EP

United Nations Environment Programme

UNEP(DEPI)/MED WG 359/Inf.10
October 2010

ENGLISH
ORIGINAL: ENGLISH

MEDITERRANEAN ACTION PLAN

Tenth Meeting of Focal Points for SPAs
Marseille, France 17-20 May 2011

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"

PNUE
CAR/ASP - Tunis, 2011

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.

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

The original version (English) of this document has been prepared for the Regional Activity Centre for Specially Protected Areas by:

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 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)

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. The information included in the present document regarding Montenegro, therefore, is 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 ofconservation 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

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 document 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

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

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.

[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.

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.

- 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

First of all, general description of the Mediterranean and Adriatic Sea are presented here.

The Mediterranean Sea (Fig.1) 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 1470 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.

Fig. 1. 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 (Fig. 2) represents only 4.6% of the Mediterranean Sea 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.

Fig. 2. The Adriatic Sea.

The 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 - about 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 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 while area deeper than 1000m covers only 7,7% of Adriatic sea bed. 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 it is mostly flat with sediments offshore and corallogenic concretions along the islands. Large coral reefs beyond depths of 300 m have also been registered.

The Adriatic was finally formed in postglacial time. Some 18,000 years ago the land was about 100 m higher (Bakran-Petricioli, 2007). The whole Northern Adriatic - previously the mainland, started to sink and it was flooded due to transgression of the sea. The peaks of karstic mountain chains stretching NW-SE became islands. Today almost the whole eastern Adriatic coast is rocky, forming so-called Dalmatian type of the coast. These geomorphological specificities represent the basis for development of diverse habitat types like marine caves or reefs along the steep slopes of islands. There are specific habitat types on submerged karst that are characteristic for Eastern Adriatic like vruljas (submerged freshwater springs), karstic estuaries, marine lakes, deep circalittoral hard bottoms (naked karst), anchihaline caves, marine caves and descending caves with bathyal elements (Bakran-Petricioli, 2007). High species diversity is the consequence of diverse habitats.

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 Montenegro, there was no available national report, 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), based on a very comprehensive catalogue of phytoplankton of Northern and Middle Adriatic (Kerzan and Stirn, 1976) as well as 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.

After 2002, new taxa have been further registered. Today, the most research on phytoplankton is connected to sites important for monitoring of the state of marine environment like estuaries of rivers (Zrmanja, Krka, Neretva) as well as to sites containing some specific characteristics like the Otrant Straight and the Jabuka Pit. Generally, Northern Adriatic is much better researched than the middle and southern part.

It is worth mentioning the centric diatom *Cyclotella choctawhatcheeana* that develops dense populations in karstic estuary of the Zrmanja River, showing preference for oligotrophic and brackish conditions (Buric et al, 2007).

A very rare dinoflagellate *Ceratoperidinium yeye* was found recently in Eastern Adriatic. This species has been registered only in few sites in the whole Mediterranean Sea (Nincevic-Gladan et al, 2006b).

During inventarisation of microphytoplankton of Neretva Delta, 146 taxa have been registered, most of them being diatoms. In the brackish lake Vlaska two new species have been found: *Oxyphysis oxytoxoides* and *Erythropsidinium agile agg*. (Jasprica and Hafner, 2005).

Very interesting and specific site is a small, karstic marine Lake Rogoznica. In this naturally eutrophic, hypoxic and periodically anoxic lake with the brackish/seawater interface, Buric et al, (2009) found 40 taxa, mainly diatoms (62.5%) and dinoflagellates (29%) The research provided evidence of exceptionally dense populations and the seasonally-recurrent appearance of two rare dinoflagellates: *Prorocentrum arcuatum* Issel and heterotrophic species *Hermesinum adriaticum* Zacharias.

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.*

The Otrant Strait between the Adriatic and Ioninan Seas is an oligotrophic area (Vilicic et al, 1995). Enrichment of the euphotic layer with the nutrients is mainly due to discharge of Albanian and Greek rivers, as well as mixing and upwelling in winter/early spring, resulting in periodical phytoplankton blooms. The eastern part of the strait is mostly influenced by the northerly inflowing current from the Ionian Sea, and the western part by the southerly outflowing current from the Adriatic Sea.

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.

Recently systematic collection of phytoplankton related data started in the framework of reporting on indicators on marine environment, mariculture and fishery. The Institute of Oceanography and Fishery (IOF) is collecting and processing relevant data for the Croatian Environment Agency (CEA). Taxonomic research is mostly concentrated on microphytoplankton while ecological research deals with changes in plankton communities due to antropogenic influence and CC. The complete *Database on indicators of marine environment, mariculture and fishery* is available on CEA webpage http://jadran.izor.hr/azo/.

Eutrophication parameters have been monitored since 1998 on some 20 sites along the coast. Data show that the largest part of coastal waters is oligotrophic, with exception of few sites that are mesotrophic due to antropogenic eutrophication (Kastela Bay near Split, Sibenik Bay near the Krka estuary and waters along the Istria under the influence of the Po River.

Phytoplankton biomass was estimated in the period 2003-2004 from satellite images. Results show that the trophic level of eastern Adriatic is significantly lower than the western part.

Recent monitoring from 2007 onwards shows that all monitored sites are oligotrophic and that water quality has been improved. No “red tide” blooms of dinoflagellates have been registered. It must be mentioned that during previous decades the blooms of the “red tide” species *Prorocentrum minimum* was common in spring and summer period. The blooms of toxic phytoplankton genus *Dinophysis* became rare, mostly registered only locally in Northern Adriatic. In 2008 concentrations of chlorophyll *a* was inside reference values on all monitored sites near river estuaries and large cities (Zadar, Sibenik, Split, Ploce). In phytoplankton communities of these sites diatoms preferring the high concentrations of nutrients were prevailing, like *Pseudo-nitzschia* spp., *Leptocylindrus danicus*, *L. minimus* and *Skeletonema costatum*. The percentage of dinoflagellates became much lower in recent years while ratio of diatoms has grown.

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.

Planktonic ostracods abundance in deep Adriatic Sea (Brautovic et al, 2007) showed that between fifteen species found, the dominant ones were *Porroecia spinirostris* and *Archiconchoecia striata*.

Research shows that abundance of copepods, especially of *Calanus helgolandicus,* is important in relation to the occurrence of basking sharks *Cetorhinus maximus* in the eastern Adriatic Sea (Soldo et al., 2008).

Acartia italica is the only strictly protected copepod in Croatia. It is the only planktonic copepod 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, *A. italica* recovers quickly as it is adapted to extreme conditions. This species has an important role in functioning of specific ecosystem of this small but very important site.

Regarding macrozooplankton, Batistic et al. (2007) reported, in the 0–1000 m water column at a deep-sea station in the northern part of South Adriatic Pit, out of 66 species identified, there were 19 hydromedusae, 14 calycophores, 3 ctenophores, 2 heteropods, 12 pteropods, 8 polychaetes and 8 chaetognaths. The calycophore *Muggiaea atlantica*, newly observed in the Adriatic, has replaced its formerly dominant congener *M. kochi*; the pteropod *Creseis virgula* has supplanted *C. acicula*, and the previously very rare *Pelagobia longicirrata* now is the dominant pelagic polychaete. Research on deep-sea gelatinous macrozooplankton in the Southern Adriatic (Onofri et al, 2009) by method of Blue Diving presented important data on ecology of several species like *Solmissus albescens*, *Nanomia bijuga* and *Forskalia formosa*.

One of the most important elements of macrozooplankton in the Adriatic is scyphomedusae because of their periodical swarms. Especially problematic are swarms of the mauve stinger *Pelagia noctiluca* because of its rather severe sting. High *Pelagia* densities have been observed with a periodicity of about 12 years in the western and central Mediterranean, while swarms in the Adriatic Sea have been less predictable. The moon jelly *Aurelia aurita* is usually present during the winter/spring in the Adriatic Sea. Since 2003, massive blooms of white jellyfish *Rhizostoma pulmo* have occurred during the autumn/winter period in the Northern Adriatic (Ramsak and Stopar, 2007).

An increasing dominance of two allochthonous macrozooplankton species was recorded recently: hydromedusa *Niobia dendrotentaculata* and thaliacea *Thalia orientalis* (Batistic et al, 2009). In August 2006 *N. dendrotentaculata* with 11.2 ind./m^3 made 44% of the total number of hydromedusae in the coastal area of the Southern Adriatic while previously predominant *Aglaura hemistoma* significantly decreased in abundance. Similar, *T. orientalis* has replaced its formerly dominant congener *Thalia democratica* in the coastal and open south Adriatic waters in January 2008. These faunal changes follow changes in zooplankton community structure recorded from 1995 in the Adriatic Sea, possibly due to large-scale hydroclimatic fluctuations, i.e. the North Atlantic Oscillation (NAO).

A new copepod *Speleophria mestrovi* was described from an anchialine cave on Vis Island. This is the first report of a misophrioid copepod, otherwise thought to be Tethyan relict, found in an Adriatic anchihaline cave (Krsinic, 2008).

A new calanoid copepod genus and species *Speleohvarella gamulini* was described from the anchihaline cave Ziva Voda on Hvar Island (Krsinic, 2005a). Also a new genus and species of calanoid copepod belonging to the family of *Ridgewayiidae* was described from an anchihaline cave on the small island of Badija (Krsinic, 2005b).

A new species of *Mesaiokeras* is described from the hyperbentos of Veliko Jezero, a marine lake on the island of Mljet. This is the first species of this genus and family *Mesaiokeratidae* reported from the Adriatic and Mediterranean Seas (Krsinic, 2003).

The most recent discovery is a new species of appendicularian, *Fritillaria ragusina*, that was described from specimens collected between the surface and 300 m depth at three stations in the open south Adriatic waters (Garic and Batistic, 2010).

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.

Microphytobenthos

Generally, there is poor data on marine microphytobenthos in Croatia, composed of diatoms *(Bacillariophyceae)* and blue-green algae *(Cyanobacteria*).

For the latter, Ercegovic (1932) studied lytophytic cyanobacteria and described several endemic genus like: *Dalmatella, Brachynema, Solentia, Hormathonema* etc. Out of 128 registered taxa of cyanobacteria in Croatia, even 53 (41%) are endemic for the Adriatic (Antolic, 1997).

For biocenosis of supralittoral and mediolittoral muds cyanobacteria represent main photosynthetic organisms. Epilitic cyanobacteria are important segment of biocenosis of supralittoral rocks, giving it characteristic dark brown-blackish colour. Endolitic cyanobacteria are characteristic for mediolittoral where they provide olive-brownish colour to the rocks of biocenosis of the upper mediolittoral (Bakran-Petricioli, 2007). In biocenosis of the lower mediolittoral rock endolitic cyanobacteria live at the base of the living part of the red coraligenous algae like *Lichophyllum lichenoides.* For biocenosis of mediolittoral caves in Croatia, cyanobacteria *Rivularia atra* is the characteristic organism (Bakran-Petricioli, 2007).

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

Among brown algae, the most important is genus *Cystoseira.* .Ercegovic (1932) has described a number of Adriatic endemic *Cystoseira* species like *C.spicata, C.adriatica, C.jabukae* (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). 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.

Red algae are important habitat structuring organisms in the Adriatic. Although the most species are sciaphyllic, 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).

Angiosperms

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

In Croatia, 5,655 species of marine invertebrates have been recorded According to available data, only one species of sea squirt *Polycitor adriaticus* is stated as endemic to the Adriatic.

Among 221 species of sponges recorded, the following species are 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 m^2. 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*.

New species of marine invertebrates are still being registered in Croatia, some of them being alien species. Several examples are as follows.

Shellfish *Rhomboidella prideauxi* (Leach, 1815) (*Mytilidae*) was discovered in the area of Kornati islands (Legac and Hrs-Benko, 2003). In 2002 and 2005 colonial stone coral *Cladopsammia rolandi* Lacaze-Duthiers, 1897, endemic to the Mediterranean, was found along outer cliffs of Lastovo and Mljet islands in Southern Adriatic (Kruzic, 2008b). The diamond-shaped squid, *Thysanoteuthis rhombus* Troschel, 1857 that is a non-abundant epipelagic inhabitant of warm tropical and partially subtropical waters was recently found in Adriatic (Marcic et al., 2008). *Neorossia caroli* was discovered in 2004 in a bottom-trawl net at depths between 449 and 594 m (Krstulovic-Hifner et al, 2007). Several decapods have been added to the check list recently (Kirincic and Stevcic, 2008) : *Plesionika gigliolii* (Senna, 1902) (*cf*. UNGARO *et al*., 2005); *Hippolyte prideauxiana* Leach, 1817 (*cf*. KIRINCIC, 2006), *Hippolyte varians* Leach 1814 (*cf*. D'UDEKEM D'ACOZ, 1996),*Brachycarpus biunguiculatus* (Lucas, 1846) (*cf*. KIRINCIC, 2003), *Scyllarus caparti* Holthuis, 1952 (*cf*. FROGLIA, 1995), *Callianassa truncata* Giard & Bonier, 1890 (*cf*. ABED-NAVAND & DWORSCHAK, 1997), *Pagurus chevreuxi* (Bouvier, 1896) (*cf*. ARKO *et al*., 2001), *Munida perarmata* A. Milne-Edwards & Bouvier, 1894 (*cf*. UNGARO *et al*., 2005), *Munida rutllanti* Zariquiey Alvarez, 1952 (*cf*. UNGARO *et al*.,2005), *Calappa tuerkayana* Pastore, 1995 (*cf*. UNGARO *et al*., 2005), *Pinnotheres marioni* Gourret, 1887 (*cf*. FROGLIA, 1995), *Hemigrapsus sanguineus* (de Haan, 1835) (*cf*. SCHUBART, 2003) and *Eriocheir sinensis* H. Milne Edwards, 1854 (*cf*. MIZZAN, 2005).

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). 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.

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:

Turtles

The loggerhead turtle *Caretta caretta* is the only resident turtle of the Adriatic Sea. Animals from several Mediterranean colonies, mostly from Greek, Turkish and Cyprus ones, enter the Adriatic in early stage of life, grow there, forage and winter, leaving it only for breeding purposes. The Adriatic Sea with its extensive area of continental shelf, suitable water

temperature and rich benthos biocenosis represents the largest and, along with Gabès Bay in Tunis, the most important critical neritic habitat of this species in Mediterranean (Lazar and Tvrtkovic, 2003).

About 2500 specimens are accidentally caught each year by the Eastern Adriatic trawl fisheries and more than 4000 by Italian fishing fleet. Based on this data and on recent satellite tracking of five animals, the analysis of critical habitats was performed in 2009 (Lazar, 2009). It included feeding areas (pelagic and neritic) and wintering areas in the whole area of the Adriatic under national jurisdiction of Croatia.

The analysis shows different distribution of loggerhead turtles in summer and in winter period. Loggerheads feed on benthic organisms from shallow coastal waters of infralittoral down to circalittoral habitats.

Wintering areas are inside neritic feeding areas, restricted to depths <100 m and water temperatures of ≥ 11ºC. According to winter isotherms, this is southern of 45ºN. From the management point of view, the core area can be defined by Croatian fishery zones I and B (Regulation on boundaries of fishery zones, OG 144/05). This is one of the most important wintering areas for loggerhead turtles in the Mediterranean (Lazar, 2009).

Pelagic habitats for loggerheads exist in deep offshore waters in the Southern Adriatic and in oceanic province of the Middle Adriatic. Only the small part of it is in Croatian fishery area while the most of it is situated in territorial waters of Montenegro and Albania as well as in open international waters. Turtles are mostly threatened by by-catch in gill-nets and degradation of habitats through fishery activities (trawling) as well as by water pollution with solid and other organic and anorganic waste.

Green turtle *Chelonia mydas* has been recorded in the Adriatic only occasionally. Several old records exist for Croatia and recently this species was registered in 2001 near Peljesac in the Southern Adriatic. Off-shore waters of the Southern Adriatic have certain importance as pelagic development area for a part of Mediterranean population of this species (Tvrtkovic, ed, 2006).

Marine and coastal birds

Small offshore islands are key habitats for several breeding species from Annex I of the SPA/BD Protocol, while coastal habitats like wetlands Neretva Delta and Vrana Lake or mudflats/sandflats in Northern Dalmatia are important for migratory and overwintering birds (Radovic et al., 2005).

Lastovo Arhipelago and Offshore Islands are parts of the National Ecological Network (NEN) and proposed NATURA 2000 sites (SPA's) with qualification species: *Calonectris diomedea, Puffinus yelkouan* and *Larus audionii*. *Falco eleonorae* is additionally important for the Offshore Islands and *Larus audionii* for the Mljet Island and Middle Dalmatian Islands. Proposed SPA's in northern part of the coast include as target features two SPA/BD Protocol species: *Phalacrocorax aristotelis desmarestii* and *Sterna albifrons. Phalacrocorax pxgmaeus* breeds on Vrana Lake (see the map 2). Additionally, important coastal species in Croatia is *Charadrius alexandrinus* that has been proposed for extension of SPA/BD Annex I list as well as *Gyps fulvus* that has the only breeding colonies in the whole Adriatic on Kvarner islands. The only SPA/BD Annex I bird species that does not occur in Croatia is *Sterna bengalensis.*

Marine mammals

All marine mammals are strictly protected in Croatia. During last decade the research activities of marine mammals has significantly intensified and there is a lot of new data.

Regarding Cetaceans, the bottlenose dolphin *Tursiops truncatus* is the only resident species in the Croatian part of Adriatic Sea.

Cres-Loinj Archipelago (Kvarneric area) represents the habitat of the resident population that has been researched since 1987, mostly by Association *Blue World*. Based on this research this area is proclaimed as the part of National Ecological Network and potential NATURA 2000 site as well as proposed marine reserve.

In 2008 and 2009 extensive research of Vis and Lastovo archipelago (area of cca 5000 km^2) was performed by the Association *Blue World.* By method of photoidentification even 287 individuals have been identified. The local community of bottlenosed dolphins of this area was estimated to 477 individuals. Data on animal behaviour indicate that the area is important feeding as well as breeding site, as 12 newborn animals have been reported. Estimated population is relatively high, comparing to other researched areas in the Adriatic (100-130 ind. in Kvarneric, 2500km^2; 70 ind. in Trieste Bay and West Istrian coast, 1200 km^2) (Holcer et al., 2010). Bottlenose dolphins are regularly registered in area of Kornati Archipelago near Zadar (Middle Adriatic) but there is no estimation of number of animals (Gomercic, 2008). It is hard to estimate the population for Croatia as the whole area was not systematically investigated.

During July and August 2010, the Institute for Environmental Protection and Research (ISPRA) from Italy, in cooperation with ACCOBAMS Partners, including Association *Blue World* from Croatia, carried out an aerial survey of cetaceans in the entire Adriatic Sea. Thepreliminary data indicate that *Gramphus griseus* and especially *Stenella coeruleoalba* (cca 1000 individuals recorded in groups up to 100) are not rare species in Adriatic like it was considered previously. It is concluded that *Stenella coeruleoalba* can be considered regular species in the Adriatic (Blue World, 2010).

Analysis of stranded cetaceans during last decades confirms the presence in Croatia of *Delphinus delphis*, *Grampus griseus*, *Stenella coeruleoalba*, *Baleanoptera physalis, Ziphius cavirostris* (Gomercic et al., 2008). The sperm-whale *Physeter catodon* is also a regular visitor in the Adriatic.

Mediterranean monk seal *Monachus monachus* - until recently it was considered extinct in Croatia (Tvrtkovic, ed, 2006b). During the last decade the number of reports is increasing, especially in the Northern Adriatic (Eastern Istria and Kvarner Islands). In 2009, 30 sightings were recorded in the Middle Adriatic (Antolovic, 2010). In 2006-2009 altogether 79 sightings were reported (Antolovic et al., 2010). According to the systematic research of suitable habitats (21 caves) of the open-sea islands and the Adriatic coast, it has been determined that a monk seal uses them. Simultaneous sightings in various areas as well as video records and photographs of individuals taken in caves or near them indicate possible breeding of the monk seal in the Adriatic (Antolovic et al., 2010).

Slovenia:

Turtles

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.

Marine birds

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*).

Cetaceans

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 (Lessepsian migration).

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).

A number of alien phyto- and zooplankton species have been introduced into the Adriatic most probably by ballast water during last several decades, such as sifonophora *Muggiaea atlantica* and several dinoflagellates like *Pseliodinium vaubanii* recorded from 1977 as well as recently recorded *Spatulodinium pseudonoctiluca*, *Alexandrium minutum* and *Ceratoperidinium yeye* (Marasovic and Zuljevic, 2006).

Invasive tropical green algae *Caulerpa taxifolia* and *Caulerpa racemosa var. cylindracea* are extremely dangerous for marine ecosystems as they create large dense settlements on the sea bottom, changing habitats of sea grass meadows and causing disappearance of indigenous algae and bottom fauna. *C. racemosa var. cylindracea* is spreading quickly in the Adriatic since 2000, up to 84 sites in 2008 have been registered in Croatia (Zuljevic et al., 2008). They are grouped in two geographic areas: Dalmatia and Northern Adriatic. *C. taxifolia* was probably transferred into the Adriatic by ship anchors and as ship fouling. It was recorded for the first time in 1994 in Starigrad Bay of the Hvar Island. Many new alien species indicate tropicalization of the Adriatic Sea. During 2008 a number of fishes that were previously rare or accidental for Adriatic, have been recorded to increase in numbers and spread northwards (Zuljevic et al., 2008). The most numerous is reticulated leatherjacket *Balistes capriscus,* feeding on corals, sea urchins and shellfish. Others include predator species that influence significantly marine food chains like *Thalassoma pavo, Sphyraena viridensis* and especially *Pomatomus saltator* that feeds on commercial fish species. It seems to reproduce in the Adriatic and could possibly become commercially important species. Other fish species in progression are *Sparisoma cretense*, *Trachinotus ovatus* and *Lichia amia.*

The first records of new fish species for the Adriatic in 2008 are: *Caranx crysos* (Istria) as well as two Lessepsian migrants*: Fistularia commersonii* and *Terapon theraps* (being also the first record for Mediterranean) (Zuljevic et al., 2008). Besides these two Lessepsian migrants, already nine of them have been recorded previously: *Pampus argenteus, Saurida undosquamis, Stephanolepis diaspros, Sphyraena chrysotaenia, Siganus rivulatus, Leiognathus klunzingeri, Epinephelus coioides, Hemiramphus far* and *Parexocoetus mento.* One species escaped from mariculture farm – *Pagrus major* that seems to have established natural population in the Adriatic.

In 2006 the new squid *Thysanoteuthis rhombus* was found (Marcic et al., 2008). The marine polychaete *Ficopomatus enigmaticus* was discovered in the Krka estuary and Neretva Delta. This invasive species lives in brackish water and often becomes dominant, sometimes even building reefs. Reefs have not yet been found in Croatia but specific habitat type (Facies with *Ficopomatus enigmaticus)* with this species has been recognised (Bakran-Petricioli, 2007).

Exotic species of decapodes have also been registered in the Adriatic recently, like: *Marsupenaeus japonicus*, *Scyllarus caparti*, *Dyspanopeus sayi, Rhithropanopeus harrisii, Callinectes danae*, *Callinectes sapidus, Hemigrapsus sanguineus* and *Eriocheir sinensis* (Kirincic and Stevcic, 2008) and *Paromola cuvieri* (Zuljevic et al., 2008).

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

The recent census of Adriatic fishes listed 442 taxa (Jardas et al., 2008) that represent about 65 % of Mediterranean ichthyofauna. The number of jawless species and subspecies is 3, of cartilaginous fishes 55 and ray-finned 384. From the biogeographical aspect, the most of Adriatic species belong to Atlantic- Mediterranean element (almost 67%). Others are mostly cosmopolitans (about 17%) and Mediterranean endemics (about 9%) while the rest of 17% belong to Mediterranean-Black Sea, Lessepsian and the Adriatic (endemic) elements (about 7%). The number of species is higher in the Southern Adriatic and it decreases towards the north.

According to Jardas et al. (2008), the Adriatic is inhabited by 6 endemic fish species (1.4 %) inhabiting the continental shelf area. These are anadromous Adriatic sturgeon *Acipenser naccarii*; the darkflank pipefish *Syngnathus taenionotus* known only from the western Adriatic coast; then four littoral and bottom-living goby species (the lagoon goby *Knipowitschia panizzae* from brackish lagoons and pertinent rivers of northern Italy, the brackish and freshwater Canestrini's goby, recently described cryptobentonic Grotto goby *Speleogobius trigloides* found in the Northern and Central Adriatic in 1975 and 2005 and the Kolombatovic's *goby Gobius kolombatovici* in the North Adriatic.

The Red list of Adriatic fishes (Jardas et al., 2008) lists 123 species (28%). One species is considered to be regionally extinct (RE): cartilaginous species *Squatina oculata* and bony fishes *Accipenser sturio* and *Argyrosomus regius.* Another 24 species belong to categories of CR, EN and VU, even 16 of them being cartilaginous species. The main reason of threat is overfishing, while others include habitats degradation, sea pollution, biological factors (reproductive potential of the species, high fry mortality, slow growth), human disturbance, alien species, climate changes and others.

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).

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:

Out of 442 registered fish taxa in the Adriatic Sea it is considered that 120 are of great or small economic significance but altogether about 200 species are affected by the fishing. Between them approximately 70 are targeted, 50 accidental and the rest are rare species and those recorded as by-catch. There is a problem of overfishing in the Adriatic Sea that has significant negative impact on fish communities (Jardas et al., 2008).

Pelagic fishing is mostly based oneight species of small fish, with the pilchard *Sardina pilchardus* and the anchovy *Engraulis encrasicolus* being the most important and the most abundant. Several other species of large fish are important, the bluefin tuna *Thunnus thynnus* holding the most important place by the volume of catch and economic importance. Others include *Scomber japonicus, Scomber scombrus* and *Sarda sarda.* Commercially the most important demersal fish species are the hake *Merlucius merlucius* and the red mullet *Mullus barbatus*. Others include *Merlangius merlangius*, *Lophius* sp*, Pagellus erythrinus, Trachurus* sp*, Trisopterus m. capelanus, Zeus faber* and some cartaligenous species like *Raja clavata, Scyliorginus canicula* and *Mustelus mustelus.* Additionally, fish stocks in coastal waters include *Boops boops, Dentex* sp*, Diplodus vulgaris, Liza* sp, *Mullus surmuletus, Oblada melanura, Sarpa salpa, Scorpaena* sp*, Solea* sp*, Spicara maena* and *S. smaris* (CEA, 2010).

Besides fishes, economically important fishery species are crustaceans and molluscs. Between crustaceans the most important is Norwegian lobster *Nephrops norvegicus,* followed by *Homarus gamarus, Palinurus elephas, Maja squinado* and *Parapenaeus longirostris.* Important cephalopods are *Loligo vulgaris, Octopus vulgaris* and *Sepia officinalis* as well as *Eledone cirrhosa, E.moschata* and *Illex coindeti. S*hellfish include *Mytilus galloprovincialis, Ostrea edulis, Pecten jacobaeus, Arca noae, Ruditapes decussates* and *Venus spp.* Also, commercial species include sponge *Spongia officinalis* and red coral *Coralium rubrum* that are still being collected in some areas as part of traditional fishery activities.

3.2. Habitats

The Adriatic Subregion possesses very peculiar habitats. Longitudinal SE-NW stretching of the Adriatic results in climatological differences along it and in specific direction of sea currents. North Adriatic is significantly influenced by boreal elements. Specially important and characteristic for Croatian side of Adriatic Sea are marine habitats in submerged karst like anchihaline caves, marine caves, descending caves with bathyal elements, vruljas (submerged freshwater springs), karstic estuaries, marine lakes and deep circalittoral hard bottoms (naked karst). All of these phenomena were formed in subaerial conditions and submerged afterwards, when Adriatic Sea level rose for approximately hundred meters (Bakran-Petricioli, 2007). The majority of Mediterranean Sea habitat types are represented in Croatia (Bellan-Santini, 2002) – 103 out of 137 (75%), including all 32 biocenosis. Bathyal habitat types, distributed deeper than 200 m are present in the Middle Adriatic, in deeper part of the Jabuka Pit and in Southern Adriatic Pit. They are very poorly investigated because they are not accessible to divers.

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.

Croatia:
The most of the Croatian Adriatic coast is formed in karstified limestone and belongs to the Dalmatian-type coast. It was created after the last glaciation by submerging of the hilly coast, leaving the parallel chains of islands and coastal mountains.
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 as well as the invasion of alien species.

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.

Many species have been introduced by ballast waters of large ships. Some invasive species spread by boats through anchoring, like green algae *Caulerpa taxifolia*, while *C. racemosa var. cylindracea* is being driven by sea currents

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.

Tropicalization of the Adriatic Sea, probably due to climate changes, brings many alien species in like Lessepsian migrant fishes that come into Mediterranean from the Red Sea through the Suez Canal. 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.

Fishery has also influence on non-target bycatch species like marine turtles and mammals. These animals are usually slow-growing animals with very low reproductive rate. The impact on their populations, therefore, quite severe. There are also many species of all taxa bycaught with fisheries. They are not consumed by humans and discarded. Although the discarded animals may be consumed by opportunistic feedes in the water, most are wasted. This is considerable damage to the ecosystem.

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

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.*

Albania:

Illegall, unreported, unregulated fisheries is one of the major issues and should be controlled and more stringent measures are 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).

Croatia:

It is hard to define influence of fishery on pelagic fish in the Adriatic, especially on clupeids and scombrids as they are subject to seasonal and years-long fluctuations caused by different environmental factors. Bluefin tuna is globally endangered species and quotas issued by the ICAAT for Croatia range from 800 -1,000 t/y. It is forbidden to fish tunas smaller than 30 kg but exception is made for the purposes of mariculture when fishes larger than 8 kg can be caught. During last decade tuna fattening has become very popular and economically important in Croatia as all production goes for Japan market.

Comparing to pelagic fishing, the catch from demersal fisheries is relatively low, amounting to 6,000 tonnes per year (mostly including *Merlucius merlucius* and *Mullus barbatus*). The most common fishing tool is the trawl-net. As a consequence of unsustainable exploitation through many years, many fish populations in the Adriatic have heavily declined in number. This may be well illustrated by the open Adriatic area where cartilaginous bottom sea fishes (*Scyliorhinus canicula, Raja* spp*, Mustelus* spp*., Squalus* spp*.,* etc) have almost disappeared as a consequence of intensive fishing (Jardas et al., 2008).

The abundance of certain fishes of coastal fish communities in the catch through years shows that they are on the verge of disappearance, such as *Sciaena umbra, Labrus merula, Labrus mixtus, Labrus viridis* while the presence of some other species, such as *Scorpaena porcus, Symphodus tinca,* increased because they proved more resistant to exploitation.

Regarding other fishery species, it seems that *Nephrops norvegicus* is the most threatened. Its biomass index shows sharp negative trend for years now because of overfishing. *Spongia officinalis* and *Corallium rubrum* became rare but are still exploited. Collecting of 100 t of sponges and 450 kg of red coral per year was registered in 2003 and 2004. Permits for collecting sponges and corals are today connected only to traditional activities in some areas. 200 kg of red corals per one permit is allowed. 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.

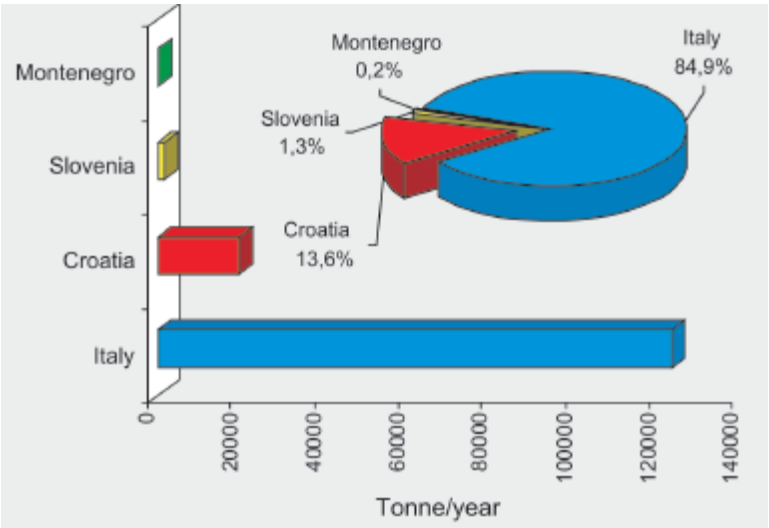

Fig. 3. Annual catch of the countries in the Adriatic Sea in the period between 1992 and 2004 (according to FAO statistical data) (Jardas et al., 2008)

4.1.2.2. Indirect effects of fishing

Slovenia:

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).*

Croatia:

Bycatch has been monitored in Croatia for several years (CEA, 2010). At least 2.500 loggerhead turtles are being caught by trawl-nets each year in East Adriatic. Other kinds of nets catch at least 658 loggerheads yearly (North Adriatic) and sometimes even *Chelonia mydas* and *Dermochelys coriacea.* As for cetaceans, mostly *Tursiops truncatus* is being registered, with average annual records of 15-20 animals.

4.1.3. Aquaculture

Aquaculture can also have significant impact on marine biodiversity, although mostly on the local level. In case of cage fish farming, the uneaten feed (some 10 per cent of the total volume) and metabolic products enter the sea, causing organic pollution and eutrophication and often even local hypoxia and anoxia. Almost all fish farms show degradation of benthic communities under the cage to a certain extent, the most often being valuable *Posidonia* meadows. The seafloor under the cage shows often compact white films of the bacteria *Beggiatoa* spp. (Jardas et al., 2010). Aquaculture can also be a source of spreading alien organisms or even microbial pathogens into open sea. Because of mentioned influences, environmental impact assessment is obligatory before issuing permits for larger aquaculture farms in most countries.

Croatia:

Today Croatian aquaculture has the total annual production around 12,000 t and income goes to 10 million €. Bluefin tuna fattening dominates with production of cca 5,000t/y and income of about 80 million €. Breeding of white fish produces cca 4,000 t/y and includes mostly the sea bass *Dicentrarchus labrax* and sea bream *Sparus aurata* and additionally (less than 5% of total production) *Dentex dentex* and *Puntazzo puntazzo*. The total production of shellfish in 2006 was estimated to 3,500 t of mussels *Mytilus galloprovincialis* and a million of oysters *Ostrea edulis*. During last several years there is a large increase in shellfish production, due to modern mechanized offshore breeding and opening new breeding sites. The trial production of new species of bivalves have been started: from species for which there is already developed technology for rearing (scallops), through the species that are in advanced phase of research (*Venus verrusoca* and *Pina nobilis*), to interesting species that have yet to be explored like dateshell *Lithophaga lithophaga* (Glamuzina et al., 2009).

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 live 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 indicators 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.*

Loggerhead turtle *Caretta caretta* will be affected by CC on Mediterranean level. East-Adriatic coastal waters represent an important foraging area for juvenile turtles while the Northern Adriatic is one of the most important wintering areas for this species in Mediterranean. Monitoring in co-ordination with other countries is necessary.

Marine mammals like the bottlenose dolphin *Tursiops truncatus* and the Mediterranean monk seal *Monachus monachus* are likely to be threatened by changes in their prey (plankton, fish and squid) distribution and abundance due to the CC.

Corals like Gorgonians (*Paramuricea, Eunicella* and others*)* are threatened by the sea temperature rise (mass mortalities due to stress induced epidemics connected with changes in sea temperature in Mediterranean have been already recorded); the same threat is posed to the colonial scleractinian coral *Cladocora caespitosa* that builds sizeable bioherms in the Adriatic Sea due to the symbiotic zooxanthellae. It is still not certain how CC (sea temperature rise, changes in sea currents etc) would affect deep sea species and biocenosis.

Marine birds could be affected by CC through availability of breeding sites and food resources because of the sea-level rise and possible changes in fish populations. Regarding commercial species, changes of spawning and distribution patterns of economically the most important pelagic species sardine *Sardina pilchardus* and sprat *Sprattus sprattus* as well as Spanish sardine *Sardinella aurita* have already been registered in the Adriatic Sea. Important spawning areas and nurseries could be threatened like Velebit Canal, Neretva Delta, Jabuka Pit and others. The European eel *Anguilla anguilla* and other anadromous fishes entering rivers will also be threatened by changes of water regime.

It was concluded that impacts of new species appearing in the Adriatic could be twofold, depending on whether they are observed in economic or ecological sense. For example, migration of dusky groupers from southern to middle and northern Adriatic has a positive economic impact to fishery, as dusky groupers are rare and quite wanted fish. However, there is also negative impact due to a competition with some local species. Implications for the fishing sector could be: increase of species that tolerate warm water and lower oxygen levels, the recruitment of species that thrive in warm water should be significantly better while the opposite is likely to occur with species that thrive in cold water, such as prawn. Also, introduction of new organisms that transmit disease or exotic or undesired species is likely to occur due to increased sea temperatures.

Positive impact of climate change is possible within the area of aquaculture. Species, better adapted to higher sea temperatures like sea bream, due to the increase in winter, could have more favorable conditions to grow and develop. Global warming will probably have a positive impact on tuna breeding as well, as the most important economic product in fishery sector.

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:

- 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 Central Adriatic.

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.

Some other pressures mentioned in Croatian report;

- Sea pollution from urban waste-waters, inputs from Adriatic rivers, activities of large harbours as well as from illegal solid waste disposal

- Intensification of nautical tourism, resulting in damaging posidonia meadows by anchoring, waste disposal, spreading invasive algae *Caulepa taxifolia* as well as in pollution with noise
- Illegal collecting of date-shells *Lithophaga lithophaga* and red coral *Coralium rubrum*, resulting in significant degradation of coraligenous habitats
- Poorely regulated diving tourism, often putting great pressure on some attractive marine caves or dive-fishing areas
- Intensive urbanization of the coast
- Illegal building along the coast along with illegal disposal of waste-waters
- Intensive process of embankment of the coast (local authorities, individuals)
- Intensification of tourism, including enlargement of tourist zones, building of hotels and tourist facilities on vulnerable sites, transformations of natural beaches for intensive tourism, planning of numerous golf resorts by coastal county physical plans without strategic environmental assessment
- Physical plans of towns and municipalities not being subject to strategic impact assessment so certain unrealistic projects, potentially harmful for biodiversity, are being planned
- Constant intensification of use of water for human consumption (urbanization, growing tourism) and for irrigation (realization of irrigation projects in coastal agricultural areas started during last few years) as well as for golf resorts
- Development of large ports like Ploce in Neretva Delta, resulting in more numerous and larger ships entering this sensitive estuary
- Lack of livestock and disappearance of grasslands in extensive agricultural areas along the coast and on islands
- Already visible effects of climate change like rise of water level. As a consequence of irrational exploitation through many years, many fish populations in the Adriatic have heavily declined in number

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.

Monitoring of alien species and an action plan to mitigate such effect made by alien species is needed.

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

Croatia

Sustainable use of marine biological resources must be ensured, including conservation mechanisms for threatened species and habitat types. It is important to estimate realistically available biological stocks and to adjust adequately fishing efforts.

There is enough evidence that biocenosis of deep sea (circalittoral and bathyal muds and sands) that are important fishery zones have been depleted and many species threatened by intensive fishing, especially trawlers, including mostly cartilaginous fishes. As biological resources are sharable between countries, there is an urgent need for cooperation in planning future management and conservation measures for these areas. National sectoral strategies should also reflect this need.

New ecologically representative MPA's should be established, including coastal zones (beaches, shallow waters, mediolittoral) that are currently exposed to tremendous pressure from human activities. During the process of designation extensive consultation process must be ensured and public awareness activities implemented in order that local people, fishermen and other stakeholders accept MPA concept.

The marine part of NATURA 2000 proposal should be finalized as soon as possible.

Designations for new SPAMI areas should be prepared and sites nominated for inclusion on SPAMI list.

There is a need to establish no-fishing zones, apart those few in existing national parks. Deep sea waters should be evaluated in cooperation with other countries that exploit them and adequate management agreed and implemented including no-take zones and restrictions. Communication with fishermen should be developed in order to implement these measures efficiently.

It is necessary to define a set of characteristics for good environmental status of marine waters, develop indicators and establish monitoring according to the Marine Strategy Framework Directive (MSFD). Croatia is currently preparing national legislation based on MSFD and activities have started to develop indicators of good environmental status of marine waters in accordance with this Directive.

Croatia should prepare and adopt strategy for its marine waters with programme of measures, as requested by Marine Strategy Framework Directive.

So far research of marine biodiversity has mostly been concentrated on commercial species, fishery problematic, plankton functions and composition. In future more attention should be paid to threatened and protected species and habitat types, including; marine mammals, marine turtles, cartilaginous fishes, Posidonia meadows, coralligenous habitats, etc.

Action plans for threatened species and habitat types should be prepared, harmonized with relevant documents under the Barcelona Convention.

International cooperation in scientific researches and monitoring should be supported and further improved, especially having in mind obligations of international agreements like SPAMI Protocol, Habitats and Birds directives, WFD and MSFD.

As there is an obligation to evaluate marine waters under national jurisdiction as part of NATURA 2000, urgent mapping of deep sea habitat types is needed in order to complete the marine part of ecological network.

Habitats of submerged karst that are characteristic for Croatia and rare on international level should be paid special attention and properly researched, evaluated and protected.

Detailed habitat mapping for important sites should be continued in cooperation with divers and scientists and all data compiled in one database

It is important to start new or continue existing relevant international co-operation in research and monitoring of marine biodiversity

More targeted research is needed to address problems of climate change consequences on marine biodiversity. Spreading of invasive species that are indicators of climate changes should be monitored.

Strategy for invasive alien species should be adopted and adequate actions implemented. Invasive species should be suppressed as much as it is possible and cost-effective and prevention measures implemented.

Problem of ballast waters and spreading of alien species should be addressed more thoroughly, especially because marine traffic is being intensified due to development of transport sea harbours like Ploce in Neretva Delta

Mariculture sites and scope should be carefully planned, appropriate assessments (strategic, EIA, AA) implemented and adequate monitoring ensured.As the bluefin tuna is globally threatened species, influence of ever-growing tuna fattening activities in Croatia should be carefully monitored.

Implementation of existing legislation should be improved, especially suppressing of illegal activities (building, collecting data-shells and red corals, degradation of habitats). Nature protection and other inspections should be strengthened.

Capacity building of management authorities of protected areas should be significantly strengthened for preparation and implementation of management plans, communication with stakeholders and effective supervision, especially in large marine protected areas.

A number of project proposals relevant for the protection of marine and coastal biodiversity should be prepared and submitted for international funding.

Promotion, education and extensive public awareness activities related to conservation of marine and coastal biodiversity should be implemented.

Physical planning process on all levels should be strengthened and ECAP and ICZM approaches implemented, as well as procedures of SEA and AA according to the Habitats Directive.

Croatia should ratify ICZM Protocol under the Barcelona Convention as soon as possible.

It is necessary to raise the issue of climate change effect on biodiversity to the policy and politics level and start with monitoring programs.

Monitoring is needed to analyse ways how species and habitats adapt to climate change, in order to develop and implement adequate adaptation measures. Some important monitoring issues are: migratory birds; IAS; threatened species and habitats; shifting of certain species and habitats distribution; “tropicalisation” of seas; effectiveness of MPA’s and ecological networks, etc.

It is predicted that the significant sea level-increase could endanger numerous commercial and fishing ports, contaminate coastal freshwater sources in karstic zone, disrupt touristic and recreative activities depending on coastal areas, etc. Adaptation to climate change impacts, related to the coast and coastal area, can include numerous technical measures as well, such as the silting of beaches with gravel and sand, developing alternative sources of water supply or increasing the capacities for water purification due to salinity intrusion.

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

As there is a clear scientific evidence that biocenosis of deep sea that are important fishery zones have been depleted and many species threatened by intensive fishing it is urgent to establish international cooperation in planning future management and conservation measures for these areas.

Finalize marine part of NATURA 2000 proposal for Croatia

Establish new MPA’s according to the MSFD and nominate new sites for the SPAMI list under Barcelona Convention.

Ensure effective management plans and their implementation in existing MPA’s.

Establish indicators of good environmental status of marine waters and adequate monitoring, prepare national marine strategy with programme of measures, according to MSFD.

Collect needed data on threatened marine and coastal species and habitat types and prepare adequate action plans for their conservation.

Ratify ICZM Protocol and start to implement ECAP and ICZM approach in physical planning process.

Start with monitoring and addressing issues of climate change impact on biodiversity.

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.

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 the leading countries, 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 Albania.

Croatian Fund for Environment and Energy Efficiency was founded in 2003 with the aim of ensuring additional financial resources for implementation of projects and programmes in the field of environmental protection and energy efficiency. Its scope of work and sources of income are defined by the Law on the CFEEE. Co-financing of projects is based on the bidding procedure on yearly basis.

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 Global Environment Facility (GEF), the World Bank, the UN Environment Programme (UNEP), GFCM/FAO, the UN Development Programme (UNDP/GEF), and the Regional Activity Centre for Specially Protected Areas (RAC/SPA). Other possible funding organizations are as follows.

- Bilateral agreements – the most projects in recent years have been co-funded by Netherlands, Norway, Japan, Germany, Sweden and some other European countries.
- EU funding opportunities like: INTERREG, PHARE, CARDS and Instrument for Preaccession (IPA). The objective of the pre-accession assistance provided to Croatia under IPA is to assist in meeting the accession criteria, i.e. the political and economic criteria, as well as the adoption, implementation and enforcement of the acquis communautaire. In addition, IPA assistance aims to support policy development as well as preparation for the implementation of the Community's common agricultural policy and the cohesion policy with a view to EU membership.
- After accession to EU, Croatia will be as member states will be in position to use post-accession financial instruments available for the EU Regional Policy. The

financial instruments made available for the EU Regional policy for actual financial period (2007-2013) are the Structural Funds – the European Fund for Regional Development (EFRD), the Cohesion Fund (CF) and the European Social Fund (ESF). The European Agricultural Fund for Rural Development (EAFRD) was previously also part of the Structural Funds but will function independently in the next financial period the same as the European Fisheries Fund (EFF). The Commission and Member States have adopted the position that environmental policy commitments (e.g. Natura 2000, Water Framework Directive) should be financed through existing financial instruments. This means environmental objectives must be integrated within the framework of Cohesion Policy (Structural Funds and the Cohesion Fund), the Rural Development (EAFRD) and European Fisheries Policy. A smaller environment fund LIFE+ is available to fund publicity, information exchange, and purely biodiversity related projects.

Scientific programmes in EU countries can be financed from the 'Framework programmes' (FPs) that have been the main financial tools through which the European Union supports research and development activities covering almost all scientific disciplines. FPs are proposed by the European Commission and adopted by Council and the European Parliament following a co-decision procedure. Currently the FP7 is being implemented, covering the period from 2007-2013. Environmental projects also include CC issues.

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 the Adriatic Sea, there are considerable efforts have been made mainly by Croatia and Italy (not included in this report). There are, however, 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.

- Analysis of available documents and data for preparation of this report pointed out to some key issues and needed actions regarding protection of marine and coastal biodiversity. Most of them have already been identified in relevant national documents (strategies, action plans) but their implementation is problematic due to lack of human and financial resources. It is important to continue or establish new cooperation on international level and to try to use international funding for relevant projects as much as possible.

- It should be stated that overfishing of Adriatic Sea, especially demersal fishing in Central Adriatic, seems to be one of the most significant issues that affect not only fishery biological resources but a number of non-targeted threatened species and influences complete biological communities. As these resources are sharable between countries, urgent international cooperation is necessary to define and implement needed conservation measures.

- Coastal areas are under great human pressure and many new development projects are being planned. ECAP and ICZM approach should urgently be included in physical planning process of coastal counties, towns and municipalities in order to ensure adequate biodiversity conservation measures.

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

9. LIST OF REFERENCES

Antolovic, J., Antolovic, M., Antolovic, E., Coppala, E., Pecchiar, G., Piccoli, M., Hervat, M. 2010. Analyses of sigthings of monk seal (*Monachus monachus* (Hermann, 1779) in the Croatian Part of the Adriatic 2006-2010. Rapp. Comm. int. Mer Med. 39: 100.

Antolic, B. 1997. The list of benthos algae of Eastern Adriatic. Background document for preparation of National Biodiversity and Landscape Strategy and Action Plan. State Institute for Nature Protection, Zagreb.

Antonic, O. et al.* 2005. Klasifikacija stanista Republike Hrvatske (Classification of habitat types in the Republic of Croatia), vol. 1.(www.drypis.info)

Arapi, D., Sadikaj, R., Nelaj, E. 2006. Fishing and cartilaginous fishes on the Adriatic and Ionina Seas of Albania. Proc. the Int. Workshop on Med. Cartilaginous Fish with Emphasis on South-east Med., Turkish Marine Research Foundation, Istanbul. Pp. 209-214.

Bakran-Petricioli T. 2007.Morska stanista – Prirucnik za pracenje i inventarizaciju stanja. (Marine Habitats – Handbook for inventory and monitoring). State Institute for Nature Protection, Zagreb, 56 pp. + Appendix 102 pp. (in Croatian, on-line version: http://www.dzzp.hr/publikacije_knjige.htm)

Brautović, I. et al. (2007): Planktonic ostracods abundance in the deep Adriatic Sea. Rapport du 38e Congres de la CIESM / Briand, F (ed). - Istanbul : Commision Internationale pour L' Exploration Scientifique de la mer Méditerranée , 2007. 441-441.

Batistic, M. 1994. Ekologija planktonskih *Chaetognatha* u Jadranskom moru (Ecology of plankton *Chaetognatha* in Adriatic Sea). MA Disertation. Faculty of Natural Science, Zagreb. 73 pp.

Batistic, M. et al.* 2007.Annual cycle of the gelatinous invertebrate zooplankton of the eastern South Adriatic coast (NE Mediterranean). Journal of Plankton Research (0142-7873) 29 (2007), 8; pp 671-686.

Batistic, M. et al.* 2009. Increasing dominance of two allochthonous gelatinous zooplankton species in the Adriatic Sea: a possible relationship with hydroclimatic changes // ASLO Aquatic Sciences Meeting 2009, Meeting Abstracts / Fee, Everett J., editor(s). Nica : ASLO, 2009. Poster presentation.

Belancic, A. et al.* 2008.Red data book of dragonflies of Croatia. Ministry of Culture; State Institute for Nature Protection, Zagreb. 132 pp.

Bellan-Santini, D. et al.* 2002. Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest. UNEP, RAC/SPA, Tunis, 217 pp. (http://www.rac-spa.org/sites/default/files/doc_fsd/msdf.pdf)

Bello, G., Casavola, N., Rizzi, E. 2004. Aliens and visitors in the southern Adriatic Sea: Effects of tropicalization. Rapp. Comm. int. Mer. Medit., 37: 491.

Beqiraj, S. 2004. A comparative taxonomic and ecological study with biogeographic data on malacofauna of Albanian coastal lagoons, PhD theses, Faculty of Natural Sciences, University of Tirana. (in Albanian).

Beqiraj, S., Kashta, L., Kuci, M., Kasemi, D., Mato. Xh., Gace. A. 2008. Benthic macro fauna of *Posidonia oceanica* meadows in the Albanian coast. Natura Montenegrina, 7(2): 55 – 69.

Berry, P. 2008. Climate change and the vulnerability of Bern Convention species and habitats. 2nd Meeting of the Group of Experts on Biodiversity and Climate Change. Seville, Spain, 13-15 March 2008. Council of Europe. T-PVS/Inf (2008) 6. Strasbourg.

Bianchi, C., Morri, C. 2000. Marine biodiversity of the Mediterranean Sea: situation, problems and prospects for future research. Marine Pollution Bulletin, 40:367-376.

Blue World, 2010. International research project: Aerial survey of dolphins in Adriatic sea. Press release. http://www.plavi-svijet.org/hr/press/aerial/

Boero, F., Bouillon, J., Gravili, C., Miglietta, M.P., Parsons, T., Piraino, S. 2008. Gelatinous plankton: Irregularities rule the world (Sometimes). Mar. Ecol. Prog.

Briand, F. 2003. Mare Incognitum? Exploring Mediterranean deep-sea biology. In: CIESM (ed.), Heraklion, p 126.

Buric, Z. et al.* 2007. The occurrence and ecology of the centric diatom Cyclotella choctawhatcheeana Prasad in a Croatian estuary. Nova Hedwigia. 84 (2007) , 1-2; pp135-153.

Cacaud, P. 2005. Fisheries laws and regulations in the Mediterranean: a comparative study. Studies and Reviews-General Fisheries Commission for the Mediterranean (FAO).

Cartes, J.E., Maynou, F., Sardà, F., Company, J.B., Llori,s D., Tudela, S. 2004. The Mediterranean deep-sea ecosystems: an overview of their diversity, structure, functioning and anthropogenic impacts. In: The Mediterranean deep-sea ecosystems: an overview of their diversity, structure, functioning and anthropogenic impacts, with a proposal for conservation. IUCN, Málaga and WWF, Rome.

CEA 2007. Report on the state of environment in the Republic of Croatia. Croatian Environment Agency, Zagreb. (http://www.azo.hr/Default.aspx? art=1443&sec =497)

CEA. 2010. Database on indicators of marine environment, mariculture and fishery. Croatian Environment Agency, Zagreb. (http://jadran.izor.hr/azo/)

CoNISMa. 2002. Interreg II Italia-Albania. Asse 3 - Ambiente. Misura 3.1 - Progetto di una rete di monitoraggio delle acque marine del Basso Adriatico. Vol I-II e Relazione Finale Sintetica.

Cukrov, M., Despalatovic, M., Zuljevic, A., Cukrov, N. 2010. First record of the introduced fouling tubeworm *Ficopomatus enignaticus* (Fauvel, 1923) in the Eastern Adriatic Sea, Croatia. Rapp. Comm. int. Mer. Med., 39: 108.

Doğan, A., Nerlovic, V. 2008. On the occurrence of *Pinctada radiata* (Mollusca: Bivalvia: Pteriidae) an alien species from the Croatian waters. Acta Adriatica, 49(2): 155–158.

Ercegovic, A. (1932): Ekoloske i socioloske studije o litofitskim cijanoficejama sa jugoslavenske obale Jadrana (Ecological and socioplogical studies on lytophyte cyanophyceae of Yugoslav coast of Adriatic Sea). Rad JAZU 244, pp 129-220.

Francese, M., Picciulin, M., Tempesta, M., Zuppa, F., Merson, E., Intini, A., Mazzatenta, A., Genov, T. 2007. Occurrence of striped dolphins (*Stenella coeruleoalba*) in the Gulf of Trieste. Annals Istr. Med. Studies 17(2), 185-190.

Fredj, G., Meinardi, M. 1992. État des connaissances sur la faune marine méditerranéenne. Bulletin de l'Institut océanographique, Num. spec. 9: 133–145.

Garić, R., Batistic, M. 2010. *Fritillaria ragusina* sp. nov., a new species of Appendicularia (Tunicata) from the Adriatic Sea. Journal of the Marine Biological Association of the United Kingdom (0025-3154) .

Genov, T., Kotnjek, P. Lesjak, J., Hace, A. 2008. Bottlenosed dolphins (*Tursiops truncatus*) in Slovenian and adjacent waters. Annals Istr. Med. Studies 18(2), 217-244.

Genov, T., Kotnjek, P., Lipej, L. 2009. New record of the Humpback whale (*Megaptera novaeangliae*) in the Adriatic Sea. Annals Istr. Med. Studies 19(1), 25-30.

Gjiknuri, L. 1980. Results of the echinoderms study on the Albanian coast, Doctorate theses. University of Tirana, Faculty of Natural Sciences. (in Albanian).

Glamuzina, B. et al.* 2009. Integralni planovi razvoja školjkarstva područja Malostonskog zaljeva, ušća rijeke Krke i akvatorija sjeverozapadnog dijela Zadarske županije (Integral development plans of shell mariculture in Maloston Bay, Krka Estuary and aquatory of NW Zadar County). Project COAST. UNDP Croatia, Zagreb

Gomercic, T. et al.* 2008. Znanstvena analiza tri područja (HR5000032, HR3000419, HR3000426) važnih za vrstu dobri dupin (*Tursiops truncatus*) izrađena za potrebe izrade prijedloga potencijalnih NATURA 2000 područja Association Val, 2008.

Golani, D. 2002. Lessepsian fish migration - characterization and impact on the eastern Mediterranean. In: Öztürk, B., Başusta, N. (eds.), Workshop on Lessepsian Migration, Proceedings. Turkish Marine Research Foundation, Istanbul. Pp: 1-9.

Holcer, D. et al. (2010): Utvrđivanje brojnosti i distribucije dupina na području Viškog arhipelaga, te davanje preporuka za očuvanje i održivo korištenje utvrđenih posebno značajnih područja. Izvještaj o provođenju projekta. (Study on abundance and distribution of dolphins in Vis Archipelago area with recommandations for conservation and sustainable use of especially important sites. Report on the project implementation). Plavi svijet (Blue World Association), Veli Lošinj. 61 pp.

Jardas, I. et al.* 2008. Red book of sea fishes of Croatia. Ministry of Culture; State Institute for Nature Protection, Zagreb. 396 pp

Jasprica, N., Hafner, D. 2005. Raznolikost fitoplanktona u delti Neretve (Phytoplankton diversity in the Neretva River delta). Priroda No 930: 10-13.

Johnston, P., Santillo, D. 2004. Conservation of seamount ecosystems: application of a marine protected areas concept. Archive of Fishery and Marine Research 51: 305-319.

Joksimovic, A., Dragicević, B. and Dulčić, J. 2009. Additional record of *Fistularia commersonii* from the Adriatic Sea (Montenegrin coast). JMBA 2 Biodiversity Records Vol. 2, e28. doi:10.1017/ S1755267208000328

Kashta, L., Beqiraj, S., Mato, Xh., Xhulaj, M., Gaçe, A., Mullaj, A. 2005. The inventory of habitats with *Posidonia oceanica* and littoral habitats in Albania. Technical Report, APAWA, Tirana, supported by Ministry of Environment (Unpublished report, in Albanian and Italian).

Kashta, L., Xhulaj, M., Mato, Xh., Beqiraj, S., Gaçe, A. 2007. The state of *Posidonia* meadows along the Albanian coast: general evaluation. Proceedings of the Third Mediterranean Symposium on Marine Vegetation, Marseilles, 27-29 March 2007: 272 – 273.

Kirincic, M., Stevcic, Z. 2008. Fauna of the Adriatic decapod crustaceans (Crustacea: Decapoda). Natura Croatica, Vol.17 No. 2.

Krsinic, F. 2003. *Mesaiokeras hurei n.sp.* (Copepoda, Calanoida, Mesaiokeratidae) from the Adriatic Sea. Journal of Plankton Research. 25 (8): 939-948.

Krsinic, F. 2005a. *Speleohvarella gamulini gen. et sp. nov.,* a new copepod (Calanoida, Stephidae) from an anchialine cave in the Adriatic Sea. Journal of Plankton Research. 27(6): 607-615.

Krsinic, F. 2005b. *Badijella jalzici* - a new genus and species of calanoid copepod (Calanoida, Ridgewayiidae) from an anchialine cave on the Croatian Adriatic coast. Marine Biology Research, 1(4): 281-289.

Krsinic, F. 2008. Description of *Speleophria mestrovi sp. nov*., new copepod (Misophrioida) from an anchialine cave in the Adriatic Sea. Marine Biology Research. 4: 304-312.

Krsinic, F. et al.* 2000. The calanoid copepod *Acartia italica* Steuer, phenomenon in the small saline Lake Rogoznica (Eastern Adriatic coast). Journal of Plankton Research, 22(8): 1441–1464.

Krsinic, F., Grbec, B. 2002. Some distributional characteristics of small zooplankton at two stations in the Otranto Strait (Eastern Mediterranean). Hydrobiologia. 482: 119-136.

Kruzic, P. 2008a. Red List of Sea Anemones of Croatia. State Institute for Nature Protection, Zagreb. (http://www.dzzp.hr/dokumenti_upload/20100414/_dzzp_201004141259030.pdf)

Kruzic, P., Pozar-Domac, A. 2002. Skeleton growth rates of coral bank of *Cladocora caespitosa* (Anthozoa, Scleractinia) in lake Veliko jezero (Mljet National Park). Periodicum Biologorum, 104(2): 123–129.

Lazar, B. 2009. Kriticna stanista glavate zelve (Caretta caretta) u ribolovnom moru Republike Hrvatske – prijedlog potencijalnih NATURA 2000 podrucja. Izvjestaj Drzavnom zavodu za zastitu prirode (Critical haitats od Loggerhead turtle *Caretta caretta* in fishery area of the Republic of Croatia – proposal for potential NATURA 2000 sites. Report for the State Institute for Nature Protection). Zagreb. 2666/08-1. 27 pp.

Lazar, B., Tvrtkovic, N. 2003. Corroboration of the critical habitat hypothesis for the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea. In: Margaritoulis D., Demetropoulos, A. (Ed) Proceedings of the First Mediterranean Conference on Marine Turtles. Barcelona Convention – Bern Convention – Bonn Convention (CMS): pp 165-169.

Lipej, L., Dulčić, J., Kryštufek, B. 2004. On the occurrence of the fin whale (*Balaenoptera physalus*) in the northern Adriatic**.** Journal of the Marine Biological Association of the UK, 84(4): 861-862.

Lipej, L.., Turk, R., Makovec, T. 2006. *Endangered species and habitat types in the Slovenian sea.* Agency for nature conservation, Slovenia, 1 – 256 pp.

Makovec, T. 1995. Occurring of the Mediterranean Shearwater *Puffinus yelkouan* on the Slovenian coast. Falco 9: 17-20. (In Slovenian)

Marčeta, B. 2002. Slovene commercial fishery by-catch. National Action Plan. 13 pp.

Matjašič, J., Štirn, J., Kubik, L., Valentinčič, T., Velkovrh, F., Vukovič, S. 1975. Fauna and flora of the north Adriatic. Academia scientiarum et artium Slovenica. Class IV: Historia naturalis. Pp. 1-54.

Miho, A,, Witkowski, A. 2003. Diatom bio-indicative taxa in Albanian coastal lagoons – taxonomy and ecology.

Ministry of Environment, Forest and Water Administration, Directory of Fishery (Albania). 2009. Fish Management Plan – Blue Action, National document.

Nincevic Gladan, Z. et al.* 2006a. Brojnost i sastav pikoplanktonske zajednice u srednjem Jadranu (Abundance and composition of pikoplankton community in the Middle Adriatic). Acta Adriatica, 47(2).

Nincevic Gladan, Z. et al. 2006b. Prvi nalaz dinoflagelata *Ceratoperidinium yeye* u istočnom dijelu Jadrana. (The first record of dinoflagellatae *Ceratoperidinium yeye* in Eastern Adriatic) Acta Adriatica, 47(2).

Onofri, V. et. al.* 2009. Istraživanje dubokomorskog želatinoznog makrozooplanktona u južnom Jadranu (Research on deep-sae gelatinous macrozooplankton in the southern Adriatic Sea). Zbornik sažetaka 10. hrvatskog biološkog kongresa. Hrvatsko biološko društvo (Croatian Biological Society), Zagreb.

Peres, J.M., Gamulin-Brida, H. 1973. Biološka oceanografija: Bentos, Bentoska bionomija Jadranskog mora. Školska knjiga, Zagreb, 493 pp

Radovic, D. et al.* 2005 .Nacionalna ekoloska mreza – vazna podrucja za ptice u Hrvatskoj (National ecological network – areas important for birds in Croatia. State Institute for Nature Protection, Zagreb, 84 pp.

Radovic, J., ed.* 2000. An Overview of the State of Biological and Landscape Diversity of Croatia with the Protection Strategy and Action Plans. Ministry of Environmental Protection and Physical Planning, Zagreb. 156 pp

Radovic, J. et al.* 2003. SAP-BIO National Report of the Republic of Croatia. Prepared for RAC/SPA, Tunis.

Radovic J. 2008.National overview on vulnerability and impacts of climate change on marine and coastal biodiversity in the Republic of Croatia. Contract N° 07 RAC/SPA-2008 SAP-BIO. 53 pp.

Radovic, J. et al.* 2009 . Biodiversity of Croatia. Second revised edition. State Institute for Nature Protection, Zagreb.

Ramsak, A., Stopar, K. 2007. Dispersal ecology and phylogeography of *Scyphomedusae* in the Mediterranean Sea. MarBEF Newsletter, Autumn 2007.

Sardà, F., Tursi, A., Tselepides, A., Calafat, A., Espino, M. 2004. An introduction to Mediterranean deep-sea biology. Sci. Mar. 68 (Suppl. 3): 7-38.

Soldo, A. 2006. Status of sharks in the Adriatic. Proc. the Int. Workshop on Med. Cartilaginous Fish with Emphasis on South-east Med., Turkish marine Research Foundation, Istanbul. Pp.128-134.

Soldo, A. et al.* 2008. Basking shark (*Cetorhinus maximus*) occurrence in relation to zooplankton abundance in the eastern Adriatic Sea. // Cybium. 32(2): 103-109.

Tvrtkovic, N. 2006a. Crvena knjiga vodozemaca i gmazova Hrvatske. (Red book of amphibians and reptiles of Croatia). Ministry of Culture; State Institute for Nature Protection, Zagreb.

UNEP-MAP-RAC/SPA. 2010. Fisheries conservation management and vulnerable ecosystems in the Mediterranean open seas, including the deep seas. By de Juan, S. and Lleonart, J. Ed. RAC/SPA, Tunis: 113pp.

Vaso, A., Gjiknuri, L. 1993. Decapods Crustaceans of the Albanian Coast. Brill pub.,

Vilicic, D. et al.* 1995. Microphytoplankton in the Strait of Otranto (eastern Mediterranean). Marine Biology, 123(3): 619-630.

Vilicic, D. et al.* 2002. Checklist of phytoplankton in the eastern Adriatic Sea. Acta Bot. Croat., 61(1): 57–91.

Vilicic, D. et al.*2009. Composition and annual cycle of phytoplankton assemblages in the northeastern Adriatic Sea. Botanica Marina, 52(4): 291-305.

Vukovič, A. 1984. Contribution to the knowledge of marine benthic algae of Slovenia. Slovensko morje in zaledje 7(6-7): 187-193. (In Slovenian)

Žiža, V., Marenčič, Z., Turk, R., Lipej, L. 2001. First data on the Loggerhead turtle (*Caretta caretta*) in Slovenia (north Adratic). Proceedings, First Mediterranean Conference on Marine Turtles, Rome, 2001. pp. 261-264.

Zuljevic, A. et al.* 2008. Introduction and spreading of invasive species. Database on indicators of marine environment, mariculture and fishery. Croatian Environment Agency, Zagreb. http://jadran.izor.hr/azo/

*__Note__: References in Croatia National Report did not list all authors when there are more than 2 authors.