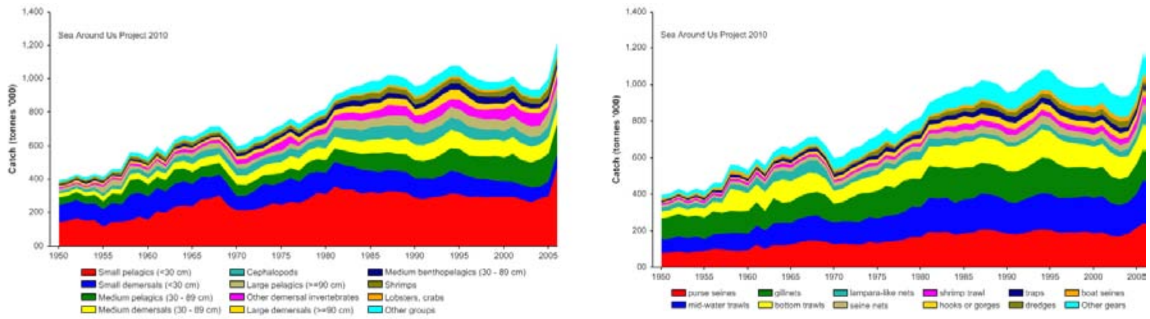

Figure 21. Landings by species group (left) and gear type in the Mediterranean Sea (Source: http://www.seaaroundus.org/ and Sherman & Hempel 2009)

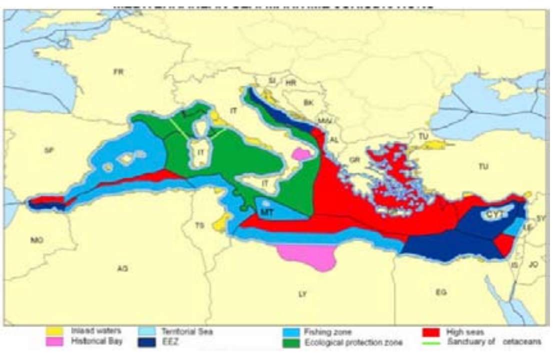

Figure 22. Mediterranean maritime jurisdictions (Source: Notarbartolo di Sciara & Agardy 2009)

CARTILAGINOUS FISHES (SHARKS, RAYS AND CHIMAERAS)

Chondrichthyan fish fauna is relatively diverse with 71 species of sharks, rays and chimaeras living and breeding in the Mediterranean Sea with some are considered critical habitat for chondrichthyans (Cavanagh and Gibson 2007). Available evidence indicates that chondrichthyans in the Mediterranean are generally declining in abundance, diversity and range and are facing a worse fate than chondrichthyan populations elsewhere in the world (Cavanagh & Gibson, 2007). 30 species (42% of total) in the Mediterranean are classified as Threatened with considerable declines in their populations, of these 13 species (18%) are classified as CR, 8 species (11%) classified as EN, and 9 species (13%) classified as VU (Cavanagh & Gibson, 2007 and their Table 3).

Table 3. Summary of numbers of Mediterranean species assigned to each IUCN Red list category regionally and globally (Cavanagh & Gibson, 2007)

IUCN Red List Categories	Number of Mediterranean chondrichthyan species Regional Assessment	Global Assessment (IUCN Red List, 2006)
Critically Endangered (CR)	13	5
Endangered (EN)	8	4
Vulnerable (VU)	9	7
Near Threatened (NT)	13	12
Least Concern (LC)	10	3
Data Deficient (DD)	18	4
Not Evaluated (NE)	0	36
Total number of species	**71**	**71**

Sharks are facing a particularly high risk of extinction: 42% of the shark species are threatened in the region in comparison with 17% globally, which has led to the Mediterranean being described as the most dangerous sea in the world for cartilaginous fishes (Cavanagh and Gibson 2007). Population declines can be attributed to a number of factors, including the life history characteristics of chondrichthyans in combination with the semi-enclosed nature of the Mediterranean Sea and intense fishing activity throughout its coastal and pelagic waters; effects of habitat loss; environmental degradation; and pollution. Although directed fisheries have caused stock collapse for some species, more significant threats to chondrichthyans are mortality in mixed species fisheries and bycatch in fisheries targeting more valuable species (Cuttelod et al 2008). Chondrichthyans most vulnerable and frequently caught with driftnets include blue shark *Prionace glauca*, common thresher *Alopias vulpinus*, shortfin mako *Isurus oxyrinchus*, porbeagle *Lamna nasus*, basking shark *Cetorhinus maximus*, giant devil ray *Mobula mobular*, pelagic stingray *Pteroplatytrygon violacea*, requiem sharks *Carcharhinus* spp. and hammerheads *Sphyrna* spp. (Cavanagh & Gibson 2007). The distribution of pelagic sharks in the Mediterranean Sea is mainly known through swordfish fishery and bluefin tuna traps as well as by catching using other pelagic fishing methods. The blue shark, basking shark, white shark, porbeagle, the shortfin mako and the common thresher shark can be considered as the most representative of the Mediterranean pelagic environment for their role in trophic webs, and also as scavengers (Wurtz 2010).

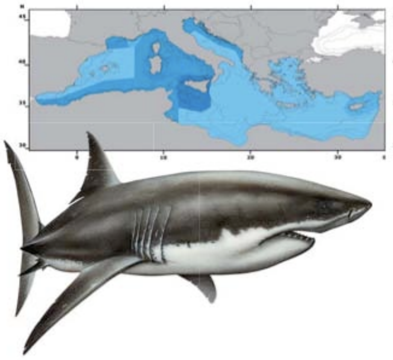

Figure 23**.** White shark (classified as EN by IUCN) distribution in the Mediterranean (Wurtz 2010)

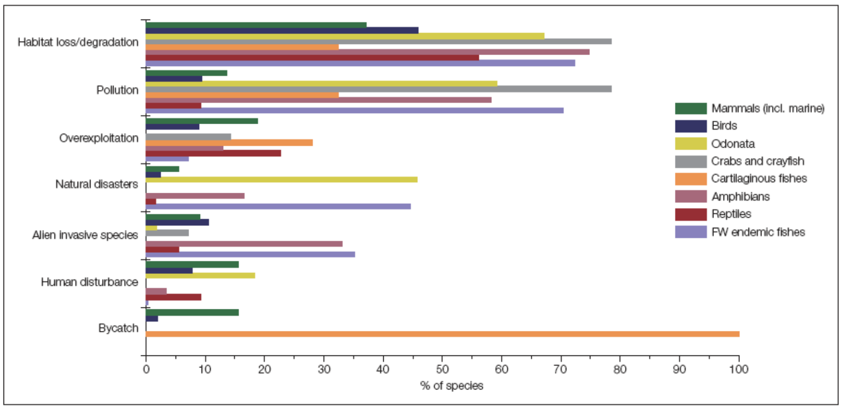

Figure 13. *Breakdown of the major threats to amphibians, birds, cartilaginous fishes, crabs and crayfish, dragonflies, endemic freshwater fishes, mammals (including marine mammals) and reptiles in the Mediterranean.*

Figure 24**.** Major threats to Mediterranean species (cartilaginous fish: orange) (Cuttelod et al 2008).

CETACEANS AND MARINE MAMMALS

23 cetacean species are known to occur in the Mediterranean and the Black Seas of which some are just visitors and nine species are year round residents in the Mediterranean (Reeves and Notarbartolo di Sciara 2006). Of the 9 assessed species in the Mediterranean, one (killer whale, strait of Gibraltar subpopulation) is considered Critically Endangered, 2 Endangered, 2 Vulnerable and 4 were Data Deficient, meaning that there was inadequate information to assess their extinction risk (Reeves & Notarbartolo di Sciara 2006).

The Mediterranean Monk Seal *Monachus monachus* is the world's most endangered pinniped (Cuttelod *et al.*, 2008). Whereas the monk seal was present throughout the basin in 1900, there are very few sightings nowadays, mainly limited to the Aegean coasts, with something in the order of 350 to 450 individuals. The species is deemed to be one of the 10 most endangered in the world and has been classified by the IUCN as being at critical risk of extinction (UNEP/MAP-Plan Bleu, 2009).

Table 4. Regular cetacean species and IUCN status (Source: Reeves & Notarbartolo di Sciara 2006)

Species / subspecies	Unit	IUCN criterion		Status: Past trend	Status: Present trend	Notes	Assessor/s
Killer Whale *Orcinus orca*	Strait of Gibraltar subpopulation	CR	C2a(i,ii); D	?	↘	Killer Whales in the Mediterranean were not assessed and are included in the "Visitor species" section	Cañadas and de Stephanis
Sperm Whale *Physeter macrocephalus*	Mediterranean subpopulation	EN	C2a(ii)	↘	↘		Notarbartolo di Sciara, Frantzis, Bearzi and Reeves
Short-beaked Common Dolphin *Delphinus delphis*	Mediterranean subpopulation	EN	A2abc	↘	↘	Assessed in 2003	Bearzi (2003)
Common Bottlenose Dolphin *Tursiops truncatus*	Mediterranean subpopulation	VU	A2cde	↘	?		Bearzi and Fortuna
Striped Dolphin *Stenella coeruleoalba*	Mediterranean subpopulation	VU	A4de	↘	↘		Aguilar
Fin Whale *Balaenoptera physalus*	Mediterranean subpopulation	DD					Notarbartolo di Sciara and Panigada
Long-finned Pilot Whale *Globicephala melas*	Mediterranean subpopulation	DD					Cañadas
Risso's Dolphin *Grampus griseus*	Mediterranean subpopulation	DD					Gaspari and Natoli
Cuvier's Beaked Whale *Ziphius cavirostris*	Mediterranean subpopulation	DD					Cañadas
Harbour Porpoise *Phocoena phocoena relicta*	Black Sea subspecies	EN	A1d + A4cde	↘	↘	Interpreted to include the animals in the northern Aegean Sea	Birkun and Frantzis
Short-beaked Common Dolphin *Delphinus delphis ponticus*	Black Sea subspecies	EN	A1d	↘	?		Birkun
Common Bottlenose Dolphin *Tursiops truncatus ponticus*	Black Sea subspecies	EN	A2cde	↘	?		Birkun

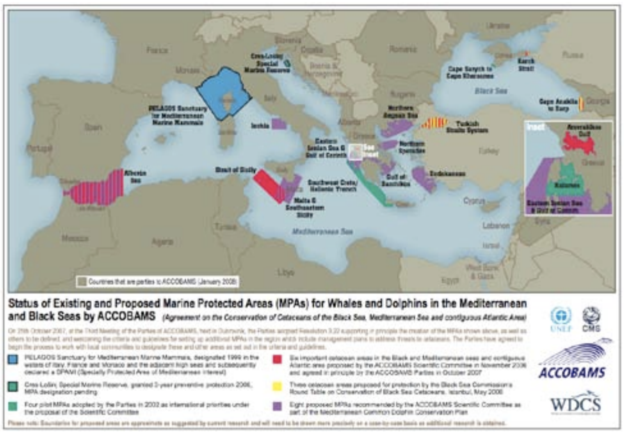

Figure 25. Mediterranean MPAs for whales and dolphins (Source: Abdulla *et al.,* 2008).

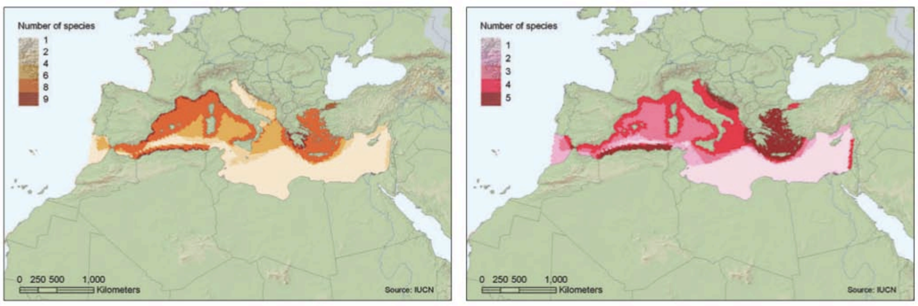

Figure 26. Species richness of existing and threatened marine mammals (Source: Cuttelod et al 2008)

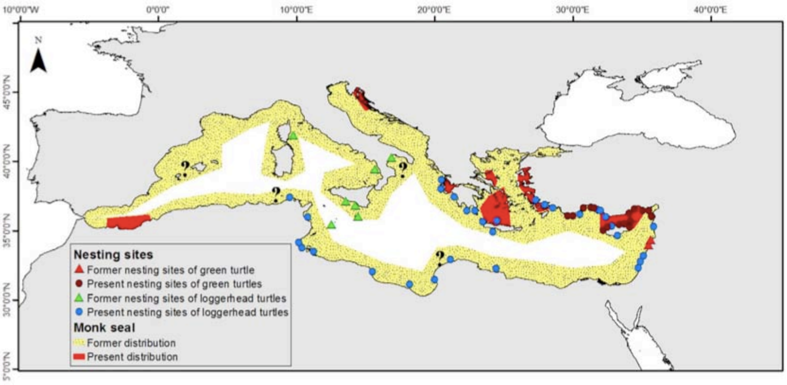

Figure 27. Former and present distribution of monk seals and marine turtles (Source: Coll et al 2010)

SEA TURTLES & REPTILES

Two species of sea turtles (the green *Chelonia mydas* and the loggerhead *Caretta caretta*) commonly occur and nest in the Mediterranean, while the leatherback turtle (*Dermochelys coriacea*) is regularly sighted but there is no evidence of nesting sites. All 3 species are listed in Annex II of the Mediterranean SPA/BD Protocol (http://www.rac-spa.org/node/30) of endangered or threatened species with a recent review pointing to variable recent population trends and historical declines in the case of loggerhead and green turtles (Casale & Margaritoulis 2010). Typical threats include habitat degradation and loss (e.g. coastal constructions, lighting), marine litter, ghost fishing and incidental catch (driftnets gillnet and longline by-catches), intentional killing, dynamite fishing, human exploitation and boat strikes (Casale & Margaritoulis 2010). The hawksbill and Kemp's riddle turtles *Eretmochelys imbricata* and *Lepidochelys kempi* are extremely rare and considered to be vagrant in the Mediterranean (Coll et al 2010).

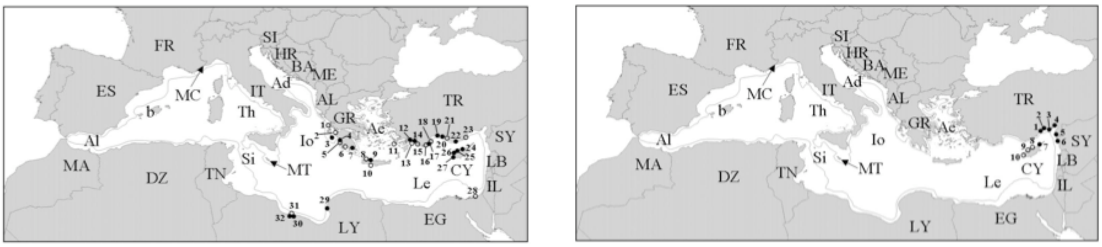

Figure 28. Major nesting sites of *C. caretta* (left) and *C. mydas* (Casale & Margaritoulis 2010)

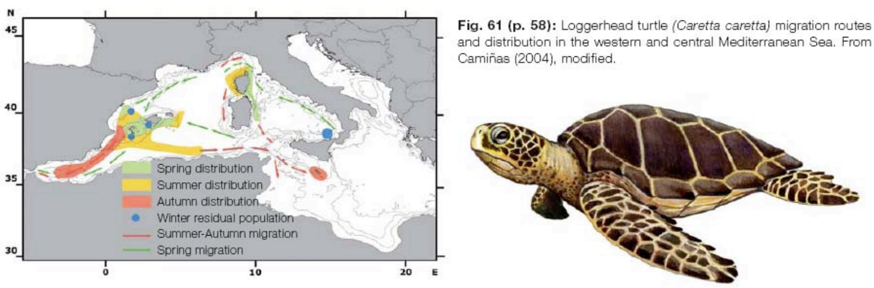

Figure 29. *C. caretta* migration routes in the Western Mediterranean (Wurtz 2010)

SEABIRDS

Seabirds from the Mediterranean have a low diversity (15 species) and their population densities are small, consistent with a relatively low-productivity ecosystem compared with open oceans, and particularly with upwelling regions. Ten of the Mediterranean species are gulls and terns (Charadriiformes), four are shearwaters and storm petrels (Procellariiformes), and one is a shag (Pelecaniformes). Three of the ten species are endemics (Coll *et al,* 2010). Most of the Mediterranean seabird species (with the exception of some large gulls) are protected by European laws because of their small or declining populations or the small number of their breeding sites. Nine species are included in Annex II of the Mediterranean SPA/BD Protocol (http://www.rac-spa.org/node/30) of endangered or threatened species. The Balearic shearwater is critically endangered (IUCN criteria), and the monitored colonies of Cory's and Mediterranean shearwaters are slowly declining (Coll et al 2010). Seabirds are vulnerable and/or highly migratory species with critical habitats and corridors (Notarbartolo di Sciara & Agardy, 2009).

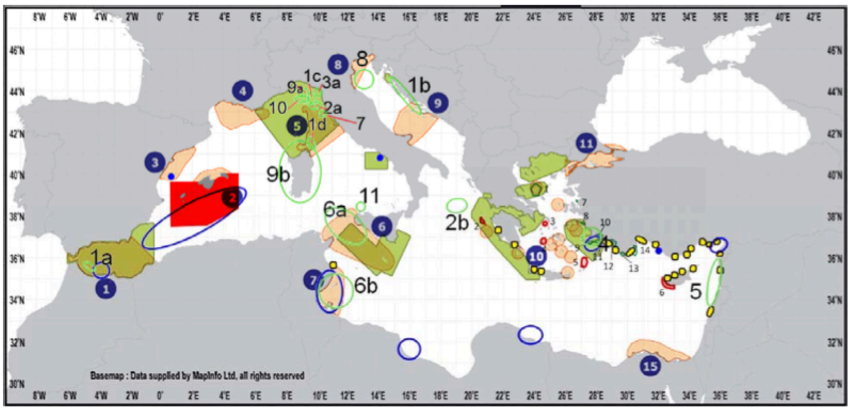

Fig. 2-10. Cetaceans, monk seal, seabirds, turtles, sharks and bluefin tuna critical habitats. Cetaceans: light green polygons; monk seal: dark green small circles (established areas) and red small circles (areas to be established); birds: pink areas; turtles: yellow circles (nesting beaches) and blue circles (feeding areas); sharks: light green circles (nursery areas of various species); bluefin tuna: red polygon (from Hoyt and Notarbartolo di Sciara, 2008).

Figure 30. Mediterranean critical seabirds habitats, source: Notarbartolo di Sciara & Agardy, 2009

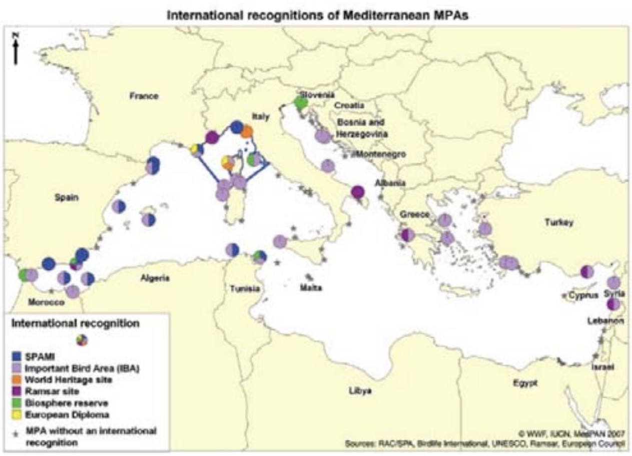

Figure 31**.** Mediterranean MPAs including important Bird areas (Source: Abdulla et al. 2008)

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SEVENTH FRAMEWORK PROGRAMME

ODEMM is funded by the EC under FP7

ISBN Number: 978-0-906370-71-1