CIESM Workshop Monographs

Marine Peace Parks in the Mediterranean – a CIESM proposal

Siracusa, 18 - 20 November 2010

CIESM Workshop Monographs ◊ 41.

To be cited as: CIESM, 2011. Marine Peace Parks in the Mediterranean – A CIESM proposal. N° 41 *in CIESM Workshop Monographs* [F. Briand Ed.], 128 pages, Monaco.

This collection offers a broad range of titles in the marine sciences, with a particular focus on emerging issues. The Monographs do not aim to present state-of-the-art reviews; they reflect the latest thinking of researchers gathered at CIESM invitation to assess existing knowledge, confront their hypotheses and perspectives, and to identify the most interesting paths for future action.

A collection founded and edited by Frédéric Briand.
Publisher : CIESM, 16 bd de Suisse, MC-98000, Monaco.

CONTENT

II – WORKSHOP COMMUNICATIONS

Proposed CIESM Marine Peace Parks.

I - Executive Summary

The Summary begins with a presentation of the "Peace Park" concept – initially developed for terrestrial habitats – followed by a short description of, and a scientific rationale for, each of the eight selected areas in the Mediterranean Sea which are detailed in the rest of the volume.

This synthesis, elaborated by Frédéric Briand, benefited from inputs received from the workshop participants, with a special mention to Jean Mascle (geodiversity, maps) and Paula Moschella (biodiversity). Enric Sala did moderate (and stimulate) the workshop discussions; Frédéric Briand reviewed the entire volume with precious editorial support from Tim Wyatt; Valérie Gollino took care of the physical production and layout.

1. Introduction

Mediterranean marine biodiversity and the ecosystem services it provides to humans are declining under the growing assaults of coastal development, tourism, fast-growing maritime traffic, oil and gas off-shore exploration, climate change, and overfishing. However, less than 2% of the Mediterranean is now under effective protection. The main reasons for this dismal level of protection are the fragmented nature of maritime governance, the poor enforcement of existing regulations, and the difficult harmonization between EU and non-EU countries in the Mediterranean Basin. Therefore there is an urgent need to rigorously define vast areas for conservation, straddling both open sea and coastal waters, if we are to preserve biodiversity and the essential services it provides. This was the main goal of CIESM workshop n. 41.

In opening the meeting, Drs Frédéric Briand and Enric Sala, respectively Director General of CIESM and Chair of the CIESM Committee on coastal systems, presented the overall background and objectives of the workshop to the 28 invited participants (see list at the end of volume). The main questions that framed the discussions were the following. How to circumvent the above obstacles to more effective conservation in the Mediterranean? How to reconcile such low protection levels with the targets defined by the Convention of Biological Diversity (CBD) at its most recent Conference in Nagoya (October 2010) – that is, protect at least 10% of the world ocean by 2020? How to move Governments of Mediterranean countries to multiply by five the coverage of marine protection within ten years?

Such was the background for the work of the international experts gathered by CIESM in the ancient, Sicilian town of Siracusa by the end of November 2011. They were asked to identify large, coast-to-coast, trans-frontier marine areas that represent key features of hydrodynamic, biological and geological importance. Protection of these areas would help achieve the CBD goals and ensure the preservation of critical Mediterranean marine ecosystems. In closing, the Director General remarked that this would provide a rare opportunity to apply the concept of 'Peace Parks' – already well tested in certain terrestrial regions of the globe – for the first time to the marine realm. In addition to strengthening marine conservation, marine Peace Parks would foster cooperation among neighbours, a rare commodity in one of the most sensitive and conflict-ridden region of the globe.

On the last day of the Meeting, the participants were joined by two high-level personalities: HSH Prince Albert II of Monaco, President of CIESM, and HE Stefania Prestigiacomo, Italian Minister for the Environment. Upon hearing the workshop conclusions and recommendations, both intervened to express their full support towards the ambitious goal of creating vast transboundary Marine Peace Parks in the Mediterranean Sea.

2. The concept of Peace Parks

Transboundary protected areas were first developed in terrestrial environments with the clear, explicit objective to conserve biodiversity while fostering regional cooperation, peace and security over countries whose relations are strained, or in regions where border disputes and conflicts are still unresolved (McNeil, 1990; Hamilton *et al.*, 1996). Even in areas clear of any trans-frontier political issue, peace parks contribute to develop collaboration, smooth cultural and technical imbalances, and enhance socio-economic exchanges (for more details on historic and political background, see Mackelworth, this volume).

The definition by Sandwith *et al.* (2001) adequately illustrates the Peace Park concept:

'transboundary protected areas that are formally dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, and to the promotion of peace and cooperation'

The benefits of trans-frontier peace parks for conservation purposes are many. From the biological perspective, the larger zone of protection so created (1) substantially preserves all the components of ecosystems straddling across countries; (2) embraces habitats for migratory or highly mobile species and increases regional connectivity for larval dispersal; and (3) helps face environmental changes. Further, from the management perspective, opportunities for staff exchange and joint training and initiatives at various levels promote mutual understanding between different approaches, different jurisdictions, and thus optimize conservation of large areas, as shown by the success of transboundary cooperation in the Wadden Sea shared by the Netherlands, Denmark and Germany <http://www.waddensea-secretariat.org/>.

The creation of trans-frontier 'peace parks' will safeguard and improve existing friendly relations between States, and lower the strain of existing disputes over contested territory. This is particularly desirable in the Mediterranean Sea, where historical conflicts and ideological tensions are the rule. To date, peace parks have been conceived only for the terrestrial environment. Recent attempts in the Gulf of Aqaba and the Korean Peninsula have met with considerable difficulties and are still at the stage of promises.

It remains that the trans-boundary dynamics of the marine environment, as well as the legal disputes regarding ownership over sea territories or boundaries, make the case for the establishment of marine peace park even more compelling.

3. An innovative, ecosystem-based solution

The CIESM proposal innovates in combining three powerful, unique features, which can be summarized as such: coast-to-coast, geo- and hydrodynamics diversity, trans-frontier.

3.1. Coast-to coast – the importance of marine connections for maintaining biodiversity

Marine peace parks will integrate contiguous coastal and open sea habitats, allowing for a coherent set of measures to protect a dynamic, inter-connected marine system. The dimension of the park will provide a more suitable range and connecting corridors to larger animals that actively move across the seascape, enhancing the robustness and resilience of the ecosystem in the face of climate change, and thus ultimately enhancing resource yields and local economies.

Traditional Marine Protected Areas (MPAs) have often been the object of debates on whether or not they exert effective conservation of marine species, especially with respect to population dynamics and larval dispersal (Willis *et al.*, 2003; Cowen *et al.*, 2007). In most cases MPAs are very limited in size and isolated, and they rarely extend beyond a few nautical miles offshore. The survival and perpetuation of populations of many benthic organisms, fish and cephalopods depend on their larval dispersal and on the connectivity between the sources and sinks of larvae.

Recruitment success of "local" populations may sometimes rely on sub-regional larval supply when local larval sources are hindered by environmental or anthropogenic factors (Bode *et al.*, 2006). The scale of connectivity also plays an essential role in genetic interchange and biogeography of coastal species (Cowen *et al.*, 2006).

Preserving the connections between coastal and marine ecosystems, including the open sea, is also vital to highly mobile animals, namely top predators such as tuna, sharks, turtles, seals, cetaceans and birds. Marine corridors, which are defined by oceanographic and geo-morphological features, are used as "channels" along which wide-ranging animals can migrate from one area to another, either to reproduce, feed or simply escape from environmental changes or anthropogenic threats (Good, 1998). In the Mediterranean Sea many endangered or threatened species migrate seasonally across sub-regional seas to reach remote breeding sites or feeding grounds. For example, different routes between the coast of Cyprus and Turkey have been observed for the green (*Chelonia mydas*) and leatherback (*Caretta caretta*) sea turtles and the monk seal *Monachus monachus* (Gucu *et al.*, this volume). Several important migratory routes in the Gibraltar/Alboran area, the North Ionian and the Levant are well known for fin whales (*Balaenoptera physalus*), sperm whales (*Physeter macrocephalus*), bluefin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*) and other large predators (see in this volume: Aguilar *et al.*; Fraschetti *et al.*; Mascle *et al.*). Coastal-marine corridors are also important for migratory marine birds that cross the straits and use coastal and marine wetlands as well as islands to rest, feed and reproduce. The Sicily Channel is one of the main bird migration routes between Europe and Africa, and many procellariiforms (shearwaters, storm petrels) use offshore islands located in the Channel to breed (Vella *et al.*, this volume; RAC/SPA, 2010). Furthermore, the coastal region between southern Montenegro and northern Albania is also a part of one of the three migration routes of European birds in the direction north – south (Beqiraj *et al.*, this volume; Holcer *et al.*, 2010).

Unfortunately, in the Mediterranean ecological corridors overlap with important shipping seaways, intensive fishery areas, and highly urbanized coastlines; thus the human pressures on these wide-ranging species are enormous and the protection efforts of small coastal areas remain irrelevant with respect to the scale of threats.

The proximity of the continental shelf of the north and south shore of the Basin makes most high seas, especially vulnerable deep-sea areas, strongly linked with the coastal ecosystems via oceanographic (currents, up-welling), physico-chemical (biogeochemical cycles) and biological (food chains) connections, which also imply unavoidable transfers of pollutants. Estuarine, coastal and marine ecosystems thus form a *continuum,* and large-scale marine conservation is credible only by means of harmonised protection measures across the different systems.

3.2. Geo- and hydrodynamic diversity – unique features essential to ecosystem functioning and resilience

Not only will Marine Peace Parks preserve an endemic, threatened biota (unique deep-sea communities, white coral beds, monk seals, rare endemic species, fin whales, spawning grounds of bluefin tuna, etc.), but they will also protect unique geological features (deep sea canyons, mud volcanoes, seamounts, hypersaline basins), and key oceanographic processes (surface sites of deep water formation, strait fluxes) from the fast-growing exploitation of marine resources by modern technology.

3.2.1 Geodiversity

The Mediterranean Sea has a long and complex geological history (see CIESM, 2003; 2007) characterized by dramatic long-term events, major catastrophes, past and recent tectonic deformations, which left peculiar geological imprints (outcrops, tectonics) in several areas of the Eastern and Western basins (Mascle, this volume) and large topographic features such as seamounts where site-specific ecosystems developed.

Seamounts are considered hotspots of biodiversity worldwide; these submarine mountains provide unique habitats and support a highly diverse benthic and mobile fauna, yet only few have been explored and studied to date (see CIESM, 2003; Galil and Zibrowius, 1998). At the same time, seamounts have attracted much interest from the fishing industry and until recently they were

exploited intensively with highly impacting techniques (e.g. bottom trawling, drift nets) leading to rapid decline of commercial deep-water fish and benthic species (CIESM, 2003). Although fishing impacts have been put under some control by the international ban of bottom trawling below 1000m, deep-sea oil exploration is intensifying, adding extra pressure to these highly vulnerable ecosystems. The protection of these geological features such as the dominant Eratosthenes seamount and the associated communities is thus highly advocated (Mascle *et al.*, this volume).

Along the steep continental slopes, other geological features such as rocky outcrops and marine canyons offer suitable habitats for settlement of hard bottom communities like gorgonians (*Paramuricea clavata*, *Eunicella* spp.) and deep-water corals (*Lophelia pertusa, Madrepora oculata*).

In addition to tectonic movements, the Basin is also subject to a variety of active volcanic and geochemical processes. Hydrothermal vents, particularly numerous in the Tyrrhenian Sea, South Aegean and Sicily Channel, are the site for specialized communities adapted to the hot temperature of waters surrounding the vents (Danovaro *et al.*, 2010). In the deep Eastern Mediterranean, several types of fluid seepages were recently discovered, making this region unique for its rich geo-diversity (Mascle, this volume). Around the Egyptian continental slope, hundreds of these cold fluid seepages are emitted from depressions pockmarks and mounds on the seabed (pockmarks), where highly specialized bacterial communities contribute to build peculiar carbonate structures (Mascle *et al.*, this volume).

Another geo-specific process leads to mud volcanoes and gas chimneys, mounds made of sediment rich in organic matter from which cold seeps containing methane and sulfide gases are produced. Hundreds of mud volcanoes are scattered across the Mediterranean Sea (CIESM, 2005), in particular along the Ibero-Moroccan Gulf (Aguilar *et al.*, this volume), on the Mediterranean Ridge, and on the Anaximander Mountains (Mascle *et al.*; Giakoumi *et al.*, this volume).

Pockmarks and mud volcanoes host a peculiar benthic macro- and megafauna, often in dense aggregations, consisting of bivalves, gastropods, giant tubeworms (*Siboglinidae*) sponges (*Rhizaxinella pyrifera*) and crabs (*Chaceon mediterraneus*) which are endemic to the Mediterranean (CIESM, 2003). Such communities exist thanks to a symbiotic association with an extremely rich and diverse chemosynthetic bacterial assemblage developed around these special geo-chemical environments.

On the Mediterranean Ridge, in particular on Napoli mud volcano (Mascle *et al.*, this volume), and on the foot of the Egyptian margin (Cheffren volcano, Mascle *et al.*, this volume) extensive deep sea hypersaline lakes and smaller brine ponds containing salt-rich fluids that emerge from sediments have been recently discovered. In these hyper-saline and anoxic basins, a large variety of microorganisms belonging to the *Bacteria* and *Archaea* worlds have been detected, including new prokaryotic taxa (CIESM, 2003).

3.2.2 Hydrodynamic diversity

The water circulation of the entire Mediterranean Basin, including the main Mediterranean deep out-flowing waters and the Atlantic surface inflowing waters, is strongly affected by a peculiar climate and wind regime that, together with the complex seabed morphology, determine the formation of deep, dense water masses as well as mesoscale features such as gyres and eddies (CIESM, 2005; 2009; Gacic, this volume;). These, in turn, play a major role in triggering phytoplankton blooms through water mixing and upwelling of nutrients, with effects on the entire food web. Coastal hydrodynamics (currents, tides, upwelling and water stratification) and other offshore meso- and large-scale processes are essential for larval transport and contribute significantly to population connectivity (Pineda *et al.*, 2007). Sea currents also mark the “routes” for migratory species such as tuna, cetaceans, sharks and marine turtles. Such hydrodynamic features have to be taken into account when considering the protection of species, especially highly mobile species. All the proposed parks enclose at least some of these important hydrodynamic features.

Straits represent often choke points where the exchange of water masses generates mesoscale features and upwelling phenomena; for example the area adjacent to the Strait of Gibraltar hosts two semi-permanent gyres, the Alboran Gyres, with distinct oceanographic and biogeochemical and properties and in the near Alboran Sea (Gacic *et al.*, this volume). Similarly, the Strait of Sicily (Pelagian Sea Park), the Strait of Otranto (North Ionian Park) and neighbouring areas are characterized by semi-permanent features, such as eddies and gyres. Periodical or semi-permanent gyres are also quite frequent in the Eastern Basin such as the Rhodes Gyre in the Aegean Sea (South Aegean Park), the Ierapetra eddy and Mersa-Matruth (Herodotus Park) gyre located south east of Crete. The special hydrodynamics and nutrient upwellings properties characterizing these structures have been found to generate primary productivity and bacterial biomass notably higher than in the surrounding oligotrophic waters (Denis *et al.*, 2010; Robarts *et al.*, 1996). The South Adriatic Gyre, located within the South Adriatic Park, is also the site of strong seasonal phytoplankton blooms resulting from vertical convection and nutrient input in the euphotic layer.

There are other important oceanographic structures that play an important role in Mediterranean biodiversity. It is the case for the peculiar circulation system between the South Adriatic and the Northern Ionian, characterized by a bimodal oscillating system (BiOS) that regulates the alternation of anticyclonic and cyclonic phases for the Northern Ionian Gyre (see North Ionian Park). These periodic inversions determine the influx of Modified Atlantic waters and Levantine waters into the Adriatic, which likely facilitate the presence of allochtonous species (and probably native species of different thermohaline affinity) from the Western Atlantic/Western Mediterranean and Eastern Mediterranean respectively (Civitarese *et al.*, 2010).

The complexity and variability of Mediterranean hydrodynamics is not completely independent from anthropogenic pressures. While the main oceanographic features result from regional climate and wind regime, the thermohaline and other dynamic properties of the Mediterranean circulation can be severely affected by human activities. For instance the drastic reduction of freshwater input to the eastern Basin following the Assuan damming of the Nile led in the long-term to an increased salinity, which affected not only the thermohaline dynamics of the Cretan Sea and the Eastern Mediterranean climatic transient, but also the deep water formation process in the Gulf of Lions and South Adriatic (CIESM, 2000; Skliris and Lascaratos, 2004).

3.3 Trans-frontier

On land, internationally designated protected areas are relatively spread worldwide and in most cases their management requires coordination of conservation measures over a territory that encompasses two or more countries and where borders are clearly defined. Each country then applies the commonly agreed conservation policy on its own territory, where it exerts sovereign rights.

At sea, political borders are often disputed, and there are still a lot of discussions and negotiations over legal definitions and rights of use related to sea ownership issues. Further, beyond Economic Exclusive Zones (EEZs), the high seas do not fall under the control of any particular State and can be used and exploited by all (part V, UNCLOS, 1982). This has led to various controversies related to the use of the sea for fishing, oil exploitation, maritime transport and military activities (Ronzitti, 2010).

The complex historical and political context of the Mediterranean Basin, and its geographic conformation, where few coastal areas are farther than 200 nautical miles away from waters under another jurisdiction, makes even more difficult a correct interpretation of the law of the sea and increasingly hampers international scientific research. To date, a large number of legal disputes, some very ancient, others quite modern, are still unresolved.

The trans-frontier structure of the CIESM Marine Peace Parks puts this problem aside: it will encourage, without prejudice to current national claims, the Governments of those countries directly concerned to join forces and develop joint planning in the pursuit of a cause higher than their national interest. In addition, the ‘borders’ of the proposed marine peace parks do not follow political boundaries, but delimit coastal and marine ecosystems hosting key features of high natural value.

3.3.1. Beyond national jurisdiction – legal and policy implications for transboundary marine peace parks in the Mediterranean

The 'High Seas' (international waters) are less and less considered as a sort of "no man's land". The sustainable conservation of marine habitats and species is explicitly considered in the UN Convention of the Sea (UNCLOS) and several international conventions and treaties (Shine and Scovazzi, 2007). At the regional level, the Protocol concerning specially protected areas and biological diversity in the Mediterranean (Barcelona Convention, 1976, amended 1995) provides a well-constructed policy framework to establish specially protected areas of Mediterranean interest (SPAMI) that would include both coastal and open seas.

In the Mediterranean, the progressive establishment of Exclusive Economic Zones (EEZs) (Fig. 1) may help resolve the inconsistency of conservation policies on the high seas since their extension, up to 200 nautical miles from the baseline of territorial waters, would in fact cover all of the Mediterranean. While EEZs attribute exclusive rights to the coastal State, they also involve duties as detailed in the part V of UNCLOS. In particular, Art. 61 to Art. 68 specifically address the conservation and management of marine resources in EEZs, including marine mammals and highly migratory species, with clear indications given on the legal rights a coastal State can exercise to implement and enforce conservation legislation. Thus the legal framework of EEZs may increase, rather than diminish, the efficiency of conservation regulations in the Mediterranean Sea, provided that these are ratified by a formal agreement between the concerned countries.

Figure 1. Current and potential exclusive zones in the Mediterranean Sea.

CIESM Marine Peace Parks, by providing an explicit, formal agreement of cooperation between two or more signatory countries, will improve their political relations and facilitate settlement of unresolved claims over territorial waters, as well as ensure a correct interpretation/use of EEZs. The implementation of a common conservation policy over large sectors of coastal and offshore waters will complement and strengthen the framework of existing conventions.

3.3.2 The Pelagos Sanctuary – lessons to learn

In 1999 the Ministries of the Environment of France, Italy and the State Ministry of Monaco signed an agreement to designate within the Corsican-Ligurian-Provençal Basin a large sector of territorial and high seas as the International Sanctuary for Mediterranean Marine Mammals. The agreement of the Pelagos Sanctuary, which came into force in 2002, aimed at protecting Mediterranean cetaceans and their feeding and breeding grounds from the effects of increasing human pressures in the region (for a detailed review of the Sanctuary; see Notarbartolo di Sciara *et al.*, 2008).

From the legal point of view, the Sanctuary represented an unprecedented achievement: for the first time in the Mediterranean, the proposal of creating a large, internationally protected area on the high seas was endorsed at high political level and a solid legislative basis was established to implement a wide range of conservation measures. Still, nine years after its creation, the efficiency of the Sanctuary in protecting marine mammals is an open question, as many researchers and NGOs see no improvement in the conservation status of cetacean populations which, for certain species such as the fin whale (*Balaenoptera physalus*) and striped dolphins (*Stenella coeruleoalba*) apparently has worsened.

The lack of an *ad hoc* management body with clear mandates, executive power and sufficient human and financial resources, has been pointed out has one of the main reasons for failure in meeting the conservation goals (Notarbartolo di Sciara *et al.*, 2009). An intrinsic weakness of the Sanctuary resides however in the reluctance of the three concerned countries in establishing EEZs, which would cover the open sea sector of the Sanctuary; without such zones, the full enforcement of protection regulations remains limited to territorial waters, since in high seas the third States are not bound by the Agreement. This means that any vessel (fishing boats, ferries, cargoes, etc.) flying other than French, Italian or Monegasque flags, is not obliged to comply with protection measures beyond the 12 nautical miles limits unless these overlap with other international or European treaties/directives. This legal limitation is not negligible: more than 50% of the Sanctuary covers high seas where threats such as illegal driftnet fishing, acoustic pollution, oil exploration and collisions are out of control (Notarbartolo di Sciara *et al.*, 2008).

4. Potential links with existing and planned national protection schemes

In the Mediterranean Sea, despite the minimal total area protected, a large variety of designation schemes exist (RAMSAR, Biosphere, MPA, SPAMI, PSSA, etc.), and several international, regional and national conservation organizations work to meet the 2020 CBD objective. The eight Marine Peace Parks proposed by CIESM, which embrace a variety of existing marine reserves (Fig. 2), could act as a convenient umbrella and forum to promote dialogue and develop synergies among the different conservation actors and stakeholders involved in these areas. A further, more concrete step would be to establish within each area a sub-regional network of MPA managers. Each sub-regional network could be:

- coordinated by all involved countries using or a common Secretariat (pooling resources to enhance the network); such a system has been adopted by the Pelagos Sanctuary;
- initiated by one MPA management body, considered to be particularly dynamic or managing a considerable protected zone; the network can then remain informal or become more institutional (with members officially appointed); as an example, in the Adriatic the MPA “Torre del Cerrano” created the Adriapan network; as above, but initiated by one country rather then a management body, it would be the case for the Pelagian Sea Park;
- managed by an international organization or a Foundation.

Figure 2. The eight CIESM Marine Peace Parks proposed by CIESM including the existing marine protected areas.

The MedPAN regional network could have the role of facilitating the creation and linking of sub-regional networks. The progress made by MPA networks should be monitored with the establishment of a Mediterranean MPA database shared between the regional, national and local network partners. The aim is to evaluate the progress made in the Mediterranean with respect to the CBD objectives and to draw up a regional report to be used as a discussion document for the MPA managers, the socio-economic stakeholders and the international, European, Mediterranean and national decision-makers.

5. Marine peace parks in the Mediterranean – the challenges and the opportunities

Moving towards the implementation of Marine Peace Parks in the Mediterranean will be a huge challenge, as the fate of recent attempts (Gulf of Aqaba, Korean Peninsula) amply demonstrates. The Mediterranean Basin is also one of the most impacted, semi-enclosed seas, where human pressures (maritime transport, coastal development, overfishing, etc.) are at peak levels. Against such a background, the idea is not to establish full protection over vast areas of the Mediterranean that depend on maritime resources and economics. Marine Peace Parks should be considered rather as dynamic "conservation experiments" where sound, harmonised spatial planning is adopted by the concerned countries to allocate within each park distinct zones with different levels of protection. For example, vessels transporting dangerous substances would follow well-defined maritime corridors, away from particularly vulnerable areas. Other zones would be temporarily restricted to fishing during the spawning season, allowing for the replenishment of fish stocks. Such dynamic conservation measures will be possible only by close, formal cooperation among the countries, starting from high political levels to conservation managers and local councils.

5.1. Coordinated scientific research – making the case for 2020 conservation target

While a lot of efforts are invested in pushing decision makers to designate coastal and marine reserves, relatively little resources are used to provide scientific evidence of the natural value of the candidate area. The implementation of a proper spatial planning and zonation to protect not only the target species and habitats but also key geo-oceanographic hotspots, requires harmonised multidisciplinary research to fully understand the dynamic processes and ecological interactions regulating ecosystem functioning and sustainability. Often, there is virtually no information on the ecological features of the zone, especially on the high seas. In June 2010, the Eratosthenes seamount was proposed as candidate SPAMI but subsequently rejected by Cyprus due to its potential for oil exploration (UNEP-RAC/SPA report, Istanbul, 2010). If valid scientific data supporting the extreme value of geological and biological features associated to this seamount

were available – the only published biological data being by Galil and Zibrowius in 1998 – this might help Cyprus to reconsider its position, at least with respect to the use and exploitation priorities of this zone.

As recognized in UNCLOS and other treaties and conventions, countries should co-operate in order to achieve the best scientific evidence prior to the implementation of proper conservation and management measures (EEZ, Art. 61), coordinate their scientific research policies and undertake joint programmes of scientific research in the area concerned (UNCLOS, Art. 123). International research can be an influential instrument to improve political relations between countries and promote transboundary cooperation in many sectors. The century-old experience of the Mediterranean Science Commission demonstrates how scientific collaborations overcome the political and cultural barriers.

5.2. Goals for concerned countries

The creation, development and maintenance on a long-term basis of efficient marine peace parks involve a complex, time-consuming process. Clearly the political, administrative and scientific challenges should not be underestimated. In particular the following steps:

reach formal agreement at high political level within (through dialogue among the relevant Ministries) and between countries (through dialogue between State leaders) for cooperation over the concerned marine park area to develop a common conservation policy and legislation, especially when EEZs are in effect or are being established by the interested countries;

jointly design and enforce pragmatic, dynamic measures, such as spatial zoning, temporary restrictions of fishing, restricted navigation corridors, optimal location of off-shore drilling operations, etc.;

increase cooperation, training and coordination between national agencies across the border and establish sub-regional networks linking national and international nature designated areas;

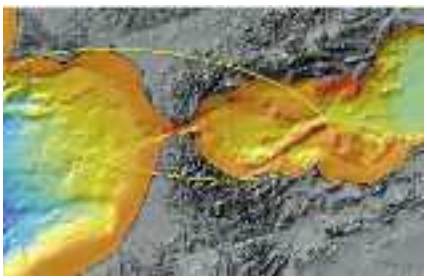
develop and manage joint research programs and data sets that will provide ground scientific knowledge for sound spatial planning as well as monitoring the effectiveness of conservation measures following the marine peace park designation.

Creating a marine peace park, setting up its conservation objectives and the measures to achieve them, will have to be a dynamic, adaptive process. If we consider nature as a fixed, static compartment, there will be always a mismatch between what advocated on paper and the marine world.

6. Preview of Marine Peace Parks proposed by CIESM

The reader will find in the following pages a synthesis of the key geological, oceanographic and biological features of high conservation value, together with the main anthropogenic threats, that characterize each selected area.

6.1 The Near Atlantic Peace Park



The whole area of Ibero-Moroccan Gulf, Strait of Gibraltar and the Alboran Sea constitutes the transition from the Atlantic Ocean to the Mediterranean Sea, with all the special interest that this entails from geological, oceanographic, and biological perspectives. This area presents a very high level of species richness due the co-existence of species from three marine biogeographic regions (Mediterranean, Lusitanian and Mauritanian provinces), plus some endemic species restricted to this zone. It also represents an obligate pathway for migratory vertebrates between the Atlantic and the Mediterranean: large pelagic fishes, cetaceans and sea turtles are very frequently observed in the area.

Key features in need of protection

- The area constitutes the "engine" where the Mediterranean water originates, playing a key control of the exchanges and modifications of the biogeochemical cycles and circulation of the entire Mediterranean;

- More than 100 mud volcanoes and many fluid escape structures have been detected scattered around the whole Ibero-Maroccan Gulf;

- A major hotspot of biodiversity, with the highest species richness in the European/North African waters;

- Unique communities, dominated by Atlantic seaweed, such us forests of *Laminaria ochroleuca* and *Saccorhyza polyschide*s, or by the north African gorgonian *Ellisella paraplexauroides*;

- Some living deep coral banks (*Lophelia pertusa*, *Madrepora oculata*) have been found near the Alboran Island and on the Chella Seamount;

- It hosts several threatened and endangered vertebrate species, including those migrating from the Atlantic to the Mediterranean; the most threatened invertebrate species of the Mediterranean, *Patella ferruginea*, concentrates most of its population in this area.

Complementary information

Extensive volcanism is expressed in the Alboran Sea with several seamounts (Chella, Djbouti, and Motril seamounts in its northern part, and Alidae, Cabliers, Porvençaux, Tofiño and Xauen in its southern parts). The Gulf of Cadiz, which is located west of the Gibraltar Arc, is characterized by mud volcanoes and fluid escape structures that formed in connection to a complex tectonics history with several episodes of extension, strike-slip and compressions. Other mud volcanoes and diapiric structures with carbonate chimneys and crusts were discovered along or in close proximity of the main channels of the Mediterranean outflow water for a total of 100 volcanoes in the whole area. All these geological features host a unique and highly diverse fauna, including living white coral reefs (*Madrepora oculata, Lophelia pertusa*) and other deep sea benthic species such as corals and gorgonians (*Desmophyllum dianthus, Dendrobrachia sarmentosa*) and sponges (*Asconema setubalense, Asbestopluma hypogea*).

The entire area is of prime importance for hydrological processes. The stratification of waters in the Strait of Gibraltar, with a top layer of less saline inflowing Atlantic water, and a deeper and narrower outflowing layer of more saline, Mediterranean waters, facilitates the passing from the Atlantic to the Mediterranean of pelagic fauna and planktonic organisms, including larvae. The Alboran Sea hosts key oceanographic features that significantly contribute to the diversity and distribution of the biota. Two large anticyclonic gyres generate upwellings in the deep waters inshore of Malaga and Granada and a dense oceanic front, the Almeria-Oran front, separates the Alboran Sea from the rest of the Basin, acting as a biogeographic barrier for many plankton species and larvae.

The region displays the highest values of species richness in the Mediterranean Sea, probably due to a wide range of physico-chemical conditions, to the co-existence of species from three marine biogeographical regions (Atlantic, north Africa and Mediterranean), plus some locally endemic species. The Gibraltar Strait is an obligate migration path for many marine mammals, large pelagics (*Xiphias gladius, Istiophorus albicans*, *Thunnus thynnus*) and sea turtles (*Caretta caretta, Dermochelys coriacea)*. Many of these species are commonly observed or even resident in the Alboran Sea (*Balaenoptera acutorostrata, Balaenoptera physalis, Physeter macrocephalus, Globicephala melas, Tursiops truncatus*). Among resident species, the short-beaked common dolphin (*Delphinus delphis*) merits particular attention, because its population in the Alboran Sea is the healthiest in the Mediterranean, after a dramatic decline of this species in most of its Mediterranean range.

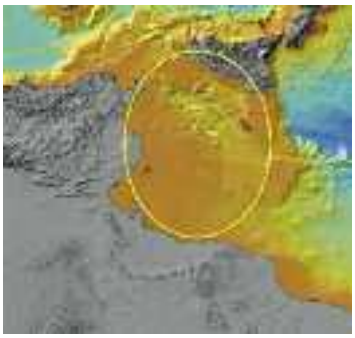
A population of the green turtle *Caretta caretta* also thrives in the area thanks to periodic proliferations of the swimming crab *Polybius henslowii*, which is its primary food resource there.

Major pressures

The entire area concentrates a large variety of human activities and a very intense maritime traffic. Coastal development, chemical pollution, military manoeuvres, oil facilities and pipelines, off-shore energetic developments, harbour constructions, sea bottom mining, sand dredging, are just some of the threats. Fishery is the main threat for this zone, with several fishing ports exerting enormous pressures on this system through an intensive fishing effort. Not only large pelagics, but also demersal and deep sea fishes, are intensively exploited causing serious decline of fish stocks as well as bycatch impacts on cetaceans and turtles passing through the Strait of Gibraltar.

Countries : Monaco, Spain

6.2 The Pelagian Sea Peace Park



Being a transitional zone between the Eastern and Western basins of the Mediterranean Sea, the Sicily Channel is an area of high productivity – coupled with important pelagic and demersal fisheries – and one of the Mediterranean marine biodiversity hotspots. Because of its geographical position, the area is influenced by human activities, in particular maritime traffic and coastal development that generate a heavy pressure on the marine environment.

Key features in need of protection

- A complex and shallow orography with seamounts, volcanic islands and submerged volcanoes, slow-flux seeps and pockmarks;
- Active volcanic processes, leading to expulsions of warm fluids that may be leading to hot spots of specific symbiotic biological communities;
- An "ocean triad" – enrichment processes (upwelling, mixing), concentration processes (convergence) and processes favouring retention of eggs and larvae within - or drift towards – appropriate habitat (fronts, vortices);
- A feeding, spawning and nursery ground for many species of ecological (white shark, fin whale, bottlenose dolphin, devils' ray, loggerhead turtle, white corals) and economic importance (bluefin tuna, sword fish, greater fork beard, hake, red mullet and pink shrimp);
- Rare or endemic species unique of this area, such as the Maltese ray *Leucoraja melitensis* and the colonial scleractinian coral *Cladopsammia rolandi*;
- One of the main bird migration routes between Europe and Africa and an important breeding site for procellariiforms.

Complementary information

Located along the African/ Europe plate boundary, the Pelagian Sea is an area of active tectonics cut by large grabens (Pantelleria, Malta)

and intruded by few active submerged and emerged volcanoes.

The two main currents, the W-E Atlantic surface water and the denser, deeper E- W Mediterranean water, convey high amounts of energy which interact with the complex seabed orography and the dominant winds, forming peculiar hydrographic features (upwelling, mixing, gyres) in the area. These generate high biological productivity, resulting in high diversity and biomass of pelagic and demersal fish. The Sicily Strait and the area around Malta still remain a major fishing ground for the bluefin tuna *Thunnus thynnus,* whose stocks are declining.

Essential Fish Habitats (EFH) have been identified in the form of spawning aggregations and nursery grounds of hake (*Merluccius merluccius*) at 100 - 200m on the Adventure and Malta Banks; nursery grounds of the greater fork beard (*Phycis blennoides*) at 200 - 400m on Adventure Bank and in the eastern Straits; spawning and nursery grounds of the red mullet (*Mullus barbatus*) to 100m on Adventure and Malta Banks. Pink shrimp (*Parapenaeus longirostris*) spawning and nursery grounds do coincide with the Adventure Bank and the Ionian Shelf vortices, respectively.

Nesting colonies of the endangered loggerhead turtle (*Caretta caretta*) still exist on the islands of Lampedusa and Linosa in the Pelagie Archipelago. The area off the coastline of Lampedusa is a feeding ground for the fin whale (*Balaenoptera physalus*) and possibly bottlenose dolphin (*Tursiops truncatus*).

The region is also one of the main migration pathways for many birds such as shearwaters, storm petrels. Breeding colonies of Cory's shearwater (*Calonectris diomedea*) exist on islands and rocky coastline of the Sicilian Straits.

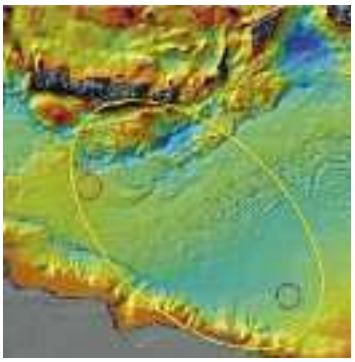
Habitat forming key species are a rare feature of this area: the Mediterranean endemic scleractinian coral *Cladopsammia rolandi*, white coral mounds composed of *Lophelia pertusa, Madrepora oculata,* the yellow tree coral *Dendrophyllia cornigera*, the octocorals *Isidella elongata*, red coral *Corallium rubrum* and *Funiculina quadrangularis* create unique habitats characterised by high biodiversity.

Major pressures

In the area several human activities are present, mainly fishing, aquaculture, shipping and tourism while others are planned like wind farm plants. Furthermore, extensive oil exploration takes place in the zone. As several concessions for oil exploration in the Sicily Strait have been recently granted by the Italian government, creating a marine park in the region represents a urgent priority. The windmill development (59 marine windmills planned in the Bank of Talbot) adds up further threats to the ecosystem. The intensive fishing efforts, especially for pelagic species (bluefin tuna, swordfish) and the dolphin fish *Coryphaena hippurus* are seriously undermining the important stocks in the area.

Countries : Italy, Malta, Tunisia

6.3 Herodotus Peace Park



The proposed Herodotus Marine Peace Park extends between the coasts of Greece (South-eastern Crete) and of Egypt (Western Desert) and covers parts of the Libyan EEZ.

The area covers three main geological domains: (a) the passive African continental margin of Egypt (and partly Libya), including the northwestern most corner of the Nile deep sea fan sedimentary construction, (b) the seismically active continental margin which borders the island of Crete and, (c) between both continental margin segments, a huge pile of tectonized sediments - 'the Mediterranean Ridge' - which results from the pilling up and strong deformations of sediments squeezed between the two rigid margins.

Key features in need of protection

- The occurrence of very abrupt and rocky continental slopes, particularly south of Crete, where deep sea corals and others fixed organisms have been observed but are still poorly studied;

- The temporary presence of some of the most popular migratory species, which should be better preserved in regions where they are reproducing or nesting; among them several species of Cetaceans (sperm whales, Cuvier's beaked whales, four dolphin species) and of sea turtles;

- The area is a major corridor for the migration of many bird species;

- Several persistent gyres (Ierapetra gyre for example), inducing local important variation in productivity, characterize the domain;

- Another specificity of the area, and particularly of the deep sea (2000 to 3000m) is the presence of deep-sea cold fluid seep fields, whose activities induce the developments of unique deep-sea environments and of microbial-related biodiversity hot spots.

Complementary information

Fluid seepage is an example of specific "geo-diversity" and its impact on deep-sea environments. In the Herodotus zone, fluids are emitted directly on the seafloor in two distinct settings: (a) within the Mediterranean ridge where they are closely linked to massive emissions of under-compacted and over-pressured mud known as mud volcanoes, and (b) at the foot of the Nile submarine sedimentary construction on the Egyptian continental slope.

On the Mediterranean ridge the Olympic field (red circle on figure), a group of several mud volcanoes discovered some 15 years ago, has been studied in detail since 2000, in particular the Napoli mud volcano. This structure, which lies by 2000m water depth, shows on its active top small sub-circular brine ponds, brine rivers, resulting from a mixing of mud, fluids and remobilized salt-rich sediments; the emitted gas, particularly biogenic and thermogenic methane, are degraded by specific Bacteria/Archeo *consortia* which favour chemosynthetic symbiosis with worms, lamellibranches, sea urchins and others species, such as crabs and fishes taking advantage of this seabed food supply. In others words cold fluid seeps are at the basis of oasis of life created in particularly extreme environments.

Similar processes are operating at the foot of the Egyptian continental margin by 3000m water depth (blue circle on figure); there the fluids are clearly originating from a deeply buried petroleum system and are similarly mixing with dissolved salt layers and over-pressured mud to generate small mud volcanoes and important gas chimneys. They also participate through chemosynthesic processes initiated by Bacteria/Archea *consortia*, degrading CH_4 and others components, to specific biodiversity hot spots, which were totally unknown until very recently. It is most important to study and preserve such bio/geo-diversity environments.

Major pressures

Maritime traffic and its potential risks such as accidents, pollution, ballast water pollution, remains probably the most important threat to be considered. In addition, the area, particularly south of Crete, is a zone of unregulated and uncontrolled fisheries activities in international waters; this impacts on biodiversity and leads to stock depletion. Underwater noises generated by oil exploration and military activities are other problems to be considered.

Countries : Egypt, Greece

6.4 Eratosthenes Peace Park

The proposed Eratosthenes Marine Peace Park extends between the coasts of Egypt and of Cyprus and covers parts of their respective EEZs.

The area covers three main geological domains: (a) the wide passive African continental margin of Egypt (and particularly large domains of the Nile submarine delta and of its sedimentary fan), (b) the seismically active continental margin which borders the island of Cyprus and, (c) a breaking African continental margin fragment, the Eratosthenes seamount, which is entering continental collision with Cyprus; this flat seamount was an island during the Messinian desiccation crisis which affected the Mediterranean Sea nearly 6 millions years ago and was thus submitted to intense continental erosion.

Key features in need of protection

- The temporary presence of migratory species of Cetaceans, such as Cuvier's beaked whales and at least three dolphin species;

- The presence of at least two species of sea turtles nesting and feeding on the Cyprus and Egyptian coasts, as well as monk seals still living on the western coast of Cyprus;

- The occurrence of very abrupt and rocky continental slopes, particularly south of Crete, where deep sea corals and other sessile organisms have been observed but are still poorly studied;

- The presence of blue fin tuna spawning ground off the Egyptian coasts;

- Important migration corridors used by many bird species do cross the area;

- Very oligotrophic waters are known around Cyprus while high productive zones exist near the Egyptian coasts (nutrients from the Nile river input);

- In addition several current gyres, inducing variations in productivity, characterize the domain;

- Another specificity of the area, and particularly of the Egyptian margin (around 500 to 1000m) relates in the presence of many cold fluid releasing features (pockmarks, gas chimneys), whose activities induce the development of specific deep sea environments and of microbial-related biodiversity hot spots. Cold fluids have also been reported to occur along active faults on top of Eratosthenes seamount.

Complementary information

Fluid seepage is an example of specific "geo-diversity" and its impact on deep-sea environments. In the southern region of Eratosthenes zone fluids are emitted directly on the seafloor following two different mechanisms: (a) along fault zones used as a sort of "plumbing" system, and where fluids appear closely linked to massive emissions of under-compacted and over-pressured mud known as mud volcanoes or gas chimneys, several kilometers in diameter, and chiefly detected on the eastern upper continental slope (red circle on figure) and, (b) through hundred of pockmarks, sub-circular and small (only a few meters in diameters), depressions, which affect wide areas of the Nile submarine delta continental slope and indicate important degassing processes.

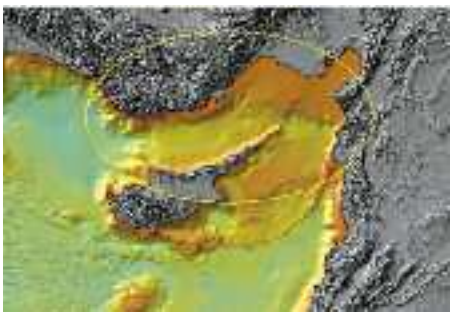
Concerning the gas chimneys it seems important to concentrate the conservation efforts on a group of several gas chimneys discovered about 10 years ago and on which *in situ* researches have been conducted in the past 7 years. One of these features, Amon gas chimney has particularly been studied. Amon GC, which lies by 1100m water depth, shows, on its active top, quite disturbed sediments believed to result from explosive mud/gas emissions; the emitted gas, particularly thermogenic methane, are assimilated by bacteria/archea *consortia* facilitating chemosynthetic symbiosis with many invertebrate species, as well as fish which feed on the seabed. Similarly to those in the Herodotus zone, cold fluid seeps located in the southern part of Eratosthenes Park form *oases of specialized life* in extreme environments.

Major pressures

Growing oil and gas exploration with current offshore production (off Egypt), underwater noises generated by oil exploration and military activities are other problems which should be considered. The area is also subject to illegal fishing. The area is one of diffusion for newly arrived exotic species from the Red Sea via the Suez Canal.

Countries : Cyprus, Egypt

6.5 The north Levant Peace Park



The Levantine Sea has almost become a sea within the Mediterranean Sea, because of the arrival and spread of Red Sea fauna and flora. Besides, it represents the most oligotrophic part of the Mediterranean. The northeast area presents special hydrological conditions and critical habitats that are vital to many endangered species. The monk seal and the bluefin tuna can still find in this area suitable sites for their breeding and feeding activities.

Key features in need of protection

- A peculiar circulation characterized by interanual variability, which triggers phytoplankton blooms via the intrusion of modified Atlantic water into the Taseli Strait;

- A greater productivity compared to the extreme oligotrophy of the Levantine Basin, offering more nutritious waters for the marine life at early life stages;

- A high diversity of fish species, especially in small pelagics such as anchovy and Atlantic horse mackerel, that find suitable spawning and nursery areas in the nutrient-rich waters of Taseli Strait;

- One of the four major spawning grounds of blue fin tuna (*Thunnus thynnus*), with the highest larval concentrations in the Taseli Strait; the commercially important hake (*Merluccius merluccius*) also uses this area as nursery ground during the juvenile stage;

- Several nesting sites for the leatherback (*Caretta caretta*) and green (*Chelonia mydas*) turtles are located on the north coast of Cyprus as well as on the Turkish coast of Taseli Strait, nearby Anamur and Akkuyu. The same area also hosts a few nesting sites of the nearly threatened Audouin's Gull (*Larus audouinii*);

- Important breeding habitats of the endangered Mediterranean monk seal (*Monachus monachus*), mainly located on the west coast of Mersin and on both sides of the Taseli Strait.

Complementary information

In the North Levant basin, which results from large scale extension between southern Turkey and Cyprus a few million years ago, phytoplankton productivity, mainly induced by the riverine inputs and eutrophic waters of the north-east Levantine Sea, is relatively high with respect to the extreme oligotrophy of the Eastern Basin. The productivity in the lower trophic levels provides suitable spawning and nursery areas for the small pelagics (*Engraulis encrasicolus, Trachurus trachurus, Sardinella aurita, Etrumeus teres*) that represent an important food resource for large pelagics such as the blue fin tuna (*Thunnus thynnus*) and hake (*Merluccius merluccius*).

The most important large pelagic fish of the region is the endangered blue fin tuna. One of the four major spawning grounds is located within the Taseli Strait which hosts the largest concentration of BFT larvae. The area between Iskenderun and the north east coast of Cyprus represent an important migration route for this species but also for, albacore (*Thunnus alalunga*), little tunny (*Euthynnus alletteratus*), and bullet tuna (*Auxis rochei*).

The north Levant hosts the Mediterranean easternmost meadows of *Posidonia oceanica,* on the north coast of Taseli Strait. Historical records show that the meadow has regressed almost 10km westwards within the last 25 years, probably due to changes in temperature, salinity and disturbance by bottom trawlers. Protection measures for *Posidonia* meadows are thus sought to help slow down this regression in its Mediterranean distribution range.

Marine turtles are important elements of the conservation value of the Taseli Strait, especially on the north coast of Cyprus. The area offers suitable beaches for nesting by the green turtle *Chelonia mydas* and leatherback turtle *Caretta caretta*. Marine turtles, especially the juveniles and subadults of *Chelonia mydas,* are also observed on the shallow waters rich of *Cymodocea nodosa* beds, which represent the major feeding grounds of the species.

One of the very few nesting sites of Audouin's Gull (*Larus audouinii*) in the region is on the Gilindire islands in Aydincik. The others are located on the northern part of Cyprus. The nesting is on spring and the hatchings turn to juveniles in summer, that feed in the region before migrating off in late summer. The main concentration of feeding juveniles is observed in flocks around Sancak cape and Besparmak Island.

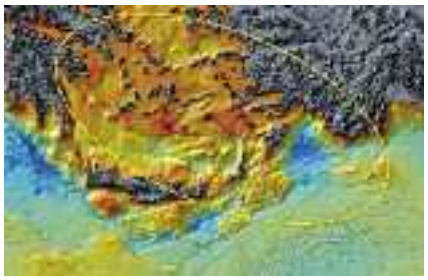
The endangered Mediterranean monk seal (*Monachus monachus*) is perhaps the most critical element of the ecosystem. Important breeding habitats have been found in the NE Levant Sea, on the west coast of Mersin and north of Cyprus. It has been estimated that the small seal population inhabiting the area consists of approximately 40 individuals, with an average fecundity of 0.22. The surroundings of the breeding caves, and the foraging area have been designated as "No-take-zone" in the sea and as "1st Degree Natural Asset" on land.

Major pressures

The north Levantine Basin is one of the Mediterranean areas most affected by exotic species, with potential risk for decline of endangered native and endemic species due to competition of habitat and resources. Anthropogenic activities such as over-fishing and by-catch, oil pollution by vessels and coastal degradation make the habitats and the associated fauna and flora more vulnerable to the invasion of exotics.

Countries : Cyprus, Turkey, Syria

6.6 The south Aegean Sea Peace Park



The Aegean Sea hosts the highest biodiversity in the Eastern Mediterranean and the second highest species richness in the whole Mediterranean. The region, because of its diversified topography and bathymetry is characterized by a great variety of habitats for populations of rare and endangered species essential to the regional ecosystems – from seagrasses to some of the most important marine mammals in the Mediterranean. It also provides important feeding and breeding grounds for sea turtles, sharks and the monk seals.

Key features in need of protection

- The so-called volcano arch, characterized by several submarine volcanoes such as Santorini and Kolumbo crater, surrounded by high-temperature venting and vigorous gas emission plumes more than 10m high;

- The Anaximander Mountains, where numerous active mud volcanoes have been discovered in the past 10 years along with associated cold fluids and gas hydrates;

- The Rhodes Gyre, a distinct vertical rotating cylinder of water generating strong upwellings that make the area the most productive in the Mediterranean Eastern Basin;

- Subpopulations of the most endangered pinniped species in the world, the Mediterranean monk seal (*Monachus monachus*) as well as important breeding sites can still be found in the area;

- An important feeding and breeding ground for sperm whales (*Physeter macrocephalus)* in the deep sea area near the island of Rhodes and one of the world' most important breeding zone of the Sandbar shark (*Carcharhinus plumbeus*);

- An important site for the *Cystoseira* meadows, including the threatened *Cystoseira amentancea*, *C. spinosa* and *C. zosteroides* species.

Complementary information

The southern Aegean Sea is a major biodiversity hotspot; it also offers highly diverse seascapes: several islands of metamorphic rock, the so-called volcanic arc, which includes the well-known Milos and Santorini volcanoes, and several submarine volcanoes among which the Kolumbo, producing gas emissions and fluids made of polymetallic massive sulfides and sulfates at temperatures up to 220 °C. The Anaximander Mountains and their numerous mud volcanoes, also provide cold fluids and gas hydrates leading to development of bacterial mats and symbiotic colonies of worms, molluscs, sea urchins and crabs.

The most prominent oceanographic feature in the area is the quasi-permanent cyclonic Rhodes Gyre – located to the south of the island of Rhodes – formed by wind-driven basin circulation and the interaction of the Mid-Mediterranean Jet and the Asia Minor Current. The anticlockwise rotation causes strong concentration of nutrients, making it the most productive area of the oligotrophic Eastern Mediterranean Sea, with the largest phytoplankton biomass. The Aegean Sea occasionally becomes the site of the dense water formation for the entire Eastern Mediterranean.

Important sub-populations of the Mediterranean monk seal (*Monachus monachus*) reside in the area of Kimolos, Gyaros and Karpathos. The Kimolos-Polyegos island complex is one of the two most important reproduction areas for the species.

The southern Aegean is a significant nesting and feeding area, predominantly for loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles. Furthermore, Boncuk Bay in Gökova, Turkey, is reported as the most important breeding zone of the Sandbar shark (*Carcharhinus plumbeus*) after the southern coasts of North America. Other vulnerable shark species such as *Cetorhinus maximus* and *Carcharodon carcharias* are normally found in the area.

The area is selected as feeding and breeding grounds for several endangered/threatened dolphins (*Delphinus delphis, Tursiops truncates, Grampus griseus, Stenella coeruleoalba*) and whales (*Physeter macrocephalus, Ziphius cavirostris, Balaenoptera physalus*) that can still be regularly found in the area.

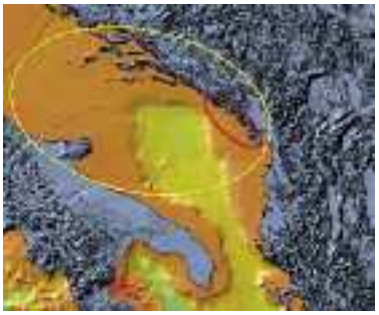
Posidonia and *Cystoseyra* meadows, which are conspicuous in the area, represent important habitat-forming species for many benthic organisms, including threatened species like *Pinna nobilis*, *Charonia tritonis* and *Hippocampus hippocampus.*

Major pressures

Maritime traffic and military activities represent the two main threats for marine mammals especially due to noise pollution and accidental collisions. The Aegean Sea experiences one of the most intense maritime traffic in the world. The lack of shipping lanes and the unregulated dense traffic present different levels of hazards for cetaceans. In addition, some zones that are used for military activities by Greece, Turkey and NATO coincide with the main marine mammal migration routes; the use of sonars has been associated with disease, loss of orientation, starvation and the stranding of the animals. Habitat degradation due to coastal urbanization and development of mass tourism and illegal fishing practices contribute to the decline of many vulnerable species.

Countries : Greece, Turkey

6.7 The south Adriatic Sea Peace Park



Despite the relatively scarce knowledge on biodiversity in the south eastern part of this area, there is a large variety of coastal and marine biological features of high ecological value, some of which already classified under national and international conservation schemes. The presence of numerous small islands, islets and semi-submerged reefs in the northern part provides for different habitats and for the development of a highly diverse fauna and flora, often rare or endemic. Several endangered and threatened species (from marine invertebrates to cetaceans, reptiles and birds) inhabit the region. The area is also well known to fisheries for the presence of many commercially important species (including picarel, red mullet, hake, squid and cuttlefish).

Key features in need of protection

- The submerged Mezosoic Apulian platform, made of karstic limestone marked by numerous marine caves and undeground freshwaters circulations;

- Peculiar geo-morphological features – the Japuka pit, the Palagruza sill and the South Adriatic Pit – associated to key oceanographic processes;

- Sites of dense water formation, vertical mixing and seasonal up-welling, cyclonic circulations characterize the area, providing important biogeochemical exchange and circulation of nutrients between the east and West Adriatic coasts;

- Numerous wetlands (e.g. the Neretva delta) and saltmarshes make the Croatian coastline one of the most important area for bird diversity, hosting many endangered species such as the Great bittern, the Ferruginous Duck, the snowy plover and the Common Snipe;

- On the Italian coast, the Varano and Lesina lagoons are important habitats bird sheltering and nesting, as well as spawning and nursery grounds for fish;

- The Vis and Palagruza Archipelagos hosts the endangered fin whale *Baleanoptera physalus,* and the giant devil ray *Mobula mobular*.

Complementary information

The South Adriatic, which rests on a homogenous geological domain made of massive Mesozoic limestones is particularly important for coastal biodiversity and the presence of sensitive habitats; the Buna/Bojana delta shelters a high proportion of coastal populations of birds, fish, mammals, reptiles and amphibians. One of the most important ecological features of the area is the biological migration, especially for globally threatened species of fish (sturgeons, lampreys), sharks and bird species. The area represents also one of the three North-South migration routes for European birds.

Many endangered species still reside in the area: bottlenose dolphins (*Tursiops truncates)*, giant devil rays (*Mobula mobular*), blue-fin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*), and birds like Eleonora's falcon (*Falco eleonorae*), Manx shearwater (*Puffinus puffinus*), Cory's shearwater (*Calonectris diomedea*) and European shag (*Phalacrocorax aristotelis*) have been regularly observed around the Vis archipelago. Other species of dolphins (*Stenella coeruleoalba, Grampus griseus*) and whales (*Balaenoptera physalus, Ziphius cavirostris*) are found in the region.

Other globally threatened species may also be encountered in the proposed area. The Mediterranean monk seal (*Monachus monachus*) is believed to be transient in the region. The loggerhead turtle (*Caretta caretta*) can be found in large numbers and is believed to reside year-round. Finally, the otter (*Lutra lutra*) inhabits the river mouths and deltas in the south-eastern part of the region.

Jabuka Pit, adjacent to the island of Jabuka, is the most important spawning and nursery ground for European hake (*Merlucius merlucius*) and Norway lobster (*Nephrops norvegicus*) in the Adriatic Sea. The cold, nutrient-rich waters generated in winter in the northern Adriatic accumulate in this depression, making the area a site of strong nutrient re-cycling processes leading to very high productivity.

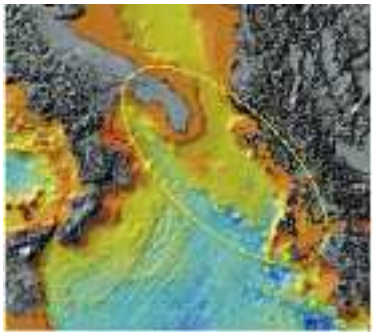
Rana e hedhun (Blown sand) in the Baks Rrjolli coastal zone represents an interesting combination of habitats with karstic caves, mountain slopes, sandy dunes, alluvial forest, tamarisks marshes, interstitial pools combined with a peculiar sandy beach. The Blown Sand is an active dune 50m high, 600m long and 100m wide, accumulated on a rocky coast by the wind activity, a unique habitat in the Adriatic. This area gives shelter to nesting bird species of regional and global concern.

Major pressures

Increasing human occupation of the coastal zone, with localised pollution, increasing fishing effort, maritime traffic, uncontrolled recreational use of the sea, habitat degradation, sewage discharge and discharges from agricultural activity and coastal erosion are the main threats for this area. Besides the numerous anthropogenic pressures which this area is subject to, there is a new potential threat represented by the wind farm industry, which is quickly expanding in areas where knowledge is still limited. In the Gulf of Manfredonia, previously considered an area essentially dominated by muddy assemblages and thus selected for development of windmills, extensive banks of coralligenous formation have been recently found. Uncontrolled and illegal fishing practices are an important threat to marine biodiversity in the Adriatic, having a significant impact in fish stock depletion. Further, intense fishing and non-selective fishing gear have already significantly affected the demersal ecosystem and species biodiversity around the regions of Jabuka Pit and the Palagruza Sill.

Countries : Albania, Croatia, Montenegro, Italy

6.8 The north Ionian Sea Peace Park



A hotspot of biodiversity: coastal wetlands hosting rare wild birds, rich coralligenous communities, seagrass meadows, deep sea white corals and many threatened and endangered species such as the common dolphin, sperm whale and Cuvier's beaked whales, sharks and rays. This section of the Mediterranean Sea combines high levels of marine diversity and a relatively low human population density, with a long history of exploitation of marine resources and an increasing alteration of coastal habitats.

Key features in need of protection

- A unique oceanographic circulation, which connects the South Adriatic Sea to the Northern Ionian Sea, establishing vital corridors for marine organisms between the East and West coasts;
- A site of deep water mass formation, essential to the functioning of the entire Mediterranean circulation;
- A seabed, derived from the Apulian platform and marked by a rich variety of marine canyons, caves and submarine valleys, the latter hosting extensive white coral banks;
- Deep hypersaline anoxic basins characterized by new, highly specialized microbial communities;
- Several submarine caves in the region represent a unique, vulnerable ecosystem, with specialized species assemblages, highly vulnerable to disturbance;
- Extensive deep sea white coral banks, considered biodiversity "hotspots" in the Mediterranean, have been found in two submerged "Messinian" valleys located in Ionian Sea and South Adriatic respectively.

Complementary information

Massive Mesozoic limestones characterize the area. About 6 million years ago, during the "Messinian" Salinity Crisis, the former Mesozoic Apulian platform was submitted to intense continental erosion and karsts processes. As a result, many caves and aerial valleys were cut into these rocks, to be later submerged in the lower Pliocene. These geomorphologic features provide hard rock settlements for fixed organisms such as deep water corals in the south of Italy and also probably along the steep Hellenic Ionian margin.

The recent exploration of the deep sea between the Southern Adriatic and the Ionian seas led to the discovery of important white-coral banks (*Lophelia pertusa*, *Madrepora oculata*): one South of Capo Santa Maria di Leuca and another, less known, between Italy and Albania (Canyon of Bari). The coral banks represent an important ''hot-spot'' of species diversity in the Mediterranean basin comparable to the *Posidonia* meadows and coralligenous bioconstructions on the shelf, and require urgent protection from trawl and long lines fishing. The North Ionian is also extremely rich in submarine caves, which are singled out the EU Habitat Directive as a special habitat in need of protection.

The eastern part of the Ionian Sea (Greece and Albania) is vital for biodiversity. Beyond the Amvrakikos Gulf, which is one of the most important wetland systems in Greece, there are important lagoons in Apulia (Aquatina, Alimini and Mar di Taranto) and in Albania (Butrinti). The Albanian part of this area, especially the Karaburuni Peninsula – Sazani Island, has also been identified as a priority area for marine biodiversity conservation by recent national and international environmental reports.

The northern part constitutes an important migrating corridor for cetaceans (*Delphinnus delphis, Physeter macrocephalus*), marine turtles and the monk seal (*Monachus monachus*) to and from the Adriatic Sea.

Major pressures

The region is a complex mosaic of relatively well-preserved stretches of coast interspersed with areas subjected to multiple stressors, in particular deep sea fishing and illegal harvest of date mussels, and heavy metal contamination.

Hundreds of kilometres of subtidal rocky coast have been destroyed in Apulia due to the illegal fishery of the date mussel *Lithophaga lithophaga* (L.). This rock-boring bivalve is extracted from the substrate with sledgehammers causing detrimental effects on communities colonising the surface. But deep sea fishing and illegal artisanal fishery are not the only threats; the Apulian area has been selected as a priority area for wind farms, with potential impacts on marine mammals due to noise and vibration generation.

Countries : Albania, Greece, Italy

II - WORKSHOP COMMUNICATIONS

The Marine Peace Park paradigm: coast to coast international marine parks in the Mediterranean

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INTRODUCTION

As regions and countries become more interdependent and environmental problems become more global, conservation on a unilateral basis is no longer a viable option for the maintenance of large ecological systems (Thorsell and Harrison, 1990). This presents a challenge for the development of strategies for the coordination of transboundary conservation (López-Hoffman *et al*., 2010). As such, there is an opportunity for the 'Peace Park' concept to contribute to the development of frameworks for ecosystem based management, whilst providing a symbol of political cooperation. The 'Peace Park' rationale recognises the equal importance of both political and environmental criteria for balanced conservation (Westing, 1998). The designation of a peace park provides a rare opportunity for conservation and politics to benefit in harmony rather than at the expense of one another, which should be attractive both to environmentalists and politicians (Hammill and Besançon, 2007). The World Conservation Union (IUCN) defines peace parks as:

> *'transboundary protected areas that are formally dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, and to the promotion of peace and cooperation'*
>
> (Sandwith *et al*., 2001).

Establishing a protected area in a single State is a challenge; bringing together two or more States, with their associated differences, is even more difficult (Westing, 1998). Besides the political border between the States, Hamilton *et al*. (1996) highlight other forms of boundaries which need to be bridged for cooperation in transboundary conservation; particularly imbalances in economics, power, or technical competence. In addition, legal compatibility between the structures of States and the application of international environmental regimes may be problematic (Young, 2002). Finally, issues of language, culture and religion may also restrict cooperation (Hamilton *et al*., 1996). Hence, these initiatives, more than many other forms, may require support or intervention at a high political level (Sandwith *et al*., 2001). The assistance of an independent third party may also help to facilitate cooperation between States (Akçali and Antonsich, 2009). Yet the environment offers certain characteristics that make it particularly suitable as a tool to foster peace and cooperation. Environmental issues cross political boundaries, require a long-term commitment, encourage the wider participation of citizens and NGOs, and extend beyond short-term economic perspectives (Conca *et al*., 2005). In the absence of direct conflict, peace parks have value for helping to develop confidence and cooperation between States. Institutions evolve though the experiences of their constituent individuals. Officials working together with colleagues from

neighbouring States, resolving issues of low political priority such as nature conservation, can help to develop institutional trust (Westing, 1993). This trust can then be built upon to find other areas of cooperation, to foster understanding of other cultures, good relations, and to reinforce confidence between States (Odegaard, 1990).

McNeil (1990) identifies four different forms of peace park: the first, celebrates the ongoing peaceful relationship between two countries; the second, occurs where international relations may be slightly strained, but the park serves to ease tensions. The third is used as a means to ease border disputes after a war; and finally, in rare situations, a park could be used to foster peace in a war-like situation or ease reunification of a divided State. Similarly, Westing (1998) categorises three political criteria for the development of a potential site: first, where it safeguards and improves good ongoing relations; second, where it would make a dispute over territory irrelevant; and finally, where it could help bring a divided State back together. In practice these definitions should not be regarded as distinct categories but points along a spectrum of social conditions and political relations ranging from peace and goodwill at the one end to armed conflict at the other. The first formal peace park is an example of celebrating peaceful relations between States; the Waterton-Glacier International Peace Park was dedicated in 1932 for the purpose of:

> *'establishing an enduring monument of nature to the long-existing relationship of peace and goodwill between the people of and Governments of Canada and United States'*
>
> (Bill HR4752, 1932 Government of Canada cited *in:* Lieff and Lusk, 1990).

Since the Waterton-Glacier International Peace Park was dedicated, numerous other Parks have been developed between States with relationships at different points along the spectrum of social and political conditions. At the positive end of the spectrum, where relations are good, political boundaries may be more fluid allowing peace parks to develop greater management cooperation; however moving further down, emphasis may be focussed on rebuilding confidence and goodwill; whilst where conflict is ongoing, a peace park may be used to demonstrate non-military methods of conflict avoidance and resolution (McNeil, 1990). The potential for conflict prevention and confidence building is further strengthened by the development of mechanisms for information exchange, joint action training, education, research, tourism, policing, governance and support of local cultural values (Sandwith *et al*., 2001). Although the concept provides a framework to work with, each area should be defined according to the context of the social and political relations between the States involved.

From a conservation perspective the primary purpose of most transboundary conservation measures are either for the management of straddling natural systems or protection of habitats important for migratory species (Phillips, 1998). Westing (1998) highlights three main environmental criteria that should be addressed by the development of a peace park. The area should be a high priority for biological diversity; or, encompass a biome that is inadequately protected; or, be important to one or all the countries involved to fulfil their 10% target for conservation. Naturally, these criteria are designed to apply to both terrestrial and marine environments. However, as with most conservation measures, work on peace parks has been dominated by the terrestrial environment (Ali, 2007). Yet the dynamics and legal ambiguity of the marine environment may lend itself to the concept more readily than on the land (McDowell, 1998). For science and management the bio-geographical complexity and difficulties in undertaking direct observation make the marine environment inherently uncertain. The connectivity of the system makes borders more permeable, enabling the free movement of groups and individuals of animal and plant species, as well as humans (Carr *et al*., 2003; Jones, 2001). In addition, although borders may be defined on paper, they are blurred on the sea by the absence of clear physical boundaries, leading to disputes over 'ownership' (Blake, 1998). Bearing these issues in mind, the initiation of projects in the marine environment is more likely to require high-level support on which formal agreements or a general memorandum of understanding can be drawn up (Sandwith *et al*., 2001). This is illustrated in the development of the Wadden Sea Area (WSA), one of the largest transboundary conservation areas in Europe. Initiated in 1978, through the Trilateral Wadden Sea Governmental Conference between Denmark, Germany, and the Netherlands, this area is one of the largest wild marine intertidal ecosystems in Europe. A Joint Declaration was

signed in 1982, with the Secretariat being established in 1987. The area hosts wild bird populations, marine mammals and fish species in addition to protected habitats (Commission of the European Communities (CEC), 2007). Cooperative management is based on the Wadden Sea Plan (WSP) (1997) with the overall objective to protect, conserve and manage the area whilst allowing sustainable use (Enemark, 2005). The WSA incorporates all the aspects of a successful Transboundary Biodiversity Conservation Area (TBCA), coordinated management principles, common targets, shared monitoring and the use of international and regional legislation. In 2002 the area was declared a Particularly Sensitive Sea Area by the International Maritime Organisation, and in 2009 added to the World Heritage List. In 2010 the States reaffirmed their commitment to cooperate in the management of the WSA as a single ecological unit for present and future generations (Joint Declaration on the Protection of the Wadden Sea, 2010).

The Mediterranean context

The Mediterranean Sea is often viewed as a microcosm of the global ocean situation, and used as a model to predict the response of the World's oceans to varying pressures (Coll *et al*., 2010). It has been a pilot area for the development of research and policy for marine conservation, including the first UNEP Action Plan, adopted in 1975, following the creation of the Regional Seas Programme in 1974 (Bliss-Guest and Keckes, 1982). The Mediterranean Sea is recognised as a hot spot for biodiversity, with a high number of species contained in a relatively small area (Bianchi and Morri, 2000). In addition the Basin has a particularly high species endemism (Myers *et al*., 2000). Much of this biological diversity is related to the historical geological and oceanographic processes of the Basin. The Mediterranean remains geologically active, with both catastrophic and longer time scale geological events unfolding on the seabed. Oceanographically, permanent and semi-permanent features, often related to bathymetry of the region, power the circulation of the Basin. The enclosed nature and connectivity of the Mediterranean requires that in the development of a protected area network oceanographic features, such as dominant currents, gyres and fronts, be taken into account (CIESM, 1999.). These factors are an important foundation for biological diversity and require protection within their own right, according to ecosystem based management model (Dudley, 2008). Of course diversity is not uniformly spread throughout the Basin; within this global hotspot are regional hotspots important for geological diversity, ocean processes and biological diversity that should be protected. Yet, its unique natural and cultural values are under threat from increasing anthropogenic use (Notarbartolo di Sciara, 2008). Threatening the Basin are a range of pressures from global to local scale, including climate change, acidification, pollution from terrestrial and maritime sources, invasive species, over fishing, habitat destruction and uncontrolled tourism to name but a few (Abdulla *et al*., 2008). Many of these issues are being felt globally; however the semi-enclosed nature of the Basin exacerbate their effects and makes the Mediterranean one of the most threatened seas in the World (Coll *et al*., 2010). Again these threats are varied and non-uniformly distributed throughout the Basin. In response there have been numerous efforts to develop conservation. Although the amount of protected marine area in the region varies from one report to another, it is widely recognised that less than 10% of the Mediterranean is managed appropriately for conservation, and few States can boast that they have fulfilled their targets (Abdulla *et al*., 2008).

The Mediterranean Basin is both culturally and politically highly diverse. Considering that the Basin links the three continents of Europe, Asia and Africa, and borders twenty-one modern States, there is a high potential for dispute and conflict between these close neighbours. There are two major narratives regarding the political, social and cultural stability of the Mediterranean. The first, refers to the concept of the 'cradle of civilisation'; generally this is a positive perception related to shared heritage, culture and values (Tassinari and Holm, 2010). The second, more recent, refers to the Basin as an area of conflict (Lia, 1999). There have been various efforts to generally promote peace and cooperation throughout the region most of which have been Eurocentric in their development. These range from the Euro-Mediterranean Partnership launched in 1995 through the European Neighbourhood Policy of 2003, to the Union for the Mediterranean created in 2008 (Balfour, 2009). These processes have been met with varied responses, particularly by post-colonial and post-socialist States, which have been concerned with the power dynamics between partners (Isaac, 2010; Mackelworth *et al*., 2011). However, attempts to define the

Mediterranean as a single unit and to find a solution to all of the issues that exist has proved impossible. Relationships between the States cover the whole social and political spectrum; however, what is consistent is that the Mediterranean is a shared collective resource. Sandwith and Besançon (2007) suggest that by concentrating on the concept of co-operation over a shared resource, mutual benefits can be accrued to promote common understanding and to foster good relations between States. Bearing this in mind, the concept of a marine peace park network in the Mediterranean has the potential to contribute to both the environmental and political aspects of relations between the States in the region. However, the context of each individual peace park, and the partners therein, should be of critical concern.

Fundamental to the development of any conservation strategy is the underlying legal framework on which measures must be based. Bearing in mind the coast to coast aspect of the proposal, many of the areas will be declared outside the territorial sea of the States involved. As such the ways in which individual States apply the United Nations Convention on the Law of the Sea (UNCLOS) (Montego Bay, 1982) to the areas contiguous to their territorial seas is essential. Generally, the further offshore a conservation area is sited, the greater the need for international cooperation and agreement. Article 192 of UNCLOS requires States *'to protect and preserve the marine environment'* including those areas outside territorial seas (Shine and Scovazzi, 2007). UNCLOS (1982) clearly obliges the party States to protect the marine environment beyond national jurisdiction. The Mediterranean is again unique in that there is no point beyond 200 nautical miles of the coast, hence should all the States of the Basin apply their legal right to an Exclusive Economic Zone (EEZ), or variations thereof, there will be no high seas in the region.

Marine conservation in the Basin is facilitated by the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona, 1976). The 1995 Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA Protocol) of the Convention applies to all the marine water, seabed and subsoil, and the terrestrial coastal areas. It was specifically conceived to apply in cases of political or legal conflict (Shine and Scovazzi, 2007). The SPA Protocol includes two important disclaimers:

> '*Nothing in this Protocol nor any act adopted on the basis of this Protocol shall prejudice the rights, the present and future claims or legal views of any State relating to the law of the sea, in particular, the nature and the extent of marine areas, the delimitation of marine areas between States with opposite or adjacent coasts, freedom of navigation on the high seas, the right and the modalities of passage through straits used for international navigation and the right of innocent passage in territorial seas, as well as the nature and extent of the jurisdiction of the coastal State, the flag State and the port State...*
>
> *...No act or activity undertaken on the basis of this Protocol shall constitute grounds for claiming, contending or disputing any claim to national sovereignty or jurisdiction*'
>
> (Article 2, paragraphs 2 and 3).

These disclaimers allow for the establishment of intergovernmental cooperation without prejudice to questions of a legal or political nature. In doing so these disclaimers also ensure that any open legal or political questions should not delay the adoption of measures needed to protect the environment.

The SPA protocol also provides for the development of the Specially Protected Areas of Mediterranean Importance (SPAMIs) with clear procedures for the listing of these areas:

> *'Proposals for inclusion in the List may be submitted:*
>
> *a) by the Party concerned, if the area is situated in a zone already delimited, over which it exercises sovereignty or jurisdiction;*
>
> *b) by two or more neighbouring Parties concerned if the area is situated, partly or wholly, on the high sea;*
>
> *c) by the neighbouring Parties concerned in areas where the limits of national sovereignty or jurisdiction have not yet been defined'*
>
> (Article 9, paragraph 2).

According to sections (b) and (c) joint proposals may be submitted by neighbouring partners. In this manner, the SPA protocol provides the opportunity for States to co-operate, regardless of the status of the definition of their maritime boundaries. The SPAMI list constitutes the core of a protected area network aimed at the conservation of Mediterranean heritage. To fulfil this objective, Parties to the Convention are required to develop cooperation on bilateral and multilateral levels, notably through the establishment of transboundary SPAMIs (Lopez-Ornat, 2006).

At a global scale, the two conventions of particular importance are the Convention on Biological Diversity (CBD) (1992) and the Convention on the Conservation of Migratory Species of Wild Animals (CMS) (1979). The protected areas work programme of the CBD highlights the importance of establishing and strengthening the development of transboundary conservation areas by 2012 in the marine environment (Anonymous, 2010). The CMS fulfils its obligations in two manners. Species identified as being in danger of extinction, under appendix I, are protected directly by imposition of strict conservation objectives on party States. Species that have an unfavourable conservation status or would benefit from international cooperation, listed under appendix II, are protected by regional agreements convened under the convention (Lyster, 1985).

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979) is the primary agreement to conserve the biodiversity of the European continent. The main objectives of the Convention are to ensure conservation and protection of wild plant and animal species and their natural habitats, to increase cooperation between contracting parties, and to regulate the exploitation of those species, including migratory species. Although the Convention does not expressly refer to transboundary conservation, Article 1 highlights the need to protect those species and habitats whose conservation requires the cooperation of several States with particular emphasis on endangered and vulnerable migratory species. For European Union States the Bern Convention has been transposed through Council Directive 79/409/EEC on the Conservation of Wild Birds (Birds Directive, 1979) and Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive, 1992). These directives have been important in the development of consistent national policies in EU Member States and encouraging partnership with accession countries and other partners in the region. In the marine environment the importance of the trans-border dimension is highlighted due to issues of connectivity (CEC, 2007). The Habitats Directive calls for Member States to encourage transboundary cooperative research, and to identify areas essential to the life, migration and reproduction of aquatic species which range over large areas (Habitats Directive Articles: 4.1; 10; 18.2). (For a full review of the legal framework and instruments for the establishment marine protected areas in the Mediterranean see Shine and Scovazzi, 2007).

Conclusion

The unprecedented environmental challenges faced by the oceans require a broader vision for successful management of the marine environment than the current fragmented national systems. This is especially true in a confined and crowded region such as the Mediterranean. Yet, seeking a cure-all solution that can be applied to the diverse environments, cultures and political systems of the region is impossible. Coast-to-Coast International Marine Parks provide the opportunity for cooperating States to develop contextually appropriate spatial plans and actualise ecosystem based management for large sections of the Mediterranean. Already the European States of the Mediterranean are expected to prepare national strategies to manage their seas to achieve or maintain good environmental status by 2020, under the requirements of the Marine Strategy Framework Directive. As spatial planning for the wider marine environment is inevitable, these International Peace Parks enable States to pre-empt future un-sustainable use by creating spatial plans with conservation as one of the primary objectives. Once again the Mediterranean provides an ideal proving ground for this concept.

The development of any form of conservation is dependent on the political will of the States involved. There are political challenges for the development of a network of marine peace parks in the Mediterranean, problems exist with coordinating not only the States in the region, but also the intergovernmental bodies and organisations. Much of the science required to identify and manage these parks already exists, and perhaps the greatest task now is to interface science with

policy. This requires an objective facilitating organisation to synthesize current scientific knowledge and deliver impartial and authoritative advice to policy makers. As such the Mediterranean Science Commission sits in a unique position to facilitate the development of the Mediterranean Marine Peace Parks.

Acknowledgements: the author would like to thank colleagues working in various institutions and non government organisations from around the Mediterranean who made comments upon this article in previous drafts, in particular Tullio Scovazzi, Frédéric Briand, Paula Moschella, Jean Mascle, Miroslav Gačić and Caterina Fortuna. The opinions expressed here are the sole responsibility of the author.

International Marine Parks in the Mediterranean: a geological background

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The incipient collision of two major tectonic plates, Africa and Europe, makes the Mediterranean Sea an area where many active geological processes, either instantaneous or at longer time scales, are directly imprinted on the surrounding landscapes (mountain chains) and on its sea floor.

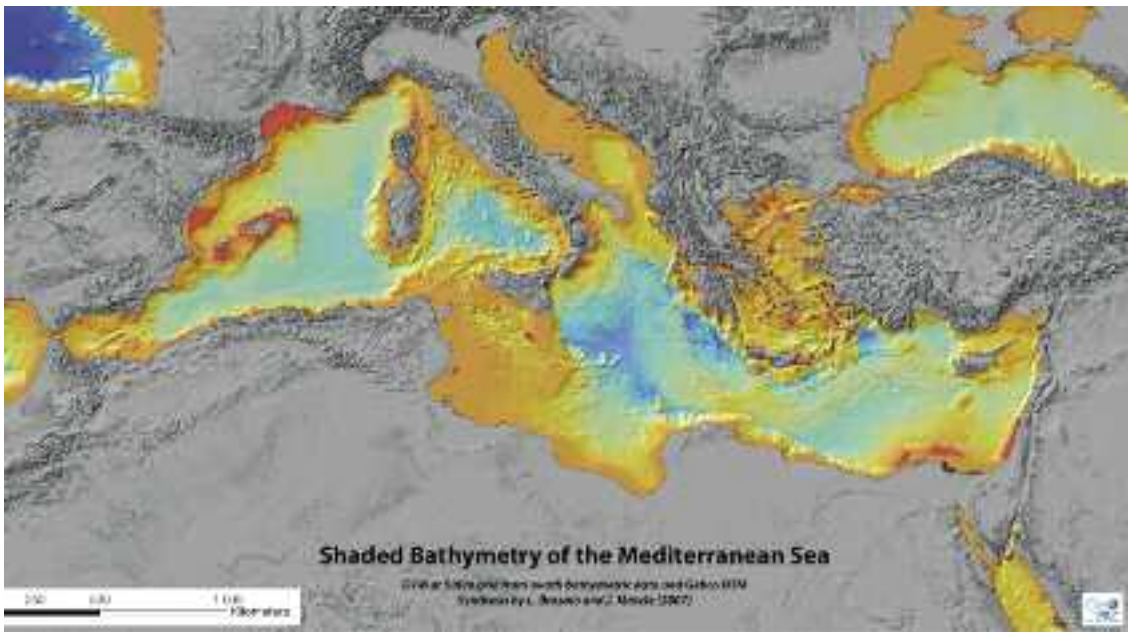

Figure 1. Shaded bathymetry of the Mediterranean Sea based on swath bathymetry (DTM at 500 m grid) completed by Gebco data.

The "coast to coast international marine parks" idea is totally new, and the geological background needs to be evaluated.

Which geological processes are involved? How and where are they imprinted on the seabed? How do active geological processes impact the biosphere and hydrosphere? What problems might emerge from such initiatives? All these are questions that should be discussed and evaluated.

Various active geological processes

As already indicated the Mediterranean is, geologically speaking, a very active area, almost continuously subject to catastrophic (instantaneous), and longer time scale geological events: seismicity, volcanism, sedimentary slides, and their frequent results, tsunamis, are among the most well-known and studied processes since they have direct impacts on human society. Climatic fluctuations, and one of their major consequences, sea level variations, are also quite well studied since they directly interfere with human settlement. Much longer time scale geological records such as specific outcrops, minerals, and fossils, or remarkable tectonic deformations, may provide good reasons to establish protected geological parks. All these geological records are well known and well recorded inshore and in coastal areas and may, locally, be preserved as specific sedimentary deposits (volcanic fields, tsunami-derived sediments), particular morphologies, or even evidence of displacements (fault zones); some of them have led to the establishment of protected areas (e.g. volcanic parks).

The consequences and appearances of geological activities in the deep sea, particularly in the Mediterranean, are less well known.

Many active geological processes however have been imprinted and observed in the deep basins of the Mediterranean thanks to systematic use of multibeam bathymetric tools, at different scales, allowing construction of detailed maps, and of near bottom surveys using submersibles and/or Remotely Operated Vehicles (ROV).

Several distinct geological processes operate on the sea floor: these processes can be of sedimentary or tectonic origin, and may result also from fluid circulations. Since erosion is almost inoperative on the deep sea floor, the morphological imprints of these processes are often well preserved and may be imaged using precise bathymetric tools.

Sedimentary processes are probably the most common since sedimentation, either of biogenic or of continental origin, operates continuously on the seabed. There is, in my view, not much to say about these categories, except to draw attention to areas where continuous records of sedimentation may have preserved paleo-climatic/ paleo-oceanographic archives, which it may be important to protect. This is for example the case for some areas of the deep sea where a regular sedimentation is mixed with products of almost instantaneous sedimentation such as volcanic ashes (tephras), or nearby large rivers where the sedimentary discharge reflect seasonal variations (for example monsoons or glacial versus arid/warm periods).

Tectonic processes are widespread in the Mediterranean, in both the Western (Alboran, Tyrrhenian Sea) and Eastern basins (off Calabria, most of the Levantine basin). In the deep, relatively flat and sedimentary abyssal plains, tectonic deformations may be recorded by series of sedimentary folds, faults, thrusts, etc., but do not show significant interactions with the surrounding environments (biosphere, hydrosphere). In contrast, recently active or active tectonic imprints on steep continental slopes may have facilitated the occurrence of hard rock outcrops, which provide favourable habitats for fixed faunas (e.g. cold water deep corals). It thus appears important to better map and preserve such areas.

Active volcanic processes, such as those operating in the Tyrrhenian Sea, in the southern Aegean Sea, and probably to a lesser extent between Sicily and Tunisia, are leading to expulsions of warm fluids, which, like the smokers of mid-oceanic ridges, may lead to hot spots of specific symbiotic biological colonies; it is thus also important to systematically map and explore areas of active venting. These areas are known at a large scale but still very poorly known in detail.

Geochemical processes; one of the very important discoveries of the past decade has been the observation of many fluid-releasing features, particularly within the deep margins and basins of the Eastern Mediterranean. Cold fluids are released in two main settings.

(a) At passive margin where they indicate the presence, at depth, of petroleum systems. This is the case for example off Egypt, and probably along parts of the easternmost Levantine margin, where they are expressed by hundreds of small (meter size) depressions and mounds on the sea floor (pockmarks) where diagenetic carbonate crusts are constructed thanks to bacterial activities. Locally these fluid-releasing systems may have led to much more important sedimentary constructions

(several kilometres in diameter) made from successive mud flows discharged from relatively deep sedimentary layers (3 to 4 km), and known as mud volcanoes or gas chimneys depending of their shape, size and activities. Driving mechanisms for these features are likely the sedimentary thickness and the induced overpressure exerted on organic matter-rich sedimentary layers.

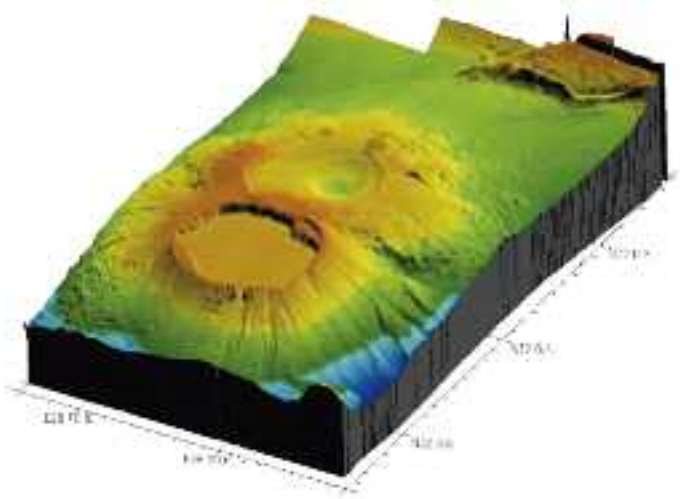

Figure 2. “Cheffren” mud volcano, at the foot (3000m) of the Egyptian continental margin; the twin mud cone contains a brine lake from which fluids are emitted.

(b) Mud volcanoes are also known along the active margins of the basin, and particularly on the Mediterranean Ridge. On this huge mass of tectonically deformed sediments, mud volcanoes constitute different belts closely matching the main tectonic lineaments such as the “backthrust” of the ridge against its “backstop” (the thinned and rigid Aegean continental crust); in this case driving mechanisms relate both to the sedimentary thickness and to the global compression stemming from the subduction collision. Whatever their origin, these features release significant amount of fluids (chiefly methane). Parts of the fluids are transformed by consortia of Bacteria and Archaea, that favour, by symbiotic mechanisms, the development of specialized worms, lamellibranches, sea urchins, crabs and others species. Such specific communities begin to be known but still need to be studied in detail, and obviously such environments should be protected.

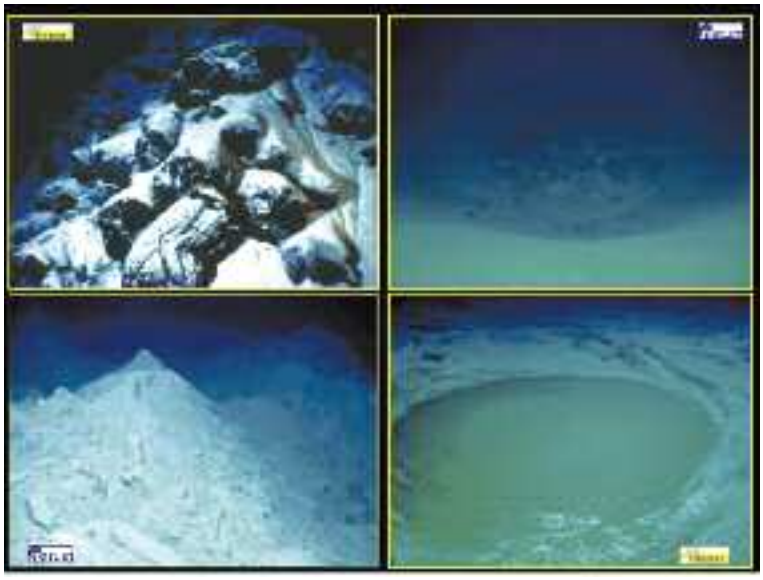

Figure 3. Different submarine geological landscapes: pillow and tube lavas in the Tyrrhenian Sea; A pockmark, an active mud cone and a brine pool surrounded by bacterial filaments on the Egyptian continental slope.

Among the amazing discoveries made on the sea floor of the Eastern Mediterranean are the occurrences of brine sources, rivers and lakes, where dense salt-rich water is either emerging from the sediments, or flowing along gentle slopes and filling local depressions. These brines may be associated, or not, with cold fluid seepages.

So far, most of the brines lakes have been discovered on top of the Mediterranean Ridge, where they are believed to be linked to progressive dissolution of exposed underlying salt-rich sediments (the famous Messinian salt layers) or to be mixed with fluid seepages. Recently brine lakes and brine ponds have been discovered in 3000 m depths within craters of active mud cones. Almost nothing is yet known of the impact of such brines on surrounding environments. Bacterial/ archaeal consortia live on brine-rich fluid seepages, and a project to study major brine lakes and their relationship with the biosphere and deep hydrosphere is in progress.

Active geological processes operating in the deep Mediterranean obviously have direct impacts on several aspects of the deep biosphere and hydrosphere; among these processes three are particularly important, tectonic, submarine volcanism, and fluid/brine releases on the sea floor, since these processes condition the setting of fixed organisms and the development of biological communities.

WHAT TO DO?

Using existing and relatively precise bathymetric maps, we already have a rough knowledge of the distribution of active geological features that may have direct impacts on the biosphere. In some cases (Mascle *et al.*, this volume) we also have detailed knowledge not only of their distribution and morphologies but also of their links with specific communities.

What is needed is probably to establish as far as possible an inventory of these features, and depending of scientific interests and of the location of future international parks, to select some of them for detailed near bottom investigations (mapping, sampling, monitoring).

POTENTIAL PROBLEMS

Exclusive Economic Zone (EEZ) definition; this is not specific to the geological characteristics but is a general problem in the Mediterranean, which strongly constraint scientific studies.

The EEZ have chiefly been created to protect the economical (fishing, mining, petroleum, etc.) resources of bordering countries. How will the proposed establishment of “coast to coast marine parks” be made compatible with potential economical exploitation of the same areas?

Oceanographic characteristics of potential coast-to-coast international parks

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In the Mediterranean basin, evaporation exceeds freshwater inputs, and thus the fresher water of Atlantic origin on its way eastward becomes, saltier and warmer, increasing in density. There is thus a two-layer exchange pattern in the Strait of Gibraltar where saltier Mediterranean waters exit below the inflowing Atlantic waters. Outflowing Mediterranean waters are formed continuously from the Atlantic Water (AW) along its path eastward by evaporation, and by dense water formation processes in some specific areas (Gulf of Lyons, Adriatic Sea, Rhodes Gyre) during winter. The upper circulation cell extends through both sub-basins (eastern and western Mediterranean) and consists of the inflowing AW and the return flow of saltier Mediterranean waters. Below, deep circulation cells in the two basins are separate and driven by the dense water formation in the Adriatic/Aegean and Gulf of Lions respectively.

From the point of view of the bathymetry, the two basins differ greatly. The eastern basin is characterized by a number of bottom features that can trap sub-basin or mesoscale circulation features; this basin also has two well-defined semi-enclosed sub-basins, the Adriatic and Aegean Seas. Dense water forms in these seas and then spreads through straits into the main eastern basin. In contrast, the western basin is characterized by a relatively flat bottom without clearly delimited semi-enclosed sub-basins: here the dense water formation site is located within the basin itself, and not separated by topographic features from the rest of the sea. These differences in the bathymetry have an important impact on the circulation patterns, and are responsible for some documented differences in the circulation structure of the two sub-basins. The upper-layer circulation of the western basin is characterized by a longshore current on the North African coast commonly named the Algerian Current. This current is unstable leading to the generation of meanders and subsequently to a series of “coastal eddies” 50 - 100 km in diameter. These eddies propagate eastwards at about 3-5 km/day. The coastal eddies interact and can be disturbed by “open sea eddies” that wander around the center of the western basin (Millot, 1999). The only stationary closed structure is the Alboran Gyres (AG). The return flow in the western basin extends along the north coast of Sicily, the western Italian coast and thence along the Ligurian and Provençal coasts (Liguro-Provençal Current). The Tyrrhenian Sea is characterized by a number of anticyclonic mesoscale eddies as well as by the semi-permanent cyclonic wind-induced gyre located in front of the Bonifacio Passage.

The eastern basin is characterized by a number of recurrent or semi-permanent topographically-trapped gyres, the Rhodes (RG), Iera-Petra (IPG), Mersa-Matruh (MMG), and Pellops (PG) Gyres,

and the South Adriatic (SAG) and North Ionian Gyres (NIG), often generated by the wind stress curl. Most of these gyres have well defined and constant rotation sense, but change in intensity on seasonal or decadal time-scales. The NIG is distinguished from the others, since its intensity and sense of rotation change on decadal time-scales (Gačić *et al.*, 2010). In addition to these gyres, instabilities along the main eastward current generate mesoscale eddies which travel mainly eastwards.

Locations of potential coast-to-coast national parks in the Mediterranean are chosen in such a way that they encompass waters of at least two Mediterranean countries, and that they cover key areas from the oceanographic point of view. Following these criteria, potential national parks are located in the neighbourhood of the most important Mediterranean straits (Strait of Gibraltar, Sicily Channel, Otranto Strait) or in areas characterized by quasi-steady mesoscale features (Alboran Gyres - AG, South Adriatic Gyre - SAG, North Ionian Gyre - NIG, Pelops Gyre - PG, Ierapetra/Mersa Matruh - IPG/MMG, Cretan Dipole – CD and Cretan Gyre - CG).

The Strait of Gibraltar is a choke point of the entire Mediterranean since it is where AW enters and deep water flows out of the Mediterranean. The average water exchange rate is around 1 Sv, and the difference between inflow and outflow compensates for net water loss due to the excess of evaporation over precipitation within the basin (Fig. 1).

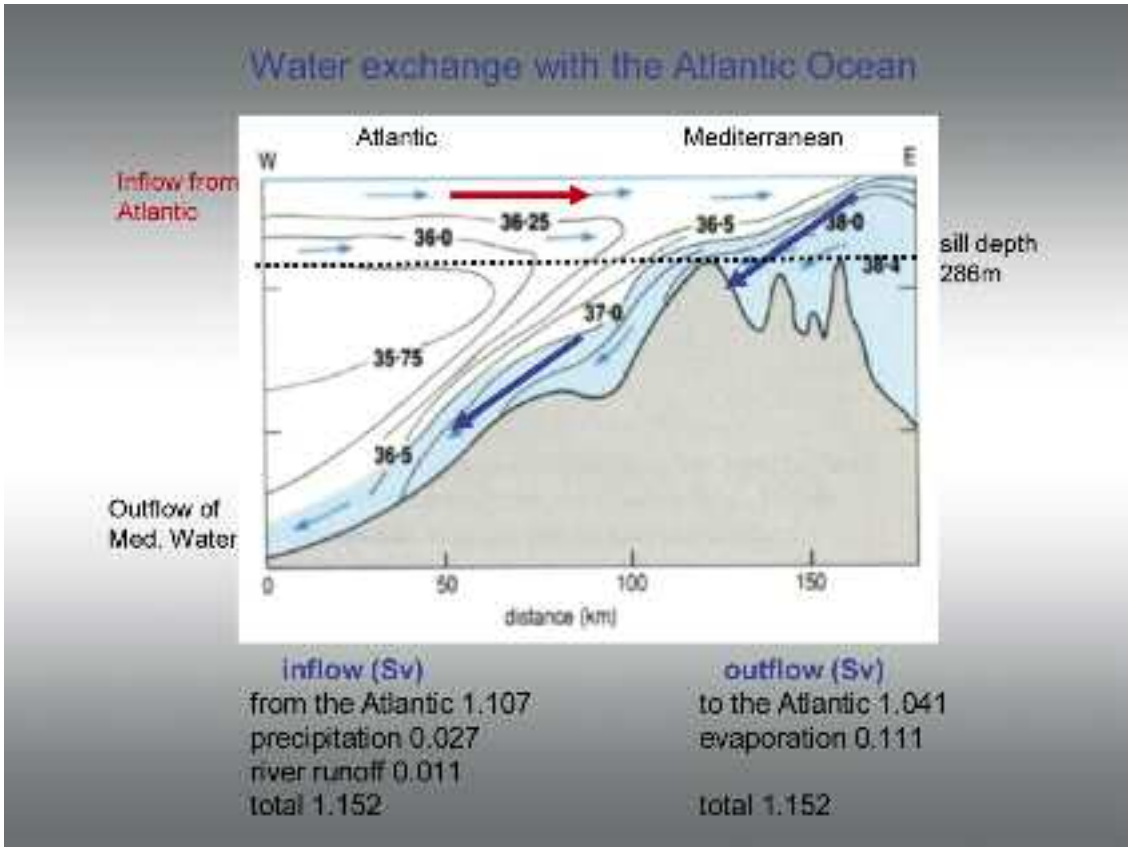

Figure 1. Scheme of water exchange through the Straits of Gibraltar.

The Mediterranean area adjacent to the Strait of Gibraltar is characterized by two semi-permanent gyres driven by the inflowing AW (Fig. 2) that preserves distinct oceanographic and biogeochemical properties. However, tidal flow is very strong and can be an order of magnitude larger that the mean flow. Internal oscillations associated with the tidal flow induce mixing and determine both vertical and horizontal exchanges of biogeochemical properties of the sea water.

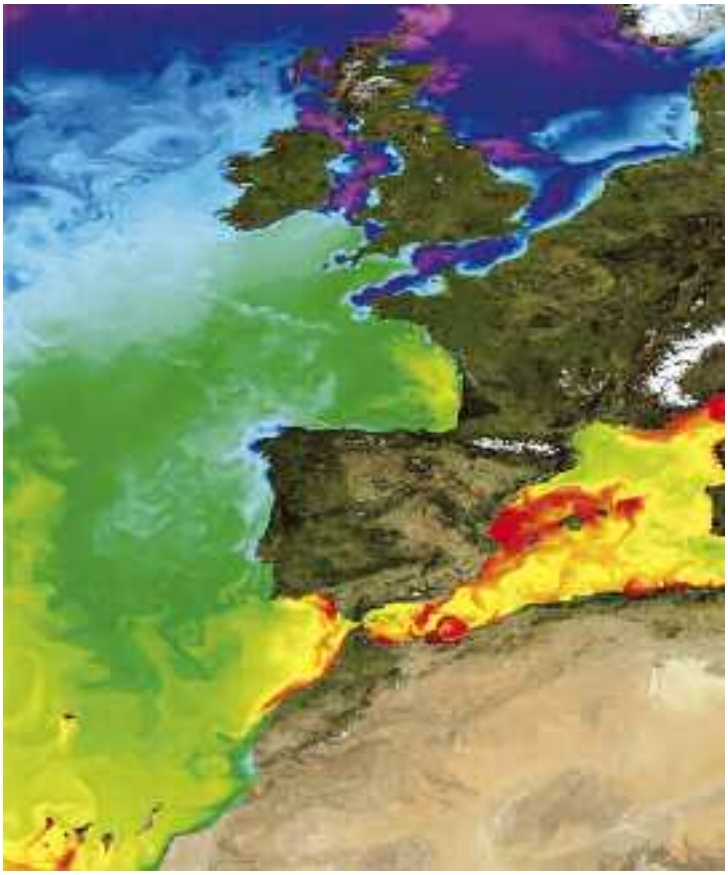

Figure 2. IR satellite image with the Straits of Gibraltar and Alboran Sea.

Another choke point in the Mediterranean is the Sicily Strait (~300 m max depth), the area of water exchange between the eastern and western basins. Here the AW that propagates along the African coast enters the eastern basin at the surface, while saltier LIW in deeper layers enters the western basin mainly across the sill south of Malta. Flow patterns in the strait are variable on different time and space scales, and strong upwelling, filaments, and meanders have been documented both from experimental and modelling data (see e.g. Lermusiaux and Robinson, 2001; and references cited therein). These mesoscale features determine to a large extent the biogeochemistry of the strait itself and of the larger adjacent area.

From an oceanographic viewpoint, the south Adriatic and northern Ionian region is a unique system connected through a feedback mechanism named "Bimodal Oscillating System" (BiOS) (Gačić *et al.*, 2010; Borzelli *et al.*, 2009). This feedback mechanism drives the inversions of the rotation of the NIG thanks to the salinity difference between AW and Levantine waters, and to open-ocean convection taking place in the centre of the SAG. In the centre of the SAG, a marked spring phytoplankton bloom is associated with the vertical mixing and nutrient input into the euphotic zone.

The bloom lasts for several days, up to a week, and is strongly dependent on cold air outbreaks and subsequent restratification. Interannual variability of the vertical convection and consequently of the bloom is rather prominent and depends on both the buoyancy content in the water column and the air-sea heat winter fluxes (Fig. 3).

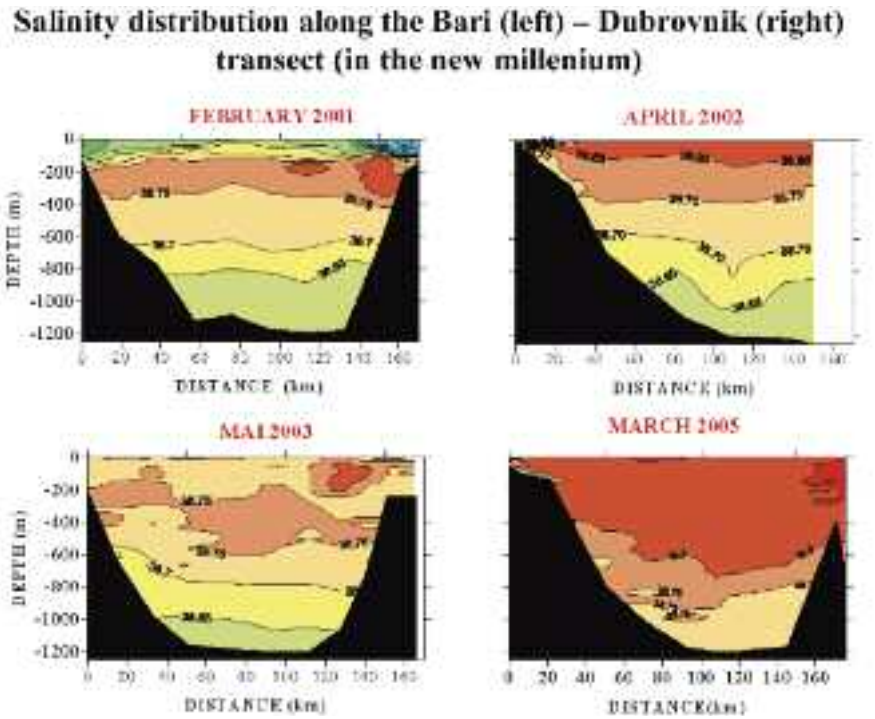

Figure 3. Distribution of salinity in post-convection periods in the South Adriatic Pit in the new millennium.

Inversions of the Ionian upper-layer circulation are on decadal time-scales and apart from bringing waters of varying salinity into the Adriatic, are also responsible for advection of allochtonous species into both areas (Civitarese *et al.*, 2010), thus changing the biodiversity. The open sea phytoplankton biomass in the Ionian Sea is generally low but associated with upwelling due to the NIG, can in some years reach larger values. In general as opposed to the rest of the Mediterranean, the northern Ionian circulation shows stronger variability on decadal time-scales; seasonal variability is of secondary importance.

Figure 4. Visible satellite image of the Cretan Sea and a portion of the northern Levantine basin.

The area of the Cretan Sea and the Levantine Sea in general is characterized by strong influence of northwesterly winds (Etesian winds) that blow continuously during summer (Fig. 4). These winds, due to the orography of the Greek islands and coast, are responsible for the formation of quasi-steady gyres like IPG and PG that in turn influence both thermohaline and biogeochemical properties of the Levantine Sea. To the north of Crete, the Cretan Dipole CD is clearly visible from satellite IR imagery and a probably baroclinic feature (Cardin and Hamad, 2003).

Scientific rationale for the proposed CIESM Near Atlantic Marine Peace Park

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Introduction

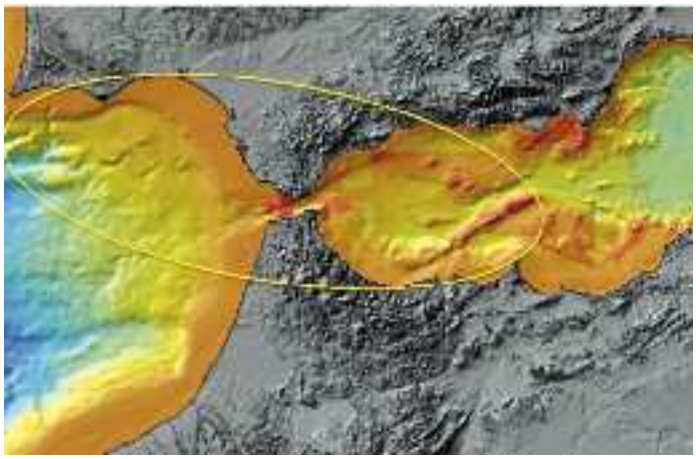

Figure 1. Shaded bathymetry of the CIESM Near Atlantic Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500m grid). Adapted from L. Brosolo and J. Mascle (2007).

The whole area of Ibero-Moroccan Gulf, Straits of Gibraltar and the Alboran Sea (Figure 1) constitutes the transition from the Atlantic Ocean to the Mediterranean, with all the special interest that this entails from all points of view. The Alboran/Gibraltar area is the engine where Mediterranean water originates. Due to its prime importance, extensive oceanographic research has been conducted in the past in this area. As a consequence, an extensive literature exists on the dynamics of the Strait and Alboran Sea (physical oceanography reviewed by Parrilla and Kinder, 1992), and the underlying physical mechanisms that govern water exchanges through this zone are now relatively well understood. In addition, the planktonic communities associated with this water exchange have also been well studied historically (i.e. Madin, 1991), although the nektonic and benthonic communities of this area were not studied intensively until the 1980's. In summary, knowledge of the hydrology, geology and biological communities of this area is now fairly satisfactory.

Geological features

The Iberian-Maghrebian region is seismically active, and has been widely discussed in plate tectonic reconstructions, as it straddles the boundary between the African and Eurasian plates. Seismic activity in the region is linked to the collision of these two plates, which are converging at approximately 5 mm/y (Gil *et al.*, 2002).

Extensive studies of the geology of the Betic (southwest Iberia) and Rif-Tell (northwest Africa) cordilleras in the southwestern Mediterranean region indicate the importance of a distinct set of tectonic and paleoceanographic events that have clearly influenced the evolution of the area (Maldonado and Comas, 1992). These include the relative movements of the African and Iberian plates during the Cenozoic, and the geodynamics of the Alboran Domain, probably related to the development of oceanic crust in the Algero-Balearic basin to the east. In addition, the location of the Atlantic/Mediterranean gateways in the Betic and Rif cordilleras were probably the most significant factors controlling evolutionary patterns. Global eustatic and climatic oscillations have also been recorded in sediments throughout this area, but their influence on depositional processes was modified by local tectonic factors.

To the north, the Betic Cordillera is divided into internal and external zones with the Guadalquivir foreland basin separating it form the Iberian Massif. During the Mesozoic and until the Oligocene, the Betic-Rif Internal Zone was situated further east, but with the opening of the Algero-Provençal basin in the early Miocene, the Betic-Rif Internal Zone moved to the west. Contemporarily, the Alboran Sea was created as the western prolongation of the Algero-Provençal basin. The Betic-Rif Internal Zone overthrust parts of the Iberian and African plates, partial sinking of both plates resulted, and is responsible for intermediate seismicity in the western sector of the Alboran Sea (López Casado *et al.*, 2001). In the Atlantic, the boundary of the Iberian and African plates extends from the Azores to the Gulf of Cadiz, and is relatively well defined in its westernmost part as far as the sector between the Gloria and Gorringe faults. Farther east, this contact zone is strongly affected by transverse faults.

Extensive volcanism is expressed at seamounts in the Alboran Sea and on Alboran Island. The Cabo de Gata volcanic province in southeastern Iberia has extensive Middle Miocene to Pliocene calc-alkaline to acidic volcanic rocks, which are disrupted by strike-slip faults suggesting significant horizontal displacements (Gil *et al.*, 2002). The Gulf of Cadiz, west of the Gibraltar Arc, has experienced a complex tectonic history with several episodes of extension, strike-slip and compression since the Cenozoic, related to the closure of the Tethys Sea, the opening of the North Atlantic, and the African-Eurasian convergence (Maldonado *et al.*, 1999). Due to the ongoing compression, these rapidly deposited sediments dewater intensely and form mud volcanoes and fluid escape structures (Diaz-Del-Rio *et al.*, 2003). The Gulf of Cadiz has been intensively surveyed with geophysical tools, leading to the discovery of the first mud volcanoes, mud diapirs and pockmarks here, in 1999 (Kenyon *et al.*, 2000; Gardner, 2001; Pinheiro *et al.*, 2003). In addition, an extensive field of mud volcanoes and diapir structures covered with carbonate chimneys and crusts was discovered along or in close proximity to the main channels of the Mediterranean outflow (Somoza *et al.*, 2003). To date, more than 100 mud volcanoes has been found in the whole area (Fernández-Puga *et al.*, 2007; Hensen *et al.*, 2007; Medialdea *et al.*, 2009).

Oceanographic features

The Strait of Gibraltar, the only significant link between the Mediterranean Sea and the world's oceans (14 km width and less than 300 m depth at the sill), is the key to the control of the exchanges and modification of the biogeochemical cycles and circulation of the entire Mediterranean and the NE Atlantic Ocean (Ami and Farmer, 1988; Minas *et al.*, 1991; Bryden *et al.*, 1994; Echevarría *et al.*, 2002; Gómez, 2003). The basic circulation in the Strait of Gibraltar comprises an upper layer (about 150 m thick) of warm, relatively fresh surface Atlantic water flowing into the Mediterranean, and a deep current of colder, saltier outflowing Mediterranean water. As evaporation exceeds the sum of precipitation and river discharges in the Mediterranean, the Atlantic inflow exceeds the Mediterranean outflow to balance the net loss. This stratification facilitates the passage of pelagic and planktonic organisms, including larvae, from the Atlantic to the Mediterranean.

It is difficult to measure water velocity in the upper layer of the Strait of Gibraltar due to alternating tidal currents and strong winds, but taking in consideration the amount of water exchange, the thickness of the upper layer and the average width of the sill, velocities are estimated to range from 0.31 to 0.37 m s^{-1} (Tsimplisand Bryden, 2000). Biomass import and export through the Straits

has been estimated to be approximately 5600 and 1100 tonnes C day^{-1} respectively (Reul *et al.*, 2002).

The Strait of Gibraltar gives access to the Alboran Sea, the western most basin of the Mediterranean. This geographic location as a transition zone makes the area a place of prime importance for any research on the gradients and variability of the biotic communities. Because of its strong Atlantic influence, the Alboran Sea has been considered as "the most Atlantic of the Mediterranean basins". The Atlantic inflow forms two large anticyclonic gyres, the permanent Western Alboran gyre, and the more episodic Eastern Alboran gyre. These gyres are separated more or less by the 3ºW meridian, where Cape Tres Forcas (in Morocco) and Alboran Island are located, and generate some upwelling of deep Mediterranean waters along the coast of Malaga and Granada (S Spain). A strong oceanic front is present between Cape Gata (SE Spain) and Oran (Algeria), called the Almeria-Oran Front (Tintoré *et al.*, 1988). It is a large-scale density front, formed by the convergence of two distinct water masses and controlled by the geographic position and strength of the Eastern Alboran Gyre. Physical and biochemical data indicate that this front is limited to the upper 300 m, with a strong southward baroclinic jet. The Almeria-Oran Front constitutes the eastern limit of the Alboran Sea, and acts as an effective barrier for many planktonic organisms and their larvae. Some molecular studies have shown noticeable genetic differences between populations on the two sides of the front (Patarnello *et al.*, 2007).

The existence of meso- and macroscale eddies and fronts, associated with the contact of different water masses, determines both the circulation and the distribution of ecological variables (biomass, productivity and composition of the planktonic community) in the area (Graze *et al.*, 1985; Prieto *et al.*, 1999; Youssara and Gaudy, 2001, among others).

In addition, there is a strong impact of the Mediterranean undercurrent that flows through the Strait of Gibraltar to the Atlantic margins of Iberia and North Africa. These outflow relationships suggest that the Betic and Rif straits may also have been important in the past evolution of the Atlantic margins.

Biological features

Biogeographically, the Strait of Gibraltar is the "meeting point" of the Mediterranean region (to the east), the Lusitanian region (to the northwest), and the Mauritanian region (to the southwest). It is a place of contact between warm-water species (from Atlantic North Africa and the Mediterranean) and cold and temperate-water species (from the northeast Atlantic). The area is thus species-rich due the confluence of three marine biogeographical regions, plus some endemic species restricted to this zone (Gofas, 1987).

Since the 1980's, multidisciplinary studies of the biodiversity of the Straits of Gibraltar have been conducted, mainly by the Laboratorio de Biología Marina of Seville University (i.e. Carballo *et al.*, 1997; Naranjo *et al.*, 1998). As a result, many new species from the area have been discovered, and the benthic communities of the northern part of the Strait described (García-Gómez *et al.*, 2003). Recently, a Marine Protected Area (MPA) has been declared in this sector, covering nearly 40 km of coastline. A description of benthic communities on the African margin of the Strait can be found in the book of Ocaña *et al.* (2009).

Obviously, the Straits of Gibraltar is an obligatory path for migratory vertebrates between the Atlantic and the Mediterranean (Rey, 1996). Large pelagic fish, cetaceans and sea turtles are very frequently observed in the area. Among the cetaceans, at least six species are very common here, the dolphins *Delphinus delphis, Globicephala melas, Tursiops truncatus,* and *Stenella coeruleoalba*, the minke whale *Balaenoptera acutorostrata*, and the sperm whale *Physeter macrocephalus*. The abundance of cetaceans in this area is related to the importance of this migratory path, the special oceanographic characteristics (de Stephanis *et al.*, 2008), and the preference of specific habitats and areas in the Alboran Sea have also been mentioned (Cañadas *et al.*, 2005).

Both loggerhead (*Careta caretta*) and leatherback (*Dermochelys coriacea*) turtles are frequent in the Strait; the former has a semi-permanent population near the Straits of Gibraltar associated with

remarkable concentrations of the swimming crab *Polybius henslowii,* here its main food resource (Ocaña *et. al.*, 2002b).

Like the Strait of Gibraltar, the Alboran Sea is a mixed area where the faunistic and floristic influences of three biogeographic regions overlap (i.e. Mauritanian, Lusitanian and western Mediterranean). Therefore, this area is useful for providing information of the recent and past faunistic interchange between the Atlantic and Mediterranean. The combination of all hydrological features together with the pronounced biogeographic differences between the Atlantic Ocean and the Mediterranean affect benthic communities and their zonation patterns.

A recent review of biodiversity in the Mediterranean (Coll *et al.*, 2010) points out that the Alboran Sea displays the highest values of species richness in the Mediterranean, probably due to the influx of Atlantic species and the wide range of physicochemical conditions. The same review highlights the ecological importance of the Strait of Gibraltar and Alboran Sea for many threatened or endangered vertebrate species. This area is key to the migration of the internationally protected loggerhead turtle (*Caretta caretta*) from the Atlantic to the Western Mediterranean, and hosts a high diversity of cetacean species. Of the nine resident marine mammals in the Mediterranean, eight are common in the Alboran Sea (including minke whale *Balaenoptera acutorostrata*, fin whale *Balaenoptera physalis*, sperm whale *Physeter macrocephalus*, pilot whale *Globicephala melas* and bottlenose dolphin *Tursiops truncatus*). Among resident species, the short-beaked common dolphin (*Delphinus delphis*) merits particular attention, because its population in the Alboran Sea is the healthiest in the Mediterranean, after a dramatic decline of this species in most of its Mediterranean range (Notarbartolo di Sciara, 2002).

Most of the species of the Annex II and III of the Barcelona Convention are present in the Alboran Sea, and the most threatened invertebrate species, the limpet *Patella ferruginea*, is concentrated in this area (Templado *et al.*, 2004).

The Alboran Sea biota is not homogeneous, since there is a west-east gradient due to the Atlantic influence, and an asymmetry in the north (European) - south (African) axis, due to the upwelling areas in the northern part. It is interesting to note that the Atlantic-Mediterranean and subtropical-temperate segregation patterns of benthic species are not the same on the North African coasts, where Tres Forcas Cape (3ºW) acts as an eastern limit for species with tropical affinities (and is at the same time the western limit for several Mediterranean species). In contrast, there are no clear limits the south Spanish coasts, and the upwelling areas determine the presence in shallow waters of typical species from deeper levels (Cebrián and Ballesteros, 2004). García Raso *et al.* (2010) have highlighted that this area has the highest species richness of all European coasts; Luque and Templado (2004) provide a complete revision of the marine flora of the entire area.

The biomass and calcium carbonate content of communities thriving on rocky bottoms of the northern (Spanish) margin of the Alboran Sea were studied by Cebrián *et al.* (2000). Total biomass is slightly higher than in other Mediterranean areas due to the high biomass of suspension feeders. Since most animals and algae with high biomass have calcareous skeletons, carbonate production is rather high (1.100 g Ca CO_3 m^{-2} y^{-1}) compared with other temperate and Mediterranean sites. As an example, carbonate production from deep-water assemblages in this area is nearly four folds higher than in similar studies carried out in the Balearic Islands (Cebrián *et al.*, 2000). This high carbonate production may be related to the particular hydrographic processes that take place in this area (mixing Atlantic and Mediterranean waters and upwelling of Mediterranean deep waters).

The African coasts of the Alboran Sea are still poorly known, but some peculiar and unique communities have been identified, such as those characterized by the North African gorgonian *Ellisella paraplexauroides*. This large gorgonian (up to 3 m high) dominates the rocky bottoms with northern orientation in the Chafarinas Islands between 20 and 40 m depth (Templado *et al.*, 2006). These islands, designated as MPA by the Spanish government, also have the healthiest known populations of the endangered limpet *P. ferruginea.*

There are several seamounts in the Alboran Sea (Chella, Djbouti, and Motril seamounts in its northern part, and Alidae, Cabliers, Porvençaux, Tofiño and Xauen seamounts in its southern parts). The benthic fauna of these banks is poorly known, but is now under study. Although very diverse

pre-modern Quaternary thanatocoenoses have been found, including dead reefs of white corals, living representatives have also been detected. Recent research on the Chella bank found important *Madrepora oculata* reefs, sometimes mixed with *Lophelia pertusa*, as well as other scleractinian corals typical of these communities, like *Desmophyllum dianthus*. This bank is also known for hosting the rare gorgonian *Dendrobrachia sarmentosa*, important aggregations of deep-sea glass sponges (*Asconema setubalense*), and the protected Mediterranean carnivorous sponge (*Asbestopluma hypogea*) (Aguilar *et al.*, 2011), among other exceptional species. Furthermore, a prominent ridge about 150 km long, of which Alboran Island forms the summit, extends in a SW-NE direction and divides the Alboran Sea in two subbasins.

A strong correlation has been found between the different water masses and the faunistic and floristic composition of the sublittoral benthos around Alboran Island (a complete review has been published by Templado *et al.*, 2006). The infralittoral and upper circalittoral assemblages (between 0 and about 50 m) of this island contain important Lusitanian components, and are dominated by the seaweeds *Cystoseira tamariscifolia* in the upper infralittoral, *Cystoseira usneoides* in the lower infralittoral and *Saccorhyza polyschides* and *Laminaria ochroleuca* in the upper circalittoral. However, lower circalittoral-upper bathyal assemblages (50-200 m) harbour fauna with a peculiar species composition, lacking affinities with equivalent communities in neighbouring areas both in the Atlantic and the Mediterranean. This suggests that the lower circalittoral of the Alboran shelf is an ecotone established in the boundary layer between the Atlantic and Mediterranean water masses (Maldonado and Uriz, 1995). The species richness associated with the *Laminaria* forests of Alboran Island is higher than that of the Mediterranean *Posidonia* meadows; but the highest species richness has been detected in the coralligenous communities here. As an example, up to 15 species of gorgonians have been found in this area. The great species turnover rate as well as the high species richness, suggest that this community is an ecotone assemblage within the Atlantic-Mediterranean axis. These coralligenous bottoms harbour well-known populations of the red coral (*Corallium rubrum*), that were intensively extracted in the past. Nowadays an extensive Mediterranean Action Plan (MAP) has been declared by Spanish Law around the island.

The marine biological assemblages around Alboran Island might be assumed to have a relatively recent origin, based on the co-existence of present-day (Holocene) species from nearby biogeographical regions with late Quaternary (Sicilian, Tyrrhenian) relicts, and alternating Mediterranean and Atlantic influences. The environmental changes provoked by Quaternary events were to some extent attenuated below the shallowest bathymetrical level, allowing survival and co-existence for elements of different origin.

In conclusion, the current marine fauna of Alboran Island can be understood as a result of the coexistence of:

- Some very ancient elements (either true elements surviving the Messinian crisis or Tethyan elements reintroduced from the Ibero-Maroccan bay in the Pliocene);
- Lusitanian and Mauritanian-Senegalese elements arising from the alternating glacial and interglacial Quaternary migrations;
- Mediterranean elements originated during the Quaternary;
- New species evolved in the current peculiar environmental conditions.

It is noteworthy that at least 32 new marine species have been described from this island in the last two decades (1 seaweed, 10 sponges, 1 isopod, 1 amphipod, 14 molluscs, 4 bryozoans, and 1 ascidian). Extensive surveys of the island marine biodiversity begun in the 1980's. Templado *et al.* (2006) list of more than 1,800 species (219 species of macrophytes, 183 of sponges, 98 cnidarians, 630 of molluscs, 123 of bryozoans, among others).

In contrast, knowledge of the benthic communities of the Ibero-Moroccan Gulf is scarce. Bobo (1998) published a guide to the littoral fauna and flora of the coast of Huelva, and the conservation organisation OCEANA is currently conducting Remotely Operated Vehicle (ROV) surveys of the sediments of the Gulf of Cadiz. In addition, the IEO is studying the mud volcanoes and diapirs in the area, with their carbonate chimneys and crusts, but mainly from the geological point of view.

The Gulf of Cadiz coast is low and sandy, often with high sedimentation rates and large dune systems. There are clear differences between the western and eastern sectors. While the bottoms off Huelva are mostly covered by soft sediments, those off Cadiz are characterized by rocky outcrops, and the shoreline has some rocky intertidal platforms with tide pools. The benthic fauna of the whole sectoris mainly dominated by communities typical of soft sediments (with some peculiar species of the area, such as the gastropods *Cymbium olla* or *Ampulla priamus*), while the rocky outcrops have rich communities of sessile filter feeding animals (*Leptogorgia sarmentosa, Eunicella verrucosa, E. gazella, Elisella paraplexauroides, Dendrophyllia ramea, Astroides calycularis,* etc.) and important fish schools concentrate in these areas *(Chromis chromis, Parapristipona octolineatum, Plectorhynchus mediterraneus, Diplodus* spp.), including endangered species, like the guitarfishes (*Rhinobatos* spp.).

Some of the mud volcanoes and chimneys scattered throughout thearea support communities of vesicomyd clams and siboglinid tubeworms (Mata *et al.*, 2009).

THREATS

The main threats to the region include intense and destructive fishing activities, urban development and infrastructure on the coastline, submarine cables, chemical pollution, military manoeuvres, oil facilities and pipelines, off-shore energetic plans development plans, harbour constructions, sea bottom mining, sand dredging, etc. There is also heavy marine traffic. Invasive species are increasingly colonising the area, like the anemone *Haliplanella lineata* and the tunicate *Styela clava.*

Fishing is one of the main human activities in the area. The Strait of Gibraltar is a transit zone for several species of large pelagic fish and crustaceans, e.g., swordfish (*Xiphias gladius*), marlins (*Istiophorus albicans*), bluefin (*Thunnus thynnus*) and other tunas (Techetach, 2002). The migrations of these species through the strait each year occur during specific seasons determined by their physiological needs, namely reproduction and diet. In fact, the highest catches of bluefin tuna and swordfish in Morocco occur in Tangier waters. The Port of Tangier is ranked as the major port of landing swordfish, making Morocco the second largest producer of swordfish across the Mediterranean, after Italy (ONP, 2008).

There are also important fisheries for deep sea species, like red sea bream (*Pagellus bogaraveo*) which is heavily fished (Gil and CopeMed II Consultant, 2010), and with stock levels in a critical state.

The Strait of Gibraltar is also a very important area for marine turtles that migrate between the Mediterranean and other areas of the Atlantic Ocean (Benhardouze, 2009; Ocaña *et al.*, 2002a). The Straits of Gibraltar does not appear to contain resident populations of marine turtles (Fretey, 2001) nor suitable nesting habitats, (Benhardouze, 2009) but is a transition zone for immature loggerheads from the Americas and the eastern Atlantic (Bolten, 2003). Migratory fluxes of loggerhead turtles near and through this strait has been reported in both directions (Camiñas, 1997; López-Juradoand Andreu, 1998; Margaritoulis *et al.*, 2003). Loggerheads sea turtles are predicted to require a minimum straight carapace length (SCL) of 36.0 cm to swim against the current from the Mediterranean to the Atlantic (Revelles *et al.*, 2007). Migration takes place from May to August, and includes both juveniles and adults (Camiñas, 1997; Revelles *et al.*, 2007). The coasts surrounding the Strait of Gibraltar (Tetuan to Ceuta, Tangier, and Asilah) appear to be foraging areas for juvenile turtles primarily (Benhardouze, 2009). The rich fisheries of the region could be the origin of the attendance of young turtles to these areas. Sea turtles and cetaceans commonly interact with fisheries in the Strait of Gibraltar (Acero *et al.*, 2009).

On both sides of the Strait of Gibraltar, there are several fishing ports (Tangier, Cadiz, etc.), which generate heavy fishing pressure. Therefore, fisheries resources are declining, according to the statistics, and also according to statements of fishermen in the area. It is time to reduce fishing effort and also to eliminate the most harmful types of fisheries (driftnet) to protect species including sea turtles and dolphins (Tudela *et al.*, 2004).

Fisheries are very important both in the Gulf of Cadiz and the Alboran Sea. Many species, including crustaceans like *Parapenaeus longirostris* and *Melicertus kerathurus*, molluscs like

Chamelea gallina, Donax trunculus, Sepia spp. and *Octopus vulgaris*, and fish like *Sardina pilchardus, Engraulis encrasicolus, Dicologlossa cuneata, Argyrosomus regius* and many others are target species for artisanal and semi-industrial fleets (IEO, 1989; Manzano *et al.*, 2004; Aguilar *et al.*, 2010).

Conclusions

Some of the key elements in favour of the proposition of the "Near Atlantic" among international MPPs within the Mediterranean are the following:

- The area constitutes the engine where Mediterranean water originates.

- It plays a key control of the exchanges and modification of the biogeochemical cycles and circulation of the entire Mediterranean.

- It is an outstanding area for biodiversity in the Mediterranean, being a transitional zone between the Atlantic Ocean and the Mediterranean, with the highest species richness in European/North African waters.

- It is key route for the migration of the internationally protected marine vertebrate species (sea turtles, cetaceans, and target species of pelagic fish) from the Atlantic to the Western Mediterranean, and hosts a high diversity of cetaceans.

- There are some unique communities within the Mediterranean dominated by Atlantic seaweeds, such us the forests of *Laminaria ochroleuca* and *Saccorhyza polyschides*, or the community dominated by the north African gorgonian *Ellisella paraplexauroides*.

- Some living deep coral banks of *Lophelia pertusa* and *Madrepora oculata* have been found near Alboran Island and on the Chella Seamount.

- More than 100 mud volcanoes and many fluid escape structures have been detected scattered over the whole Ibero-Moroccan Gulf.

- Most of the species included in Appendices II and III of the Barcelona Convention are present in this area.

- The most threatened invertebrate species of the Mediterranean, *Patella ferruginea*, is most abundant in this area (Templado *et al.*, 2004).

- There are four important Spanish MPAs in this area: Cabo de Gata Natural Park and Marine Reserve in the northeast limit of the Alboran Sea, The Alboran Island Marine Reserve in the centre of this basin, the North Littoral of the Strait of Gibraltar Natural Park, and the Chafarinas Islands Refuge on the Moroccan coast. There are also some other less extensive marine protected areas, some of them within Nature 2000 sites.

Scientific rationale for the proposed CIESM Pelagian Sea Marine Peace Park

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Introduction

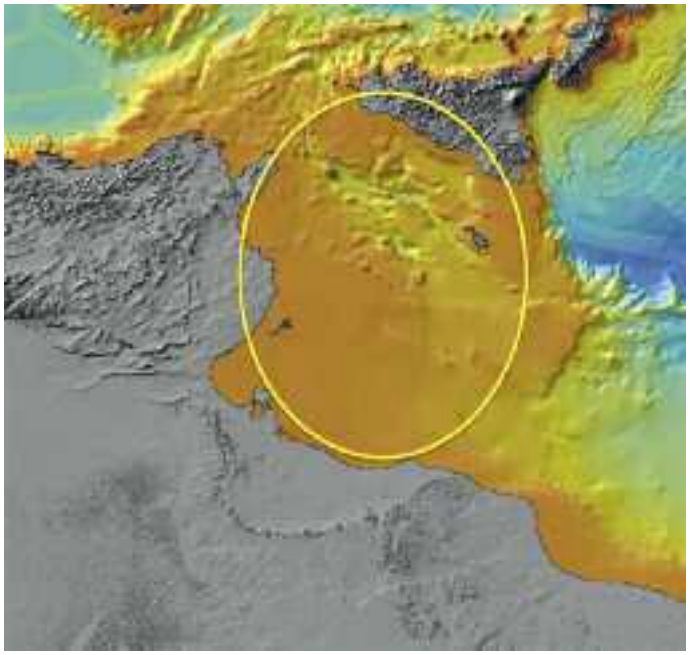

Figure 1. Shaded bathymetry of the CIESM Pelagian Sea Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500m grid). Adapted from L. Brosolo and J. Mascle (2007).

The geological, oceanographic, and biological characteristics suggest that the marine zone within the oval illustrated on the satellite and geological maps (Fig. 1), referred to as the Pelagian Sea, would benefit from conservation actions that should be achieved through collaborative efforts in research, monitoring and effective management (Gačić, this volume; Greenpeace, 2009; Mascle, this volume; Vella, 1998; 2000; 2001; 2002; 2005; 2008; 2009; 2010a,b).

The following highlights some aspects of the region, and provides a base line on which to develop further research collaboration and knowledge exchange toward the conservation needs of the area.

Topographic features of biological importance in this region include: seamounts, volcanic islands and submerged volcanoes, slow-flux seeps, and pockmarks (Mascle, this volume). Shallow, offshore banks found in this region are also important for marine biodiversity.

From the oceanographic view point this zone is considered a choke point where the surface Atlantic Water enters in eastern basin and the Levantine intermediate waters flows into the western basin

(Gačić, this volume); the area is also characterised by several mesoscale features (upwelling, filaments, and meanders) that play an important role in the biogeochemistry dynamics of the Sicily Strait and surrounding area (Fig. 2).

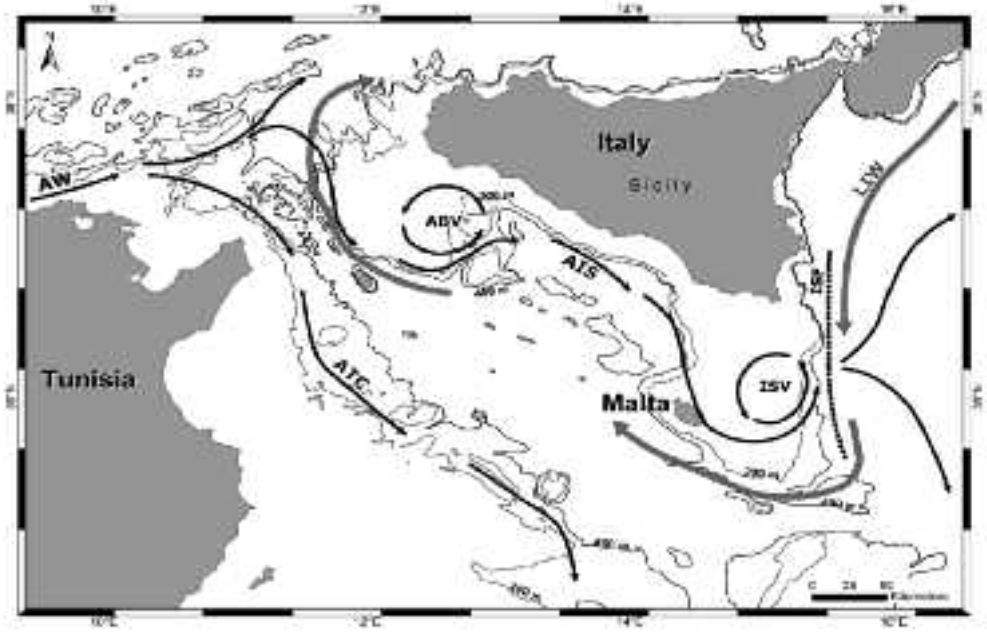

Figure 2. Features of the Strait of Sicily/Malta/Pelagian Islands: AW= Atlantic Water; LIW=Levantine Intermediate Water; AIS = Atlantic Ionian Stream; ATC=Atlantic Tunisian Current; ABV=Adventure Bank Vortex; ISV=Ionian Shelf-break Vortex—After Lermusiaux (1999); Lermusiaux and Robinson (2001); Béranger *et al.* (2004); Poulain and Zambianchi (2007).

Greenpeace published a proposal for a regional network of large-scale marine reserves with the aim of protecting the full spectrum of life in the Mediterranean (Greenpeace, 2006; 2009). The Sicilian Straits Channel was identified as one of the areas to be protected within the network.

The network was drawn up with the help of experts and used a variety of data sets including distribution of species, areas important for key life stages e.g. spawning grounds, important habitats such as seamounts, and sites previously identified as priority sites for protection, such as Specially Protected Areas of Mediterranean Importance (SPAMIs) (Greenpeace, 2009).

In the context of Ecologically and Biologically Significant Areas (EBSA) the Pelagian Sea offers various scientific criteria, and protocols for conservation and management measures, including the establishment of representative networks of marine protected areas in accordance with international law (Convention on Biological Diversity Decision IX/20). All the seven CBD EBSA criteria adopted are relevant in this area.

Uniqueness or rarity

Rare habitats/assemblages are found in this region, such as the facies formed by *Isidella elongata* and that formed by *Funiculina quadrangularis*, and white corals. Rare and endemic species in the area include the Maltese ray, *Leucoraja melitensis* and the scleractinian coral *Cladopsammia rolandi* (Pipitone *et al.*, 1992).

Special importance for life histories of species

The area includes spawning, and nursery grounds for several species of ecological (fin whales, turtles, seabirds) and economic importance (bluefin tuna, deep sea gadoids, swordfish). To this extent, a 25 nm fisheries conservation zone around Malta has been established (Aissi *et al.*, 2008; Dalli and Vella, 2006; Greenpeace, 2009; Vella, 1998; 2000; 2001; 2002; 2005; 2008; 2009;

2010a,b).

Importance for threatened, endangered or declining species and/or habitats

Common dolphins (*Delphinus delphis*) and various other cetaceans including bottlenose, striped, and Risso's dolphins, sperm and fin whales, elasmobranchs, including great white shark (*Carcharodon carcharias)*, basking shark *(Cetorhinus maximus)* and devil's ray (*Mobula mobular*), sea birds including shearwater species (*Calonectris diomedea* and *Puffinus yelkouan*) are vulnerable species resident or frequently observed in the region; some of them have been classified in the red list as threatened or endangered species. *Posidonia oceanica* meadows are still extensive in this region (Dalli and Vella, 2006; Greenpeace, 2009; Vella, 1998; 2000; 2001; 2002; 2005; 2008; 2009; 2010a,b; Vella and Vella, 2010).

Vulnerability, fragility, sensitivity, slow recovery

Vulnerable deep coral assemblages, cold seep assemblages and benthic and pelagic species affected by over-exploitation and habitat degradation are found in the region (Vella, 2010). Overall, marine biodiversity impoverishment and change due to increasing human activities including oil exploration, aquaculture, maritime and fisheries activities, climate change and alien species from both sides of Gibraltar and Suez Canal openings.

Biological productivity

Mesoscale structures referred to by Gačić (this volume) are related to wind driven upwelling, which affect both the Mazurka del Vallo fishing area and the Capopassero upwelling. While these structures may be stationary when wind-driven, they can move when influenced by sea currents. In the latter case the effects are temporary and last up to 20 days. he hydrography, canyons and complex fluxes in the region need to be considered in the light of their effects on biological productivity too. The region is recognised as being important for spawning and as a nursery for various species including bluefin tuna (*Thunnus thynnus*) spawning areas (Vella, 2009; 2010a), swordfish (*Xiphias gladius*), anchovy (*Engraulis encrasicolus*), and several demersal species (Fortibuoni *et al.*, 2010). The area around Malta was also found to be important for fisheries conservation, and a 25 nm fisheries conservation zone around these islands was established.

Biological diversity

This area is important from an evolutionary point of view due to different sea level changes and isolation episodes, and therefore secondary contacts that may have paved the way to speciation and separation between basins. Molecular genetics studies of species and populations in this region in comparison with other region in the Mediterranean are important for conservation and for monitoring changes in this region and in the Mediterranean distribution of species.

Naturalness

Though human use of the region is extensive, with impacts on its biological and environmental status, unique natural conditions found here are essential to safeguard the marine life present, and to study the various unknown geological and environmental characteristics of this region in more detail. The region is geologically complex, even though the Pelagian Sea overlies the African platform and is thus mostly limestone. Extensive oil research takes place in the region, but the data collected have not so far been released, and thus full bathymetric data for the area is not yet available (Mascle, this volume).

Scientific rationale for the proposed CIESM Herodotus and Eratosthenes Marine Peace Park

Jean Mascle [1], Myroula Hadjichristoforou [2] and Howaida Zakaria [3]

[1] Geo-Azur, CNRS, Villefranche-sur-mer, France ; [2] Department of Fisheries and Marine Research, Nicosia, Cyprus ; [3] NIOF, Alexandria, Egypt

The proposed Herodotus and Eratosthenes Marine Peace Parks (Figure 1a, b) are located in the south Eastern Basin: the forme extends between the coasts of Greece (South-eastern Crete) and of Egypt (Western Desert) and the latter lay between the coasts of Egypt and of Cyprus. Both overlap partially with Exclusive Economic Zones.

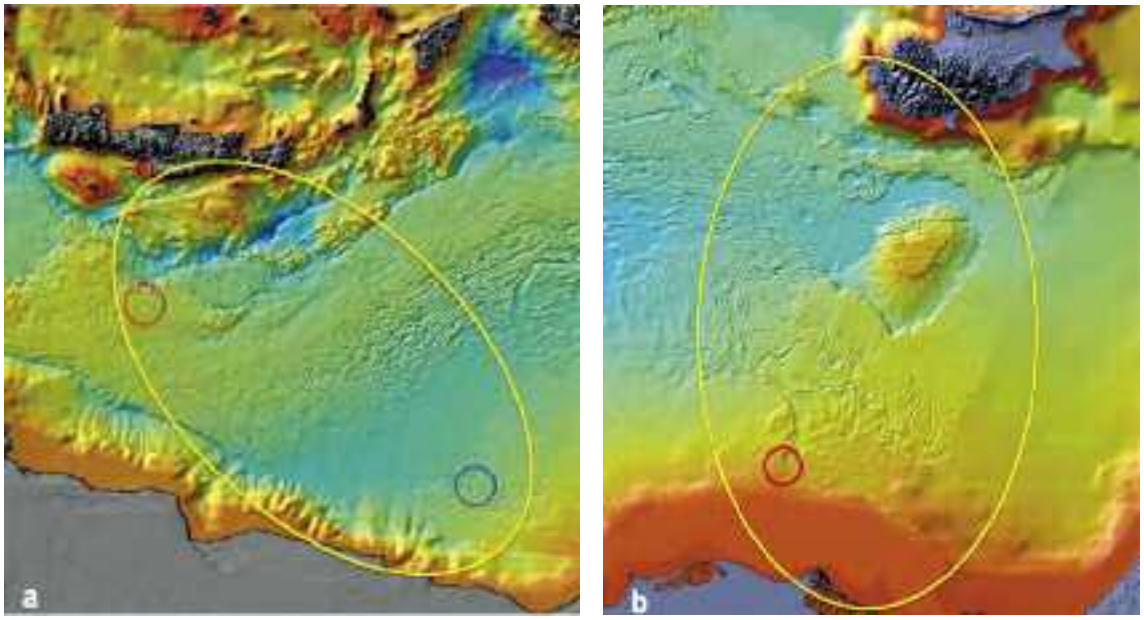

Figure 1a. Shaded bathymetry of the CIESM Herodotus Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500 m grid). Red circle: Olympic field; Blue circle: are of twin Cheffren mud volcano. 1b. Shaded bathymetry of the CIESM Eratosthenes Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500 m grid). Red circle: area of Amon gas chimney. Adapted from L. Brosolo and J. Mascle (2007).

GEOMORPHOLOGY

Herodotus[1] Marine Peace Park, which lies, with water depths up to 3000 m, between the coasts and the continental slopes of Crete (to the North) and of the Western desert (Egypt, to the South). The area covers three main geological domains: (a) the passive African continental margin of Egypt (and partly Libya), including the northwestern most corner of the Nile deep sea fan sedimentary construction, (b) the seismically active continental margin which borders the island of Crete and, (c) between both continental margin segments a huge mass of tectonic sediments, the Mediterranean Ridge, which results from the piling up and strong deformations of sediments squeezed between the two rigid margins.

Eratosthenes[2] Marine Peace Park, which extends up to 3000 m water depth, between the coasts and the continental slopes of Egypt (Nile delta to the south) and of Cyprus (to the North); it includes a wide, flat-topped and relatively shallow (water depth less than 1000 m) seamount, the Eratosthenes seamount. The area covers three main geological domains: (a) the wide passive African continental margin of Egypt (and particularly large domains of the Nile submarine delta and of its sedimentary fan), (b) the seismically active continental margin which borders the island of Cyprus and, (c) between both a breaking African continental margin fragment, the Eratosthenes seamount, which is entering continental collision with Cyprus; moreover this flat-topped seamount was an island during the Messinian desiccation crisis which affected the Mediterranean Sea sometimes between 6 and 5 millions years ago, and thus submitted to intense continental erosion.

GEO- AND HYDRODYNAMICS DIVERSITY

Several current gyres characterize both Herodotus and Eratosthenes zones (Gačić, this volume), inducing at local scale temporarily highly productive zones. Primary productivity is particularly high in waters near the Egyptian coast (Eratosthenes Park) due to the considerable input of nutrients from Nile Delta.

Another specific feature common to the two areas is the presence of deep-sea (between 2000 to 3000 m in Herodotus and between 500-1000 in Eratosthenes), cold fluid seep fields, whose activities induce the development of unique deep sea environments and of microbial-related biodiversity hot spots.

FLUID SEEPAGE: AN EXAMPLE OF SPECIFIC "GEO-DIVERSITY" AND ITS IMPACT ON DEEP-SEA ENVIRONMENTS

In Herodotus zone fluids are emitted directly to the seafloor in two distinct settings: (a) within the Mediterranean ridge where they are closely linked to massive emissions of under-compacted and over-pressurized mud known as mud volcanoes, and (b) at the foot of the Nile submarine sedimentary construction on the Egyptian continental slope.

On the Mediterranean ridge, particularly on the so-called *Olympi field*, group of several mud volcanoes were discovered about 15 years ago and on which *in situ* research has been conducted in the past 10 years. One of these features, the Napoli mud volcano MV, has received particular attention. Napoli MV (see Figure 2), which lies in 2000 m depth, has small sub-circular brine ponds and brine rivers on its active top, resulting from mixing of mud, fluids and remobilized salt-rich sediments; the emitted gases, particularly biogenic and thermogenic methane, are degraded by

[1] Herodotus was a Greek historian (c.484 t-c. 425 BC), well known for his "Histories" of the Mediterranean world. His name was given some 50 years ago to the deep abyssal plain extending to more than 3000 m depth at the foot of the African continental margin from Libya to Egypt in the Eastern Mediterranean.

[2] Eratosthenes, Greek mathematician and geographer (born in Libya, c. 276 BC, died in Alexandria, c. 195 BC), created a system of latitude and longitude, and was the first to demonstrate that the earth was round! His name was given some 50 years ago to the large flat seamount, which lies, in less than 1000 m water depth, between the African continental margin off Egypt and Cyprus.

specific bacterial/archaea consortia which favour chemosynthetic symbiosis with worms, lamellibranches, sea urchins and others species, including crabs and fishes which take advantage of this seabed food supply (Figure 3). Thus these cold fluid seeps form *oases of life* in particularly extreme environments.

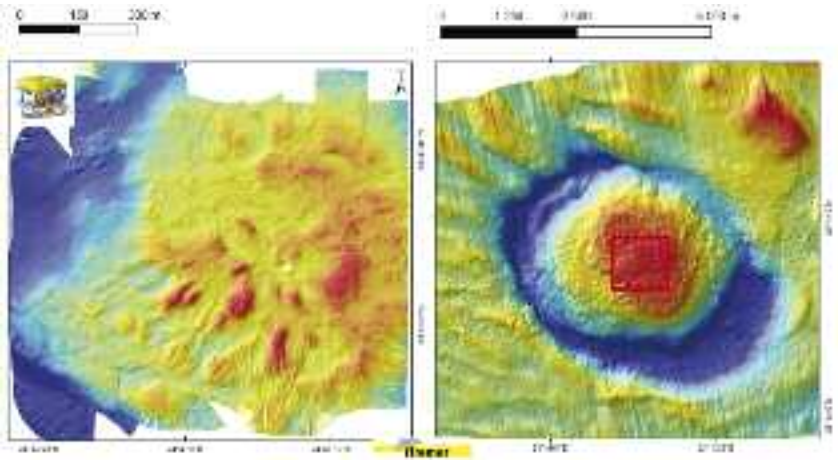

Figure 2. Napoli Mud Volcano in 2000 m water depth in the Olympi field, south of Crete.

Figure 3. Seabed views of Napoli Mud Volcano showing brine rivers, bacterial mats, crabs, rays and sponges.

Similar processes are operating at the foot of the Egyptian continental margin in 3000 m water depth (Figure 4). There the fluids clearly originate from a deep buried petroleum system, and are similarly mixing with dissolved salt layers and over-pressurized mud to generate small mud volcanoes and important gas chimneys. These fluids also contribute through chemosynthesis processes initiated by bacterial/archaea consortia, degrading CH_4 and other components, to specific biodiversity hot spots, which were totally unknown less than 10 years ago. These discoveries highlight the need to better study and preserve such bio/geo-diversity environments.

Figure 4. Seabed views of Cheffren Mud Volcano showing brine lake and brine rivers and bacterial mats and filaments.

In the southern region of Eratosthenes zone fluids are emitted directly on the seafloor following two different mechanisms: (a) along fault zones that form a "plumbing" system, where the fluids appear closely linked to massive emissions of under-compacted and over-pressurized mud known as mud volcanoes or gas chimneys, several kilometers in diameter, and chiefly detected on the eastern upper continental slope and, (b) through hundreds of pockmarks, small sub-circular (only a few meters in diameters) depressions, which affect wide areas of the Nile submarine delta continental slope and indicate important degassing processes.

Concerning the gas chimneys we propose it is important to concentrate efforts on a group of several gas chimneys discovered about 10 years ago, and on which "in situ" research has been conducted in the past 7 years. One of these features, Amon gas chimney (GC), has received special attention (Figure 5). The sediments on the active top of Amon GC, which lies in 1100 m water depth, are strongly disturbed and believed to result from explosive mud/gas emissions; these gas emissions, particularly thermogenic methane, are assimilated by bacteria/archea consortia facilitating chemosynthetic symbiosis with many invertebrate species, as well as fish which feed on the seabed. Similarly to those in the Herodotus zone, cold fluid seeps located in the southern part of Eratosthenes Park form *oases of specialized life* in extreme environments.

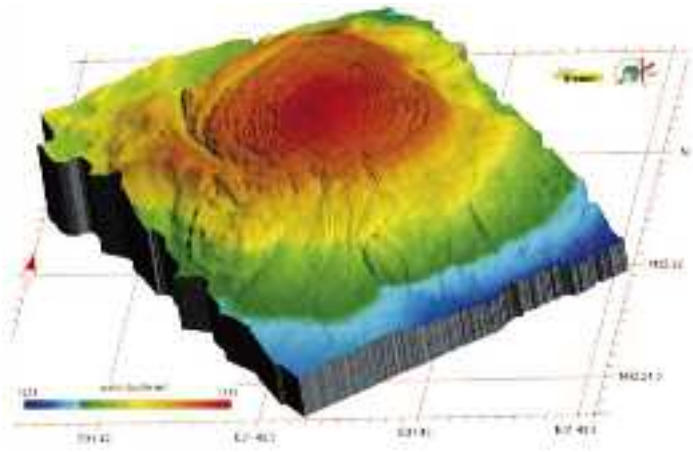

Figure 5. Amon gas chimney, in 1100 m water depth, along the Eastern Nile fan continental slope North of Damietta. Plan and 3D views from a DTM at 2 m recorded near the seabed with an AUV system.

Pockmarks are themselves quite widespread on many areas of the Egyptian continental slope; they are loci of more diffuse gas escapes, which can be detected acoustically as gas plumes in the seawater. Authigenic carbonates and chemosynthetic symbiosis resulting from bacterial activities are quite common in pockmark fields (Figure 6).

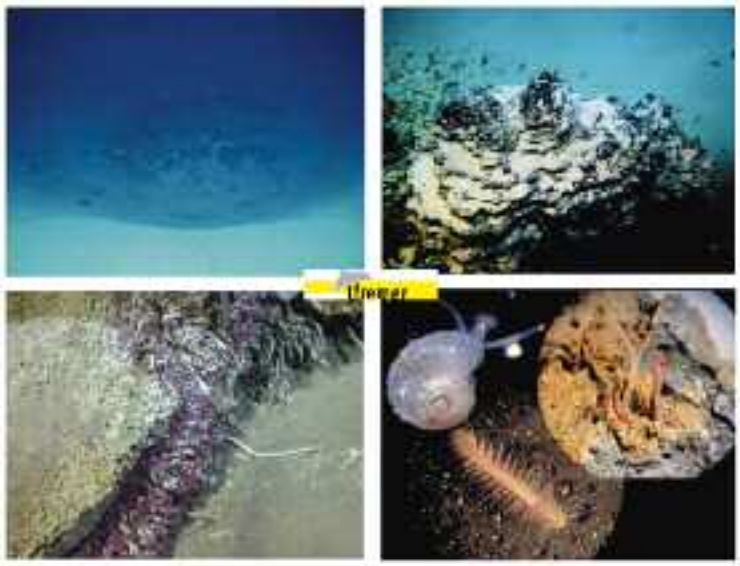

Figure 6. Seabed views of a pockmark, of carbonate constructions and of different species living in this environment thanks to chemosynthetic symbiosis.

Ecological features of interest

Eratosthenes and Erodothus parks represent two important zones of reproduction for several popular migratory species, including sperm whales (*Physeter macrocephalus*), Cuvier's beaked whales (*Ziphius cavirostris*), dolphin species. The coast of Cyprus and Egypt and sea host breeding sites and feeding grounds for sea turtles and monk seals (western coast of Cyprus). The areas also provide important corridors for many bird migrations.

The occurrence of very abrupt and rocky continental slopes, particularly south of Crete and of Cyprus, allowed the development of deep-sea corals and others sessile organisms although these have been poorly studied so far.

One of the few remaining spawning grounds of blue fin tuna is located off the Egyptian coast.

Main threats

Maritime traffic and its potential risks such as accidents, pollution, ballast water pollution, remain probably the most important threat in both areas. Further, these zones are subject to unregulated and uncontrolled fishing activities, especially in international waters, with serious impacts on fish stock depletion and biodiversity. Growing oil and gas exploration and military activities, which are quite frequent in the two parks, cause great disturbance to migratory species especially cetaceans. Like most of the Levantine Basin, the region is also colonized by non-indigenous, Eritrean species transiting from the Red sea through the Suez Canal.

Scientific rationale for the proposed CIESM North Levant Marine Peace Park

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[2] Faculty of Fisheries, Istanbul University, Turkey

INTRODUCTION

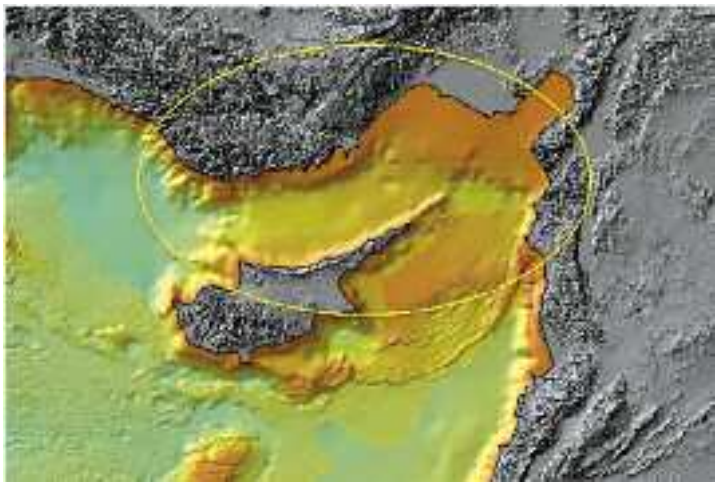

Figure 1. Shaded bathymetry of the CIESM North Levant Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500m grid). Adapted from L. Brosolo and J. Mascle (2007).

This report summarizes the major and peculiar features of Taseli Strait between Anatolia and Cyprus, within the context of the eastern Mediterranean ecosystem (Figure 1). For this, we consider the phytoplankton and zooplankton, essential building blocks of pelagic ecosystems, the ichthyoplankton that determines/ensures the future of fish stocks, the gelatinous organisms which form trophic dead-ends in pelagic ecosystems, and endangered and threatened species protected by international conventions and national laws. Life histories, habitats, spawning, nursery and overwintering grounds are evaluated to the extent that available data permits.

The oceanography of the Eastern Mediterranean is characterized by a complex system of mesoscale eddies, jets and meanders entrained and embedded in the general cyclonic circulation (Hamad *et al.*, 2005; CIESM, 2005a). Although some of the main oceanographic features persist, the general circulation is subject to remarkable inter-annual variability (Özsoy *et al.*, 1991; 1993). One of the most important temporal variations is the geographical range achieved by the (modified) Atlantic Water (MAW). This water mass enters the Levant Basin through the Cretan Passage, and the core of the jet branches southwest of Cyprus. One branch passes Cyprus to the south and reaches the eastern boundary of the basin. In some years, an arm turns north, advecting a considerable amount of the Atlantic water into the NE Levant in the form of a subsurface filament (Özsoy *et al.*, 1993). This is the main motive force of the Asia Minor Current that feeds Taseli Strait. However, at other times the mainstream flow is blocked in the Latakia basin, between Cyprus and Syria (Özsoy *et al.*, 1991).

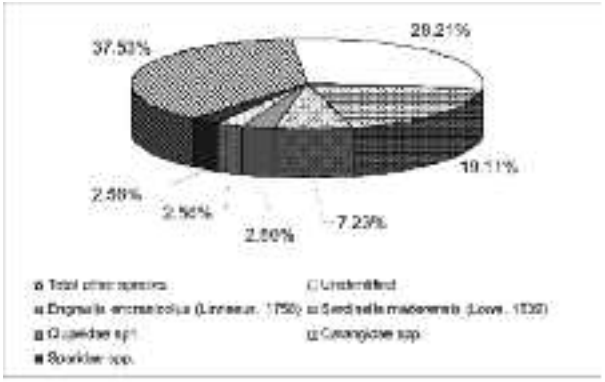

Figure 2. Percentages of dominant yolk sac larval fish during the study periods (Ak and Uysal, 2008).

Productivity in the north-eastern Mediterranean is characterised by extreme oligotrophy (Yılmaz *et al*., 1994; Ediger and Yılmaz 1996; Ediger *et al.*, 2005). However, nearshore waters are typical ROFI (Regions of Freshwater Influence) with significant inputs from small to medium scale rivers flowing into the region (Dogan-Saglamtimur and Tugrul, 2004). This feature leads to strong contrasts between the continental shelf waters and those offshore in term of productivity.

Phytoplankton productivity, mainly induced by riverine inputs, is generally unimodal; but in some years increased productivity is observed in late summer. This variable feature is associated with intrusions of modified Atlantic Water into the area (Uysal *et al.*, 2008).

The spatial variability in chlorophyll shows that the spring bloom is more pronounced in the eastern part of the basin, especially in the inshore waters. The bloom productivity is absorbed by the ecosystem until summer. Then in autumn a remarkable increase is observed in Taseli Strait.

The phytoplankton in the area is composed of three main groups, diatoms, dinoflagellates and chrysophytes. The first two groups always contribute 90% or more of total phytoplankton cells. Given that the diatom to dinoflagellate ratio may be used as an indicator of eutrophication level, the phytoplankton composition in the area shows eutrophic character relatively to the extreme oligotrophy of the Eastern basin. Taseli Strait is distinguished from the rest of the basin by the longer duration of the period when diatoms exceed dinoflagellates, indicating that the spring bloom lasts longer and so provides a longer nutritious state.

To sum up, despite the extreme oligotrophy of the eastern Mediterranean, Taseli Strait is fed by the eutrophic waters of the NE Levant Sea, especially during late summer. Also, intrusions of Atlantic Water additionally augment productivity in the area. These features increase the nutritious quality of the Taseli region for zooplankton at early life stages.

Ichthyoplankton surveys carried out in the NE Levant Sea show a diversified composition, within Taseli Strait alone a total of 125 larval fish taxa belonging to 39 families are recorded (Ak, 2004; Ak and Uysal, 2008). Among them small pelagics (mainly anchovy) are the most commonly observed species (Figure 2). It seems that productivity in the lower trophic levels provides suitable spawning and nursery areas for small pelagics in Taseli Strait.

Despite their slight commercial importance in Taseli Strait, small pelagics are among the dominant fish. Although present in summer, they do not then form dense schools as they do in winter. Dispersed aggregations are not suitable for exploitation, but nevertheless provide an important food source for the larger fish such as juvenile bluefin tuna and hake.

The most important large pelagic fish of the region is the bluefin tuna (*Thunnus thynnus*). One of the four major spawning grounds of the species is located within Taseli Strait (Figure 3). In a survey of the area, the largest concentration of bluefin larvae was found in Taseli Strait (Karakulak *et al.*, 2004 – Figure 4). Bluefin larvae bluefin, increase in size from east to west. The eggs and larvae of bluefin are very small compared to the adult size of the species, and development of the larvae is very rapid. Larvae usually hatched within 24 hours of spawning, so that the occurrence of larvae in an area indicates that the adults spawned in the close vicinity.

Figure 3. Most important spawning ground of bluefin tuna (*Thunnus thynnus)* in the Mediterranean. Numbers in grey circles are spawning ground located in the western Mediterranean; the black spot indicated by the black arrow is the major spawning ground of the species (from Karakulak *et al.*, 2004).

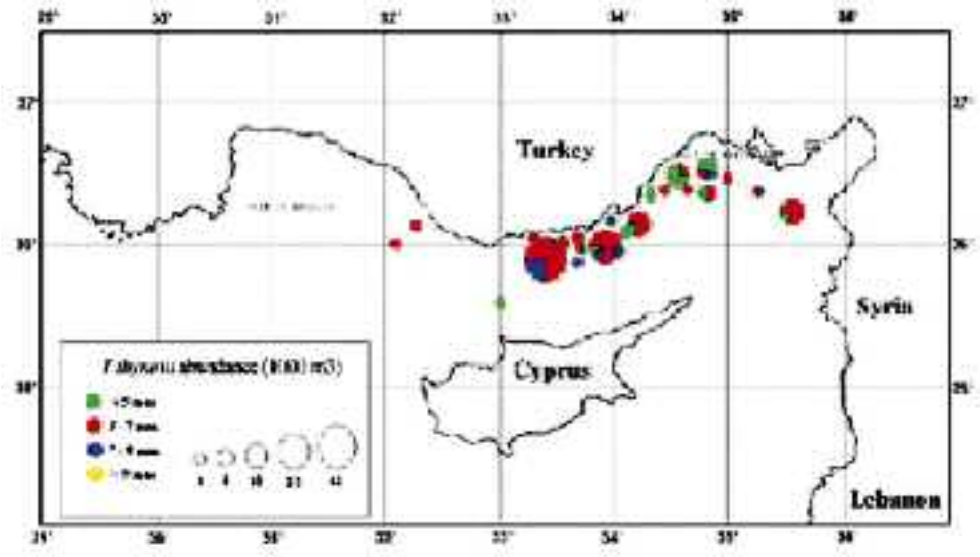

Figure 4. The position, abundance and length composition of bluefin tuna (*Thunnus thynnus*) larvae in the Levant Sea (Oray and Karakulak, 2005).

Amongst the demersal species, hake is commercially important. This species undergoes ontogenetic migrations between the continental slope and upper shelf area; juvenile hake migrate to the upper shelf to fulfil their changing dietary requirements (Carpenteri *et al.*, 2005). A trawl survey carried out in the area showed that the majority of hake sampled were juveniles (95% of the samples ranged from 12 to 28 cm, representing the 0 and I year classes). This group probably comprises those changing their feeding behaviour from benthivorous to piscivorous, hence in search of small pelagic fish in shallow waters. The sudden increase in the density of juvenile hake in the area may indicate that the spawning and nursery grounds are located within Taseli Strait (Gücü, 2006).

The range of *Posidonia oceanica* ends on the north coast of Taseli Strait (Figure 5 – Gücü and Gücü, 2002a). Historical records (Cirik, 1991) show that these meadows have regressed almost 10 km westwards within the last 25 years. Temperature, salinity and mechanical stress by bottom trawlers seem responsible for the absence of *Posidonia oceanica* in the Levant Sea (Celebi *et al.*, 2006). Surprisingly, this northeastern limit of the species coincides with a remarkable gradient in the distribution of Lessepsian fish (Figure 6 – Gücü and Bingel, 1994; Gücü and Gücü, 2002b).

Figure 5. The position of northeastern boundary of the *Posidonia oceanica* in the Mediterranean.

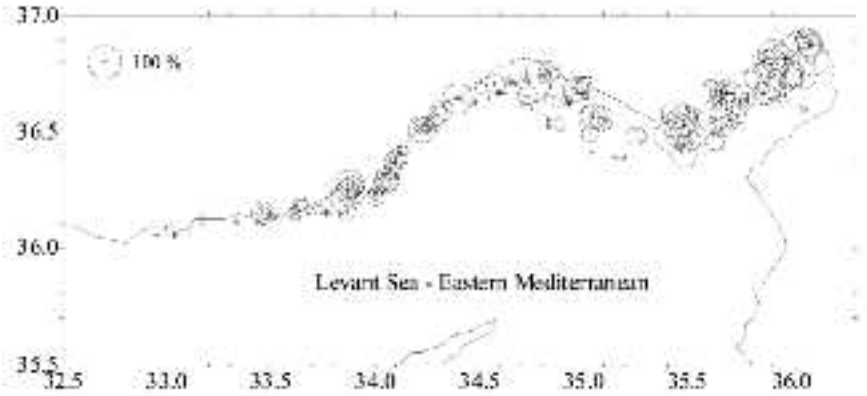

Figure 6. Percentage of Lessepsian fish in the total catch (Gücü and Bingel, 1994).

Marine turtles are important elements of the conservation value of Taseli Strait. The area provides important nesting sites for *Chelonia mydas* and *Caretta caretta* (Figures 7, 8 and 9).

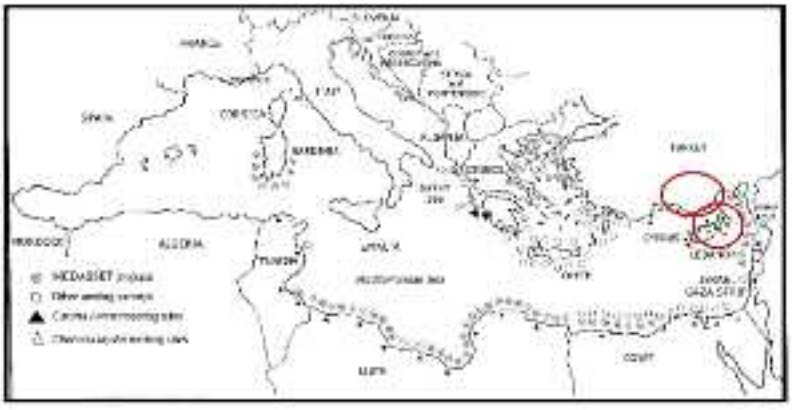

Figure 7. Nesting beaches of the green turtle, *Chelonia mydas*, in the Mediterranean (Venizelos *et al.*, 2005). The upper red circle is enlarged in Figure 8 and the lower circle in Figure 9.

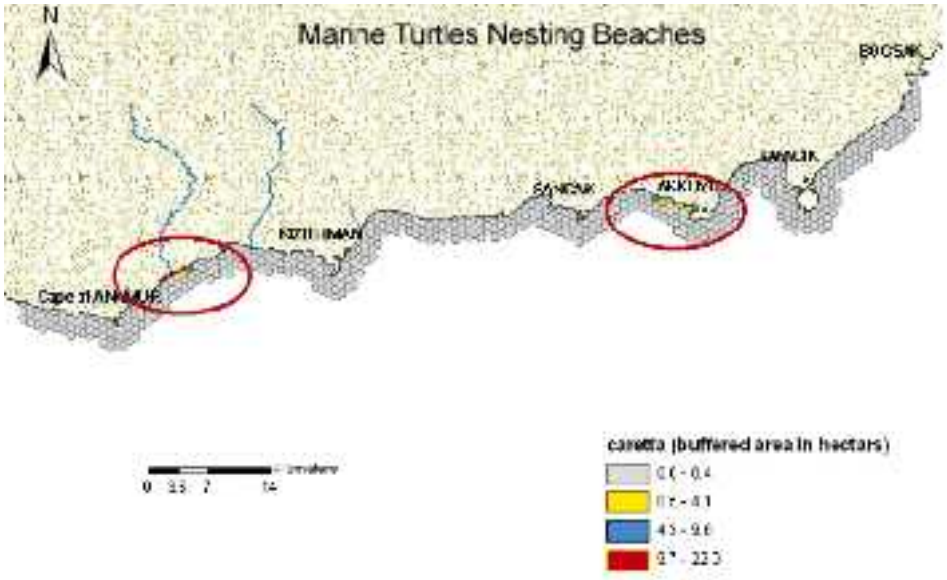

Figure 8. Important marine turtle nesting sites between Tasucu-Anamur (from Sakınan, 2008).

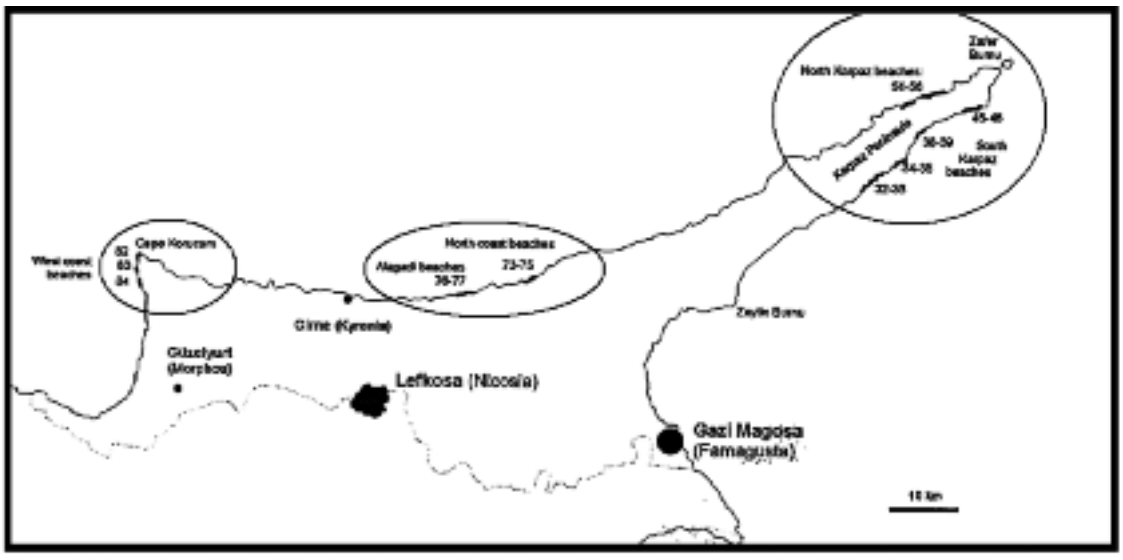

Figure 9. Nesting beaches used by green turtle, *Chelonia mydas* in northern Cyprus (Kasparek *et al*., 2001).

In addition to the nesting beaches, the turtles, especially subadult green turtle (*Chelonia mydas*) are also observed in the shallow waters rich with sea grass meadows. The *Cymodocea nodosa* beds are the major feeding grounds of the species. The dense meadow off Babadıl creek is therefore a favourable fishing ground for the species. The juveniles are observed frequently in the meadow.

One of the very few nesting sites of Audouin's gull (*Larus audouinii*) is on the Gilindire islands in Aydıncık. Another may lie in northern Cyprus. Nesting is in spring, and the juveniles feed locally before the migration in late summer. The main accumulations of feeding juveniles are observed in flocks around Cape Sancak and Besparmak Island. Positions of Audouin's gull sightings are given in Figure 10.

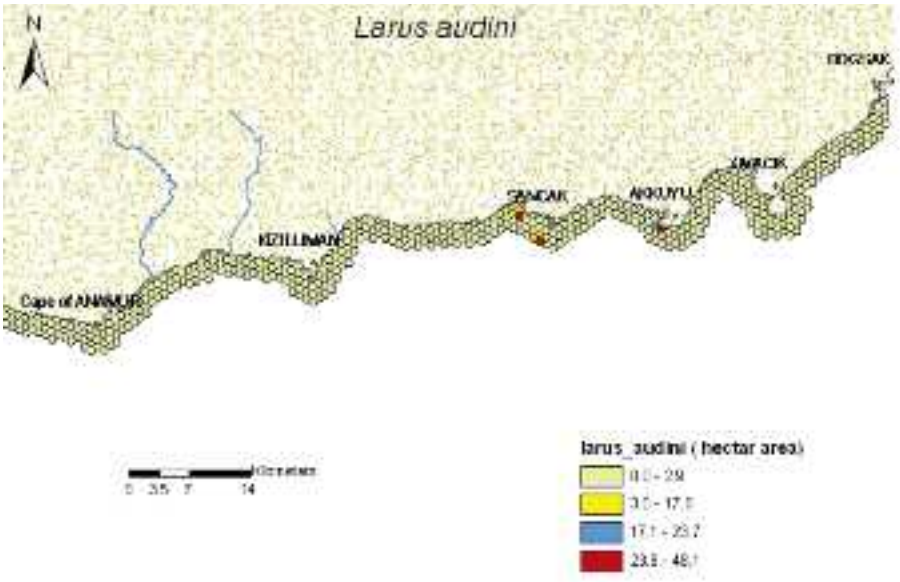

Figure 10. Sightings of Audouin's gull (*Larus audouinii*) in the area between Tasucu and Anamur (Sakınan, 2008).

The Mediterranean monk seal is perhaps the most critically threatened element of the ecosystem. Its occurrence in the NE Levant Sea has been investigated, and there are important breeding habitats in Taseli Strait, on the west coast of Mersin (Gücü *et al.*, 2004) and in northern Cyprus (Figures 11, 12; Gücü *et al*., 2009a). It was estimated that around 40 individuals inhabit the area (Gücü *et al.*, 2009b) with an average fecundity of 0.22 (Gücü and Ok, 2006).

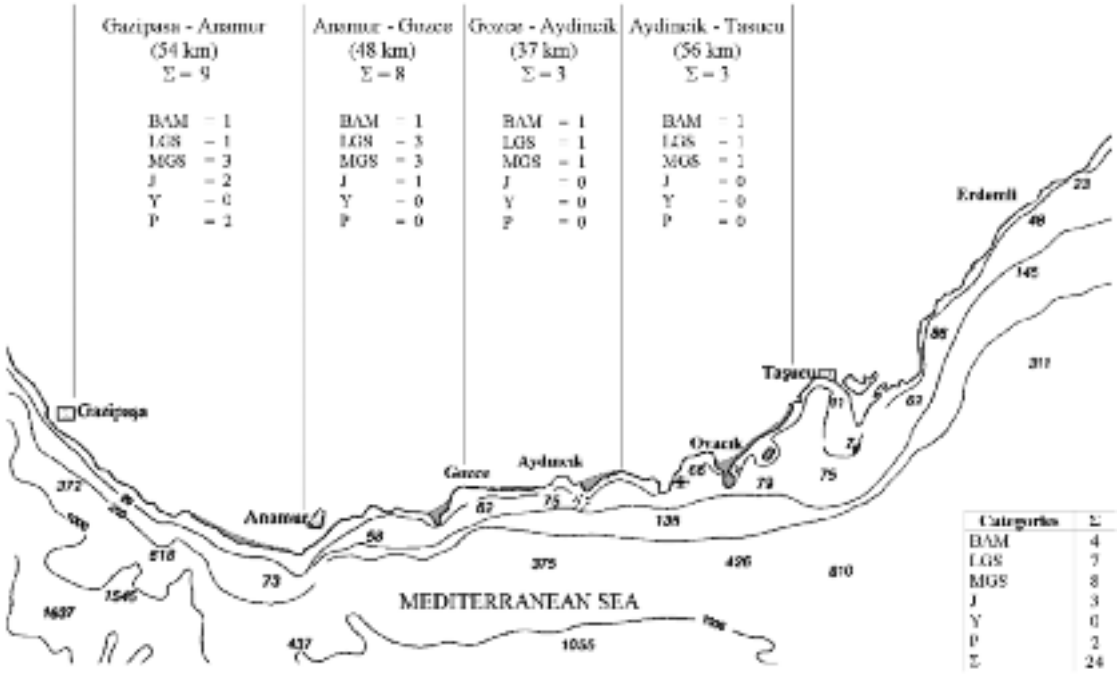

Figure 11. Distribution of monk seals along the Cilician Basin with the arbitrary ranges of the sub-regions, the total numbers of individuals using each sub-region, and the sub-group category compositions. The data presented in the bottom right corner summarize the total numbers of seals in each category.

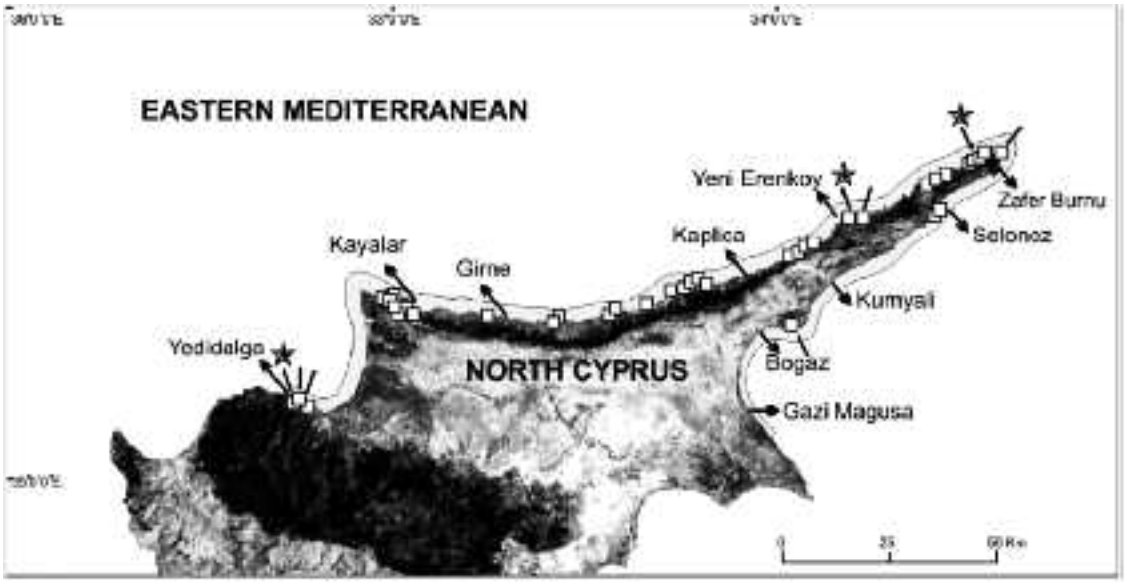

Figure 12. Map showing the position of the main fishing ports (arrows); monk seal sightings recorded by the research team (⋆); the positions of all discovered caves (□), monitored caves (I), and the survey tracks (gray line along the coast).

The areas were marked for conservation in 1997. The surroundings of the identified breeding caves, and the foraging areas have been designated as "No-take-zone" in the sea, and on the land as "1st Degree Natural Asset".

Existing MPAs

Several studies of the area between Tasucu and Anamur, particularly those by the Middle East Technical University Institute of Marine Sciences, have identified high values of marine biodiversity. Based on these studies, a 75 km stretch of coast has been declared a 'first degree natural asset' by the Ministry of Culture, Adana Counsel of Protection of Natural and Cultural Heritage. Additionally, to facilitate recovery of the depleted ecosystem, the entire territorial waters in front of 16 nm of the coast between Cape Sancak, Aydıncık, and Cape Kızılliman, Bozyazı, is

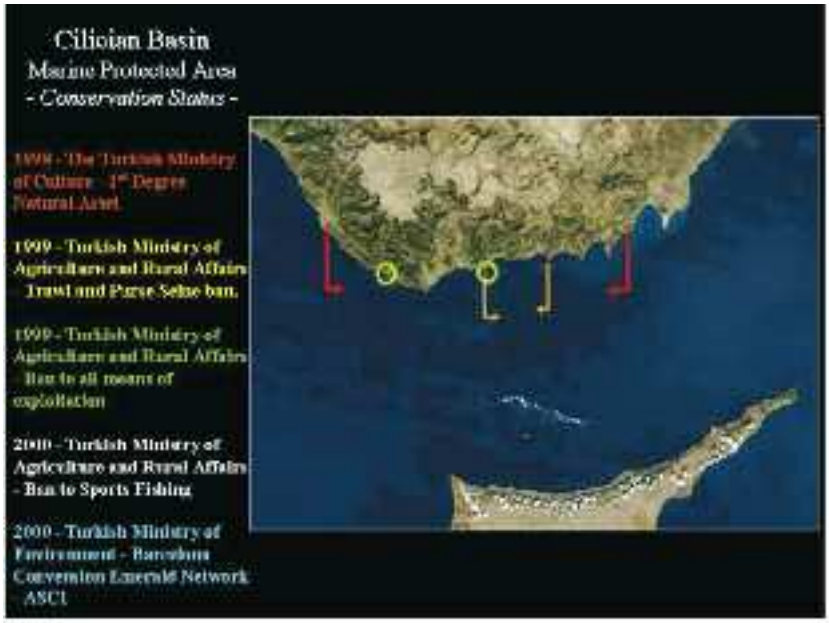

Figure 13. Conservation status of Taseli Strait area.

closed for industrial fishery by the decisions of the Ministry of Agriculture and Rural Affairs, General Directorate for Protection and Control. Finally in 2000, the Ministry of Environment decided to include the area within the Emerald Network of the Barcelona Convention. Although national nature protection legislation does not include the term, according to the criteria proposed by IUCN (International Union for the Conservation of Nature) the area (Figure 13) is defined as a “Marine Protected Area”.

Scientific rationale for the proposed CIESM South Aegean Sea Marine Peace Park

Sylvaine Giakoumi [1], Miroslav Gačić [2], Jean Mascle [3], Anastasia Miliou [4], Giuseppe Notarbartolo di Sciara [5] and Vangelis Papathanassiou [6]

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The proposed Southern Aegean Sea Marine Peace Park encompasses coastal and off-shore areas between Greece and Turkey (Fig. 1).

Geological characteristics

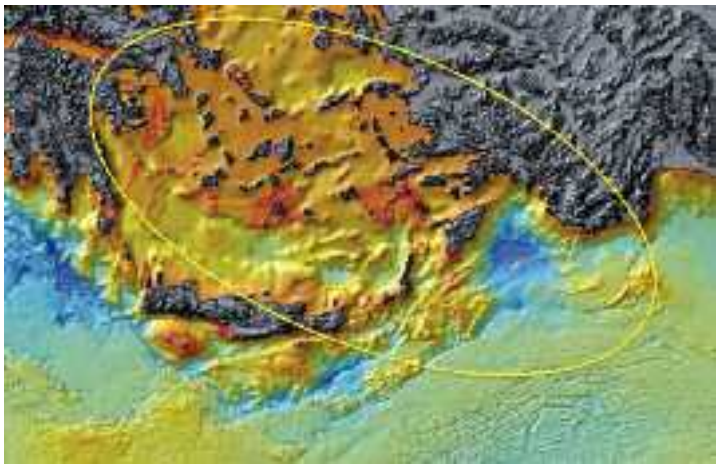

Figure 1. Shaded bathymetry of the CIESM South Aegean Sea Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500m grid). Adapted from L. Brosolo and J. Mascle (2007).

The southern Aegean Sea includes three main domains: (a) a northern one, or Central Aegean plateau, a shallow area including many islands made of massive metamorphic rocks, (b) the volcanic arc which bounds the Central plateau to the south and runs between the area of Aegina and Methana in the Saronic Gulf, to Nysiros to the east, and includes the well known Milos and Santorini volcanoes, (c) the Cretan Sea, formed by a series of recent grabens and troughs which indicate the progressive stretching of the underlying continental crust as a consequence of the Hellenic subduction. Santorini is located on a major NE-SW oriented crustal fracture along which several others minor submarine volcanoes exist, including Kolumbo (Fig. 2a). High-temperature venting occurs in the northern part of the Kolumbo crater, with vigorous gas plumes more than 10 meters above the crater floor, and fluid temperatures up to 220ºC from vent chimneys up to four meters in height, constructed of massive polymetallic sulfides and sulfates (Sirgudsson *et al.*, 2006). These warm fluid expulsions are likely fuel microbial activities and symbiotic biological colonies that need to be explored in detail.

The southeastern corner of the proposed "Southern Aegean Peace Park" includes also a group of important relief features, the Anaximander Mountains (Fig. 2b), tectonically controlled, where numerous mud volcanoes have been discovered in the past 10 years. Cold fluids and gas hydrates have been observed and sampled on some of these features. The microbiologically degraded expelled fluids are also leading to development of bacterial mats and symbiotic colonies of specific fauna such as worms, lamellibranches, crabs, and sea urchins.

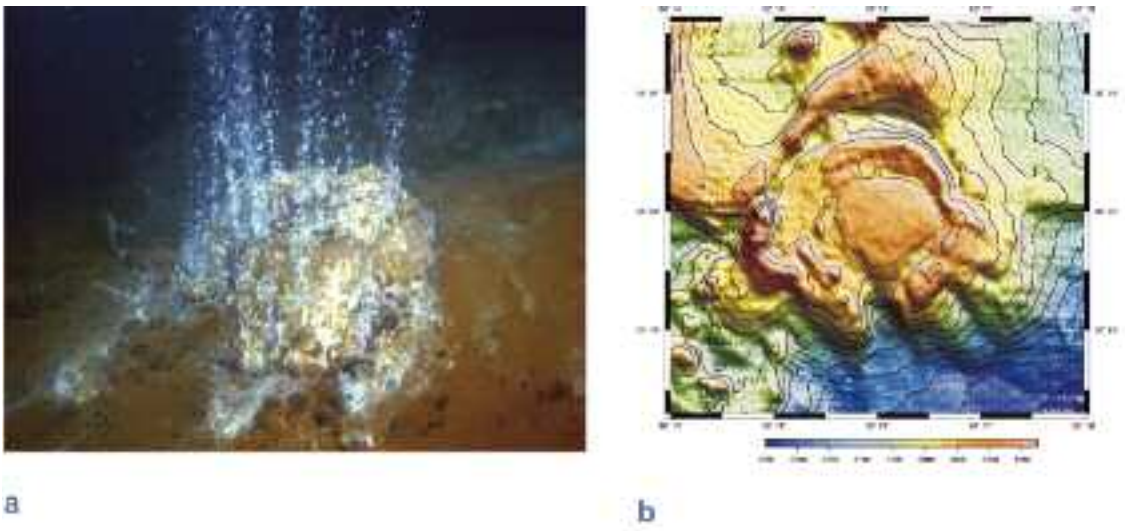

Figure 2. a) Kolumbo Volcano and b) Anaximander Mounts.

Rare and adapted biological communities are thus hosted in this particular deep benthic environment, similar to the ones described in CIESM Herodotus and Eratosthenes Sea Marine Peace Park (Mascle, pers. comm.).

Oceanographic characteristics

The most prominent oceanographic feature in the area is the permanent cyclonic Rhodes Gyre (Fig. 3).

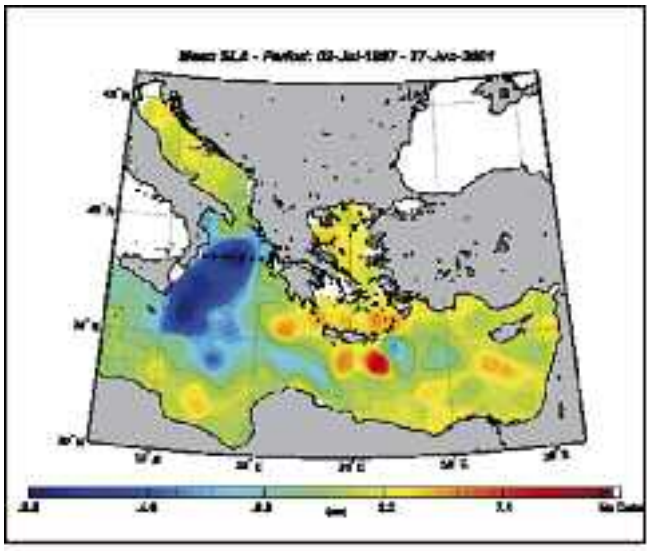

Figure 3. Map of sea level anomalies. The blue area south of Rhodes and east of Crete is where the Rhodes Gyre is situated.

It is located to the south of the island of Rhodes, presumably being a result of the wind driven circulation and the interaction of the Mid-Mediterranean Jet and the Asia Minor Current as they pass over the Rhodes Trench (Gaines *et al.*, 2006).

The rotation causes water rich in nutrients to rise from deeper layers to the surface and in consequence the Gyre is the most productive area of the oligotrophic Eastern Mediterranean Sea. There, larger phytoplankton biomass is recorded.

Regarding the oceanography of the region, it is also worth mentioning that the Rhodes Gyre is the site of the formation of the Levantine Intermediate Water (LIW) that represents one of the most important water masses for the entire Mediterranean. Another important oceanographic feature of the area is the occasional dense water formation for the entire Eastern Mediterranean taking place in the southern Aegean Sea as it happened in mid 1990's during the Eastern Mediterranean Transient (M. Gačić, pers. comm.).

Ecological characteristics

The Aegean Sea is considered a biodiversity hot spot as it shows high concentrations of endangered, threatened, or vulnerable species (Coll *et al.*, 2010). In order to evaluate the ecological importance of the proposed area, the criteria outlined by the Convention of Biological Diversity were used.

Uniqueness or rarity

There are no references to unique biological features in the proposed area. However, the unique geological (presence of mud volcanoes) and oceanographic (Rhodes Gyre) features may be regarded as surrogates for rare biological communities.

Special importance for life history of species

The Mediterranean monk seal (*Monachus monachus*) is the most endangered pinniped species in the world. According to Aguilar and Lowry (2008), the estimated total population size is 350-450 animals, with 250-300 in the eastern Mediterranean within the largest subpopulation, of which about 150-200 are in Greece and about 100 in Turkey. The species is still widely distributed throughout coastal and insular parts of this zone, with important sub-populations found in Kimolos, Gyaros and Karpathos (Dendrinos *et al.*, 2008; Legakis and Maragou, 2009). The Kimolos-Polyegos island complex in the southern Aegean is one of the two most important reproduction areas for the species (Fig. 4a). The size of that population is estimated at approximately 43 individual seals with a reproduction rate of 7 newborns annually (Mom, 2010).

The deep sea area near Rhodes (Fig. 1) is an important feeding and breeding ground for sperm whales (Dede *et al.*, 2009), and also an important feeding ground for beaked whales (Woodside *et al.*, 2006). In the sea area south of Samos, short-beaked common dolphins (*Delphinus delphis*), one of the most endangered cetaceans in the Mediterranean, can still be regularly found (Miliou and Notarbartolo di Sciara, pers. comm.). Furthermore, Boncuk Bay in Gökova, Turkey, is reported as the one of the most important breeding zones of the Sandbar shark (*Carcharhinus plumbeus*) (Fig. 4b), after the southern coasts of North America (Öztürk, 2005). The Southern Aegean is also a significant nesting and feeding area, predominantly for loggerhead turtles (*Caretta caretta*) as well as for green turtles (*Chelonia mydas*) (Geldiay *et al.*, 1982; Margaritoulis, 1998).

Figure 4. a) Mediterranean monk seal (*Monachus monachus*) pup in breeding cave in the Southern Aegean. b) Sanbark shark (*Carcharhinus plumbeus*) near the coast of Turkey.

Importance for threatened, endangered or declining species and/or habitats

As stated above, the area is important for endangered or threatened marine mammals such as the Mediterranean monk seal, the sperm whale and the short-beaked common dolphin. Other marine mammals present in the proposed area are bottlenose dolphins (*Tursiops truncatus*), striped dolphins (*Stenella coeruleoalba*), Risso's dolphins (*Grampus griseus*), Cuvier's beaked whales (*Ziphius cavirostris*) and fin whales (*Balaenoptera physalus*) (Frantzis and Alexiadou, 2003). Additionally, the region is important for the seagrasses *Posidonia oceanica*, *Cymodocea nodosa* and *Zostera marina* as well as for coralligenous reefs. There are also *Cystoseira* forests including the threatened *Cystoseira amentancea*, *C. spinosa* and *C. zosteroides*. The importance of the area for sea turtles has already been mentioned, while other species listed as endangered or threatened in the Barcelona Convention Protocol have populations in the region such as the molluscs *Pinna nobilis* and *Charonia tritonis* and the sharks *Cetorhinus maximus* and *Carcharodon carcharias*, and the fish *Hippocampus hippocampus.*

Vulnerability, fragility, sensitivity, slow recovery

All the above mentioned species are considered vulnerable or fragile or sensitive or with slow recovery.

Biological productivity

The region is characterized by low primary productivity with the exception of the upwelling area of the Rhodes Gyre, where unusually high productivity is observed.

Biological diversity

The Aegean Sea presents the highest biodiversity in the Eastern Mediterranean and the second highest species richness (along with the Adriatic Sea) in the whole Mediterranean Sea (Coll *et al.*, 2010). The region, because of its diversified topography and bathymetry is characterized by a great variety of habitats, supporting high mesozooplankton diversity with an estimated 367 species (SoHelME, 2005). The area also hosts 467 fish species, while the macrophyte flora of the Hellenic coasts is estimated at about 550 taxa (SoHelME, 2005; SoHelFI, 2007). Regarding zoobenthic communities, more than 3200 benthic species have been recorded in the Aegean Sea, including 200 species of sponges, 43 cumaceans, 107 echinoderms and 93 anthozoans (SoHelME, 2005; Coll *et al.*, 2010).

Naturalness

In terms of naturalness, the region is quite heterogeneous; there are some areas with high human pressure, others with lower human impact. At the same time, some areas (eastern) are more susceptible to invasive species than others (western). In general, the Mediterranean has been exploited by humans, centuries or even millennia (Juanes, 2001; Coll *et al.*, 2010), so the concept of "naturalness" can only be used comparatively.

Threats

Most of the threats in the proposed area are common to the whole Mediterranean. These are:

- Overfishing and illegal fishing practices. Illegal, unregulated and unreported fisheries activities take place in national and international waters, due to lack of efficient control mechanisms and fisheries management regulations in the region. Öztürk *et al.* (2001) have reported dolphin by-catch due to swordfish driftnets in the Aegean Sea.

- Land-based pollution. Industrial, agricultural and urban sewage is frequently untreated, and sometimes causes mortality of marine organisms (Öztürk and Öztürk, 2003).

- Maritime traffic. In the area there is intense shipping traffic that causes both functional and accidental pollution. Moreover, the noise associated with this traffic and collisions with vessels are major threats to marine mammals. The clear lack of shipping lanes results in dense unregulated traffic of all types of vessels, with varying hazard levels (Miliou *et al.*, 2010), illustrated in Fig. 5.

- Habitat degradation due to urbanization of coastal areas and the development of mass tourism. Increasing human activities have caused significant alterations to coastal ecosystems, disturbance to marine species, and destruction of their habitats.

- Invasive species. The Eastern Mediterranean is particularly susceptible to invasive species due to its proximity to the Suez Canal (Galil, 2000). Even though the Aegean Sea is less threatened than the Levantine Sea, this may change as global warming facilitates the expansion of Lessepsian species (alien species originating from the Red Sea) to northwestern areas of the Mediterranean (Raitsos *et al.*, 2010). These species can affect the survival of native species through competition and predation (Zenetos *et al.*, 2009).

- Military activities in national and international waters. Some of the zones used for naval activities by Greece, Turkey and NATO coincide with the main marine mammal migration routes. The use of sonar has been associated with disease, loss of orientation, starvation and the stranding of marine mammals (Frantzis, 1998).

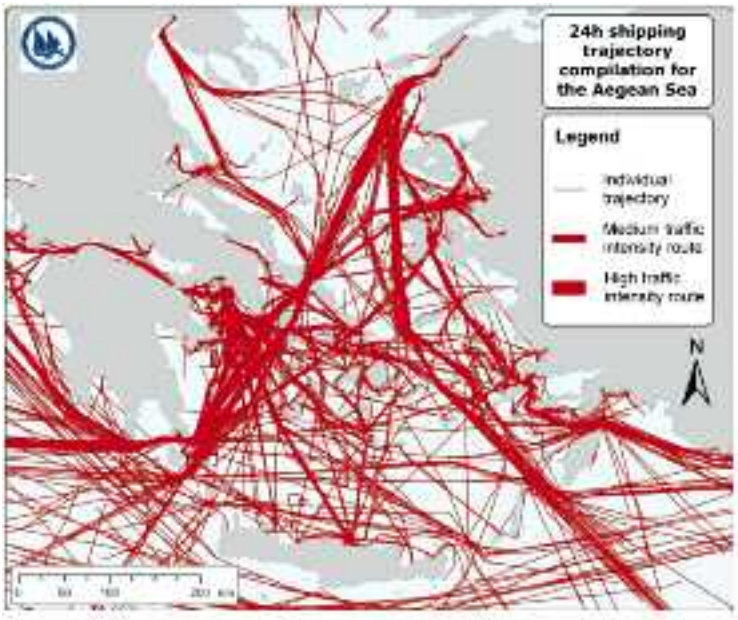

Figure 5. Example of 24hr shipping traffic in the Aegean Sea 19/10/10 – Source: Archipelagos Institute of Marine Conservation.

Current Marine Protected Areas (MPAs)

In the proposed area there are seven MPAs on the Turkish coasts: Datça-Bozburun, Dilek Yarimadisi, Fethiye-Göcek, Gökova, Köycegiz-Dalayan, Kas-Kekova and Patara (Fig. 6). However, none of them has a management plan (Abdulla *et al.*, 2008). On the Hellenic coasts some areas have been identified as Sites of Community Interest (SCIs) or as Special Protection Areas (SPAs) within the framework of the Natura 2000 network. However, these areas do not receive protection at present, with the exception of the Karpathos-Saria MPA, where only basic conservation is being applied, since the management authority has only recently been established. Therefore, there is an urgent need for the establishment of an efficient MPA network in the region (Giakoumi *et al.*, 2010).

Figure 6. MPAs in the proposed area–Source: Abdulla *et al.* (2010).

Scientific rationale for the proposed CIESM South Adriatic Sea Marine Peace Park

Sajmir Beqiraj [1], Simonetta Fraschetti [2], Miroslav Gačić [3], Aleksandar Joksimovic [4], Peter Mackelworth [5], Jean Mascle [6], Giuseppe Notarbartolo di Sciara [7] and Roberto Odorico [8]

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SUMMARY

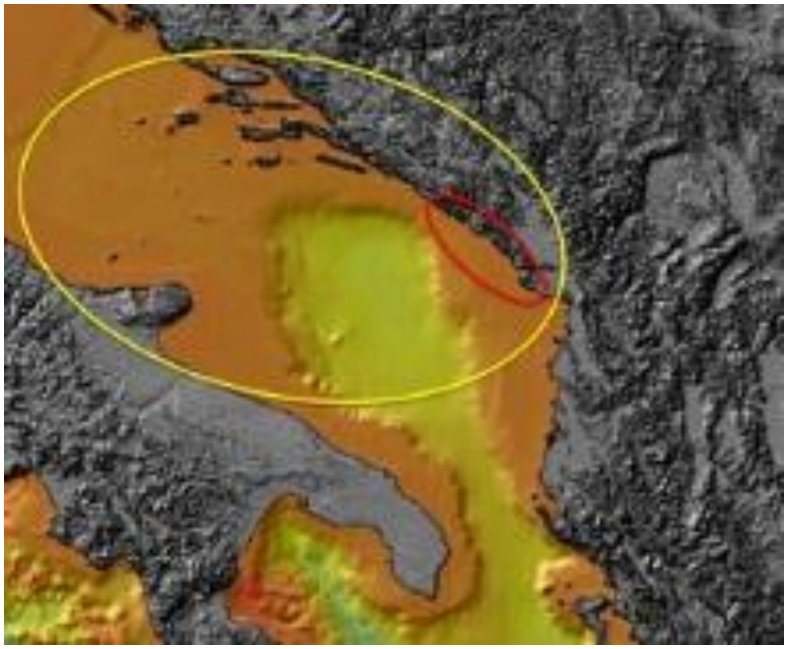

Figure 1. Shaded bathymetry of the CIESM South Adriatic Sea Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500m grid). Adapted from L. Brosolo and J. Mascle (2007).

The proposed area, South Adriatic, covers a domain including parts of the central Croatian and Montenegro coasts, and northern Albanian shore on the Eastern Adriatic (Figure1). On the Western side of the Adriatic it extends from Manfredonia to Brindisi in Italy. The onshore area is geologically quite homogeneous, dominated by limestone outcrops that belong to the Mesozoic Apulian platform. The central Adriatic region displays several specific morphological features such as the Jabuka Pit and the Palagrusa sill and deeper areas to the north with a maximum depth of 270m. The South Adriatic Pit is the dominant morphological feature of the Southern Adriatic. Dense water formed on the Northern Adriatic shelf accumulates in the Jabuka Pit. Along the eastern border of this Pit during summer, wind driven upwelling makes the area potentially rich biologically. The South Adriatic Pit is an area of open ocean convection and dense water formation, whose intensity depends on the air-sea heat flux and buoyancy content. In

the centre of the South Adriatic Gyre the spring phytoplankton bloom is associated with vertical mixing and nutrient input into the euphotic zone. The northern part of the proposed area has been included (together with the northern Adriatic) in lists of important areas for biodiversity in the Mediterranean, such as in potential SPAMI candidates, in the Ecologically or Biologically Significant Areas (EBSAs), in the priority conservation areas for sea birds, and in the priority conservation areas considering the impacts of fisheries in the open seas, including the deep sea. A considerable number of key and endangered species are found in this area. The seagrass *Posidonia oceanica*, several cetacean species, many waterfowl, the monk seal, the loggerhead turtle, and the otter are among the most important globally threatened species of this area. This area is characterized by several unique and sensitive habitats, especially in the south-eastern part. Neretva and Buna/Bojana river deltas, besides their role as sheltering habitats, are also important as migration corridors, especially for fish and bird species. Several MPAs have been instituted in Italy and Croatia, and regionally important Coastal Protection Areas (CPAs) in the Montenegro and Albania. Increasing human occupation of the coastal zone, with localised pollution, increasing fishing effort, maritime traffic, recreational use of the sea, habitat degradation, sewage discharge and agricultural wastes are among the main threats to this area. In recent years, there has been increasing interest in research and environmental work in the southern part of the proposed area, where studies and knowledge are more limited. This work is enlarging the database on marine biodiversity of the southern Adriatic, and improving biodiversity conservation and management in this region. Countries in the eastern Adriatic (Croatia, Montenegro, Albania) are making important steps towards fulfilling the environmental criteria and standards for their accession to EU structures: from this point of view, their involvement in the CIESM initiative for establishing coast-to-coast Marine Parks is another progressive step.

Key geological features

Generally, in the South Adriatic, the onshore area is geologically quite homogeneous dominated by limestone outcrops which belong to the Mesozoic Apulian platform, a former shallow region of a passive continental margin. On the Italian side, these rocks have only been fractured during their deposition, while on the Eastern side they are incorporated into tectonic units, the 'Apulian nappes' emplaced along the frontal domain of the Dinarides and Hellenides during the Alpines orogenies. These thick piles of limestone are characterized by intense karstic processes, resulting in their dissolution, and the creation of numerous caves and frequent underground freshwater drainage systems.

Specific morphological features of the central Adriatic include the Jabuka Pit and the Palagrusa sill and deeper areas to the north with a maximum depth of 270m. The South Adriatic Pit is the dominant morphological feature of the Southern Adriatic. A number of islands, made mainly of massive limestone, are present in the area, which due to their isolation and abundant caves host numerous endemic species.

Key oceanographic features

Jabuka Pit is a sink for some of the dense water formed on the Northern Adriatic shelf that flows along the Italian coast. This water partly sinks into the pit and partly continues southward over the Palagrusa sill. The renewal of bottom water in Jabuka Pit does not occur every year, but depends on the density of the newly formed water; thus ventilation of the bottom layer is not necessarily an annual occurrence.

Along the eastern border of Jabuka Pit, during summer, the wind drives upwelling making the area potentially biologically rich. Along the Italian shelf, fresher water of terrestrial origin flows southward in the form of the coastal boundary current, separated from the open sea by the coastal front. To the south of the Gargano peninsula (Gulf of Manfredonia) there is a semi permanent anti-cyclonic gyre.

The South Adriatic Pit is an area of open ocean convection and dense water formation, whose intensity depends on the air-sea heat flux and buoyancy content. The buoyancy content depends on the salinity of the inflowing water from the Ionian Sea. The bottom layer is renewed by dense

water from the northern Adriatic shelf that sinks in the Bari canyon and occupies the deepest part of the South Adriatic Pit.

In the centre of the South Adriatic Gyre, the spring phytoplankton bloom is associated with vertical mixing and nutrient input into the euphotic zone. The bloom is occasional, taking place over several days up to one week, depending on the frequency of cold air outbreaks and subsequent re-stratification. Inter-annual variability of the vertical convection, and consequently of the bloom, is rather prominent, and depends on both the buoyancy content of the water column and the winter air-sea heat fluxes.

Ionian waters enter the Adriatic close to the Albanian side (East Adriatic Current) and flow out along the Apulian side (West Adriatic Current), forcing a basin-wide cyclonic circulation. This circulation is subdivided into three cyclonic sub-circulations, occupying the northern, central and southern portions of the Adriatic, trapped by bathymetry (the central one being centred on the Jabuka Pit, the southern one on the Southern Adriatic Pit). Focusing on the southern gyre, surface and subsurface cyclonic circulations may provide an important link between the Marine Protected Areas located on the Eastern and Western coasts of the central and southern Adriatic Sea. This ensures possible exchange of hydrological and biogeochemical characteristics as well as organisms from the eastern to the western side.

At an intermediate and deep level, communication is ensured throughout the whole water column by intense convection occurring in relation to the South Adriatic Pit, originating in the South Adriatic Deep Water. Whilst on the western side of the basin coastal/deep-sea mixing is further enhanced by the overflow and deepening process of the North Adriatic Deep Water. This water is funnelled by gravity and submarine canyons from the shelf break to the continental slope before exiting, along with the surface waters, through the Otranto Channel into the Ionian Sea and the Gulf of Taranto.

BIOLOGICAL FEATURES

General information about biodiversity

There is a significant difference in knowledge of marine biodiversity between the north-central and southern parts of the Adriatic Sea. The Northern Adriatic has been studied for many decades, while in the southern basin, especially in the south-eastern part, data about marine biodiversity are more limited.

The northern part of the proposed area has been included (together with the northern Adriatic) in lists of important areas for biodiversity in the Mediterranean, such as the potential SPAMI candidates (UNEP/DEPI/MED WG.348/5), in the Ecologically or Biologically Significant Areas (EBSAs), in the priority conservation areas of sea birds (UNEP/DEPI/MED WG.348/inf.5) and in the priority conservation areas considering the impacts of fisheries in the open seas, including the deep sea (UNEP/DEPI/MED WG.348/inf.4).

In recent years the central eastern Adriatic has started to become a focal point for marine research. Recent projects, including the UNDP/Croatian Ministry of Environment/GEF project "Conservation and Sustainable Use of Biodiversity in the Dalmatian Coast through Greening Coastal Development (COAST)" and the WWF Mediterranean Gap Analysis, have identified the islands of Vis, Lastovo, Mljet and their surrounding waters as a priority for Mediterranean conservation. The UNDP Coast project has integrated information from many of the national institutes, non government organisations and universities in Croatia. This list includes the University of Zagreb, the Croatian Natural History Museum, the Institute for Oceanography and Fisheries, the University of Split, and the Blue World Institute.

The Croatian Adriatic is fringed with over 1000 islands, islets and semi-submerged reefs. Within these dense archipelagos are numerous varied environmental niches including mud bottoms, substantial *Posidonia* meadows, limestone reefs and sandy bottoms, many of which have not been fully investigated and mapped. There are offshore island areas thought to have high levels of biological diversity, partly due to their isolation. These are the Vis archipelago, Jabuka, and Palagrusa (United Nations Development Programme (UNDP), 2005). In addition the underwater

regions around the islands of Lastovo and Mljet are considered as highly important and listed in protected area networks.

The eastern coast of the proposed park is known for high diversity of birds, especially waterfowl. On the continental shoreline there are other areas of importance for birds. The Neretva Delta contains the largest complex of wetlands in the Croatian littoral, with well developed coastal vegetation, as well as floating and submerged flora. The area is important for central and northeast European bird populations (Muzinic, 2007).

Much of the Croatian Adriatic has been identified as important for the Croatian National Ecological Network (CroNEN) as part of the Bern convention. Some of the same sites, and others, have been listed as potential Natura 2000 sites for when Croatia joins the EU.

Biodiversity in the southern Adriatic is less known. Data about zooplankton, benthic invertebrates, fish and large marine vertebrates are limited. Although the region is generally considered to be of low productivity, in the open waters of the southern Adriatic, micro-phytoplankton including diatoms is quantitatively important (Fonda Umani, 1996). A recent aerial survey for large marine vertebrates has also suggested that there may be rare species, previously unrecorded, inhabiting the region (Fortuna *et al.*, 2010).

The coastal terrigenous mud biocenosis is well developed along almost the entire south-eastern Adriatic, and particularly well developed in areas with relatively weak bottom currents. Sessile form facies are formed through a prolonged process of sedimentation; these are widely distributed and economically important for the coastal demersal fishery. Many economically important commercial species are found in this area, such as picarel, red mullet, hake, squid, cuttlefish, octopus, as well as many selachian species. In the infralittoral, *Posidonia oceanica* meadows are in relatively good conservation pristine status. Deeper bottoms are characterized by high gradients that host pristine sciaphilous assemblages. Coastal and open water detritic bottom biocoenoses, as well as bathyal mud biocoenoses are also present in this area.

The south eastern corner of the proposed area (including north Albania and south Montenegro) is an important area for the coastal biodiversity and includes sensitive coastal habitats. The Buna/Bojana delta shelters a high proportion of coastal biodiversity of the southwestern Balkans. The role of this area is particularly important for certain vertebrates such as birds, fish, mammals, reptiles and amphibians. One of the most important ecological features of the area is migration, especially for globally threatened species fish and bird species. This area is a part of one of the three migration routes of European birds in the north – south direction. It plays a very important role for maintaining bird diversity at regional level, also sheltering species of global conservation concern and species of European conservation concern (see information in the paragraph below).

In recent years, there has been increasing interest in research and environmental work in the southern part of the proposed area, mainly through the implementation of projects at national, bilateral and regional scale, with the participation of universities and research institutions, such as University of Salento, University of Bari, CNR Lesina, University of Split, University of Zagreb, Ruder Boskovic Institute, University of Podgorica, Institute of Marine Biology in Kotor, University of Tirana, University of Shkodra, among others. An important contribution is also provided by non-governmental organisations, especially studies of cetaceans, marine turtles, fish, birds and macrobenthos. These NGOs, include the Tethys Research Institute (Italy), the Blue World Institute of Marine Research and Conservation (Croatia), and the Association for Protection of Aquatic Wildlife of Albania. This work is enlarging the data on marine biodiversity of the southern Adriatic and contributing to the improvement of biodiversity conservation and management in this region.

Presence of endangered/key species

Meadows of *Posidonia oceanica* are widely distributed and in relatively good condition along parts of the eastern coast of the proposed area.

The central Adriatic is an important region for cetacean species. Since 2007, cetacean research has been undertaken around the Vis archipelago; bottlenose dolphins (*Tursiops truncatus*) are regularly seen, and the presence of mother and calf groups indicates that this area may be important for this species. In addition to bottlenose dolphins, surveys also encountered other animals like

giant devil rays (*Mobula mobular*), blue-fin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*), as well as birds like Eleonora's falcon (*Falco eleonorae*), Manx shearwater (*Puffinuspuffinus*), Cory's shearwater (*Calonectris diomedea*) and European shag (*Phalacrocorax aristotelis*) among others (Holcer *et al.*, 2010). A recent aerial survey for large marine vertebrates indicates that this region hosts fin whales (*Balaenoptera physalus*), particularly around the Palagrusa archipelago where they are sighted on a regular basis. Striped dolphins (*Stenella coeruleoalba*) can be found in the middle of the Adriatic, and Cuvier's beaked whales (*Ziphius cavirostris*) (Figure 2) and Risso's dolphins (*Grampus griseus*) are found on the edges of the Southern Adriatic Pit (Fortuna *et al.*, 2010) (Figure 3).

Figure 2. Cuvier's beaked whales on the edge of the south Adriatic Pit.

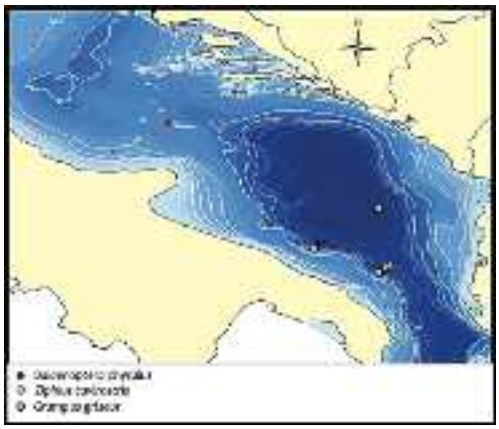

Figure 3. Rare cetacean species of the southern and central Adriatic.

Other globally threatened species may also be encountered in the proposed area. The Mediterranean monk seal (*Monachus monachus*) is believed to be a transient in the region. The loggerhead turtle (*Caretta caretta*) can also be found in large numbers and is believed to be resident year round (Lazar, 2010; Fortuna *et al.*, 2010). Finally, the otter (*Lutra lutra*) is found around river mouths and deltas, particularly in the southeastern region of the area (MacDonald and Mason, 1994).

The Neretva delta and river feeds a large number of protected species, provides breeding grounds for certain fish and crabs, and is important for fish and bird migrations. There are 310 bird species in the Neretva Delta and 115 of them are nesting. Some endangered European species, like the great bittern (*Botaurus stellaris*), the ferruginous duck (*Aythya nyroca*), the snowy plover (*Charadrius alexandrinus*), the common snipe (*Gallinago gallinago* L.) and other species, like the baillon's crake (*Porzana pusilla*) and the moustached warbler (*Acrocephalus melanopogon*) (Mrakovcic, 2001).

In the south-eastern part of the proposed area, around Buna/Bojana river delta in Albania and Montenegro, at least 36 globally threatened animal species (referring to the IUCN Red List of Threatened Species, 2008) have been recorded. Among them there are sturgeons *Acipenser sturio, Acipenser naccarii, Acipenser stellaus*, lampreys *Lampetra fluviatilis* and *Lampetra planeri*, 16 shark species, and birds like the Levant sparrow hawk (*Accipiter brevipes*), the European nightjar (*Camprimulgus europaeus*), the European roller (*Coracias garrulous*), the black headed bunting (*Emberiza melanocephala*), the lesser gray shrike (*Lanius minor*), the woodchat shrike (*Lanius senator*), the black-eared wheatear (*Oenanthe hispanica*), the Eurasian scops owl (*Otus scops*), the Eurasian spoonbill (*Platalea leucorodia*) and the common redshank (*Tringa tetanus*).

Critical habitats and unique communities/ecosystems

Within the central Adriatic are a number of islands some of which, including Jabuka and Brusnik, are formed from volcanic rock (Pelleri, 1942; Tućan, 1953). Many of the islands, due to their isolation, host endemic species, including reptiles and mammals (UNDP, 2005). Jabuka island has particularly high biodiversity. Zavodnik *et al.* (2000) review surveys around and on the island of Jabuka and identify 300 taxa, more than 150 of them noted for the first time for the area. In addition, 159 taxa were identified during a dive survey of the near shore. Jabuka Pit, adjacent to the island of Jabuka, is also the most important spawning and nursery ground in the Adriatic Sea for European hake (*Merlucius merlucius*) and Norway lobster (*Nephrops norvegicus*) (Vrgoč *et al.*, 2004). The cold, nutrient-rich waters generated in winter in the northern Adriatic accumulate in this depression, making the area a site of strong nutrient re-cycling processes (Zavatarelli *et al.*, 1998; Artegiani *et al.*, 1997).

The area around the Palagrusa archipelago is also an important fishing area with productivity related to the mixing of waters from the northern Adriatic with the southern Adriatic (Vilibic and Supic, 2005). The Palagrusa archipelago is also considered an important habitat for fin whales *(Balaenoptera physalus)* that are sighted on a regular basis in this area. The Vis archipelago is a habitat for a resident population of bottlenose dolphins (*Tursiops truncatus*) (Holcer *et al.*, 2010).

The Neretva river region is unique in Croatia as a marsh delta. It provides numerous habitats important for nesting bird species. Nesting is important in the cane fields, on the sand beaches and the trees. The mouth of Neretva provides a nursery habitat for fish and crustacean species. The river also functions as a gateway for fish migrations (Muzinic, 2007).

The karst limestone coastline found along the eastern border of the Adriatic Sea provides a diversity of unique threatened habitats (Bakran-Petricioli and Petricioli, 2008). Within the karst system, a number of unique habitats can be found such as anchialine caves, sea caves, cold saltwater caverns with bathyal elements, submarine springs, karstic estuaries, saltwater lakes and submarine bare karst stone. These are all considered as endangered in Croatia (Ministry of Culture of the Republic of Croatia, 2009).

On the Italian coast (Gulf of Manfredonia) of the proposed area, the Varano and Lesina lagoons are important habitats for bird sheltering and nesting, especially waterfowl, as well as spawning and nursery sites for fish. In this area, several studies have been carried out on benthic assemblages (Marzano *et al.*, 2003; Munari *et al.*, 2009). Attempts have been made to analyse the affinity between the zoobenthic assemblage recorded in the hyperhaline lagoon of Karavasta and the assemblages from two Italian lagoons, the brackish Lake of Lesina and the euhaline Lake of Fogliano, according to the different hydrological conditions and the geographical location (Marzano *et al.*, 2010). In the Gulf of Manfredonia, previously considered an area essentially dominated by muddy assemblages, extensive coralligenous banks have been found (Terlizzi, unpub. data); this represents important information in terms of spatial planning, since this area was recently selected for development as a wind farm area.

In the South Adriatic Pit, a significant *Nephrops norvegicus – Thenea muricata* biocoenosis is present. Recent data suggests that this area could also be important for endangered cetacean species such as Cuvier's beaked whale (Fortuna *et al.*, 2010).

The south-eastern corner of the proposed area represents a large transboundary ecosystem between Albania and Montenegro, the delta of Buna/Bojana River (Figure 4). This ecosystem is important

Figure 4. Aerial view of Buna/Bojana delta (Albania & Montenegro).

on a regional scale in terms of biodiversity and hydrology. The Buna/Bojana delta, with Ada Island in Montenegro, the Velipoja coastal forest in Albania, the whole river bed and the Shkodra/Skadar Lake from whence the river flows, has been proclaimed a Ramsar site and an international IBA (Important Bird Area). The mouth of the Buna/Bojana facilitates fish migration from Shkodra Lake and its watershed into the Adriatic Sea. It also links the lakes of Ohrid and Prespa through their connection with Drin River, which joins Buna upstream. This effectively covers a large hydrographic network of the southwestern Balkans, including Albania, Montenegro, Kosovo, Former Yugoslav Republic of Macedonia and Greece. At least 13 fish species and subspecies migrate through Buna/ Bojana mouth, of which 6 are globally threatened. The Buna/Bojana delta offers important food sources for fish, spawning grounds, nursery and migration paths on which fish stocks depend (either within the wetland or other habitats connected to them). This area is also very important hydrographically, and is well-known fot its high ecological sensitivity. The so called "hydrologic junction" Shkodra Lake - River Buna - River Drin determines the hydrological regime of Shkodra Lake, River Buna itself, and their tributaries, and has an important impact on the morphology and water regime in Buna delta in the south-eastern Adriatic.

In its northern part, in Montenegro, the saltpan (salina) of Ulcinj, is an important site for bird sheltering and nesting, and Ada Island, an interesting habitat as a wetland and alluvial forest, with many globally threatened species of plants and nesting birds (Schneider-Jacoby *et al.*, 2003).

In the southern part of the delta, in Albania, the small Island of Franz Joseph (Figure 5) is well-known for the rare flora and fauna, and as a nesting site for globally threatened birds. It is a very sensitive area that, due to coastal erosion, often changes shape and size, shifting from an island to a promontory and *vice-versa*.

The Velipoja forest reserve, an alluvial coastal forest and a wetland complex created by Buna delta and the Adriatic Sea, is well-known for the high diversity of flora and fauna, including rare and threatened species at national and regional scales.

The Viluni lagoon, situated about 7 km south of Buna mouth, is known for its high diversity of fish, invertebrates and especially waterfowl of global concern.

Figure 5. Franz Joseph Island (Albania).

Baks Rrjolli coastal zone – Rana e hedhun (Blown sand) (Figure 6) - represents an interesting combination of habitats with karstic caves, mountain slopes, sandy dunes, alluvial forest, tamarisk marshes, and interstitial pools combined with an excellent beach. The Blown Sand is an active dune 50 m high, 600 m long and 100 m wide, accumulated on a rocky coast by wind, a unique habitat in the Adriatic. This area gives shelter to nesting bird species of regional and global concern.

Figure 6. The sand dune “Blown sand” (Rana e hedhun) (Albania).

Main threats

The proposed zone faces similar threats to those found in all marine environments, increasing human occupation of the coastal zone, with related localised pollution, increasing fishing effort, increasing maritime traffic and increasing recreational use of the sea, besides the global threats of climate change, ocean acidification and invasive species. Being the most northern arm of the semi

enclosed Mediterranean, the Adriatic as a whole is strongly influenced by the adjacent terrestrial area. Yet it remains relatively well preserved on its eastern side due to political isolation during the cold war period. However, Croatia, Montenegro and Albania have undergone significant change over the last 20 years. Associated with this has been an increase in human population density in the coastal zone, and accompanying urban development. In some areas these developments have been uncontrolled, causing considerable impacts to marine biodiversity and environment.

Habitat degradation is also related to increased human activity, urban development, and sewage and agricultural discharges in the coastal area. Chemical water pollution in the area is mainly due to industrial activity, especially on the Italian coast. Also of concern for the Gargano area and Tremiti Islands are chemical residuals from the 2nd World War. Perhaps the most polluted region of the eastern Adriatic is located in the northern part of this area. Kaštela Bay north of Split, Croatia's second city, hosted a chlor-alkali cement works between 1950 and 1990 as well as other heavy industry, and the bay remains contaminated with inorganic mercury and other heavy metals (Kljakovic-Gaspic *et al.*, 2006). Other major towns and cities along the Croatian coast have inappropriate waste water treatment with high levels of faecal coliforms in adjacent waters (World Bank, 2008).

Excessive tourism can be found in some localised areas, such as Velipoja beach in Albania, and Velika Plaza in Ulcinj, Montenegro. In Croatia, where tourism is the largest contributor to GDP, there are numerous islands, including Mljet, Lastovo, Vis, Korcula, Hvar, Brac and Solta, subject to high levels of seasonal migration related to tourism, as well as hosting fishing communities and agriculture (Mackelworth and Caric, 2010). Additionally, sites along the coast host major tourist populations in the summer season, including in and around the major cities of Split and Dubrovnik.

The sensitive areas around the Buna/Bojana and Neretva rivers are threatened by untreated waters from large watersheds. Neretva is also threatened by increasing agricultural development. The extensive karst ecosystems face similar threats from polluted water sources. These sensitive karst systems also face disturbance from diving tourism, similar to those seen on coralligenous facies.

Increasing maritime transport, with merchant, ferry and cruising tourism, is another important factor affecting marine biodiversity. Maritime transport is one of the main reasons for increased pollution, noise and disturbance in marine waters. The impact of noise is of major concern, especially for cetaceans, since the central Adriatic is an important area for these animals. The area around Dubrovnik faces threats from increasing pollution from visits by cruise liners, associated with this waste water pollution, solid pollution (including plastics), and air pollution (Caric, 2010).

Marine traffic also increases the transport and introduction of invasive species. Perhaps the greatest threat is from *Caulerpa taxifolia* and *C. racemosa*, both of which are overwhelming habitats in the region. Since 2001, *C. taxifolia* has been present in Stari Grad Bay, Hvar Island (Zuljevic and Antolic, 2002). Although data on alien and invasive species for this area are limited, a recent assessment in the shallow coastal waters of Albania and Montenegro, together with existing data, has recorded about 23 alien species for both countries, including macroalgae, macrophytes, annelids, crustaceans, molluscs and fish (Beqiraj *et al.*, in press).

On the Albanian coast, erosion has become a major problem in the last 3 decades, mainly related to human activity and especially to hydrological changes and river damming. In the Buna/Bojana delta, the Velipoja coast is one of the areas highly impacted by coastal erosion, and of Franz Joseph Island is rapidly losing its surface.

Finally, uncontrolled and illegal fishing practices are important threats to marine biodiversity in the Adriatic, and have a significant impact on fish stock depletion. High fishing pressure and non-selective fishing gear has already affected the demersal ecosystem and species biodiversity around the regions of Jabuka Pit and the Palagruza Sill (Jukic-Peladic *et al.*, 2001). Depletion of catches in Albanian waters is mainly related to overfishing, water pollution, and habitat destruction. Generally in Croatia, the development of the industrial pelagic fishery threatens to overwhelm fish stocks if unchecked (Mackelworth *et al.*, 2011). Ghost nets are also a threat to sensitive ecosystems, such as coralligenous facies.

Proposed modifications of zone boundaries and justifications

It has been proposed to exclude most of the Montenegrin coast and territorial waters from theSouth Adriatic Sea Peace Park, since the inclusion of the whole coastline was deemed to be impractical and politically sensitive.

The area was extended in the central part of the Adriatic, aiming to cover three important geological and oceanographic features, the southern Adriatic Pit, the Palagruza Sill and the Jabuka Pit.

The Albanian part has also been reduced to exclude the most southern segment, due to the high impact of pollution and uncontrolled development in that segment.

The Albanian part is extended from Buna/Bojana river mouth to the Shengjini rocky coast (about 25 km of coastline), while the Montengrin part is from Buna/Bojana river mouth to Ulcinj saltpan.

Current MPAs and regulations

There are a number of protected areas in the region. Marine Protected Areas (MPAs) have been proclaimed in Croatian and Italian waters, while in Montenegro and Albania the currently existing protected areas within the proposed area have the status of Coastal Protected Areas (CPAs).

There are three protected areas in the Croatian part including a marine component: Mljet National Park, Malostonski Bay Special Reserve and Lastovo Park of Nature (Figure 7). Mljet National Park is managed mainly for ecosystem protection and recreation, with the original designation based on terrestrial aesthetics rather than biodiversity. At the time of designation, there was little available scientific data that would justify protective measures, and, it was only recently that the national park boundaries were extended to include surrounding marine areas (Benoviç *et al*., 1999). Mljet National Park is under pressure predominantly from tourism, with additional problems regarding illegal construction on the islands, localised pollution, uncontrolled access, and illegal fishing by visitors and the local community. Malostonski Bay was designated a Special Marine Reserve, officially managed mainly for scientific reasons. However, this site was designated for historical bivalve aquaculture areas that have been protected with the aim of conserving present and future bivalve production (Benoviç *et al*., 1999). But recreational use of the bay continues, with increasing risk of pollution that could threaten the integrity of bivalve production. In 2006 the Lastovo archipelago, which represents the second largest protected marine area in the country (UNEP-MAP RAC/SPA, 2007) was established for both terrestrial and marine natural values, archaeological findings, and a rich cultural heritage. It has been designated on biological grounds, but with the concept of multiple-use as part of its rationale. However, despite consultations, initial local support for the designation appears to have declined (Frankic, 2004; WWF, 2006).

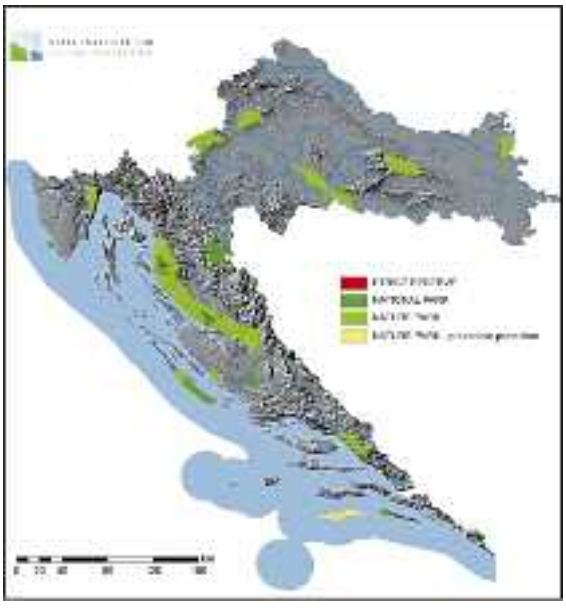

Figure 7. Protected areas in Croatia.

Additionally within the Neretva Delta is a Ramsar site, Mediterranean Specially Protected Area, Ornithological Reserve, Zoological Reserve and Protected Landscape Area. The Delta, its associated salt marshes, saline lagoons, sand banks and wet meadows are of considerable importance for wintering and staging birds and for several species of breeding birds. Large parts of the area have been subject to drainage and agricultural development, increasing road construction, urbanization and hunting.

Marine conservation has lagged behind terrestrial conservation in Croatia, and less than 1% of the territorial sea is protected. Generally protected area management capacity and political will has been lacking (Frankic, 2004). Recently, EU tenders have started to focus on marine conservation, and the Marine Natura 2000 sites should be identified in the coming months.

In Italy, the Gargano National Park includes the MPA of Tremiti Islands and the Varano and Lesina lagoons along the coast. Tremiti Islands was instituted in 1989. Systematic mapping activities have shown that the Archipelago is characterized by critical habitats (coralligenous formations, submarine caves, seagrasses, rhodolite banks) deserving careful monitoring due to increasing threats from tourism (diving, bathing, shipping, anchoring). Protection is generally weak, and poaching is still very active (Guidetti *et al.*, 2008). Long term monitoring, carried out by the University of Salento, shows that the MPA has not been correctly zoned and that the no take no man zone (called Pianosa) is characterized by low biodiversity assemblages even after more than twenty years of protection, (Fraschetti *et al.*, 2011). Pianosa can be considered a de facto marine refuge (e.g., a remote reef that is inaccessible) requiring the input of new recruits from neighbouring unprotected areas. Considering the position of this MPA and the oceanographic features described above, large-scale regulation could be a profitable strategy to facilitate the recovery of this area.

In the middle of the Adriatic, the Jabuka - Pomo Biological Protected Zone (BPZ) jointly declared by Italy and Croatia is located outside national territorial boundaries. Other BPZs (for nurseries as main purpose) are located around Tremiti Islands (Area Tremiti) and off Bari (so named Zone C “al largo della Puglia”).

In Montenegro, Ada Island, in the southern part of the Buna/Bojana delta is a Ramsar site, an international IBA (Important Bird Area) and IPA (Important Plant Area).

In the Albanian sector, there are several units with different protection status within the proposed area. In the southern part of Buna/Bojana mouth, the Velipoja Forest has the status of a Managed Natural Reserve with a core area, the Franz Joseph Island, which is strictly protected as a National Natural Monument. The Velipoja Reserve also has the status of a Ramsar site, IBA and IPA, together with Buna/Bojna River and Shkodra Lake in the Albanian part, as a whole unit. Further south, the Viluni lagoon – Baks Rjolli coast is a Managed Nature Reserve, with a core area, the peculiar sand dune “Blown sand” (Rana e hedhun), strictly protected as a National Natural Monument.

In Albania, despite the presence of protected areas, the implementation of environmental legislation is still weak. Damage to natural habitats, including that within protected areas, is due to uncontrolled human access and illegal activities, such as construction of tourist facilities, deforestation, and fishing and hunting. Some recent efforts through national and international projects on protected areas in Albania aim to strengthen the national network of Coastal Protected Areas and encourage the proclamation of new MPAs. This should have positive impacts on marine ecosystem conservation in the country.

The presence of different approaches and different levels of institutional conservation extended to the middle of Adriatic (i.e. Jabuka) should help a shared process of developing management based on the best practice in the existing situations. Jabuka, for example, not only “covers” (with almost 2000km^2) one of the most important geo-oceanographic peculiarities, but also protects the nursery areas for many of commercial fishes, thereby supporting the economies of the Croatian/Italian coastal fisheries.

FINAL CONSIDERATIONS

The Bosnia and Herzegovina territorial sea and shared resources of the Neretva region should also be considered as they are included within the border of the proposed South Adriatic Park.

There are potential threats from the adjacent Northern Adriatic Sea. There is increasing hydrocarbon exploration in this shallow region, and proposals for the development of refinery and storage capacity in the region. Associated tanker traffic must transit through this zone. In addition, the planned expansion of Northern Adriatic ports will add to maritime traffic and threats.

On the eastern coast, as the standard of living in Croatia, Bosnia and Herzegovina, Montenegro and Albania rises towards EU levels, we can also expect a rise in the use of the coastal zone for tourism and recreation; this leads to further potential exploitation and disturbance. Some form of integrated planning for the Adriatic is urgently required.

Scientific rationale for the proposed CIESM North Ionian Sea Marine Peace Park

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SUMMARY

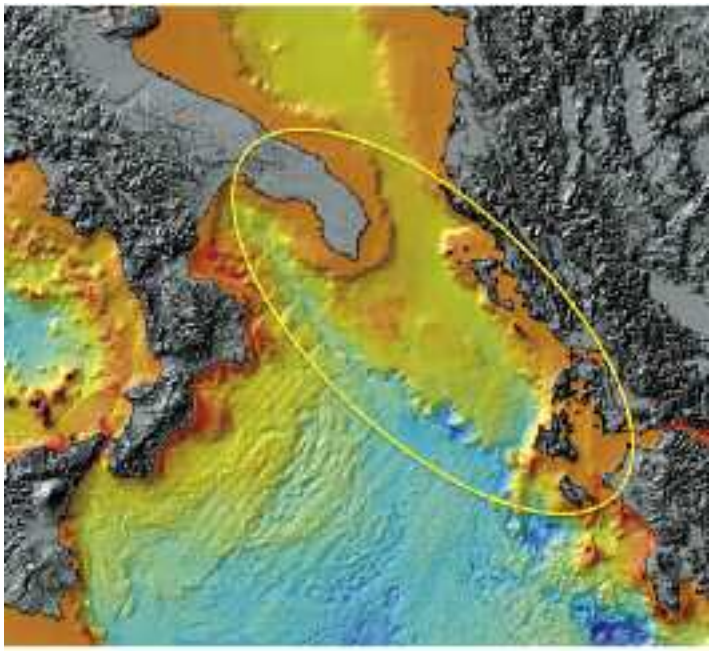

Figure 1. Shaded bathymetry of the CIESM North Ionian Sea Marine Peace Park (within yellow circle) based on swath bathymetry (DTM at 500m grid) – Adapted from L. Brosolo and J. Mascle (2007).

The North Ionian Sea roughly includes the southeast of Italy with part of the Apulia region, Calabria, Albania and Greece in the Ionian portion. This section of the Mediterranean combines high levels of marine biodiversity, a relatively low human population density, a long history of exploitation of marine resources, increasing alteration of coastal habitats, together with several attempts of protection and management of marine eco-systems. From an oceanographic point of view, this area is a region of strong, pervasive horizontal and vertical exchanges, shaped by a strong seasonal and interannual/ interdecadal variability, that might be of great ecological importance, possibly particularly exposed to the global warming trend. From a biodiversity point of view, the North Ionian Sea is characterized by large wetland, seagrass meadows, coralligenous formations, submarine caves, and seamounts. It is a complex mosaic of relatively well-preserved stretches of coast interspersed within areas impacted by cumulative multiple stressors. Some regions like Albania and the Ionian Greece, should be less affected by human activities, even though, in some cases, the lack of quantitative

information on spatial and temporal variations of their biodiversity, and of floristic and faunistic inventories might raise expectations about the presence of pristine environments no longer present. Several MPAs are present in this area (three in the south of Italy, one in Albania, and one in Greece). Results relative to the effectiveness of protection are promising. However, the limited extension of these MPAs does not guarantee regional marine conservation. In some cases, poaching and illegal activities are still widespread. Fishing (both artisanal and commercial fleets) is considered a crucial pressure, but actual effort data are not available. Management of marine coastal areas is, at least in the south of Italy, confined to the presence of Sites of Conservation Interest (SCIs) implemented for *Posidonia* meadows. No attempt at ecosystem-based approaches to the management of human activities has been implemented so far. However, this area surely requires priority for conservation efforts since impacts, singular or cumulative, are still limited in space so that there is still potential for restoration. Also, since the North Ionian Sea is characterized by strong oceanographic connections, this area has potential as a real ecological network.

Key geological characteristics

Geologically speaking, the selected area is rather homogenous, consisting mainly of massive Mesozoic limestones of the former Apulian platform, once the upper part of a passive continental margin created during the evolution of the Mesogean Sea, some 150 Ma ago. On the Italian side (Apulia), this platform has not been strongly compressed during the creation of the southern Apennines, while on the Hellenic border (Albania, Greece) the Apulian domain, and the so-called Pre-Apulian zone, also predominantly made of massive limestones, were incorporated in westward verging tectonic nappe systems related to the alpine collision.

It is also important to keep in mind that during the "Messinian" salinity crisis, which affected the entire Mediterranean between 6 and 5 million years ago, large parts of the domain emerged, since sea level dropped by probably more than 1200 meters. As a consequence, limestone outcrops were exposed to continental erosion and intense karstic processes; which cut many caves and aerial valleys into these rocks, leading to further submarine canyons when sea level was re-established in the lowermost Pliocene. These submerged aerial morphologies subsequently provided hard rock settlement sites for fixed organisms such as the deep water corals discovered south of Italy, and which probably also exist along the steep Hellenic Ionian margin (Fig. 1).

Key oceanographic characteristics

Among the different regional systems of the Mediterranean, the southern Adriatic and Northern Ionian Seas are of particular relevance and importance since they are presumably characterized by strong oceanographic connections. Cooled down by cold northern winds, the surface waters of the Adriatic become colder than the rest of the Mediterranean; their increased density makes them sink to the deeper parts of the Ionian Sea. Ionian waters typically enter the Adriatic close to the Albanian side (East Adriatic Current) and flow out along the Apulian side (West Adriatic Current). This flow regime is part of the basin-wide cyclonic circulation, which comprises three sub-basin cyclonic gyres, occupying the northern, central and southern portions of the Adriatic, trapped by bathymetry (the central one being centred on the Jabuka Pit, the southern one on the Southern Adriatic Pit). Focusing on the southern gyre, at the surface and subsurface level, the cyclonic circulations may provide an important link among the Marine Protected Areas located on the East and West coasts of the central and southern Adriatic Sea, via possible exchange of hydrological and biogeochemical properties as well as of organisms between the eastern and the western sides. Vertically mixing due to intense convection occurs with the South Adriatic Pit a source of Adriatic Deep Water; on the western side of the basin, coastal/deep-sea mixing is further enhanced by the overflow and deepening process of the North Adriatic Deep Water, funnelled by gravity and by the presence of canyons from the shelf break to the continental slope. This water then exits, along with the surface waters, through the Otranto Channel into the Ionian Sea and the Gulf of Taranto. Thus, the area comprising the southern portion of the Adriatic and the northern Ionian Sea represents a place of strong, pervasive horizontal and vertical exchanges, shaped by a seasonal and interannual/ decadal variability that is of great ecological importance in connecting the Italian and the Balkan Peninsula coasts.

Ecological characteristics

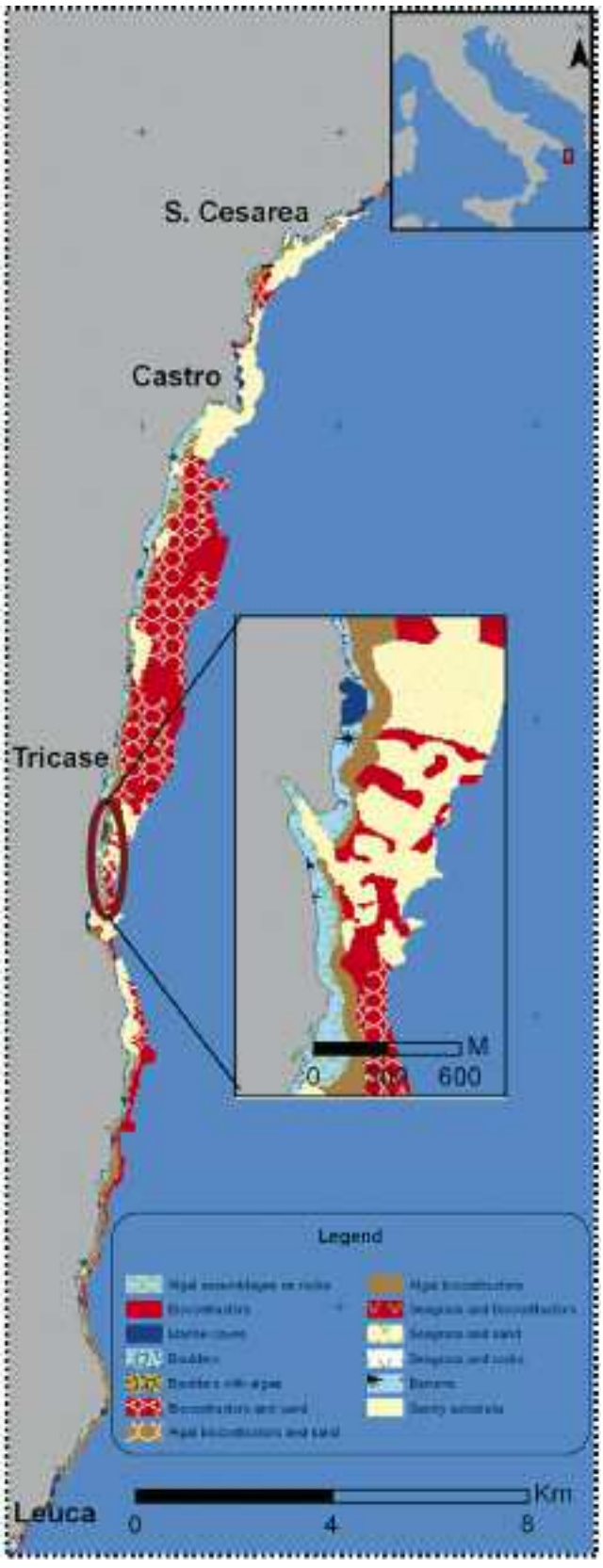

Figure 2. Habitat mapping along the coast between Otranto and S. Maria di Leuca (Puglia, Italy) (from Fraschetti *et al.,* 2009).

If the Mediterranean is considered a hot spot of biodiversity, both on land and in the sea, this area surely represents its core. This area is a complex mosaic of habitats and assemblages, changing abruptly at small scales (e.g., see Fig. 2 with habitat distribution along the 40 km coast between Otranto and S. Maria di Leuca). The eastern part of the Ionian Sea (Greece and Albania), has been identified by the WWF Mediterranean Program as one of the 10 Mediterranean marine and coastal areas that are vital for biodiversity. This sector is also noted for the presence of important lagoons (Aquatina, Alimini and Mar di Taranto in Apulia, and Butrinti in Albania). In Greece, the Amvrakikos Gulf (which comprises a series of marshes and lagoons and is one of the most important wetland systems in Greece), was designated a Ramsar site in 1975, as a Special Protection Area (EC Directive 79/409 for bird conservation) and as a Specially Protected Area (SPA) under the SPA/BD Protocol to the Barcelona Convention (Bearzi *et al.*, 2008a). In Albania, the Butrinti lagoon together with its surrounding wetland complex was designated as Ramsar site in 2003, as an internationally Important Plant Area (IPA), and an Important Bird Area (IBA). The Albanian part of this area, especially the Karaburuni Peninsula – Sazani Island, has also been identified as a priority area for marine biodiversity conservation by many recent national and international environmental reports.

Several studies have been carried out in this area, adding to our knowledge of spatial and temporal patterns of species and assemblages (Fraschetti *et al.*, 2001; 2002; 2005a; Terlizzi *et al.*, 2007; Giangrande *et al.*, 2003; Bussotti *et al.*, 2007; Beqiraj *et al.*, 2008; in press; Kasemi *et al.*, 2008; Kashta *et al.*, 2005b; Kashta *et al.*, 2007; Pititto *et al.*, 2009; Maiorano *et al.*, 2011; Miho *et al.*, in press), trophic cascades (Guidetti, 2006), effects of Marine Protected Areas (Terlizzi *et al.*, 2004; Fraschetti *et al.*, 2005b; 2009; Guidetti and Sala, 2007; Guidetti *et al.*, 2008; Kashta and

Beqiraj, 2009; Kashta *et al.*, 2010) and impacts of stressors such as coastal sewage discharges (Terlizzi *et al.*, 2002; 2005; Fraschetti *et al.*, 2006), offshore platforms (Terlizzi *et al.*, 2008; 2009), species introductions (Gravili *et al.*, 2010; Beqiraj *et al.*, in press; Katsanevakis *et al.*, 2011), habitat destruction (Fraschetti *et al.*, 2001; 2011; Claudet and Fraschetti, 2010), fisheries (Bearzi *et al.*, 2006; 2008b), and direct and indirect effects of climate change (Guidetti and Boero, 2001; Kapur *et al.*, 2010). Several local research institutions have traditionally studied the marine environment: the University of Salento, the University of Bari, the Talassografico di Taranto, the University of Tirana, the University of Vlora, the University of Athens and the Hellenic Center for Marine Research share a long tradition of transnational research programmes. Several Marine Protected Areas have been instituted along the Italian coast, one on the Albanian Coast and one in Greece. There is already collaboration between research institutions and the MPAs present in this area so that, to some extent, a network of institutions trying to coordinate their research activity already exists.

Presence of endangered / key species – assemblages – critical habitats

The Sazani–Karaburuni area in Albania is a shelter for at least 36 internationally endangered marine species that belong to the lists/annexes of several conventions: Barcelona, Bern, CMS, CITES) and for about 75% of marine animal species included in the list of endangered species on a national scale (Red List of Albanian Fauna, 2007).

In Apulia and Albania, species such as *Corallium rubrum*, *Pinna nobilis* and *Lithophaga lithophaga* are still present along the coast even though their populations are under threat.

Sperm whales, Cuvier's beaked whales, common dolphins, Risso's dolphins, bottlenose dolphins, marine turtles, sharks and rays can be present in this area. The northern part of this area, a "bridge" between the Adriatic and the Ionian, is an important migration corridor for cetaceans, marine turtles, and monk seals to and from the Adriatic Sea.

Dramatic changes are occurring in Ionian Sea ecosystems (Bearzi *et al.*, 2005; 2006). Once-abundant top predators such as the monk seal *Monachus monachus* and the short-beaked common dolphin *Delphinus delphis* are in danger of extinction due to human impact; other high-order/upper trophic level marine predators risk a similar fate unless appropriate management measures are implemented immediately, particularly with regard to fishing. Once one of the commonest cetaceans in the Mediterranean, the common dolphin, has declined throughout the region during the last 30-40 years (Bearzi *et al.*, 2003). In 2003, the Mediterranean common dolphin population was classified as endangered in the IUCN Red List of Threatened Animals (<www.iucnredlist.org>). The causes of this decline arepoorly understood but are thought to include prey depletion (Bearzi *et al.*, 2003 and Bearzi *et al.*, 2004a).

Largely based on the presence of common dolphins, the eastern Ionian area around the island of Kalamos has been included by the Greek Ministry of the Environment in the Natura 2000 network ("Sites of Community Importance") under the 9243 EEC "Habitats" Directive (Frantzis, 1998). The area around Kalamos has also been identified by ACCOBAMS (2002) as one where pilot conservation and management actions should be developed and implemented immediately to preserve common dolphin habitat. So far, however, no specific conservation actions have been taken.

Forests of fucoids used to be diverse and abundant in this area. Losses have been documented at numerous locations, and present-day *Cystoseira* forests are scattered and fragmented canopies. *Cystoseira* belts (mainly *C. amentacea*) are commonly present along the whole coast of Karaburuni Peninsula and Sazani Island in Albania. Even though quantitative studies and historical information are largely lacking, it has been estimated that 70% of the canopies have been lost during 2002-2005.

In the last twenty years, different institutions along the southern part of the Adriatic and the northern Ionian Sea have carried out detailed mapping. A map (scale 1:5000) is available for the seagrass *Posidonia oceanica*. Most information refers to depths between 0 and 30-50 meters. In Apulia, Sites of Conservation Interest (SCIs, Natura 2000) have been implemented based exclusively on the presence of *Posidonia* meadows. However, official regulation of human activities is still not active in this net of sites. At present, rough estimates indicate that about 16%

of the meadows within the borders of the Apulian MPAs are protected. In Torre Guaceto MPA (Brindisi), data on *Posidonia* meadows have been collected since 2001. Fraschetti *et al.* (2011) show a general reduction of shoot density through time, although lower in protected beds than in unprotected ones. In Albania, in Vlora Bay, an interdisciplinary study (Interreg III, CISM project 2006-2008; <www.cismalbania.it>) showed that 15 years of coastal development can result in a loss of over 50% of seagrass cover (Fraschetti *et al.*, 2011). Data are also available on the seagrass of the MPA of Zakynthos in Greece (Interreg Project 2008), and show that fishing and anchorage have destroyed a remarkable percentage of the meadows, and that *Caulerpa* is spreading on the *Posidonia* matte.

Coralligenous formations are widespread in the Mediterranean, and are particularly extensive in this sector. Here, they have been studies since a long time ago for their peculiar morphological features (Sarà, 1971), but continuous large-scale maps are not available. In Apulia, the most recent information on the regional distribution of bioconstructors comes from mapping carried out in 1989 by the Environmental National Energy Agency (ENEA), within 30 meter depth. According to the values provided by ENEA, only 4% of this habitat is under protection regimes and, for the moment, is not included under international regulation interventions. Preliminary comparisons of the subtidal rocky reefs between Otranto and S. Maria di Leuca (south Apulia) with those of Albania (Fig. 3), about 50 nautical miles apart, show that, even though compositional differences are slight, the Albanian reefs have higher biodiversity in terms of mean numbers of taxa (Terlizzi *et al.*, unpubl. data).

Figure 3. Rocky reefs in Albania, Karaburuni.

Unique communities / ecosystems

Caves. Submarine caves are widespread in the Mediterranean, and one of the few habitats deserving a generalized form of protection from EU initiatives (Habitat Directive).

In the seventies, submarine caves were the focus of several studies describing biodiversity changes along environmental gradient, but structural and functional information on this habitat are still scarce. Furthermore, studies on the effects of human activities (e.g. diving frequency, harvesting) on this habitat are very limited. The North Ionian is extremely rich in caves: in the Salento

Peninsula in SE Italy, subtidal habitats are characterized mostly by calcareous substrates, conducive to the formation of large cavities: in 100 km of rocky coast, about 90 submarine caves have been mapped (see: <www.tamug.edu/cavebiology/Research/research.html>). Bussotti *et al.* (2007) compared three caves in Salento showing significant differences in species assemblages. This result suggests that the processes determining spatio-temporal patterns are complex and context- and scale-dependent. Results also revealed the uniqueness of these assemblages, which has important implications for their conservation and management (Fig. 4). As karstic areas, Albania and Ionian Greece are also rich in caves. However, no detailed studies on these habitats have been published. As shown by several studies of submarine caves show they are not very resilient ecosystems, and an understanding their potential to recover after major disturbances is essential for their management and conservation.

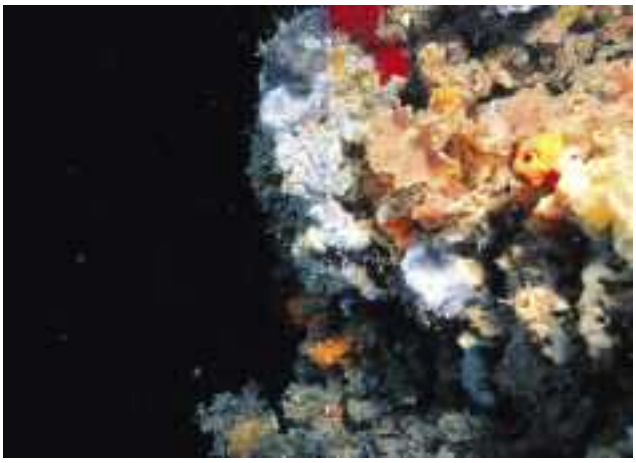

Figure 4. Sessile assemblages within a cave in the Salento Peninsula in SE Italy.

Deep sea. The recent exploration of the deep sea between the Southern Adriatic and Ionian seas led to the discovery of important white-coral banks, one between Italy and Albania (Bari canyon), and one South of Capo Santa Maria di Leuca (SML). The Santa Maria di Leuca White Coral System could provide a model for deep-sea MPAs in the Mediterranean, due to its strong connection with the surrounding ecosystems via the current regimes. These deep-sea communities are possibly connected, forming a network of areas in which Cold Water Corals thrive. The same community type has also been identified in Bari Canyon, North of Santa Maria di Leuca, although this latter is much less well-known than the former. The SML coral banks represent important ''hot-spots'' of species diversity in the Mediterranean basin, comparable to the *Posidonia* meadows and coralligenous bioconstructions on the shelf. For this reason, consideration of the impact of trawls and other fishing gear (i.e. longlines) on white coral banks is crucial. In January 2006 the General Fisheries Commission for the Mediterranean (GFCM) recommended prohibition of towed gears (dredges and trawl nets) in the deep-water coral banks of SML. To protect these deep areas, the GFCM has created the new legal category of ''Deep-sea fisheries restricted area''. The GFCM recommends members to notify the appropriate authorities to protect these particular habitats. The institutional process for a marine protected area beyond territorial waters in the northern Ionian Sea should be carried out in the context of the Barcelona Convention Protocol relative to Specially Protected Areas and Biological Diversity in the Mediterranean (SPA Protocol), asimplemented for the Ligurian Sea Cetacean Sanctuary in 1999 by France, Italy and Monaco on the Mediterranean High Seas (Mastrototaro *et al.*, 2010). The Mediterranean deep-sea contains several extremely peculiar and interesting ecosystems, such as the deep hypersaline anoxic ''lakes'' in the Ionian Sea that are reported to include several new and little-known microbial lineages (Yakimov *et al.*, 2007).

Main threats

Coastal development is less and human population densities lower in the North Ionian Sea than in other Mediterranean areas. This is especially true for the coast between Otranto and S. Maria di

Leuca, the Karaburun in Albania and the Ionian coast of Greece. The Karaburun peninsula-Sazani Island is a MPA since April 2010 and has had a neighbouring terrestrial Managed Nature Reserve since 1968. However, the lack of quantitative information on spatial and temporal variations of biodiversity and of floral and faunistic inventories in this area may raise expectations of pristine environments no longer present. Poor historical baseline data prevent impact assessment and restoration practices. As an example, in the last 20 years, Albania has undergone deep changes, almost without comparison in other transition economies. The effects of such transformation have become very visible in terms of the spatial distribution of human activities, and in the living condition of the people in urban areas, especially the rapidly growing ones (World Bank Urban Sector Review, January). In Apulia, impacts associated with different human pressures on key habitats are generally significant, and overall greater for hard-bottom habitats (rocky reefs, rocky shores, and coralligenous communities) and vegetated habitats (seagrass beds) than for muddy and sandy bottoms (Claudet and Fraschetti, 2010).

Multiple, possibly interacting stressors are widespread in other coastal areas where a combination of costal development and erosion, invasive species, organic and inorganic pollution, habitat loss and overfishing and illegal fishing are present. When coupled with climatic variability, localized human perturbations contribute to generate new regimes of disturbances expected to greatly affect the stability, resilience and productivity of these marine ecosystems.

In this area, human threats have typically been studied and managed in isolation, although it is becoming increasingly clear that a single-stressor perspective is inadequate when ecosystems are threatened by multiple, co-occurring stressors. Few examples: coastal erosion is pervasive and, in some zones of Apulia characterised by a gently sloping shore platform, a significant shoreline retreat was calculated to be about 20 m in the last 100 years (0.2 m yr(-1)), caused, above all, by human activity (Andriani and Walsh, 2007). The same issue is shared with Albania (Ciavola *et al.*, 1999).

The effects deriving from the two big harbours (Brindisi and Taranto) are well documented. The waters in the port of Brindisi are classified as hypertrophic and have very high biopolymeric carbon (BPC) concentrations and protein to carbohydrate ratio (PRT:CHO on average > 1). Taranto harbour, located in Mar Piccolo, contains acutely toxic concentrations of metals.

This area also seems to favour the establishment of non-indigenous species (NIS) and deserves greater attention, being a hotspot of alien biodiversity. Indeed, since it houses the Italian Navy shipyard, the largest Italian mussel farms, as well as an expanding trade port, it is particularly exposed to the introduction of NIS. The geographical location of Apulia and Albania is central in the Mediterranean, and biological communities here may be affected by arrivals of new species from all directions. Lessepsian migrations through the Suez Canal probably reach their western extreme on the Italian coast, but Apulia also seems to accept species arriving from the west (Atlantic). In both cases, a warmer affinity and subtropical derivation of most species is evident. Thirty-eight NIS (macroalgae, sponges, hydrozoans, molluscs, polychaetes, crustaceans, ascidians and fish), are reported from the Apulian coast of Italy. Shipping, aquaculture, and migration through the Suez Canal are the main pathways of introduction of the NIS (Gravili *et al.*, 2010). Reliable information about fishing effort is not available, but overfishing is generally considered one of the main pressures everywhere in the Mediterranean.

Furthermore, in this area, shallow rocky calcareous habitats are heavily threatened due to destructive fishing of the European date mussel *Lithophaga lithophaga* (L.), which leads to the desertification of tens of kilometres of rocky coast each year (Fraschetti *et al.*, 2001) (Fig. 5). This illegal fishery involves the removal of the benthic assemblages, since to extract these boring bivalves from rocky reefs, scuba divers scrape and break the carbonate rocks with special hammers, to the detriment of the organisms living on the surface and within the substrate. The extending clearing action of date mussel fishing (DMF) is causing a shift from multilayered macrobenthic assemblages to coralline barrens in large areas of subtidal reefs in the Mediterranean, representing one of the most harmful human activities affecting temperate shallow rocky habitats. The impact of DMF also affect sea urchin distribution patterns, which have higher densities and biomass in impacted areas (Guidetti *et al.*, 2003).

Thus, patches created by DMF may remain barren for a long time because increased grazing pressure restrains recolonization. So far, hundreds of kilometres of subtidal rocky coast have been destroyed in Apulia.

In Albania signs of impact are widespread, and the failure of subtidal assemblages to recover from natural and human disturbance, and their ultimate replacement by degraded habitats, are concrete risks recognised globally. From this perspective, appropriate management and conservation measures able to reverse the observed trends are urgently needed.

Finally, the production of "clean" energy that has been directed towards the use of wind as a source of power. Wind facilities are blooming throughout Europe, often impacting on the attractiveness of rural landscapes. Marine-based wind facilities are a feasible alternative to land-based technologies. However, coastal wind facilities can impact on benthic habitats of particular value and Apulia has been selected as a priority area by EU where to implement these structures. There are plans also to put these wind facilities in Karaburuni Peninsula. The effects of a large-scale implementation area are totally unknown.

Figure 5. The effects of the date mussel fishery in Apulia.

Proposed modifications of zone boundaries and justifications

We slightly modified the boundaries of a previously designated area. The present proposal is more focused on a geographical area characterized by a combination of available scientific knowledge and ecological connections.

Current MPAs / Regulations (including legal status of threatened / endandered species)

Several Marine Protected Areas have been or are being instituted along the Italian coast, namely the Tremiti Islands (N of the Gargano Peninsula), Torre Guaceto (N of Brindisi), the coast from Otranto to Santa Maria di Leuca (legislation underway), and Porto Cesareo (on the Ionian Sea). One MPAs has been designated on the Albanian Coast (Sazani Island - Karaburun Peninsula). Five additional areas along the Ionian coast of Albania have been proposed as potential MPAs by the National Biodiversity Strategy and Action Plan (NEA/AKM, 1999). In Greece, the MPA of Zakinthos was implemented by 1999.

It is important that detailed habitat maps are available for the three MPAs in Apulia and that of Zakinthos. In Albania, only a map of coastal habitats is available at the moment. Results show that in all cases zonation is never correctly designed and vulnerable habitats are systematically outside the zones under total protection. Fraschetti *et al.* (2009) used site selection algorithms along the Otranto and S. Maria di Leuca coast, and showed that despite widespread human

influence, identification of parts of habitats to be protected from direct human disturbance as core no-take areas is still possible using the inclusion of 10 and 30% of low and high priority habitat within reserves, respectively, as a conservation target.

Implementation of MPAs with limited protection schemes that also include several small no-take areas may represent a feasible strategy for the conservation of Mediterranean coastal marine habitats. Moreover, MPAs could be combined with coastal zoning of activities as a means of further controlling effects over broader areas and allowing for recovery of degraded areas.

The MPA of Torre Guaceto (Brindisi), instituted in 1991 and embedded into a human-dominated landscape, is a rare example of well-managed MPA where adequate enforcement determined target fish recovery. This MPA provides an excellent opportunity to analyse the effects of protection on subtidal benthic assemblages, through the comparison of protected and unprotected locations. Clear differences between protected and unprotected assemblages have been revealed, with invertebrates and canopy forming algal species recovering within the MPA, whereas unprotected locations are still characterized by barren habitats. Lower temporal variability in protected assemblages than in controls has also been observed, demonstrating that, at least at a local scale, conservation can reverse the decline of marine biodiversity, and enhance community stability. Our results suggest that, even though marine benthic assemblages can be significantly affected by human activities, these trends are still reversible through effective ecosystem management. Here, fishing was completely banned in the entire MPA from 2001 to 2005. In 2005 fishing resumed within the buffer zone surrounding no-take zones. From 2005 to 2008, artisanal professional fishing was monitored and CPUE values (kg km^{-1} of net) within the buffer MPA compared with those obtained outside (where fishing grounds are fully open to professional and recreational fishing) (Guidetti *et al.*, 2010). Catches were higher inside than outside the MPA. Overall assemblage structures were significantly different inside and outside the MPA, with the two most important commercial species, i.e. *Mullus surmuletus* and *Scorpaena scrofa*, accounting for about 40% of the catch inside and about 20% outside. Average CPUE outside the MPA was approximately 10 kg km^{-1} of net and remained quite stable over the years. This study shows that the use of fishing co-management protocols within MPAs that properly involve local fishermen in the decision process is a promising approach to balance fishermen's and conservation needs.

Beside this excellent example, Tremiti and Porto Cesareo MPAs in Italy are still subjected to poaching and other illegal activities, even though, increased efforts by local managers are slowly changing local attitudes.

Final considerations

In this context, local management tools, such as isolated Marine Protected Areas (MPAs), are clearly insufficient. Suitable strategies for conservation and sustainable management of marine biodiversity need large-scale integrative regulation of the uses of marine resources. Unfortunately, the fragmented geopolitical scenario characterizing the Mediterranean basin has led, and still leads, to weak, uncoordinated, conflicting, or non-existent regulatory frameworks, policy mechanisms and enforcements. Ecosystem-based management (EBM) frameworks including networks of MPAs are invoked as profitable strategies, but examples of effective EBM are rare, and single-sector management strategies are still the rule. This initiative represents an excellent opportunity to reverse this trend.

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