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Regional Activity Centre for Specially Protected Areas

”Further development of the Ecosystem Approach within the Barcelona Convention”

Step 3 of the Road map for the implementation of the Ecosystem Approach

RAC/SPA Component

Sub-regional report on the “Identification of important ecosystem properties and assessment of ecological status and pressures to the Mediterranean marine and coastal biodiversity in the Ionian Sea and Central Mediterranean”

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Responsible of the study:
Sami Ben Haj ,
RAC-SPA International consultant

With the participation of:
Daniel Cebrian. SAP BIO Programme officer (overall co-ordination and review)
Atef Limam. RAC-SPA Project officer (overall co-ordination and review)
Argyro Zenetos, Nikos Streftaris, Panayotis Panayotidis, Nomiki Simboura, Maria Salomidi (Greece)
Esmail Shakman (Libya)
Romdhane Med Salah (Tunisia)
Silvia de Juan Mohan (Open Seas)
Jordi Lleonart Aliberas (Open Seas)

Mediterranean Action Plan
Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du Leader Yasser Arafat
BP 337 –1080 Tunis Cedex –TUNISIA
E-mail : car-asp@rac-spa.org

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CONTENTS

INTRODUCTORY NOTE

At their Fifteenth Meeting of the Contracting Parties to the Barcelona Convention (Almeria, Spain, 15-18 January 2008), the Contracting Parties decided to gradually apply the ecosystem approach to managing the human activities that could affect the Mediterranean's marine and coastal environment (Decision IG 17/6). They even set up a 7-phase road map for the gradual application of the approach.

The present report was crafted as part of RAC/SPA's active involvement in the process, and its contribution to carry out Step 3 of the road map, which consists of identifying the ecosystem's important properties and assessing the state of the environment and the pressure exerted on it. This contribution particularly involves assessing the ecological state and pressure exercised on marine and coastal biodiversity in the Ionian sea and the Central Mediterranean.

The document summaries and extrapolates to the countries of Ionian Sea and the Central Mediterranean, the ideas presented in the national reviews.

- Greece (Ionian sea), prepared by Argyrou Zenetos
- Libya, prepared by Esmail Shugman,
- Tunisia (eastern and southern areas), prepared by Mohamed Salah Romdhane

For Italy and Malta, there has been no selection of National Consultants. Thus, no reports have been prepared and the information included in the present document regarding these two countries, when available, are taken from:

- National Action Plans and Reports prepared as part of the Strategic Action Programme for the Conservation of Marine and Coastal Biodiversity in the Mediterranean Region (SAP BIO);
- RAC/SPA's 2009 national reports on vulnerability and the impacts of climate change on marine and coastal biodiversity in the Mediterranean;

When crafting the national reviews, the authors informed and consulted the various national leaders (SPA Focal Points, national correspondents for SAP BIO, ministries,...) plus many national experts. However, the thoughts and suggestions included in the national reviews remain the opinions of experts.

Thus, the present document is a summary of the state of the ecosystems in the Ionian sea and the Central Mediterranean, particularly the biological features and types of habitat that exist there. A second part deals with the analysis of the pressures and impacts on these ecosystems, essentially as regards biological disturbance and emerging problems such as the effects of climate change and modifications of the deep sea ecosystems, given the interest they are arousing worldwide.

This report was drafted for the Regional Activity Centre for Specially Protected Areas (RAC/SPA), by Mr Sami Ben Haj (International Consultant, Cabinet Thétis, Bizerta, Tunisia), supported by Atef Limam (RAC/SPA Project officer) and Daniel Cebrian (SAP BIO Programme officer).

METHODOLOGY

Participatory approach

To carry out step 3 of the road map for applying the ecosystem approach, related to identifying the important properties of the ecosystem and assessing the state of the environment and the pressure exerted on it, the Mediterranean Sea was subdivided into four regions, as a result of a consensus based on biogeographical and oceanographic considerations (2nd Meeting of Government-designated Experts on the Application of the Ecosystem Approach, Athens, 9-10 July 2008). The four regions identified are (i) Region 1: Western Mediterranean; (ii) Region 2: Adriatic Sea; (iii) Region 3: Ionian Sea and central Mediterranean; and (iv) Region 4: Aegean Sea-Levant Sea.

All the Mediterranean countries in their quality as Contracting Parties to the Barcelona Convention were invited to take part in this process, to reach the major objective of Step 3 of the road map, which consists of conferring with each other and gathering pertinent data and recommendations at national, sub-regional and regional level.

The Mediterranean countries were distributed around the four biogeographical and oceanographic regions as follows:

(i) Western Mediterranean: Algeria, France, Italy (Tyrrhenian-Ligurian area), Monaco, Morocco, northern Tunisia and Spain
(ii) Region 2 (Adriatic Sea): Albania, Bosnia Herzegovina, Croatia, Italy (Adriatic Sea), Montenegro and Slovenia
(iii) Region 3 (Ionian Sea and central Mediterranean): Greece (Ionian Sea), Italy (Ionian Sea), Libya, Malta and eastern and southern Tunisia, and
(iv) Region 4 (Aegean Sea-Levant Sea): Cyprus, Egypt, Greece (Aegean and Cretan Seas), Israel, Lebanon, Syria and Turkey.

The national consultants were selected in close consultation with the SAP BIO National Consultants and the SPA/BD Protocol's National Focal Points to ensure an assessment at national level.

For the Ionian Sea and central Mediterranean, in Greece (Ionian Sea), Libya and Tunisia (eastern and southern Tunisia), National Consultants were hired right from the start of the process. For Italy and Malta, there has been no selection of National Consultants.

At sub-regional level, the role as sub-regional consultant is to give the necessary technical assistance to the National Consultants to draft the national reports and to draw up a sub-regional assessment documents regarding the Ionian Sea and central Mediterranean sub-region.

Tasks and anticipated outcomes

1. National level

Each National Consultant has to draft a national report on an assessment of the state of the ecology and identification of any lacunae concerning the major properties of

the ecosystems and associated pressures. The parts to be prepared deal with (i) a section on the state of the ecosystems, particularly their biological features and habitat types, and (ii) a section on pressures and impacts involving biological disturbance and emerging problems such as the effects of climate change and modifications of deep sea ecosystems.

2. Sub-regional level

The Sub-regional Consultant is responsible for (i) coordinating, assisting, guiding and harmonizing the work of the National Consultants in the region under his responsibility, (ii) looking into, revising and ensuring the consistency of the received inputs, and (iii) preparing a consistent draft report for each sub-region and presenting this to RAC/SPA, and then finalizing it in compliance with the remarks made at possible work meetings and RAC/SPA's recommendations.

RAC/SPA has provided the various actors with the necessary advice and directives and helped in harmonizing the work and the inputs. It has indeed provided annotated contents and structures of the national and sub-regional reports.

1. CONTEXT

The ecosystem approach was introduced to improve the way in which human activities are managed in order to protect the natural environment. As with the World Summit on Sustainable Development (Johannesburg 2002), the ecosystem approach has been adopted by many international conventions and regional seas organisations. Its implementing aims to help reach a balance between the needs of human activities and the conservation of the natural environment.

Box 1: The 12 principles of the Ecosystem Approach (CBD Secretariat, 2004)

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice
Principle 2: Management should be decentralized to the lowest appropriate level
Principle 3: Managers should consider the effects of their activities on adjacent and other ecosystems
Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any management programme should:

a) reduce market imbalances which have harmful effects on biological diversity
b) harmonize incentives to encourage the conservation and the sustainable use of biological diversity
c) as far as possible, integrate the costs and advantages within the managed ecosystem.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target
Principle 6: Ecosystems must be managed within the limits of their functioning
Principle 7: Action should be undertaken at the appropriate spatial and temporal scales
Principle 8: Objectives for ecosystem management should be set for the long term
Principle 9: Management must recognize that change is inevitable
Principle 10: Action should seek the appropriate balance between, and integration of, conservation and use of biological diversity
Principle 11: Action should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices
Principle 12: The approach should involve all relevant stakeholders of society and scientific disciplines

The Mediterranean, an ecoregion that is remarkable for its climate and the common sea that links three continents, for the richness of its biodiversity, for its classical heritage and the diversity of its landscapes and its cultural places (UNEP/MAP-Plan Bleu, 2009)..

The Mediterranean sea shows the importance of the sustainability of use of goods and services and the potential interest in applying an ecosystem approach and conservation- and management-related measures not only to the areas under state jurisdiction but also to the habitats and ecosystems that lie in waters outside national jurisdiction.

The Central and Ionian Mediterranean

The shores and marine areas of the Ionian Sea and Central Mediterranean contain a rich and extremely diversified biodiversity. This heritage is already subjected to great pressure deriving mainly from the human activities that contribute to its erosion.

The central area of the Mediterranean is a transitory zone between the occidental basin, under Atlantic influence and the oriental basin, under the influence of changes between the red sea and the Mediterranean and incomes of the black sea on the other hand

On this account, the Contracting Parties to the Barcelona Convention, in their Almeria Meeting (15-18 January 2008) decided to gradually apply the ecosystem approach to the management of human activities that could affect the Mediterranean marine and coastal environment (Decision IG 17/6) and adopted a road map for this purpose (Box 2 below).

Box 2: Steps of the ecosystem approach road map (ECAP)

The ECAP road map adopted by Decision IG 17/6 of the 15th Meeting of Contracting Parties (2008) consisted of the following 7 steps:

Step1: Definition of an ecological Vision for the Mediterranean.

Step 2: Setting of common Mediterranean strategic goals.

Step3: Identification of important ecosystem properties and assessment of ecological status and pressures*.

Step 4: Development of a set of ecological objectives corresponding to the Vision and strategic goals.

Step 5: Derivation of operational objectives with indicators and target levels.

Step 6: Revision of existing monitoring programmes for ongoing assessment and regular updating of targets.

Step 7: Development and review of relevant action plans and programs.

Step 3 of the road map aims at identifying the major properties of the ecosystems and assessing the state of the ecology and pressures has also been discussed and is being implemented. RAC/SPA has been actively involved in the phases of this approach, in particular as regards Phase 3 of the road map, and it is in this context that the present document has been prepared as RAC/SPA's contribution to this phase.

This contribution consists of preparing a sub-regional documents on 'identifying major properties of the ecosystems and assessing the state of the environment and the pressures exercised on marine and coastal biodiversity in the Ionian sea and the Central Mediterranean', as described in the methodological approach.

* From this step onwards, it is necessary to consider the appropriate spatial and temporal scale of application of the approach

In joint agreement with the other MAP elements, the sections handled by RAC/SPA in the present report basically dealt with (i) the state of the ecosystems, especially their biological features and habitat types, and (ii) pressures and impacts, particularly biological disturbance, and emerging issues like the effects of climate change and modifications of the deep sea ecosystems.

2. SCIENTIFIC KNOWLEDGE AND AVAILABLE INFORMATION

2.1. Reference documents and available information

RAC/SPA made available to all the national and sub-regional consultants a wide variety of pertinent documents having international, regional, sub-regional and national pertinence.

A particular attention was paid to the :

- National Action Plans and Reports prepared as part of the Strategic Action Programme for the Conservation of Marine and Coastal Biodiversity in the Mediterranean Region (SAP BIO);
- RAC/SPA's 2009 national, sub-regional and regional synthesis reports on vulnerability and the impacts of climate change on marine and coastal biodiversity in the Mediterranean;
- Reports defining and explaining the ecosystem approach – how it works and is implemented

On the basis of these documents, important information, especially very recent information on the state of the ecosystems, impacts and pressures, was gathered and integrated within the national reports. The documents also constituted a source of vital information for identifying gaps noticed as regards knowledge, funding issues, the expression of urgent actions and needs, conclusions and recommendations.

Documents defining and dealing with the ecosystem approach as a concept were also used by the national experts to set the crafting of the documents within this context. Integrating this conceptual information underlies the entire process as undertaken by RAC/SPA in this third phase of the road map, and will enable the products expected from this activity (national and sub-regional contributions) to be grasped within this perspective. The document produced by the CBD[1] Secretariat is in itself an excellent reference work.

Detailed information of local and national pertinence used in this document mostly comes from the national contributions devoted to the ecosystem approach in Greece, Libya and Tunisia. For Italy and Malta, informations of local and national coastal and marine biodiversity come from national reports devoted to the effects of climate change on marine and coastal biodiversity

2.2. Comments

In the bulk, the documentary base used and the knowledge available is relatively rich, especially that on biodiversity and those on pressures and impacts, but disparities and gaps still exist at both national and sub-regional level:

[1] The Secretariat of the Convention on Biological Diversity (2004), Approach by Ecosystem (CBD Guidelines), Montreal: Secretariat of the Convention on Biological Diversity, 51 p.

- Variable availability of information at geographical level
  - From one country to the next, the information needed for documentation for the national documents sometimes appears in documents that are difficult to access
  - The bibliographical references used vary from one national contribution to the next;
- Variable availability of information at subject level
  - The number of subject-based or sector-based bibliographic sources varies considerably from country to country and subject to subject. This variability results from the disparity of national capacities generally and the relative availability of specialists for certain subjects. Some subjects are sometimes not well documented because they are expensive to handle or require equipment that is not available to certain countries or regions
  - For some countries, priority issues are linked to natural resources of commercial interest, and most of the means are devoted to such aspects
  - The inventories and data are fragmentary and often do not concern the totality of the marine and coastal places
  - Data and cartography is very poor concerning issues related to high seas and deep seas (status, pressures and impacts)

3. STATUS OF COASTAL AND MARINE ECOSYSTEMS

3.1. Biological characteristics

Similar to the whole Mediterranean, biodiversity hotspots in the Ionian sea and the Central Mediterranean are characterized by both high levels of endemism and critical levels of habitat loss, and it is thus on them that conservation efforts mainly focus.

This high biological diversity is to be related to the specific geomorphological and hydrographical features of the Mediterranean basin, its geological history and its position as interface between temperate and tropical biomes that allow it to host both cold- and hot-affinity species (UNEP/MAP-Blue Plan, 2009).

The Central Mediterranean, as same as the whole Mediterranean, is currently experiencing a decline in the number of species and a deterioration of habitats, related to various human-origin activities, basically uncontrolled urbanisation and coastal development, ports, fish farming, pollution and fishing.

In the sections below, a synthesis summary will be given regarding each item followed by a summary of the main features and characteristics that have been presented in the available national reports. For Malta and Italy, there were no available national reports, a tentative of synthesis will be done, when possible based on the information taken from the National Action Plans and Reports prepared as part of the Strategic Action Programme for the Conservation of Marine and Coastal Biodiversity in the Mediterranean Region (SAP BIO) and also RAC/SPA's 2009 national reports on vulnerability and the impacts of climate change on marine and coastal biodiversity in the Mediterranean;

3.1.1. Description of water column biological communities (basically phyto- and zooplankton)

Broadly speaking in the Ionian sea and the Central Mediterranean, the planktonic element (phytoplankton and zooplankton) remains little studied. In general, there is a low primary production, linked to low development of the higher levels of the trophic chain, including low production of fishes, are the main features that characterize the Mediterranean. The growth in oligotrophy from the west to the east is reflected in the abundance of the zooplanktonic biomass.

'Bloom'/proliferation of certain life forms in the has become increasingly common over the past few years, in the Gulf of Gabes in the southern area of Tunisia.

<u>Greece :</u>

- Both the Ionian and the Aegean offshore waters are oligotrophic, while most coastal areas are mesotrophic (Gotsis-Skretas and Ignatiades, 2007; Siokou-Frangou *et al*., 2005).
- Within the pelagic food web mesozooplankton is the link between the lower level producers (phytoplankton, microbes) and the top predators (fish)
- Mesozooplankton abundance and biomass and species composition present the same trends of the rest of the Mediterranean; enclosed or semi-enclosed

bays and gulfs affected by anthropogenic inputs, such as the Amvrakikos (Ionian Sea) and Thermaikos as well as Elefsis Bay are the most productive whereas in offshore waters, the Ionian sea is characterized by a low mesozooplankton abundance values.

Libya :

- No comprehensive study has been done on the Libyan coast about plankton,
- The last survey done in the Libyan coast (Med-Sud-Med 2006) pointed out that the phytoplankton of the Libyan western coast is characterized by abundant diatoms and dinoflagellates, rare coccolithophores and very rare Silicotlagellates. A very high concentration of phytoplankton is located in Musrata area with diatoms are the most dominant phytoplankton, followed by coccolithophores and then Silicoflagellates.
- As for the Zooplankton, few studies have been undertaken. The Med-Sud-Med 2006 survey have focused on the location areas of major concentration of Ichthyoplankton (eggs, and larvae of fish). The predominant species recorded were anchovy (Engraulis encrasicolus) representing 51% of the collected larvae, round sardine (Sardinella aurita) with 9.6% of the larvae and minor fraction of other species (Serranidae, Gobidae and Labridae).

Tunisia :

Phytoplankton

- On the specific level, the number of phytoplankton species identified in Tunisia is about 493 species distributed over 11 groups and mainly dominated by *dinoflagellates (259 species) and diatoms (198 species)*

- In the Gulf of Gabes, the summer season characterized by high temperatures and salinity, promotes stratification of the water column and induces the appearance of phytoplankton blooms with prominent presence of dinoflagellates, diatoms and cyanobacteria,

- The phenomena of phytoplankton blooms have been recorded, however. Summer 1994 seems to be the most momentous season in the Gulf of Gabes. These episodes accompanied by a mortality and stranding large quantities of fish (eels, cuttlefish, ...). The phenomenon had continued for a week and microscopic observation revealed the proliferation of a monospecific population of *Gymnodinium* sp. very similar to *Gymnodinium nagasakiense.* The highest concentrations are recorded in the order of 4 to 6 ×. 10^{7} cells. $l^{-1.}$ In the Offshore area of Kerkennah islands, an overgrowth of cyanobacteria of the genus *Trichodesmium* (called "Muffa") is common

- Generally in the Gulf of Gabes, the confined areas or tidal lagoons often show signs of eutrophication, such as the case of the Sea Bougrara where level of chlorophyll a is moderate to fairly high, plankton communities are typically Mediterranean with some alien species including dinoflagellates.

- In Tunisia, a national network for monitoring of production areas of bivalve mollusks has been established since 1995 to ensure continuous monitoring of toxic plankton.

Zooplankton

- The Zooplankton of Tunisian coast is quite diverse, represented by 269 species distributed over 23 groups dominated by tintinnids and copepods,
- In the Gulf of Gabes, the zooplankton is distributed over 11 groups dominated by copepods, which represent 69-83% of the total zooplankton. Both species *Oithona nana* and *Acartia clausi* are particularly abundant along the coast and up to 50 m depth.

3.1.2. Information on invertebrate bottom fauna, macro-algae and angiosperms

A large number of invertebrate bottom fauna, macro-algae and angiosperms groups have been studied:

Greece :

- *Polychaeta :*According to an annotated list of Polychaetes found in the Hellenic marine waters, 220 species are found in the Ionian Sea and 13 of them are exclusively reported from the Ionian Sea. Most of them characterize sandy, biogenic and generally coarse substrate reflecting high dynamic littoral environment or angiosperm coverage.
- Mollusca: A total of 1160 mollusc species have been recorded so far in Hellenic seas with an increasing trend in bivalvia species recorded in Hellenic waters is most apparent since 1980.
- Crustacea: In a recent assessment of the decapod fauna of Hellenic waters (Kitsos, *et al.,* 2006), a total of 250 species was recorded with the predominance of the true crabs (brachyurans) followed by caridean shrimps and anomurans(hermit crabs, squat lobsters).
- *Anthozoa:* Contrary to the Aegean Sea, the anthozoan diversity of this region, and especially its deeper parts, is yet to be explored (Vafidis *et al.*, 2006; Salomidi *et al.*, 2010).
- *Porifera:* Much of our knowledge on the Ionian sponge fauna comes from the Italian coasts, while the Hellenic (eastern) Ionian side remains poorly known, with only few and scattered relevant information (e.g. Tsoukatou *et al.*, 2003; Vacelet *et al.*, 2008;)
- *Macroalgae:* Case studies in the Hellenic part of the Ionian Sea estimated similar (163 taxa; Tsekos and Haritonidis 1977) or higher (265 taxa; Schnetter and Schnetter 1981) trend in seaweed diversity than in Aegean.
- *Seagrasses:* On soft substrates of the Ionian the angiosperms *Posidonia oceanica* and *Cymodocea nodosa* are widespread, whereas the angiosperms *Zostera noltii* and *Halophila stipulacea* are restricted to specific areas.

Libya

Studies regarding these aspects have to be conducted to further investigate the Libyan costs. The results coming from few studies have revealed the following:

- About 24 species of the cephalopods were recorded in the Libyan coast (Ben Abdalha et al., in press), belonging to 8 families and 3 orders. Although most of these species are commercial and have economic value in the Libyan market, no comprehensive study exists about these specie till now.

- The study that has been done from Al-Gomas to Musrata regarding sponges reported many species such as the economic species Spongia afficinalis and Hippospngia communis and other species like Arcorina cerebum, Axinella sp, Petrosia sp and Calyx nicaensis (Report 2009, MBRC).
- In the western part of the Libyan coast, 38 species of mollusca were found in the rocky zones, (27 Gastropoda, 10 Bivalva and 1 Polyplacophora). 37 species of Crustaceans were recorded (6 Isopoda, 23 Decapoda, 7 Amphipoda and 1 Balanomorpha).
- The macroalga diversity in Libya is not rich. Fifteen genera (29 species) of Chlorophyta, 19 genera (34 species) of Phaeophyta, 76 genera (112 species) of Rhodophyta and 2 genera of Cyanophyta (3 species) were recorded according to Nizamaldeen (1979). Introduced species have been also recorded such as *Halophila stipulacea* in Ain-Al-Ghazala marine area, introduced from the Red sea through the Suez canal and *Halimeda sp*.

Tunisia :

- Sponges: Sponges are represented in an uneven manner across the regions of Tunisia; the southern region is the richest at both generic and specific levels. 115 species of sponges are identified in the eastern and southern Tunisia. Among the Tunisia sponges, at least six species are considered as endangered or threatened species including *Aplysina sp. , Axinella cannabina, Axinella polypoid, Geodia cydonium, Tethya Ircinia and foetida sp.* Ten species are designated as protected by the SPA/BD of the Barcelona Convention, namely *Aplysina aerophobia, Axinella polypoid, Geodia cynodium, Hyppospongia communis, Ircinia foetida, Spongia agaricina, S. officinalis, S. zimocca, T. citrina and Tethya auranium. One specie, Calyx nicaeensis* deserves also to be protected according to Tunisian experts

- Echinodermata: In Eastern and Southern regions of Tunisia, studies revealed the presence of 52 species of echinoderms. Three species are mentioned in lists of the Barcelona Convention *(Asterina Panceri, Centrostephanus longispinus, Paracentrotus lividus).* One species *(Hacelia attenuata)* and the type Holothuria are on the specific Tunisian list of species to be protected. Only *Centrostephanus longispinus* is considered threatened in the Mediterranean (Annex 1 of the SPA/BD protocol)

- Annelids: Annelids specified in the eastern and southern regions amounted to 105 species. The sedentary polychaete annelids represent 64% of the total annelids against 35% of errant polychaetes and 1% of oligochaetes.

- Bryozoans: In Eastern and Southern regions, 83 bryozoans are identified. *Hornera lichenoides* is listed in Annex II of the SPA/BD protocol of the Barcelona Convention, while Electra posidoniae, Pentapora fascialis and Reteporella grimaldii appear into the specific Tunisian list of species to be protected.

- Mollusks: In Eastern and South regions, 328 species are recorded, distributed in 188 snails, 126 bivalves, 6 Polyplacophora, 4 scaphopods and 4 cephalopods. Seven species have heritage value and are subject to protection state, namely *Luria lurida, Tonna galea, Zonaria pyrum, Pinna nobilis, Pinna rudis, Haliotis tuberculata and Spondylus gaederopus.* Thirteen introduced species are reported in the Gabes Gulf, namely *Cellana radiata radiata,*

Crepidula fornicata, Cerithium scabridum, Erosaria Turdus, Bursatella leachii, Acteocina mucronata, Chromodoris quadricolor, Melibea viridis, Musculista senhousia, Crasostrea gigas, Pinctada radiata, Fulvia fragilis and Ruditapes philippinarum). Among these shellfish, octopus, cuttlefish, squid, clams and snails are commonly used as a fishing product in this region.

- Crustaceans: For crustaceans, various groups were studied for exploitation and management. A total of 167 species of crustaceans are identified in the Gulf of Gabes. Two species of amphipods and isopods, Ten inventoried in the Gulf, are exotic. Penaeus kerathurus is considered as a species to be protected by the Tunisian experts while Maja squinado is listed on Annex III of the SPA/BD protocol of the Barcelona Convention.

- The Ascidians: 77 ascidians are present in the Gulf of Gabes. Only four species are listed as Tunisia species that deserve protection: *Clavelina nana, Halocynthia papillosa, Microcosmus sabatieri* and *Microcosmus vulgaris.* Two exotic species are reported, namely *Cystodytes philippinensis and Microcosmus exasperatus*

3.1.3. Information on vertebrates other than fish

Greece

- In Hellas, the population of the monk seal (*Monachus monachus*) is estimated to represent ca 90% of its total Mediterranean abundance (Notarbartolo di Sciara *et al.*, 2009). Although the Aegean Sea is known to be one of the most important areas for the species' conservation worldwide (Cebrian et al 1995), an approximate 15-20% of the Hellenic population lives and breeds in the Ionian Sea (Cebrian 1998a). The best studied seal concentrations until now are those found along the coasts of Zakynthos, Kefallonia, Ithaca and Lefkada islands (Panou *et al.* 1993, Cebrian 1998b).
- The Ionian Sea, hosts an important part of the total Mediterranean populations of the sperm whale (*Physeter macrocephalus*), the bottlenose dolphin (*Tursiops truncatus*) and the common dolphin (*Delphinus delphis*). Regarding the latter, the Inner Ionian Archipelagos - a Natura 2000 Site of Community Importance- used to be one of the last places in the central Mediterranean Sea where abundant common dolphins would be found (Politi *et al.* 1999). However Bearzi *et al.* (2008) showed recently a dramatic decline of the species' local population (from 150 to 15 recorded individuals in the last 13 years), urging for direct management measures for the conservation of this endangered species. Another exceptional and rare characteristic of the cetacean fauna of the Ionian Sea, is the permanent presence of mixed groups of striped dolphins with short-beaked common dolphins and even -occasionally- Risso's dolphins in the semi-enclosed Korinthiakos Gulf (Frantzis & Herzing, 2002).
- Three species of marine turtles, namely the loggerhead turtle *Caretta caretta*, the green turtle *Chelonia mydas*, and the leatherback turtle *Dermochelys coriacea* are encountered in the Hellenic seas. *For the* loggerhead populations (*Caretta caretta)* in the Mediterranean Hellas is among the major nesting sites (Margaritoulis, 2007). According to same source, one among the highest nest density, is Laganas Bay on the Ionian island of Zakynthos. Other nesting areas are found in Peloponessos (Bay of Kyparissia, Bay of Lakonikos). For the foraging species available data from Hellas indicate that juvenile green

turtles (C. *mydas)* have been recently identified in Lakonikos Bay, southern Hellas (Margaritoulis, 2007).

Libya

- As regards the marine mammals in Libya, there is a vast gap of knowledge and very few studies or confirmed observations.
- Eight species of cetaceans are present in Libya, namely: Striped Dolphin (*Stenella coeruleoalba),* Sperm Whale (*Physeter macrocephalus),* Risso's Dolphin (*Grampus griseus),* Pilot Whale (*Globicephala melas),* Bottlenose Dolphin (*Tursiops truncates*), Cuvier's beaked whale (*Ziphius cavirostris*), Common Dolphin (*Delphinus delphus*) and Fin Whale (*Balenoptera Physalus)*. Except for bottlenose and striped dolphins, all of the other species are mainly offshore and seldom found near the coast.
- Regarding the Monk Seal, there are only few documented sightings for this species in Libya and mostly in the areas of Tubruk and Bombah gulf (60 km east of Derna) (Norris1972; Sergeant et al., 1978; UNEP 2003). In the Green Mountain, there are two areas that might still hold a potential habitat for the Monk Seal. The first one is between Derna and Rass Ateen and the second is between Haboon and Al-Uglah. The shear costal cliffs of these areas hold caves that can be used by this species for breading and resting. There is a running project at the moment between EGA, IFAW and UNEP-MAP-RAC/SPA to fit camera traps in selected caves in order to monitor the population (Hamza et al., 2003).
- Concerning the sea turtles, the Gulf of Sirt is considered as the most important area for sea turtle feeding, wintering and breeding on the national level. Thus, Environment General Authority (EGA) have started an initiative to protect three nesting beaches in west of Sirt (Libyan Seaturtle Program). Finally, In April 2006 (prior to nesting season) two loggerhead females and one male were released with satellite transmitters from Gulf of Sirt area. The two females remained around the Gulf area, whereas The male headed north to Italian waters (Pers. Comm., Hamza, 2007).
- Aquatic birds: A regular survey of birds in Libya has started on 2005 aiming at the census of the wintering birds along the coast of Libya. This project is conducted by local and international team and sponsored by EGA, UNEP-MAP-RAC/SPA and AEWA. The objectives of these surveys (2005 – 2010) were to investigate whether a critical threatened species Slender – billed Curlew exist in Libyan habitat and accounting water birds wintering in Libya.

Tunisia

- The sea turtles present in Tunisia are mainly present in the east and south of the country. They include *Caretta caretta* (common in Tunisia), *Chelonia mydas* (rare species) *and Dermochelys coriacea* (regularly observed).

- Mammals observed in the region are Minke whale *(Balaenoptera acutorostrata),* the fin whale *(Balaenoptera physalus),* the Risso's dolphin *(Grampus griseus),* the Humpback whale *(Megaptera novaeangliae),* the Striped dolphin *(Stenella coeruleoalba),* the bottlenose dolphin *(Tursiops truncatus);* these mammals are rather large pelagic, some may attend coastal waters for food. Apart from the common dolphin, the other species are rare to very rare.

- Aquatic birds: Tunisia is an important wintering site for Palearctic waterbirds and an important port of call for trans-Saharan-Palaearctic migration. However, studies on biodiversity of aquatic birds are limited.

3.1.4. Temporal occurrence, abundance and spatial distribution of exotic, non-indigenous and invasive species

Same as habitat destruction through pollution or anthropogenic effects, the introduction of species is considered as a nuisance and disruption to biodiversity.
The number of introduced species in the Mediterranean has increased spectacularly since the start of the last century. Their distribution varies from country to country. They have been mainly introduced through two pathways : (i) by maritime transport and fish farming and (ii) through the Suez Canal.

Greece:

- In the Hellenic Ionian Sea, 60 alien species have been recorded . they are in all belonging mostly to zoobenthos (24 Species) and phytobenthos (18 species).
- Studies directly investigating the impact of alien species on the diversity of native biota as well as socio-economic impact of invasive alien species are missing.
- Monitoring of alien species and their impact in hot spot areas for biological introductions such as ports and lagoons none exists.

Libya

- In the Libyan coast, 22 exotic fish species have been recorded
- Most of the studies have focused on the Lessepsian fish species, Status, Biology, Ecology (Shakman, 2008).
- In the Libyan coast, the most abundant herbivorous fish were the Indo-Pacific fish species S. rivulatus and S. luridus, which are more numerous than the native fish species S. cretense and S. salpa (Shakman and Kinzelbach, 2007b).
- Two ectoparasite species Anilocra physodes (Linnaeus, 1758) and Nerocila bivittata (Risso 1816) belonging to the subfamily Anilocrinae are the first records of cymothoids from the Libyan fauna.

Tunisia

- Introductions recorded in Tunisia come mainly through the Suez Canal and the Strait of Gibraltar (Indo-Pacific marine species and Eritrean origin or Atlantic)
- Besides the Suez Canal and the Strait of Gibraltar, other routes of introduction are identified:
    - Clinging or fouling (on the hulls of ships)
    - Ballast water
    - Leaks from aquaculture
    - The accidental introduction of species
    - The unknown vectors
- Introduced species in Tunisia are mainly observed in the Gulf of Gabès, which has suffered from the consequences of several disturbances and changes in

habitats. Introduced species have increasingly recorded in recent decades, probably due to of maritime traffic, accidental introductions or ballast water.

3.1.5. Fish including mollusks and shellfish species of commercial interest

In the Central Mediterranean, marine fisheries are characterized by a large number of species caught per main fishing gear (i.e. multi-species fisheries) as well as by a variety of species that are exploited concurrently by different fishing gears (i.e. multi-gear fisheries)

Fish farming is a relatively ancient practice in the Mediterranean basin. It has expanded enormously since the 1990s, particularly marine fish farming. This involves farming the gilthead sea bream Sparus aurata, the sea bass Dicentrarchus labrax, the mussel Mytilus galloprovincialis and the flat oyster Crassostrea gigas. Greece is the first offshore marine fish farming producer country in the sub-region but also in the whole Mediterranean with over 120,000 tons per year of sea bass and gilthead sea bream. As for the raising of bivalve molluscs, mussels and flat oysters hold respectively first and second place.

Greece:

Existing fishery assessments from research surveys indicate that most of the existing stocks are being overfished. This is causing growing concerns with regard to the sustainability of both commercial catches and the aquatic ecosystem from which they are extracted, as well as to safeguarding the livelihoods of fishermen. Fishing impact on the demersal resources of Hellenic waters could be considered strong for depths shallower than 500 m. Deep water fisheries in the Ionian recently under exploitation deserve proper ecosystem approach management.

- *Fish:* The Hellenic Seas are characterized by a thermophilic tropical and subtropical fish fauna originating from two different sources: i) relicts of the Tethys Sea and ii) immigrants of various origin arriving at different times from the Indian Ocean and the Red Sea (SoHelFi, 2007). According to the latest update of the IMAS-Fish database (IMAS-Fish, 2007), the total number of recorded fish species in Hellenic waters collected from experimental and onboard sampling by trawls, purseseines, nets and beachseines, since 1983 is 393 (S. Kavadas pers. commun.) of which 300 occur in the Ionian Sea (and 365 in the Aegean). Theminimum size allowed for fisheries and the closed fisheries period for selected species is regulated according to the Presidential Degree 227/03 and EU Regulation 1967/2006.
- Mollusca: A total of 1160 mollusc species have been recorded so far in Hellenic seas. Twenty one species of mollusca (other than cephalopoda) have a commercial interest particularly in fisheries and aquaculture since they are collected and/or cultivated for human consumption. Fisheries of these species is regulated by the Ministry of Agriculture (General Directorate of Fisheries) and supported by the relative legislation (Presidential Degree 86/98 as it has been recently reformed 227/03). Population assessment exist only for few species e.g., *Pinna nobilis, Lithophaga lithophaga, Donacilla cornea* in Hellenic seas, and these only at a local scale.

- *Crustacea :* In a recent assessment of the decapod fauna of Hellenic waters (Kitsos, *et al.*, 2006), a total of 250 species was recorded. In the upper slope of the Ionian Sea, thirty species of megafaunal decapods have been reported from trawl catches. Most abundant are the shrimps *Parapenaeus longirostris* and *P. heterocarpus*. The main Hellenic fishing grounds of the Norway lobster N. norvegicus are located in Ionian Sea. In the 500-700 m zone, the giant red shrimp *A.foliacea* and the pandalid shrimp *P. martia* predominate in the experimental catches of the Ionian Sea. The former species and the blue and red shrimp *Aristeus antennatus* are the dominant decapods found in the 700-900 m zone.

Libya :

- Fish: The highest fish species diversity in the coastal area is in the eastern region (45.65% corresponding to 42 fish species) while in the Gulf of Sirt and western regions the averages are are 23.91% and 30.43% respectively corresponding to 21 and 28 species,
- Chondrichthyan in the Libyan coast: Few surveys conducted by Ben Abdallha et al., (in press). have permitted to list 55 species and reported that the fishing activity of these species were concentrated on the middle of the Libyan coast from Musrata in the west up to Benghazi in the East. Most of these species were caught by special gill net named KELLABEI in local, using seasonal landing sites

Tunisia

- Fish: The fishery production in Tunisia has reached 100,578 tons in 2008 against 90,039 in 1998 with a rise of 11%, primarily due to pelagic species. The eastern and southern areas provide 87,693 tons of catches, representing 87% of national production. The active fleet in this area consists of 10,214 active units (90% of the national fleet) and the maritime population of the area has 43,583 fishermen representing 84% of the national population. The Gulf of Gabes represents the most exploited area for fishing followed by the Eastern Zone.

- The latest estimates of pelagic resources, conducted by the Institut National des Sciences et Technologies de la Mer (INSTM) in order to develope the small pelagic fishery, have clearly shown the existence of significant resources of which only a part of this potential is currently worth. Indeed, the exploitable biomass in this resource is greater than 80,000 tons while the domestic production does not exceed 45,000 tons. This situation of underexploitation is due to several factors, among them the exploitation of traditional fishing areas and the low efficiency of some fishing gears used.

3.2. Habitats

The Mediterranean continental shelf possesses rich and important habitats. In the context of the tools developed by the Regional Activity Centre for Specially Protected Areas (RAC/SPA), a reference list of 27 major types of benthic habitat was made, to help the Mediterranean states in drawing up inventories of natural sites of conservation interest (UNEP-MAP RAC/SPA, 2002). The SAP BIO Programme (UNEP-MAP RAC/SPA, 2003) had identified among its priority actions the making of a complete, integral inventory of its Mediterranean habitats, including mapping their spatial distribution and the cohort of species associated with each habitat.

The marine and coastal area of the central Mediterranean sub-region contain the most typical marine and coastal Mediterranean habitats. We will present hereinafter the most known ones present in the Central Mediterranean and the Ionian sea:

- **Magnoliophyte meadows:** These are among the most productive ecosystems in the marine environment. Their economic value is estimated at over 15.000 euros per hectare, i.e. 100 times greater than that of their terrestrial equivalents (UNEP/MAP-Plan Bleu, 2009). The available data on these habitats is very heterogeneous on a regional scale, and in certain countries even does not exist. In the following part, we will pay a particular attention to the meadows having been cited in the national reports

    - The *Posidonia oceanica* meadows are considered to be the Mediterranean's most important ecosystems. The most extensive meadows are those in the Gulf of Gabès (Tunisia). Posidonia meadows are the most common biological feature on the Aegean as well as on the Ionian coasts. It is present in Libya (Bamabah Bay, Farwa, Ain Elghazala and El-Bardyya, Al Elghazalaha Bay) but also in the malteese coastal and marine areas and the Italian waters. *Posidonia oceanica* is endemic in Mediterranean. Annex I of Directive 92/43/EEC describes meadows of *Posidonia oceanica* as a priority habitat type. Posidonia meadows do not appear in areas with low salinity and weak light penetration due to pollution. The ecological parameters that affect the distribution of the upper and lower limit of the meadows as well as their density are light and hydrodynamic conditions. According to the Barcelona Convention typology, in the habitat type "Posidonia meadows" (BC type III. 5. 1) two ecomorphosis are described: The ecomorphosis of striped meadows (III. 5. 1. 1.) and the ecompphosis of barrier-reef meadows (III. 5. 1. 2.). A facies of dead "mattes" without much epiflora and an association with *Caulerpa prolifera* has also to be added.
    - The *Cymodocea nodosa* meadows are second after *Posidonia*. These meadows wre recorded in the Aegean and Ionian Seas, where it is widely found on loose substratum (Zenetos *et al*., 2010a and b); in Libya (Al Elghazalaha Bay) (Shakhman, 2010) in Tunisia (Romdhane, 2010) and in Malta.
    - The *Halophila stipulacea* meadows. This Lessepsian specie, restricted to specific areas has been sighted in Greece (Zenetos *et al*., 2010a and b); and in Tunisia in the Gulf of Gabès (Romdhane, 2010). It was also spotted in central Italy in 2006.

- Coralligenous communities: These biogenic constructions constitute the second most important hotspot of specific biodiversity in the Mediterranean after the Posidonia meadows (Boudouresque, 2004). The coralligenous habitats and bioconcretions (pre-coralligenous populations, shelf coralligenous, associations with rhodoliths – maërl facies, association with rhodoliths – *pralines* facies, association with rhodoliths – *Lithothamnion minervae* facies, association with *Peyssonnelia rosa-marina* – free Peyssonneliaceae facies and big bryozoan facies of the coastal detrital bottoms) are being studied in the Ionian Sea. They have been also recorded in Tunisia (from El Haouaria to La Chebba) (Romdhane, 2010).
- Cystoseira forests: They can occupy large areas in the marine ecosystems, where they form highly productive communities with remarkable biodiversity. Species of the *Cystoseira* genus species are in a speciation process which has led to many varieties within a single species and these algae present significant morphological variability. Cystoseira forests have been reported in Ionian Sea of Italy, in the in the Aegean and Ionian Seas; in Ramla Bay in Gozo, Malta (*Sargassum vulgare and* in Tunisia
- Concretion with *Neogoniolithon brassica-florida*: The habitat known in the hypersaline lagoon of Bahiret-el-Bibane in the south of Tunisia (where it can be as long as 31 km) has no parallel in the entire Mediterranean

In the Central Mediterranean and the Ionian sea, outside these habitats, the available knowledge is extremely fragmentary and very variable (UNEP/MAP-Plan Bleu, 2009). In the context of the ECAP process, the national reports, without being exhaustive, allow information to be gained on some habitats as well as the above-mentioned ones.

In the coastal strip, there are few ecosystems of world interest for the conservation of biodiversity. These are basically coastal sand dunes and coastal wetlands, especially coastal lagoons. The lagoons present diversified, rich habitats that deserve more specific study.

Finally, in the high seas, thermal fronts correspond to areas of contact between two masses of water of different temperatures. These regions are often the site of vertical mixtures likely to bring to the surface mineral salts that encourage plankton development and help install a food chain. Upwellings are considered as being among the most productive ecosystems in the marine environment.

4. PRESSURES AND IMPACTS

The ecological disturbances are several and diverse. The erosion of coastal and marine biodiversity has specific origins probably amplified by the concomitant causes and effects. The most noticeable disturbance is the one caused by overfishing and illegal fishing, which strongly affects the fishing activity and the availability of seafood in the markets. The impacts of certain fishing gears are evident through the presence of litter on benthic organisms and fish in the wrong ports and their environments, showing the damage caused by certain types of fishing on marine biodiversity in general. Also strongly perceived are the temporal appearances as green tides reflecting the eutrophication of environments, red tides and blooms of toxic plankton. furthermore, the increasingly apparitions of jellyfish on coastal areas are often noticed in the coastal resorts.

It will also highlight the impact of pollution, development and change of vocation on coastal sites and coastal wetlands.

Among other changes affecting global biodiversity: the increased frequency of signs of alien species and invasive organisms more visible and latent expected effects of climate change on marine and coastal biodiversity.

On a more global, it is necessary to emphasize the impacts of anthropogenic disturbances or others, not only on organisms but on the breeding, spawning, nursery and feeding. These aspects remain little known and inadequately quantified and contribute undoubtedly to the biological impoverishment of the Mediterranean.

4.1. Biological disturbance

The biological disturbances described below focused on non-native species, the impacts of fishing activities and aquaculture and address the effects of climate changes on biodiversity as an emergent issue. Unevenly documented, data and information are at varying stages of elaboration and development but may nevertheless exhibit with interesting trends to understand.

4.1.1. Non indigenous and invasive species

The alien species and invasive species are recognized as a major cause of biodiversity loss, although the establishment of non native species is sometimes considered an enrichment factor of biodiversity.

It is important to remember that all exotic species are not always invasive, as some native species may be considered invasive when they proliferate excessively in favor of changes or disturbances having often directly or indirectly anthropogenic origins

Nevertheless, the impacts of invasive species and exotic species on native biodiversity are recognized even if no native species extinction has been reported to date neither proven indeed. These impacts result from various mechanisms such as food or space competition, changes in the intensity of predation and vegetable consumption. The impacts of genetic pollution and introduced pathogens remain poorly documented to date.

Inventories of alien species have been unevenly documented in national reports.

Aspects related to the impacts of invasive species and introduced species are little known and poorly documented in national reports and have mostly been collected from the literature.

Among the most pertinent broader impacts are included:

- The contraction of populations of native species, including those of heritage value
- Changing landscapes and coastal and marine habitats
- The introduction of pathogens
- Impacts on human health
- The impacts on fishery resources of commercial value

On land, the factors promoting species introductions and invasive proliferation of numerous and diverse and often man-made (accidental introduction of black rats on the islands, planting of *Carpobrotus* for ornamental plantations alien species for sand dune fixation ...)

At sea, the main agents of introduction are known, but the trend is to thermophilisation or southernalization with a gradual and regular spatial extension of the species observed from east to west and from north to south. Introductions are identified primarily through the Suez Canal and to a lesser extent through the Strait of Gibraltar (marine species of Indo-Pacific or Atlantic and Eritrean). In addition to the Suez Canal and the Strait of Gibraltar, important pathways have been identified:

- The fouling or Clinging (on the hulls of ships)
- Ballast water
- The aquaculture farms of nonnative species
- The accidental introduction of species
- The unknown vectors

Finally, among the proliferation of invasive species native, we would stress that if the exact causes of these phenomena are sometimes known as for example the green tides *Ulva* and *Enteromorpha* are generated by eutrophication of coastal waters and lagoons , others are only partially known (jellyfish blooms, red tides ...).

These phenomena are causing large disruptions of ecosystems (dystrophies, anoxia) and their effects on biodiversity and human health are recognized.

The main effects and impacts of invasive exotic and native species are outlined below:

- **In coastal areas and wetlands**

In the terrestrial environment, introductions and their impacts are many and varied; they fall under the human impact on coastal areas through the development of sea side areas but also because of forestry, soil and shorelines conservation. It is mainly forest and ornamental plant species introduced or naturalized as the Aleppo pine and eucalyptus which grow naturally on the spaces occupied by the maquis or garrigue. these plantations cause the limitation of the environment and the decline of indigenous species. The characteristics of the litter of some of these species decreases very noticeably the development of annual and woody plant cover .

These most salient and most iconic impacts of the coastal environments in the central Mediterranean are the presence of *Carpobrotus edulis*, used for its decorative qualities in urban and peri-urban coastal and whose rapid expansion is to cover completely originally laid open spaces covered by native species.

The black rat *Rattus rattus*, is another pest species by definition. Its negative effects are seen on the flora but also and especially on fauna in particular on invertebrates, herpetofauna and many species of birds, some of heritage value.

The black rat and *Carpobrotus* support each other: the black rat spreads the seeds of *Carpobrotus* which provides shelter and water supply for the black rat.

In terms of wetlands, there is no relevant data on invasive species or exotic species introductions at the salt pans. In lagoons, the phenomena described as biological invasions, exotic species introductions and temporal appearances are often similar to what happens in the coastal environment. What particularly distinguishes the lagoons is the presence of intentionally introduced species for aquaculture (*Crassostrea gigas, Ruditapes philippinarum*), which spread out through the facilities and come into competition with local species.

Furthermore, we highlight the vulnerability of certain areas of operation paralic endorheic or semi-endorheic to eutrophication which causes green tides with a net spread of native species such as *Ulva* and *Enteromorpha*, sometimes causing dystrophy and asphyxiation of the ecosystem. The degradation of this biomass at the end of cycle is the source of emanation of sulfur dioxide to the adverse effects on biodiversity and human health.

- **Coastal waters**

National reports have helped to highlight the magnitude of the establishment of exotic coastal waters. These statistics remain more or less incomplete and need to be to updated and completed.

In the Greek Ionian Sea, there are 3 species of phytoplankton, 3 zooplankton species, 17 benthic plant, 24 species of invertebrates and 13 fish species. On the eastern and southern coasts of Tunisia, 21 plant species are listed, 51 invertebrates and 24 fish species. 22 exotic fish are cited in the Libyan national report. In the Maltese national report of SAPBIO, reference is made of 10 species of plants, 6 invertebrates and 1 fish. In Italian waters, 34 species of algae, 70 invertebrates and 19 fish were identified in the national report of SAP BIO.

These statistics do not definitely reflect the reality; the level of knowledge is very uneven from one country to another and from one group of species to another.

The impacts of most of these species remain poorly studied and misunderstood.

Regarding the phytobenthos the presence of *Caulerpa taxifolia* is reported but its distribution and extension remains anecdotal. If considered as potentially invasive, it does not cause known effects due its sporadic character. The potential invasive *Caulerpa racemosa* is more important. The new signs are numerous in both Greece and Tunisia and the effects of this species are noticeable. The rapid growth of stolons resulting in almost total coverage of the substrate, mainly muddy sands at the

expense of seagrass, algae but encrusting organisms. Its proliferation leads to difficulties in the fishing activity because large quantities contribute to clogging of the nets.

Cases of inter-specific competition are also well shown among the invertebrates such as the compatition of *Percnon gibbesi* with native species (Malta and Italy) and also in fish populations. In Libya, rivalry between the two lesseptien species *Siganus luridus* and *Siganus rivulatus* and native species *Sarpa salpa* and *Sarpa cretans* is a prominent example.

Other phenomena due to the proliferation of invasive have direct effects on human health and economic activities. We mention in particular the increase in outbreaks of jellyfish blooms, including *Pelagia noctiluca* causing inconvenience to many holidaymakers. The proliferation of jellyfish significantly affects marine biodiversity, including commercial interest; these animals feeding on larvae and fish fry.

Also in terms of impacts on human health, some cases of tetrodotoxin poisoning have been reported recently in Libya.

Economically, the case of the establishment *of Metapenaeus monoceros* in the Gulf of Gabès reveals sometimes the paradoxical economic impacts that invasive species could cause on economically and socially levels. This species has partially replaced the native prawn *Penaeus kerathurus*. In this region, catches of shrimp have not declined but are composed 50% of non-native species. The economic loss is due to the fact that the commercial price of the new species is seven times lower than that of native shrimp, in the benefit of the less affluent consumers.

- **Open seas**

The data on the impacts of invasive alien organisms are even more scarce. in the deep and high seas

These changes are mainly due to the slow but perceptible thermophilization of the Mediterranean in general but also in the central Mediterranean.

Phenomena of competition are duly recognized such as the retreat to the deep waters of native species *Merluccius merluccius* and *Mullus barbatus* under pressure from exotic *Upeneus moluccensis* and *Saurida undosquamis* in the Hellenic Ionian waters.

The by-catches of thermophilic fish *Coryphaena hyppurus* and barracudas have increased in the region. These super-predators fall certainly compete with native fish, but the effects are not measured.

4.1.2. Fisheries on target and non-target species

It is clear that intensive fishing has a significant impact at all levels of biological organization of Marine Life (EEA 2006). The impacts of some inappropriate practices on marine biodiversity are outlined in the reports prepared under the SAP BIO programme, but also in the present process leading to an observed decline of fish stocks and degradation of ecosystems .

Advances in navigation and localization of resources contribute to the escalation of this situation.

The pressure of fishing activity can be classified as follows:
- Commercial fishing,
- Recreational fishing,
- Aquaculture.

In spite of stringent laws and efforts in order to ensure fleet reduction, these activities generate direct and indirect effects on resources and ecosystems.

4.1.2.1. Direct effects of over-fishing on the target species

The main species threatened by overfishing and illegal fishing are: *Anguilla anguilla*, *Epinephelus marginatus*, *Sciaena umbra, Thunnus thynnus, Xiph gladius, Mullus barbatus, Mullus surmuletus, Merluccius merluccius, Sarda sarda,* some species of cartilaginous fishes, crustaceans as *Homarus gammarus*, *Palinurus Elephas* and *Scyllarides latus*, bivalves such as *Lithophaga lithophaga*, sponges (*Hypospongia communis, Spongia spp*.) and red coral (*Corallium rubrum*).

The fisheries of the region are characterized by a high level of exploitation, often resulting in overfishing. The target species are dominated by juveniles.

The trophic level of exploited species is clearly decreasing. Due to the modernization of fleets for longer campaigns and navigation in rough seas, a tendency to increase the exploitation of species living in open ocean and deep water is noticed.

The use of non-selective fishing methods often illegal contribute to the destruction of marine organisms in general and particularly juvenile fish, decreasing significantly the maintaining or recovery of the stocks. For instance, the use of dynamite or kyss (gear used in waters of southern Tunisia) is a significant example.

The spear fishing is one of the causes of overfishing of protected species such as grouper.

Finally, it is noted that a recent fish activity dedicated to the maintaining and growth of tuna *Thunnus thynnus*, contributes noticeably to the collapse of this species and an increased pressure on drilling fish.

4.1.2.2. Indirect effects of fishing

Several techniques of fishing and aquaculture techniques contribute directly or indirectly to the disruption of ecosystems, habitats and species.

Among the most harmful fishing gears is include the "tonailles” (nets for tuna), long lines and drift nets, fine mesh nets and all trawling arts. Other fishing techniques, such as totally illegal use of poison or dynamite, significantly affects the entire natural environment.

The most egregious damage is caused on benthic habitats and associated communities.

The indirect effects of fishing on biodiversity include the impact on non-commercial species (discards), habitat structure and ecosystem functioning. Some indirect impacts of fishing are listed below:

- The decline of populations (either commercial or not), due to by-catch fish, discarding, ghost fishing, etc. .. ;;
- decrease of populations of non-commercial endangered and protected species such as cartilaginous fish, sea turtles, sea birds…
- The disturbance or destruction of habitats such as *Posidonia oceanica* meadows, coral and maêrl beds; this impact is mainly due to trawlers, often illegally used in shallow waters and certain practices such as illegal collection of date shells *Lithophaga lithophaga*;
- alteration of functioning and structure in other marine habitats such as sandy and muddy bottoms by trawling in particular because of sediment resuspension which causes extensive damage to non-target species.
- Cascading effects on trophic structure of the marine ecosystem by the harvesting of top predators, either pelagic or demersal. Overfishing reduces the populations of more valuable large fish that are at higher trophic levels, such as piscivorous, significantly reducing the average level of catches.
- The establishment of exotic species such as *C. racemosa* following the deterioration of seagrass beds. Some species overfished also yield up to non-native species.

Jellyfish blooms are reported by certain authors as consequences of overfishing.

Moreover, aquaculture can contribute, along with other numerous human pressures, to causing high nutrient concentrations in the water and in the sediment of lagoons.

4.1.2.3. Open seas

The main direct effects of fishing on marine resources are over-fishing of large pelagic inducing a highly significant decrease in stocks for the following species: *Xiphias gladius, Thunnus thynnus* and *Thunnus alalunga.*

Fishing gear such as drift nets and long lines may cause serious mortality to marine turtles and marine mammals.

The following heading further treats this issue, together with the deep seas topics

4.2. Emerging issues

4.2.1. Climate changes effects

The shores and marine areas of the countries of central Mediterranean contain a rich and extremely diversified biodiversity. This heritage is already subjected to great pressure. But the inventories are generally sketchy, incomplete and/or obsolete for few countries, and thus do not enable us to envisage a systematic, exhaustive monitoring of the effects of CC on MCBD.

Many analogies have been noticed when setting out the eloquent stakes, stressing their pertinence at national, sub-regional, Mediterranean and world level. They concern more particularly:

- the effects CC on the physical environment are already being detected, especially related with increase in surface sea temperature, hydrological and hydrodynamic changes, sea level rise and the expected repercussions on the integrity of the coastline, wetlands generally and more particularly lagoons, salty lakes (sebkhas), and estuaries, supra- and midiolittoral zones and the ecological and economic values thereof, – with particular emphasis on the threats to islands, and changes in the nutrient supply and dynamics of coastal and high-sea waters and increased frequency of extreme events –winds and storms.
- At medium term, more complex phenomena are expected, such as changes in the life cycle of marine species, distributional range shifts of species and habitats, local extirpation of vulnerable species and, ultimately, decrease in the resilience (i.e. resistance and reversibility to disturbance) as well as profound changes in the functioning of marine ecosystems, which at present are difficult to forecast with the adequate level of accuracy
- the rising risk of forest fires
- the impacts on coastal and marine natural resources
- the amplifying of the effects of CC by human activities
- the thermophylous non-native species, especially Lessepsian, Special emphasis has been putted on the occurrence and spread of thermal species (both by colonisation of new species originating from the Atlantic through the Gibraltar strait and principally the Indo-Pacific through the Suez Canal,. Other phenomena such as mucilage events, harmful algal blooms and mass occurrence of scyphomedusae are likely to be facilitated by CC in synergy with other anthropogenic impacts (e.g. overfishing, nutrient load and other sources of pollution, etc.). Another ongoing phenomenon, increasingly frequent in coastal waters of the countries, is the occurrence of mass mortality of structural species (e.g. gorgonians, octocoral colonies, sponges, etc.)

4.2.2. Open seas and Deep seas ecosystems modifications

The Mediterranean deep sea comprises a high diversity of habitats, because of its geological history (Bianchi & Morri 2000). In particular, geomorphologic structures, such as submarine canyons, seamounts, mud volcanoes and deep trenches can harbor important biological communities.

In general, deep sea Mediterranean biological communities are adapted to an oligotrophic environment; local areas of higher productivity and biodiversity hotspots are present.

The Mediterranean deep sea is physically split into two basins separated by the shallow Straits of Sicily (about. 400 m dept). Important differences between the eastern and the western basins, both in species composition and abundance have been observed (Sardà *et al.* 2004).

The Mediterranean deep sea is considered by some authors to be among the most heavily impacted deep-sea environments in the world, and at the same time among the least known areas in terms of biodiversity (UNEP-MAP-RAC/SPA, 2010): the risk is that a significant loss of biodiversity occurs before scientists have had time to document its existence (Briand 2003, Cartes *et a*l. 2004).

The main pressures affecting deep seas can be graded as below:

- trawl bottom fishery
- other fishing practices
- waste disposal (solid refuse)
- other marine pollutants
- oil exploration and exploitation
- deep pipeline laying
- climate change

In a worldwide context the deep seas are considered (among other definitions) to be the marine environment that extends downwards from the continental shelf break, i.e. waters deeper than 200 m to its maximum depth. Deep-sea fisheries currently only operate at depths of less than 1000 m in the Mediterranean, but that might exploit many SH, i.e. seamount fisheries could be exhausted in a period of time as short as three to four years (Johnston & Santillo 2004). The potential fishing interest of the currently unexploited bottoms below 1000 m depth (towed gears banned by GFCM, 2005) is very limited. This is so because the overall abundance of crustacean species is considerably lower, and fish communities are largely dominated by fish either of non-commercial interest (like the smooth head *Alepocephalus rostratus*) or of a small size (such as the Mediterranean grenadier *Coryphenoides guentheri*). If these species ever become of economic interest and trawlers could reach deeper areas, then the ecosystem could be rapidly deteriorated by fishing.

Pelagic fishing in the Mediterranean open seas, targeting large pelagic species (with few exceptions targeting small pelagic, eg. anchovy and sardine, in the Adriatic Sea), is the only industrial fishing; it takes place mainly at international waters and even non-Mediterranean countries can be involved (Cacaud 2005).

Most information on the activity of the fishing fleets in the Mediterranean comes from the working group STECF and the GFCM Demersal Working Group, of the Subcommittee on Stock Assessment, and ICCAT for large pelagics, which relates the activity of the fleets from member countries. Therefore, there is a lack of reported information of fishing activity of EU non-member countries (e.g. North Africa) in STECF, although GFCM task 1, and the cooperation projects (Medfisis, COPEMED II, ADRIAMED and EASTMED) work on this direction.

The most important negative consequence of fishing activities is the degradation of marine ecosystems by the removal of target or non-target species and by physical disturbance inflicted by some fishing gears. Essential Fish Habitats (EFH) are those habitats necessary for feeding, refuge or reproduction of the species; and Sensitive Habitats (SH) consist on those areas with endemic species, high biodiversity or high productivity and vulnerable to fishing practices. The degradation of ecosystems by fishing indirectly affects the commercial species if the habitat is not longer adequate for these species. In this context, there is a necessity of regulating fishing activities to reduce the ecosystem degradation by the establishment of an Ecosystem Approach to Fisheries (EAF), which considers not only the protection of target species, but the ecosystem as a whole. Within the EAF framework the Precautionary Approach considers the most restrictive measures for fisheries management (including the establishment of areas closed to fishing, or Marine Protected Areas) against a general lack of knowledge on the functioning of many ecosystems that sustain fisheries resources.

Most Mediterranean waters constitute open seas. The Mediterranean open seas encompass a high diversity of habitats, both pelagic and demersal (deep seas). These habitats are poorly known in relation to coastal and continental shelves ecosystems, which are more easily surveyed, while at the same time there is a good knowledge of their commercial species stocks status, by means of fisheries surveys and commercial captures. The protection of fauna at those areas is important for fisheries and ecosystem conservation because organisms can determine the healthiness of an ecosystem. Sessile benthic fauna play an important role as habitat structuring organisms providing refuge for many marine species (e.g. cold coral reefs, deep sea sponges, crinoidea beds).

Deep bottoms consist on wide extensions of soft sediments interrupted by geological features like submarine canyons, brine pools, seamounts, hydrothermal vents, cold seeps and mud volcanoes, that create a special habitat that harbour high diversity and endemism; many of these habitats have been only recently discovered and must be protected after the Precautionary Approach.

Demersal fisheries operating in Mediterranean high seas can be summarized as: bottom trawling, bottom long line, and gillnet. Deep-sea fisheries currently operate on continental shelves and some slopes, down to depths of less than 800m. Bottom trawling is a highly damaging practice that was banned in 2005 to Mediterranean bottoms deeper than 1000m, aiming to protect the vulnerable deep sea fauna.

Amongst benthic habitats at Mediterranean open seas, the components most vulnerable to fishing are coralligenous facies, the crinoidea *Leptometra phalangium,* and the cnidaria *Funiculina quadrangularis* and *Isidella elongata*, facies of sessile organisms that have been so far detected in continental shelves and the shelf break in the Western basin, although the location and extent of these habitats in the whole region is still poorly known.

At the deep seas there are several areas with considerable abundance of the highly vulnerable cold coral reefs, mostly detected in continental slopes, seamounts and on the walls of submarine canyons (e.g. off Cape Santa Maria di Leuca, in the Central basin, or at numerous submarine canyons and seamounts scattered along the Alboran Sea, in the West basin). Several abyssal plains, that harbour poorly known and vulnerable deep sea fauna, are located throughout the Mediterranean, with the deepest grounds found in the Central basin (e.g. Calypso depth in the Ionian Sea, SW of Greece). Other geological features might be vulnerable to fishing as they are hotspots of diversity and are habitat of vulnerable fauna like cold corals. The massive Eratosthenes seamount in the East basin (south of Cyprus) and numerous scattered seamounts in the Alboran Sea and south Tyrrhenian; cold seeps, brine pools and hydrothermal vents have been mostly located in the East Mediterranean basin (south of Crete and Turkey, and near Egypt). The Western Mediterranean basin harbours numerous submarine canyons that are EFH for red shrimp, like numerous canyons in the Gulf of Lions that sustains important fisheries of red shrimp, Norway lobster, hake, monkfish, among other important commercial species; hake nursery areas are mainly located on wide extensions of continental shelves or banks, highlighting the south of Sicily, central Adriatic in the Jabuka Pit, and Thracian sea, whereas hake spawning grounds seem to be located on the shelf break and slope canyons, being the Gulf of Lions the clearest example.

The large pelagic species that inhabit the open seas, mainly bluefin tuna, swordfish, and albacore, but also pelagic sharks (short fin mako, blue shark and porbeagle) are of high conservation interest and have long been overexploited by pelagic fishing gears. The main fishing gears for large pelagics are purse seines and pelagic longlines. Pelagic long lining fleets operate in Mediterranean waters, ranging from local coastal state fleets to large industrial foreign fleets; these are highly mobile, and cover almost the whole Mediterranean basin. Drift nets have been banned in the Mediterranean in 2005, although this activity is still practiced. The Mediterranean high sea is also the habitat of endangered cetaceans and turtles that are a common by-catch of pelagic fisheries and deserve special protection. Important EFH for large pelagic species are mostly determined by oceanographic features like upwelling areas or gyres, creating productive areas important for feeding and breeding; these areas that act as EFH must be identify to define protection measures for pelagic species. The main spawning areas for bluefin tuna have been located south of the Balearic Islands, Alboran Sea and Strait of Sicily, whereas swordfish spawns in almost all the Mediterranean area and albacore overlap with the bluefin tuna spawning grounds.

4.2.3. Critical areas vulnerable to effects of open seas fishing on marine and coastal biodiversity

Those critical areas considered as EFH and SH that receives fishing impacts in the Mediterranean open seas, could represent an essential tool for managing fisheries in Mediterranean open seas within an EAF and Precautionary Approach; however, these areas might imply effective restriction of fishing activities, needing an adequate surveillance system and a long-term monitoring.

The following sites are considered critical areas in the subregion, regarding fishing impacts in Mediterranean open seas, including demersal and pelagic ecosystems:

Demersal priority areas:

- South of Sicily, Adventure and Malta banks. Demersal ecosystem important as hake nursery areas where bottom fishing activities, specially trawling, should be restricted.
- Cold coral reefs (Lophelia pertusa) off Cape Santa Maria di Leuca. SH highly vulnerable to any physical disturbance inflicted by bottom trawling. Already adopted as FRA (Fishery Restricted Area) by GFCM.

Pelagic priority areas:

- Strait of Sicily. It is an important migratory route for tuna-like species.

Both areas

- Mediterranean Bottoms beyond 1000m. Habitat of poorly known and vulnerable fauna that encompasses the four Mediterranean sub-regions. Fishing using towed gears in this area has been prohibited by GFCM.

5. EVALUATION OF GAPS

Overall, the coastal and marine biodiversity as well as the pressures and impacts exerted on of the Mediterranean Sea remains relatively little known despite the increasingly considerable efforts made by the international scientific community to grasp it.

5.1. Concerning status of coastal and marine ecosystems

Knowledge of marine and coastal biodiversity is not homogeneous throughout the Central Mediterranean and the Ionian Sea and has many gaps. In the bulk, data is patchy and does not allow us to pronounce on the many marine species, habitats and communities on a sub-regional scale, in particular the MAP Protocol species and habitats that are of conservation interest in the Mediterranean. The availability of reliable information varies from country to country and the available information on marine and coastal biodiversity cannot be considered to be satisfactory, for it is neither complete nor systematic and gaps are obvious at both population/individual level (genetic diversity) and at that of species and habitats/communities.

Broadly speaking, the main gaps identified at sub-regional level can be summarized as follows:

- Lack of clear national strategy to systematically inventory marine and coastal biodiversity in many countries. Marine and coastal biodiversity -linked aspects do not have priority in political decisions, as is the case for social aspects
- The national inventories of marine and coastal species and habitats are not homogeneous. For most countries they are incomplete; the effort made is more focused on the north-western Mediterranean
- Many Mediterranean sectors and/or ecosystems remain little studied, even per country. Prospecting is usually done in areas that are easily accessed. The inventories drawn up in some countries (bibliography, site prospecting, updating etc.) are usually made in sectors concerned by programmes or action plans. Knowledge of the presence, distribution, abundance and conservation status of Mediterranean coastal and marine species is uneven for taxa and regions
- Deep sea and high seas reference habitats have commonly been little explored
- Lack of national taxonomic skills for many groups of marine flora and fauna. This inevitably results in dubious identification of species. Experts in taxonomy of most groups are strongly concentrated in a few countries, mostly lying in the northern part of the Mediterranean
- Little sharing of recent knowledge within scientific circles in the various countries of the northern and southern Mediterranean
- Absence of programmes for monitoring non-native species in many countries, particularly the countries of the southern Mediterranean
- Patchy mapping of marine and coastal species and biocenoses, particularly those of conservation interest for the Mediterranean
- Research done on marine and coastal biodiversity is compartmentalized, restricted to very narrow aspects, and lacks interdisciplinarity

- Absence of coordinated and cross-border scientific research, probably related to financial and administrative constraints.

5.2. Gaps regarding impacts on coastal and marine ecosystems

Gaps about "impacts and effects on marine and coastal biodiversity" can be observed at several levels: scientific knowledge; legal tools availability; enforcement of existing laws; public awareness; concrete actions and operative plan implementations.
Specifically, the main gaps, issue by issue, can be summarized as follows:

- Invasive species : (i) a lack of a mechanism for collecting, compiling and circulating information on invasive non-indigenous species still exists, (ii) a lack of knowledge still exists, in particular about impact on structures and functioning of the ecosystems, (iii) the real extent of the phenomenon of exotic species' transfer is not known, (iv) lists of exotic species are available only for few taxa and often regard a limited geographic extent, (v) studies directly investigating the impact of exotic immigrants on the diversity of autochtonous biota as well as socio-economic impact from alien species causing, (vi) co-ordinated, cooperative regional research is needed to investigate the phenomenon, particularly in pollution susceptible areas such as ports and lagoons and (vii) a lack of long term monitoring programs on invasive species must be emphasized too…
- Impact of fishery on target and non-target species : (i) An important lack regarding the limitation of the ecosystem approach application in fishery management, (ii) discards composition and quantification needs particular attention, (iii) Gaps in the fisheries research include assessing the level of damage that can be sustained and/or is acceptable by the ecosystem through fishing practices (ex fishing gears); also secondary effects such as the impact of the partial removal of a predator or a part of a life cycle of one species are unclear.(iv) Recreational fishery gaps as regards both control of composition, abundance and size of catch and scientific data about landings, (v) gaps about the knowledge of possible interactions between eutrophication and fish cultivation practices in coastal lagoons and other marine sites, (vi) lack of enforcement of control and surveillance of fishery regulations and (vii) lack in monitoring, control and surveillance is particularly evident for high seas…
- Microbial pathogens: The main gaps to bridge in order to enhance knowledge of microbial pathogens have to be distinguished among classical and new ones as follows:
  (i) *"Classical" pathogens :* (i) low level of monitoring plans is generally found, (ii) a lack of basic knowledge of classical pathogens in sediments and beaches, (iii) an important gap is constituted by the lack of law enforcement to prevent or reduce the pathogens concentration in the sea water, (iv) a lack of knowledge on the consequences and impacts of pathogens on ecosystems and habitats…
  (ii) *"New" pathogens:* (i) lack of basic knowledge on new pathogens, (ii) the lack of legislation enforcement in controlling the vectors of introduction into the Mediterranean of non indigenous species and invasive marine species (i.e. mariculture) constitutes a significant issue, (iii) a lack of public awareness on health and safety issues for hazard species, gaps on knowledge regard consequences and impacts on ecosystems and habitats, (iv) a lack of effective scientific monitoring for Harmful Algal Blooms (HABs), especially for Southern Mediterranean waters…
- Climate change: the magnitude of Mediterranean marine biodiversity in response to climate change remain largely unknown due to (i) the lack of

consistent long-term monitoring of Mediterranean marine biota and ecosystem processes; and (ii) the scarce information available on climate change impacts on marine organism physiology, population demography, reproduction, species distribution and ecosystem function, (iii) lack of monitoring, targeted research, institutional scientific capacities, technical expertise, national polices and priorities, critical area identification and studies and funding opportunities at national level, (iv) lack of studies on the socio-economical consequences of the impact of climate change on marine and coastal biodiversity, (v) lack of knowledge on the consequence of climate change on biodiversity due to the changes in the chemistry and biogeochemical cycling of carbon and carbonate (ocean acidification)…

- Deep sea: (i) The main gaps about deep sea deals with the very limited knowledge of this environment, particularly poor are data and scientific researches below 1000 m depth, (ii) especially for several areas of Eastern Mediterranean and in Southern waters, nothing is known about deep-sea biology, (iii) gaps exist also about the effects of anthropogenic pressures on deep sea species and habitats, where few data are available for fishery and no data are available about the effects and consequences on deep biodiversity of waste accumulation, (iv) an important gap, not specific for the Mediterranean sea, but in any case relevant also to the Mediterranean region, regards the lack of emergency technology and plans to deal with petrol spillage in deep water.

6. PRIORITY NEEDS

6.1. Needs

Greece

- Better consideration to taxonomy issues in the framework of the two HCMR initiatives (State of the Hellenic Marine Environment and State of Hellenic Fisherie)
- Better consideration to climate changes effects. Hence the need for regular assessments presenting the national picture to all interesting bodies is paramount.
- Integration of fishery-based approach in the future collection of bio-economic data. In addition to statistical analysis, it provides advanced modelling and predictions made with the help of GIS.
- There is a need to expand existing data collection and analysis programs to assure an adequate knowledge base that can efficiently support sound scientific advice to decision makers, and they even provide suggestions that may contribute to the improved management of fishery resources, highlighting the importance of developing such management mechanisms that will promote the sustainable exploitation of marine resources to optimally accommodate the increasing demands from diverse stakeholders.
- EL-NET Database has been constructed as a biodiversity transitional waters information system for the development of distributed information in Hellas. The system is a functional application consisting of a comprehensive database and an online interface with an interactive map, and search capabilities for biological and environmental data on Hellenic transitional waters. Results from a case study carried out on the macrobenthic inventories of the lagoonal systems included in the system demonstrate the potential use of this simple type of information by environmental managers and scientists. The system, still in its initial phase, will be improved by integrating new datasets and developing tools for data retrieval and analyses. The database should be linked to other biodiversity databases to participate in a distributed information network and disseminate the information through other global biodiversity portals.
- Expand knowledge about the systematic of zooplankton and phytoplankton communities and improve knowledge on the ecology of phytoplankton species and the place of phytoplankton in the food chain of the pelagic ecosystem and on the blooms, particularly of red tide phenomena.
- Defining the composition and ecology of mesozooplankton including groups other than copepods and Cladocera and the role of mesozooplankton as a link between the lower trophic levels (phytoplankton, microbes) and higher trophic levels (fish). These aspects should be studied in both inshore and offshore.
- The implementation of the Water Framework Directive, through a program of large-scale sampling, will help fill gaps in knowledge in some areas and water bodies with unknown ecological status and biodiversity.
- Gaps exist in understanding of climate change and its impact on biodiversity. What remain to be implicitly addressed are the implications of changes in the water mass characteristics and the influence of the modified water masses to the biology of the Hellenic Seas' as assessed through experimental and

modelling studies. Long-term data on climate change and on communities changes in the Hellenic seas and an appropriate framework are required.

Libya

There are no comprehensive studies especially in the diversity, ecology and biology for marine fauna and flora examples of needed studies:

- Ecological and biological study of Mollusca in certain area like Sirt gulf in the Libyan coast,
- Species and distribution of crustaceans
- Implementation of Chondrichthyan fishes project along the Libyan coast presented by RAC-SPA, 2005
- study of the sea turtle nesting sites (monitoring for the whole summer season (EGA),
- Study on the sea grass Posidonia oceanica ecosystem,
- A project for defining and studying the ecosystem of Libya
- Studies of wetlands at various areas
- Fish stock assessment along the coastal water
- Studies on cold water and hot water springs and their economic value
- Impact of fisheries on sea turtle
- National survey of wetlands
- Studies of marine pollution and its impact on marine life and environment
- Studies of fish diseases
- Studies marine phyto-and zooplankton
- Studies the marine benthos along the Libyan coast
- Studies of growth and productions of fish
- Studies sea grass, algae and sponge
- Training of some individuals to carry out and solve certain environmental problem.

Such plans need cooperation between the institutions in Libya and international institution.

Projects: Three projects have been recently accepted by the National Authority for Scientific Research (NASR) – Libya, these projects are as follows:

- Biology and Ecology of flowing ecosystem in eastern part of Libya,
- impact of the Lessepsian marine species on the Libyan coast,
- The third dealing with fish diseases along the Libyan coast.

Genetic studies for different marine species are important to make barcode for different species and study the gene populations.

Tunisia

Needs concern globally:

- Improved knowledge on biodiversity
- A conservation action and management of marine protected areas
- A reduction of human pressures and human impacts on the environment

More specifically, the needs can be expressed in terms of:

- strengthening of conservation and protection structures, particularly by establishing a program to protect species and habitats in danger, through the development and creation of marine protected areas

- strengthening the role of institutions involved in conservation based on the improvement of capacity building of staff specialized in the conservation
- establishment of reference collections of endangered or vulnerable species
- inventory of endangered species and / or vulnerable species
- creation of a Museum of Natural History
- establishment of management structures for marine protected areas

Highlighting links between ecosystems, ecological functions and ecosystem services, by developing the concept of information monitoring, which allow collecting, analyzeing, synthesizing and disseminating useful informations.

6.2. Urgent actions

Greece

The main objectives of the National Strategy for the sustainable development have set towards the protection and conservation of the marine environment, the prevention of its degradation and, wherever possible its restoration, where it has been unfavorably affected. To achieve this target the following actions are proposed:

- Adoption of measures for the control of pollution from land based sources such as best agricultural practice in river basin catchments for the control of pollution of marine coastal areas from the unsustainable use of fertilizers and pesticides and the adoption of best available techniques in industry. Correlation with the respective measures that are being undertaken in the framework of the implementation of the Community Water Framework Directive (2000/60/EC) and implementation of the respective actions that have been adopted in the framework of the Barcelona Convention (Land Based Sources protocol and respective action programmes).
- Integrated management and identification of suitable uses in the coastal zone, adoption of the respective Community and Regional (UNEP/MAP) provisions. Strengthening of mechanisms for the effective control of illegal construction and development of illegal activities in the coastal zone areas.
- Development of a strategy for the marine waters for each marine area with independent characteristics with the intention to achieve a good environmental status by 2020, adopting an ecosystem approach to the management of human activities that exert an effect on the marine environment.
- Promotion of basic research to fill the knowledge gaps concerning the status of the marine environment of Hellas as well as the adoption of applied research for the development of suitable tools for monitoring, detection (eutrophication, oil spills etc,), upholding the relevant legislation and control concerning the development of cleaner and more environmentally friendly technologies and production procedures (for fisheries, aquaculture etc.)
- Identification and carrying out the studies required for the introduction of new marine areas into the Natura 2000 Network (SCI and SPA).
- Systematic inventorying and mapping (scale 1:10.000) of the Posidonia meadows at a national scale, with suitable storage of the inventory data to support management and monitoring.
- Implementation of effective programmes for the management, wardening and monitoring of the most important Hellenic lagoons.

- Implementation of programmes for systematic monitoring and collection of data to evaluate the status of threatened marine species populations, identification and application of measures and actions for their sustainable management and the preparation of the respective national legislation wherever this is required.
- Systematic monitoring of the phenomenon of the introduction of alien species into the marine environment and in the framework of the implementation of the Water Framework Directive, international cooperation to study the effects and interactions of the introduced alien species with the natural environment and native species covering the entire Mediterranean (species fished, possible effect on human health) and wherever possible development of a strategy to confront the phenomenon. Adoption of measures for prevention of the transfer of alien species through maritime activity.
- Evaluation of the magnitude and effect of the interactions between fisheries and marine species populations (monk seal, sea turtles, cetaceans, etc.), identification and application of action plans for the normalization of conflicts.
- Application of measures for the sustainable use of fisheries resources in the sense of the Community Regulation for the Mediterranean (EC) 1967/2006.
- Effective reduction of fishing capacity in the direction of stock recovery, applying a targeted enforcement of measures for the permanent termination of fishing activity on vessels that exert the greatest pressure on fisheries stocks.
- • Evaluation of the fisheries stocks and carrying capacity of lagoons, drawing up plans for fisheries management of lagoons, giving priority to Natura 2000 areas. Control of small scale interferences in lagoons linked to aquaculture such as the construction of embankments, and the opening up of dikes and channels.
- The intensification of controls and inspections in support of the sustainable use of fisheries resources, the effective protection aquatic resources of fishery interest and the application of the principles of responsible fishing and aquaculture, including the compliance with conditions for environmental use.
- Promotion of fisheries research to support the formulation of fisheries policy, for more effective management of common fisheries resources and best use of resources for the protection of stocks, through the realization of reliable scientific evaluations and analyses.

- Specific Conservation needs

<u>*Turtles*</u>

Management plans have been elaborated for the major nesting areas of *C, caretta* (Crete and Peloponnesus) but there is not a National Action Plan for the conservation of marine turtles in Hellas. Management plans for the “major” nesting beaches of Crete and Peloponnesus exist, whereas nesting beaches of Zakynthos are protected since they are included within the limits of the National Marine Park of Zakynthos. However, the enforcement of existing legislation and the implementation of management plans by the local authorities are not at a satisfactory level, allowing the persistence of threats to the nesting populations (SAP BIO, 2002). In the SAP-BIO it has been proposed that ‘*The National Action Plan will provide guidelines and measures for the conservation of marine turtles and for addressing emergency local incidents. It could also be used by the central and regional government and by local authorities during the preparation of development plans in areas hosting marine turtle habitats’*. Margaritoulis et al (2007) have also suggested framework actions to be

implemented as a simple fundamental approach towards the assessment, and the reduction of turtle by-catch and associated mortalities in fishing gears used in Hellas.

Seals

Notarbartolo di Sciara G., (2009) provided a Critical analysis on the conservation status of the monk seals that stated that '*based on the very large number of international agreements and conventions that Hellas has adhered to, which explicitly require endeavouring to protect and strive to recover Mediterranean monk seals and their habitat, undoubtedly Hellas is formally fully committed to monk seal protection on the international scene. Such condition, however, clashes resoundingly with the disappointing lack of factual commitment by the Hellenic State, in terms of direct, practical and effective initiatives, that comes in direct contrast with the achievements of the work of NGOs working for the conservation of the species*. The authors then suggested in agreement with previous long term research for the species in the country (Cebrian, 1998a) that ' *The only aspect that seems important addressing is the possibility of conceding exclusive fishing rights to local fisheries within specially zoned MPAs, established to protect monk seals and other endangered species or habitats. Such possibility is apparently excluded by the current Hellenic constitutional law'.*

Furthermore they set up four objectives to be reached by 2015:

1. Monk seal conservation is established as a national priority.
2. Knowledge of monk seal ecology and biology important for the conservation of the species is secured.
3. Areas containing monk seal critical breeding habitat in Hellas are identified, legally protected and organised into a functional network of protected areas in which monk seal numbers are stable or increasing.
4. Monk seal conservation measures are legally adopted and effectively implemented throughout national waters, so that threats are diminished and monk seal populations and habitat nation-wide are not lost.

Cetaceans

According to Fratzis (2007) '*although still not complete, the existing image of the Hellenic cetacean fauna, in terms of species presence and distribution, is now close to the real situation. Nevertheless, quantitative data regarding the absolute abundance and the population status of any species do not exist and are urgently needed. Without such data, it is very difficult to place conservation priorities. Thus decisions regarding the proper conservation policy for cetaceans have to be based on assumptions. Further, the effectiveness of any conservation measure cannot be monitored and assessed*'.

The author then suggested that future effort has to focus on: i) the estimations of abundance for each cetacean species, ii) the assessment of population status and trends for cetacean species that constitute conservation priorities at the local or regional level, iii) the identification of critical areas for these species, and iv) the establishment of a properly organised, national stranding network, in collaboration with the secretariat of ACCOBAMS. This network should be based on strictly scientific methods and rules, according to the international standards (Fratzis, 2007).

Fisheries & Biodiversity

The waters east of Lefkada and around Kalamos are an important spawning area for epipelagic schooling fish (Somarakis *et al*. 2000, 2006a,b) and a nursery area for hake (Politou *et al*. 2006), making this Natura 2000 Site of Community Importance a candidate for special protection based on EC Regulations for the sustainable exploitation of fishery resources in the Mediterranean.
In addition to common dolphins, the area is home to a resident community of bottlenose dolphins *Tursiops truncatus*. Endangered species such as monk seals *Monachus monachus* and loggerhead sea turtles *Caretta caretta* are also regularly sighted. All these species are included in Annex II to the Habitats Directive. Fishery management measures are needed to reduce current over-exploitation, protect the local biodiversity, ensure continued ecosystem services, achieve sustainability, and allow for the recovery of endangered marine megafauna.

Deep water resources
A number of recommendations have been suggested based on the results from projects dealing with the resources in the Ionian Sea. These included the increase of the cod-end mesh size and the closure of trawling during the reproductive period and recruitment of the red shrimps.

More studies should be carried out to protect areas of particular interest (e.g. corals, nursery and spawning grounds). Since a Hellenic deep-water trawl fishery could be developed in the future, more detailed studies should be promoted to investigate the pristine Hellenic deep-water stocks (ANON., 2001a).

Red coral- Corallium rubrum
In Hellas, exploitation of the red coral (*Corallium rubrum*) is regulated by the Hellenic Ministry of Rural Development and Food. However, the absolute lack of scientific data on red coral distribution, abundance and population dynamics in the Hellenic seas, renders any such management scheme rather uncritical. The need for an international research programme aiming at investigating the spatial distribution and population structure of red coral in the Hellenic Seas is, thus, urgently recommended in order to address proper and effective management measures.

- Specific Actions

Fisheries within the Lefkada and around Kalamos Natura 2000 Site
With reference to Council Regulation (EC) No 1967/20063 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea and considering that fisheries management measures within "Natura 2000 sites" are possible under the Common Fisheries Policy the following urgent actions have been proposed to be taken within this Natura 2000 Site (Notarbartolo *et al.*, 2009) :

1. Strict enforcement of national legislation and of Council Regulation 1967/2006, and appropriate penalties for illegal fishing.
2. Immediate temporal restrictions on purse seining and trawling, to ensure that these fisheries are fully sustainable and do not harm the ecosystem and its biodiversity, as well as endangered dolphin populations (either directly or indirectly). In addition to existing regulations, purse seining should only be allowed from May to October, trawling from November to March.
3. Prompt implementation of the ban of beach seining by May 31st, 2010, as demanded by Council Regulation 1967/2006. Beach seining is known to devastate ecosystems and has been banned in most EU Countries.

4. Adoption of larger mesh size for all bottom-set nets than what is being used by coastal fishermen (current practice is 20-22 mm knot-to-knot minimum), in order to increase selectivity.
5. Current fishing capacity in the Natura 2000 area should not increase.
6. Restrictions on recreational fishing, which should be carefully regulated to minimize impact on the ecosystem, according to the available scientific evidence.

Coralligenous concretions and maërl beds

UNEP, has proposed that "*Coralligenous/maërl assemblages should be granted legal protection at the same level as Posidonia oceanica meadows. A first step would be the inclusion of coralligenous concretions and maërl beds as a priority natural habitat type in the EU Habitats Directive (92/43/EEC), which would enable EEC countries to undertake surveillance of the conservation status of coralligenous/maërl assemblages and also to set an ecological network of areas of conservation (LICs/ZECs) hosting coralligenous/maërl assemblages, which would ensure their conservation or restoration at a favourable conservation status.*" (UNEP, 2007)

Alien species

The monitoring of alien species should be one of the priorities of any strategy to protect biodiversity and should be promoted outside the scientific community. Sports clubs, SCUBA divers, naturalists, fishermen, aquaculture farmers must be encouraged to either look for specific species, report unusual findings of species or to carry out specific recording duties where possible. Apart form the designated 'hot spots', the NATURA 2000 sites and other marine protected areas (MPA) should be the focus of such monitoring scheme. Data on NIS from these sites could be reported and could be adapted for bioinvasion assessments. WFD monitoring should also be used to provide additional data where possible.

The monitoring of alien species should be one of the priorities of any strategy to protect biodiversity and should be promoted outside the scientific community. The ongoing assessments should report: the inventory of newly arrived NIS and areas of their origin; vectors associated with new introductions; changes in power of pathways and their vectors; account of newly colonised localities as a result of primary introduction and secondary spread;impacts of newly established IAS;and changes in bioinvasion impacts of previously established IAS.

Climate change

Gaps exist our understanding of CC and its impact on biodiversity. Long-term data on climate change and on communities changes in the Hellenic seas through an integrated framework are required.

Endangered species

The current Red list of threatened animals in Hellas (Legakis & Maragou, 2009) includes 27 species (see table 10). It is obvious that the majority of the Hellenic fauna has either not been evaluated for the Red List or there have been no sufficient data for safe evaluation (for example there are only 3 invertebrates in the current list). The evaluation should be extended to increase the coverage of most species in the marine environment

Libya

- Status condition of heavily polluted area and future studies to improve the conditions, such as in Alburdiy bay near the Libyan east border.
- Tubruk harbour needs the urgent action. It has oil port and sewage pollution and the population is increasing in this area.
- Brackish water area near Benghazi city needs urgent action. It is polluted by sewage; this area is considered as sanctuary city for migratory birds.
- Coast of Al-brgia and Ras Lanouf need urgent action to assist their impact on the marine environment.
- The coast of Musrata needs urgent action to assist its impact on the marine environment.
- Accurate Mapping of the Libyan coast to describe the exact coast.
- Survey the available Seagrass (distribution and abundance).
- Ghost crap needs an action plan especially in the east part of Libya.

Tunisia

Protection of habitats:

- For the marine area, measures to be undertaken will involve firstly the reduction and mastery of the form of "classic" pressures represented by the fishery, namely the strict enforcement of regulations regarding prohibited gear, fishing areas and specific campaigns and the size of catches of species. The results of research on overfished stocks should be taken into account.
- Control of pollution in all its forms, industrial (especially in the Gulf of Gabès, Sfax, Gabès and Skhira), wastewater and solid waste.
- The monitoring of developments and the occupation of habitats by invasive species, in particular the vegetation (Halophylla) and benthic.
- Ecological keeping up to maintain the water quality balanced with respect to, the physical chemistry of water, nutrients and phytoplankton primary production, to reduce the phenomenon of eutrophication often accompanied by proliferations of toxic algae .
- It is also essential to consider the effects of the sea level rise and consequently the adaptation to climate change during the implementation of these actions.
- For areas of high biodiversity including *Posidonia* meadows on the one hand and various anthropogenic pressures and impacts on the other hand, actions should be focusing on:
    - The conservation of species and habitats, in particular those of Posidonia and Magnoliophyta, taking into account the evolution of lower and upper limits of seagrasses. Particular attention should focus on the waterbirds (Thyna, Kneis, Bin el Oudiene etc..)
    - Monitoring and management of the evolution at the foreshore and coastal wetlands (marshes and salty lakes, islands and islets, estuaries)

Protection of species:

- In terms of species, the starting point is the database or inventory of marine and coastal biodiversity of Tunisia, who despite the updating efforts still needs to be developed. The inventory should emphasizes especially the list of species already under threat, and the list of introduced species given that this area (particularly the Gulf of Gabès) represents the centre of the intrusion.

- Alien species that have reached commercial biomass shall deserve even more interest and follow-up as threatened species.
- For both habitats and species, mapping and spatial representation of the observations and monitoring have to be developed.

Actions to preserve fisheries in the open seas including the deep seas

General management failure for Mediterranean marine resources implies the necessity of urgently adopting an EAF. The Mediterranean open seas, including deep seas, are still poorly known, which implies that the precautionary approach has to be applied.

Marine Protected Areas (MPA) help fisheries management by providing local release from fishing and maintaining undisturbed areas favouring the prevalence of vulnerable ecosystems. But in order to evaluate the efficiency of MPAs for fishery purposes, it is essential to have a good knowledge on the ecosystem components and functioning, and to promote a continuous monitoring.

In order to select the most adequate areas as candidate sites for MPAs, we need to identify sites addressing ecological importance, including the uniqueness or rarity, of special importance for life history stages of species, importance for threatened, endangered or declining species and/or habitats, the vulnerability, fragility, sensitivity or slow recovery of the ecosystem, its biological productivity and biological diversity. Furthermore the establishment of a MPA must carefully consider its location (after the criteria mentioned above), but also its size and connectivity. In the Mediterranean, most MPAs have been located around coastal rocky bottoms or islands, despising the importance of open seas ecosystems.

There is only one protected area embracing the Mediterranean high seas, so there is an urgent need of planning and implementing protection zones under the SPAMI criteria, and that should be correctly surveyed and scientifically monitored. Within this framework, a consistent and well monitored network of SPAMIs located in open seas, including deep seas (comprising both pelagic and demersal ecosystems) should be proposed by the concerned Party/Parties, according to the five possible SPAMI status regarding the area of location (area under one national jurisdiction, mixed national jurisdictions area, mixed national jurisdiction and beyond national jurisdiction area, mixed national jurisdictions and beyond national jurisdiction area, area fully beyond any national jurisdiction).

7. FUNDING PROBLEMS AND OPPORTUNITIES

7.1. Regular national sources that are potentially available

As quoted by all the national sources of information, sources of national funding are specific to each country. In some Mediterranean countries of the central area, such as Libya and Tunisia, national funding is extremely limited and do not allow ambitious research programmes to be undertaken. However, in others countries, it is guaranteed, even if it is irregular and insufficient, by the state via the various national ministries, centres or agencies, as in Greece and Italy. In Greece, for instance, none of the Greek funded projects has so far focused on marine and coastal biodiversity issues but rather on the environment generally.

Potential private sources of funding as identified by all the countries are not generalized. Being usually local in nature (although they can cover critical / sensitive areas), they can provide only limited information on marine biodiversity. Moreover, they are unrealistic for some countries but possible in others through private national funds. This essentially concerns the fishery-linked private sector and environmental impact studies, which constitute a source of funding for research laboratoriesin Greece.

7.2. International funds, projects, programmes

These constitute the major contribution to funding research on marine and coastal biodiversity. The main sources of funding identified by the different countries come mainly from the EU via its framework programmes on the environment and biodiversity, the World Bank, the African Development Bank, the UN Environment Programme (UNEP), the UN Development Programme (UNDP), and the Regional Activity Centre for Specially Protected Areas (RAC/SPA). Also, many international NGOs (BirdLife International, WWF, IUCN etc.) were identified by certain countries as important funding sources for marine and coastal biodiversity aspects-linked research

It is also important to mention that with some exceptions directly related to marine and coastal biodiversity, most projects include biodiversity issues only as supplementary issues. Furthermore, EU funded projects being competitive in nature, diverse in topic, with a wider area in scope and with a rather limited time span cannot be considered as a regular source of funding. On the other hand, as the EU becomes more concerned about ECAP, more funds are expected to become available on related research topics in the Mediterranean.

8. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations constitute a synthesis emerging from the national contributions as regards the marine and coastal biodiversity in the Central and the Ionian Mediterranean sea areas and the pressures and impacts exerted on them. They have been completed with relavant data as regards Taking into account the analysis made in the previous pages of this document and the Italy and Malta.

8.1. Conclusions

Although knowledge concerning marine and coastal biodiversity is more or less satisfactory in the Central and Ionian Mediterranean, there are considerable gaps regarding the distribution, range, populations and conservation status for the majority of species and habitats. Inventories are rare, and scientific research, in this field, is very limited and uncoordinated, probably due to financial and administrative constraints. Therefore, research and systematic monitoring of marine and coastal biodiversity must be supported. The adoption of the National Biodiversity Strategies and Action Plans, elaborated within the SAP BIO Programlme, the integration of biodiversity concerns into sectoral policies combined with the effective operation of the Natura 2000 European ecological Network, especially for the Mediterranean Europrean countries, will be decisive for its preservation.

The current trend, related to global change, reveals a considerable change in the marine and coastal biodiversity in the Central and Ionian Mediterranean. This is shown both in the marked erosion of biodiversity so that many species that appear in many international treaties aiming at protection are currently threatened, and in the fact that marine habitats are undergoing alarming pressure, which is expressed in the alteration and destruction of these habitats.

During the last 20 years, the state of the Central and Ionian Mediterranean fisheries, similarly to the whole Mediterranean resources have shown negative trends, despite the reduction of the fishing capacity in accordance to national efforts and EU regulations for the management of the fishing fleets of the member states, aiming at the reduction of the fishing pressure on stocks. Moreover, the Mediterranean fisheries' sector's viability appears to be pessimistic, influenced by a variety of factors related to the capacity to produce sufficient amounts of fisheries' products and the conditions of the market. The above underline the complexity and the sensitivity of the problem and denote that management of Mediterranean fisheries should be based on both the sustainable exploitation of resources and the viable development of the sector.

The estimates of the Mediterranean marine resources are limited and are based on information gathered within research projects which are funded by national or community sources and therefore, the information we have is scarce and geographically limited. This makes the management of the fisheries' resources rather difficult, complicated and of high cost.

Fisheries, in particular inappropriate fishery practices, strongly impact marine biodiversity. Over-exploitation is responsible for the decline of many fish stocks.

Particularly harmful to biodiversity is the direct impact of fishing on the seabed (mainly by trawl) and the fact that fishing practices lead to discards.

Gaps exist regarding our understanding of CC and its impact on biodiversity. What remain to be implicitly addressed are the implications of changes in the water mass characteristics and the influence of the modified water masses to the biology of the Mediterranean sea as assessed through experimental and modelling studies. Long-term data on climate change and on communities changes in Central and whole Mediterranean seas and an appropriate framework are required.

As regards non-indigenous and invasive species, several authors consider invasive species one of the biggest causes of losing of biodiversity. However, up today, even if rapid decline in abundance, till local extirpations of native species are been documented, no extinction of native species is known. The presence of non-indigenous and invasive species represents a growing problem mainly due to the unexpected impacts that these species can have on ecosystems and consequently on the economy and human health. Recognizing the need for collaboration in research and management of aquatic alien species at both national, sub-regional and international level and in particular for data exchange is a major issue. The case of the Hellenic network for Aquatic alien species in Greece is the best example.

Measures for the minimization of the adverse effects of human activity on the marine environment, such as the implementation of restrictions on solid and liquid waste disposal, are required to be implemented along with effective measures for the protection and conservation of endangered marine species and important marine sites.

Finally, an attention should be also paid to the deep sea, hosting some important ecosystems, habitats and assemblages (cold seeps, brine pools, seamounts, cold-water coral reefs). Deep sea species and habitats are, in general, particularly sensitive. Several pressures threaten this environment, in particular fishing practices (especially trawl bottom), pollutants, oil exploration and exploitation and climate change.

8.2. Recommendations

Taking into account the analysis made in the previous pages of this document and the main relevant national reports and consulted documents for Italy and Malta, the following recommendations can be made.

- Knowledge on marine and coastal biodiversity should be improved and extended for the field of studies on an ecosystem scale through multidisciplinary projects. Investigation of the diversity of little studied and/or unexplored groups in each country and in unexplored geographic areas and habitat types e. should also be addressed.
- Extension of the scope of studies beyond the level of species matrices, incorporating more data on size, life cycle, trophic relations, productivity, ecophysiology and genetics.

- Promotion of basic research to fill the knowledge gaps concerning the status of the marine environment of the Central and Ionian Mediterranean sea as well as the adoption of applied research for the development of suitable tools for monitoring, detection (eutrophication, oil spills etc.), upholding the relevant legislation and control concerning the development of cleaner and more environmentally friendly technologies and production procedures (for fisheries, aquaculture etc.).
- Promotion of training and capacity building, especially in: monitoring, planning, co-operation, project formulation and training of specialists
- Application of measures for the sustainable use of fisheries and aquaculture assessing the level of damage that can be sustained and/or is acceptable by the ecosystem through these practices, including also secondary effects such as the impact of the partial removal of a predator or a part of a life cycle of one species, information on fate and survival of discards and the impact on epifaunal benthic communities.
- Promote researches, in particular on by-catch, discard, ghost-fishing and technology, in particular necessary gear modifications to limit discards, by-catch, impacts on endangered species and on biodiversity in general (e.g. modifications of gears, increase of mesh size of trawl net, repellent devices).
- Improve controls and promote awareness campaigns in order to eradicate illegal fishing practices (i.e. trawl within 50 m depth, driftnets, dynamite fishing, poison fishing, date extraction).
- Co-ordinated, cooperative multidisciplinary research is to understand and investigate the impact of CC on the marine ecosystem. Long-term data on climate change and on communities changes in the national, sub-regional and Mediterranrean areas through an integrated framework are required.
- A regional awareness raising program in order to influence decision makers to put climate change impacts on marine and coastal biodiversity as high priority in national agendas should be planned and implemented.
- Co-ordinated, cooperative regional research is to investigate the phenomenon of introduced species, particularly in hot spot areas such as ports and lagoons. Particularly studies on the pelagic ecosystem presumably affected by ballast waters are urgently needed.
- Particular importance should be paid for studying, understanding and protecting deep ecosystems. Action plans and scientific research for the sustainable management of deep water fisheries with emphasis on the protection highly vulnerable deep-water communities, either by immediate removal of (erect, slow growing) organisms and/or by habitat and trophic level modifications. Studies on the deep water coral mounds in the areas must be intensified.
- Networking: joining forces, setting the essential questions, developing the National Strategies in compliance with the International Treaties and Conventions, linking with the relevant EU Networks

- Establishment of national working groups addressing various biodiversity issues meeting regularly and reporting once a year.

- Since marine protected areas are becoming an important tool for preserving biodiversity and for managing fisheries, there is an urgent need for studies to determine baseline information such as size, number and location in order to improve the efficiency of these areas.

Finally, it is very important to mention that the ecosystem approach must be implemented in order to improve the knowledge of the marine and coastal ecosystems and to better understand and evaluate the effects of pressures and impacts on biodiversity. In particular, indirect ecosystem consequences and cascade effects can be interoperated only through an ecosystem approach. Ecosystem approach to fishery management is accepted as the necessary framework to secure sustainable use of marine ecosystems

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United Nations Environment Programme

Mediterranean Action Plan

Regional Activity Centre for Specially Protected Areas

”Further development of the Ecosystem Approach within the Barcelona Convention”

Step 3 of the Road map for the implementation of the Ecosystem Approach

RAC/SPA Component

Sub-regional report on the “Identification of important ecosystem properties and assessment of ecological status and pressures to the Mediterranean marine and coastal biodiversity in the East Mediterranean”

June, 2010.

Note: The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNEP or RAC/SPA concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Responsible of the study:
Ferdinando Boero,
RAC-SPA International consultant

With the participation of:

Daniel Cebrian. SAP BIO Programme officer (overall co-ordination and review)
Atef Limam. RAC-SPA Project officer (overall co-ordination and review)
Sami ben Haj. RAC-SPA International consultant (overall co-ordination and review)
Youssef Halim (Egypt)
Argyro Zenetos, Panayotis Panayotidis, Nomiki Simboura, Maria Salomidi and Nikos Streftaris (Greece)
Bella Galil (Israel)
Manal Nader (Lebanon)
Amir Ibrahim (Syria)
Bayram Ozturk (Turkey)
Silvia de Juan Mohan (Open Seas)
Jordi Lleonart Aliberas (Open Seas)

Mediterranean Action Plan
Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du Leader Yasser Arafat
BP 337 –1080 Tunis Cedex –TUNISIA
E-mail : car-asp@rac-spa.org

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Introduction:

The part of the Mediterranean Sea considered in this report regards the marine domain under the jurisdiction of the following states: Egypt, Israel, Lebanon, Syria, Turkey, Greece. The responsible persons of the reports on the above states made a great effort in providing detailed accounts, founded on the available expertise and know how in their countries. This expertise is not equally distributed throughout the area, though, and the situations depicted by the various consultants reflect these different levels of knowledge. This was already highlighted in a previous study made for RAC/SPA, about the state of knowledge of Marine Biodiversity throughout the Mediterranean Basin (Boero 2003). It is very evident, at the very first sight, that every country has developed own concepts and strategies and that a concerted action is lacking on how to tackle problems that are of vital importance for the region, since the environment knows no political boundaries.

Fig. 1. The Eastern Mediterranean Basin, and its bordering states.

The present synthesis is based on the reports prepared by the regional consultants, but stems also from work carried out by the responsible of the study while accomplishing the above mentioned contract for RAC-SPA, several projects of the European Union, and many workshops and meetings carried out under the umbrella of the Mediterranean Commission (CIESM).
The literature cited in this report is kept to a minimum, since the national reports already contain a wealth of references and the reader is addressed there for a complete bibliographic list.
The punctual analysis of local situations is not repeated here and, again, the interested reader is addressed to the specific reports.

Ecological history of the Levantine Basin

During its long history, the Mediterranean Sea (as the Tethys Sea) was once connecting the Atlantic and the Indo-Pacific Oceans, then it went through the Messinian Crisis (CIESM, 2008a) and was finally re-colonized by Atlantic biota, through the Strait of Gibraltar. After the Messinian crisis (5 MY BP), the basin has been interested by cold and warm periods. Overall, the perception of biodiversity by the scientific community is that the species numbers are higher in the Western than in the Eastern part of the basin, so that, as the distance from the source (i.e. the Atlantic biota, through Gibraltar) increases, the conditions are less and less favourable for the establishment of the whole set of species that recolonized the basin after the Messinian crisis. The eastern basin, and especially the southern shore, are much warmer than the western basin, and have almost tropical conditions for most of the year. The explanation of the reduction in biodiversity going from the West to the East, thus, was based on the fact that the conditions of the Levantine Basin are not conducive for the thriving of the Atlantic contingent, being so biased by a founder effect. Furthermore, the floods of the Nile deeply affected the biology of this part of

the Mediterranean sea but, after the construction of the Aswan Dam, in the Seventies, the bearing of the Nile on the Mediterranean was severely reduced.

The Suez Canal and alien species.

The opening of the Suez Canal, in 1869, reconnected the Mediterranean Sea with the Indo-Pacific Ocean, through the Red Sea, but the Bitter Lakes constituted an almost insurmountable barrier to the passage of species through the newly available water way. The salinity of the Bitter Lakes gradually decreased and, in the last decades, the passage of species through the canal has become impressive. The passage was and still is almost one-way, from the Red Sea to the Mediterranean Sea. The entrance of Red Sea species through the Suez canal has been called Lessepsian Migration. This term, however, is not right. Migration, in fact, implies a back and forth movement of organisms that pass from one part of the world to another, and back. The Red Sea species that enter the Mediterranean, however, do not perform migrations, and they are properly labelled as immigrants, hence: Lessepsian Immigration.
The arrival of species from the Red Sea has been considered in different fashions by the scientific community and even by different countries. Some authors consider the arrival of "aliens" as a terrible event, whereas some other authors salute the new contingent as an enrichment of Mediterranean biodiversity.
The Egyptian report, for instance, reports much about the beneficial effects of the arrival of Non Indigenous Species (NIS), with the proposal of compiling a list of the 100 most beneficial aliens, to oppose to the available list of the 100 worst aliens (Streftaris and Zenetos, 2006). NIS, furthermore, arrived and still arrive to the Mediterranean also by other means, and not only through the Suez Canal (CIESM, 2002). Most authors (e.g. Galil 2000) consider the spread and settlement of alien species as a menace to the integrity of biodiversity and, in many reports, alien species are seen as one of the worst threats to the environment, if not The worst. Especially in recent times, some authors (e.g. Por, 2009) argue that this part of the Mediterranean has been impoverished by the Messinian crisis and that its tropical vocation could not be fulfilled due to the constraint of having been colonized, from Gibraltar, by a contingent that was not preadapted to the local conditions of this part of the Mediterranean. The opening of the Suez Canal, in this way, allowed the fulfilment of the unexpressed tropical features of an environment that had been colonized by an "alien" biota after the Messinian crisis! The present situation should bring the Eastern Mediterranean biota back to the state they were when the Mediterranean was the Tethys Sea, connected with the Indo-Pacific! With this vision, the resident species in the Mediterranean, are the "invaders" whereas the Red Sea species entering from Suez are the descendants of the original biota of the Tethys sea.

Fig. 2. A ship passing through the Suez Canal

Of course, this position is not tenable, since one cannot expect today that the conditions of the past are to be restored. History is a one-way process and it is tenuous to hope that it can be brought to former states. It is true, however, that the Mediterranean is shifting from a temperate to a tropical condition at a very fast pace, and that the prevalence of NIS of tropical affinity is a clear adaptation of the Mediterranean biota to the new situation.

The issue of NIS is not of easy resolution, and calls for a deep analysis on a case by case basis. One aspect is the possibility for species to reach a place, and this occasion is offered by the Suez Canal, another aspect is to have the possibility of forming thriving populations in the newly reached place. This depends on tolerance to chemico-physical conditions (interactions with abiotic environmental features) and on the competitive efficiency with the local biota (interactions with biotic environmental features).

All national reports describe a dramatically changed situation in the composition of the local biota, when known, in respect to some decade ago. The changes are invariably linked to the prevalence of alien species that are more or less rapidly replacing native ones. The spread goes in both directions, starting from the Suez Canal and proceeding both northwards (Israel, Lebanon, Syria, Turkey, Greece) and westwards (in this case Egypt, but the phenomenon is going on also in Tunisia and Algeria, whereas little is known about Libyia). Some of these species are a nuisance and even a danger for humans (see the problem of jellyfish below), but others are a resource for local populations that are very happy to harvest them, and some are even cultured after their establishment. A parallel phenomenon, denounced at least by some reports, is the regression of the native species.

In a way, biodiversity might be unaltered in respect to the past, at least in terms of species numbers, but the quality of the species is much different. A key question is: did the alien species became successful due to the preceding failed success of the resident ones that, with their absence, made ecological space available for new colonizers? Or did the new colonizers cause the regression of the resident species by competing with them?
If the first option is met, the Mediterranean biota would be much impoverished if the NIS hadn't occupied the vacant ecological space of the species in distress, and the aliens are not the cause of the regression of the residents. If the second option is met, the aliens are the cause of the regression of the residents. Chances are good that both explanations might be valid and the evaluation of the impact of NIS on the local biodiversity and on ecosystem functioning must be covered at the level of individual species.

The resolution of this issue is important also for management reasons. Some people, in fact, call for the eradication of aliens, as soon as their presence is detected, considering them as negative *a priori*. Investments in this direction might be more negative than positive and, anyway, it is very difficult to eradicate a species if it becomes invasive. We are very powerful with vulnerable species (e.g. cetaceans) but we end up being harmless with species with more subtle ways of performing their activities (e.g. jellyfish).

All reports admit that some NIS are beneficial and some are dangerous to the status quo. The issue about how to manage this phenomenon requires deep knowledge at a case by case level.

The construction of the Suez Canal is a product of human activities and, thus, the arrival of NIS through that waterway is considered as the result of human impact. It is true, however, that the Canal connects two seas that have much in common, in terms of abiotic features, and this explains why Red Sea species are thriving in the Eastern Mediterranean Sea. The low diversity of the recipient basin, in respect to that of the donor basin, and the preadaptation of the Red Sea biota to Eastern Mediterranean conditions, coupled with the maladaptation of Mediterranean species to Red Sea conditions, explain why the circulation of species through the Canal is a one-way process.

Climate change and the problem of multiple stressors

All reports contain information about the impact of global warming on coastal ecology. This is linked, of course, to increased temperatures but, also to the rising of the sea level and, hence, of coastal erosion.

In the rest of the Mediterranean, two main biotic events are referred to the impact of global warming. One is **Meridionalization**, i.e. the northward widening of the distribution of species of warm water affinity that usually thrive in the southern, and warmer, part of the basin (i.e. meridional species). Of course this means that the conditions that are met in the Eastern sector of the Mediterranean are widening northwards and, with the establishing of new physical conditions, also the preadapted species follow. These southern species are thus favoured by the new conditions that are met in the northern part of the basin.

Fig. 3. Examples of southern species that expanded their distribution northwards (Meridionalization): *Sparisoma cretense*, *Colubraria reticulata, Aplysia parvula*

The other reaction to global warming is **Tropicalization**, i.e. the establishment of tropical species that were previously absent from the basin. Of course, these species usually start their colonization in the Easternmost part of the Mediterranean, i.e. the warmest one and, also, the one in direct contact with the Suez Canal, the main conveyor of tropical species to the Mediterranean Sea. Meridionalization and Tropicalization occur because the climate is warming and this response is an adaptation of the Mediterranean biota, both with its internal resources (Meridionalization) and with the acquisition of other contingents (Tropicalization). On the other hand, the cold water species are regressing (Boero and Bonsdorff, 2007; CIESM 2008b) so leaving an ecological vacuum that is being filled by the new tropical contingent. In a way, it is to be expected that, if climate becomes warmer, species of warm water affinity tend to become dominant, whereas those of cold water affinity tend to regress.

This part of the Mediterranean is the “source” of meridionalization processes and, also, is the “crossroad” where the tropical species first converge, to be eventually “distributed” throughout the basin.

If the Mediterranean Sea is a miniaturized ocean, where we can find in advance what will happen in the future to the oceans of the world (Lejeusne et al. 2010), the Eastern Mediterranean is the portion of the basin where these changes will become more apparent, and deserves, thus, the greatest attention by the scientific community, so to give proper management inputs to the rest of the basin. The first settlement of tropical NIS, in

fact, occurs here, and the resident species are the most probable colonizers of the northern part of the basin (as suggested by Galil in the Israel report).

The problem of **multiple stressors** is very important and emerges from the national reports. For instance, the typical Mediterranean seagrass (*Posidonia oceanica*) is almost extinct in the easternmost countries. The Syrian report declares the complete disappearance of the species from Syrian waters, Lebanon declares its great regression, Israel does not even mention about its presence. In Egypt, *Posidonia* meadows start at Alexandria, to expand then westwards.
The **absence of *Posidonia*** from the easternmost corner of the Mediterranean is often ascribed to global warming, but chances are good that this is not the case. Just due to global warming, in fact, *Posidonia* meadows are blooming in the northern part of the basin, where flowers, seeds and seedling were unrecorded prior the global warming period that is currently affecting the basin. *Posidonia*, thus, might be even favoured by the warming of the waters. All these countries, however, denounce a great development of coastal settlements, with increases in coastal erosion.

It is true that **coastal erosion** might ensue from the **rising of the sea level**, but it is also true that the impairing of the dynamics of coastlines by **irrational coastal development** might be a major cause of coastal erosion. Erosion, furthermore, increases the turbidity of coastal waters and, also, sedimentation rates, so affecting the viability of *Posidonia* meadows.
It is very probable that the regression of *Posidonia* meadows is due more to coastal development than to global warming.

Fig. 4. A *Posidonia oceanica* meadow

The problem of multiple stressors is very important, since a strong correlation might be found between one event (e.g. *Posidonia* regression) and a putative cause for it (e.g. global warming) but the comparison with other situations might lead to the individuation of other causes (i.e. coastal development) that are co-occurring with the one individuated in the first place.

It is important, thus, to carry out experimental studies to ascribe with some certainty a detected event to its putative causes. Comparisons with other areas of the Mediterranean might also lead to single out the real processes leading to the observed patterns.
Multiple stressors (e.g. coastal development and global warming) might even act in **synergy**, leading to tangled situations that should be completely understood before any proposal of mitigation measures since, if the identified cause is not the right one, all management actions might prove ineffective.

From Fish to Jellyfish

Overfishing is another issue that is denounced by all reports. The use of fish populations to satisfy the protein needs of every country is becoming unbearable, with a trend to shift from fisheries to aquaculture, at least in some countries. The impoverishment of fish populations is considered as one of the causes of the increase in jellyfish presences worldwide (Boero et al. 2008). The ecological vacuum ensuing from the removal of large carnivores from marine biota is being filled, in fact, by jellyfish which, in their turn,

exacerbate the predatory pressure on fish, preying on fish eggs and larvae, and competing with their larvae for the use of planktonic resources, especially crustaceans. It is also true, however, that one of the worst invaders in this part of the Mediterranean, the alien scyphozoan *Rhopilema nomadica*, forms huge populations that, since almost a decade, strongly affect coastal economies in terms of nuisance both to tourism (swimmers are stung) and to fisheries (for the above mentioned reasons). *Rhopilema* is a warm water animal, and, so far, it did not spread to the rest of the Mediterranean due to the presence of lower temperatures there than in the Levant basin. In this case, thus, global warming might be the first cause for the success of this species, followed by overfishing. Also in this case, thus, the presence of multiple stressors might determine a given situation.

Fig. 5. Blue fin tuna preying on a bank of anchovies

In the regional reports, the problem of jellyfish has received different treatment. If a specialist is present in the country (e.g. Israel and Turkey) the presence of jellyfish is evidenced and is considered as an important issue, in other countries it was not even mentioned in the first draft, to be then introduced when the rapporteur was asked directly if there was no jellyfish problem in his or her country. Besides the tropical jellyfish, like *Rhopilema nomadica* and *Cassiopea andromeda*, last year another gelatinous plankter reached the easternmost coasts of the Mediterranean: the ctenophore ***Mnemiopsis leidyi*** (Galil et al. 2009). *Mnemiopsis* reached the Black Sea in the early Eighties, presumably through the ballast waters of US oil tankers, since the invader is from the Eastern coast of the American continent. For decades *Mnemiopsis* remained confined to the Black Sea, to be sparingly recorded right outside it, along the Turkish and Greek coasts, but with no large populations. The reason invoked for this lack of spread to the Mediterranean was that the conditions of the Mediterranean presumably did not meet its physiological and ecological requirements. The establishment of this species in Israel (the Israel report states that *Mnemiopsis* is thriving also in 2010) means that it became acclimated to the warmer conditions of the Mediterranean Sea and, as a matter of fact, in 2009 it also reached the Western Mediterranean coasts, having been recorded from Italy, France and Spain, so having spread throughout the basin.

Fig. 6 *Rhopilema nomadica*

Fig. 7 *Cassiopea andromeda*

Fig. 8 *Mnemiopsis leidyi*

The sooner this jellyfish problem will be properly perceived, the better it will be.

Fishermen, tourists, coastal managers are perfectly aware of this situation, whereas the least prepared to tackle it are both the scientific community (lack of specialists) and the funding agencies (lack of funds).
When, in the Eighties, the swarms of *Pelagia noctiluca* became a constant in a series of summers, UNEP made money available to study the phenomenon. But when a whole task force had been assembled to tackle the problem of jellyfish, the jellyfish disappeared and remained rare for many years, to have some local bursts that were not as important as the swarms of the early Eighties. Now jellyfish are back, and not with a single, indigenous species. And they come both from warm places, like the newly recorded *Phyllorhiza punctata* (Galil et al. 2009), and from temperate ones, like *Mnemiopsis*. As stated by Boero et al (2008) the problem of jellyfish is affecting the whole world, and chances are good that it will not fade away as it happened in the early Eighties.

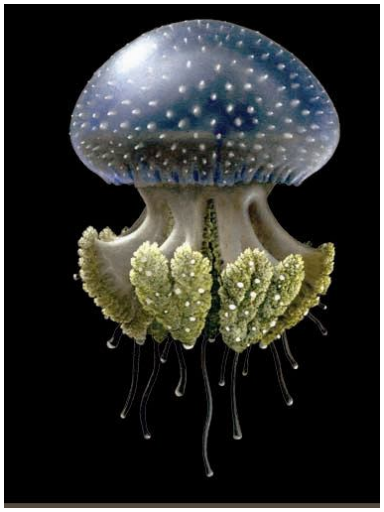

Fig. 9 *Phyllorhiza punctata*

Flagship species

Species declared as having a great conservation interest are present in this part of the Mediterranean Sea.
The most important one is the **Mediterranean monk seal** (*Monachus monachus*), still present in Greece, Cyprus and Turkey. This part of the Mediterranean is also very important for the great availability of nesting sites for **marine turtles**, especially *Caretta caretta*, and for the presence of many species of **cetaceans**. Local governments are aware of the importance of these species, and special regulations have been issued, also with the institution of marine protected areas focused at the conservation of these species. In spite of stringent regulations, it is reported that human activities deeply interact with these species and it is possible that more stringent application of the protection measures is to be attempted, so to make them effective.

Much attention is dedicated to these species, whenever they are present in a country. This is due to their high visibility, to their status of protected species in international treaties, and to their popularity. It is obvious, however, that a species cannot be protected if its habitat is badly managed and if the ecosystem that supports it does not work properly. These stringent requirements for the effective protection of these important species are usually not met.

Limited knowledge

The great importance of the Eastern Mediterranean for the understanding of the patterns and processes of change of the whole Mediterranean Sea, unfortunately, is counterbalanced by the scarcity of information on its biology and ecology, and this is recognized by all national reports. The **inventory of biodiversity**, both at species and habitat level, is scant and is linked to contingencies. The various countries, in fact, do have some expertise in some aspects of biodiversity but a coherent vision is lacking. It is true that, in the last decades, great advances have been accomplished, especially by the countries that had easier access to EU funding (with the remarkable example of Greece) but, in general, all reports highlight the **lack of taxonomic expertise** covering the most important taxa. Every country has own highlights (for instance the study of Harmful Algal Blooms in Egypt, or the study of NIS in Israel and Turkey), often focusing on flagship species such as cetaceans, marine turtles or seals, but it is evident that a great investment is needed to fill the many gaps in knowledge that characterize this sector of the Mediterranean Sea. All the local scientific communities are willing and able to contribute to fill these gaps, but more resources are needed than those made available by the local governments.

The study of biodiversity at species level

The appreciation of **biodiversity**, a key requisite for the enforcement of the **ecosystem approach**, is based on the possibility of identifying species. The basic science that performs this activity is **taxonomy**. Taxonomy, however, is not only the simple identification of specimens, but has also the scope of describing new species and to recognize species that are not previously recorded from the considered area (a crucial issue in a period of rapid change like the present one). All reports highlight a **crisis in the taxonomic expertise** of their country. This crisis (labelled as the **taxonomic impediment**) is occurring worldwide (Boero, 2010) and it is paradoxical that, in the era of biodiversity, the basic science of the appreciation of biodiversity is in distress.
All the reports refer about **species lists** in the various compartments (phytoplankton, zooplankton, benthos, and nekton), including the identification of the **alien contingent**. The main problem is that all these observations derive from short-term projects in restricted areas and are referred to limited periods of time. Lists of phytoplankton species deriving from one or two-year studies do not necessarily reflect a situation that remains constant in time. Usually, especially in the plankton, this is not the case in any place of the world. It is important, thus, that serious investments in terms of capacity building are implemented in all countries, so to build up a scientific community that is willing and ready to study the biodiversity of the Eastern Basin in a professional way. This will be very important also for the rest of the basin, since, as explained above, it is in the Eastern Basin that the future changes in Mediterranean biodiversity take place.

It is useless, however, to build capacities that will not be properly employed. The presence of experienced taxonomists should attract funds to make **inventories of biodiversity** at species level so to start a serious **monitoring** of the species composition of this part of the Mediterranean. This area, unfortunately, is affected by strong political problems among its states, otherwise it might be wise to share the expertise of each state, without the necessity of building multiple expertise. One or two specialists per major group might be enough for the whole area, leading then a larger group of parataxonomists that will carry out the monitoring. It is important to implement careful **checklists** of the species present in the area, prepare identification sheets, and start the monitoring of the status of biodiversity at species level.

This part of the basin is very important for the survival of most of the flagship species that inhabit the Mediterranean, namely the monk seal and marine turtles. The presence of particular habitats (marine caves for seals, and long stretches of sandy beaches for marine turtles) are conducive to the thriving of these species, and some protection is being enforced, also with the institution of MPAs, to preserve the remaining populations of these species. All reports, however, state that these species are threatened by human activities, as are cetaceans in general. Coastal development and fisheries are the most impacting activities on these species.
The knowledge of biodiversity at species level will require a long time. A more feasible task is to make the inventory of biodiversity at habitat level.

The habitat diversity of the Levant

The European Union, with the **Habitats Directive**, identified the Habitat as a feasible **conservation unit** to preserve biodiversity. The species, in fact, are not isolated entities that might be preserved in splendid isolation. Species need a habitat to thrive in, and preserving habitats is a prerequisite to the preservation of species. RAC SPA (2006) published a detailed inventory of **Mediterranean Habitat Types**, much improving the scant list of marine habitat types of the EU Habitats Directive (covering just nine habitat types). A further input to the protection of marine Mediterranean environments is, of course, the Barcelona Convention. It is very evident, however, that there is a big difference between signing a document and the real application of its principles.

The principle of identifying habitats as a primary conservation target is a very wise start of a **conservation policy**, and RAC SPA implemented it in a consistent way. The lists of Mediterranan marine habitat types have been recently revised by Fraschetti et al. (2008) with an attempt at **integration** of all the lists available so far in the scientific literature. Whatever the list, however, it is very important to **map the habitats** so to have a clear figure of the surface of their extension and their state of conservation. Habitats must not be confused with the species assemblages inhabiting them, even though some species are **persistent habitat formers** (like the bioconstructors) whereas others are **temporary habitat formers** (like many algae), so that the **primary substrate** is often changed radically, as habitat for other species, by the habitat formers that colonize it during a given season. Most lists are biased in favour of algae, and have been clearly compiled by phycologists. This **unbalance** with animals must be settled, but the starting point is a very solid one. All country reports stated that the distribution and state of conservation of their habitats are poorly known and set **GIS-based habitat mapping** as a stringent priority. This basic information is a prerequisite to any effective policy of marine conservation. In many countries, for example, **Marine Protected Areas** have been instituted without a prior detailed knowledge of the habitats comprised in their area. This led to uneffective zonation of the protected area, with little representativeness of the habitat diversity within its boundaries.

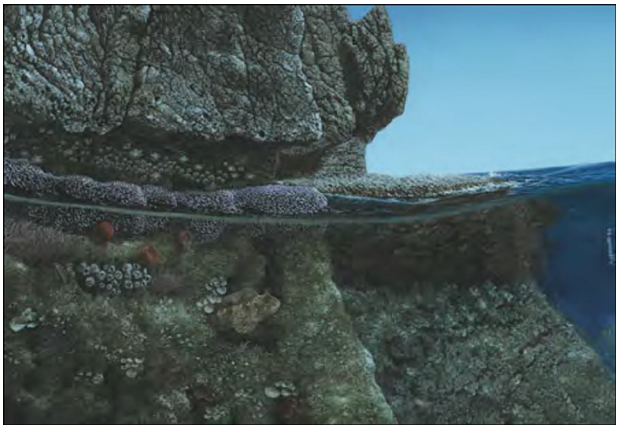

Fig. 10. *Lithophyllum* rim

A strong priority is to be given to **bioconstructors**, from vermetid reefs to *Lythophyllum* rims, to *Posidonia* meadows, to coralligenous formations in general. Some of these bioconstructions are almost extinct in the easternmost part of the basin (e.g. *Posidonia* meadows) whereas others are still thriving, albeit being threatened by anthropogenic activities.

The very first priority is, thus, to map benthic habitats and, from this, start to inventory the species inhabiting them.

Fig. 11. Coralligenous formation

Most habitat types are referred to the sea bottom, and the **water column** is often considered as a simple medium for the organisms living in it. The water column, however, is far from being uniform. The features of the coast, in fact, often do interfere with the main current patterns, forming conditions that, albeit temporary, might be of great importance for many species. Gyres, eddies, upwellings, downwellings, sites of intense terrestrial runoffs, among others, set particular oceanographic conditions that determine peculiar features for at least some portions of biodiversity. These **pelagic habitats** are more elusive than benthic ones, but are presumably even more important.

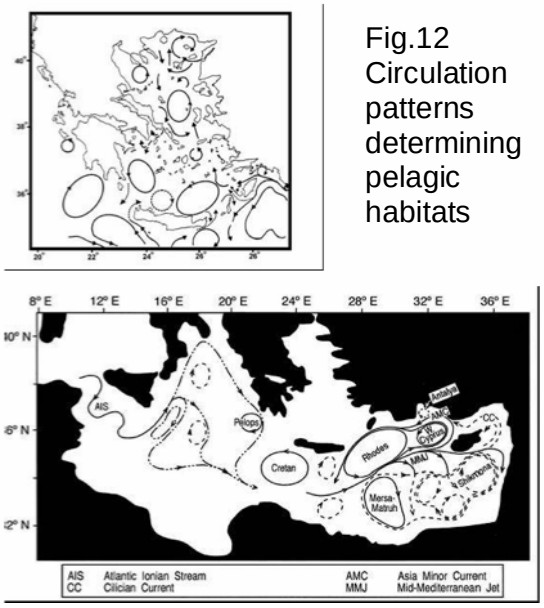

Fig.12 Circulation patterns determining pelagic habitats

The summer thermocline

Each summer, when days become longer and solar radiation increases, surface temperatures tends to warm up and, day after day, the increase in temperature deepens in the water column. The layer of heathed water, thus, becomes increasingly wider and the thermocline deepens. There are species, like the sea fans, that usually thrive below this summer thermocline, being intolerant to high temperatures. The limit to the vertical distribution of sea fans can be about 12 m in the northern part of the Mediterranean sea, whereas it can reach even 30 or 35 m in the south.

The upper limit to the vertical distribution of sea fans, thus, is a proxy for the detection of the main depth of the summer thermocline. A sudden increase in temperature at depths where species sensitive to cold water thrive did lead to the immediate appreciation that “something was not working properly”, since these species were affected by mass mortalities. These phenomena affected most of the northern shore of the Mediterranean, but are recorded also from Turkey.

The ecosystem approach

The ecosystem approach to the management and protection of biodiversity was invoked by the Rio Convention on Biological Diversity. The rationale behind this is that species, and even habitats, cannot be either protected or managed *per se*, with *ad hoc* practices, but that they are part of larger systems (**ecosystems, including humans**) that should become the proper units for management and conservation.
This vision is rarely enforced in a consistent way, and the very definition of what is a sound ecosystem approach is rather elusive.

The ecosystem approach to fisheries, for instance, cannot be applied to fisheries without considering also the jellyfish that feed on the eggs and larvae of fish (Boero, 2009) since the mortality of the fish might be caused both by fisheries (acting on adults) and by predation and/or competition by gelatinous plankton (acting on eggs, larvae and juveniles). Furthermore, due to the widespread shift from fisheries to aquaculture, also the impact of aquaculture on wild fish populations is to be taken into account, since the aquacultured fish are often carnivores and they are fed with pellets that derive from the treatment of smaller fish taken from wild populations.

All these activities, when put into an ecosystem framework, form a much **tangled scenario** that requires a completely different approach from the so-far accepted visions on how to tackle these problems. It is often the case, thus, that the ecosystem approach is invoked but, then, the previous reductionistic approach is still widely adopted, just with another label.

Biodiversity and ecosystem functioning

The link between biodiversity and ecosystem functioning is another buzz-concept that permeates the most recent approaches to biological conservation (Boero and Bonsdorff 2007).
Any approach of this kind should rely on solid and unambiguous definitions of the adopted terms.

Biodiversity is a rather elusive concept, ranging from genes to populations, species, communities, their habitats, ecosystems, landscapes. In such a framework, the concept becomes all-embracing and, according to the available expertise or even the adopted philosophy, one of the current definitions is often taken for the whole concept.
Species and habitats, however, are the most commonly adopted descriptors of biodiversity. All regional reports concur in stating that the knowledge of both species and habitats is scant and, in most cases, outdated. So, one of the components of the BEF approach is not well defined. This situation is not limited to this part of the basin but, instead, is the rule throughout the world ocean, in spite of many projects aimed at studying species. The paradox, as denounced by Boero (2010) is that, in spite of these big efforts in studying biodiversity, the science of species diversity (taxonomy) is almost extinct. It is not understandable, then, how biodiversity is to be protected if the expertise to recognize it is almost vanished (besides the knowledge of the most obvious and flagship species). Even the habitat level, which is of much easier implementation than the species level, is rather unexplored.

If biodiversity is the **structure** of the environment, then the ecosystems represent its **functioning**. Also ecosystem functioning is a rather elusive concept, often defined as “the efficiency of biogeochemical cycles” (Boero and Bonsdorff 2007). When defined as such, however, ecosystem functioning becomes a matter of microbial ecology, since microbes are the main responsible for the cycling of living and non living matter. It is also true,

however, that microbes are the most resilient part of ecosystem functioning and that the basis of these processes is hardly affected by our action. The rest of the functions, that are based on microbial efficiency, however, can be much affected by us. These functions have been categorised by Boero and Bonsdorff (2007) as **intraspecific cycles** (the life cycles of the organisms, allowing for species persistence, with passages of matter from one generation to the next), **interspecific cycles** (the passage of matter from one species to another, that is: food chains), **extraspecific cycles** (the passage of state of living matter to a non living state, and back: biogeochemical cycles). These cycles are played by different actors, as shown in figure 13 (after Boero and Bonsdorff 2007) and, together, are a more feasible representation of the functioning of an ecosystem than the current definitions of ecosystem functioning.

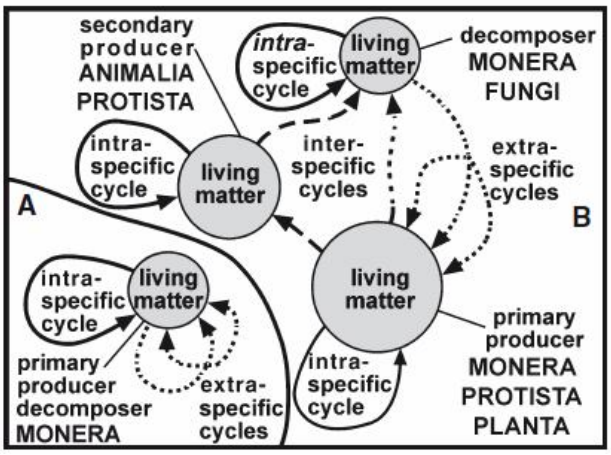

Fig. 13. A schematic representation of ecosystem functioning. A: when life first evolved; B: in more complex situations

From the above, it is obvious that a long way is to be run before biodiversity and ecosystem functioning are really appreciated, not to say preserved or managed. This overwhelming ignorance about the patterns and processes of the structure and function of ecological systems is to be coped with by proper policies aimed at mitigating the currently low level of understanding of these phenomena.

Pollution

All reports denounce alarming increases in pollution rates, with local emergencies linked to specific phenomena, such as the after-war oil pollution that greatly affected and still affects the Lebanese coast.

The search for marine resources on the sea floor is leading to drillings aimed at finding oil or gas, with risks that are becoming increasingly apparent after the disaster still going on in the Gulf of Mexico. Oil tanker traffic is extremely intense in the area, and the risk of accidents is not negligible. Oil pollution, deriving from oilspills from the tanker traffic that crosses the Mediterranean Sea at an increasing rate, is to be more and more expected, both to “normal” (albeit illegal) discharges and to accidents that, from time to time, do occur. These ships transport ballast waters, even though the risk of alien transport by ballast waters is intense only at the harbours of destination, where the ballasts are disposed and the oil is uploaded.

Chemical pollution, due to industry, is rising almost in all countries, as is urban pollution. Under some circumstances, however, the organic load of towns (e.g. Cairo) might replace the organic load that enriched Egyptian waters due to floods of the River Nile before the construction of the Aswan Dam.

New types of pollution are now being added to the “classical” industry, agriculture, and urban pollution. Aquaculture, for instance, is a highly polluting enterprise, due to the rejects of the reared fish (especially for cage mariculture), the unused food that fells on the

bottom, the antibiotics etc. Furthermore, cultured fish are spreading diseases that affect the natural populations, with severe effects on their viability.
Some anti-pollution measures have been taken, as the ban of tributyl tin from antifouling paints but, overall, these countries are going through fast “development” and pollution might be a logical consequence of these choices.

Coastal management

Human intervention, coupled with sea level rise, is greatly altering coastal habitats. The traditional reaction to sea level rise is **coastal defences**, often to protect settlements that have been placed very near to the coast line. Coastal development, in terms of **settlements on the shore**, for both touristic and industrial reasons, is a common way of using the land. Furthermore, it is often the case that coastal lagoons are radically altered or even destroyed for the management of mosquito presence, once linked with malaria. The development of tourism is heavily affecting the coast line, with increasing settlements right on the shore, and road constructions running parallel to the sea.

The widespread expectation is that the coastline will remain stable, but this is very difficult to achieve in this period of global warming and the ensuing rise in the sea level.
Furthermore, sandy habitats are often intensively exploited to mine the sand, for the construction of buildings.

From one side the **construction of dams** brings less sediments to the sea, from another side **the extraction of sand** further removes sediments, and, as a final blow to coastal integrity, coastal “development” is so intense that the word “coastal dynamics” loses its meaning, since the expectation is “coastal statics”.

The country reports provide some more details about specific situations, but, overall, the general picture denotes high human pressures on the coast and the marine environment, ensuing environmental degradation that is perceived in a qualitative way, and that should be quantified in a more stringent way.

Open seas and Deep seas ecosystems modifications

The Mediterranean deep sea comprises a high diversity of habitats, because of its geological history (Bianchi & Morri 2000). In particular, geomorphologic structures, such as submarine canyons, seamounts, mud volcanoes and deep trenches can harbor important biological communities.

In general, deep sea Mediterranean biological communities are adapted to an oligotrophic environment; local areas of higher productivity and biodiversity hotspots are present.
The Mediterranean deep sea is physically split into two basins separated by the shallow Straits of Sicily (about. 400 m dept). Important differences between the eastern and the western basins, both in species composition and abundance have been observed (Sardà *et al.* 2004).

The Mediterranean deep sea is considered by some authors to be among the most heavily impacted deep-sea environments in the world, and at the same time among the least known areas in terms of biodiversity (UNEP-MAP-RAC/SPA, 2010): the risk is that a significant loss of biodiversity occurs before scientists have had time to document its existence (Briand 2003, Cartes *et a*l. 2004).

The main pressures affecting deep seas can be graded as below:

- trawl bottom fishery
- other fishing practices
- waste disposal (solid refuse)
- other marine pollutants
- oil exploration and exploitation
- deep pipeline laying
- climate change

In a worldwide context the deep seas are considered (among other definitions) to be the marine environment that extends downwards from the continental shelf break, i.e. waters deeper than 200 m to its maximum depth. Deep-sea fisheries currently only operate at depths of less than 1000 m in the Mediterranean, but that might exploit many SH, i.e. seamount fisheries could be exhausted in a period of time as short as three to four years (Johnston & Santillo 2004). The potential fishing interest of the currently unexploited bottoms below 1000 m depth (towed gears banned by GFCM, 2005) is very limited. This is so because the overall abundance of crustacean species is considerably lower, and fish communities are largely dominated by fish either of non-commercial interest (like the smooth head *Alepocephalus rostratus*) or of a small size (such as the Mediterranean grenadier *Coryphenoides guentheri*). If these species ever become of economic interest and trawlers could reach deeper areas, then the ecosystem could be rapidly deteriorated by fishing.

Pelagic fishing in the Mediterranean open seas, targeting large pelagic species (with few exceptions targeting small pelagic, eg. anchovy and sardine, in the Adriatic Sea), is the only industrial fishing; it takes place mainly at international waters and even non-Mediterranean countries can be involved (Cacaud 2005).

Most information on the activity of the fishing fleets in the Mediterranean comes from the working group STECF and the GFCM Demersal Working Group, of the Subcommittee on Stock Assessment, and ICCAT for large pelagics, which relates the activity of the fleets from member countries. Therefore, there is a lack of reported information of fishing activity of EU non-member countries (e.g. North Africa) in STECF, although GFCM task 1, and the cooperation projects (Medfisis, COPEMED II, ADRIAMED and EASTMED) work on this direction.

The most important negative consequence of fishing activities is the degradation of marine ecosystems by the removal of target or non-target species and by physical disturbance inflicted by some fishing gears. Essential Fish Habitats (EFH) are those habitats necessary for feeding, refuge or reproduction of the species; and Sensitive Habitats (SH) consist on those areas with endemic species, high biodiversity or high productivity and vulnerable to fishing practices. The degradation of ecosystems by fishing indirectly affects the commercial species if the habitat is not longer adequate for these species. In this context, there is a necessity of regulating fishing activities to reduce the ecosystem degradation by the establishment of an Ecosystem Approach to Fisheries (EAF), which considers not only the protection of target species, but the ecosystem as a whole. Within the EAF framework the Precautionary Approach considers the most restrictive measures for fisheries management (including the establishment of areas closed to fishing, or Marine Protected

Areas) against a general lack of knowledge on the functioning of many ecosystems that sustain fisheries resources.

Most Mediterranean waters constitute open seas. The Mediterranean open seas encompass a high diversity of habitats, both pelagic and demersal (deep seas). These habitats are poorly known in relation to coastal and continental shelves ecosystems, which are more easily surveyed, while at the same time there is a good knowledge of their commercial species stocks status, by means of fisheries surveys and commercial captures. The protection of fauna at those areas is important for fisheries and ecosystem conservation because organisms can determine the healthiness of an ecosystem. Sessile benthic fauna play an important role as habitat structuring organisms providing refuge for many marine species (e.g. cold coral reefs, deep sea sponges, crinoidea beds).

Deep bottoms consist on wide extensions of soft sediments interrupted by geological features like submarine canyons, brine pools, seamounts, hydrothermal vents, cold seeps and mud volcanoes, that create a special habitat that harbour high diversity and endemism; many of these habitats have been only recently discovered and must be protected after the Precautionary Approach.

Demersal fisheries operating in Mediterranean high seas can be summarized as: bottom trawling, bottom long line, and gillnet. Deep-sea fisheries currently operate on continental shelves and some slopes, down to depths of less than 800m. Bottom trawling is a highly damaging practice that was banned in 2005 to Mediterranean bottoms deeper than 1000m, aiming to protect the vulnerable deep sea fauna.

Amongst benthic habitats at Mediterranean open seas, the components most vulnerable to fishing are coralligenous facies, the crinoidea *Leptometra phalangium,* and the cnidaria *Funiculina quadrangularis* and *Isidella elongata*, facies of sessile organisms that have been so far detected in continental shelves and the shelf break in the Western basin, although the location and extent of these habitats in the whole region is still poorly known.

At the deep seas there are several areas with considerable abundance of the highly vulnerable cold coral reefs, mostly detected in continental slopes, seamounts and on the walls of submarine canyons (e.g. off Cape Santa Maria di Leuca, in the Central basin, or at numerous submarine canyons and seamounts scattered along the Alboran Sea, in the West basin). Several abyssal plains, that harbour poorly known and vulnerable deep sea fauna, are located throughout the Mediterranean, with the deepest grounds found in the Central basin (e.g. Calypso depth in the Ionian Sea, SW of Greece). Other geological features might be vulnerable to fishing as they are hotspots of diversity and are habitat of vulnerable fauna like cold corals. The massive Eratosthenes seamount in the East basin (south of Cyprus) and numerous scattered seamounts in the Alboran Sea and south Tyrrhenian; cold seeps, brine pools and hydrothermal vents have been mostly located in the East Mediterranean basin (south of Crete and Turkey, and near Egypt).

The Western Mediterranean basin harbours numerous submarine canyons that are EFH for red shrimp, like numerous canyons in the Gulf of Lions that sustains important fisheries of red shrimp, Norway lobster, hake, monkfish, among other important commercial species; hake nursery areas are mainly located on wide extensions of continental shelves or banks, highlighting the south of Sicily, central Adriatic in the Jabuka Pit, and Thracian sea, whereas hake spawning grounds seem to be located on the shelf break and slope canyons, being the Gulf of Lions the clearest example.

The large pelagic species that inhabit the open seas, mainly bluefin tuna, swordfish, and albacore, but also pelagic sharks (short fin mako, blue shark and porbeagle) are of high conservation interest and have long been overexploited by pelagic fishing gears. The main fishing gears for large pelagics are purse seines and pelagic longlines. Pelagic long lining fleets operate in Mediterranean waters, ranging from local coastal state fleets to large industrial foreign fleets; these are highly mobile, and cover almost the whole Mediterranean basin. Drift nets have been banned in the Mediterranean in 2005, although this activity is still practiced.

The Mediterranean high sea is also the habitat of endangered cetaceans and turtles that are a common by-catch of pelagic fisheries and deserve special protection. Important EFH for large pelagic species are mostly determined by oceanographic features like upwelling areas or gyres, creating productive areas important for feeding and breeding; these areas that act as EFH must be identify to define protection measures for pelagic species. The main spawning areas for bluefin tuna have been located south of the Balearic Islands, Alboran Sea and Strait of Sicily, whereas swordfish spawns in almost all the Mediterranean area and albacore overlap with the bluefin tuna spawning grounds.

Critical areas vulnerable to effects of open seas fishing on marine and coastal biodiversity

Those critical areas considered as EFH and SH that receives fishing impacts in the Mediterranean open seas, could represent an essential tool for managing fisheries in Mediterranean open seas within an EAF and Precautionary Approach; however, these areas might imply effective restriction of fishing activities, needing an adequate surveillance system and a long-term monitoring.

The following sites are considered critical areas in the subregion, regarding fishing impacts in Mediterranean open seas, including demersal and pelagic ecosystems:

Demersal priority areas:

- Thracian sea. Demersal ecosystem at Strymonikos gulf and Samotraki plateau as important spawning grounds for hake where bottom fishing activities, mainly trawling should be restricted.
- Eratosthenes Seamount. Important SH vulnerable to bottom fishing activities. Already adopted as FRA (Fishery Restricted Area) by GFCM.
- Nile Hydrocarbon cold seeps. SH being a unique environment in the Eastern Mediterranean basin that needs to be protected from damaging bottom fishing activities. Already adopted as FRA (Fishery Restricted Area) by GFCM.

Pelagic and demersal priority areas:

- Mediterranean Bottoms beyond 1000m. Habitat of poorly known and vulnerable fauna that encompasses the four Mediterranean sub-regions. Fishing using towed gears in this area has been prohibited by GFCM.

General considerations and conclusions

Strengths

All reports were very well written and covered in detail the available information about each country.
Even if most aspects were lacking high quality information, important key features were evidenced.
All reports denoted profound awareness of the limits characterizing our knowledge about marine and coastal life and the authors proposed right remedies to fill these gaps.
All this means ability of auto-evaluation, gap identification and proposal of remedies to these gaps, so to increase the level of awareness of environmental features and of the pressures on them, leading to effective coastal management, based on the ecosystem approach.

Capacity building and Funding opportunities

Some countries enjoyed long periods of huge financial support from the EU (especially Greece, but also Turkey and Israel). This led to prodigious advancements in the building of both expertise and research infrastructures. This large investment is giving its fruits especially in the recent years.
As chair of two CIESM committees within a period of 12 years, I have witnessed an impressive rise in the quality of the presences of these Countries to CIESM big meetings and focused workshops. Some Countries are deeply nested in international collaboration (i.e. Greece, Turkey, Israel), whereas others are often underepresented in both scientific journals and in international projects (i.e. Syria, Lebanon and, to a lesser extent, Egypt). It is suggestive that the higher the investments in research, the faster the development is.
The presence in international projects, and the participation to international congresses, are crucial to amalgamate the area, bring internationality in the local scientific community, and obtain precious expertise to tackle environmental problems of each country.

Gaps

These gaps are denounced in every report since decades, and are affecting almost every country, not only in this area:

Species - The knowledge of species is scant. The available species lists are obtained by adding new records to the old ones, giving the impression that biodiversity is steadily increasing. This procedure does not allow for the real inventory of the biodiversity present in a country in a given period.

Much emphasis is given to flagship species (seal, marine turtles, cetaceans) and to commercial or obvious species, the rest being known in a very fragmentary way. Fisheries statistics are far from being reliable, with hints at high rates of illegal fisheries and, thus, at unfaithful evaluation of the pressures experienced by commercial species.

All species inventories should be accomplished, based on actual samplings, so to build a baseline of knowledge for future monitorings of the species richness as a descriptor of biodiversity.

Taxonomic monographs, covering all groups, should be published. It is not important to prepare one for each country, but it would be important to have them for the region (and

also for the Red Sea, the donor sea that is rapidly colonizing the Mediterranean with its biota).

Besides recording aliens, it should be extremely important to know about the state of conservation of indigenous species, from algae, to seagrasses, to animals.

Some lists of planktonic organisms are present in some reports. Besides being outdated, these reports highligh their gaps, mostly due to lack of taxonomic expertise.

Habitats - An agreed upon list of Mediterranean habitats (integrating the one already prepared by RAC SPA), representing better all the components of marine biodiversity, should lead to extensive coastal and deep sea cartography.
This will lead to know where the habitats are, and their putative importance, inferred from their availability and distribution.
The distinction between “primary substrate” (sand, rock, mud, etc.) and “habitat fomer” (a species or a group of species, living on a primary substrate) must be very clear.
The seasonality of many habitat formers (e.g. *Cystoseira*) represents a limit to the delimitation of habitats, since the species assemblages describing the primary habitats (either as facies or associations...) are often inconstant in presence. The same primary habitat, thus, can host much different species assemblages in the different periods of the year.
All reports highlighted that habitat maps are not available.

Ecosystems - Every report highlights scant knowledge of the functioning of ecosystems, due to lack of information of the primary features of ecosystem structure (species and habitats). The suggested patterns of ecosystem functioning derive from hypotheses that are far from being tested with experimental evidence, even though it is highly probable that the pervasive presence of alien species is heavily affecting the functioning of ecosystems. Tropicalisation (i.e. the establishment of many tropical NIS) is changing the structure of ecosystems and chances are good that these will cause changes in their functioning. The swarms of the tropical jellyfish *Rhopilema nomadica* are probably affecting in a dramatic way the species composition of both the plankton and the nekton of the Levantine basin. But how this is taking place is still largely unexplored.
The interaction of multiple stressors, from NIS species, regression of indigenous species, anthropogenic impact of many kinds, are creating a network of causes and effects that is difficult to disentangle. This, however, is a prerequisite to the enforcement of the ecosystem approach.

Priority needs and recommendations

Revive taxonomy. Taxonomy is disappearing in all these countries and, for many groups, it was never developed. Capacity building in taxonomy is a priority if biodiversity is considered as an important issue. It is unwise to plan to protect biodiversity while destroying the expertise that is necessary for its evaluation.
The only way to relaunch a discipline is to make money available for the results that it can provide. Contrary to all expectations, the expertise in taxonomy is becoming extinct in a period in which funding agencies are investing a lot in the study of biodiversity. Evidently these funds are not being used to study biodiversity, in spite of their destination. It is crucial, then, to control if money is really employed for the scopes it was made available.

The financing of regional species lists (including NIS), and of monographs for all the major groups will provide a strong impulse to the development of taxonomy. If Institutes become aware that taxonomy is attracting research funds, they will be induced at hiring taxonomists. So far, all measures to revive taxonomy have been unsuccessful. The request for the revival of taxonomy is being made in every report and in every recommendation, but then it is never satisfied, in spite of fund availability. Evidently there is a mismatch between the objectives of funding and the obtained results.

Map habitats. Terrestrial habitats have been mapped in many states and this result is easily obtained due to the modern techniques employing satellites. The bottom of the sea cannot be studied by satellites, and the mapping of benthic habitats requires much more work in the sea than on land. The availability of a list of habitat types is an important step towards the fulfilment of this requirement. The available lists still need some refinement, but this will require a small investment since most of the work is done.
Funds must be made available for the mapping of both benthic and open water habitats, with GIS-based approaches. This is extremely important for the protection of biodiversity through Marine Protected Areas and for any other initiative aimed at the management of biodiversity. The knowledge of habitat distribution is then to be matched with the knowledge of species distribution.

Link biodiversity to ecosystem functioning. The knowledge of the structure of biodiversity (in terms of both species and habitats) must be linked to the way ecosystems function. This is not an easy task and the link is not clear. Some species are obviously important for ecosystem functioning, for instance the species that have important roles for the definition of habitats (i.e., permanent and temporary habitat formers, such as coralligenous formations, or seasonal algae and animals), whereas others have important functional roles that are not linked to their abundance (e.g. keystone species).
The disentangling of the relationships connecting biodiversity with ecosystem functioning requires long and complex experimental work, which is being carried out by the scientific community at large.

Identify trends, and their causes. Many descriptors of biodiversity (from species composition to habitat and species distribution) are changing and the reconstruction of the history of biota is a stringent priority for the identification of trends.
This will be possible when careful time series will be carried out, with long periods of monitoring of the state of biodiversity.
This activity is not being accomplished for almost any descriptor of biodiversity, with some outstanding exception. Fisheries statistics, for example, allow to reconstruct the history of fish populations. The reports, however, denounce high rates of illegal fisheries, and the statistics might not be a faithful representation of the actual trends. The perception is almost invariably towards a decrease of the yields of fisheries, compensated by increases in fishing efforts. Fish populations, thus, are declining, at least for the indigenous species.
NIS are providing precious resources to local fisheries, so a parallel trend to the decline of fisheries of indigenous species, is the increase in yields of NIS fisheries. In general, NIS are increasing their presences, and this is a very definite trend.
A trend towards an increase in jellyfish presences, also in impressive swarms, is parallel to the trend in fish depletion.
Another important trend is the degradation and fragmentation of habitats, with the outstanding example of the disappearance of *Posidonia* meadows in the Easternmost corner of the Mediterranean Sea.
Coastal erosion is on the increase, with a clear tendency towards a retreat of the coastline, with important losses for human activities.

The causes of all these trends are not easily detected, even if many reports attempt at ascribing the observed patterns to definite processes. The problem of multiple stressors, however, makes it difficult to understand what are the real drivers of the changes that are affecting the Mediterranean. Some drivers might be global (e.g. global warming, or sea acidification, or sea level rise) others might be local (e.g. coastal development, overfishing, pollution).
Of course, management is required so to mitigate negative trends but, before doing so, the real causes for them must be singled out, otherwise the measures will be uneffective.
The application of the Ecosystem Approach and of Integrated Coastal Zone Management will be crucial in order to enforce effective management practices, but this will require a big investment in basic and applied research.

Depict scenarios. The knowledge of the present state of ecosystems and the comparison with past states (the history of the ecosystems), with the identification of trends and of their causes will allow inference about the future of ecosystems. Since ecological systems are non-linear due to their historical nature, it is tenuous to try to predict future history with precision (i.e. with algorithms). It is however possible to depict scenarios of future possible states of Mediterranean ecosystems, such as the following ones:
***tropicalization* -** the establishment of species of warm water affinity (hence tropical) is radically changing the biota. This is already very evident at species level, but chances are good that these species will start to form different communities, and will change ecosystem functioning. How species will assemble, however, is very difficult to say.
***meridionalization* -** the species that usually thrived on the southern part of the basin are expanding northwards, adding to the tropical contingent in changing northern biota.
***impairment of cold water engines* -** The Eastern Mediterranean Transient (not covered in the reports from this part of the Mediterranean) showed that the Northern Adriatic can stop to play its role of originator of deep waters for the Eastern Mediterranean basin. This role was luckily taken by the Northern Aegean (an area included in the Mediterranean sector considered in this report). If global warming will increase, and these phenomena will occur in the three sites of deep-water formation, what will be the outcome? A worst scenario suggests permanent stratification, with widespread anoxia in the deeper portions of the whole basin.
***extinction of cold water species* -** the species endemic to the areas of the “cold engines” will be pushed in deeper waters or, when this is not possible (i.e., the Northern Adriatic) they will become extinct. This prediction, however, might not occur if some species evolve and become adapted to the new conditions, as is possibly happening for the Northern Adriatic endemic *Fucus virsoides* which, instead of disappearing due to higher temperatures, is now particularly abundant. Also the non-tropical ctenophore *Mnemiopsis leidyi* recently arrived to the Easternmost (and warmer) part of the Mediterranean sea, showing a potential for adaptation at non-optimal conditions of early colonizers. Some temperate species, such as sea fans, are experiencing mass mortalities due to the deepening of the summer thermocline.
***less fish, more jellyfish* -** the fish-jellyfish transition is becoming evident at a world scale, and it is particularly dramatic in the Mediterranean, where tourism and fisheries are very developed. Fisheries are heavily affected by jellyfish blooms, but chances are good that overfishing is one of the causes of gelatinous plankton outbreaks. Since jellyfish are beautiful, and very few species are really dangerous, we must learn to cope with them, since in other parts of the world (e.g., Palau) they are touristic attractions. Whereas, in other parts of the world (e.g., China) they are delicacies.
***habitat destruction* -** economy wants all its indicators to rise, with the expectation of infinite growth. This hope is infantile: since the world is finite, infinite growth is an illusion.

Our growth occurs at the expenses of the rest of Nature, and the destruction of habitats is the most dramatic outcome of this trend.

Create networks. There are no countries that express a scientific community able to explore and study biodiversity in a completely autonomous way. And it would be unwise to attempt at creating such expertise in every country, since the diversity of the approaches is probably unbearable by the small funding that is traditionally allocated to these enterprises. The only way to solve this problem is to create networks, so to unite the available expertise in more than one state and to build on it the filling of knowledge gaps, by a serious policy of capacity building.
Such networks need a well defined architecture, with a careful identification of roles that must be played by the members. The word “excellence” is often used to define such networks, and this stems from a terminology adopted by the European Union. Excellence, however, is often self-referential and is not based on actual measurements of the performances of the so-called “excellent” members.
If such networks are aimed at increasing our knowledge so to advise management, the label of excellence should be appointed upon measurements in terms of contributions to the increase of knowledge generated by the members of the network, and also by the relevance that this increase has gained in the international scientific community. The status of “excellent”, thus, is gained by a substantial scientific production in peer-reviewed journals (the repositories of new knowledge) and by other measurements of scientific production.
The credentials of the experts must be checked very carefully.
Each country, thus, must incentivate own scientists to improve their scientific performances, not only in terms of what is done but also in terms of how it is spread throughout the scientific community.
Courses in scientific publishing, agreements with peer-reviewed journals, and similar initiatives might lead to rapid improvement of local scientific communities.
Access to internet-based libraries is crucial for the advancement of science in countries that do not possess huge scientific libraries on biodiversity.
The implementation of networks of scientists will surely foster collaboration among countries that have historical difficulties in relating to each other.
The problem of environmental integrity knows no political boundaries and cannot be tackled with fragmented actions.

Link science with politics - Increase public awareness. Decisions about how to manage the environment must be taken by informed politicians, and the information they need is provided by the scientific community. Scientists are saying since a very long time that building houses and infrastructures directly on the shore will lead to coastal erosion and to great management problems. Scientists are saying since a very long time that overfishing is a problem and that fish stocks are going to be depleted. Scientists are launching signals but they are usually unheard. Politicians often do support the scientists that tell them what they want to hear, and this game is played in far too many countries. Politicians are interested in short-term results and disregard the long-term. Sort-term solutions, however, often do end up in long-term problems that will be tackled with a short-term attitude, in a vicious circle of unwise decisions.
This attitude is becoming unbearable by the planet as a whole, and also by the Eastern Mediterranean.

A cultural evolution is badly needed and this evolution cannot take place if the public at large do not understand that preserving the environment is preserving ourselves.

This cultural change is the prerequisite to any policy aimed at implementing a plethora of treatises and conventions that are a bureucratic response to a problem that requires strong pragmatism. Treaties and conventions will become effective when politicians, and the people, will have understood the importance of respecting them.

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APPENDIX

EXECUTIVE SUMMARIES OF NATIONAL REPORTS

Greece

Availability and problems of actual information and knowledge

The Hellenic scientific community is represented by experts in Mediterranean and or European Committees such as the MSFD in five task groups:

Zoobenthic data has largely been archived into an advanced database, the Hellenic MEDOBIS.

Zooplankton and phytoplankton data on abundance, biomass, and species composition has been collected in the frame of many national and international projects, however, there is a lack of detailed information on the systematics of zooplanktonic and phytoplanktonic communities.

Fisheries data have been archived in an integrated fisheries databank. Gaps in fisheries research include the assessing of both the level of damage that can be sustained and/or is acceptable by the ecosystem through fishing practices, and the secondary effects such as the impact of the partial removal of a predator or a part of a life cycle of one species. There is no information on survival and fate of discards or recovery of epifaunal benthic communities.

With regard **biological invasions** in the Aegean Sea, a database includes information on their first finding, establishment success and distribution. However, studies directly investigating the impact of alien species on native ecosystems as well as the socio-economic impact of invasive alien species are missing. Monitoring of alien species and their impact in hot spot areas for biological introductions such as ports and lagoons is non existent.

Level and quality of national activities

Two reports published by the HCMR with the collaboration of Research Institutes and Universities across Hellas address the State of Marine Environment and the Status of Hellenic Fisheries (SoHelMe, 2005; SoHelFi, 2007). Following SoHelME, environmental studies in sensitive/ impacted areas have tailored the ecosystem approach by trying to assess EQS for the needs of the WFD, the CFP and lately for the Marine Strategy. Scientific effort on investigating biodiversity issues taking the ECAP approach has led to a plethora of publications in high impact scientific journals.

Hellenic Networks on biodiversity topics include:

EL-NET: a database constructed as a biodiversity information system in transitional waters for the development of distributed information in Hellas.

1. ELNAIS: Hellenic network for Aquatic Invasive species. ELNAIS currently includes 42 experts based in 11 research centres/Universities across the country, carrying out relevant research.
2. NATURA: A large scale ecological cartography was carried out in the Hellenic Seas (from 2000 to 2002), for the implementation of the “Habitats” Directive 92/43/EEC and the delimitation of the sites which would contribute to the European NATURA 2000 network. In the last 5 years, the EU has opened the discussion on off shore NATURA sites. For this occasion, around 10 new sites are under investigation and will be part of the network (in 2012 at the latest)

HCMR in collaboration with the Greek Biotope/wetland Centre, has produced a baseline assessment of the Ecological Status of all Hellenic surface waters (HCMR/EKBY, 2008) and has designed a monitoring plan (operational and surveillance types) for coastal and

transitional waters. The implementation of the WFD monitoring projects (operational and surveillance) throughout the first River Basin Management Plan period, is expected to fill in biodiversity knowledge gaps, as large scale sampling will cover areas and water bodies whose ecological and biodiversity status are still unknown.

List of critical issues and gaps in national marine /coastal areas

An overview of the existing state of the marine ecosystem confirms that, apart from a number of marine coastal areas where the concentration of human activity has caused a disturbance to the marine environment (such as the Saronikos Gulf and the Bay of Thessaloniki), the Hellenic Seas still maintain high environmental quality characteristics as far as the planktonic, benthic invertebrate and benthic macrophyte communities are concerned. Biodiversity in port areas is severely reduced and the biotopes become simplified.

Existing fishery assessments from research surveys indicate that most of the existing stocks are being overfished. This is causing growing concerns with regard to the sustainability of both commercial catches and the aquatic ecosystem from which they are extracted, as well as to safeguarding the livelihoods of fishermen. Fishing impact on the demersal resources of Hellenic waters could be considered strong for depths shallower than 500 m. According to the existing data, the demersal stocks of hake and common pandora in most studied areas of the Aegean Sea were found to be overfished to a higher or lower degree, depending on the area and the species. The only exceptions were the Evvoikos and Pagasitikos gulfs (partly closed to trawling), the demersal stocks of which, seemed to be under an optimal exploitation state.

Results from studies at a few aquaculture sites clearly demonstrate that fish farms affect deep *P. oceanica* meadows growing in open coasts, and that these impacts are still progressing, c.a. 10 years after farm onset.

The existing Marine parks in Hellas have been established rather on the narrow scope of protecting endangered marine species than on an integrated ecosystem-based approach. For instance, the National Marine Park of Northern Sporades in the Aegean Sea was originally established to protect the indigenous populations of the Mediterranean Monk seal (*Monachus monachus*). On these grounds, much scientific and NGOs' effort has been put into saving and rehabilitating traumatized animals, as well as resolving strong fisheries conflicts that torment this area. However, basic research to describe the Marine Park at biodiversity or even habitat scale, still lags behind. Such lack of data restrains the scientific community from assessing the hitherto protection effects and/or providing decision makers with proper and effective management schemes.

Sponge banks in the Dodecanese have been mostly harvested through time, and as such are subject to particularly high mortality rates. Recent results have revealed signs of recovery of bath sponges after recent devastating epidemic events.

Scientific effort should be directed towards highly vulnerable deep-water communities such as cold corals that are present in Crete, Karpathos and Rhodes islands, in order to timely detect, map and effectively protect these remarkable biogenic formations.

There are large gaps in our knowledge at all levels of biological organization, including the basic biology and ecology of most marine and estuarine-lagoon species, life cycle, competence, sensitivity-tolerance and genetics.

There is a lack of information on the species composition and ecology of mesozooplankton, concerning groups other than copepods and cladocerans. Macrozooplankton is poorly known whereas there are very few studies on copepod production, grazing impact and metabolism. The role of mesozooplankton as a link between the lower trophic levels (phytoplankton, microbes) and the higher trophic level (fish) has to be investigated in both coastal and offshore waters.

The study of feeding habits of many commercially exploited fish species and of other important components of the marine ecosystems (such as large crustaceans, cephalopods, marine mammals, turtles and seabirds) together with estimates of their trophic levels, is of primary importance for quantifying trophic interactions and energy flow as well as for the identification of the effects of fishing on the Hellenic marine ecosystems.

List of priority needs and actions

- Extending the scope of studies beyond the level of species matrices, incorporating more data on size, life cycle, trophic relations, productivity, ecophysiology and genetics.
- Establishing an international research programme aiming at investigating the spatial distribution and population structure of red coral in the Hellenic Seas, in order to address proper and effective management measures
- Including coralligenous concretions and maërl beds as a priority natural habitat type in the EU Habitats Directive (92/43/EEC),
- Developing Long-Term Projects that cover the need for assessing temporal trends and comparisons among anthropogenical impacted vs. naturally disturbed environments.
- Networking: joining forces, setting the essential questions, developing the National Strategy in compliance with EU and International Treaties and Conventions, linking with the relevant EU Networks (MARBEF, EUR-OCEANS etc.).
- Undertaking of baseline surveys in Marine protected areas. At the marine protected species level, an estimation of population status, threats and trends for the top priority species is highly needed.
- Co-ordinated, cooperative regional research is needed to investigate the phenomenon of introduced species, particularly in hot spot areas such as ports and lagoons. Particularly studies on pelagic ecosystems presumably affected by ballast waters are urgently needed.

Commented funding problems

Greek ministries provide necessary funds for research related to the marine environment. However, none of the Greek funded projects (with the exception of the project "*Excellence of the Institute of Marine Biology of Crete in Marine Biodiversity*") has so far focused on biodiversity issues. A regular source for data collection is the Department of Fisheries that supports HCMR for implementing the Data Collection Regulation (DCR, 1543/2000). This data collection is partly funded by HCMR. Important funding was provided by the department of Nature Conservation for the first steps in the implementation of the Habitat Directive as well as from the Central Water Agency for the implementation of the Water Framework Directive. In both cases the next steps in the implementation (surveillance and operational monitoring and reporting) are not funded yet, although the milestones for the implementation are very strict for the near future.

Private funds are allocated to 'projects' that concern the Environmental Impact Assessment (e.g. of a plan to be built and the monitoring of its operation). The obligations of the Hellenic authorities resulting from the needs of the ensuing EU legislation and initiatives as well as its membership and collaboration with organisations and agencies such as UNEP/MAP, EEA, have played a significant role in determining the allocation of funds on targeted needs of marine environmental research. As in the case of EU funded projects the local scientific capacity is more than adequate to monitor driving forces, pressures and their impact on marine biodiversity and EQS taking an ECAP approach and provide advice or even solutions to the problem.

Key recommendations

- The investigation of the diversity of little studied and/or unexplored groups such as Ascidia, Foraminifera, dinoflagellates, mesozooplankton groups other than copepoda and cladocera, macrozooplankton, microplankton.
- The development of Rapid Assessment Surveys (RAS) for the assessment of the Marine Environment EQS and trends in Alien species introductions.
- The development of Long-Term Projects in a few selected areas covering the need for assessing temporal trends and comparisons among anthropogenical impacted vs. naturally disturbed environments. Suggested areas could be Rhodes representative of the Dodecanese, South Evvoikos Gulf (Asopos delta), a Kyklades island (Naxos) in the Central Aegean, and Mytilini, Kavala in the North Aegean.
- Networking: joining forces, setting the essential questions, developing the National Strategy in compliance with EU and International Treaties and Conventions, linking with the relevant EU Networks (MARBEF, EUR-OCEANS, MARINERA).
- The further development of existing databases employing new tools (e.g. IMAS-Fish and ELNAIS). MEDOBIS needs to be enriched and become the central depository of data from the Hellenic Environment.
- The establishment of national working groups addressing various biodiversity issues that meet regularly and report once a year.

TURKEY

The Turkish Aegean and Mediterranean coasts contain a variety of rich ecosystems including islands, reefs, coasts, lagoons, benthic and pelagic. However, The Turkish coasts has suffered significant ecological damage from various sources. In the Aegean and the Mediterranean part of Turkish waters, the main pressure on the coastal and marine ecosystems comes from land-based pollution. Overfishing, by-catch and habitat loss are threats for marine biodiversity. Use of detrimental fishing gears and fishing power increasing threat to diminishing fish stocks in the coastal areas. When the food web structure carrying capacity of the Mediterranean fisheries ecosystem and the amount of fish removed by the fishing fleet are taken into account, the future of any large apex predator population, such as the monk seal and the dolphins, is threatened.

Furthermore, the monk seals, sea turtles, and coastal small-scale artisanal fishermen are in increasing conflict with each other due to lack of management, enforcement, protection zones and due to illegal fishing. The side effects of coastal urbanisation and tourism are numerous, including untreated waste discharges into the sea, sand extraction for construction, infrastructures on the shore and disturbance to wildlife by increased recreational activities. Eutrophication is an equally significant factor threatening marine biodiversity. It is induced by excess nutrient load from untreated sewage that reaches the sea. As a consequence, phytoplankton growth is enhanced and planktivorous small pelagic fish move into an advantageous position. Increased phytoplankton growth also shadows the light penetrating the bottom and hinders benthic productivity that is food to most of the demersal fish. Surplus plankton production that is not utilised in the food chain also sinks to the bottom, and is decomposed further depleting bottom oxygen available for benthic fauna.

Enforcement and more stringent measures of the existing marine protected areas in the Turkish part of the Aegean and Mediterranean Seas is highly required. Besides, more marine protected areas and/or fishing restricted areas are needed to protect unique habitat peculiarities mostly first 200 meters depths in euphotic zone.

Solid wastes, such as plastic bottles and bags, greenhouse materials, are excessively used and mostly wasted in daily life. A great proportion reach the sea and are rapidly spread, even to very remote areas, by the action of wind and currents. Plastic material is not easily degradable and stays as a deposit for decades in the sea. Their impact is highly significant for benthic life as they blanket the bottom surfaces, hinder the oxygen exchange and form lethal anoxic patches killing all life. Apart from damaging the natural sand transport in sand dunes, coastal extraction also has an adverse effect on fish nursery grounds.

The adverse environmental impacts of aquaculture on the marine ecosystem are inevitable, however, as a solution to over-fishing and unemployment in the coastal rural communities.

In the Mediterranean and the Aegean coast of the country there are three hot spots for industrial pollution, namely the Gulf of Izmir, the Gulf of Iskenderun and Mersin Bay. Economical bottlenecks lead the industrial factories to reduce their cost of waste treatment. Use of artificial fertilisers and chemicals like pesticides, insecticides, etc. are becoming an increasingly common practice. Impacts of agriculture on biological diversity are felt in estuaries.

Alien species and their impacts to the native biota, impacts to the fishery are also vital importance in the Mediterranean ecosystem. At present, more than 40 alien fish species

entered into the Turkish waters. Poisonous invasive fish and invertebrate species will be one of the threats for human health and the national economy. This threat is only one of the ecological and socio-economic impacts of the climate change in the Turkish coastline of the Mediterranean Sea. Wetlands, supralittoral zones and estuary ecosystems will be negatively affected by the climate change in the Turkish part of the Mediterranean Sea.

At the species level, marine phanerogams, like *Posidonia oceanica*, *Cymodosa nodosa* and *Zostera nana,* will also be negatively impacted due to habitat loss and irregular flooding, mostly nearby rivers such as the Menderes and Gediz in the Aegean Sea. Sea level rise will affect sea grass meadows as the intensification of erosion consequently increases turbidity, thus decreases light penetration. Low lying small islets will be impacted from the sea level rises mostly in the Aegean Sea. These islets are important for the avifauna and some bio-constractive coralligenous species.

One of the protected species, the loggerhead sea turtle, *Caretta caretta*, may change nesting beaches and depth at which they lay eggs in the sand due to temperature variation. Duration of incubation and hatching period may be affected in Dalyan area. Changes in the coastal zones and erosion in this area is also predicted.

Mass mortality of gorgonians like *Eunicella singularis* and *Paramuricea clavata* due to the rise of the sea water temperature (resulting in the deepening of the shallow, summer thermocline) shows indication of climate change.

Changing the water circulation patterns or mini conveyor belts in the eastern Mediterranean Sea may create domino impacts on entire fauna and flora including those of the Marmara and Black Seas.

Effective sensibilization programmes for the public are needed for mitigating the impacts of climate change on the marine ecosystem. Besides, special funds should be allocated for the better understanding and monitoring several expected negative scenarios. Concerted action and international cooperation are also essential for the halt of the destructive impacts of the climate change in the Mediterranean basin, including the Turkish waters.

SYRIA

During the preparation of this overview, a set of reference documents and information on the topic were consulted and various relevant authorities and information sources were referred to. Many essential qualitative and quantitative data related to the theme of Ecosystem Approach (ECAP) are lacking. Thus, conclusions were made, when possible, on the basis of the practical knowledge and on the opinion of a wide range of specialists and stakeholders retrieved from the relevant questionnaire prepared for the purpose of this study. The existing legislations are insufficient for the proper implementation and the majority of key institutions lack the proper infrastructure to function effectively in ACAP. Many basic data on the marine and coastal ecosystems are needed to initiate basic assessment of the situations.

Biological characteristics of marine and coastal ecosystem status were described. Spatial variations of phytoplankton species recorded showed that the dominant species are mostly the same but differ in timing of appearance. Zooplankton species were apparently high and estimated to be of some 300 species. Benthic fauna were also described and seasonal and the spatial variations in species composition were obvious. 173 macro-algal species have been identified from various littoral terraces along Syrian coast. Out of these, many were Lessepsian migrants or registered in the Red Book. Fourteen sponge species representing 3 classes and many other invertebrates (26 Species) and fish (12 species) are found in close vicinity of sponge individuals

Three angiosperm species are present in the Syrian marine ecosystem, *Posidonia oceanica* was not seen since the eighties of the last century. This indicates habitat degradation at large scale and may lead to disappearance of many species that are associated with.

In general, due to the lack of proper equipment and sampling, most of the work carried out so far on benthic species did not consider clearly substrate types that accommodate the species. In other cases the substrate types were classified in an arbitrary way,

Research projects on vertebrates other than fish, such as marine mammals and birds are very rare and tentative; giving very basic and scattered information and, thus, information in many cases has been built on personal observations. It has been confirmed that monk seal is present in Syrian waters and may breed there. Many species of cetaceans are encountered alive and others were stranded dead. Three species of sea turtles are present in the Syrian marine waters. All of these species undergo habitat degradation.

Elaboration was made on the temporal occurrence, abundance and spatial distribution of exotic, non-indigenous and invasive species. Out of the 227 fish species recorded from Syrian marine waters, for example, 54 entered the area through Suez Canal or from the western Mediterranean and the Atlantic. Some of these became widespread in the area. 30 bottom fauna species of Indo-pacific origin were recorded; some of which were registered in the Red Book (UNEP, 1990).

As water temperature increases by global warming, alien species are expected to have more expansion range in their original habitats and heavily inhabit Syrian marine waters, resulting in higher effects on local biodiversity.

114 fish species are usually caught by the fishing gears and such fishing exerts a heavy pressure on fisheries stocks. Some fish species that largely contribute to the landing are originally from out of Mediterranean. Cartilaginous fish accounted to 3.7% of the total marine bony fish caught.

Syrian continental shelf is small in area and more complex and having more small Islands in the north but wider, sandy and has fewer and larger Islands in the south. Habitat types along Syrian coast are complex and diverse and more work should be

done to identify them correctly. One coastal wetland is located to the south of Tartous; it is the only surviving natural coastal wetland in Syria and represents one of the few remaining wetlands on the eastern Mediterranean coast. Suitable Monk seal sites present along the Syrian coast could be of interest as eventual habitats. The Levantine Vermetid Terraces which are rich in biodiversity are distributed almost everywhere at the rocky coasts along the northern parts of Syrian coast. Seventeen assemblages, facies or associations were identified and described from a survey carried out in the northern coast of Syria. The habitats suitable for various biological species were described.

The study had identified some gaps in terms of the need for more comprehensive monitoring & research programs to deal effectively with issues related to MCECs. Adequate research, surveys and monitoring programs of some related marine species should be initiates in the marine and coastal ecosystems of Syria.

A more comprehensive work should be done on Non Indigenous Species and joint work with neighboring countries (Lebanon, Egypt, Saudi Arabia, and Turkey) is needed. Direct projects on ecosystem health are still to be activated.

Numbers of the biological species presented in this study do not represent all species actually present in Syrian marine waters, and much more work has to be done to reach the goal. In Syrian marine water marine organisms of various origins often occur at a single location indicating tropicalization of the marine ecosystem. However, the available information is qualitative only and need to be quantitative in order to impose the required measures to reduce the effect of the already known harmful species.

Despite of the lack of reliable statistical data, there are some strong indications that the demersal fish resource is heavily overexploited and the catch per unit effort is decreasing. Illegal fishing is impacting the region through direct taking off and under the only few regulations in Syria that take marine fisheries into consideration. The present situation of marine fisheries and the threats they cause impair the wealth-generating capacity of the marine ecosystem.

Syrian MCECs are vulnerable to CC through the consequences of total coverage by SLR through water acidification and reduction in the calcification rate. It is estimated that some 17km^2 of the coastal areas will be covered when sea level rises. A wide spectrum of species will be affected by increasing water temperature, decreasing pH and decreasing tendency of calcification. However, quantitative and qualitative studied on such effects should be carried out. Levantine vermetid terraces are vulnerable to CC and to coverage by SLR and by pollution resulted from human activities.

The assemblages that live in the surf zone of the infralittoral areas at water depths up to 2m will be affected by CC and by the change in water property. Many biological species in the marine and coastal habitats will suffer from the risk of habitat fragmentation.

These elements highlight the impact of natural disturbances and shape the distribution of marine habitat types. Mitigation of local human-induced and enhanced disturbances becomes the key element for any attempt to reduce or stop the rate of degradation of Syrian near-shore marine resources.

Critical impacts and effects on marine and coastal biodiversity can be seen in marine turtles, marine mammals, marine birds and shallow water biodiversity that undergo a great pressure due to human activities and interventions along the coast. Ten sensitive & endangered areas along the Syrian coast had been identified and the main sources of impact had been specified. The estimations point out at 8 major geographical locations regarded as having the most threatened species.

The most related priority national needs are represented by:

- The need for national inventories of species and natural habitats using the standard classification terminology and the need to study the present status of the key species in each habitat.
- More comprehensive work on biodiversity status is needed and harmonized ecological habitats maps are needed.
- Projects on phytoplankton cells grazed by micro-zooplankton should be initiated in the Syrian marine waters.
- In order to have wider view about species introduction, their origins and the mode of introductions, cooperation should be extended to include more countries of concern. Assessing the impact of the invasive species on local biodiversity is important for proper management.
- Studies should be done on the degradation costs of various components of MCECs and combine the results with the degradation status to specify the components of high priorities.
- The strong interaction processes between the three ecosystems (marine, coastal and forestry) favours management integration.
- In order to reduce sandy-habitat fragmentations, establishing connection corridors between the isolated ones is needed and research projects on sand supplies and beaches ability to naturally accumulate sand by wave and wind actions are also needed.
- More MPAs are needed to restore the health of the marine and coastal ecosystems in areas jeopardized by habitat and species losses and special management plan should be formulated to protect the nursery grounds of many species of special interest.
- A regular yearly report to analyze and evaluate the effectiveness of various measures applied in the country is needed.
- The existing legislations are insufficient and should be enforced for proper implementations of the imposed management measures. Integrated Coastal Zone Management of Syria should take MCEC dimension into account and a National Information Database on MCECs should be established to make all research results available for consultations.
- The improvement in the status of the MCECs will not succeed without political will to formulate the proper action plans and to renew and enforce current environmental legislations. This requires convincing middle and high ranking planners and decision makers with the necessity of incorporating ECAP concept into the national, regional and international activities.
- Specific conservation efforts can activate the responsibility of coastal communities towards marine ecosystem protection. Awareness programs should focus on MCECs sensitivity towards various pressures and campaigns to enhance the knowledge with the ECAP concept need to be initiated.

Funding problems and opportunities to deal with ECAP issues were discussed and the regular national and international sources that potentially available were specified. Other funding sources (private, public, partnership) were also discussed. National funding is usually low and accounts for ~1‰ for environmental projects, even though the funding process has been slightly improved during the last few years. Private funding is similarly low. This makes the environmental projects depend largely on funding from the international organisations and on funds provided by other governments.

It can be concluded that:

- Tropicalization phenomena characterizes Syrian marine ecosystem where milti–origin species coexist. Every effort should be made to identify such species and impose measures to overcome their negative impacts.
- It is good for Syria to establish a National Informative Network that gathers the information on the state of the ecosystems, species invasion and degradation among biodiversity species.
- The ecosystem approach and environmental dimension in the proposed national strategies need to be convincing to the decision makers in order to highlight the rewarding outcome that can be gained from the proper management of MCECs.
- The problem of human concentration in the coastal area needs to be solved through proper strategic actions that expand the range of settlement. This may decrease the impact of human activity on the coast.
- Creating capacity in laboratory techniques and raising campaigns on ECAP issues are important to improve the situations.
- Detailed mapping and conservation strategy of the important species and ecosystems should be developed in the country. As the environmental problems existed in MCECs are multi-dimensional, it is also important to establish "scientific research teams" to deal with the environmental issues of special concern.

LEBANON

Since 2001, the number of studies on trends observed in the environment and their relationship with regional climate change has considerably increased. The quality of the data has also improved but assessment of vulnerability, which incorporates the ideas of exposure, sensitivity and adaptive capacity, as defined by the IPCC, needs more data and contributions. It has been proven that human activities affect the climate with a probability of above 90%. In 2005, atmospheric concentrations of CO_2 and CH_4 greatly exceeded the natural variation interval of the last 650,000 years.

Average world temperature should increase during the 21st century. The size of the expected warming is between 1.8 and 3.4° C. On a world scale, the 1990s will have been the warmest decade. In the year 2100 the sea level will rise by one metre. According to projections, the coasts will be exposed to greater risks of erosion. These consequences will be worsened by human activities and also help to narrow the wet coastal strips. The effects of climate change and the rise in temperature will be felt at every level: health, water resources, biological resources, quality of the environment and economic activities. The forecasts and effects of global warming on biodiversity and ecosystems are worrying. The changes are expressed either as physiological disturbances of individuals or as extinctions or extensions of certain species, or as changes in the period of migration and reproduction. The rise in temperature is at the origin of the ecosystems weakened resistance to invasions and displacements of the native species northwards and may facilitate the establishing and propagation of exotic species. Extreme events like abnormal temperatures can provoke mass mortalities of benthic organisms and allow exotic species to occupy the ecological niches that have thus been vacated.

Climate change in Lebanon is an undeniable fact: changes in the seasons, less frequent but heavier rainfall, slighter and less long-lasting snow cover than before. Over the past years extreme phenomena have been recorded: storm waves, floods and landslides, heat-waves and forest fires.

Much of the coastal area, including beach areas and vermetid platforms, is being degraded by pollution and then uncontrolled development of human activities. An on-going study highlights two areas greatly affected by extreme events and human activities (Akkar Bay and the Tyre region, in which the sea has advanced more than 150 m.). Both biodiversity and the benthic marine ecosystems are affected by climate change, pollution and exotic and invasive species. The exotic species are very numerous and help structure and modify habitats (biocenoses). Our underwater prospections show the presence of invasive species, particularly the brown alga *Stypopodium schimperi* that invades vast areas between 1 and 30 metres down, where seasonally it replaces the native associations (communities) while seasonally producing dense monospecific cover.

A study on changing heat structure, based on a temporal set of hydrological parameters over 4 years (1999 to 2002) showed inter-annual differences and a change in the level of the thermocline. Similarly, a coloured water phenomenon was observed in 2007 for the first time in the Zouk-Nahr el Kelb region. This phenomenon, with its repercussions on the pelagic ecosystem, was explained by the hydro-climatic conditions during a heat-wave and the presence of high levels of nutrients.

The forecasts are that climate change will have effects at different levels, *inter alia*: disappearance of the oroMediterranean climate and appearance of an extreme arid level in the north of the country; a major deficit in water resources; repercussions on low-lying land; very great loss as regards coastal and marine activities.

Taking into account the impacts of climate change (rise in sea level, variations in the temperature of the water and frequency of extreme events), pollution and species introduced into the coastal and marine biodiversity, plus adaptation to and mitigation of these impacts represents a major issue for Lebanon. As part of its commitment to the UNFCCC, Lebanon has drawn up a national inventory of greenhouse gases, assessed the vulnerability of several sectors and ecosystems, and proposed a strategy for mitigating greenhouse gas emissions in

various sectors with certain adaptation measures. Phase II of the Climate Change project, aiming at increasing the country□s capacity, has been completed in 2002. The Second National Communication is being currently prepared.
In order to start and promote the process of implementing the national SAP BIO, taking climate change and the harmful effects of the oil slick of the 2006 war into consideration, a revision of the national strategy documents crafted in 2002 has allowed us, in the light of publications that were already available before that date and were not taken into consideration, to restructure certain action plans that had been proposed in SAP BIO and to add others. These priority actions are:

- Oceanographic observations-climate change action
- Biological diversity action
- Habitats (coastal and marine) and mapping activities. With sub-actions: dunes, beaches, vermetid platforms, the photophilous algae biocenosis, meadows, the coralligenous, the marl bed, semi-dark and dark caves, port environments and salty populations
- Exotic and invasive species action
- Impact studies, monitoring and long-term protection of species and biocenoses, especially bioindicators, action
- Marine reserves action
- Fishing action
- Birds, turtles and marine mammals action
- Legislation and crafting of guidelines for marine and coastal conservation action
- Awareness for coastal communities and the public sector action.

Implementing these action plans requires available, regular funding sources but in fact the national budget for research is very small and far from sufficient, and thus does not at all meet the needs and ambitions of Lebanese researchers. The MoE has a tiny budget to carry out limited studies. An opportunistic policy must be envisaged, to have the financial backing of donor bodies in order to implement these action plans, which are becoming increasingly urgent. Alongside these priority plans it is recommended that: long-term federative research programmes be set up and modelling studies done; the feasibility of projects of installing or building or filling in be studied; various impact, ecophysiology and macro-physiology studies be encouraged.

ISRAEL

Considered the cradle of civilization nearly 9000 years old, yet only in the late L9th century did anthropogenic changes begin severly affecting the Levantine marine environment. The opening of the Suez Canal in 1864 - linking the Red Sea with the Mediterranean - allowed hundreds of Erythrean species to settle along the Levantine coasts. The completion of the high dam at Aswan in the mid 1960s deprived the Levant of its influx of freshwater, nutrients and sediments, contributing to the diminishing sediment transport and negatively impacting fisheries. The rapid increase in population density along the Levantine coastal plain in the past half-century, urbanization and industrialization have impacted the littoral environment.

The study of the Mediterranean coast of Israel began in the 1930s, and has intensified following the establishment of the State of Israel. Scores of scientific articles and professional reports document the composition of biota along the Israeli littoral (see below), but no attempt was made at a synoptic review of its major marine habitats.

Israel is a signatory of CBD and UNFCCC. In 2000 the Ministry of Environment commissioned a National Report under The United Nations Framework Convention on Climate Change (Pe'er and Safriel, 2000). However, little attention was paid to the impacts, some already apparent, on the marine communities along that coast. In 2008 the Chief Scientist Office, Ministry for the Protection of the Environment, published an extensive report on the preparedness of Israel to global climate change (Golan-Angelko and Bar-Or, 2008). Again, the discussion concerning biodiversity is limited to terrestrial and inland waters and no mention is made of marine biodiversity, beyond the increase in thermophilic marine alien species entering the Mediterranean through the Suez Canal. The 'Fourth Country Report to the United Nations Convention on Biological Diversity' prepared for the Ministry of Environmental Protection by Achiron-Frumkin (2009) has significant anthropocentric & terrestrial bias in assessment, analysis and action plan; and its marine section should be reassessed and strengthened.

The marine environmental protective measures in Israel are encompassed within the framework of three main complementary legislative/administrative systems: the land-use planning system, the system of marine and pollution control and the system for nafure protection. A national plan for an integrated sustainable coastal zone management was completed. It aims to guide the national coastal zone committee in a sustainable global planning policy, including nature protection. The land-use planning system (under the Planning and Building law of 1965) incorporates regulations for environmental protection both in regional masterplans and in specific projects. An environmental impact statement (EIS) has been a statutory requirement since 1982 for development projects with anticipated significant environmental impacts. In 1983 a National Masterplan for the Mediterranean coast was affirmed. The plan includes regulations on the preservation and protection of the natural coastline and beaches, on the open view to the sea and on free public access to the beach. An additional part of the program was submitted in 1991, and includes a more detailed land-usea ssessment based on a land and sea uses database prepared by a professional multidisciplinary team.

The Israeli Nature Reserves and National Parks Authority oversees 36 reserves and fourteen coastal parks along the Mediterranean coast of Israel. Declared Reserves have full legal protection; proposed reserves have a limited level of protection until they are legally declared. Twelve of the fourteen proposed marine reserves (area 2500 ha, shoreline 45921 m) come under the limited protection. Of the 20 coastal reserves (area

3500 ha, shoreline 45732 m), four are declared, and thus fully protected. The two islets reserves (33 ha), serving as important nesting sites, are also fully protected.

The single most important issue affecting the biota off the Mediterranean coast of Israel (and the Levantine basin as a whole) is the **Erythrean invasion** through the Suez Canal. Over 300 Erytrean alien multicellular species have been recorded thus far, and the number is increasing.

The Israeli Ministry of Agriculture noted in a report from 2007 that there had been a 20 % demise in the fishing industry. **Overfishing** and the Erythrean invasion have impacted the quality of the catches, both in terms of species composition and size of fish caught has generally declined. Long-lived and slow-growing species and the larger specimens of targeted fish have largely disappeared from various demersal catches. Recent studies show that the average size of fish in Israeli waters is less than 20 % of the size of fish in Turkey.

The **critical issues** resulting from the impact of **climatic change** on national marine biodiversity are a temporal mismatch between various elements in the marine foodweb, SLR–driven extirpations, and outbreaks of thermophilic native and aliens species. Rising sea-water temperature enhances the reproduction, growth, and survival of the Erythrean aliens, and provides them with a distinct advantage over the native Mediterranean biota.

The southeastern Mediterranean basin is an emerging **oil, gas and condensate** province. The area is still in an immature exploration stage, despite significant discoveries made during the last decade. **Accidents inevitably accompany offshore exploration and extraction**. The causes, scale, and severity of the accidents' consequences are extremely variable. Their ecological hazard and associated environmental risk can be rather considerable. At present Israel lacks environmental regulations for deep sea energy exploitation.

Parts of the littoral have been undergoing rapid change in the past 30 years. Extensive port building and enlargement, marinas and coastal barriers, causing **habitat loss and fragmentation,** the modification of sedimentary coastal dynamics, and the subsequent destruction of large extensions of valuable marine coastal habitats. In recent years maritime infrastructure – gas and oil pipeline installations, evermore marine discharge outfalls and intake pipes – litter the littoral.

The main **pollution sources** are connected to the intense coastal metropolis and industrial activities. The three major classes of pollutants affecting the area are **nutrients, heavy metals and toxic organic compounds**. The main point source inputs include direct pipeline discharges and riverine input, and the main diffused pathways are atmospheric deposition and runoff. Since the early 1980s the overall pollution load into the coastal zone has declined.

The coastal sand reservoirs of Israel have been depleted by massive mining for construction, outlawed only in1964, and by the construction since the late 1960s of coastal structures hindering its natural northward movement. To satisfy construction needs options such as offshore sand mining and sand importation are being examined. The effects of detached breakwaters and other marine structures on beach morphology were investigated: in 35 years, Ashdod port breakwater alone trapped more than 4.5 million m^3 of sand and has greatly affected the nearby shoreline and sea bottom. It was estimated

the total sand deficit due to human activity along the Israeli coast at 20 million m^3 (Golik, 1997). Sea level rise will accelerate **coastal erosion** - a rise of 1 m will lead to loss of coastal strip of 50-100 m wide along the sandy beaches which make up more than half the Mediterranean coastline of Israel.

Desalination is increasingly considered as a secure source of drinking water in Israel. The first large (100 Mm^3/y) desalination plant along the Mediterranean coast of Israel (Asqelon) began operation in 2005. Plans are underway to add more plants and increase capacity to 875 Mm^3/y of desalinated water. The plants impact the littoral by discharging brine (44–90 psu) and chemicals used in the desalination processes. Marine life **impingement and entrainment** associated with seawater intake are are among the most significant environmental threats associated with desalination and may represent the most significant direct adverse environmental impact.

The **priority needs** concerning national marine and coastal areas are **inventorying and mapping marine biodiversity in the Levant** - a concentrated and concerted effort to complete the inventory of the littoral marine biota is necessary if we are to monitor changes in its biodiversity. The number of new species, mostly smaller invertebrates and protists, undergoes upward revisions and new discoveries modify previous estimates every year. To continue updating our knowledge of marine diversity it is necessary to further invest in taxonomic knowledge, increase sampling of taxonomic groups and habitats that have been poorly studied. Past inventories should be validated, because littoral habitats have been greatly modified, and the list of species and their abundance may no longer be current. Spatial and temporal data should be integrated using innovative information technology and combined with physical and chemical data. **Priority should be given to threatened and sensitive habitats such as vermetid reefs, rocky littoral, rhodolithe beds and trawled bottoms.** Marine and coastal pollution-monitoring programs include a "status and trends" type of heavy metal monitoring that has been carried out continuously from 1988 along the entire coastline, and constitutes a part of Israel's National Monitoring Program within the framework of MED POL. Nutrient loads of coastal rivers began in 1990, atmospheic loads were added in 1996, nutrients and phytoplankton in the littoral to 30 m depth, in 2000; benthic assemblages in the shallow littoral to 15 m, as well as Satellite-based imaging used to determine the relative distribution of chlorophyll and particulate matter in coastal waters, began in 2005. **Benthic monitoring should be extended to encompass the littoral to 80 m depth, in order to monitor the impacts and trends of the two main threats to biodiversity stressors (in addition to land-based pollution): bioinvasion and trawl fisheries.**

In the past two decades scientists and decision-makers have realized that the natural ecosystems upon whose services our economy, agriculture, health, and well-being are dependent are endangered. With a rapidly growing population, overexploitation of fishery resources, and already detectable adverse impacts on ecosystem services – the scientific study of the Mediterranean coast of Israel is a crucial basis for protecting, managing, and sustainably exploiting biodiversity for the benefit of society. Research and scientific expertise are key to maintaining functioning ecosystems and for **rational and knowledgeable decision-making**. Special care at the national and the university levels must be taken to promote marine research in Israel. Conservation biology as a field of research does not exist in Israel, though some Israeli ecologists and behavioral ecologists do study aspects of conservation. Biodiversity research, now a global priority for both scientific and direct societal reasons, is being strangled in Israel, and **the coming few years are critical in terms of hiring and training as some crucial fields are actually on the brink of extinction or declining beneath the critical mass.** Thus the situation of

biodiversity research in Israel requires special attention at the national and the university scales.

Only **limited funding** is available for the study of marine/coastal ecosystem properties and assessment of ecological status and pressures in the budgets of the Environmental Protection Ministry, the Ministry Marine and coastal Environmental Division; Ministry of Agriculture and Rural Development, Department of **Fisheries** and Aquaculture; Nature and Parks Authority, Division of Science and Conservation.

Anthropogenic pressures cause serious degradation of marine and coastal ecosystems, with far-reaching consequences for the environment, human health and welfare. In Israel **most attention has been paid to anthropocentric impacts**: dwindeling fisheries and coastal erosion.

The **most pressing need is for research**, requiring active collaboration across several disciplines, as we lack a solid understanding of the possible impacts of old and new pressures on marine and coastal biodiversity and ecosystem properties. Following that, **improving and updating current environmental legislation**, or when necessary preparing new legislation, to address new environmetal pressures such as large volume desalination plants and oil, gas and condensate exploration and extraction. A clear policy mandate and the **setting of national marine priorities** is needed with high-level direction and policy guidance from a clearly designated and identifiable authority, a consistent and sustained attention on marine-related issues from all member ministries and agencies and **stronger linkages between management and science**.

EGYPT

The Ecosystem Approach is not a set of guidelines to manage ecosystems but a codification of earlier strategies aiming at integrating Biodiversity management into development practices and decision making.

There is a priority need to motivate policy makers towards sustainable development. The role of public opinion as organized in NGOs is crucial in raising awareness and resisting the tendency to ignore or minimize environmental problems. The concept of Biosystem Approach needs to be translated into more practical terms, emphasizing its significance for present and future human welfare.

Numerous studies have been carried out on the coastal environment in Egypt since the pioneering survey of Steuer (1935). We now know more about the planktonic and benthic communities and their trends of variation, about fish and other living resources and about anthropogenic stresses on the environment. The available information, however, is not fully satisfactory as it is limited in geographical coverage and in time and often lacks the ecosystem perspective. Large gaps remain to be dealt with to provide the scientific basis needed for a sound management of the marine and coastal environments of Egypt.

The brackish Delta lakes or wetlands, the Posidonia oceanica meadows, the west coast beaches are key habitats among others. Their outstanding importance derives from their biodiversity, their peculiar ecosystems and –for the former two- for their productivity.
The wetlands are of immense importance for migratory and wintering birds.

Migratory Erythrean organisms through the Suez Canal have enriched the Levantine sub-basin of the Mediterranean Sea, the Egyptian waters in particular, with a wealth of fish, crustaceans and other invertebrates enhancing biodiversity without causing any observable damage to the ecosystem. On the other hand, their economic returns are considerable. Invasive species in this area are not nuisance species, with the exception however of two cases, a poisonous finfish and a stinging jellyfish.

Fishing as it is currently practiced is unsustainable. It suffers from malpractices and poor management. There are undeniable signs of overfishing, namely a drop in the catch per effort and in the average size of some of the target species. Fishing operations with the current gear, on the other hand, are damaging to the environment and wasteful. Fisheries in Egypt need to be monitored and managed in the framework of the ICZM in order to achieve sustainability while minimizing lateral impacts on the ecosystem. The reliability of the fishery statistics needs to be improved. Efforts need to be made to reduce the capture of non-target species such as marine turtles and mammals.

In the light of likely scenarios, climate change, global warming and the rise in sea level might severely impact the Delta and the marine and coastal waters in several ways. With increasing water scarcity, recycling of waste water inland will increase and the coastal zone will be deprived of fertilizing runoff. Stratification with SST rise will enhance oligotrophy in the offshore waters. Red tides will be more frequent in semi-closed embayments. Immigration of erythrean species from the Red Sea to the Mediterranean, through the Suez Canal, will accelerate. The most severe impact will be flooding of the northern Delta lowlands causing immense economic losses and social problems.

The magnitude of the consequences of sea level rise and global warming is that of a

potential National catastrophe. A priority task is to elaborate a long term precautionary strategy to adapt to the various climate change impacts, even if they seem to be remote or uncertain.

There is strong need for a comprehensive programme for research and monitoring focused on the key habitats and ecosystems.

United Nations Environment Programme

Mediterranean Action Plan

Regional Activity Centre for Specially Protected Areas

"Further development of the Ecosystem Approach within the Barcelona Convention"

Step 3 of the Road map for the implementation of the Ecosystem Approach

RAC/SPA Component

Sub-regional report on the "Identification of important ecosystem properties and assessment of ecological status and pressures to the Mediterranean marine and coastal biodiversity in the Adriatic Sea"

June, 2010

Note: The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNEP concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries.

Responsible of the study:
Bayram ÖZTÜRK ,
RAC-SPA International consultant

With the participation of:
Daniel Cebrian. SAP BIO Programme officer (overall co-ordination and review)
Atef Limam. RAC-SPA Project officer (overall co-ordination and review)
Sami Ben Haj RAC-SPA International consultant (overall co-ordination and review)
Zamir Dedej, Pellumb Abeshi, Nehat Dragoti (Albania)
Branko Vujicak, Tarik Kuposovic (Bosnia ad Herzegovina)
Jasminka Radovic, Ivna Vuksic (Croatia)
Lovrenc Lipej, Borut Mavric, Robert Turk (Slovenia)
Silvia de Juan Mohan (Open Seas)
Jordi Lleonart Aliberas (Open Seas)

Mediterranean Action Plan
Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du Leader Yasser Arafat
BP 337 –1080 Tunis Cedex –TUNISIA
E-mail : car-asp@rac-spa.org

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CONTENTS

INTRODUCTORY NOTE

At their Fifteenth Meeting of the Contracting Parties to the Barcelona Convention (Almeria, Spain, 15-18 January 2008), the Contracting Parties decided to gradually apply the ecosystem approach to managing the human activities that could affect the Mediterranean's marine and coastal environment (Decision IG 17/6). They even set up a 7-phase road map for the gradual application of the approach.

The present report was crafted as part of RAC/SPA's active involvement in the process, and its contribution to carry out Step 3 of the road map, which consists of identifying the ecosystem's important properties and assessing the state of the environment and the pressure exerted on it. This contribution particularly involves assessing the ecological state and pressure exercised on marine and coastal biodiversity in the Adriatic Sea.

The document summaries and extrapolates to the countries of Adriatic Sea, the ideas presented in the national reviews prepared by following experts.

Albania, prepared by Zamir Dedej, Pellumb Abeshi, Nehat Dragoti
Bosnia ad Herzegovina, prepared by Branko Vujicak, Tarik Kuposovic
Croatia, prepared by Jasminka Radovic, Ivna Vuksic
Slovenia, prepared by Lovrenc Lipej, Borut Mavric, Robert Turk

Italy's report was evaluated elsewhere. Montenegro's report was not presented and Croatia's report was incomplete (total 26 pages). The information included in the present document regarding these two countries, therefore, are taken from the following reports when available:

- National Action Plans and Reports prepared as part of the Strategic Action Programme for the Conservation of Marine and Coastal Biodiversity in the Mediterranean Region (SAP BIO);
- RAC/SPA's 2009 national reports on vulnerability and the impacts of climate change on marine and coastal biodiversity in the Mediterranean;

However, the thoughts and suggestions included in the national reviews remain the opinions of experts.

Thus, the present document is a summary of the state of the ecosystems in the Adriatic Sea, particularly the biological features and types of habitat that exist there. A second part deals with the analysis of the pressures and impacts on these ecosystems, essentially as regards biological disturbance and emerging problems such as the effects of climate change and modifications of the deep sea ecosystems, given the interest they are arousing worldwide.

This report was drafted for the Regional Activity Centre for Specially Protected Areas (RAC/SPA), by Mr. Bayram Öztürk (International Consultant), supported by Atef Limam, Sami Ben Haj and Daniel Cebrian.

METHODOLOGY

Participatory approach

To carry out step 3 of the road map for applying the ecosystem approach, related to identifying the important properties of the ecosystem and assessing the state of the environment and the pressure exerted on it, the Mediterranean Sea was subdivided into four regions, as a result of a consensus based on biogeographical and oceanographic considerations (2nd Meeting of Government-designated Experts on the Application of the Ecosystem Approach, Athens, 9-10 July 2008). The four regions identified are (i) Region 1: Western Mediterranean; (ii) Region 2: Adriatic Sea; (iii) Region 3: Ionian Sea and central Mediterranean; and (iv) Region 4: Aegean Sea-Levant Sea.

All the Mediterranean countries in their quality as Contracting Parties to the Barcelona Convention were invited to take part in this process, to reach the major objective of Step 3 of the road map, which consists of conferring with each other and gathering pertinent data and recommendations at national, sub-regional and regional level.

The Mediterranean countries were distributed around the four biogeographical and oceanographic regions as follows:

(i) Western Mediterranean: Algeria, France, Italy (Tyrrhenian-Ligurian area), Monaco, Morocco, northern Tunisia and Spain
(ii) Region 2 (Adriatic Sea): Albania, Bosnia Herzegovina, Croatia, Italy (Adriatic Sea), Montenegro and Slovenia
(iii) Region 3 (Ionian Sea and central Mediterranean): Greece (Ionian Sea), Italy (Ionian Sea), Libya, Malta and eastern and southern Tunisia, and
(iv) Region 4 (Aegean Sea-Levant Sea): Cyprus, Egypt, Greece (Aegean and Cretan Seas), Israel, Lebanon, Syria and Turkey.

The national consultants were selected in close consultation with the SAP BIO National Consultants and the SPA/BD Protocol's National Focal Points to ensure an assessment at national level.

At sub-regional level, the role as sub-regional consultant is to to give the necessary technical assistance to the National Consultants to draft the national reports and to draw up a sub-regional assessment documents regarding the Adriatic sub-region.

Tasks and anticipated outcomes

1. National level

Each National Consultant has to draft a national report on an assessment of the state of the ecology and identification of any lacunae concerning the major properties of the ecosystems and associated pressures. The parts to be prepared deal with (i) a section on the state of the ecosystems, particularly their biological features and habitat types, and (ii) a section on pressures and impacts involving biological disturbance and emerging problems such as the effects of climate change and modifications of deep sea ecosystems.

2. Sub-regional level

The Sub-regional Consultant is responsible for (i) coordinating, assisting, guiding and harmonizing the work of the National Consultants in the region under his responsibility, (ii) looking into, revising and ensuring the consistency of the received inputs, and (iii) preparing a consistent draft report for each sub-region and presenting this to RAC/SPA, and then finalizing it in compliance with the remarks made at possible work meetings and RAC/SPA's recommendations.

RAC/SPA has provided the various actors with the necessary advice and directives and helped in harmonizing the work and the inputs. It has indeed provided annotated contents and structures of the national and sub-regional reports.

1. CONTEXT

The ecosystem approach was introduced to improve the way in which human activities are managed in order to protect the natural environment. As with the World Summit on Sustainable Development (Johannesburg 2002), the ecosystem approach has been adopted by many international conventions and regional seas organisations. Its implementing aims to help reach a balance between the needs of human activities and the conservation of the natural environment.

Box 1: The 12 principles of the Ecosystem Approach (CBD Secretariat, 2004)

Principle 1: The objectives of management of land, water and living resources are a matter of societal choice
Principle 2: Management should be decentralized to the lowest appropriate level
Principle 3: Managers should consider the effects of their activities on adjacent and other ecosystems
Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any management programme should:

a) reduce market imbalances which have harmful effects on biological diversity
b) harmonize incentives to encourage the conservation and the sustainable use of biological diversity
c) as far as possible, integrate the costs and advantages within the managed ecosystem.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target
Principle 6: Ecosystems must be managed within the limits of their functioning
Principle 7: Action should be undertaken at the appropriate spatial and temporal scales
Principle 8: Objectives for ecosystem management should be set for the long term
Principle 9: Management must recognize that change is inevitable
Principle 10: Action should seek the appropriate balance between, and integration of, conservation and use of biological diversity
Principle 11: Action should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices
Principle 12: The approach should involve all relevant stakeholders of society and scientific disciplines

The Mediterranean Sea is the largest semi-enclosed Sea, characterized by a narrow shelf, a narrow littoral zone and a small drainage area especially in the northern part. The Sicilian Channel (150 km wide, 400 m depth) separates two distinct basins, the western and eastern and functions as a geographical and hydrographical border between them. This and other channels play a significant role in determining the oceanographic characteristics of each regional sea, such as the Adriatic, Aegean and Levantine Sea. The size of the Mediterranean Sea from west to east, from Gibraltar to Syrian Arab Republic, is about 4 000 km. At its greatest breadth, from the coast of France to that of Algeria, the distance is 900 km. The area of the Mediterranean, including all of its adjacent seas except the Black Sea, is 2 523 000 km^2 and its volume is 3 708 000 km^3, giving a mean depth of 1 470 m .

Oxygen level is almost saturated in the surface layer (6 ml/l in winter and 4.8 ml/l in summer). In deep water the oxygen concentration is about 4.5 ml/l in the western and 4.2 ml/l in the eastern basin. The Mediterranean Sea has seasonal variation in the surface temperature. During summer, warm water (warmer than 20ºC) at the surface creates important stratification of water. During winter, cold water (12–15ºC), which distributes homogeneously between the surface and depth, causes important vertical convections (upwelling), recycling nutrients abundant in the depths.

The circulation of the water masses in the Gibraltar Strait has a vital importance for the biota of the Mediterranean. A permanent surface current towards the east, the entry of superficial Atlantic water into the Mediterranean Sea and a deep current of the Mediterranean water flowing westwards, is remarkable for the water circulation. However, this circulation pattern may change with climate change in near future.

The Mediterranean Sea

The Mediterranean Sea is an oligotrophic sea and has low phytoplankton biomass and low primary production due to weak fluvial supplies and poor surface water input from the Atlantic. The Mediterranean fauna and flora have evolved over millions of years and by the mixture of temperate and subtropical elements include a large proportion (28 percent) of endemic species (Fredj and Meinardi, 1992).

The Mediterranean sea shows the importance of the sustainability of use of goods and services and the potential interest in applying an ecosystem approach and conservation- and management-related measures not only to the areas under state jurisdiction but also to the habitats and ecosystems that lie in waters outside national jurisdiction.

The Adriatic Sea

The Adriatic Sea represents a small but very specific and the most isolated part of the Mediterranean Sea. Due to its specificities it is considered as distinct biogeographical subunit of the Mediterranean Sea (Pérès and Gamulin-Brida, 1973). While Northern Adriatic clearly shows its relationship with boreal region, termophilous elements dominate in middle and southern basin. Due to geomorphology of this area and its main abiotic characteristics, very high diversity of habitats and species has evolved in marine and coastal environment, including significant proportion of endemic elements.

The Adriatic Sea represents only 5 per cent of the Mediterranean Sea. Its northern part is the shallowest, with depths that do not exceed 50 m. The High Adriatic in particular represents only 0.4% of Mediterranean waters; however the specific environmental situation, with the presence of the Po basin, the Venice lagoon and its

shallow waters, demands immediate action to manage and protect this particularly sensitive area. Alongside the Rhone and the Ebro, the Po is one of the three most important Mediterranean rivers in terms of discharge. Roughly one-third of the Mediterranean continental water flows into the northern and central Adriatic Sea. Eutrophication is one of the threat for the Adriatic Sea due to excessive nutrient discharge.

The Adriatic Sea stretches in the NW-SE direction in the length of 783 km, with the surface area of 138,595 km² at the mean sea-level. Its salinity is relatively high - cca 38,3 ‰. North Adriatic is extremely shallow with depths varying from 25 to 50 m and also rather cold (6-12 ºC) because of the influence of cold winds and water coming from Alps. It makes this area unique in Mediterranean and famous for a number of boreal biota. The sea bottom here consists mostly of sand and sand-detritic sediments due to the inflow from the Po River. Although the Adriatic as the whole is oligotrophic sea, its northern part is one of the most productive parts of Mediterranean (Pérès and Gamulin-Brida, 1973). Middle Adriatic is also rather shallow (average depth of 140 m) with the exception of Jabuka Pit that reaches depth of 275 m. South Adriatic depression goes down to 1330 m. The depths of up to 200 m (continental shelf) occupy as much as 73.9 % of the Adriatic. Water temperatures in Middle Adriatic vary from 12-13 ºC and in South Adriatic from 13-15 ºC. The sea bottom along the eastern Adriatic coast is rocky while offshore it is mostly flat with sediments and corallogenic concretions along the islands. Large coral reefs beyond depths of 300 m have also been registered.

On this account, the Contracting Parties to the Barcelona Convention, in their Almeria Meeting (15-18 January 2008) decided to gradually apply the ecosystem approach to the management of human activities that could affect the Mediterranean marine and coastal environment (Decision IG 17/6) and adopted a road map for this purpose (Box 2 below).

Box 2: Steps of the ecosystem approach road map (ECAP)

The ECAP road map adopted by Decision IG 17/6 of the 15th Meeting of Contracting Parties (2008) consisted of the following 7 steps:

Step1: Definition of an ecological Vision for the Mediterranean.

Step 2: Setting of common Mediterranean strategic goals.

Step3: Identification of important ecosystem properties and assessment of ecological status and pressures*.

Step 4: Development of a set of ecological objectives corresponding to the Vision and strategic goals.

Step 5: Derivation of operational objectives with indicators and target levels.

Step 6: Revision of existing monitoring programmes for ongoing assessment and regular updating of targets.

Step 7: Development and review of relevant action plans and programs.

* From this step onwards, it is necessary to consider the appropriate spatial and temporal scale of application of the approach

Step 3 of the road map aims at identifying the major properties of the ecosystems and assessing the state of the ecology and pressures has also been discussed and is being implemented. RAC/SPA has been actively involved in the phases of this approach, in particular as regards Phase 3 of the road map, and it is in this context that the present document has been prepared as RAC/SPA's contribution to this phase.

This contribution consists of preparing a sub-regional documents on 'identifying major properties of the ecosystems and assessing the state of the environment and the pressures exercised on marine and coastal biodiversity in the Adriatic Sea is described in the methodological approach.

In joint agreement with the other MAP elements, the sections handled by RAC/SPA in the present report basically dealt with (i) the state of the ecosystems, especially their biological features and habitat types, and (ii) pressures and impacts, particularly biological disturbance, and emerging issues like the effects of climate change and modifications

2. SCIENTIFIC KNOWLEDGE AND AVAILABLE INFORMATION

2.1. Reference documents and available information

RAC/SPA made available to all the national and sub-regional consultants a wide variety of pertinent documents having international, regional, sub-regional and national pertinence.

A particular attention was paid to the:

- National Action Plans and Reports prepared as part of the Strategic Action Programme for the Conservation of Marine and Coastal Biodiversity in the Mediterranean Region (SAP BIO);
- RAC/SPA's 2009 national, sub-regional and regional synthesis reports on vulnerability and the impacts of climate change on marine and coastal biodiversity in the Mediterranean;
- Reports defining and explaining the ecosystem approach – how it works and is implemented

On the basis of these documents, important information, especially very recent information on the state of the ecosystems, impacts and pressures, was gathered and integrated within the national reports. The documents also constituted a source of vital information for identifying gaps noticed as regards knowledge, funding issues, the expression of urgent actions and needs, conclusions and recommendations.

Documents defining and dealing with the ecosystem approach as a concept were also used by the national experts to set the crafting of the documents within this context. Integrating this conceptual information underlies the entire process as undertaken by RAC/SPA in this third phase of the road map, and will enable the products expected from this activity (national and sub-regional contributions) to be grasped within this perspective. The document produced by the CBD[1] Secretariat is in itself an excellent reference work.

Detailed information of local and national pertinence used in this document mostly comes from the national contributions devoted to the ecosystem approach in Albania, Bosnia and Herzegovina, Croatia and Slovenia.

2.2. Comments

In the bulk, the documentary base used and the knowledge is limited, especially that on biodiversity and those on pressures and impacts, but disparities and gaps still exist at both national and sub-regional levels. Besides, Montenegro report was not presented and Croatia report was incomplete.

[1] The Secretariat of the Convention on Biological Diversity (2004), Approach by Ecosystem (CBD Guidelines), Montreal: Secretariat of the Convention on Biological Diversity, 51 p.

- Variable availability of information at geographical level
  - From one country to the next, the information needed for documentation for the national documents sometimes appears in documents that are difficult to access
  - The bibliographical references used vary from one national contribution to the next;
  - Some countries do not have basic data and a data collecting system.
- Variable availability of information at subject level
  - The number of subject-based or sector-based bibliographic sources varies considerably from country to country and subject to subject. This variability results from the disparity of national capacities generally and the relative availability of specialists for certain subjects. Some subjects are sometimes not well documented because they are expensive to handle or require equipment that is not available to certain countries or regions
  - Some countries scientific knowledge was so limited or fragmented.
  - For some countries, priority issues are linked to natural resources of commercial interest, and most of the means are devoted to such aspects
  - The inventories and data are fragmentary and often do not concern the totality of the marine and coastal places
  - Data and cartography is very poor concerning issues related to high seas and deep seas (status, pressures and impacts)

3. STATUS OF COASTAL AND MARINE ECOSYSTEMS

3.1. Biological characteristics

Similar to the whole Mediterranean, biodiversity hotspots in the Adriatic Sea are characterized by both high levels of endemism and critical levels of habitat loss, and it is thus on them that conservation efforts mainly focus. This high biological diversity is to be related to the several rivers flowing into the Adriatic Sea. This river discharge, however, gives eutrophic characteristics to the sea as well.

The Adriatic Sea is same as the whole Mediterranean, is currently experiencing a decline in the number of species and a deterioration of habitats, related to various human-origin activities, basically uncontrolled urbanization and coastal development, ports, fish farming, pollution and fishing.

In the sections below, a synthesis summary will be given regarding each item followed by a summary of the main features and characteristics that have been presented in the available national reports. For Malta and Italy, there were no available national reports, a tentative of synthesis will be done, when possible based on the information taken from the National Action Plans and Reports prepared as part of the Strategic Action Programme for the Conservation of Marine and Coastal Biodiversity in the Mediterranean Region (SAP BIO) and also RAC/SPA's 2009 national reports on vulnerability and the impacts of climate change on marine and coastal biodiversity in the Mediterranean;

3.1.1. Description of water column biological communities (basically phyto- and zooplankton)

Generally speaking about the Adriatic Sea, the planktonic element (phytoplankton and zooplankton) has been very little studied.

Albania:

The studies for the Albanian algae flora have started on a regular basis after the 1990, on the basis of the establishment of the respective research group on some Universities and the Sciences Academy institutions. Some decades before there had been very few and sporadic studies made by foreign experts, but regarding the coastal and marine studies the data were nearly absent.

More than 440 species or subspecies of Diatoms (70 centricae and 370 pennatea) were described totally along the brackish coastal wetlands (Miho and Witkowski, 2003). More frequent are found the genus *Chaetoceros, Cyclotella*, *Actinocyclus*, *Navicula*, *Nitzschia*, *Amphora, Mastogloia*, etc.

On the analysis of the coastal waters about 111 species had been identified, of which there are 74 Diatoms, 27 Dinoflagellata and 10 species of other groups like cocolitophoridae, silicoplagellatae, eugenophytae, clorophytae. Unfortunately there

are no data published in Albania regarding the zooplankton. Recently a research study started as CoNISMa (2002).

Bosnia and Herzegovina:

There is no data on spatial distribution of phytoplankton and Zooplankton production and chlorophyll a biomass.

Croatia:

Phytoplankton

Complete composition of phytoplankton in Eastern Adriatic is still not known. Diatomeae encompass more than 80% of species. While microphytoplankton (cells >20 μm) is better known, nanoplankton (cells <20 μm) in Croatian waters is very poorly researched. There were some investigations of pikoplankton in coastal and open waters of Middle Adriatic in period 1996-1998 (Nincevic-Gladan et *al*., 2006). Results show that cyanobacteria *Synechococcus* makes even 96% of pikoplankton community. Pikoplankton is much more represented in phytoplankton biomass of open waters (31%) than of the coastal sea (9%).

The *Checklist of phytoplankton in the eastern Adriatic Sea* has been published in 2002 (Vilicic et *al*., 2002). It was based on already published data from very comprehensive catalogue of phytoplankton of Northern and Middle Adriatic (Kerzan and Stirn, 1976). This data was supplemented with more recent information from the period 1981-2000. According to recent insights, phytoplankton of the Eastern Adriatic Sea is composed of 888 determined species. The diatoms are represented with 518 species (330 pennates, 176 centric diatoms), dinoflagellates 254, prymnesiophyceae 101, chrysophyceae 2, raphidophyceae 1 and euglenophyceae 2 species. The checklist is accompanied by information on the general distribution of species in the north, central and south part of the Eastern Adriatic. The sources of data for the checklist were samples collected in naturally eutrophic areas (bays, highly stratified karstic estuaries), in areas with antropogenic influence (harbours), as well as in the oligotrophic Southern Adriatic.

Research of phytoplankton abundance and seasonality in the NE Adriatic Sea in the period 2002–2007 showed its direct relation to the annual regime of the Po River discharge (Vilicic et *al*, 2009). The dominant taxa are the diatoms *Cerataulina pelagica*, *Chaetoceros socialis*, *Chaetoceros vixvisibilis* and *Pseudo-nitzschia* spp., which appear at maximum abundances. Among other phytoplankton, the most common is the coccolithophorid *Emiliania huxleyi* and the dinoflagellate *Prorocentrum minimum.*

Phytoplankton of the Jabuka Pit was investigated in 2003 during the winter mixing of waters as well as in spring period of stratification (Buric, 2007). Dominant species are: *Calyptrosphaera* sp., *Emiliania huxleyi*, *Cerataulina pelagica*, *Chaetoceros socialis* and *Pseudo-nitzschia* spp. Spatial distribution of phytoplankton is connected with the exchange of water masses.

Zooplankton

In the framework of preparation of the First National Report for the CBD, 767 marine zooplankton species have been registered for Croatia (Krsinic, 1997): 220 Protozoans, 117 Cnidarians, 10 Ctenophora, 15 Rotatoria, 18 Mollusca, 340 Arthropods - most of them being Copepodes (224), 11 Chatognatha and 36 Tunicata.

Apart from Protozoans, the best researched group is Copepodes. On the basis of spatial variations in the abundance of the dominant species, three characteristic communities of copepods can be defined in Eastern Adriatiac (Hure and Krsinic, 1998). Biomass of Copepodes correlates with biomass of their predators Chaetognaths, the most abundant being *Sagitta inflata, S. lyra* and *S. minima* (Batistic, 1994). Chaetognats make significant proportion of zooplankton biomass at the end of summer and during the autumn, especially along the coast.

A copepod is *Acartia italica*, the only strictly protected copepod in Croatia. It is the only planktonic copepode in the small marine Lake Rogoznica with characteristic periodical hypoxia and even total anoxia (Krsinic et al, 2000). After the period of total anoxia when massive mortality of all organisms occurs, *Acartia italica* recovers quickly as it is adapted to the extreme conditions. This species has an important role in functioning of specific ecosystem of this small but very important site.

Slovenia:

The Gulf of Trieste has only recently been involved in long-term phytoplankton studies, but it is well recognised that phytoplankton dynamics in the Gulf are mostly driven by freshwater runoff and being the reflection of rapidly modifying hydrological and nutrient conditions in the Gulf of Trieste. The chlorophyll biomass in the surface layer displays two annual peaks. A strong temporal variability is also characteristic for the phytoplankton community structure in the surface layer. The seasonality is similar to that of chlorophyll biomass.

Zooplankton

Few studies were devoted to the microzooplankton populations of the area, but there are not available any special data regarding their grazing impact on phytoplankton. Among microzooplankton oligotrich ciliates are representing the dominant group through the whole year, while copepod nauplii are important mostly in the warmer period of the year. Tintinnids are present more or less in modest abundances only occasionally they may become very abundant. Among such studies (though is not dealing with microzooplankton, but with metazooplankton) it should be mentioned the role of a marine cladoceran *Penilia avirostris*, which is usually a dominant metazooplankton element in the summer period. In that period their abundance is commonly higher than the abundance of copepods.

3.1.2. Information on invertebrate bottom fauna, macro-algae and angiosperms

A limited number of invertebrate bottom fauna, macro-algae and angiosperms groups have been studied in the Adriatic Sea.

Albania :

Data on marine macrozoobenthos of Albania are relatively limited. The most studied groups of macrozoobenthos are echinoderms, decapods crustaceans and molluscs. Data on sponges, cnidarians, bryozoans, annelids and ascidians are poor and collected just recently. Several benthic groups are almost or completely unstudied.
Among the first studies on marine benthos in Albania is that on the echinoderms, by Gjiknuri (1980). In his doctorate he reported the distribution of about 46 echinoderms

species along the Albanian coast. Vaso, during his doctorate theses has studied the Albanian decapods, reporting more than 100 species (Vaso and Gjiknuri, 1993).

A comparative taxonomic and ecological study of molluscs (Gastropods and Bivalve) of the Albanian coastal lagoons was carried out by Beqiraj (2004), where about 77 species were reported. Molluscs and annelids predominate in the species composition of the macrozoobenthos of the Albanian coastal lagoons and the highest abundance has been recorded for molluscs, crustaceans and chironomids (Beqiraj et *al*., 2008).

Bosnia and Herzegovina:

Posidonia oceanica was not recorded in B&H part of Adriatic Sea, and reason for that may be insufficient dissolved salts due to expressed attenuation of sea water from Neretva River. *Cymodocea nodosa* beds can be found in Neum-Klek Bay but these beds are very limited in space. Precise data on endemisms, species of restricted distribution and species of known sharp reduction along last decades were not available since there is no monitoring in B&H which could provide it.

Regarding bottom fauna a number of 219 animal species classified in the following taxonomic categories have been determined in Neum-Klek Bay: Porifera (19), Cnidaria (11), Annelida (20), Echiurida (1), Artropoda (312), Mollusca (91), Tentakulata (6), Echinodermata (29) and Tunicata (12). The most important are Mollusca among which 89 species from 35 families have been registered.

Croatia:

Benthos of the Adriatic Sea has been described very comprehensively in the book *Biological oceanography – Benthos – Benthos bionomy of Adriatic Sea* (Pérès and Gamulin-Brida, 1973). Also there is a lot of new data based on recent research of relevant scientific institutions.

Macro-algae

The most numerous are red algae *Rhodophyta* with 350 registered species out of 816 Mediterranean, including 30 Adriatic endemics (Antolic, 1997). Brown algae *Phaeophyta* are represented with 179 species out of 255 Mediterranean, including 52 Adriatic endemics (Antolic, 1997), while green algae *Chlorophyta* are represented with 134 species out of 209 Mediterranean. All algae listed in the Annex II of the SPA/BD Protocol are strictly protected in Croatia.

There are no endemic marine green algae in Croatia. Two are strictly protected: SPA/BD species *Caulerpa prolifera* and rare species *Penicillus capitatus.*

Between brown algae, the most important is genus *Cystoseira* that has a number of species endemic for Mediterranean or even for Adriatic. Ercegovic has described a number of Adriatic endemic *Cystoseira* species like *C.spicata, C.adriatica, C.jabukae* and others (Pérès and Gamulin-Brida, 1973). Brown algae represent the main element of biocenosis of photophilic algae that is, along with sea grass meadows, the most diverse and ecologically the most important biocenosis (Bellan-Santini et al, 2002). The most significant settlements of brown algae in the Adriatic are those of genus *Cystoseira* spp, *Padina* sp. and *Sargassum* spp.

Important species is the Adriatic wrack *Fucus virsoides*, endemic brown algae for east part of Northern Adriatic, represented in biocenosis of lower mediolittoral rock. It is boreal element, considered to be a pre-Messinian relict and the only *Fucus* population in the Mediterranean.

The most of brown algae are photolytic, but some sciaphyle species are represented in biocenosis of infralittoral algae in deeper sites that form transition to coralligenous biocenosis, like *Flabellia petiolata* and different *Peyssonnelia* species.

Strictly protected species of brown algae in Croatia are: *Cystoseira amentacea var. spicata* (Ercegovic) G. Iaccone; *C. barbata* (Stackhouse) C. Agardh; *C. compressa* (Esper) Gerloff & Nizamuddin; *C. corniculata* (Turner) Zanardini; *C. crinita* Duby; *C. crinitophylla* Ercegovic; *C. spinosa* Sauvageau (Cystoseira adriatica Sauvageau); *C. squarrosa* De Notaris; *C. zosteroides* C. Agardh; *Fucus virsoides* J. Agardh; *Sargassum hornschuchii* C. Agardh; *S. vulgare* C. Agardh and *Laminaria rodriguezii* Bornet.

Red algae are important habitat structuring organisms in Adriatic. Although the most species are sciaphyl, some form the important part of biocenosis of the upper mediolittoral rocks like *Catenella caespitosa*, *Bangia atropurpurea* and *Porphyra leucosticta*. Some species from *Corallinaceae* family, like *Lithophyllum papillosum*, create pink carbonate layers on surface of rocks. For biocenosis of the lower mediolittoral rocks on some sites of outer coasts of Middle and Southern Adriatic islands, important habitat is coraligenous rims created by red carbonate encrusting algae like *Lithophyllum lichenoides*, *Lithophyllum byssoides* and *Tenarea undulosa*. Biocenosis of mediolittoral caves has some characteristic red algae like *Catenella caespitose* and *Hildenbrandia rubra* as well as encrusting coraligenous algae *Phymatolithon lenormandii*. Coralligenous biocenosis of circalittoral hard bottom is based on *Mesophyllum alternans*, *Lithophyllum cabiochae*, *L frondosum* as well as *Peyssonnelia rosa-marina* and *P. rubra*. Circalittoral coarse sands and fine gravels are inhabited with rhodolithes and maërl facies with *Phymatholithon calcareum* and *Lithothamnion corallioides* (Bakran-Petricioli, 2007).

Strictly protected red algae in Croatia are: *Lithophyllum byssoides* (Lamarck*)* Foslie *(L. lichenoides); L. dentatum* (Kützing) Foslie, *L. tortuosum* (Esper) Foslie and *Titanoderma trochanter* (Bory de Saint-Vincent) Benhissoune, Boudouresque, Perret-Boudouresque & Verlaque *(Goniolithon byssoides).*

Status of protected species (adequate to protection status of Annex III species of the SPA/BD Protocol) have following species: *Lithothamnion corallioides* (P.L. Crouan & H.M. Crouan) P.L. Crouan & H.M. Crouan and *Phymatolithon calcareum* (Pallas) W.H. Adey & D.L. McKibbin.

Vascular flora

In the Adriatic there are meadows of four species of marine vascular plants out of nine Mediterranean. The most widespread is the eelgrass *Posidonia oceanica*, inhabiting the bottom covered by coarse sand and gravel up to 40 m of depth. On the sand and sometimes silt seabed the commonest among them are meadows of the lesser Neptune grass *Cymodocea nodosa*, more characteristic for Northern Adriatic. *Zostera marina* and *Zostera noltii* are represented on muddy sands of bays protected from the wind as well as in eurihaline and eurithermic bocenosis.

Posidonia meadows are considered as the most important ecosystem of the Mediterranean Sea and an ecological indicator of sea biodiversity because of their high primary production as well as of the health status of coastal ecosystems.

Invertebrates

Invertebrate fauna of Adriatic is very diverse, but still insufficiently known. So far 5,655 species of marine invertebrates have been recorded in Croatia. According to available data, only one species of sea squirt *Polycitor adriaticus* is stated as endemic to the Adriatic. Invertebrates are best explored at coastal and open waters of Northern Adriatic but poorly explored at river estuaries, pelagic string of islands and deep Southern Adriatic basin.

221 species of sponges are known, some of them being strictly protected: *Geodia cydonium; Sarcotragus spinosulus; Tethya spp.; Axinella cannabina , Axinella polypoides ; Eunapius subterraneus molisparpanis; Eunapius subterraneus subterraneus; Asbestopluma hypogea; Aplysina cavernicola; Petrobiona massiliana* and *Oopsacas minuta. Sponigia officinalis* is still being exploited under the Marine Fishery Act.

Especially interesting are sponges *Oopsacas minuta* and carnivorous *Asbestopluma hypogea* that are usually typical for deep water of the bathyal zone but recently species has been found in several littoral caves in Croatia (Bakran-Petricioli et al, 2007). Because of morphology of these caves, the cold winter water stays there the all year long so these habitats represent the enclave of bathyal in infralittoral/circalittoral area.

Corals are very important habitat structuring elements. In 2008 the Red list of threatened corals in Croatia was completed (Kruzic, 2008). Even 65 species have been classified in IUCN categories CR, EN and VU. Critically endangered (CR) are: *Eunicella verrucosa*, *Sagartia luciae*, *Paramuricea macrospina, Pachycerianthus multiplicatus, Antipathes subpinnata, Gerardia savaglia, Dendrophyllia ramea* and *Coralium rubrum* that is still being exploited under the Marine Fishera Act. Strictly protected species are: black corals *Antipathes dichotoma*, *A. mediterranea* and *A. subpinnata* as well as *Astroides calycularis* and *Gerardia savaglia*.

Especially important habitat structuring species is *Cladocora caespitosa*, a colonial scleractinian coral. Due to the symbiotic zooxanthellae, sizeable bioherms of this species can be found. The *Cladocora caespitosa* bank in the lake Veliko jezero in the Mljet National Park is significant for its large size of 650 m2. It spreads at depth from 4 to 18 meters and is one of the largest banks of this coral found in the Mediterranean Sea. (Kruzic and Pozar-Domac, 2002).

Red gorgonian *Paramuricea clavata* and Yellow sea fan *Eunicella cavolini* also form rich coralligenous communities around Croatian islands. The latter one is particularly significant for coralogenic biocenosis of the deep craggy seabed and in the biocenosis of semi-dark caves. Coral trees and branches are often overgrown by other organisms and also represent sites for depositing cephalopod and cartilaginous fish eggs.

Deep sea is still poorly investigated so it is not sure if deep sea coral reefs are distributed in Eastern Adriatic. The elements of this biocenosis deeper than 300 m (so called ‘white corals’ are known from the Jabuka Pit and area between Lastovo and Palagruza islands (Bakran-Petricioli, 2007). Characteristic species are *Lophelia pertusa* and *Madrepora oculata.*

Bryozoans that are also important habitat structuring elements belong to the least known phyla in the Adriatic Sea. The list of Bryozoans with 184 species was published in 2001 (Novosel and Pozar-Domac, 2001) but today there are 263 species registered. *Hornera lichenoides* is strictly protected species.

The Adriatic decapod fauna shows a high diversity. The checklist was recently supplemented (Kirincic and Stevcic, 2008). So far, 241 decapod species have been noted, including recently recorded new species for the Adriatic Sea as well as eight aliens from Asian and North American waters. Up to now, no Lessepsian migrants have been noticed. Several species are being exploited under the Marine Fishera Act like: *Maja squinado, Homarus gammarus* and *Palinurus elephas.*

Strictly protected benthic species from other groups of marine invertebrates are: *Asteroidea - Asterina panceri* and *Ophidiaster ophidianus* ; *Bivalvia - Pholas dactylus, Lithophaga lithophaga* and *Atrina pectinata (Atrina fragilis)* ; *Gastropoda - Erosaria spurca, Luria lurida, Zonaria pyrum, Charonia lampas (Ch.rubicunda, Ch.nodiferum), Charonia tritonis (Ch.seguenziae), Ranella olearia, Tonna galea , Mitra zonata, Pinna nobilis* and *Pinna rudis*.

Slovenia:

Despite relatively long tradition of macroalgal studies in the Slovenian part of the Gulf of Trieste, the number of species known to inhabit the area is still not ascertained. According to Matjašič et *al.* (1975) and Vukovič (1984) at least 277 algal species are known to inhabit Slovenian coastal sea.

Five marine angiosperms are known to inhabit Slovenian coastal sea and Slovenian coastal wetlands: *Posidonia oceanica, Cymodocea nodosa, Nanozostera noltii, Zostera marina* and *Ruppia cirrhosa.* Among them only *C. nodosa* is widely distributed in the area, whereas others are restricted to particular habitat types. *Ruppia cirrhosa* inhabits various salt-marsh habitats such as basins and ponds, found in hyper-saline environment. *Zostera marina* is considered to be a rare species present only in the form of small “islets”, mainly in the mouths of rivers and streams. *Nanozostera noltii* is on the other hand quite common sea-grass occurring in different parts of the Slovenian coastal sea. The most endangered sea grass in the studied area is certainly *Posidonia oceanica*. It is present only in a restricted sea grass meadow along the coastal road between the towns Izola and Koper. The sea-grass meadow is embraced with a dense meadow of *Cymodocea nodosa*, forming a pattern of a “leopard spot”. An approximately 1 km long meadow is restricted in a depth range from 0.5 to 4 m.

The soft bottom communities in the Slovenian part of the Adriatic seas were studied mostly in seventies and eighties in the last century. The studies covered mostly the meiofauna and soft-bottom macrofauna in bays of Koper, Izola and Piran. Particular interest has been given to the impact of sewage outfall on benthic communities. There are also some specialist works, dealing with different taxonomic groups such as polychaets, echinoderms and tunicates. The hard bottom communities deserved less attention. As a result of such studies some checklists of fauna are available for certain groups. Recently, due to the responsibilities of MS to assess the ecological quality of water bodies in accordance to European Water Framework Directive (WFD), a plethora of new samplings have been performed in the area, resulting in a huge dataset of soft-bottom macrobenthic animals and hard-bottom fauna, as well.

The hard bottom communities are less studied and only few reports are published in that regard. There are certain habitat structuring species known as bioconstructors and bioeroders. The main such species is the mussel date (*Lithophaga lithophaga*), which is boring burrows in the sandstone. Due to the exploitation of this species in the past, many huge rocks were fragmentated into smaller pieces, which were subsequently less interesting for colonization of benthic organisms. Another habitat forming species in the Slovenian coastal area is the Mediterranean Stony coral (*Cladocora caespitosa*) which forms a unique facies with this species in the biocoenosis of photophilic algae (Lipej *et al.*, 2006) in the Natural Monument of Cape Madona.

3.1.3. Information on vertebrates other than fish

Albania:

Albanian marine and littoral habitats are frequently visited by the rare marine mammals. The Mediterranean monk seal (*Monachus monachus*) has been a visitor of coastal waters in Karavasta region and in the Ionian Sea (Stillo and Qefali capes in Saranda, Palasa and Karaburuni) (Cebrian, 1998). Although the Monk seal is a very rare visitor in Albanian waters, it is thought that the coastline from Stillo Cape to Karaburun peninsula at the Ionian Sea offers several caves as potential habitats for resting shelters (UNEP MAP RAC/SPA. 2005).

There are no specific studies on cetaceans in the Albanian waters. Nevertheless, occasional surveys, stranding and accidental entrapments in fishing gears have confirmed the presence of five species of cetaceans in Albanian waters: the short-beaked common dolphin (*Delphinus delphis*), the common bottlenose dolphin (*Tursiops truncatus*), the striped dolphin (*Stenella coeruleoalba*), the sperm whale (*Physeter macrocephalus*) and the Cuvier's beaked whale (*Ziphius cavirostris).* Three species of cetaceans, occurring also in the Albanian waters, are identified by ACCOBAMS as the species in greatest danger of disappearing from the Mediterranean: *Delphinus delphis, Tursiops truncatus* and *Physeter macrocephalus*.

The loggerhead turtle (*Caretta caretta*), in recent reports based on their stranding and catches in the waters around Italy, it has been suggested that the Ionian/South Adriatic Sea area may be an important developmental oceanic habitat for the turtle population nesting on Greek beaches. The current status of nesting in Albania is unclear and remains to be quantified. The sea turtle was commonly found in Patoku Lagoon where about 250 individuals had been monitored during the last 5 years. In this lagoon, the green turtle *Chelonia mydas* has been also recorded several times in the last years. Leatherback turtle *Dermochelys coriacea* is a very rare visitor in Albanian waters.

Bosnia and Herzegovina;

For the presence of marine mammals it can be said that one species *Monachus monachus* (from the family Phocidae) was once recorded in Neum-Klek Bay and two marine mammals species from the family Delphinidae (dolphins), based on very old data. Also, there are some data that in Bosnian part of the Adriatic Sea was recorded

the presence of 4 mammal's species, but not the exact names of the species. Recent and precise data on status of marine mammals' species were not available

Since turtle *Caretta caretta* can be found in Mali Ston Bay, probably it is also present in the Bosnian part of the Adriatic Sea.

Croatia:

One of the most critically endangered species in the Mediterranean, the Mediterranean monk seal *Monachus monachus* has critical habitats in Croatia (Cebrian, 1995, Cebrian, 1998) and has been sighted in recent years in the Croatian coast (Cebrian, 1995. Antolovic et *al.*, 2010).

Slovenia:

The most common marine turtle species is the loggerhead turtle (*Caretta caretta*). It can be found in the area mainly from May through October (Žiža et *al.*, 2001). The regular monitoring of the species began in 1998. The majority of loggerhead turtle specimens are juveniles in the size range from 20 to 50 cm. The second marine turtle is the leatherback turtle (*Dermochelys coriacea*), which was only recently confirmed by two specimens for the very first time in Slovenia.

As for marine birds, the Mediterranean shearwater (*Puffinus yelkouan*) occurs only seasonally, from July to November. The data on this species are rather scarce since it is only rarely approaching the coast (Makovec, 1995). The regular monitoring on the yellow-legged gull (*Larus cachinnans*) in its breeding ground in a coastal wetland Sečovlje salina started from 1986, when the first nesting pairs were recorded. For many previous years, the number of breeding pairs has been more or less exceeding the carrying capacity of the salina (more than 200 breeding pairs), resulting in the fact that gulls are becoming an increasing threat for other salina breeders such as terns. Last year the number of pairs fell drastically to only 50 pairs (Iztok Škornik, *personal communication*). Two other important breeders are the common tern (*Sterna hirundo*) and the little tern (*S. albifrons*). The breeding population of the first is more or less stable or showing a slightly increase in the very last years, whereas the trend of the later is growing increasingly (Iztok Škornik, *personal communication*).

As for cetaceans, the Slovenian part of the Gulf of Trieste is inhabitated regularly only by one species, the bottlenose dolphin (*Tursiops truncatus*), whereas other cetaceans are only sporadically or rarely observed in the area. There is a regular monitoring of this species, performed by Morigenos, a NGO, dedicated to the research, monitoring and conservation of marine mammals. There is an evidence of more than 100 specimens, identified by the mean of photo-identification. There is going on a systematic and comprehensive research on this species with some issues, which have been already published (for example Genov et *al.,* 2008).

Other dolphins known to be reported in the area are the striped dolphin (*Stenella coeruleoalba*), the Risso's dolphin (*Grampus griseus*) and the Common dolphin (*Delphinus delphis*). All of them are known for the broader area of the Gulf of Trieste, however, only from scarce records. While the Common dolphin has been almost completely extirpated in the area, there is an increasing trend of records of striped dolphins in the Gulf (Francese et *al.*, 2007).

Other cetaceans including baleen whales were only rarely reported for the area. The last record of the Fin whale (*Balaenoptera physalus*) occurrence in the area is from 4th November 2009. This species has been previously recorded in several occasions (see Lipej et *al.*, 2004). The second species of baleen whale was the Humbpack whale *Megaptera novaeangliae*) which was extraordinarily observed for almost two months in the Slovenian part of the Adriatic Sea (Genov et *al*., 2009). This was only the second record of this species in the Adriatic Sea.

3.1.4. Temporal occurrence, abundance and spatial distribution of exotic, non-indigenous and invasive species

Same as habitat destruction through pollution or anthropogenic effects, the introduction of species is considered as a nuisance and disruption to biodiversity.

The number of introduced species in the Mediterranean has increased spectacularly since the start of the last century. Their distribution varies from country to country. They have been mainly introduced through three pathways: (i) by maritime transport (fouling and ballast water), (ii) through intentional introduction such as fish farming, and (iii) through the Suez Canal.

Albania:

There are no major data regarding this point. The most evidently identified problems are related to the genus *Caulerpa*. Last years it has been identified that a large distribution of the invasive algae (tropical seaweeds) *Caulerpa racemosa* var. *cylindracea* developed mainly on “dead mattes” from 2 m to 21 m depth (Kashta et al., 2005; 2007). On the other hand, there are only a few observations of the most dangerous species *Caulerpa taxifolia* that is substituting the *Posidonia* meadows in some cases.

Meanwhile in this coastline was present the seaweed *Halophila stipulace* which came here in the 1980’s from the Indian Ocean. Its presence in this coastline stresses the northeast point of the Mediterranean Sea.

There is no monitoring or any data collection for alien invasive species but most of the information have been gathered during some projects related to the marine biodiversity.

Bosnia and Herzegovina:

Invasive species or species non-indigenous may be carried in ballast water, but since there is no seaport at B&H coastal area it is unlikely that these species are present in its marine area, even though there was no specific research on this issue in last 20 years.

Croatia:

Alien mollucs occurrence of *Pinctada radiate* was reported (Doğan and Nerlovic**,** 2008). *Ficopomatus enigmaticus* were recorded at two locations in the Krka river estuary and Neretva river delta (Cukrov et *al*., 2010). Croatia has also joined the

GloBallast Partnership (GBP) to reduce the risks and impacts of marine bio-invasions caused by international shipping in the Adriatic Sea

Montenegro:

Invasion of alien species is a growing threat for Montenegro and needs to be investigated.

One of the most successful lessepsian migrants in the Mediterranean, *Fistularia commersonii* indicates the spreading of this species in the Montenegrine water (Jaskomovic et *al*., 2008). Rapid population explosion at invaded areas and potential effects on the local fish fauna are emphasized. In addition, *Rapana venosa* entered Mediterranean Sea, and settled in the brackish parts of the upper Adriatic Sea. It was also observed in the Adriatic coast of Montenegro in 2008. This species may have some detrimental impact to the native oyster and mussel beds as it did in the Black Sea previously. Similarly, *Caulerpa racemosa*, a species of algae that has recently introduced itself to the Montenegrin coast also may have adverse impacts on the native biota.

Slovenia:

Up-to-date the number of alien species is still rather poor in comparison with other states. The first reason lays in the fact that Slovenia covers only a very small portion of the Adriatic Sea, while the other reason seems to be a rather scarce research in that regard. Since the NIS are occurring only rarely and with single specimens it is at the time impossible to discuss on temporal and spatial distribution of such species. However, a checklist of all such species exists and it is complemented on continuous basis.

The colonization of the Mediterranean Sea by Indo-Pacific and Red Sea species *via* the Suez Canal, known as Lessepsian migration, is an ongoing process that has considerably enriched the biodiversity in the Mediterranean Sea. The temperature is the most important abiotic factor determing the dispersal of Lessepsian fish (Golani, 2002). Changes in the Adriatic ichthyofauna have been recorded and among that some Lessepsian fish species were recently reported. In August 2007, a specimen of *Terapon theraps*, was captured by trawl in Slovenian coastal waters. There are some NIS such as epibionts on ship's hull. One of such species is *Ficopomatomus enigmaticus*, which inhabits the brackish habitats in Slovenian coastal wetlands. Another vector of introduction related to maritime traffic is ballast water.

There are also some species which were purposely or accidentally introduced in the area by mariculture. The former example of introduction is the Japanese Oyster (*Crassostrea gigas*), known to inhabit many shallow areas in the Slovenian coastal sea, while the example of the accidentally released species are certain algae such as *Falkenbergia ruflolanosa*. The mosquito fish *Gambusia hoolbroki* is an example of the introduction of NIS by means of biocontrol.

3.1.5. Fish including mollusks and shellfish species of commercial interest

In the Adriatic Sea, fisheries is a growing sector with both fish farming and fishing. Besides, some lagoons are also exploited for fisheries purposes. Sea bream and sea bass are common farmed species. Oyster and mussel are also cultivated. There are not many industrial type fishing boats and most of them are artisanal type. Illegal, unreproted and unregulated fisheries have become common practices.

Albania:

The ichthyofauna of Albania is well studied and about 313 species have been recorded. About 64 of these are freshwater species and other 249 fish species from marine waters of Albania. As mention before the marine bottoms vary from north to south on our seashore; while in the north the shelf is wide and generally with soft bottoms, reaching up to 200m isobars, in the south the sea is deeper and the bottoms are hard. The marine ichthyofauna consists of a number of species and subspecies, 100 of which are important for the fishing industry. However, the majority, which includes a small number of rare species, are not important for fishing.

The fish production in the last 5 years, even is increased, has not yet succeeds to reach the level of the period before the year 1990 with 10.400 ton. The actual production is equal to 74% of the production before '90 (MoEFWA, 2009). The bottom fishing is increased but there is a considerable decrease for the small pelagic fish. The fish stock data are, due to the lack of funding, are gathered mostly from the donors' projects but there is no continuity and scientific base monitoring, which lead to a difficulty in presenting accurate data on fish structure population and abundance. The official data available are those from the Mediterranean international trawl survey (MEDITS), a program aiming to support the fish management in the Mediterranean area (MoEFWA, 2009).

The table below presents the total distribution of fisherman by vessels type and length classes of their nets (MoEFWA, 2009).

Type of boats	Number of fishermen				**Total number**	**Total %**
	>12m	>12m %	<12m	<12m %		
Purse Seiners	0	0%	4	1%	**4**	1%
Seiners Other	2	2%	31	5%	**33**	5%
Trawlers	9	8%	502	86%	**511**	72%
Gill netter	83	70%	45	8%	**128**	18%
Long liners	14	12%	2	0%	**16**	2%
Multipurpose	9	8%	3	1%	**12**	2%
Unknown	2	2%		0%	**2**	0%
TOTAL	119	100%	587	100%	**706**	**100%**

The most common and commercial fish are *Sardina pilchardus sardina, Engraulis encrasicholus, Merluccius merluccius, Sparus auratus, Dicentrarchus labrax, Mullus barbatus, Mugil cephalus, Mugil labrosus*, *Anguilla anguilla*, *Lithognathus mormyrus, Solea* sp., *Aphanius fasciatus, Lichia amia, Pagrus pagrus, Arnaglosus laterna*, etc.

- Sardine (*Sardina pilchardus sardina*) is one of the most important fish for the fishing industry, which is found along the Albanian coast and mainly in Vlora and Shengjin 30-80m deep. It is more frequently found from 50-70m deep.
- Anchovy (*Engraulis encrasicholus*) is another small pelagic of a special significance for fishing industry, occurring from 100-300m deep and more often 50-120m deep.
- The European codfish, *Merluccius merluccius* is also important for fishing. It occurs along the Albanian coast, particularly in Vlora, in Buna from 50-350m deep and more often occur from 70-150m deep.
- *Dicentrarchus labrax*, occurs along the coast up to 60m deep and mainly occurs 20m deep and in coastal lagoons.
- Sparidae species, such as *Sparus auratus*, *Diplodus* spp, (five species), *Pagellus* spp. (three species) *Dentex* spp. (three species etc occur mainly in the near coastal area.
- Red Mullets, *Mullus barbatus* and *Mullus surmuletus*, occur along the whole coast, mainly on the Adriatic from 20-150m deep and mostly in the rocky and muddy bottoms from 5-60m deep.

The shellfish (mostly sepia species) is also a very important part of the commercial fish species in the country but is not monitored or numbered in the existing documents.

Fishing in Albania is primarily marine fisheries, although lagoon and inland fishing does take place on a limited scale. During recent years aquaculture is being increasingly promoted with particular focus on carp fingerlings and fish for general consumption (including sea farms). Currently there are 58 Albanian fish farms: 9 fish farms, 3 carp fingerling hatcheries and 46 for trout culture. Albania's domestic fisheries production in 2006 was approximately 7 699 tonnes, of which 5 729 from capture and 1 970 from aquaculture. In addition, fishery imports in 2003-2007 totalled an average of about 13 559 tonnes, while fish exports stood at 4 382 tonnes. Fishery imports in 2006 totalled about 16 347 (1 000 USD) while exports was 23 914 (1 000 USD) with a net balance of 7 567 (1 000 USD). In 2003-2005, average per capita supply was 4.5 kg/year (FAO, 2008).

During the last ten years, there has been fishing along the whole marine stretch with a depth of 2-30 meters, which has led to the depletion of the breeding grounds of Sparidae, Soleidae, Mullidae, and other families. The breeding grounds of *Posidonia oceanica* have also been severely deteriorated because of changes in the structure of the fishing fleet. More than 50% of fishing boats have small power motors (100 HP) and hence are able to apply deep fishing techniques (trawling) in shallow areas since they are unable to fish in zones more than 50 meters deep. It is evident that the Albanian fishing fleet is characterized by a high presence of trawlers (62%) followed by gill-netter (28%). A good part of fishing fleet of Albania is concentrated in its fishing activity, illegally, in the shallow waters in front of communication channels of the lagoons with the seas, fishing in distance less than 3 miles from the seashore. Consequently, the natural regeneration and repopulation of the coastal lagoons is seriously damaged, and fishery resources have depleted in all the lagoons (MoEFWA, 2009).

Artisanal fisheries are expanding along the coast and exploit the shallow area of the sea up to 2 sea miles from the shore in dependence of the structure of the zone,

particularly as the coasts become much more populated while the highest part less. There are about 250 small boats that are used for this kind of fishing (MoEFWA, 2009). The small scale or artisanal fisheries category until now was neglect due to the small quantity of fish caught from them and the final destination of the production, which is almost for familiar consumption as well as Sportive Fishing which is included in the same category with artisanal fisheries. Artisanal fishery, during the last years, is increased caused from the low employment that exists in Albania as well as in the coasts of the seas.

In Albania there does not exist a great culture of fishing mollusc, but mostly they have been farmed in some particular areas. Before 1995 there were 5 particular boats equipped with a tool named “turbosofiante” operating in this field and damaging the bottom habitats. In 1995, as a result of the drastic reduction in number and the closing of EU market for veterinary reason, this boat activity was stop and with the regulation No 1, data 29.03.2005 of the Minister of Environment this kind of fishing is forbidden (MoEFWA, 2009). Also Albania is not allowed to export mollusc from the country due to EU rules and requests. On the other hand the development of bivalve culture farming has been cultivated since the beginning of the 1960s in the coastal lagoon of Butrint where fixed structures are being used for the production of Mediterranean mussel (*Mytilus galloprovincialis*). Due to the excellent environmental conditions in this lagoon, about 80 fixed concrete units were constructed here during the 1970s and the production has grown steadily, reaching a maximum of 5 000 tonnes/year by the end of the 1980s.

The last 5 years the gathering of the species *Litophaga litophaga* (which means "stone-eater") is much spread and is causing a lot of damage to the rocky coast due to the destruction of the habitat for their extraction.

Bosnia and Herzegovina:

Not much data about fisheries is available but 176 fish species have been reported.

Two fish farms for sea bass and gilthead sea bream rearing exist, together with several low scale mussel rearing sites (*Mytilus galloprovincialis)* in Neum-Klek Bay (there are also very close mussels and oysters (*Ostrea edulis*) farms in Mali Ston Bay in Croatia).

Precise data on abundance and spatial distribution and age/size structure of fish including mollusc and shellfish species were not available since there is no monitoring in B&H which could provide it.

Slovenia:

The fishing of small pelagic fish is performed by three types of fishing gears. Among the gears used the drift nets are the most primeval. The target species for this gear with very good selectivity is *Sardina pilchardus (*Marčeta, 2002). The next types are purse seines, used for European pilchard, European anchovy, Atlantic mackerel, chub mackerel, and horse mackerels. Two pairs of midwater trawlers are used for fishing in international waters of North Adriatic Sea. They are working around the year following the target species - European pilchard. The bottom trawl fleet (23 trawlers in 2001) is fishing from September to February.The most important species

in their multi-specific catches are musky octopus, common cuttlefish, and various demersal fish species. The number of small scale fishermen is approximately 80.

Croatia:

No data were provided. It is known, however, that bluefin tuna farming (fattening) is well practiced in Croatia. Impact to the coastal ecosystem has also been reported.

Montenegro:
No data provied

3.2. Habitats

The Adriatic Subregion possesses very peculiar habitats. In the context of the tools developed by the Regional Activity Centre for Specially Protected Areas (RAC/SPA), a reference list of 27 major types of benthic habitat was made, to help the Mediterranean states in drawing up inventories of natural sites of conservation interest (UNEP-MAP RAC/SPA, 2002). The SAP BIO Programme (UNEP-MAP RAC/SPA, 2003) had identified among its priority actions the making of a complete, integral inventory of its Mediterranean habitats, including mapping their spatial distribution and the cohort of species associated with each habitat.

The marine and coastal areas of the Adriatic Subregion contain the most typical marine and coastal Mediterranean habitats such as:

Magnoliophyte meadows: These are among the most productive coastal ecosystems in the marine environment. The available data on these habitats is very heterogeneous on a regional scale, and in certain countries like Bosnia and Herzegovina have not found. All national reports contains meadows in the Adriatic Sub region reports.

- The *Posidonia oceanica* meadows are considered to be the Mediterranean's most important ecosystems. *Posidonia oceanica* is endemic in the Mediterranean. It is present in Albania and Slovenia. Annex I of Directive 92/43/EEC describes meadows of *Posidonia oceanica* as a priority habitat type. Posidonia meadows do not appear in areas with low salinity and weak light penetration due to pollution. The ecological parameters that affect the distribution of the upper and lower limit of the meadows as well as their density are light and hydrodynamic conditions. According to the Barcelona Convention typology, in the habitat type "Posidonia meadows" (BC type III. 5. 1) two ecomorphosis are described: The ecomorphosis of striped meadows (III. 5. 1. 1.) and the ecompphosis of barrier-reef meadows (III. 5. 1. 2.). A facies of dead "mattes" without much epiflora and an association with *Caulerpa prolifera* has also to be added.
- The *Cymodocea nodosa* meadows are second after *Posidonia*. These meadows are recorded in Albania (less spread than Posidonia) and Slovenia,
- The *Halophila stipulacea* meadows. This Lessepsian species, restricted to specific areas has been sighted in Albania (small populations in Saranda Bay and in Vlora Bay (Kashta et *al*, 2005)).

- Coralligenous communities: These biogenic constructions constitute the second most important hotspot of specific biodiversity in the Mediterranean after the Posidonia meadows. The coralligenous habitats and bioconcretions (pre-coralligenous populations, shelf coralligenous, associations with rhodoliths – maërl facies, association with rhodoliths – *pralines* facies, association with rhodoliths – *Lithothamnion minervae* facies, association with *Peyssonnelia rosa-marina* – free Peyssonneliaceae facies and big bryozoan facies of the coastal detrital bottoms) are being studied in the Adriatic Sea. They have been also recorded in Ionian part of the Albania. In Slovenia, *Cladocora caespitosa,* biocoenosis of the coastal detritic bottom and biocoenosis of the muddy detritic bottom and coralligenous biocoenosis (=precoralligenous formations have been reported.
- *Cystoseira* forests: They can occupy large areas in the marine ecosystems, where they form highly productive communities with remarkable biodiversity. Species of the *Cystoseira* genus species are in a speciation process which has led to many varieties within a single species and these algae present significant morphological variability. *Cystoseira amentacea* sp. *spicata* and *Cystoseira crinita* have been reported in Albania (Kashta et *al*, 2005). In Slovenia, biocoenosis of infralittoral algae with *Cystoseira crinita* also reported. In Bosnia and Herzegovina, *Cystoseira barbata* and *C.crinata* reported in the biocenosis of infralittoral area.
- *Zostera nana* and *Zostera noltii*: Zostera meadows are found in Bosnia and Herzegovina, as biocoenosis of mediolittoral detritic bottom. The association with *Zostera marina* was observed in Slovenia.

Sea caves: Peculiar habitats in the submerged karst characteristic for the Croatian side of the Adriatic Sea are anchihaline caves, sea caves, cold sea caves and pits with bathyal elements, *vruljas*, karst estuaries, submerged river canyons, submerged tuffa barriers, marine lakes, and bare karst in the sea.

Coastal lagoons and marshes: In Albania, these are important transitional water systems at the mouths of the Drini and Mati rivers. These coastal lagoons which cover 15.000 hectares have economic and ecological interest for Albania and constitute important centers for fishing. Besides, these are important nestling places for birds. The lagoons of Patok and Karavasta are important habitats which need protection.

In the Adriatic subregion, several habitat types have been identified, among which wetlands, lagoons, sea caves, cold seep areas are found. However, more scientific studies are needed.

4. PRESSURES AND IMPACTS

The ecological disturbances are several and diverse. In the Adriatic Subregion, eutrophication, overfishing and illegal, unreported and unregulated fisheries are considered as major ecological disturbance.

4.1. Biological disturbance

The biological disturbances described below focused on non-native species, the impacts of fishing activities and aquaculture and address the effects of climate changes on biodiversity as an emergent issue. Unevenly documented, data and information are at varying stages of elaboration and development but may nevertheless exhibit with interesting trends to understand.

4.1.1. Non indigenous and invasive species

Alien species is a growing threat for biodiversity, human health and socio- economic conditions. Their distribution varies from country to country. In the Adriatic Subregion, most countries reported several alien species. In some countries, such as Bosnia and Herzegovina, almost no information was available.

Inventories of alien species have been unevenly documented in national reports. They include *Caulerpa taxifolia* and *C. rasemosa*. Impact of the two algae species, however, to the marine biodiversity in the Adriatic Subregion, is not clearly known.

Lessepsian fish migrants and venomous fish species has been found in the Eastern, and even in the Central, Mediteranean Sea. Those species need to be monitored in the Adriatic Subregion as well.

Irregular jellyfish occurrence has become more frequent in the northern Adriatic Sea, including alien comb jellies *Mnemiopsis leidyi* and *Beroe ovata*. This gelatinous invasion is one of the threats for the marine biodiversity and fisheries. Whether these two species have established viable populations in the area is not known but this needs to be investigated.

The cubozoan, *Carybdea marsupialis,* was firstly recorded from the Adriatic in the mid-1980's and now an obnoxious stinger. Besides, *Pelagia noctulica* is increasing again. The global trend towards high abundance of jellyfish might also be correlated with overfishing. Jellyfish and fish interact both as predators and competitors of each other. The removal of large fish, due to overfishing, is opening an ecological niche for jellyfish (Boero et *al*., 2008).

4.1.2. Fisheries on target and non-target species

Fisheries sector is rapidly growing in the Adriatic Subregion due to high demand during the tourism season and most of the government substitute fisheries sector. Thus may result in serious overfishing in the coming years.

4.1.2.1. Direct effects of over-fishing on the target species

Illegall, unreported, unregulated fisheries is one of the major issues and should be controlled and more stringent measures is requested within shallow waters and lagoons in Albania. Banning and limitation of some fishing techniques, temporal closure of fishing activities in some areas, establishment of no fishing zone are also needed. Among the migratory fish risking to extinct and require full protection is the sturgeon (*Acipenser sturio*) and Adriatic sturgeon (*Acipenser naccari*), that occurs in Buna of Shkodra Lake, where they migrate for reproduction. Among cartilaginous fish species *Carcharodon carcharas* and *Galeus melastomus* are under the protection (Arapi et *al*., 2006).

Invertebrates in the Croatian water are threatened by overexploitation, destruction of habitats due to economic use and tourism. Most vulnerable of the economically important species are the prawn *Nephrops norvegicus* and scallop shell *Pecten jacobaeus*, and In some areas, divers have almost completely eradicated lobster colonies *Homarus gammarus* and *Palinurus elephas*. Despite the longstanding legal protection of noble pen shell *Pinna nobilis* and the dateshell *Lithophaga lithophaga*, these species are still illegally collected.

4.1.2.2. Indirect effects of fishing

By-catch is a serious problem in Slovenia. There are many known cases of species suffering from by-catch. Some data are available for the loggerhead turtle (*Caretta caretta*) and the bottlenose dolphin (*Tursiops truncatus*). Besides , the problem is even more crucial for shark and ray species in the area. Many rays are continuously discarded in the sea, with rather negligible possibilities for survival. Some of the species recorded as byctach are the basking shark (*Cetorhinus maximnus*), thresher shark (*Alopias vulpinus*), blue shark (*Prionace glauca*), bull rays (*Pteromylaeus bovinus*), eagle rays (*Myliobatis aquila*) and pelagic stingray (*Dasyatis violacea.*

The most common and commercial fish are *Sardina pilchardus sardina, Engraulis encrasicholus, Merluccius merluccius, Sparus auratus, Dicentrarchus labrax, Mullus barbatus, Mugil cephalus, Mugil labrosus*, *Anguilla anguilla*, *Lithognathus mormyrus, Solea* sp., *Aphanius fasciatus, Lichia amia, Pagrus pagrus* and *Arnaglosus laterna.*

Recently total 28 shark species were confirmed from the Adriatic Sea and the Adriatic was supposed to be nursery and spawning areas for many large shark species, such as *Carcharhinus plumbeus*, *Alopias vulpinus*, *Prionace glauca*, *Oxynotus centrina* and *Lamna nasus* (Soldo, 2006).

4.2. Emerging issues

4.2.1. Climate change effects

The shores and marine areas of the Adriatic countries contain rich and diversified biodiversity. This heritage is already subjected to great pressure. But the inventories are generally sketchy, incomplete and/or obsolete for few countries, and thus do not enable us to envisage a systematic, exhaustive monitoring of the effects of climate change (CC) on marine and coastal biodiversity. CC can adversely affect places like the city of Venice and several lagoons due to flooding and coastal erosion. Marine and coastal creatures lives in the lagoons and delta ecosystems will be severely

impacted, such as eels, mullet fish and others. Besides, coastal wetlands may be impacted from the sea level rise.

One of the significant indicator of CC in the Mediterranean Sea is tropicalization. Bello et *al.* (2004) reported that the tropicalization of the Adriatic Sea is confirmed by the population expansion northward along its south-western coast of the some resident species (bony fishes *Thalassoma pavo* and *Sparisoma cretense*, a gastropod species *Stramonita haemastoma*, a cephalopod species *Octopus macropus*, and the short-term resident *Caulerpa racemosa*, a chlorophyte) and the settlement in the province of Bari of three tropical dinoflagellates (*Ostreopsis lenticularis, Coolia monotis* and *Prorocentrum mexicanum.*

Irregular alien jellyfish occurrence has been also noticeable in the Adriatic Sea, which is also indicating the tropicalization of the Mediterranean.

4.2.2. Open seas and Deep seas ecosystems modifications

The Mediterranean deep sea comprises a high diversity of habitats, because of its geological history (Bianchi and Morri, 2000). In particular, geomorphologic structures, such as submarine canyons, seamounts, mud volcanoes and deep trenches can harbor important biological communities.

In general, deep sea Mediterranean biological communities are adapted to an oligotrophic environment; local areas of higher productivity and biodiversity hotspots are present.

The Mediterranean deep sea is physically split into two basins separated by the shallow Straits of Sicily (about. 400 m dept). Important differences between the eastern and the western basins, both in species composition and abundance have been observed (Sardà et *al.,* 2004).

The Mediterranean deep sea is considered by some authors to be among the most heavily impacted deep-sea environments in the world, and at the same time among the least known areas in terms of biodiversity (UNEP-MAP-RAC/SPA, 2010): the risk is that a significant loss of biodiversity occurs before scientists have had time to document its existence (Briand, 2003; Cartes et *al*., 2004).

The main pressures affecting deep seas can be graded as below:

- trawl bottom fishery
- other fishing practices
- waste disposal (solid refuse)
- other marine pollutants
- oil exploration and exploitation
- deep pipeline laying
- climate change

Human pressures through fishing activities on open seas ecosystem including on the deep seas.

In a worldwide context the deep seas are considered (among other definitions) to be the marine environment that extends downwards from the continental shelf break, i.e. waters deeper than 200 m to its maximum depth. Deep-sea fisheries currently only

operate at depths of less than 1000 m in the Mediterranean, but that might exploit many SH, i.e. seamount fisheries could be exhausted in a period of time as short as three to four years (Johnston and Santillo, 2004). The potential fishing interest of the currently unexploited bottoms below 1000 m depth (towed gears banned by GFCM, 2005) is very limited. This is so because the overall abundance of crustacean species is considerably lower, and fish communities are largely dominated by fish either of non-commercial interest (like the smooth head *Alepocephalus rostratus*) or of a small size (such as the Mediterranean grenadier *Coryphenoides guentheri*). If these species ever become of economic interest and trawlers could reach deeper areas, then the ecosystem could be rapidly deteriorated by fishing.

Pelagic fishing in the Mediterranean high seas, targeting large pelagic species (with few exceptions targeting small pelagic, eg. anchovy and sardine, in the Adriatic Sea), is the only industrial fishing; it takes place mainly at international waters and even non-Mediterranean countries can be involved (Cacaud, 2005).

Most information on the activity of the fishing fleets in the Mediterranean comes from the working group STECF and the GFCM Demersal Working Group, of the Subcommittee on Stock Assessment, and ICCAT for large pelagics, which relates the activity of the fleets from member countries. Therefore, there is a lack of reported information of fishing activity of EU non-member countries (e.g. North Africa) in STECF, although GFCM task 1, and the cooperation projects (Medfisis, COPEMED II, ADRIAMED and EASTMED) work on this direction.

The most important negative consequence of fishing activities is the degradation of marine ecosystems by the removal of target or non-target species and by physical disturbance inflicted by some fishing gears. Essential Fish Habitats (EFH) are those habitats necessary for feeding, refuge or reproduction of the species; and Sensitive Habitats (SH) consist on those areas with endemic species, high biodiversity or high productivity and vulnerable to fishing practices. The degradation of ecosystems by fishing indirectly affects the commercial species if the habitat is not longer adequate for these species. In this context, there is a necessity of regulating fishing activities to reduce the ecosystem degradation by the establishment of an Ecosystem Approach to Fisheries (EAF), which considers not only the protection of target species, but the ecosystem as a whole. Within the EAF framework the Precautionary Approach considers the most restrictive measures for fisheries management (including the establishment of areas closed to fishing, or Marine Protected Areas) against a general lack of knowledge on the functioning of many ecosystems that sustain fisheries resources.

Most Mediterranean waters constitute open seas. The Mediterranean open seas encompass a high diversity of habitats, both pelagic and demersal (deep seas). These habitats are poorly known in relation to coastal and continental shelves ecosystems, which are more easily surveyed, while at the same time there is a good knowledge of their commercial species stocks status, by means of fisheries surveys and commercial captures. The protection of fauna at those areas is important for fisheries and ecosystem conservation because organisms can determine the healthiness of an ecosystem. Sessile benthic fauna play an important role as habitat structuring organisms providing refuge for many marine species (e.g. cold coral reefs, deep sea sponges, crinoidea beds).

Deep bottoms consist on wide extensions of soft sediments interrupted by geological features like submarine canyons, brine pools, seamounts, hydrothermal vents, cold seeps and mud volcanoes, that create a special habitat that harbour high diversity and endemism; many of these habitats have been only recently discovered and must be protected after the Precautionary Approach.

Demersal fisheries operating in Mediterranean high seas can be summarized as: bottom trawling, bottom long line, and gillnet. Deep-sea fisheries currently operate on continental shelves and some slopes, down to depths of less than 800m. Bottom trawling is a highly damaging practice that was banned in 2005 to Mediterranean bottoms deeper than 1000m, aiming to protect the vulnerable deep sea fauna.

Amongst benthic habitats at Mediterranean open seas, the components most vulnerable to fishing are coralligenous facies, the crinoidea *Leptometra phalangium,* and the cnidaria *Funiculina quadrangularis* and *Isidella elongata*, facies of sessile organisms that have been so far detected in continental shelves and the shelf break in the Western basin, although the location and extent of these habitats in the whole region is still poorly known.

At the deep seas there are several areas with considerable abundance of the highly vulnerable cold coral reefs, mostly detected in continental slopes, seamounts and on the walls of submarine canyons (e.g. off Cape Santa Maria di Leuca, in the Central basin, or at numerous submarine canyons and seamounts scattered along the Alboran Sea, in the West basin).

Several abyssal plains, that harbour poorly known and vulnerable deep sea fauna, are located throughout the Mediterranean, with the deepest grounds found in the Central basin (e.g. Calypso depth in the Ionian Sea, SW of Greece). Other geological features might be vulnerable to fishing as they are hotspots of diversity and are habitat of vulnerable fauna like cold corals. The massive Eratosthenes seamount in the East basin (south of Cyprus) and numerous scattered seamounts in the Alboran Sea and south Tyrrhenian; cold seeps, brine pools and hydrothermal vents have been mostly located in the East Mediterranean basin (south of Crete and Turkey, and near Egypt). The Western Mediterranean basin harbours numerous submarine canyons that are EFH for red shrimp, like numerous canyons in the Gulf of Lions that sustains important fisheries of red shrimp, Norway lobster, hake, monkfish, among other important commercial species; hake nursery areas are mainly located on wide extensions of continental shelves or banks, highlighting the south of Sicily, central Adriatic in the Jabuka Pit, and Thracian sea, whereas hake spawning grounds seem to be located on the shelf break and slope canyons, being the Gulf of Lions the clearest example.

The large pelagic species that inhabit the open seas, mainly bluefin tuna, swordfish, and albacore, but also pelagic sharks (short fin mako, blue shark and porbeagle) are of high conservation interest and have long been overexploited by pelagic fishing gears. The main fishing gears for large pelagics are purse seines and pelagic longlines. Pelagic long lining fleets operate in Mediterranean waters, ranging from local coastal state fleets to large industrial foreign fleets; these are highly mobile, and cover almost the whole Mediterranean basin. Drift nets have been banned in the Mediterranean in 2005, although this activity is still practiced. The Mediterranean high sea is also the habitat of endangered cetaceans and turtles that are a common by-catch of pelagic fisheries and deserve special protection. Important EFH for large

pelagic species are mostly determined by oceanographic features like upwelling areas or gyres, creating productive areas important for feeding and breeding; these areas that act as EFH must be identify to define protection measures for pelagic species. The main spawning areas for bluefin tuna have been located south of the Balearic Islands, Alboran Sea and Strait of Sicily, whereas swordfish spawns in almost all the Mediterranean area and albacore overlap with the bluefin tuna spawning grounds.

4.2.3. Critical impacts, areas and effects on marine and coastal biodiversity

Those critical areas considered as EFH and SH that receives fishing impacts in the Mediterranean open seas, could represent an essential tool for managing fisheries in Mediterranean open seas within an EAF and Precautionary Approach; however, these areas might imply effective restriction of fishing activities, needing an adequate surveillance system and a long-term monitoring.

The following sites are considered critical areas in the subregion, regarding fishing impacts in Mediterranean open seas, including demersal and pelagic ecosystems:

Demersal priority area:

- The Central Adriatic. Fosa di Pomo/Jabuka Pit. This important nursery area for hake in the central Adriatic should be protected from demersal fishing activities, mainly trawling. Besides that, Pomo/Jabuca Trench has cold seeps.

Pelagic priority areas:

- The Northern Adriatic. Spawning grounds for anchovies and pilchards.
- The Northern & Central Adriatic. Important areas for pelagic sharks

Demersal and Pelagic priority area:

- Mediterranean Bottoms beyond 1000m. Habitat of poorly known and vulnerable fauna that encompasses the four Mediterranean sub-regions. Fishing using towed gears in this area has been prohibited by GFCM.

5. EVALUATION OF GAPS

Overall, the coastal and marine biodiversity as well as the pressures and impacts exerted on of the Adriatic Sea remains poorly known despite some efforts made by the riparian countries.

5.1. Gaps concerning the status of marine and coastal ecosystem

The main gaps identified at the Adriatic sugregional level are as follows. Many of these gaps are due to financial difficulties that some of Adriatic countries are still facing.

- Lack of clear national strategy to inventory marine and coastal biodiversity in most countries.
- For most countries, the national inventories of marine and coastal species and habitats are incomplete.
- Deep sea and high seas habitats have been little studied.
- Lack of national taxonomic experts for the identification of species.
- Absence of monitoring programmes for alien species, except Italy and Croatia
- Absence of coordinated and cross-border scientific research, probably related to financial and administrative constraints.

5.2. Gaps concerning impacts on coastal and marine ecosystems

Gaps concerning impacts on marine and coastal biodiversity can be summarized as follows.

- Alien species: (i) No national and regional monitoring study on a long-term scale in the Adriatic Sea, (ii) no impact assessment of the alien species for fisheries and human health has been made, (ii) little effort made for public awareness raising, (iii) not much information has been collected for intentionally introduced species.

- Impact of fishery on target and non-target species: (i) no mitigation effort has been elaborated for bycatch, (ii) little effort made for public awareness raising.

- Climate change: (i) no national and regional monitoring study for the sea level rise and the effect of CC on marine and coastal biodiversity on a long-term scale, (ii) not much study has been done on the impacts of CC on the social life, tourism, fisheries and others, (iii) not much cooperation between the Global Ocean Observation System and monitoring within the Adriatic Subregion.

- Deep sea: (i) The main gaps about deep sea deals with the very limited knowledge of this environment, particularly poor are data and scientific researches in the deep sea part of the Adriatic Sea and Trench, (ii) lack of

harmonization of the regional initiatives for the exploration of the deep sea areas.

6. PRIORITY NEEDS

6.1. Needs

Albania

There is a lack of substantial data on marine biodiversity and ecosystems in the Albanian water.

Enforcement of the national law for fisheries is difficult as the inspectors have no equipments to control the fishermen. Particularly the trawling near the coast, with the increasing request of the market during the touristic season started to damage adversely the fish stocks and their habitats. Unregulated, unreported and illegal fishing is the priority for Albania.

The conservation action in fisheries is the intervention to stop some of the fishing activities and the following three actions are proposed:

- The banning and limitation of some fishing techniques;
- Temporal closure of fishing activities in some areas;
- Establishment of Marine Protected Areas. (Particularly financial and institutional support for the establishment of the Karaburun National Marine Park is urgent).

The attempt designation of Marine Parks in Albania does exist and it regards the area of the Karaburun Peninsula. In Albanian coasts, the Adriatic part had been under human impacts much more than the Ionian Sea, mostly for the tourism development and the immigration of the population.

Because of the financial constraints faced by Albanian institutions, monitoring of environmental elements is not complete, neither in space, nor in time, and indicators are still to be. The same happens with the studies for the environmental impacts in coastal zone and the marine environment from economic activities.

The educational programmes and public awarenes need to be strengthened either in schools or in local communities. Particularly information and training must be intensified on the fishermen for making them clear what are the request of the laws and the new approach for the conservation and protection of marine and coastal areas.

Bosnia and Herzegovina

Absence of regular and accurate data due to financial difficulties and appropriate national mechanisms is obvious, thus capacity building programmes are urgently needed with the help of RAC/SPA for all RAC/SPA Action programmes.

For developing a management system for sustainable fisheries, technical assistance is needed from FAO/GFCM.

Starting marine scientific studies with the national and international funds, monitoring at least some ecological and physico-chemical parameters in water colomn in certain areas, preferably Neum area, setting the national needs and priorities in terms of

marine and coastal biodiversity, such as elaboration of a list of endangered species, national action plans, are urgently needed.

Fish and shellfish farms need to be monitored due to their adverse impacts on the biota.

To develop a national plan for climate change and impacts is also needed.

Alien marine species monitoring and action plan is needed.

To prepare and implement transboundary projects with Croatia for the Neretva River is encouraged.

Croatia

Impacts of the aquaculture to the coastal and marine life need to be investigated.

The issue of climate change (CC) impacts on biodiversity has been identified only recently but not as the priority in national strategic documents. There is a lack of research and monitoring of CC impacts on biodiversity.

Montenegro

Impacts of the aquaculture on the coastal and marine life need to be investigated.

Invasion of alien species is a growing threat for Montenegro and needs to be monitored carefully.

Slovenia

It is necessary to be able to predict marine snow and mucilage phenomena to mitigate severe impacts such as oxygen depletion and hypoxia, which can cause damage to fisheries and local biota.

A monitoring program on alien species and a national databank is needed. This gap may be filled with Slovenia's cooperation with RAC/SPA and GFCM.

Bycatch issue is related with unreported unregulated and illegal fisheries. This matter can be solved or mitigated with some actions. One of such actions is to cooperate with the GFCM bycatch working group, secondly to educate fishermen to release by-catch animals. Besides, the minimum mesh size adjustment is needed

6.2. Urgent actions

Albania

Illegall, unreported, unregulated fisheries is one of the major issues and should be controlled and more stringent measures is requested within shallow waters and lagoons. Banning and limitation of some fishing techniques, temporal closure of fishing activities in some areas, establishment of no fishing zone.

Except for Italy, all countries in the Adriatic Sea lack a broad capacity building programme with the close cooperation of RAC/SPA, FAO/GFCM, MAP and other competent international and regional organizations. Financial constraint is another important issue and a special fund mechanism should be developed through

international donors such as GEF, World Bank or others, to upgrade their national capacity for biodiversity problems.

Regional cooperation is essential for the protection of biodiversity in the Adriatic Sea in case of toxic plankton blooms, harmful invasive species, mucilage aggregate and IUU fisheries.

Posidonia meadows are endemic of the Meditarranean and more effort should be made to conserve them in the whole Adriatic Sea.

Bosnia and Herzegovina

Starting marine scientific study with the national and international funds. Monitoring at least some ecological and physico-chemical parameters in water colomn in certain areas, preferably Neum area. Setting the national needs and priorities in terms of marine and coastal biodiversity such as list of endangered species, national action plans, etc.

Croatia

A special study is needed for the flag species of the Mediterranean, such as the cetaceans and the Mediterranean monk sealswhose status needs an update with regard to the last field surveys done in the country (Cebrian,1995).

A national or regional strategy should be developed to reduce fishing-related mortality (bycatch) of marine mammals and turtles.

Control, monitoring, management and mitigation of the introduction and spreading of alien invasive species and dissemination of information and public awareness raising.

Slovenia

Controlling unregulated and illegal fisheries is urgent by law enforcement.

Eutrophication process needs to be mitigated by efficient water treatment plants to avoid marine snow and mucilage phenomena.

A monitoring program on alien species and their impacts is urgently needed.

Actions to preserve fisheries in the open seas including the deep seas

General management failure for Mediterranean marine resources implies the necessity of urgently adopting an EAF. The Mediterranean open seas, including deep seas, are still poorly known, which implies that the precautionary approach has to be applied.

Marine Protected Areas (MPA) help fisheries management by providing local release from fishing and maintaining undisturbed areas favouring the prevalence of vulnerable ecosystems. But in order to evaluate the efficiency of MPAs for fishery purposes, it is essential to have a good knowledge on the ecosystem components and functioning, and to promote a continuous monitoring.

In order to select the most adequate areas as candidate sites for MPAs, we need to identify sites addressing ecological importance, including the uniqueness or rarity, of special importance for life history stages of species, importance for threatened, endangered or declining species and/or habitats, the vulnerability, fragility, sensitivity or slow recovery of the ecosystem, its biological productivity and biological diversity. Furthermore the establishment of a MPA must carefully consider its location (after the criteria mentioned above), but also its size and connectivity. In the Mediterranean, most MPAs have been located around coastal rocky bottoms or islands, despising the importance of open seas ecosystems.

There is only one protected area embracing the Mediterranean high seas, so there is an urgent need of planning and implementing protection zones under the SPAMI criteria, and that should be correctly surveyed and scientifically monitored. Within this framework, a consistent and well monitored network of SPAMIs located in open seas, including deep seas (comprising both pelagic and demersal ecosystems) should be proposed by the concerned Party/Parties, according to the five possible SPAMI status regarding the area of location (area under one national jurisdiction, mixed national jurisdictions area, mixed national jurisdiction and beyond national jurisdiction area, mixed national jurisdictions and beyond national jurisdiction area, area fully beyond any national jurisdiction).

6.3. Comments

There was high discrepancy among the country reports of the Adriatic Sea in terms of the quality and quantity of the information presented. These gaps should be minimized and countries in the sub-region, such as Italy, should assist other countries until they can develop their own capacity for issues of marine biodiversity.

7. FUNDING PROBLEMS AND OPPORTUNITIES

7.1. Regular national sources that are potentially available

According to the information given by national reports, sources of national funding are specific to each country. In some Adriatic Countries, such as Bosnia and Herzegovina and Albania, national funding is extremely limited and do not allow even minimum research programmes to be undertaken. Because of the financial constraints faced by Albanian institutions, monitoring of environmental elements is not complete, neither in space, nor in time, and indicators are still to be.

However, Slovenia and Croatia do allocate more fund for the coastal and marine biodiversity. They have also various funds besides governmental supports. Nevertheless, majority of the sources comes from the government and private sources are too scarce. Some fish farm owners support some of the short term studies in Montenegro, Albania and Croatia.

7.2. International funds, projects, programmes

These constitute the major contribution to funding research on marine and coastal biodiversity. The main sources of funding identified by the different countries come mainly from the EU via its framework programmes on the environment and biodiversity, the World Bank, the UN Environment Programme (UNEP), GFCM/FAO, the UN Development Programme (UNDP/GEF), and technical support by the Regional Activity Centre for Specially Protected Areas (RAC/SPA).

8. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be summarized for the Adriatic Subregion from the national contributions as regards the marine and coastal biodiversity in the Adriatic Subregion and the pressures and impacts exerted on them.

8.1. Conclusions

Although knowledge concerning marine and coastal biodiversity is not satisfactory in the Adriatic Sea, there are considerable gaps regarding the distribution, range, populations and conservation status for the majority of species and habitats. Inventories are rare, and scientific research, in this field, is very limited and uncoordinated, mostly due to financial and administrative constraints. Therefore, research and systematic monitoring of marine and coastal biodiversity must be supported. The adoption of the National Biodiversity Strategies and Action Plans, elaborated within the SAP BIO Programme, the integration of biodiversity concerns into sectoral policies combined with the effective operation of the Natura 2000 European ecological Network, especially for the Mediterranean Europrean countries, will be decisive for its preservation.

The estimates of the Mediterranean marine resources are limited and are based on information gathered within research projects which are funded by national or community sources and therefore, the information we have is scarce and geographically limited. This makes the management of the fisheries' resources rather difficult, complicated and of high cost.

Illegal, unreported and unregulated fisheries practices strongly impact marine biodiversity. Over-exploitation is responsible for the decline of many fish stocks. Particularly harmful to biodiversity is the direct impact of fishing on the seabed (mainly by trawl) and the fact that fishing practices lead to discards.

Eutrophic characteristic of the shallow northern Adriatic needs to be monitored to predict marine snow and mucilage phenomena to mitigate severe impacts such as oxygen depletion and hypoxia, which can cause damage to fisheries in the Northern Adriatic.

Gaps exist regarding our understanding of climate change and its impact on biodiversity. Long-term data on climate change and on communities changes in the Adriatic Subregion is required.

As regards non-indigenous and invasive species, severe adverse impacts to the native biota have not yet been observed and have not caused loss of biodiversity so far in the Adriatic Sea. However, the presence of non-indigenous and invasive species represents a growing threat, mainly due to the unexpected impacts that these species can have on ecosystems and consequently on the economy and human health, such as venomous fish or jellyfish. Recognizing the need for collaboration in research and management of aquatic alien species at both national, sub-regional and international level and in particular for data exchange is a major issue. Croatia has also joined the GloBallast Partnership (GBP) to reduce the risks

and impacts of marine bio-invasions caused by international shipping in the Adriatic Sea.

Finally, an attention should be also paid to the deep sea, hosting some important ecosystems, habitats and assemblages (cold seeps, brine pools, seamounts, cold-water coral reefs). Deep sea species and habitats are, in general, particularly sensitive. Several pressures threaten this environment, in particular fishing practices (especially trawl bottom), pollutants, oil exploration and exploitation and climate change.

8.2. Recommendations

Taking into account the analysis made in the previous pages of this document and the main relevant national reports and consulted documents, following recommendations can be made for the Adriatic Subregion.

- Knowledge on marine and coastal biodiversity should be improved and extended for the field of studies on an ecosystem scale through multidisciplinary projects. Investigation of the diversity of little studied and/or unexplored groups in each country and in unexplored geographic areas and habitat types should also be addressed.

- Promotion of basic research to fill the knowledge gaps concerning the status of the marine environment of the Adriatic Sea as well as the adoption of applied research for the development of suitable tools for monitoring.

- Application of measures for the sustainable use of fisheries and aquaculture assessing the level of damage that can be sustained and/or is acceptable by the ecosystem through these practices, including also secondary effects such as the impact of the partial removal of a predator or a part of a life cycle of one species, information on fate and survival of discards and the impact on epifaunal benthic communities.

- Promote researches, in particular on by-catch, discard, ghost-fishing and technology, in particular necessary gear modifications to limit discards, by-catch, impacts on endangered species (e.g. marine mammals and turtles) and on biodiversity in general (e.g. modifications of gears, increase of mesh size of trawl net, repellent devices).

- Improve controls and promote awareness campaigns in order to eradicate illegal fishing practices.

- Co-ordinated, cooperative multidisciplinary research is to understand and investigate the impact of CC on the marine ecosystem. Long-term data on climate change and on communities changes in the national, sub-regional and Mediterranrean areas through an integrated framework are required.

- A regional awareness raising program in order to influence decision makers to put climate change impacts on marine and coastal biodiversity as high priority in national agendas should be planned and implemented.

- Routine monitoring programmes, in order to define temporal variability of abundance, biomass and other variables of key species within sensitive habitats should be planned and carried out.

- Co-ordinated, cooperative regional research is to investigate the phenomenon of introduced species, particularly in hot spot areas such as ports and lagoons.

- Particular importance should be paid for studying, understanding and protecting deep ecosystems. Action plans and scientific research for the sustainable management of deep water fisheries with emphasis on the protection highly vulnerable deep-water communities, either by immediate removal of (erect, slow growing) organisms and/or by habitat and trophic level modifications. Studies on the deep water coral mounds in the areas must be intensified.

- Networking: joining forces, setting the essential questions, developing the National Strategies in compliance with the International Treaties and Conventions, linking with the relevant EU Networks

- Establishment of national working groups addressing various biodiversity issues meeting regularly and reporting once a year.

- Since marine protected areas are becoming an important tool for preserving biodiversity and for managing fisheries, there is an urgent need for studies to determine baseline information such as size, number and location in order to improve the efficiency of these areas.

- It should be strongly emphasized that all riparian countries of the Adriatic Sea, except for Italy, need a capacity building programme especially in: monitoring, planning, co-operation, project formulation and training of specialists, with the close cooperation of RAC/SPA, FAO/GFCM, MAP and other competent international and regional organizations. Financial constaint is another important issue and a special fund mechanism should be developed through international donors such as GEF, World Bank or others, to upgrade their national capacity for biodiversity problems.

- Regional cooperation is essential for the protection of biodiversity in the Adriatic Sea in case of toxic plankton blooms, harmful invasive species, mucilage aggregate and IUU fisheries.

- Awareness campaigns must be developed for stakeholders such as fishermen, decision makers, local administrators and public at large on the protection of marine biodiversity in the region.

- There was high discrepancy among the country reports of the Adriatic Sea in terms of the quality and quantity of the information presented. These gaps should be minimized and the leading countries, such as Italy, should assist other countries until they can develop their own capacity for issues of marine biodiversity.

Finally, it is very important to mention that the ecosystem approach must be implemented in order to improve the knowledge of the marine and coastal

ecosystems and to better understand and evaluate the effects of pressures and impacts on biodiversity. In particular, indirect ecosystem consequences and cascade effects can be interoperated only through an ecosystem approach. Ecosystem approach to fishery management is accepted as the necessary framework to secure sustainable use of marine ecosystems

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Programme des Nations Unies pour l'Environnement

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Centre d'Activité Régionale pour les Aires Spécialement Protégées

Etat d'avancement de l'approche écosystémique dans la Convention de Barcelone

Phase 3 de la feuille de route pour la mise en place de l'approche écosystémique

Composant du CAR/ASP

Synthèse sub-regionale « Méditerranée Occidentale » des documents nationaux d'identification des proprietes majeures des ecosystemes et d'evaluation de l'etat ecologique et des pressions sur la biodiversite marine et cotiere

(version provisoire)

June, 2010

Note: Les désignations employees et la presentation de matériel dans ce document n'implique pas la moindre expression d'opinion de la part du PNUE ou du CAR/ASP sur le statut legal d'un Etat, d'un Territoire, d'une Ville ou d'une aire, ou de leurs autorités, ou encore de la délimitation de leurs frontières.

Responsable de l'étude :

Thierry Pérez, consultant international CAR-ASP

Avec la participation de:

Arthur Antonioli. Co-rédaction
Daniel Cebrian. Chargé du programme PAS/BIO (coordination générale et révision)
Atef Limam. Chargé du projet CAR-ASP (coordination générale et révision)
Sami Ben Haj. consultant international CAR-ASP (coordination générale et révision)
Samir Grimes (Algerie)
Thierry Pérez, Arthur Antonioli (France)
Hocein Bazairi (Maroc)
Thierry Pérez ,Arthur Antonioli, Raphael Simonet (Monaco)
Mohamed Salah Romdhane (Tunisie)
Silvia de Juan Mohan (Mer ouverte)
Jordi Lleonart Aliberas (Mer ouverte)

Mediterranean Action Plan
Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du Leader Yasser Arafat
BP 337 –1080 Tunis Cedex –TUNISIA
E-mail : car-asp@rac-spa.org

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SOMMAIRE

INTRODUCTION

L'approche Ecosystémique (ECAP) a été mise en place par soucis d'un développement durable des activités humaines et de protection de l'environnement marin. Après le Sommet mondial sur le développement durable, l'ECAP a été adopté par de nombreuses conventions internationales et les organisations maritimes régionales. Les parties contractantes à la Convention de Barcelone l'ont adopté en Janvier 2008 lors de leur réunion à Almeria.

Ainsi, toute politique de l'environnement devrait être élaborée d'une manière à assurer une protection efficace du milieu marin et ainsi que la fourniture durable de biens et services maritimes pour les populations humaines. L'application de l'ECAP a le potentiel d'aider à atteindre un équilibre entre les exigences des activités humaines et la conservation du milieu marin. Son adoption et la mise en œuvre progressive dans le cadre du Plan d'action pour la Méditerranée (PAM, Convention de Barcelone) donnera un nouvel élan à l'élaboration des politiques plus intégrées et plus holistique de la Convention, y compris l'impact des activités humaines sur l'environnement marin.

Pour assurer la viabilité de l'exploitation des biens et des services maritimes, il est important que l'application de l'ECAP dépasse les frontières des Etats membres en couvrant les habitats et les écosystèmes situés au-delà des juridictions nationales.

Le projet du PAM vise à promouvoir et à renforcer la mise en œuvre d'une feuille de route pour l'application de l'approche écosystémique de la gestion des activités humaines. La feuille de route exige que l'évaluation de l'état écologique et des pressions et des impacts soit mis en œuvre dans quatre régions différentes de la Méditerranée, identifiées selon des bases bio-géographiques et océanographiques. Ces quatre régions sont (i) la Méditerranée Occidentale, (ii) la Mer Adriatique, (iii) la Mer Ionienne et la Méditerranée centrale, (iv) la Mer Egée et le Bassin Levantin. Ce rapport représente une première étape de l'ECAP en identifiant pour la Méditerranée occidentale les propriétés majeures des écosystèmes et en évaluant leur état de conservation en relation avec les pressions subies par la biodiversité marine et côtière. Cette synthèse des connaissances au niveau sub-régional fait suite à différents rapports nationaux (France, Monaco, Tunisie, Algérie, Maroc[*]) et à une première synthèse réalisée en 2008 sur les effets des changements climatiques sur la biodiversité en mer Méditerranée (PNUE-PAM-CAR/ASP, 2008).

Les objectifs de ce travail étaient:

- D'identifier, synthétiser et de fournir une analyse critique de la situation régionale actuelle en matière de mise en œuvre d'initiatives liées aux propriétés importantes des écosystèmes et à la nécessaire évaluation de leur état écologique et des pressions subies.
- De fournir un avis d'experts sur les impacts attendus sur les écosystèmes et les habitats particulièrement vulnérables face aux activités humaines et aux changements climatiques.
- D'identifier et recommander des priorités régionales en termes de mesures, actions et projets de recherche ou de surveillance de l'état de conservation des écosystèmes. D'évaluer comment renforcer les

[*] *Pour la plupart, les documents nationaux utilisés pour réaliser cette synthèse sont des documents provisoires, parfois incomplets (France notamment). Aucun rapport n'a été fourni pour les parties italiennes et espagnoles.*

possibilités de collaboration sous-régionale pour des actions relatives à la conservation de la biodiversité et la gestion durable des ressources.

- D'identifier si possible les sources potentielles de financement national et international pour soutenir ces politiques, mesures et actions.

METHODOLOGIE

Cette synthèse est conduite à partir de différents documents réalisés par des consultants nationaux du CAR/ASP, guidé par les correspondants nationaux du PAS BIO, en s'appuyant sur une documentation fournie en partie par le CAR/ASP (documents pertinents produits par les conventions et accords régionaux englobant la Méditerranée (Berne, Bonn, ACCOBAMS, etc.). Dans certains cas, l'absence de documents nationales de synthèse fournis par le CAR/ASP ou son Point Focal national a conduit le consultant national à effectuer une recherche bibliographique conséquente.

Chaque expert national avait pour objectif de fournir une analyse critique de la situation dans son pays en termes de mise en œuvre d'initiatives pour l'évaluation de la biodiversité côtière, son état écologique et les pressions qu'elle subit. Les avis d'experts devaient permettre d'identifier notamment les écosystèmes menacés et les espèces ou populations vulnérables face aux activités humaines et aux changements climatiques.

Participants à l'approche ECAP en Méditerranée Occidentale

Pays	Consultants nationaux	Organisme d'origine	Adresses e-mail	Etat des rapports nationaux
Algérie	Samir GRIMES	Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral (ENSSMAL), Alger, Algérie	samirgrimes@yahoo.fr	Fait
France	Thierry PEREZ	Centre d'Océanologie de Marseille, CNRS UMR 6540 DIMAR, France	thierry.perez@univmed.fr	incomplet
Italie (Mer Ligure et Tyrrhénienne)	Etude annulée			Pas de rapport
Monaco	Thierry PEREZ	Centre d'Océanologie de Marseille, CNRS UMR 6540 DIMAR, France	thierry.perez@univmed.fr	Fait
Maroc	Hocein BAZAIRI	Université Hassan II Aïn Chock, Casablanca, Maroc	hoceinbazairi@yahoo.fr	Fait
Espagne	Nuria MARBA & Carlos DUARTE	Instituto Mediterráneo de Estudios Avanzados (IMEDEA/CSIC), Esporles, Baléares, Espagne	nuria.marba@uib.es	Pas encore de rapport
Tunisie (Zone nord)	Mohamed Salah ROMDHANE	Institut National d'Agronomie de Tunis (INAT), Tunisie	romdhane.medsalah@inat.agrinet.tn	Fait

Références des documents et des données consultés

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Documents nationaux disponibles et publications identifiées et consultées

Cf. liste bibliographique

Qualité et compréhensibilité des documents et des donnés disponibles

D'une manière générale, les données compilées sont d'une bonne qualité et montrent qu'il existe une assez bonne connaissance de la composition de la biodiversité de Méditerranée occidentale. Dans les listes d'espèces fournies par plusieurs experts, on retrouve des tas de dénominateurs communs que ce soit dans le compartiment pélagique comme dans le benthique. Ceci étant dit, les principaux manquent résident dans la connaissance de la distribution de cette biodiversité à l'échelle d'une façade, qu'il s'agisse d'une espèce ou groupe d'espèces, ou encore d'habitats. Les listes d'espèces apportées dans les documents nationaux sont le plus souvent celles de lieu précis (Golfe de Tunis ou Baie d'Alger par ex.) ou au contraire des listes extrapolées à l'échelle de la Méditerranée (voir Boudouresque 2004 pour une revue complète).

Les initiatives telles que celle qui vient d'être démarrée en France par l'Agence des Aires Marines Protégées sont rares. Les objectifs sont de cartographier l'ensemble du littoral et d'évaluer l'état de conservation des écosystèmes patrimoniaux, ou considérés comme tels par la Directive Européenne Habitat. En toute rigueur, ce type d'initiative devrait exister en Espagne et en Italie, mais aucune information n'a été arrivée de ces parties à la date de rédaction . Malgré tout, ce manque de connaissances dans les pays de la rive sud de Méditerranée devraient être prochainement comblé grâce la mise en place de nombreuses Aires Marines

Protégées. Parfois des premiers essais d'évaluation ont été réalisés dans ces aires marines protégées (cas de l'Algérie notamment), et des études destinées à la caractérisation des limites et de l'état de conservation des écosystèmes clés devraient être réalisées.

Un rapport récent sur les effets des changements climatiques en Méditerranée montrait qu'il existait un vrai déficit de connaissances dans les pays du sud (PNUE-PAM-CAR/ASP, 2008). Les rapports nationaux rendus par les experts algérien, tunisien et marocain confirment ce premier inventaire et montrent que les connaissances même de possibles indicateurs de réchauffement climatique sont parfois très floues. On note dans ces rapports plusieurs inexactitudes notamment sur les liens qui peuvent exister entre l'occurrence d'espèces introduites (cas de *Caulerpa racemosa* en Tunisie ou au Maroc, *Oculina patagonica* en Algérie) et la tendance au réchauffement dans cette partie de Méditerranée. L'émergence récente de séries d'enregistrements de température à long terme a permis de démontrer pour la Méditerranée Nord Occidentale une tendance au réchauffement de l'ordre de 1°C en 30 ans et une augmentation de la fréquence des événements extrêmes. Ce type de données fait défaut dans les autres parties de Méditerranée. Même les événements climatiques extrêmes occasionnant parfois des conséquences écologiques dramatiques sont peu documentés dans les pays du sud.

Les conséquences attendues des changements de biodiversité occasionnés par les déplacements ou les disparitions de certaines espèces sont des modifications du fonctionnement des écosystèmes marins. Dans ce cas, c'est bien à l'échelle du bassin occidental qu'il existe un vrai déficit de connaissances.

1. ETAT DES ECOSYSTEMES MARINS COTIERS

1.1 Caractéristiques biologiques

1.1.1 Description des communautés biologiques dans la colonne d'eau

Les études de plancton accomplies ces 25 dernières années en Méditerranée ont été récemment compilées par Siokou-Fragou et al. (2010). La Méditerranée est caractérisée par une dynamique physique riche et complexe qui inclut des caractéristiques de thermohaline uniques et une circulation particulière. Les études les plus récentes ont confirmé son caractère oligotrophique, avec des gradients marqués d'Ouest en Est et du Nord au Sud. La disponibilité nutritive est basse, surtout en terme de Phosphore (N : P jusqu'à 60). La biomasse phytoplanctonique indiquée par la chlorophylle affiche généralement des valeurs basses (moins de 0,2 µg/L chl-a) sur de grandes étendues, avec une augmentation légère à la fin de l'hiver. Un grand bloom (jusqu'à 3 µg/L) est généralement enregistré de la fin de l'hiver et jusqu'au début du printemps, mais uniquement en Méditerranée nord occidentale. Des pics de biomasse relativement hauts sont aussi enregistrés dans les fronts et gyres cycloniques. Un maximum de chlorophylle profond est une caractéristique commune en Méditerranée, mais avec une variation importante d'Ouest en Est : environ 30 m en Mer d'Alboran (30 m) à 120 m dans le bassin Levantin. La production primaire révèle également une tendance à la diminution d'Ouest en Est, avec des valeurs allant de 59 à 150 g C. Toute la Méditerranée est grandement dominée par les autotrophes de petite taille, micro-hétérotrophes et par les espèces incubantes de copépodes. Le phytoplancton tant autotrophe qu'hétérotrophe et le zooplancton révèlent une diversité considérable et une variabilité à la fois spatiale et temporelle. Il existe aussi une grande diversité de dinobiontes et de coccolithophores, les dinobiontes à PSP faisant l'objet d'une attention particulière dans la quasi-totalité des pays de Méditerranée occidentale.

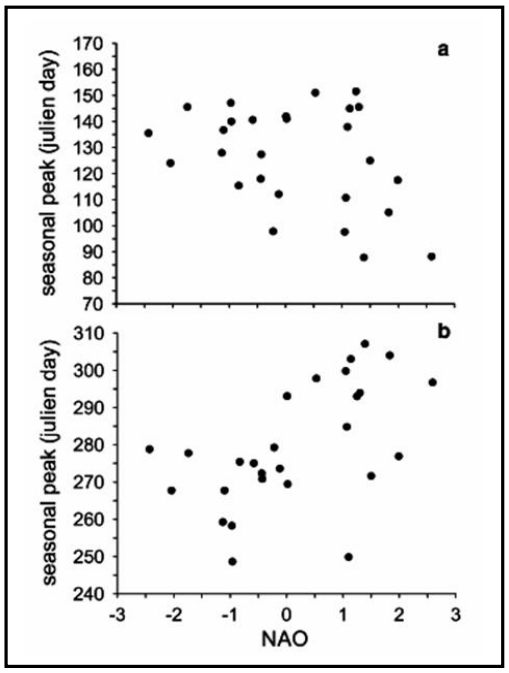
Exemples sélectionnées de quelques fractions phytoplanctoniques et compositions taxonomiques en Méditerranée. (Abbreviations: SL for Surface Layer, DCM for Deep Chlorophyll Maximum, DI for Depth Integrated, C for Carbon, HPLC for pigment-based group discrimination, Dino. for dinoflagellates, Prymn. for prymnesiophytes, Pelago. for pelagophytes, Crypto. for cryptophytes, Chromo. for nanoflagellates containing 190–HF and/or 190–BF, Nano. for nanoplankton, Cocco. For coccolithophores, *Synecho.* for *Synechococcus*, *Prochloro.* for *Prochlorococcus* (extrait de Siokou-Fragou et al. 2010)

Area	Date and Site	Depth	Method	Picoplankton	Nanoplankton	Microplankton	Cyanobacteria	Picoeukaryotes	Flagellates	Diat
Alboran Sea	**Apr–May 1991** Site 1 (jet front)	DCM (%size); DI (0–150 m) (%groups)	chl *a* HPLC	<1 µm: 11% 1–3 µm: 6%	3–10 µm: 8%	>10 µm: 75%	2% 2%		22%	76% *Prob* *Pseu* *Thal* *Lept*
	Apr–May 1991 Site 2 (oligotrophic)			<1 µm: 40% 1–3 µm: 32%	3–10 µm: 8%	>10 µm: 8.5%	16%		65%	19%
	May 1998 upwelling	DI (photic zone)	chl *a*	<2 µm: 15.9%	2–20 µm: 26.6%	>20 µm: 57.5%				>20 (*Cha* *Pseu*
	May 1998 non-upwelling			<2 µm: 46.1%	2–20 µm: 35.9%	>20 µm: 18.0%				
Catalan Sea	**May 1989** front, St. 4	DI (0–100 m)	C (counts)	1–2 µm: 2.4% 2–5 µm: 44.7%	5–10 µm: 17.5% 10–20 µm: 9.4%	>20 µm: 5.6%	20.3%		Dino. (*Gyrodinium*, *Gymnodinium*)	(*Pse*
	Feb 1990 front, St. 8			1–2 µm : 2.1% 2–5 µm: 20.7%	5–10 µm : 10.1% 10–20 µm: 8.0%	>20 µm: 54.8%	4.2%			(*Cha* *Pseu* *Guin* *Aste*
Gulf of Lion	**Jun 2000**	SL (4–8 m)	HPLC				6%		Prymn.: 51% Green algae: 21% Pelago.: 4% Dino.: 4%	13% *nitzs* smal *Pseu* *Rhiz*
Ligurian Sea	**May–Jun 1985**	DI (water column)	chl *a*	<3 µm: 65.7%	3–10 µm: 22.0%	>10 µm: 12.2%				
Ligurian Sea	**May 1995** DYFAMED 1st leg	DI (0–200 m)	HPLC				8.41%		Crypto.: 11.6% Chromo.: 38.3% Green flag.: 5.3%	29.0
	DYFAMED 4th leg						18.3%		Crypto.: 5.2% Chromo.: 31.8% Green flag.: 5.3%	19.9
S Tyrrhenian Sea	**Jul 2005**	DI (water column)	chl *a* C (counts) (% groups)	0.2–2 µm: 64%	2–10 µm: 17%	>10 µm: 19%	48%		Dino.: 28% (*Ceratium*, *Heterocapsa niei*, *Prorocentrum minimum*)	23% *Guin* *Lept* *medi* *Prob*
	Dec 2005			0.2–2 µm: 76%	2–10 µm: 17%	>10 µm: 7%	52.9%		Dino: 43.8% (*Prorocentrum minimum*,	3.4% *Thal*

Les inventaires de biodiversité donnent des résultats variables selon les pays. Ils sont assez complets en Afrique du nord à l'exception du Maroc où la connaissance du compartiment pélagique est essentiellement basée sur l'étude de la lagune de Nador. La diversité rapportée du zooplancton va de 269 à 400 espèces, avec une dominance (environ 60%) de crustacés.

La connaissance changements de biodiversité au sein de compartiment est beaucoup plus limitée par manque d'observations à long terme. Quand elle existe ces observations ont permis de mettre en évidence des changements importants de communautés en relation avec les changements environnementaux. C'est le cas dans le bassin nord occidental grâce au suivi à long terme des stations marines françaises. Les communautés planctoniques, et particulièrement les assemblages de copépodes, jouent un rôle majeur dans les flux de matière et d'énergie au sein des écosystèmes pélagiques, offrant une pompe biologique de carbone vers le profond, et exerçant une forte influence sur les recrutements de poissons. Ces mêmes communautés planctoniques peuvent subir le contrôle puissant des « gélatineux » (méduses au sens large, Siphonophores et Cténophores), parmi lesquels on trouve d'importants prédateurs de copépodes, d'œufs et de larves de poissons. Il est ainsi capital d'évaluer l'influence du climat sur le cycle de vie de ce type d'organismes à très courte durée de vie, dont les stocks sont renouvelés chaque année, et dont les modifications peuvent engendrer des conséquences importantes pour le fonctionnement des écosystèmes. L'équipe de Molinero (2005a et b) a ainsi identifié une série de réactions en chaîne liées aux oscillations Nord Atlantique (NAO). Dans un premier temps, une étude de phénologie conduite sur 27 années a montré que la période d'apparition des pics d'abondance de deux espèces de copépodes, *Centropages typicus* et *Temora stylifera,* était bien corrélée avec l'indice NAO (Molinero *et al*. 2005a). Les réponses des deux espèces étudiées sont opposées. Les NAO positifs sont favorables à *C. typicus*, et défavorables à *T. stylifera* dont le pic d'abondance est retardé et diminué d'un facteur 2. Les effets exactement inverses sont observés les années à NAO plus faibles. Selon les auteurs, ces différences de réactivité face aux fluctuations climatiques sont expliquées par plusieurs facteurs. Dans le contexte actuel de changement global en Méditerranée (réchauffement, modification des teneurs en nutriments), on assiste depuis deux décennies à des changements importants au sein des communautés phytoplanctoniques, avec une diminution de la représentation des espèces « siliceuses » (diatomées) au bénéfice d'espèces « non siliceuses » dont des dinophytes (Béthoux *et al*. 2002 ; Goffart *et al*. 2002). Ainsi, les deux espèces de copépodes étudiées ont un régime alimentaire qui change au cours du cycle de vie, mais des préférences globalement différentes. En l'occurrence, l'augmentation de la représentation des dinophytes dans le phytoplancton en période de NAO positif profiterait à *C. typicus*. Pour cette espèce, les anomalies thermiques positives pourraient aussi agir au niveau de la reproduction, notamment en raccourcissant la période de développement embryonnaire, permettant ainsi un développement dans la colonne d'eau plus précoce que celui de sa congénère *T. stylifera* (Molinero *et al*. 2005a). Les mêmes auteurs ont également montré un changement important dans la dynamique des relations entre copépodes et plancton gélatineux durant les années 80 en Mer Ligure (Molinero *et al*. 2005b). Les successions d'anomalies thermiques, de conditions de sécheresse et ainsi de relative stabilité des masses d'eau, survenues au milieu des années 80 auraient grandement favorisé les blooms de méduses, augmentant ainsi la prédation sur les copépodes. Cet ensemble de résultats montre la complexité des effets du forçage climatique sur les interactions entre deux groupes trophiques différents. Même si ces études devraient être étendues à d'autres groupes fonctionnels pour obtenir une meilleure connaissance

des mécanismes qui conduisent à la modification du fonctionnement des écosystèmes pélagiques, elles ont permis pour la première fois d'attirer l'attention sur des compartiments biologiques qui sont les principales sources de petits poissons pélagiques (anchois, sardines, etc.) dont les stocks ont été également modifiés au cours des dernières décennies (cf. sections précédentes). Une bonne évaluation des conséquences à moyen et long terme du réchauffement global sur les ressources naturelles méditerranéennes passe donc par un plus grand nombre d'études des effets du climat sur les interactions interspécifiques et des études comparées des réseaux trophiques de différentes aires géographiques.



Relation entre la variabilité interannuelle des pics saisonniers d'abondance de deux espèces de copépodes en relation avec le NAO. Les tendances pour les deux espèces sont inverses : a) *Centropages typicus* ($r = -0,58$; $p < 0,01$) ; b) *Temora stylifera* ($r = 0,53$; $p < 0,01$). Extrait de Molinero *et al.* 2005a.

1.1.2 Informations sur les invertébrés benthiques (faune), les macroalgues et les angiospermes, notamment la composition spécifique, la biomasse et les variabilités saisonnières/annuelles

Les inventaires en général

Dans la majorité des cas, les inventaires sont partiels et souvent anciens. Il existe des pays pour lesquels, il est difficile de faire un bilan précis à l'échelle de la façade méditerranéenne car les études sont nombreuses (France, Algérie) et d'autres où au contraire les inventaires sont basés sur l'étude de quelques systèmes de référence. La flore et la faune méditerranéenne du Maroc est de loin celle qui souffre le plus de l'absence d'études exhaustives. Bien sur ce type d'inventaire est très couteux en temps et requiert une expertise naturaliste qui se fait de plus en plus rare en Méditerranée.

Une alternative à ces approches consiste à étudier la répartition de taxons ciblés en fonction de leur statut, comme cela est fait dans le cadre des ZNIEFFs en France ou plus généralement dans le cadre de NATURA 2000 en Europe. Les critères nécessaires à la définition des espèces marines déterminantes ou remarquables des « Zones Naturelles d'Intérêt Ecologique, Faunistique et Floristique (ZNIEFF)» ont été sélectionnés et confrontés à ceux retenus lors de l'établissement des Aires Spécialement Protégées d'Importance Méditerranéenne (ASPIM) dans le cadre de la Convention de Barcelone. Les espèces retenues sont celles en danger, vulnérables, rares ou présentant un intérêt particulier, répondant aux cotations mises en place par l'UICN (*The World Conservation Union*) ou extraites des livres rouges publiés nationalement, régionalement ou à l'échelle du département (de Beaufort, 1987 ; Boudouresque et al., 1991 ; Boudouresque et al., 1996). Les critères de sélection sont listés ci-dessous :

- Cotation relative aux notions de rareté et de menace (espèces présumées disparues, rares à non menacées) ;
- Cotation relative à la notion d'endémisme (littoral provençal à Méditerranée et proche Atlantique) ;
- Cotation relative au niveau et à l'évolution des effectifs de l'espèce (niveau critique à stable) ;
- Cotation relative à la classe d'abondance des effectifs (de rares individus à population dense) ;
- Cotation relative aux intérêts patrimoniaux (symbolique, économique, esthétique, pédagogique) ;
- Cotation relative aux intérêts fonctionnels (espèces structurantes, clés de voûte d'écosystème, indicatrices de facteur du milieu).

Les listes d'espèces ZNIEFFs actuelles (utilisées en France) ne sont pas des « listes rouges » régionales et n'ont pas vocation à être diffusées largement. Il s'agit d'un outil interne lié à la méthodologie de l'inventaire des ZNIEFF. Toute utilisation en dehors de ce contexte peut générer des oublis ou des contre-sens dommageables. Par contre, il serait intéressant d'adopter la même démarche à l'échelle de la Méditerranée occidentale.

Evaluation partielle du nombre d'espèces (ou taxons) de la faune et de la flore méditerranéenne (d'après Boudouresque 2004, modifié)

Porifera	622
Cnidaria	420
Ctenophora	23
Echinodermata	144
Chaetognatha	20
Annelida	791
Brachiopoda	15
Entoprocta	19
Ectoprocta	494
Mollusca	2026
Arthropoda	1908
Chordata	244
Vertebrata	694
Rhodophyta	616
Fucophyceae	255
Chlorophyta	209
Phanerogama	9

Quelques espèces patrimoniales qu'il pourrait être intéressant de suivre à l'échelle de la Méditerranée occidentale et qui pourrait renseigner sur l'état de conservation d'un écosystème ou sur l'effet des changements environnementaux. De gauche à droite : la grande nacre (*Pinna nobilis)*, la grande cigale (*Scyllarides latus*), le mérou brun (*Epinephelus marginatus) et l'oursin diadème (Centrostephanus longispinus).

Parmi ces espèces patrimoniales, il peut y avoir des espèces indicatrices de l'état de conservation d'un écosystème (grand prédateur par ex.) ou encore indicatrices des effets des changements climatiques. Dans ce cas aussi, il serait intéressant de travailler à une liste commune à un bassin méditerranéen, voire même à toute la Méditerranée de manière à : (i) établir les limites de distributions de ces espèces patrimoniales ; (ii) suivre à long terme l'évolution de leurs effectifs ou de leur aire de répartition en fonction des mesures de conservation et/ou des changements environnementaux.

Dans le cadre d'un groupe de travail de la CIESM sur les changements climatiques en Méditerranée (Programme Tropical Signals), des listes d'espèces ont été proposées par une série d'experts nationaux.

Peuplements superficiels de macroalgues. Des ceintures étroites d'algues spécifiques du medio-littoral et de l'infra-littoral supérieur se situent dans la zone de battement des vagues. La composition du peuplement et sa vitalité sont conditionnées par une grande résistance à l'hydrodynamisme, par la qualité de l'eau, ainsi que par une bonne adaptation aux très fortes variations de température et de salinité. Ces peuplements sont particulièrement exposés aux pollutions de surface,

comme les rejets d'émissaires urbains ou les pollutions d'origine pétrolière. L'étude de leur répartition géographique, ainsi que leur suivi dans le temps, peut permettre de caractériser la qualité du milieu littoral. Ce sont aussi des indicateurs biologiques pouvant être utilisés comme outils de diagnostic de la qualité des eaux marines littorales.

La méthode CARLIT (Ballesteros *et al.,* 2007 ; *Cartography of littoral and upper-sublittoral rocky-shore communities*) est une méthode de mesure de la qualité environnementale des eaux littorales. Cet outil écologique a été expérimentée pour la première fois sur la côte catalane (Torras *et al.,* 2003 ; Ballesteros *et al.,* 2007) puis en Italie (Buia *et al.*, 2007), sur l'île de Malte (Thibaut & Mannoni, 2008) en France (données non publiées) et localement en Tunisie (Omrane, 2009). Ce type d'outil pourrait donc être transposée à l'échelle de la Méditerranée occidentale.

Communautés considérées et niveaux de sensibilité utilisés dans la méthode CARLIT

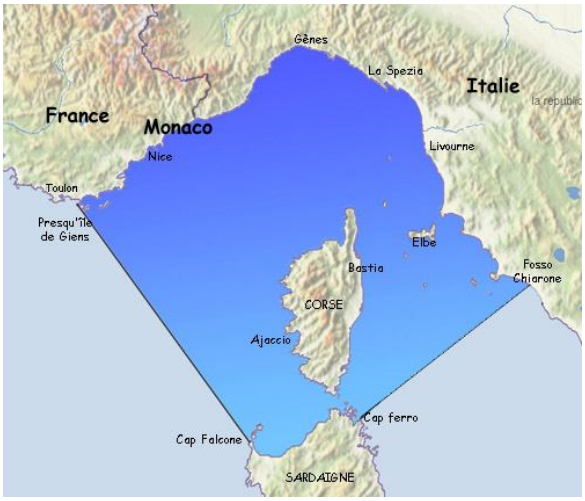
Category	Description	Sensitivity
Cystoseira mediterranea 5	Continuous belt of *C. mediterranea/stricta*	20
Cystoseira crinita	Populations of *C. crinita*	20
Cystoseira balearica	Populations of *C. balearica*	20
Cystoseira sheltered	Populations of *Cystoseira foeniculacea/barbata/spinosa* v. *tenuior/compressav.pustulata*	20
Posidonia reef	Barrier and fringing reefs of *Posidonia oceanica*	20
Cymodocea nodosa	*Cymodocea nodosa* meadows	20
Zostera noltii	*Zostera noltii* meadows	20
Trottoir	Build-ups of *Lithophyllum byssoides*	20
Cystoseira mediterranea 4	Almost continuous belt of *C. mediterranea/stricta*	19
Cystoseira mediterranea 3	Abundant patches of dense stands of *C. mediterranea/stricta*	15
Cystoseira mediterranea 2	Abundant scattered plants of *C. mediterranea/stricta*	12
Cystoseira compressa	Populations of *C. compressa* v. *compressa*	12
Cystoseira mediterranea 1	Rare scattered plants of *C. mediterranea/stricta*	10
Corallina	Belt of *Corallina elongata* without *Cystoseira*	8
Haliptilon	Belt of *Haliptilon virgatum*, without *Cystoseira*	8
Mytilus	Mussel (*Mytilus galloprovincialis*) beds, without *Cystoseira*	6
Encrusting corallines	Belt of *Lithophyllum incrustans, Neogoniolithon brassica-florida* and other encrusting corallines	6
Green algae	Upper sublittoral belts of *Ulva* and *Cladophora*	3
Blue greens	Communities dominated by Cyanobacteria and *Derbesia tenuissima*	1

Les cétacés

Parmi les espèces en danger ou menacées en Méditerranée inscrite à l'Annexe II du protocole ASP/DB, on compte 8 espèces principalement présentes sur les côtes de Méditerranée occidentale :

- Le rorqual commun (*Balaenoptera physalus*)
- Le cachalot (*Physeter macrocephalus*)
- La baleine à bec de Cuvier (*Ziphius cavirostris*)
- Le globicephale noir (*Globicephala melas*)
- Le dauphin de Risso (*Grampus griseus*)
- Le grand dauphin (*Tursiops truncatus*)
- Le dauphin commun à bec court (*Delphinus delphis*)
- Le dauphin bleu et blanc (*Stenella coerulzoalba*)

Ces espèces font l'objet d'une attention particulière au sein du sanctuaire PELAGOS, en Méditerranée nord occidentale, mais également dans le détroit de Gibraltar (Museo del Mar, Ceuta).



Le Sanctuaire PELAGOS

Espace maritime de 87500 km² situé entre l'Italie, Monaco et la France, le Sanctuaire a été créé après constatation dans les années 80 d'une fréquentation importante et diversifiée de mammifères marins. Les cétacés semblent, en effet, être attirés par une production primaire élevée.

L'objectif de cet accord tripartite est de garantir un état de conservation favorable des mammifères marins. Les pays signataires se sont engagés à identifier les menaces et à prendre les mesures appropriées

Synthèse des activités humaines affectant les cétacés de Méditerranée occidentale

Activités	Effet	Impact sur les cétacés
Activités militaires Travaux sous-marins Sonars	Pollution sonore	Problème d'écholocalisation, surdité, mort
Navigation sportive Plaisance	Pollution sonore, Collision, dérangement	Problème d'écholocalisation, surdité, mort
Whale watching	Dérangement stress Harcèlement	Perturbations des activités et liens sociaux
Transport de marchandises et de passagers	Collision, dérangement	Blessures, mortalités, échouages
Pêche professionnelle	Captures accidentelles	Blessures, mortalités, échouages
Pollution tellurique	Bioaccumulation de métaux lourds et pesticides	Troubles hormonaux, reproduction affecté, transmission des contaminants à la descendance

Outre les Cétacés, une seule espèce de Pinnipèdes était présente en Méditerranéenne occidentale. Il s'agit du Phoque moine *Monachus monachus,* une espèce dont le dernier représentant a disparu du Maroc 2004 (Cebrian, 2005).

1.1.3. Inventaire des apparitions temporelles, l'abondance et la distribution spatiale des espèces exotiques, non indigènes et invasives

En Méditerranée le protocole ASP/DB adopté en juin 1995 précise : « 1. Les Parties prennent toutes les mesures appropriées pour réglementer l'introduction volontaire ou accidentelle dans la nature d'espèces non indigènes ou modifiées génétiquement et interdire celles qui pourraient entraîner des effets nuisibles sur les écosystèmes, habitats ou espèces dans la zone d'application du présent Protocole. 2. Les Parties s'efforcent de mettre en oeuvre toutes les mesures possibles pour éradiquer les espèces qui ont déjà été introduites lorsque, après évaluation scientifique, il apparaît que celles-ci causent ou sont susceptibles de causer des dommages aux écosystèmes, habitats ou espèces dans la zone d'application du présent Protocole ».
On compte en Méditerranée 581 espèces introduites en tenant compte notamment des Ciliés, des invertébrés et des Téléostéens (voir revue de Boudouresque, 2008). Elles représentent 5% des effectifs en espèces. La plupart des espèces introduites sont des immigrants lessepsiens, c'est-à-dire arrivée après l'ouverture du canal de Suez, beaucoup d'autres espèces sont arrivées sur les coques de bateaux. Depuis les années 70, l'aquaculture est devenue une voie majeure d'introduction (Boudoureque, 2004).
Peu de données sont disponibles sur les espèces invasives au Maroc, le peu d'informations transmises est erronée (origine de *Caulerpa racemosa* par ex.). Dans le mesure où il existe plusieurs « hot-spot » d'introduction dans le bassin occidental (Gabès en Tunisie ou encore Thau en France), il serait étonnant qu'une lagune comme celle de Nador soit pas grandement concernée par les introductions. D'une manière générale, les signalisations d'espèces introduites ont nettement augmenté au cours des dernières décennies, probablement à cause du trafic maritime, des introductions accidentelles, ou des eaux de ballast.

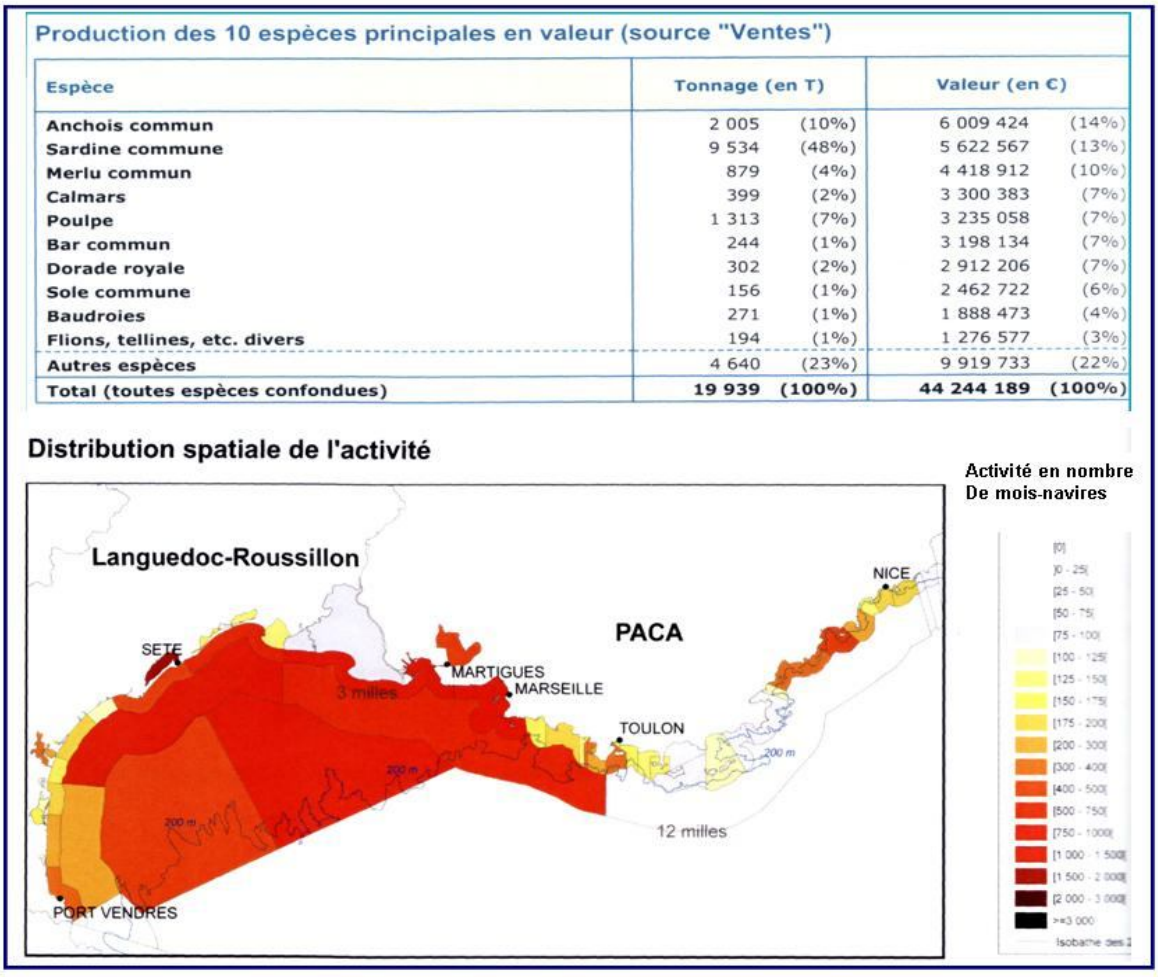
Un des cas récurrents dans tout le bassin occidental est celui des caulerpales, *C. taxifolia* et *C. racemosa*. Dés 1990, des efforts importants ont été déployés pour suivre et mesurer la progression de *C. taxifolia*, puis *C. racemosa* en Méditerranée occidentale. Trois campagnes de sensibilisation internationale ont été réalisées en 1993 et 1997 et 1999 dans le cadre du programme *Life DG XI* "Contrôle de l'expansion de *Caulerpa taxifolia* en Méditerranée", puis dans le cadre du programme européen ALIEN. La colonisation par *C. racemosa* est actuellement extrêmement rapide, cette algue affectant même des sanctuaires sous-marins. Des procédures rapides existent pour suivre l'expansion de ces algues (appliquées en France et à Monaco) et il conviendrait de les transposer aux autres pays du bassin occidental.

1.1.4. Information sur les espèces d'intérêt commercial pour la pêche (poissons, mollusques et crustacés)

Des Etats de Méditerranée occidentale, Monaco est le seul qui ne présente pas d'activités de pêche significative, et l'Algérie est le seul à ne pas avoir présenté de cartes des zones de pêches indiquant efforts et nature des prises. Pour les autres, il conviendrait d'harmoniser le mode de présentation des statistiques de pêche.

Production des 10 espèces principales en valeur (source "Ventes")

Espèce	Tonnage (en T)		Valeur (en €)	
Anchois commun	2 005	(10%)	6 009 424	(14%)
Sardine commune	9 534	(48%)	5 622 567	(13%)
Merlu commun	879	(4%)	4 418 912	(10%)
Calmars	399	(2%)	3 300 383	(7%)
Poulpe	1 313	(7%)	3 235 058	(7%)
Bar commun	244	(1%)	3 198 134	(7%)
Dorade royale	302	(2%)	2 912 206	(7%)
Sole commune	156	(1%)	2 462 722	(6%)
Baudroies	271	(1%)	1 888 473	(4%)
Flions, tellines, etc. divers	194	(1%)	1 276 577	(3%)
Autres espèces	4 640	(23%)	9 919 733	(22%)
Total (toutes espèces confondues)	**19 939**	**(100%)**	**44 244 189**	**(100%)**



Mode de représentation des statistiques de pêche en Méditerranée française. Synthèse des flottilles françaises 2006. IFREMER.

1.2. Habitat types

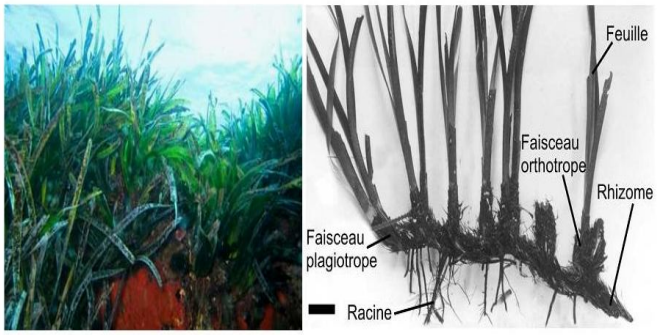
Chaque Etats participants a avancé une liste, parfois conséquence, d'aires marines protégées. La question de la réglementation en matière de conservation se pose souvent, surtout lorsqu'il ne s'agit pas de Parcs Nationaux. Par exemple, il faut noter que la caractérisation des habitats n'est pratiquée au Maroc que lors d'expertises commandées par le CAR-ASP (MedMPA, 2002 ou PAC-Maroc, 2009). A l'opposé, il existe actuellement en France une forte volonté de cartographie et de suivis écologiques des principaux habitats se trouvant au sein des aires marines protégées, et ce depuis le littoral jusqu'aux grands fonds.

Deux exemples d'habitat : 1) Methodes de suivi écologique existent ; 2) méthodes n'existent pas !

Herbier de posidonie

Posidonia oceanica est une magnoliophyte marine endémique de Méditerranée. Elle constitue des herbiers pouvant être présent jusqu'à 40 mètres de profondeur. Les feuilles mesurent de 40 à 80 cm et environ 1 cm de large et sont regroupés en faisceaux qui poussent sur une tige appelée rhizome. Cet ensemble édifie peu à peu une « matte » composée de rhizome, racine et sédiment. Les mattes jouent notamment un rôle de stabilisation des fonds meubles. La posidonie craint particulièrement la déssalure et on ne la trouve pas à l'embouchure des grands fleuves, dans les lagunes et à l'entrée des estuaires. Les herbiers souffre également de l'activité humaine et notamment : les aménagements littoraux et la modification des flux sédimentaires, la modification des apports par les fleuves, la diminution de la transparence de l'eau, la pollution chimique, les ancrages, les arts traînants, les explosifs, l'aquaculture et la compétition avec les espèces introduites.

L'herbier de posidonie constitue un enjeu majeur de protection et de gestion du milieu marin Méditerranéen depuis quelques décennies. Cet habitat représente un écosystème de haute valeur écologique qui est l'un des plus productifs de la planète (Boudouresque et *al*. 2006). Etant un élément fondamental pour la qualité des milieux littoraux, l'herbier de posidonie est important pour le développement du tourisme et la pêche artisanale. Inscrite sur de multiple convention internationale, elle est légalement protégée en France par la loi du 10 juillet 1976 relative à la protection de la nature et par l'arrêté interministériel du 19 juillet 1988. Tous les pays membres en sont conscients et des méthodes robustes de suivi écologique existent.



A gauche, un herbier de posidonies sur roche. A droite, un rhizome plagiotrope de posidonie portant, vers le haut, des rhizomes orthotropes et, vers le bas, des racines. Chaque rhizome porte un faisceau de feuilles. La barre d'échelle mesure 2 cm. D'après Boudouresque & Meinesz (1982).

Coralligène

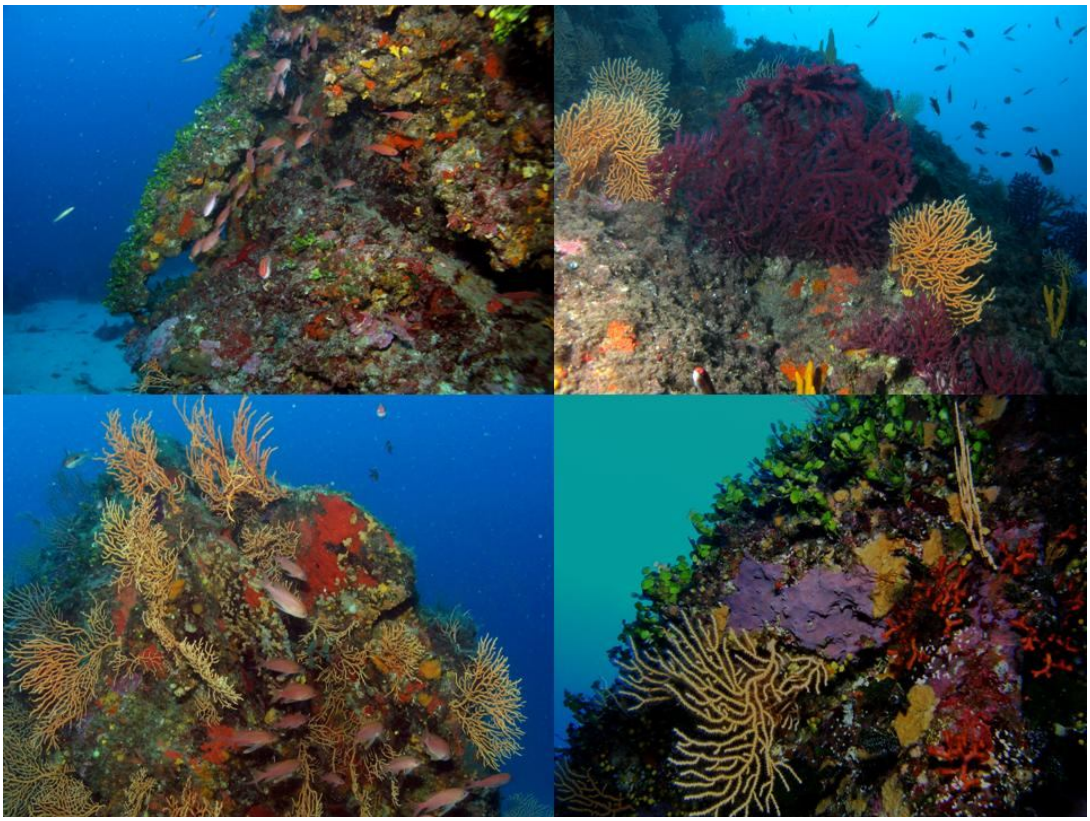
La biocénose du coralligène est parfois dominée par des grands invertébrés fixés tels que les gorgones (*Paramuricea clavata* et *Eunicella* spp.), des éponges et des bryozoaires ou encore certaines grandes algues pérennes, organismes emblématiques de Méditerranée, souvent clés de voûte de l'écosystème, et qui sont les principaux attraits pour des activités de loisirs liées à la pratique de la plongée (photo, vidéo, biologie). A l'instar des récifs coralliens, ces paysages sous-marins exceptionnels sont le résultat de constructions biogènes pouvant atteindre plusieurs mètres d'épaisseur et pouvant couvrir de très grandes surfaces ou former des corniches sur les falaises sous-marines (Laborel, 1987). Les principaux agents constructeurs du coralligène sont des corallinaceae des genres *Mesophyllum*, *Lithophyllum* et *Pseudo-lithophyllum* (Laborel, 1961 ; Hong, 1980). La communauté abrite une très forte diversité d'invertébrés sessiles et suspensivores de plus petite taille (e.g. Pérès & Picard, 1964 ; Ros et al. 1985) qui contribue également à la construction et qui du fait de leur mode vie subissent et intègrent l'ensemble des perturbations de l'environnement côtier. D'ailleurs, la bioconstruction est généralement contrebalancée par l'action des foreurs ou rongeurs de substrats calcaires dont l'abondance est parfois favorisée par des modifications des conditions physico-chimiques du milieu (ex. éponges cliones et oursins) (e.g. Rose & Risk, 1985 ; Carballo et al., 1996 ; Harmelin et al., 1981 ; Hong, 1983).

Les sources de dégradation de cette communauté sont multiples. Elles peuvent être d'origine anthropique (envasement, apports de contaminants, macro-déchets, action mécanique…), d'origine biologique (compétitions par des espèces introduites et invasives, prolifération de pathogènes) ou encore climatiques comme par exemple les anomalies thermiques estivales de 1999 et 2003 (Pérez et al., 2000a ; Cerrano et al., 2000 ; Bonhomme et al., 2003).

Certains taxons présents dans cette communauté se sont déjà révélés comme de bons indicateurs, mais le plus souvent à des échelles très locales. Par exemple, les spongiaires ont de nombreuses caractéristiques de bons bioindicateurs et sont apparus être des outils très pratiques pour l'évaluation de l'état de santé des écosystèmes tempérés comme sous les tropiques (Battershill & Abraham, 1999 ; Pérez, 2000). De nombreux travaux ont permis de démontrer leur pertinence pour indiquer les fractions de contaminants biodisponibles dont les plus récents employaient notamment l'éponge de toilette méditerranéenne *Spongia officinalis* (Pérez et al., 2003b ; Pérez et al., 2004 ; Pérez et al., 2005). Les assemblages d'éponges et le suivis d'espèces indicatrices, dont les éponges perforantes de la famille des Cliones, sont également régulièrement employés pour mettre en évidence des déséquilibres au sein des communautés de substrats durs (e.g. Muricy, 1991 ; Carballo et al., 1996 ; Schönberg, 2001 ; Schönberg & Wilkinson, 2001). Autre exemple, les gorgonaires sont extrêmement sensibles aux perturbations de toute sorte. Chez ces organismes coloniaux, les effets des perturbations se manifestent généralement dans un premier temps par des nécroses (mort partielle de la colonie), puis une diminution de leur abondance et de leur diversité (*e.g.* Arnoux et al., 1992 ; Harmelin & Marinopoulos, 1994 ; Roberts, 1997 ; Pérez et al., 2000 ; Pérez et al., 2002; Bonhomme et al., 2003). Depuis l'observation de mortalité massive en Méditerranée (Cerrano et al., 2000 ; Pérez et al., 2000), l'espèce *Paramuricea clavata* a été au cœur d'un réseau de surveillance en région PACA (Sartoretto, 2002), malheureusement abandonné depuis. Plusieurs autres espèces font l'objet d'une veille écologique dans le cadre de programmes soutenus notamment par l'Institut Français de la Biodiversité (Boury-Esnault et al., 2003). Les bryozoaires

constituaient également un modèle intéressant à évaluer (Harmelin & Capo, 2001). A l'heure où diverses directives (relatives à la qualité de l'eau, des habitats) et conventions internationales demandent de prendre des mesures de contrôle de l'état de santé du milieu, de conservation des écosystèmes ou même de restauration, de nombreux groupes d'experts se réunissent pour décider des méthodes scientifiques et techniques en mettre en œuvre. Les communautés marines de substrats durs de Méditerranée, et le coralligène notamment, sont certainement parmi les plus diversifiées du littoral européen, sources de biens et services pour les activités humaines. Pourtant, il n'existe encore aujourd'hui aucune stratégie de surveillance de cette communauté à grande échelle. Les méthodes et savoir-faire existent. Des indicateurs biologiques ont localement fait leur preuve. Il s'agit aujourd'hui d'avoir une approche standardisée permettant la création d'un référentiel applicable en Méditerranée occidentale.

Le principal obstacle à la détermination d'un bon référentiel pour évaluer l'état de conservation de cette biocénose est la grande variété de faciès qu'elle peut présenter en Méditerranée occidentale. Pour cela, il est nécessaire de compléter les connaissances sur la composition de cette communauté dans les différents pays.



DIFFERENTS ETATS DE REFERENCE DU CORALLIGENE DANS LE BASSIN NORD DE MEDITERRANEE OCCIDENTALE

2. PRESSIONS ET IMPACTS

2.1. Changements climatiques en Méditerranée

Le changement global, singulièrement le réchauffement climatique et l'augmentation de la fréquence des événements extrêmes, affecte les écosystèmes terrestres comme marins. Les changements climatiques actuels sont très nettement conditionnés par le développement exponentiel des activités humaines et surpassent largement les frontières de la variabilité naturelle. Les effets potentiels du changement global agissent à différents niveaux d'organisation biologique, depuis des perturbations physiologiques d'individus jusqu'à des modifications d'une communauté et de son fonctionnement, et ce, par des extinctions locales ou/et des extensions de certaines espèces. Toutes les prévisions concernant les conséquences du réchauffement sur la biodiversité dans son ensemble sont très préoccupantes. Sur la base d'un scénario modéré de changement climatique, on prévoit actuellement une extinction de 15 à 37% des espèces occupant cette surface d'ici 2050. La Mer Méditerranée est une des régions sensibles aux changements climatiques et abritent de 4 à 18% de la biodiversité marine mondiale selon les groupes taxonomiques considérés. Pourtant, à ce jour, aucune modélisation n'a tenté d'évaluer le devenir de la biodiversité méditerranéenne. A partir des publications scientifiques et des données validées disponibles, on a dressé ici un inventaire aussi complet que possible de l'impact des changements climatiques sur la biodiversité marine en Mer Méditerranée. A partir de ce bilan, il sera possible de discuter de différentes mesures d'adaptation afin de limiter les aspects négatifs des impacts en réduisant la vulnérabilité des écosystèmes, et de tirer parti au mieux des aspects positifs ou opportunités.

L'émergence récente de séries d'enregistrements de température à long terme a permis de démontrer pour la Méditerranée Nord Occidentale une tendance au réchauffement de l'ordre de 1°C en 30 ans et une augmentation de la fréquence des événements extrêmes. Ce type de données fait souvent défaut dans les autres parties de Méditerranée, et il convient donc de mettre en place des stratégies adéquates à l'échelle de la Méditerranée de manière à développer des modèles de prédiction des changements des conditions environnementales (réchauffement, circulation, teneurs en nutriments).

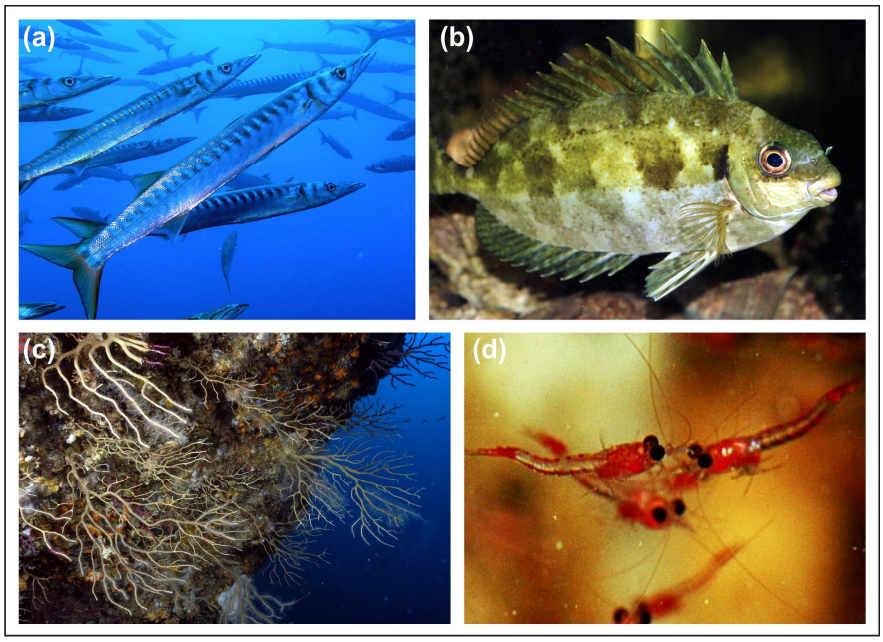
Les migrations d'espèces méridionales, le plus souvent vers l'Ouest et le Nord, ont constitué les premières indications des effets biologiques du réchauffement en Méditerranée. Les rapports les plus nombreux sont pour la Méditerranée Nord Occidentale et l'Adriatique. On considère que les modifications à court terme des peuplements ichthyologiques reflètent en temps quasi réel, en tout cas à l'échelle d'une génération, des changements dans les conditions hydrologiques. En Méditerranée Nord Occidentale, l'inventaire le plus récent fait état de plusieurs dizaines d'espèces dont l'aire de répartition a significativement changé depuis les années 70. Parmi ces mouvements, on note l'arrivée de plusieurs espèces de poissons (sardinelles, barracudas, coryphènes) qui prennent peu à peu place dans les pêcheries régionales. Au-delà de ces effets positifs, on assiste également à l'effondrement des stocks de petits pélagiques (sprat, anchois) et/ou à des modifications du cycle de vie de certaines prises privilégiées (thons, sérioles). Les invasions biologiques sont souvent considérées comme une composante du changement global, puisqu'elles affectent la biodiversité et apparaissent souvent

reliées aux changements climatiques, en favorisant, notamment en Méditerranée Orientale, la progression d'espèces lessepsiennes. Par ailleurs, des récents cas d'introduction de dinophytes exotiques à biotoxines ou de prolifération d'espèces produisant des mucilages ont été également corrélés aux occurrences d'anomalies climatiques.

Les événements climatiques extrêmes sont vécus comme des stress aigus perturbant le fonctionnement normal d'un système biologique. Le stress thermique est aujourd'hui largement reconnu comme le principal facteur de déclenchement des maladies en mer, avec une tendance apparente à l'augmentation de la fréquence de ces événements en Méditerranée. Les espèces affectées par ces événements sont des éléments essentiels des paysages sous-marins, et majoritairement des spongiaires et des gorgonaires. Si les mortalités de gorgones étaient connues depuis les années 70, et celles d'éponges commerciales depuis le milieu des années 80, les deux événements qui ont marqué les esprits sont ceux de 1999 et 2003, tout deux survenus à la suite d'anomalies thermiques d'ampleur exceptionnelle. Le rôle primordial du réchauffement a été bien établi, mais différents modes d'action ont été évoqués. Il a été montré à plusieurs reprises que les anomalies thermiques pouvaient déclencher la virulence et/ou conditionner la propagation d'agents pathogènes (des *Vibrio* notamment) pour des spongiaires, des cnidaires ou encore des échinodermes. Par ailleurs, l'action d'agents pathogènes pourrait être facilitée par une inhibition des capacités de défenses des organismes subissant le stress thermique. Il apparaît ainsi nécessaire de développer des études épidémiologiques pour déterminer les facteurs de déclenchement et de propagation des agents pathogènes. D'une manière très générale, il serait intéressant de créer une base de données géo référencées sur la distribution des espèces sensibles aux changements climatiques en Méditerranée, et de mettre au point des méthodes de suivi des limites de répartition, et des modèles de prédiction des risques d'extinction en Méditerranée. Des informations majeures manquent encore avant que l'on puisse évaluer précisément la résilience des populations d'invertébrés affectées par les événements climatiques extrêmes : (i) une bonne connaissance des cycles de vie, des efforts reproducteurs, des succès de reproduction et de recrutement des larves, la contribution de la reproduction asexuée et de la régénération dans le maintien des populations ; (ii) une bonne caractérisation de la structuration génétique des populations permettant d'évaluer les flux de gènes entre elles et les capacités de dispersion des propagules ; (iii) des outils permettant d'apprécier les possibilités d'adaptation au stress généré par le changement global en Méditerranée, qu'il s'agisse d'ajustements physiologiques (plasticité phénotypique) ou de processus micro évolutifs.

Les conséquences attendues des changements de biodiversité occasionnés par les déplacements ou les disparitions de certaines espèces sont des modifications du fonctionnement des écosystèmes marins. Seules des observations à long terme permettent d'apprécier les variations naturelles de la composition des communautés et les liens avec les fluctuations climatiques à différentes échelles. Elles sont essentielles pour prédire les effets des changements climatiques sur les ressources naturelles. Par exemples, les anomalies thermiques du milieu des années 80 ont été à l'origine de modifications très importantes des communautés planctoniques à la base du réseau trophique de nombreuses espèces pélagiques. La productivité des écosystèmes marins peut être également conditionnée par les variations du débit des grands fleuves, lui-même sous l'influence de la variabilité climatique. C'est ainsi qu'il a été montré une série de réponses en chaîne après les crues du Rhône, causant des apports importants de matière organique terrigène en milieu côtier, favorisant les

peuplements de polychètes, puis ceux de poissons plats. La démonstration a été faite aussi que les écosystèmes profonds pouvaient également répondre très rapidement à la variabilité climatique.



Des exemples représentatifs d'espèces qui répondent aux changements climatiques en Méditerranée occidentale. (a) le barracuda *Sphyraena viridensis* a grandement augmenté son aire de répartition ces 30 dernières années, (b) l'espèce lessepsienne *Siganus rivulatus* est un herbivore qui affecte la Méditerranée orientale mais qui vient d'arriver dans le golfe du Lion (c) un paysage de gorgones affecté par la mortalité massive survenue après la canicule sous marine de 2003, d) les crustacés mysidacés *Hemimysis* spp. sont des exemples maintenant classiques d'un remplacement d'espèces en relation avec le changement climatique. Extrait de Lejeusne et al 2010

2.2 Modifications des écosystèmes de haute mer et d'eaux profondes

Les eaux profondes méditerranéennes renferment une forte diversité d'habitats, du fait de leur histoire géologique (Bianchi & Morri 2000). En particulier, les structures géomorphologiques telles que les canyons, les monts sous-marins, les volcans de boue et les fosses abyssales peuvent abriter d'importantes communautés biologiques.

En général, les communautés biologiques des eaux profondes méditerranéennes sont adaptées à un environnement oligotrophique ; il existe des aires locales de productivité plus forte et des régions névralgiques de la biodiversité.

Les eaux profondes méditerranéennes se divisent sur le plan physique en deux bassins séparés par le détroit de Sicile peu profond (environ. 400 m de profondeur). On observe d'importantes différences entre les bassins oriental et occidental, tant en termes de composition que d'abondance des espèces (Sardà et al. 2004).

Selon certains auteurs, les eaux profondes méditerranéennes font partie des environnements d'eaux profondes les plus fortement touchés au monde, et en même temps, les zones les moins connues en termes de biodiversité (PNUE-PAM-CAR/ASP, 2010) : il existe un risque qu'une perte importante de biodiversité se produise avant que les scientifiques n'aient eu le temps de enregistrer son existence (Briand 2003, Cartes et al. 2004).

On peut classer ainsi les principales pressions subies par les eaux profondes :

- chalutage de fond
- autres pratiques de pêche
- élimination des déchets (déchets solides)
- autres polluants marins
- prospection et exploitation pétrolières
- pose de pipelines en eaux profondes
- changements climatiques

Dans un contexte mondial(à l'échelle mondiale, on considère comme eaux profondes (entre autres définitions) l'environnement marin qui s'étend vers le bas à partir de la rupture de la pente continentale, autrement dit des eaux situées en dessous de 200 m jusqu'à sa profondeur maximale. Actuellement, la pêche en eaux profondes ne se pratique en Méditerranée qu'à des profondeurs inférieures à 1 000 m, mais cela pourrait exploiter de nombreux SH, autrement dit la pêche dans les monts sous-marins pourrait atteindre un seuil d'épuisement dans un délai ne dépassant pas trois à quatre ans (Johnston & Santillo 2004). L'intérêt potentiel de la pêche dans les fonds actuellement inexploités situés à une profondeur supérieure à 1000 m (engins traînants interdits par la CGPM, 2005) est très limité. La raison en est que l'abondance globale des crustacés est extrêmement plus faible, et dans les communautés de poissons prévalent largement des poissons qui ne présentent pas d'intérêt sur le plan commercial soit (comme la caussinie *Alepocephalus rostratus*) ou sont de petite taille (comme le grenadier méditerranéen *Coryphenoides guentheri*). Si ces espèces devaient un jour présenter un nouvel intérêt commercial et les chalutiers atteindre des zones plus profondes, l'écosystème pourrait en peu de temps être détérioré par la pêche.

La pêche pélagique de haute mer en Méditerranée, ciblant généralement des espèces pélagiques de grande taille (à l'exception d'espèces pélagiques de petite taille comme les anchois et sardines, en mer Adriatique), est la seule pêche industrielle ; elle se déroule essentiellement dans les eaux internationales et même certains pays non méditerranéens y participent (Cacaud 2005).

La plupart des informations sur l'activité des flottilles de pêche en Méditerranée émanent du groupe de travail du STECF et du Groupe de travail de la CGPM sur les espèces démersales, du Sous-comité de l'évaluation des stocks et de l'ICCAT pour les poissons pélagiques de grande taille, et portent sur l'activité des flottilles des pays membres. Par conséquent, le STECF ne fournit pas d'informations sur l'activité de pêche des pays non membres de l'UE (par ex. l'Afrique du Nord), même si la Tâche 1 du CGPM, et les projets de coopération (Medfisis, COPEMED II, ADRIAMED et EASTMED) œuvrent dans cette direction.

La conséquence négative la plus importante des activités de pêche est la dégradation des écosystèmes marins due à la l'élimination des espèces cibles et non cibles et aux perturbations physiques infligées par certains types d'engins de pêche. Les Habitats essentiels des poissons (EFH) sont les habitats nécessaires à l'alimentation, au refuge ou à la reproduction des espèces ; et les Habitats sensibles (SH) comprend les aires peuplées par des espèces endémiques, à forte biodiversité ou productivité élevée et qui sont vulnérables aux pratiques de pêche. La dégradation des écosystèmes provoquée indirectement par la pêche touche les espèces commerciales si l'habitat cesse d'être adéquat pour ces espèces. Dans ce contexte, il est nécessaire de réglementer les activités de pêche afin de réduire la dégradation des écosystèmes par la création d'une Approche écosystémique des pêches (AEP), qui prenne en compte non seulement la protection des espèces cibles, mais également l'écosystème dans son ensemble. Dans le cadre de l'AEP, l'Approche de précaution étudie les mesures les plus restrictives pour la gestion de la pêche (notamment la constitution d'aires fermées à la pêche, ou Aires marines protégées) dans un contexte d'absence générale de connaissances sur le fonctionnement de nombreux écosystèmes qui maintiennent les ressources halieutiques.

La plupart des eaux méditerranéennes sont constituées de haute mer. La haute mer méditerranéenne englobe une forte diversité d'habitats, tant pélagiques que démersaux (haute mer). Ces habitats sont mal connus en ce qui concerne les écosystèmes côtiers et de plateaux continentaux, qui sont plus facilement étudiés, alors qu'il existe une bonne connaissance de l'état des stocks des espèces commerciales qu'ils abritent, grâce à des études sur la pêche et aux captures commerciales. La protection de la faune dans ces aires est importante pour la pêche et la conservation de l'écosystème parce que les organismes peuvent déterminer la santé d'un écosystème. La faune benthique sessile joue un rôle important en tant qu'organismes structurant les habitats fournissant un refuge pour de nombreuses espèces marines (par ex. les récifs coralliens d'eau froide, les éponges profondes, lits de crinoïdes).

Les grands fonds consistent en larges étendues de sédiments meubles interrompues par caractéristiques géologiques telles que canyons sous-marins, lacs de saumure, monts sous-marins, évents hydrothermaux, « cold seeps » (suintements froids) et volcans de boue, qui créent un habitat spécial abritant une forte diversité et un endémisme ; nombre de ces habitats n'ont été découverts que récemment et doivent être protégés selon l'Approche de précaution.

La pêche démersale pratiquée en haute mer en Méditerranée peut se résumer ainsi : chalutage de fond, ligne de fond et filets maillants. La pêche en haute mer se pratique actuellement sur les plateau continentaux et quelques pentes, jusqu'à des

profondeurs inférieures à 800 m. Le chalutage de fond est une pratique éminemment nocive qui a été interdite en 2005 to fonds méditerranéens d'une profondeur supérieure à 1 000 m, afin de protéger la faune vulnérable des grands fonds.

Dans les habitats benthiques en haute mer en Méditerranée, les composantes extrêmement vulnérables à la pêche sont les faciès coralligènes, l'échinoderme crinoïde *Leptometra phalangium* le cnidaire *Funiculina quadrangularis* et *Isidella elongata,* faciès d'organismes sessiles jusque-là repérés sur les plateaux continentaux et la rupture de pente continentale du bassin occidental, bien que l'emplacement et l'étendue de ces habitats dans l'ensemble de la région soient encore très mal connus.

Dans les eaux profondes existent plusieurs aires pourvues d'une abondance considérable des récifs coralliens d'eau froide extrêmement vulnérables, principalement repérés sur les pentes continentales, les monts sous-marins et sur les parois des canyons sous-marins (par ex. au large de Cape Santa Maria di Leuca, dans le bassin central, ou dans de nombreux canyons et monts sous-marins répartis le long de la mer d'Alboran, dans le bassin occidental). Plusieurs plaines abyssales, abritant une faune des grands fonds vulnérable et mal connue, sont situées dans toute la Méditerranée, les plus profondes se trouvant dans le bassin central (par ex. la Calypso en mer Ionienne, au sud-ouest de la Grèce). D'autres types géologiques peuvent être plus vulnérables à la pêche du fait qu'ils sont des régions névralgiques en termes de diversité et l'habitat d'une faune vulnérable comme les coraux d'eau froide. L'énorme mont sous-marin Eratosthenes dans le bassin oriental (au sud de Chypre) et de nombreux monts sous-marins dispersés dans la mer d'Alboran et le sud de la mer Tyrrhénienne ; les « cold seeps », bassins de saumure et évents hydrothermaux ont principalement été repérés dans le bassin oriental de la Méditerranée (sud de la Crète et de la Turquie, et près de l'Egypte). Le bassin occidental de la Méditerranée abrite de nombreux canyons sous-marins qui constituent des EFH pour les crevettes rouges, comme de nombreux canyons du golfe du Lion qui contiennent d'importantes ressources en crevettes rouges, homards norvégiens, merlus, lottes, entre autres espèces commerciales importantes ; les zones de nourricerie de merlus sont principalement situées sur de vastes étendues de plateaux ou rives continentaux, parsemés dans le sud de la Sicile, le centre de la mer Adriatique dans la fosse de Jabuka, et la mer de Thrace, tandis que les zones de frai des merlus semblent se trouver dans les canyons situés sur une rupture de pente continentale et une pente continentale, l'exemple le plus évident étant celui du golfe du Lion.

Les espèces pélagiques de grande taille qui habitent la haute mer, essentiellement thon rouge de Méditerranée, espadon et thon blanc, mais aussi requins pélagiques (requin-taupe bleu, requin bleu et requin-taupe commun) présentent un grand intérêt sur le plan de la conservation et sont surexploités depuis longtemps par les engins de pêche pélagique. Les principaux engins de pêche au poisson pélagique de grande taille sont les sennes coulissantes et palangres pélagiques. Les flottilles utilisant la palangre pélagique pêchent dans les eaux méditerranéennes, comprennent aussi bien des flottilles locales d'Etats riverains que de grandes flottilles industrielles étrangères ; ces dernières sont extrêmement mobiles et couvrent quasiment tout le bassin méditerranéen. Les filets dérivants ont été interdits en Méditerranée en 2005, et malgré cela cette activité est encore pratiquée. La haute

mer en Méditerranée est également l'habitat de cétacés et tortues en voie de disparition qui constituent des prises accessoires fréquentes de la pêche pélagique et méritent d'être particulièrement protégés. Les EFH importants pour les espèces pélagiques de grande taille sont essentiellement déterminés par des types océanographiques comme les zones d'upwelling ou gyres, créant des aires productives importantes pour l'alimentation et le frai ; ces aires qui jouent le rôle d'EFH doivent être identifiés pour déterminer des mesures de protection des espèces pélagiques. Les principales zones de frai du thon rouge de Méditerranée ont été localisées au sud des îles Baléares, dans la mer d'Alboran et le détroit de Sicilie, tandis que celles de l'espadon se trouvent quasiment dans toute la Méditerranée et celles du thon banc coïncident en partie avec les zones de frai du thon rouge de Méditerranée.

2.3. Zones critiques sensibles aux effets de la pêche en haute mer sur la biodiversité marine et côtière

Les zones critiques considérées comme des EFH et SH subissant les impacts de la pêche hautière en Méditerranée, pourraient constituer un outil essentiel pour gérer la pêche en haute mer en Méditerranée dans le cadre d'une AEP et d'une Approche de précaution ; mais ces zones impliqueraient alors une restriction effective des activités de pêche, nécessitant un système de surveillance adéquat et un contrôle à long terme.

Les sites suivants sont considérés comme des zones critiques dans la sous-région, en matière d'impacts de la pêche hautière en Méditerranée, notamment les écosystèmes démersaux et pélagiques :

Les aires prioritaires démersales :

- Pente du Golf de Lion : écosystème démersal pour protéger plusieurs espèces commerciales (incluant merlu, crevette, lotte) aire de frai sensible aux activités de pêche démersal. Déjà adoptée comme FRA par la CGPM

- Les montagnes sous marin d'Alboran : cette aire contient des récifs de coraux d'eau froide et canyon sous marin, très sensible à la pêche de fond

Les aires prioritaires pélagiques

- Sud des îles Baléares : une aire de frai importante pour le thon rouge en Méditerranée ainsi que les cétacés et les requins.

- Détroit de Gibraltar et mer d'Alboran : une route de migration importante pour le thon rouge et les cétacés

Les aires prioritaires pélagiques et démersales :

- Fonds méditerranéens en dessous de 1 000 m. Habitat d'une faune vulnérable mal connue se trouvant dans les quatre sous régions méditerranéennes. La pêche utilisant des engins traînants dans ces aires ont été interdite par la CGPM