# Transboundary Diagnostic Analysis

# TDA

## for the Mediterranean Sea

prepared by
**Fouad Abousamra**
**Ante Baric**
**Francesco Saverio Civili**

IMPRINT

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*Graphic Design & Infographics: /fad.hatz@november*

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# Acronyms & Abbreviations

| | |
|---|---|
| AB | Algal Bloom |
| ACCOBAMS | Agreement for the Conservation of Small Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area |
| ADRIAMED | Scientific Cooperation to support Responsible Fisheries in the Adriatic Sea |
| | |
| BAT | Best Available Technology |
| BEP | Best Environmental Practices |
| BOD | Biolochemical Oxygen Demand |
| BSEP | Black Sea Environment Programme |
| BSP | Baltic Sea Programme |
| | |
| CBD | Convention on Biological Diversity |
| CD | Compact Disc |
| CFP | Common Fisheries Policy |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| cm/s | centimeters per second |
| COD | Chemical Oxygen Demand |
| COFI | Committee on Fisheries |
| CPUE | Catch per Unit Effort |
| CZ | Coastal Zone |
| | |
| DL | Daily Limit |
| dw | dry weight |
| | |
| EBRD | European Bank for Reconstruction and Development |
| EC | European Commission |
| EEA | European Environment Agency |
| EIA | Environmental Impact Assessment |
| EIN | Environmental Information Networking |
| EQO | Environmental Quality Objective |
| ER | Emergency Response |
| EU | European Union |
| EUCC | European Union for Coastal Conservation |
| EU SCOOP | European Union Scientific Cooperation |
| EU WFD | European Union Water Framework Directive |
| | |
| FAO | Food and Agricultural Organization, UN |
| | |
| g | gram |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GESAMP | Joint Group of Experts on the Scientific Aspects of Marine Pollution |
| GFCM | General Fisheries Commission for the Mediterranean |
| GIS | Geographical Information System |

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| | |
|---|---|
| *GNP* | *Gross National Product* |
| *HAB* | *Harmful algal bloom* |
| *HDI* | *Human Development Index* |
| | |
| *IAEA* | *International Atomic Energy Agency* |
| *IARC* | *International Agency for Research on Cancer* |
| *ICCAT* | *International Commission for the Conservation of Atlantic Tunas* |
| *ICES* | *International Council for the Exploration of the Seas, UN* |
| *ICZM* | *Integrated Coastal Zone Management* |
| *IMO* | *International Maritime Organization* |
| *IOC* | *Intergovernmental Oceanographic Commission* |
| *IPPC* | *Integrated Pollution Prevention and Control* |
| *IRPTC* | *International Register of Potentially Toxic Chemicals* |
| *ITCAMP* | *Integrated Coastal Area Planning and Management* |
| | |
| *kg* | *kilograms* |
| *km* | *kilometer* |
| | |
| *l* | *liter* |
| *LBS* | *Land-Based Sources* |
| *LRTAP* | *Long Range Transboundary Air Pollution* |
| *LEARN* | *Learning Exchange and Resource Network* |
| | |
| *m* | *meter* |
| *MAP* | *Mediterranean Action Plan* |
| *MARPOL* | *International Convention for the Prevention of Pollution from Ships* |
| *MEA* | *Multilateral Environmental Agreement* |
| *MED POL* | *Mediterranean Pollution Action Program* |
| *METAP* | *Mediterranean Environmental Technical Assistance Program* |
| *MG* | Mytilus galloprovincialis *(mussel)* |
| *mm* | *millimeter* |
| *MPPI* | *Major Perceived Problems and Issues* |
| *MT* | *metric ton* |
| | |
| *NAP* | *National Action Plan* |
| *NATO* | *North Atlantic Treaty Organization* |
| *NEAP* | *National Environmental Action Plan* |
| *NEC* | *National Emissions Ceilings* |
| *NGO* | *Non-Governmental Organization* |
| *NSA* | *National Shellfish Association* |
| | |
| *OECD* | *Organisation for Economic Co-operation and Development* |
| *OSPAR* | *Convention for the Protection of the Marine Environment of the North East Atlantic* |
| | |
| *PAH* | *Polycyclic Aromatic Hydrocarbons* |
| *PCDD* | *Polychlorinated dioxins* |
| *PCDF* | *Polychlorinated Drans* |
| *PCU* | *Programme Coordination Unit* |
| *PDF* | *Project Development Facility* |
| *pg* | *Picogram* |
| *PIC (Convention)* | *Prior Informed Consent* |

| | |
|---|---|
| *PIP* | *Priority Investment Portfolio* |
| *PPP* | *Purchasing Power Parity* |
| *ppt* | *parts per thousand* |
| *PSSA* | *Particularly Sensitive Sea Area* |
| *PTIW* | *Pretreatment of Industrial Wastes* |
| *PTS* | *Persistent Toxic Substances* |
| *QA* | *Quality Assurance* |
| *QC* | *Quality Control* |
| *RA* | *Regional Action* |
| *REMPEC* | *Regional Marine Pollution Emergency Response Center for the Mediterranean Sea* |
| *RFO* | *Regional Fisheries Organization* |
| *SAC* | *Scientific Advisory Committee* |
| *SAP* | *Strategic Action Programme* |
| *SAP BIO* | *Strategic Action Programme for Biodiversity in the Mediterranean Region* |
| *SAP MED* | *Strategic Action Programme to Address Pollution from Land-Based Activities* |
| *SC* | *Steering Committee* |
| *SEA* | *Strategic Environmental Assessment* |
| *SME* | *Small and Medium Enterprise* |
| *SPA* | *Specially Protected Areas* |
| *SPAMI* | *Specially Protected Areas of Mediterranean Importance* |
| *TDA* | *Transboundary Diagnostic Analysis* |
| *TDI* | *Total Daily Intake* |
| *TEQ* | *Toxicity Equivalent Quotient* |
| *THC* | *Total Hydrocarbon Concentration* |
| *TOR* | *Terms of Reference* |
| *TPB* | *Toxic, Persistent, and Bioaccumulative substances* |
| *TSS* | *Total Suspended Solids* |
| *UN* | *United Nations* |
| *UNCED* | *United Nations Conference on Environment and Development* |
| *UNECE* | *United Nations Economic Commission for Europe* |
| *UNECE/EMEP* | *United Nations Economic Commission for Europe / Co-operative programme for monitoring and evaluation of long range transmission of air pollutants in Europe* |
| *UNDP* | *United Nations Development Programme* |
| *UNEP* | *United Nations Environment Programme* |
| *UNESCO* | *United Nations Education, Science and Culture Organization* |
| *UNIDO* | *United Nations Industrial Development Organization* |
| *UNOPS* | *United Nations Office for Project Services* |
| *WB* | *World Bank* |
| *WHO* | *World Health Organization* |
| *WMO* | *World Meteorological Organization* |
| *WSSD* | *World Summit on Sustainable Development* |
| *WTO* | *World Trade Organization* |
| *ww* | *wet weight* |
| *WWTP* | *Wastewater Treatment Plant* |
| *WWW* | *World Wide Web* |

# FOREWORD

The Mediterranean region has witnessed substantial progress during the last few years in the fight against land-based pollution. The Protocol on land-based pollution sources (LBS) to the Barcelona Convention, in force since June 1983, has managed to promote awareness and shared participation on the issue of pollution from land, and the MED POL Programme has supported capacity building programmes and has helped the gathering of large amounts of information and data on sources, levels and effects of marine pollution. However, it was only at the end of the nineties that the Mediterranean, on the long wave of the Rio Summit and the adoption of the UNEP Global Programme of Action (GPA) to address pollution from land-based activities, started moving towards concrete action for pollution reduction. The signature of an amended LBS Protocol (1996) and the adoption of a Strategic Action Programme (SAP MED) to address pollution from land-based activities (1997) can be considered the turning points since they offered to Mediterranean countries effective instruments and a concrete road map to achieve gradual reduction and elimination of land-based pollution by the year 2025. The shift from assessment to control of pollution was supported by several factors, the most important of them being the interest and the concrete backing of the Global Environment Facility (GEF). GEF believed in the political and technical potential of the region and has supported a number of fundamental steps that have now created a very promising momentum in the fight against land-based pollution in the Mediterranean. The process of preparing and adopting the SAP MED was in fact substantially supported by GEF by offering the methodology and the experience gained in other regions and by transferring them in the Mediterranean. Through GEF, the Mediterranean countries in fact managed to identify the marine pollution hot spots —the basis for achieving pollution reduction— and prepared for the first time an assessment of transboundary pollution. In particular, the first Transboundary Diagnostic Analysis (TDA, 1997) was an innovative and original piece of work for the region that, by coupling pollution data with an analysis of root causes and possible pollution control measures, indicated for the first time a concrete road map for the reduction and elimination of pollution. With the support of GEF, the Mediterranean countries worked in a new and more effective direction and, as a result, they are soon to adopt solid and politically supported National Action Plans for the reduction of pollution. Considering the progress made, the developments at the regional and international levels and the need to update and complete the existing data and information, a second TDA has been prepared to be used once again as the basis for prioritizing and implementing action. Furthermore, the present TDA achieved an additional step compared with the 1997 TDA, that is the use of the Environmental Quality Objectives adopted in the SAP MED, the recently adopted SAP for biodiversity (SAP BIO) and the Code of conduct for fisheries. This has led to the identification of specific targets, deadlines and specific interventions and actions to be adopted by the countries in the framework of their National Action Plans (NAPs) and the SAP MED. The present TDA therefore represents once again a reference point for all Mediterranean countries and the basis for action for the years to come.

***Francesco Saverio Civili***
*MED POL Programme Coordinator*

TRANSBOUNDARY DIAGNOSTIC ANALYSIS (TDA) FOR THE MEDITERRANEAN SEA

# i.
# EXECUTIVE SUMMARY

## i.1 TDA Content and Process

The purpose of conducting a Transboundary Diagnostic Analysis (TDA) is to scale the relative importance of sources and causes, both immediate and root, of transboundary 'waters' problems, and to identify potential preventive and remedial actions. The TDA provides the technical basis for refinement of both the National Action Plans (NAPs) and the Strategic Action Programme (SAP) in the area of international waters of the GEF.

This TDA, was elaborated on the basis of the previous TDA adopted in 1997, as well as extensive information gathered since that time. The 1997 TDA was based on more than three years of activities. Numerous meetings and workshops were held to provide inputs to the TDA, various studies were carried out and reports were commissioned to support the TDA. The 1997 TDA also benefited from information made available by the Mediterranean Action Plan (MAP) Secretariat through its business as usual activities.

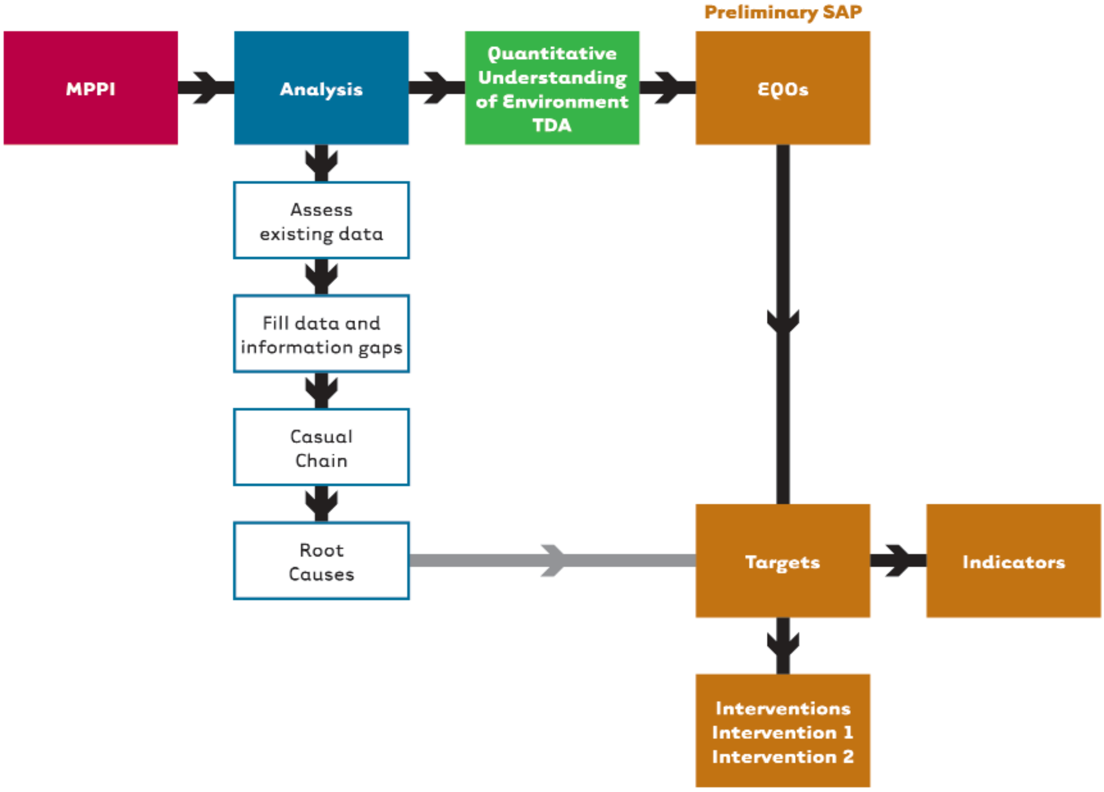
This TDA serves as an update of the 1997 TDA and was prepared during the implementation of the full GEF Project. To complete this update, a set of reports were prepared. An "Assessment of the Transboundary Pollution Issues in the Mediterranean" was drafted and then discussed at the regional experts' meeting (a list of participants is provided in Annex I) where the major perceived issues were identified. Based on the outcomes of this meeting, an updated draft of the TDA was prepared, circulated for comments and finalized.

The TDA provides the expert opinion on the state of the environment and priority problems. It terminates in a list of actions that are recommended for consideration. This list of recommendations must be considered in the context of national priorities and regional priorities. In addition, the list of recommendations is not exhaustive. Rather, the list is designed to address the major transboundary issues of interest to the Global Environment Facility's (GEF) International Waters (IW) focal area.

The Mediterranean Sea environment is affected by activities in heavily industrialized, developed countries in the northwest sector of the Sea, as well as by less industrialized activities in the southern and eastern parts of the Sea. The GEF-eligible countries in the region include Albania, Algeria, Bosnia & Herzegovina, Croatia, Egypt, Lebanon, Libya, Morocco, Slovenia, Syria, Tunisia, and Turkey. Serbia & Montenegro was not participated in the Project. Other countries participating in these GEF activities include the non-eligible countries of Cyprus, France, Greece, Israel, Italy, Malta, Monaco and Spain. Together, these countries account for much of the coastline of the Mediterranean Sea. The challenges to conducting a successful GEF/IW project in a region having such disparate mixes of development are great. Problems associated with industrial countries (e.g., organochlorines, hydrocarbons, PCBs, etc.) are mixed with environmental problems associated more often with developing countries (agricultural discharges, solid waste disposal, sewage treatment). Thus, the activities resulting from this GEF intervention will be mixed and varied.

The first step (Figure i.1) in the TDA process is to identify the major perceived problems and issues (MPPIs). This step was performed through a participatory process. These MPPIs then were the basis for the analysis phase, during which time the MPPIs were investigated for validity. Do data support the MPPI as a priority concern? What data are necessary to evaluate the MPPI? What do the Stakeholders think about the importance of the MPPI? What are the causes of the MPPI (causal chain analysis)? What are the environmental impacts of the MPPI? What are the socio-economic impacts of the MPPI? The analysis phase ends with a *de facto* ranking of the relative importance of the various MPPIs. This importance is based on the perspective of the GEF/IW, as the TDA is a product of the GEF/IW process.

*Figure i.1 Flow Diagram for the TDA Process*




These steps lead to investigation of the Quantitative Understanding of the Environment, which is the TDA. This quantitative understanding by nature has uncertainties: the data are not perfect, they are too infrequent, they are too sparsely located around the region, the analytical methods are imperfect, etc. However, the TDA is based on expert judgment of the best available data. The TDA then is followed by agreement of overarching regional Quality Objectives: if the TDA gives the present status of the environment, what is the common vision of the desired status? What environmental goals are desirable for the Mediterranean Sea? These are the Environmental Quality Objectives (EQOs).

After the MPPIs are ranked and the EQOs agreed, the root causes are then examined using a causal chain analysis. The causal chain analysis reviews the immediate causes of the MPPIs, as well as the root causes contributing to creation of those MPPIs. The root causes normally are the target of interventions; such interventions at the root cause level generally provide more sustainable and effective results.

The root causes and the MPPIs generally "drive" the next step in the process: selection of specific targets and actions to move towards achievement of the EQOs. These targets must be realizable, have finite and defined duration, and be associated with definable and measurable indicators.

What steps are necessary to achieve the EQOs, given the present condition of the environment? Some EQOs may need no additional steps, except perhaps routine implementation. Other EQOs may require vast changes in environmental practices and conditions to achieve them. To move towards the EQOs, targets are set: targets are time-constrained and quantifiable in their impact. The targets give the initial movements towards the EQOs, but they are mainly Status Indicators. The activities or interventions that lead to the achievement of the targets are the main output of the TDA: they represent experts' opinions about how to achieve the EQOs best given the existing conditions (environmental, institutional, capacity, state of knowledge, etc.). This section, therefore, summarizes the results of this process.

The TDA focuses on the major Transboundary issues. Transboundary is the regional context for the TDA, and separates national issues from issues eligible for incremental assistance from GEF to achieve global benefits. Transboundary can be defined from several perspectives. It can be an environmental issue that originates in one country, but affects other countries (river discharge is an example). It can be an environmental issue that comes from many countries (air pollution, Transboundary rivers). In some cases, Transboundary has been defined as a problem common to several target countries even though they may not have common sources; however, this is not a general definition.

Borrowing from methodology commonly used in the European Union and other regions, the TDA process identified three Environmental Quality Objectives (EQOs), which represent the regional perspective of major goals for the Mediterranean environment. The use of EQOs helps to refine the TDA process by achieving consensus on the desired status of the Mediterranean Sea. Within each EQO (which is a broad policy-oriented statement), several specific targets were identified. Each target generally had a timeline associated with it, as well as a specific level of improvement / status. Thus, the targets illustrate the logic chain for eventual achievement of the EQO. Finally, specific interventions or actions were identified to permit realization of each of the targets, within the time frame designated. For the purposes of this TDA, the time frames were limited to the first five or ten year periods, with some targets achieved prior to that time.

In summary, this TDA follows the general GEF TDA Guidelines for International Waters projects. However, an additional step was achieved, that is, use of Environmental Quality Objectives, in order to facilitate consensus on the desired state of the Mediterranean Sea after the next pentade or decade. The EQOs naturally led to identification of specific targets to be met within the desired time frame, and from there identification of specific interventions and actions that can be considered in the framework of the NAPs and SAP.

The TDA is comprised of several sections:

- The first Section is the Executive Summary.
- Section 1 is the Introduction.
- Section 2 is the technical basis of the TDA, addressing the MPPIs.
- Section 3 is the Legal and Institutional Framework Analysis.
- Section 4 is the Stakeholder Analysis.
- Section 5 covers the Environmental Quality Objectives.

Section 1 summarizes much knowledge of the Mediterranean's natural and socio-economic regimes. Environmental characteristics are identified, and socio-economic aspects addressed.

## i.2 Mediterranean Sea Environmental Status and its Major Transboundary Issues

The identification of the major perceived issues is the first step in the TDA process and it constitutes the justification for the subsequent in-depth analyses. The significance of the perceived issues and problems should be substantiated on environmental, economic, social, and cultural grounds. The following list of major perceived problems and issues was finalized to include four existing problems / issues:

- MPPI 1: Decline of Biodiversity
- MPPI 2: Decline in Fisheries
- MPPI 3: Decline of Seawater Quality
- MPPI 4: Human Health Risks

These perceived[1] problems and issues form the basis for the subsequent analysis, in which each of these problems and issues is addressed from a status perspective: what do we know about each problem / issue? What data support the quantification of the extent of the problem / issue? Do the data support these as real problems and issues, or just as perceptions? This analysis took place on a scientific level, including biological, oceanographic, physical, social, and other perspectives on the problem. This is in effect the "status" assessment. Next came the Causal Chain Analysis, where the major perceived problems and issues were analyzed to determine the primary, secondary and root causes for these problems / issues. Identification of root causes is important, because these tend to be more systemic and fundamental contributors to environmental degradation. Interventions and actions directed at the root causes tend to be more sustainable and effective than interventions directed at primary or secondary causes. However, because the linkages between root causes and solution of the perceived problems are often not clear to policymakers, interventions commonly are directed at primary or secondary causes. This TDA attempts to make the linkages between root causes and perceived problems more clear, to encourage sustainable interventions at this level. Fortunately, root causes are common to a number of different perceived problems and issues, so addressing a few root causes may have positive effects on several problems and issues.

Finally, the analysis recognizes that society commonly acts within a number of nearly independ-

[1] *"Perceived" is used to include issues which may not have been identified or proved to be major problems as yet due to data gaps or lack of analysis or which are expected to lead to major problems in the future under prevailing conditions.*

ent sectors (agriculture, industry, transport, etc.), which are poorly coordinated and often have conflicting interests and associated policies. Within these sectors, various Stakeholders have interests in the Mediterranean Environment, both affecting and being affected by that environment. Sectors and their Stakeholders work in an uncoordinated and sometimes conflicting fashion, but they typically affect the Mediterranean environment in similar ways. Loss of habitat, for instance, may be caused by activities of various sectors (transport, farming, industry), and by various types of Stakeholders (governmental policy-makers, ranchers grazing animals, small farmers). A major concern of this TDA, therefore, has been to identify common root causes and link them with improvements to perceived problems and issues. A Stakeholders analysis has been completed, and is summarized in this TDA.

The result of the analysis is a prioritization of the MPPIs for later regional intervention, supported by GEF. In order to avoid long lists of unfocused interventions, the TDA should identify concrete priorities for action, and justify their status as a transboundary concern.

The TDA analysis of the major perceived problems and issues can be summarized as follows:

1. Decline in biodiversity: strongly transboundary.
   a. Brief statement of the problem: Some critical habitats are severely threatened by a variety of human activities. Major threats to the biodiversity of the area include pollution (sewage, oil, nutrients), invasive species, introduced species, land reclamation, river damming and flow modification, over-fishing, by-catch, and adverse effects of fishing gear and uses on marine habitats (e.g., bottom trawling), solid waste disposal at sea, uncontrolled tourist presence in ecologically sensitive areas as well as inadequate public and stakeholders awareness, and inadequate or non-existent legislation and available enforcement means. Ecological effects include disruption of biocenosis; dramatic change in community structure; disruption of key ecotones, some of which are globally valuable; and adverse impacts on endangered species. Socio-economic impacts of decline in biodiversity include loss of high value ecological services; reduction in nearshore fisheries, particularly for artisanal fisheries; loss of tourism and its documented economic benefits; and loss of cultural heritage.
   b. Analysis: Particularly heavily impacted are seagrass habitats (including *Posidonia* meadows and eelgrass meadows, *inter alia*) that have been affected by eutrophication, bottom trawling, dredging, and other human activities. These are high ecological service habitats. Additional habitats include biogenic constructions by both vegetal and animal coral builders, and comprises also some very sensitive deep-water coralline habitats, though these effects are less well known. Coastal wetlands, including lagoons and estuaries, are adversely affected by pollution, land reclamation, mismanagement of the phreatic basins (aquifers), and river diversion / loss of flow. Invasion by alien species is an ongoing process, and forms part of the basis for the Mediterranean's high biodiversity. Although introduction of alien species by humans is a priority problem to be addressed, preventing invasion by new species by natural means is not. Primary causes of decline in biodiversity include excess supply of nutrients, bottom fishing, by-catch, degradation and uncontrolled human presence of breeding and / or nursery areas for marine pulmonata and fish, pollution, solid waste disposal, competing land uses including land reclamation, alteration of river flows and constituents, and introduction of alien species. Root causes for this MPPI include poor stakeholder awareness and participation, inadequate control over fishing effort and gear employed, insufficient scientific knowledge and monitoring of the biodiversity in the region and related processes, as well as inadequate implementation of treaties and international agreements, lack of investment in wastewater treatment, and poor solid waste disposal practices.
   c. Priority Areas for GEF Intervention:
      i. One target for reversing decline in biodiversity is preservation of key Mediterranean biotopes such as seagrass and other

marine vegetation beds (*Posidonia*, eelgrass, and others listed in the Red Book), coralligenous, sea mounts, wetlands, marine caves, etc., and creating conditions for their enhancement. The priority areas for this activity are encountered throughout the region, and their proper mapping is a priority still in need of completion.

ii. A second target for GEF intervention is addressing other important sites at risk that are important for marine biodiversity. These are elements of biodiversity that, due to their abundance, special importance, or endangered status, require special attention. Figure i.2 shows the locations of the areas where the resources require attention, according to the list of Table i.1.

iii. A third target for GEF intervention is expanding the number of protected areas in the Mediterranean Sea, and to facilitate the management and a well-established networking for existing ones. Regional mechanisms for Protected Areas exist (e.g., SPAMI). However, most of these are in the northwest Mediterranean Sea. Some main priority areas of particular interest are listed in Table i.2 and some are shown in Figure i.3.

iv. A fourth GEF target area is to reduce eutrophication of coastal waters. To address this, sewerage and wastewater treatment plants, a primary source of excess nutrients, must be expanded in coverage. The map of areas where eutrophication has been reported to exist is shown in Figure i.4. Note, unfortunately, that the southern and eastern Mediterranean countries have not reported on eutrophication, though satellite images show that if it happens there, it is local. Eutrophication is a common problem, but a local problem, though its effects are widespread and transboundary. The primary areas where wastewater treatment plants are required to avoid damage to sensitive habitats (see Section 2.3.6.4) are listed in Table i.3. GEF's role could be directed at reducing nutrient and BOD discharges, to reduce the eutrophication of the Sea.

2. Decline in fisheries: strongly transboundary.

   a. Brief statement of the problem: Various threats to fisheries include pollution, overfishing, loss of habitat, excessive bycatch, deleterious fishing gear, lack of enforment of laws and agreements in the high seas, and sophisticated methods to find and catch fish. Concern has arisen that there is an underlying problem of long-term depletion in Mediterranean marine catches. In fact, most of the Mediterranean fishery resources, be they demersal, small pelagic or highly migratory species, have long been considered overexploited. The issue is transboundary because many fish are either migratory or represent shared stocks. Overall, the fisheries are overseen by the General Fisheries Commission for the Mediterranean (GFCM).

   b. Analysis: Fish catch information shows some remarkable constancy on time periods of decades, and even more so in years, fluctuating only by a factor of two or less in total catch. However, the number of fishing vessels has increased markedly during this time, increasing in some countries by a factor or three or four. Composition of the catch has also changed with time, though not as dramatically as in some areas such as the Yellow Sea. The most targeted species already show signs of intensive exploitation. Catch-per-unit effort (CPUE) and other measurements and biological indicators such as reduction of individual fish sizes led the GFCM to conclude that most of the commercial fish stocks are considered fully or over-exploited. Major causes of decline in fisheries include pollution (especially eutrophication leading to loss of suitable benthic habitat), loss of habitat, overfishing, antiquated (not habitat friendly) fishing methods (primarily in southern countries), overly sophisticated and hence efficient fishing methods (in some countries). Root causes include inadequate stakeholder awareness and involvement; lack of enforcement and

**Figure i.2 Transboundary Sites at Risk related to Mediterranean Marine Biodiversity**

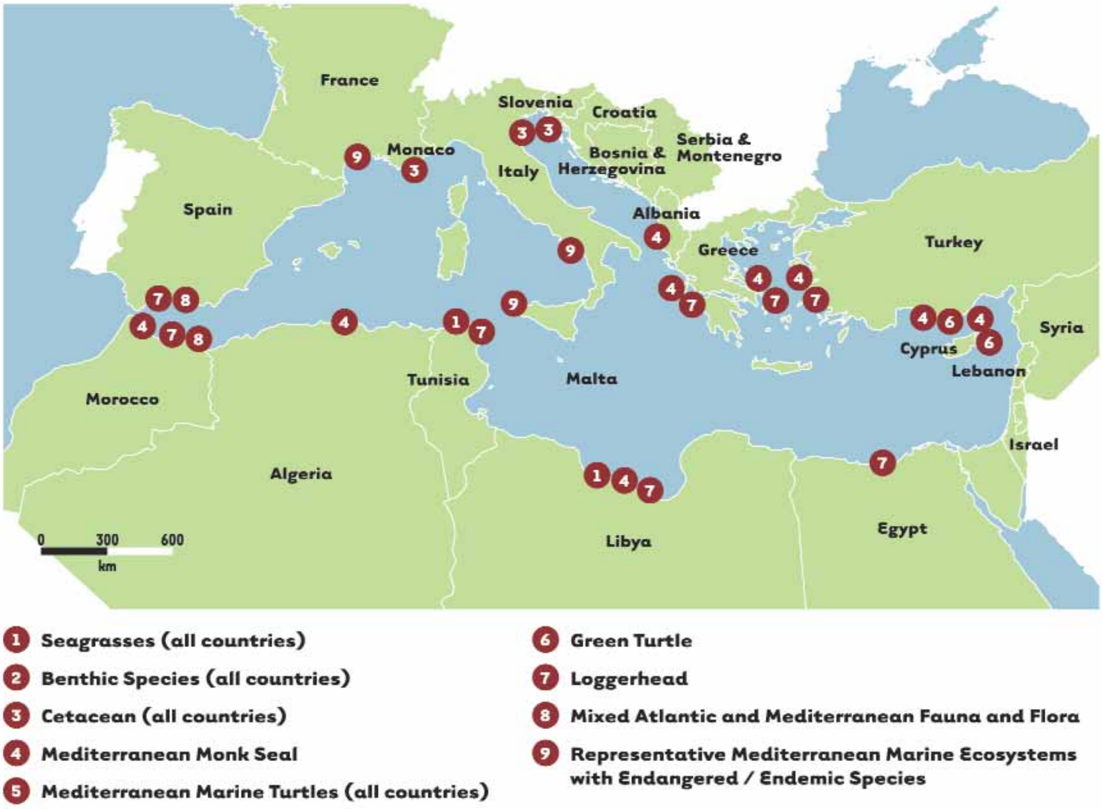



**Table i.1 Transboundary Sites at Risk related to Mediterranean Marine Biodiversity**

| Species / site of interest | Countries concerned |
|---|---|
| Seagrasses | All countries (mentioned in NAPs of Tunisia, Libya) |
| Benthic species including coralligenous communities | All countries |
| Sea mounts and canyons | All countries |
| Cetaceans | All countries<br>Ligurian Sea: France, Italy, Monaco<br>Alboran Sea: Spain, Morocco<br>Northern Adriatic: Italy, Slovenia, Croatia<br>Ionian Sea: Albania, Italy, Greece<br>Aegean Sea: Greece, Turkey |
| Mediterranean Monk seal | Western: Morocco, Algeria, Tunis<br>Ionian: Albania, Greece<br>Aegean: Greece, Turkey<br>Eastern: Turkey, Cyprus, Syria, Libya |
| Mediterranean marine turtles | All countries |
| Green turtle | Eastern: Greece, Cyprus, Lebanon, Syria, Turkey |
| Loggerhead | Ionian: Italy, Albania, Greece<br>Southern: Tunisia, Libya, Egypt<br>Aegean: Greece, Turkey<br>Eastern: Cyprus, Lebanon, Syria, Turkey<br>Alboran: Spain, Morocco |
| Elasmobranches | Alboran: Spain, Morocco<br>Southern: Algeria, Tunisia, Libya, Malta, Italy |
| Fish breeding and nursery areas | All countries |
| Mediterranean shearwater | Spain-Morocco, Algeria |
| Mixed Atlantic and Mediterranean fauna and flora | Alboran Sea: Morocco, Spain |
| Representative Mediterranean marine ecosystems with endangered / endemic species | Bonifacio Straight (and western tip of Sicily)<br>France, Italy |

*Table i.2 Marine and Coastal Sites of Particular Interest identified by Country, with Relevant Actions listed*

| Country | Sites and / or type of action |
|---|---|
| Albania | • Rehabilitation of the Kune-Vaini lagoon system<br>• Proclamation of the Marine National Park of Karaburuni Area |
| Algeria | • Selection of marine sites to be protected: Habibas Islands, Rachgoun island, PNEK marine area, Taza-Cavallo-Kabyles shoal, Gouraya, Chenoua-Tipaza, Plain Island, Collo peninsula, Cape Garde, Aguellis Islands, Tigzirt marine area<br>• Conservation of the Al Kala wetlands |
| Bosnia & Herzegovina | • Identification of processes in the Neum karst coastal area<br>• Management of the sensitive area of the Mali-Ston Bay<br>• Biodiversity protection of the lower Neretva with the Hutovo Blato wetland and of the delta of the Neretva River as a unique eco-system |
| Croatia | • Transboundary management plan for the Lower Neretva Valley including Malostonski Bay<br>• Management plans for national parks and nature parks (Kornati-Telascica, Velebit-Paklenica, Biokovo, Krka, Vransko jezero, Brijuni, Mljet)<br>• Management plan and protection of Cres-Losinj Archipelago with surrounding sea<br>• Protection and management of rivers: Mirna (including Motovun forest); Cetina (including Pasko field); Zrmanja<br>• Protection of sand and muddy shores in NW part of Ravni Kotari<br>• Protection of Sandy Beaches Saplunara and Blace on the Mljet Island<br>• Protection of Konavle area<br>• Fisheries management at Jabuka Pit (Fossa di Pomo) |
| Cyprus | • Adoption and implementation of the provisions of the EU Habitat and Bird Directives and completion of the NATURA 2000 network (38 proposed sites) and incorporation of proposed sites in town and country planning legislation, local plans and countryside policy |
| Egypt | • Combating eutrophication in the coastal lakes of the Nile Delta<br>• Development and management of the Matruh Nature Conservation Sector (MNCZ) |
| Greece | • 121 sites out of 238, included in the Greek National list of the Natura 2000 network, host marine and coastal habitats and habitats of important species. Efforts are being made to set up and manage the Natura 2000 sites, ensuring the appropriate short, medium and long term funding mechanism<br>• Seven Ramsar sites on the Montreux list |
| Lebanon | • National Action Plan for the conservation of the Tyre Coast Nature Reserve |
| Libya | • Bays and coastal lagoons: Ain El-Gazalah Bay, Bumbah Bay, Ain Ziana lagoon, Farwa lagoon<br>• Wadis: Wadi Al-Hamsah, Wadi Al-khabtah, Wadi Ka'am, Tawrurgha spring and salt marshes |
| Malta | • Xlendi Bay Munxar / SW Gozo<br>• Dwejra bay and Qawra San Lawrenz / W Gozo; mouth of Wied Ghasri N. Gozo<br>• Reqqa Point N. Gozo; Xwejni N. Gozo<br>• Ramla Bay and San Blas Bay NE Gozo<br>• Mgarr ix-xini SE Gozo<br>• Cominotto, Ras l-Irqieqa SW Comino<br>• Ras Il-Qammieh N/NW Malta<br>• Cirkewwa NW Malta<br>• Ahrax Point NW Malta<br>• Sikka l-Bajda NW Malta<br>• St. Pauls Island and Mistra Bay N Malta<br>• Qawra Point N Malta<br>• Merkanti Reef Northern coast of Malta<br>• Off Lazzarett (Marsamxett Harbour)<br>• Zonqor Reef (off Zonqor Point) East Malta<br>• Sikka tal-Munxar (off St. Thomas Bay) E. Malta<br>• Delimara Peninsula SE Malta<br>• Wied Iz-zurrieq S Malta<br>• Ghar Lapsi; Migra Ferha SW Malta<br>• Ras Il-Wahx SW Malta<br>• Hamrija Bank S Malta<br>• Filfla, an islet in SW Malta |
| Slovenia | • Shared management (with Croatia) of the Dragonja River<br>• Debeli Rtic natural monument (marine and coastal)<br>• Sv. Nikolaj salt-marsh (coastal salt-marsh)<br>• Skocjanski Zatok nature reserve (coastal lagoon)<br>• *Posidonia oceanica* meadow (marine)<br>• Strunjan nature reserve (marine and coastal)<br>• Stjuza natural monument (coastal lagoon)<br>• Rt Madona natural monument (marine)<br>• Secovlje salt-works landscape park (salinas) — Ramsar site from 1993 |
| Tunisia | • Remedial measures for the impact of dams on the Ichkeul Ramsar site |

*Figure i.3 Areas where Marine Protected Areas have been recommended within National Action Plans*


1 Karaburuni Area
2 Kune-Vaini Lagoon System
3 Various Areas
4 Wetland Areas
5 Matruh Nature Conservation Area
6 Palm Islands and Tyre Coast Nature Reserve
7 Various Areas
8 Various Areas (including Lattakia Beach)
9 Coralligenous Communities
10 Various Areas

*Figure i.4 Mediterranean Areas where Eutrophication Phenomena have been reported* (Source: UNEP/FAO/WHO, 1996b)


Sea Water
Lagoons
No data reported

*Table i.3 Locations where Sensitive Ecosystems are threatened by Eutrophication*

| Designation / location | Country | Priority |
|---|---|---|
| Kuna-Vain lagoons | Albania | High |
| Gulf of Ghazaouet, Gulf of Arzew-Motaganem, Bay of Algiers, Bay of Annaba, Gulf of Skikda, Bay of Bejaia, Bay of Zemmouri | Algeria | High |
| Beirout, Tripoli, Jounieh, Saida, Sour | Lebanon | High |
| Anchor Bay | Malta | High |
| Tanger Bay, Smir Bay, Mouloya Estuary, Martil Beach, Sfiha Beach | Morocco | High |
| Ghar El Melh | Tunisia | High |
| Adana, Izmir Bay, Icel, Mersin-Kazanli, Hatay-Samandag, Aydin | Turkey | High |

monitoring; insufficient alternatives to fisheries employment; and lack of regulation in some countries. Environmental impacts of decline in fisheries include imbalance in some ecosystems due to loss of top predators; other environmental impacts are related to fisheries impacts such as destruction of bottom habitat (seagrass beds) by bottom trawling and excessive bycatch including endangered species (such as turtles, scarce bird and elasmobranch species, etc.). Socio-economic impacts of declining fisheries include loss of income and employment; loss of cultural practices; possible decline in food security.

c. Priority areas for GEF interventions: In general, the need for GEF interventions in fisheries is only weakly motivated. A regional fisheries commission already exists, and some sub-regional fisheries commissions also exist. There is no overarching evidence that existing commissions are not functioning well, but they are not enough by themselves to cope with the underlying environmental problems affecting the fisheries stocks in the Region. There are no dramatic declines in important commercial fisheries, although as a multispecific fisheries there is some evidence for decline in commercial catches during the recent decades. GFCM indicates that most of the commercial fish stocks are fully-to-over-exploited. Big pelagic fisheries also have experienced some decline. Twelve national action plans listed priority fisheries related actions, most of which were to minimize the effects of overfishing on the environment. Therefore, this MPPI is not as high a priority for GEF intervention, though institutional strengthening might improve existing management practices. Addressing other MPPIs (decline in biodiversity, decline in seawater quality) will per force contribute to improvement of fisheries.

3. Decline of seawater quality: strongly transboundary.
   a. Brief statement of the problem: Increasing trends in eutrophication and its related oxygen deficiency and bloom of nuisance species (e.g., jellies such as *Noctiluca*); presence of hot spots of pollution leading to decline in biodiversity, fisheries, diseases or loss of health in marine organisms, and overall water quality; human health problems from consuming fish and shellfish or contacting polluted waters; loss of endangered species; and overall imbalance of some ecotones (e.g., seagrass meadows) all result from decline in seawater and sediment quality. Although many of these effects are local in extent, they have transboundary consequences. Important transboundary consequences arise due to ocean currents transporting pollutants throughout the Sea; migration and transport of various life stages of marine organisms (e.g., dinoflagellate cysts) to other parts of the Sea from polluted areas; marine transport through shipping; and transport through the atmosphere.
   b. Analysis: Budgets for heavy metals, organochlorines, hydrocarbons, nutrients, pesticides, and other pollutants entering the Mediterranean Sea from land, from

the atmosphere, and from sea (shipping), have been developed during the PDF-phase of the project. At the same time, limited but available data and observations on declining health of marine populations (ecotoxicology) linked to various pollutants point to ecosystem effects from declining seawater quality. Increases in frequency, intensity, duration, and spatial extent of eutrophication have raised alarms about pollution. This study has identified a series of land-based pollution hot spots around the Mediterranean (Figure i.5) (Annex III), including 125 for all countries (France was not included), and 92 for GEF-eligible countries. These hot spots were identified geographically, and classified as to cause of the hot spot (industry, sewage, agriculture, etc.). In addition to these hot spots, ecosystems have been identified that are associated with the hot spots with the highest pollutant loads (Figure i.6). Sixty-two ecosystems associated with the highest pollutant-load hot spots have been identified, of which forty-five are in GEF-eligible countries. Table i.4 shows the 20 cities in the Mediterranean with the most BOD discharges to the Sea from industrial sources.

c. Possible Interventions by GEF: There are several areas where intervention by GEF may be able to assist in improving the seawater quality of the Mediterranean Sea.
   i. Reduce nutrient and BOD loading to the sea from sewage: this intervention is addressed as part of MPPI 1. In addition, those cities identified in Table i.4 above could benefit perhaps from both sewerage and treatment, and / or improved industrial processes prior to discharge of wastewater to sewers and / or the Sea. Similar process improvements would be required for atmospheric discharge, since atmospheric discharge is a major pathway for certain pollutants, including excess nutrients, to the Sea. The goal would be to reduce the discharge of excess BOD and nutrients to the coastal and offshore waters.
   ii. Reduce discharge of toxic materials to the Sea: The point sources of pollution identified above bring toxic heavy metals, toxic organochlorines, toxic hydrocarbons, and other toxins to the Sea either directly through discharge to the Sea, or indirectly through atmospheric transport to the Sea. Of concern are toxic, persistent, and bioaccumulative (TPBs) contaminants;

*Figure i.5 Pollution Hot Spots in the Mediterranean Sea*

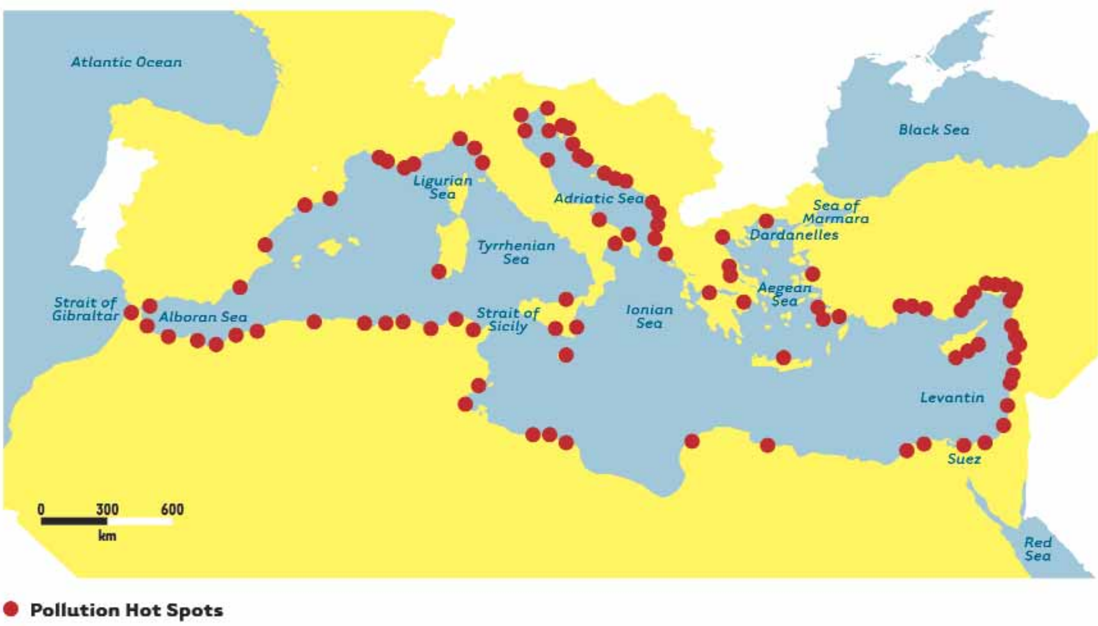


*Figure i.6 Ecosystems associated with Highest Pollutant-load Hot Spots*


*Table i.4 The 20 Urban Centres discharging the most BOD*

| Country | Urban centre | $BOD_5$ disch. (kt/yr) |
|---|---|---|
| Algeria | Algiers* | 58.87 |
| Greece | Athens* | 58.00 |
| Italy | Naples | 44.4 |
| Egypt | Alexandria | 43.6 |
| Spain | Barcelona (+San Adrian del Besos) | 41.2 |
| Algeria | Oran* | 28.06 |
| Turkey | Izmir | 26.3 |
| Algeria | Skikda* | 19.94 |
| Israel | Tel-Aviv (Shafdan)* | 19.75 |
| Algeria | Bejaia* | 19.73 |
| Libya | Tripoli* | 16.06 |
| Turkey | Mersin* | 14.3 |
| Turkey | Antalya* | 13.29 |
| Italy | Palermo | 13.0 |
| France | Marseilles | 12.0 |
| Spain | Malaga | 11.5 |
| Lebanon | Greater Beirut area* | 10.18 |
| Tunisia | Tunis Centre | 8.3 |
| Italy | Bari-Barletta | 7.7 |
| Italy | Piombino | 7.5 |

** Updated information since 2002*

Figure i.7 shows the locations of the major industrial sources of TPBs listed in Table i.5.

iii. Urban and other solid waste: urban solid waste is dumped at sea in some countries, leading directly to deterioration of water quality. Solid waste has been identified as a major issue at certain locations, and also in general due to dumping at sea by ships and pleasure craft. Figure i.8 shows the Mediterranean-wide partitioning of sources of solid wastes that make it to the Sea. Figure 2.11 in the main text breaks this distribution out, country-by-country. Interestingly, none of the countries

***Figure i.7 Location of Major Industries contributing TPBs to the Mediterranean Sea***

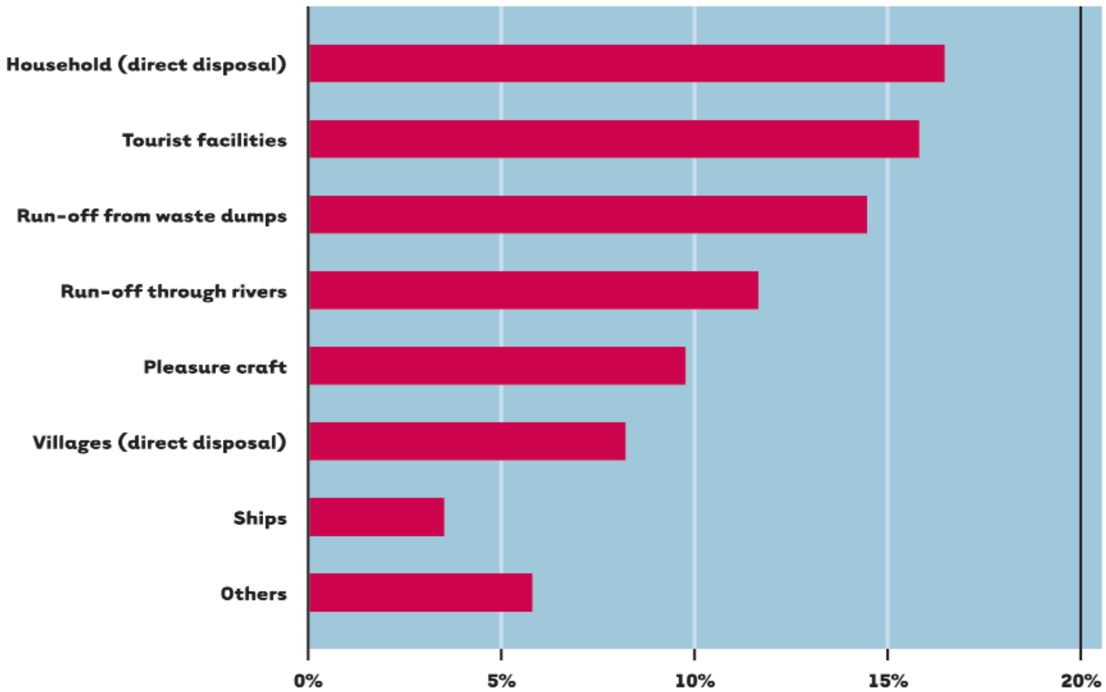

- **1 Durres (Albania)**
- **2 Vlora (Albania)**
- **3 Abu Qir Bay (Egypt)**
- **4 El-Max Bay (Egypt)**
- **5 Larymna Bay (Greece)**
- **6 Shafdan (Israel)**
- **7 Tangiers (Morocco)**
- **8 Various (Morocco)**
- **9 Lattakia (Syria)**
- **10 Tartous (Syria)**
- **11 Sfax South (Tunisia)**

***Table i.5 Some of the Main Sources of TPBs to the Mediterranean*** *(Source: UNEP/WHO, 1999)*

| TPB (kg/yr) | Hg | Cd | Pb | Cr | Cu | Zn | Ni | Others (t/yr) |
|---|---|---|---|---|---|---|---|---|
| Abu Qir Bay (Egypt) | | 31+ | 193+ | 362+ | 2,669+ | 3,394+ | 859 | 1,906 (oil) |
| Tartous (Syria)* | 140 | | 10 | 50 | 310 | 540 | | 200 (oil) |
| Lattakia (Syria)* | 130 | 20 | 50 | 130 | 640 | 2.480 | | 91 (oil) |
| El-Mex Bay (Egypt) | 1,278 | 1,562 | | 530 | 25,430 | 46,524 | | 1,319 (oil) |
| Shafdan (Israel)* | 80 | 270 | 2,510 | 8,330 | 19,610 | 67,130 | 3,850 | |
| Sfax South (Tunisia) | | | | | 3,456 | 17,000 | | |
| Larymna Bay (Greece) | | | | | | 313,170 | | |
| Tangiers (Morocco)* | 20 | 490 | 60 | 720 | 440 | 1,800 | 270 | |

** Updated information since 2002*

***Figure i.8 Sources of Solid Waste to the Marine Environment*** *(Source: UNEP/MAP, 2001b)*




identified solid waste as a major priority in their National Action Plans. Plastics are identified as the dominant source of marine litter, making up some 75% of the litter on the sea surface and seabed. Major areas where industrial waste has been identified as a problem are in the attached Table i.6.

4. Human health risks: weakly transboundary.
   a. Brief statement of the problem: Pollutants that degrade the ecosystem also present risks to human health, including not only heavy metals, organochlorines, pesticides, hydrocarbons, and the like, but also microbial and viral pollution. In addition, the response of the ecosystem to stress may induce toxicity that may affect humans, such as toxic dinoflagellates that arise from eutrophic conditions in some instances. Primary pathways for human health risks include ingestion of water or seafood products, contact with contaminated seawater (or in some cases, beaches), and perhaps contact with contaminated sea food (for marine products workers). Those at risk include marine products workers, recreational beach users, swimmers, divers, and consumers of marine food products.

***Table i.6 Selected Locations where Major Industrial Waste Problems exist***

| Designation / location | Country | Wastes |
|---|---|---|
| Durres | Albania | Hexavalent chromium salts |
| Vlora | Albania | Mercury |
| Skikda and Annaba in the east, Algiers-Oued Smar and Rouiba-Reghaia in the centre, Oran-Arzew in the west, and on the other the industrial complexes of Ghazaouet, Mostaganem, Béjaia and Jijel | Algeria | Various |
| Abu Qir Bay | Egypt | Various: industrial discharges |
| Various | Lebanon | Various |
| Various | Morocco | Mining wastes |

b. Analysis: Though incomplete data are available on this topic, there is ample evidence that human health risks are possible through the pathways described above. There are no ecosystem health risks arising from the Human health risks (though the two are related). There are serious socio-economic impacts, however, such as loss of tourist revenue, loss of sales of marine products (such as when bivalves are contaminated and the industry is shut down), and loss of cultural use of the marine resources.

c. Possible GEF interventions: Since human health is not directly a topic for intervention by GEF/IW, no areas of interventions can be proposed here. However, some of the interventions arising from other MPPIs may improve the health situation, including sewerage and treatment of discharges, and reduction of nutrient inputs leading to decreased eutrophication.

### i.3 Environmental Quality Objectives

Environmental Quality Objectives (EQOs) are a means to develop broad Stakeholder agreement on the major environmental objectives of the region. They are useful for communication of the desired state of a particular environment or component of the environment. They represent consensus views of environmental priorities, or visions of what the environment should look like in the future. Often, EQOs are simple restatements of existing consensus views. EQOs can be regional or national.

EQOs commonly have specific targets identified with them. The targets are quantitative statements of progress towards achieving a particular EQO, and generally have associated timelines or milestones. The targets generally are focused on relatively short-term goals (for instance, 5 years), which are achievable on time frames that governments can understand. If the timelines are too long, governments may tend not to act, but rather leave the solution to the next administration. The targets must also be realizable: they must be achievable at a reasonable pace and cost. If the targets are too ambitious, they may be ignored. Better to have an achievable, modest target, than an aggressive, unreachable target.

Once EQOs and targets are identified; it is relatively straightforward to identify specific or concrete steps required in the next few years to achieve these targets. What policies are required? What legislative acts? What investments? What capacity building? What infrastructure? These specific steps are identified in this TDA as activities or interventions. The steps form the "workplan" to achieve the targets within the agreed time frame. The progression from EQOs, to targets, to concrete activities is a logic chain that leads to consensus on complex environmental issues.

The three EQOs developed for the Mediterranean Sea are listed below, along with the MPPIs with which they are associated:

1. Reduce the impacts of LBS on Mediterranean Marine Environment and Human Health: addresses MPPIs 3 and 4, and to a lesser extent MPPIs 1 and 2.
2. Sustainable Productivity from Fisheries: addresses MPPI 2.
3. Conserve the Marine Biodiversity and Ecosystem: Addresses MPPI 1.

Each of these EQOs had targets defined as a means of achieving these EQOs. The targets associated with the EQOs were identified as follows in Table i.7.

### i.4 Priority Actions and Interventions for NAPs/SAP

Following the identification of environmental quality objectives and their associated targets, specific interventions / actions were identified to achieve first the targets, and ultimately, the EQOs. These priority actions and interventions can be categorized within one or more of the following major groupings:

- Policy actions
- Legislative / regulatory reform
- Institutional strengthening
- Capacity building
- Baseline investments
- Incremental investments
- Scientific investigation
- Data management
- Information and awareness actions

The priority areas and actions, listed by EQO, are given in Table i.8. More detailed activities and interventions listed by EQO are found in Section 5.

***Table i.7 Targets Categorized according to Environmental Quality Objective***

| Environmental Quality Objectives | Targets |
|---|---|
| I. Reduce the impacts of LBS on Mediterranean Marine Environment and Human Health | 1. By 2005 dispose of sewage from cities of more than 100,000 people in conformity with LBS. By 2025, dispose all sewages in conformity with LBS. |
| | 2. By 2005, create a solid waste management system in all cities of more than 100,000 people. By 2025, create solid waste management for all urban agglomerations. |
| | 3. By 2005, conform to air quality standards for all cities of more than 100,000 people. By 2025, all cities to conform to air quality standards. |
| | 4. By 2005, reduce inputs, collect, and dispose of all PCBs otherwise entering the marine environment. By 2010, phase out all inputs of POPs. |
| | 5. By 2010, achieve 50% reduction in TPB by Industry. By 2025, industrial point source discharges and emissions conform with LBS and standards. |
| | **Other targets for heavy metals, organohalogen compounds, and radioactive materials:** |
| | • By 2005, collect and dispose of all obsolete chemicals in an environmentally safe manner. |
| | • By 2005, collect and dispose of 50% of lubrication oils in an environmentally safe manner. |
| | • By 2010, reduce industrial nutrient input by 50%. |
| | • By 2010, 20% reduction of generation of hazardous wastes, of which half are safely disposed. By 2025, all hazardous wastes disposed in safe manner. |
| | • By 2010, achieve 20% reduction of generation of batteries, and dispose of 50% of batteries in an environmentally safe manner. By 2025, dispose of ALL batteries in an environmentally safe manner. |
| | • By 2025, reduce inputs of agricultural nutrients. |
| II. Sustainable Productivity from Fisheries | 1. Implement the Code of conduct for fishing. |
| | 2. Assessment, control and elaboration of strategies to prevent impact of fisheries on biodiversity. |
| | 3. Promote the adequate monitoring and survey of the effectiveness of marine and coastal protected areas. |
| | 4. Assist countries to protect marine and coastal sites of particular interest. |
| | 5. Declare and develop of new Coastal and Marine Protected Areas including in the high seas. |
| | 6. Assist countries in the development of existing marine and coastal protected areas. |
| | 7. Control and mitigate the introduction and spread of alien and invasive species. |
| | 8. Control and regulation of aquaculture practices. |
| | 9. Promote public participation, within an integrated management scheme. |
| | 10. Preserve traditional knowledge of stakeholders. |
| | 11. Coordinate and develop common tools to implement National Action Plans (NAPs) related to fisheries. |
| III. Conserve the Marine Biodiversity and Ecosystem | 1. Improve the management of Marine and Coastal Protected Areas. |
| | 2. Enhance the protection of endangered species and habitats. |
| | 3. Reinforce relevant national legislation. |
| | 4. Foster the improvement of knowledge of marine and coastal biodiversity. |

### *Table i.8 Areas and Actions for Priority Intervention*

| Major Concerns | Priority Actions | Where to intervene |
|---|---|---|
| Decline of Biodiversity | Implementation of SAP BIO | All Mediterranean countries |
| | Rehabilitation of coastal Solid Waste landfills | Eastern, Southern Mediterranean countries |
| | Reduction of 50%of industrial BOD by 2010 | All Mediterranean countries |
| | Reduction of riverine inputs of nutrients | Adriatic region |
| | Follow up investment of 12 preinvestment studies for Hot Spots in GEF eligible countries | 12 GEF eligible countries: Algeria, Morocco, Tunisia, Libya, Egypt, Syria, Lebanon, Turkey, Albania, Croatia, Slovenia, Bosnia & Herzegovina |
| | Conservation of habitats | Rehabilitation of wetlands (refer to countries reports in SAP/BIO) Implementation of ICZM in locality where Demonstration projects have been achieved (amount of localties in brackets): Turkey (1), Lebanon (1), Syria (1), Spain (2), Italy (4), Greece (5), Morocco (1), Algeria (1), Tunisia (1), Malta (1), Egypt (1), Israel(1) |
| | Control of inputs of alien species | Management of ballast water in all Mediterranean Countries |
| Decline in Fisheries | Implementation of FAO Code of conduct | Eastern Mediterranean, Adriatic and southern Mediterranean |
| | Control of inputs of alien species | Management of ballast water in all Mediterranean Countries |
| | Implementation of EC related Directives | EU Mediterranean countries |
| | Implementation of SAP BIO | All Mediterranean countries |
| Decline of seawater quality | Reduction of 50% of industrial BOD | All Mediterranean countries |
| | Implementation of SAP/NAP list of priority actions for POPs | All Mediterranean countries |
| | Implementation of SAP/NAP list of priority actions for industrial releases | All Mediterranean countries Eastern Mediterranean countries, Syria, Lebanon, Turkey, Israel, Egypt |
| | Implementation of regional plan for reduction of 20% hazardous waste | Obsolete chemicals in Southern, Eastern and former Yugoslavia Mediterranean countries |
| | Treatment of urban wastewater | Refer to table on cities without WWTP. Section 2.4 |
| | Follow up investment of 12 preinvestment studies for Hot Spots in GEF eligible countries | 12 GEF eligible countries: Algeria, Morocco, Tunisia, Libya, Egypt, Syria, Lebanon, Turkey, Albania, Croatia, Slovenia, Bosnia & Herzegovina |
| | Management of PCBs and stock of Obsolete chemical | Management of PCBs waste and disposal of Obsolete chemicals in Southern, Eastern and former Yugoslavia Mediterranean countries |

# INTRODUCTION

The purpose of the Transboundary Diagnostic Analysis for the Mediterranean Sea (TDA MED) is to address the transboundary concerns of the Mediterranean Sea and as such contribute directly to the achievement of the water body-based operational Programme of the GEF Operational Strategy.

According to GEF guidance, the purpose of conducting a Transboundary Diagnostic Analysis (TDA) is to scale the relative importance of sources and causes, both immediate and root, of transboundary 'waters' problems, and to identify potential preventive and remedial actions.

This TDA, which was elaborated on the basis of the previous TDA prepared in 1997 as well as extensive information gathered since that time, summarizes existing information available from the region. In order to reflect the convenient and reliable regional vision on the transboundary issues in the Mediterranean, a regional experts' meeting including scientists, representatives of industry and non-governmental organizations (NGOs) (Annex I), reviewed the draft report of the support data entitled "Assessment of the Transboundary Pollution Issues in the Mediterranean" and identified the major perceived issues to be considered in the present document. Based on the outcomes of this meeting, an updated draft of the TDA was prepared, circulated for comments and finalized.

The methodology of the Mediterranean TDA consists of the following steps:

- Identification of Major Perceived Problems and Issues, including status and gaps;
- Elaboration of Causal Chain Analysis for perceived problems;
- Legal and Institutional Framework Analysis;
- Stakeholder Analysis; and
- Environmental Quality Objectives (EQOs).

The evaluation of impacts of transboundary pollution on the marine ecosystem is based on two types of scientific findings: a) indicators of change of composition and / or stress of the ecosystem of the Mediterranean, and b) analysis of trend of levels of bioaccumulation of chemical contaminants in the ecosystem elements which are considered as indirect indicators of impact on the ecosystem.

The comparative, logical and thematic analysis of major concerns, their impacts, the policy options and the EQOs enabled the regional experts to identify environmental areas of priority actions together with the priority interventions that should be considered in the time frame from the present up to the year 2025.

The Legal and Institutional Framework and Stakeholder analyses are based upon the Barcelona Convention system including the Strategic Action Programme to address Pollution from Land-Based Activities (SAP MED), Strategic Action Programme for the Conservation of Biological Diversity (SAP BIO) in the Mediterranean Region, MAP partners' analysis report, FAO code of conduct related to fisheries, and other Multilateral Environmental Agreements (MEAs).

This TDA achieved an additional step compared with the 1997 TDA —that is, use of Environmental Quality Objectives adopted in the SAP MED, SAP BIO and Code of conduct for fisheries which led to specific targets to be met within a desired time frame, and specific interventions and actions that can be considered in the framework of the National Action Plans (NAPs).

This analysis shows that the Mediterranean Countries have initiated and taken effective measures during the last 25 years to protect the marine environment and human health in the coastal Mediterranean region. Even though gaps and barriers still exist, the support information collected showing trends highlights and reflects this reality.

This TDA is considered an important milestone and benchmark in the long-term effort of these countries consolidated by the active participation of NGOs to implement the policy options adopted by the region.

# 1.0

# THE MEDITERRANEAN REGION

This section describes the Mediterranean Sea and its coastal zone by reviewing its natural characteristics and main socio-economic aspects. By doing so, it sets the framework into which information from following sections on the main environmental pressures and policy options addressing those falls.

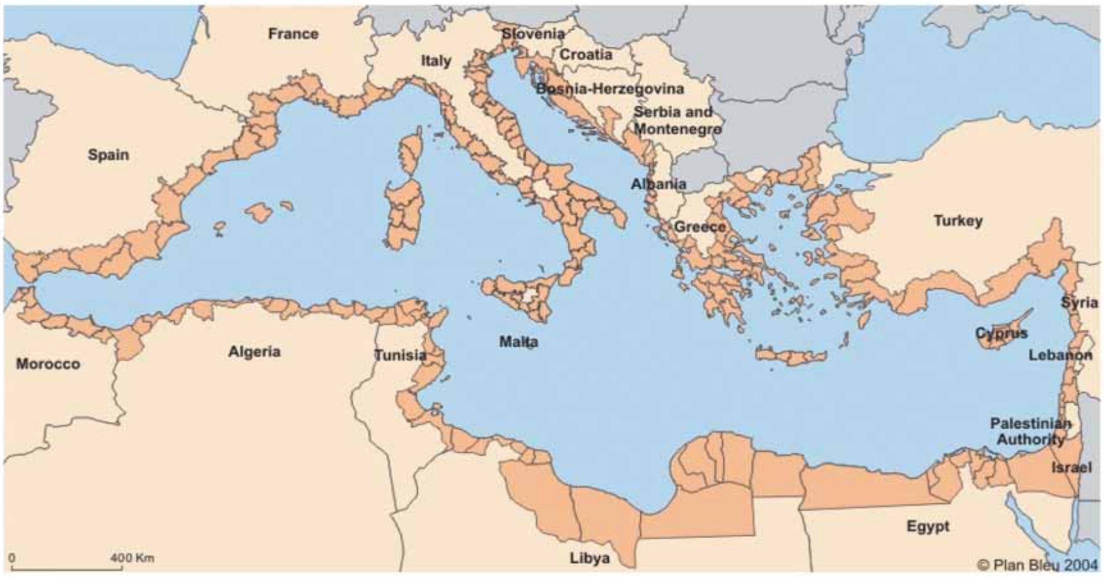
Flanked by mountain ranges to the north, east and southwest and desert or arid zones from Tunisia to Syria, the Mediterranean coastal fringe harbours cultures looking inward, towards the sea. This common sea, or *Mare Nostrum* of the Roman age, is also a network of shared interests, from trade and investment, through safeguarding the environment to ensuring sustainable development of regional resources for continued stability and prosperity.

The review of the Mediterranean setting highlights the geographic factors that give rise to a unique Mediterranean context. It focuses on the geographic setting and climate, the hydrological and dynamic system, biological diversity and natural resources. Arrays of Mediterranean socio-economic aspects are also considered here including demography and human settlements, industrial activity and trade, agriculture and fisheries and tourism.

The geographic boundaries of the project are defined broadly as all Mediterranean countries and their coastal regions (see Figure 1.1 below). Within this framework the GEF-eligible countries include Albania, Algeria, Bosnia & Herzegovina, Croatia, Egypt, Lebanon, Libya, Morocco, Slovenia, Syria, Tunisia, and Turkey. In addition, other participating countries include Cyprus, France, Greece, Israel, Italy, Malta, Monaco and Spain.[2] From a practical standpoint, this

[2] *Although Serbia & Montenegro has not participated in this GEF project, some data from this country are incorporated in this report as this is included in the Mediterranean area.*

**Figure 1.1 The Mediterranean Countries and their Coastal Regions**



definition of the geographic scope is at once too limiting, and secondly, too broad. The limitation comes from the importance of atmospheric deposition to contaminants deposited in the Sea, which come from places more distant than the coastal areas and watersheds. The excessive breadth comes from the fact that the major activities being addressed are weighted towards the water body, and include the water body and coastal areas. In much of the Mediterranean Sea area, particularly for most GEF-eligible countries (Egypt is an exception), coastal mountains limit the watershed to close proximity to the Sea; in these cases, the watershed boundary is ideal.

## 1.1 Environmental Characteristics

### *1.1.1 Geographic setting and climate*

The Mediterranean Sea occupies an area of about 2.5 million $km^2$, is about 3,800 km wide from East to West and has a maximum north-south distance of 900 km between France and Algeria.

The Mediterranean Sea is the remnant of an older ocean, tens to hundreds of millions of years old and several times wider, named 'Tethys'. According to plate tectonics theory, the Tethys Ocean began to be consumed by the converging Euroasiatic and African continental plates some 50–70 million years ago, concurrently with the opening of the Atlantic Ocean. This process is still active, especially in the eastern part along the Hellenic Trench, where the eastern Mediterranean crust is submerging beneath the Aegean microplate, while it has only recently ceased along the Tyrrhenian Arc. Thus the eastern part of the Mediterranean Sea is more active in terms of plate tectonics and is characterized by more complex morphology than is the western part.

The Mediterranean Sea is an enclosed sea connected to the Atlantic by the strait of Gibraltar, a 15 km wide and 290 m deep sill and to the Black Sea by the Strait of Canakkale (Dardanelles), having a maximum width of only 7 km and an average depth of 55 m. The connection of the southeastern with the Red Sea occurs through the Suez Canal. The Mediterranean is divided into two main basins, the western and the eastern, separated by the Sicilian Channel that is about 150 km wide, reaching a maximum depth of 400 m. In contrast to the flat, 2,700 m deep basin of the western Mediterranean (west of Sardinia and Corsica), the Tyrrhenian, Ionian, Levantine and the Aegean seas are characterised by alternating deep depressions and morphological highs, submarine valleys and steep slopes. The greatest depth of the entire Mediterranean Sea, 4,982 m, is found in a narrow basin located off the shores of southwest Greece within the Hellenic Trench, along which several other small basins exceed 4,000 m depth. The shallowest part of the Mediterranean Sea is the northern Adriatic, the depth of which does not exceed 50 m. The estimated, average depth of the Mediterranean Sea is around 1,500 m.

Morphologically, Corsica, Sardinia and the Balearic islands are the most significant islands of the western Mediterranean basin. Sicily and Malta are located in the central part. Cyprus, Crete and Rhodes are the biggest islands in the eastern part of the Mediterranean Sea, where the 700 or more islands and islets of the Aegean archipelago form the most striking morphological feature.

Along the coastal areas, rocky shores —both hard and soft— predominate, with cliffs over 150 m high occurring in Spain and Croatia. These are only occasionally interrupted by sandy beaches of limited length, associated with relatively narrow valleys cutting through the mountains or with small coastal plains surrounded landwards by mountainous areas.

The few big rivers flowing into the Sea affect the Mediterranean's morphology. The biggest in length is the Nile in Egypt, the catchment basin of which extends several thousands of kilometres into the northeastern part of the African continent. The Nile river deposits, formed before the construction of the Aswan dam, create a very impressive onshore delta plain on the coastal area of northeastern Egypt and a huge submarine alluvial cone in front of its mouth in the Levantine Sea. Together with the submarine cone or the Rhone River, these two alluvial cones constitute some of the most striking morphological features of the Mediterranean basin. The Rhone itself rises in the central Alps in Switzerland and flows through Lake Geneva and southeastern France to the Gulf of the Lion in the western Mediterranean Sea. The third most important river flowing out into the Mediterranean Sea is the river Po in northern Italy. The Po drains the southern flanks of the Alps and the northern part of the Apennine mountain range through the Po plain to the northern Adriatic Sea. The fourth most important river flowing into the Mediterranean Sea is the Ebro river in Spain. The large river catchments have delivered sediment to the coast as erosion of the mountains has taken place, thus creating new coastal habitats which include the large sedimentary coastal plains, which in micro-tidal areas in the Mediterranean region have grown to form large deltaic systems such as the Ebro Delta in Spain, the Po Delta in Italy or the coastal plain of Albania, to mention a few.

The Mediterranean climate is subjected to both subtropical and mid-latitude weather systems. It is characterised by a windy, mild, wet winter and a relatively calm, hot dry summer; the transition periods April–May and September–October being too short to appear as well defined seasons. The seasonal features are associated directly with the motion and development of the great pressure systems: the permanent Azores anticyclones, the great continental anticyclone of Eurasia, the low pressure over the north African desert and the tropical Atlantic. The winter months are characterised by low-pressure centres over the Tyrrhenian, east Ionian and Aegean seas and high pressure over the land. In summer, the pressure pattern is dominated by competition between a ridge of high pressure from the Azores and low pressure over the Middle East originating from the south Asian monsoonal low, creating a dominantly east-west pressure gradient across the Mediterranean Sea. Most depressions (about 70 percent) occurring in the Mediterranean area are formed in the Gulf of Genoa although North Africa, south of the Atlas Mountains, is an important source in spring. Around one tenth enter from the Atlantic, mainly through the Strait of Gibraltar or the Garonne-Carcassonne gap. In the central and eastern Mediterranean the formation of new depressions can occur in the northern Ionian Sea, the southern Aegean and in the region of Cyprus; but this is rare and limited to the winter months.

The orographic effects of the continental masses surrounding the Mediterranean basin are crucial for the vertical motion of air masses and give rise to regional and local winds. Several persistent regional wind systems are present, the strongest of them being the Mistral and the Etesian winds. The Mistral is an intense, cold, dry, northwesterly wind blowing mainly during winter down the Rhone valley between the Pyrenees and the Alps. It reaches the Gulf of the Lion and spreads over a wide area of the western Mediterranean region. The Etesian winds (or Meltems in Turkish) are the dominant winds in the eastern Mediterranean. They are northerly winds, strongest in late summer or early autumn, which are funnelled onto the Aegean Sea through the gap between the mountains of the Balkans and Anatolia. Other important wind systems are the Bora, a strong but infrequent winter wind flowing over the Adriatic; the westerly Vendaval, flowing through the Strait of Gibraltar into the Alboran Sea between Spain and Morocco; and the Sirocco or Khamsin, a warm southerly wind from the desert areas of Africa and Arabia. Gales over the Mediterranean basin mainly occur in the winter; especially in the Gulf of the Lion (with about 27 gales per year), the Aegean Sea and the Sardinian Channel (with, on average 12 and 10, respectively).

Air temperature differences between winter and summer are generally limited to about 15°C. Nevertheless, local meteorological and geographic factors can result in extreme temperatures. The highest air temperatures are recorded near the coasts of Libya and Egypt between March and June, when they may reach as much as 50°C. High temperatures occur regularly at a number of places in the Mediterranean area, such as the lee side of the Corsican mountains, the northern coasts of Sicily, Crete and Cyprus. High air temperatures can also occur in Spain when tropical continental air spreads north from Africa. Lowest temperatures are reached during winter on the northeastern coast of the Aegean Sea and the North Adriatic.

Mean annual precipitation shows a north to south gradient, with precipitation decreasing towards the south. Mountains are naturally the dominant factor in precipitation patterns. High precipitation values of 1,500–2,000 mm and more are found in the Alpine and Pyrenean headwater regions of the Po, the Rhone and the Ebro rivers and they are very abundant in the Alpine mountain belt bordering the Dalmatian coast, from the Istrian peninsula down to Albania. This makes these countries the most humid countries of the Mediterranean area.

Low summer and high winter rainfall is one of the major features of the Mediterranean climate. This contrast is more and more pronounced from north to south and from west to east. Precipitation mainly falls during winter and autumn whereas summer season precipitation is less than 10 percent of the annual total. High precipitation during autumn is typical for the coasts of Spain, France, Italy, Croatia, Serbia & Montenegro, Albania and Greece. Further east, such as in Turkey and in Lebanon, autumn precipitation is much less important. By far most of the rainfall occurs here in winter.

In certain regions, precipitation especially in autumn can occur in the form of heavy downpours, causing flash floods in the rivers of these regions. The prevalent zones for flash floods are the Côte d'Azur, East Pyrenees, Cevennes and Corsica in France, the northwestern areas of Italy and Catalonia and Valencia in Spain.

One result of the seasonal rainfall and high evaporation is that water shortages are endemic. The problem is particularly striking in the southern parts of the Mediterranean in contrast to seasonal shortages in the north (corresponding to the dry months). The dry season in some southern countries exceeds six months, meaning that water shortage is a permanent handicap for sociological and economic development.

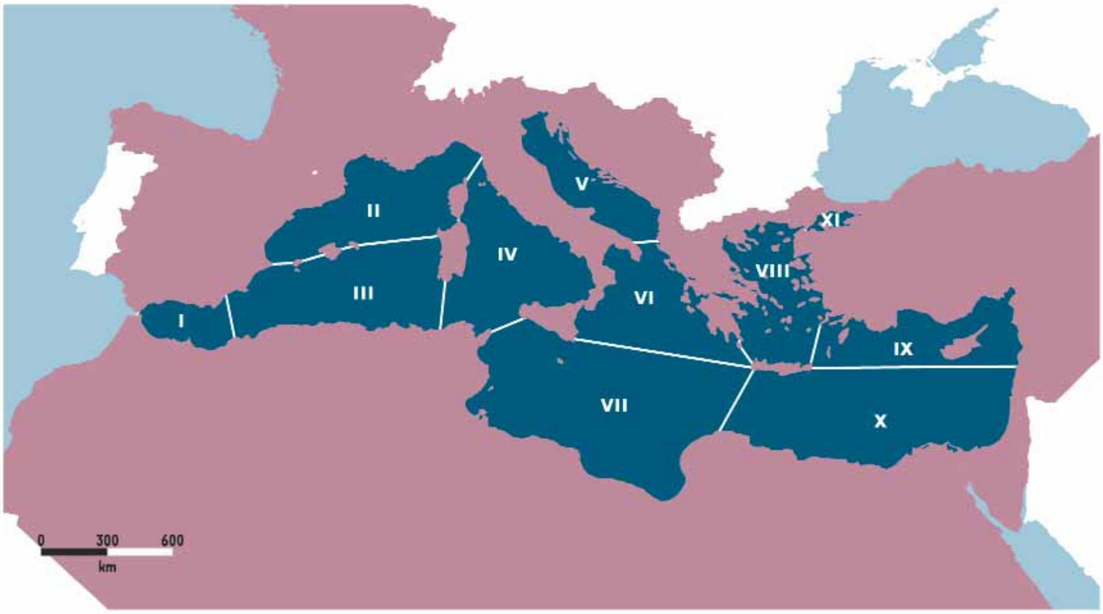
### 1.1.2 The hydrological system

All major rivers flowing into the Mediterranean have lost much of their waters to agriculture over the past 40 years. Freshwater inflow into the Mediterranean is therefore low while irrigated farmland in Mediterranean basin countries has increased between 1960 and 1999 from approximately 20 mil hectares to 38 mil hectares. Freshwater recharge is higher in the northern Mediterranean where the Rhone, the Po and the Ebro, the three most important Mediterranean rivers in terms of discharge, are found. Roughly one-third of the Mediterranean's continental water flows into the northern and central Adriatic Sea wedged between Italy and the eastern Adriatic coast. By contrast, the Nile, with a catchment area by far greater than any other Mediterranean river, covering 3,350 $km^2$, discharges minor quantities of water into the sea. In fact, as a result of the High Aswan Dam, the Nile now discharges less than 5 percent of its original flow. New irrigation schemes and the Peace Canal bringing Nile water to the Sinai will further reduce the Nile inputs to practically zero.

In terms of overall river water discharge into the Mediterranean basin, the reduction witnessed over the past 40 years is estimated to be between 30 and 40 percent. Major Mediterranean rivers other than the Nile have seen a reduction in the quantities discharged, such as the Rhone and Ebro, while further reductions are expected to take place in other Mediterranean regions in the future. In the case of the Ebro River in Spain, a total of 128 reservoirs extracting water have led to a decrease in water discharge of about 29 percent (Ibanez et al., 1996). Zahar and Albergel (1999) reported that the closure of the Sidi Salem Dam in Tunisia led to a reduction of the mean annual discharge of the Medjerdah River by 65 percent due to diversion for irrigation and evaporative losses. The most affected sub-basins of the Mediterranean are probably the south Levantin, Alboran, southwest Aegean, central and north Levantin (Figure 1.2).

Low river inflow into the Mediterranean is also explained by the fact that most of the rivers tend to be small, owing to the dry climate and mountainous coast

*Figure 1.2 Major Sub-basins of the Mediterranean Sea*




| | | | |
|---|---|---|---|
| I | Alboran (MT1) | VII | Central (MT7) |
| II | North-Western (MT2) | VIII | Aegean (MT8) |
| III | South-Western (MT3) | IX | North-Levantin (MT9) |
| IV | Tyrrhenian (MT4) | X | South-Levantin (MT10) |
| V | Adriatic (MT5) | XI | Marmara Sea (MT11) |
| VI | Ionian (MT6) | | |

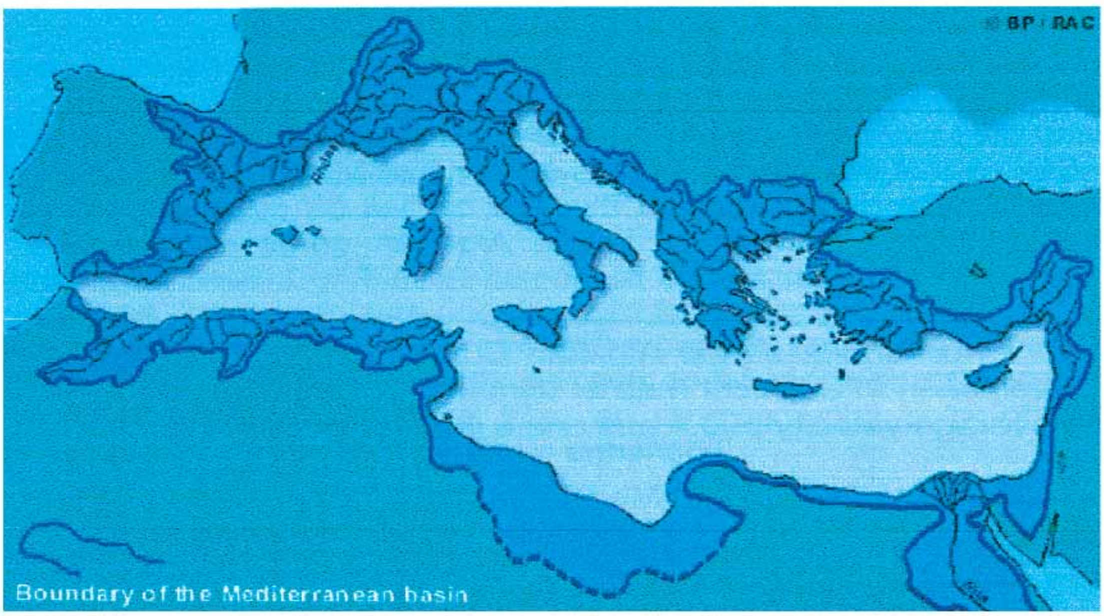
relief of the basin. In the northern part of basin steep relief reduces the area of catchment basin, which are on average less than 10,000 $km^2$ for the Mediterranean as a whole (Figure 1.3). In the southern part, hot and dry climate is in favour, with few exceptions, of the formation of small coastal rivers with relative short distance between the headwaters and the river mouths. Seasonal flood events, typical of Mediterranean rivers, have also been affected by damming works. Often, most of the water discharge in the region occurs during short floods. Floods are associated with maximum river flow due to pronounced rainfall, which generally occurs between February and May in the Mediterranean. In the large and medium-sized river basins situated in north and central Europe, wide-ranging and continuous precipitation is commonly the main factor in flood generation, often also in association with snow melt. Intense rainfall falling on small catchments is the main cause of floods in the Mediterranean area. However, the building of dams, as in the case of the Ebro, has smoothened seasonality of the river's hydrography.

Coastal aquifers provide another source of freshwater discharge to the Mediterranean. The seepage from the coastal aquifers, estimated at 13 billion $m^3$/yr in the UNEP / Blue Plan study (http://www.planbleu.org/), accounts for about one quarter of the total freshwater inflow into the Mediterranean. The seepage inflows are prevalent on the eastern coast of the Adriatic, dominated by its karstic aquifer systems, as well as the eastern and southern Mediterranean coast with semi-arid and arid conditions and limited precipitation and runoff and limited surface watercourses and discharge points. The karstic coastal aquifers discharge directly into the sea without previous intervention of rivers or lakes and the functions as flows and storage in karst are directly related to the quantitative status, represented by the discharge flows and the water budgets. The karstic aquifer discharges include also substantial submarine discharges with large submarine karstic freshwater springs with flows as high as 50 $m^3$/sec that are recharged on land. The coastal seepage and submarine discharges are critical to the water balance and seawater quality in the marine sub-basins and support wetlands and brackish water habitats with biodiversity and fishery nursery areas in the coastal zones. The coastal aquifers are threatened by over-exploitation and consequent seawater intrusion and water and land salinization, thereby adding to the deficit in recharge of the Mediterranean.

This deficit in water recharge of the Mediterranean is offset by Atlantic water entering the basin through the straits of Gibraltar. In general, Atlantic surface waters come in and the Mediterranean deep waters go out to the Atlantic Ocean. Estimates for the turnover period for water entering through Gibraltar range from about 80 to 200 years.

As is discussed in more detail above, the Mediterranean Sea is composed of two nearly equal size basins: the western and eastern Mediterranean. The Mediterranean circulation is forced by water exchange

***Figure 1.3 Hydrologic Boundary of the Mediterranean Basin***



through the various straits, by wind stress, and by buoyancy flux at the surface due to freshwater and heat fluxes (Robinson et al., 2001). Maximum depths in the two subdivisions are about 3,400 m in the west and about 4,200 m in the east. A sill between Sicily and Tunisia has a depth of about 400 m. The second connection between the western and eastern basins, the narrow Strait of Messina between Sicily and mainland Italy, has a sill depth of only 120 m. This strait has little significance for the general circulation; however it is famous for its strong tidal currents reaching 2–3 m/s in magnitude (Tomczak & Godfrey, 2003).

The flow through the Gibraltar Strait is mainly driven by the density difference between the water masses on either side of the strait. Inflow velocities in excess of 1 m/s in combination with a rapidly shoaling bottom in a constricted passage result in a situation where normal ocean dynamics give way to hydraulic control of the flow. The inflowing Atlantic water initially continues eastward as a free jet and breaks into one or two large eddies of 150 km diameter before the Coriolis force deflects it and the flow carries on along the African coast (Figure 1.4). The change from the Spanish to the Algerian coast occurs in a narrow current associated with a front, known as the Almeria-Oran Front, which separates the relatively fresh Atlantic water from the salty Mediterranean water (Tomczak & Godfrey, 2003). The Atlantic inflow then continues as the Algerian Current, a narrow jet less than 30 km wide. The Algerian Current has an average velocity of 0.4 m/s and a maximum velocity of 0.8 m/s.

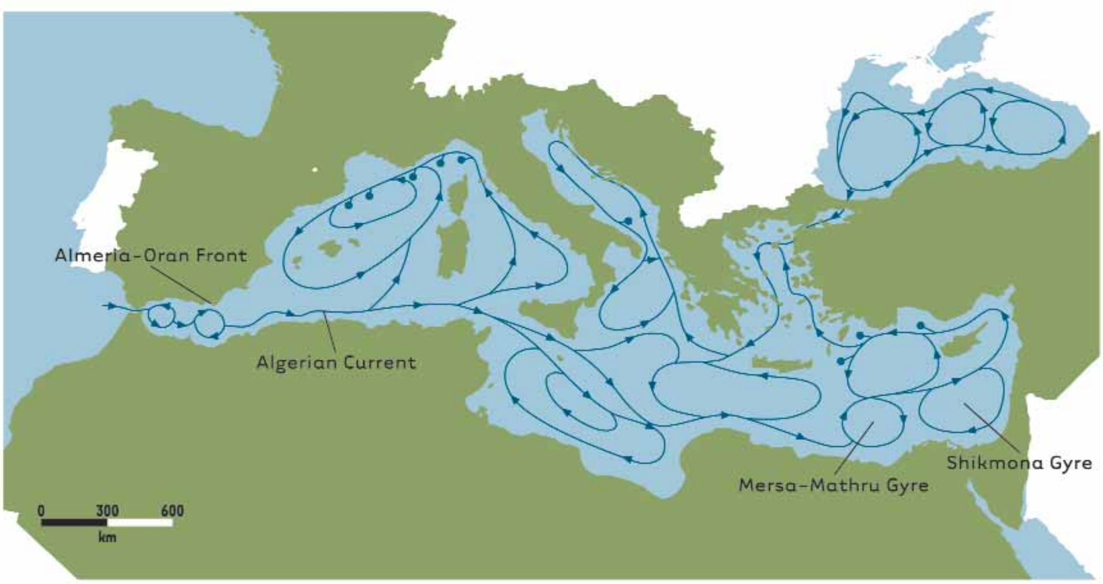
The surface circulation of the western Mediterranean is quite steady during the four seasons, although it gets more intensified during the winter (Tziperman & Malanotte-Rizolli, 1991).

In the eastern Mediterranean basin, due to complex bathymetry, the circulation is dominated by eddies, some large and quasi stationary as indicated in Figure 1.4. The seasonal signal of the eastern Mediterranean upper circulation is stronger than that of the western basin, due to stronger variability in the forcing by the wind and heat fluxes at the surface. In all seasons except winter the flow of the Atlantic Water from the Sicilian Straits forms a meander that extends from about 15°E to 20°E. This dynamic feature may be related to the interaction of the eastward flow with the topographic or planetary b effects. Its disappearance in the winter may be related to the change in the wind curl in the Ionian Sea during this season (Tziperman & Malanotte-Rizolli, 1991).

Outside the Algerian Current the Atlantic relatively colder waters continue submerged under a shallow surface layer of high salinity and can be followed as a salinity minimum at 20–30 m depth.

Because the Mediterranean Sea is a concentration basin, the Atlantic water is converted into denser water that eventually leaves the sea over the sill of the Strait of Gibraltar. This conversion process involves deep vertical convection during winter. It does not act uniformly in the entire basin but occurs in three small regions affected by cold winter winds. Deep vertical convection that occurs in the western

***Figure 1.4 A Scheme of Mediterranean Sea Circulation*** *(Source: Tomczak & Godfrey, 2003)*



basin forms the Mediterranean Deep Water. Cold winter winds affecting the region between Rhodes and Cyprus and on the northern and central Adriatic Sea are responsible for the formation of Levantine Intermediate Water (LIW). The dense water mass from the Adriatic Sea does not maintain its identity very long. It turns eastward and enters the Levantine Basin where it encounters water freshly formed in the region between Rhodes and Cyprus. The two sources mix, and together they form the LIW, which is typically identifiable as a salinity maximum underneath the Atlantic Water salinity minimum.

Thus, the large-scale circulation of the Mediterranean Sea is composed of sub-basin scale and mesoscale gyres interconnected and bounded by currents and jets with strong seasonal and inter-annual variability. This circulation pattern, combined with shelf relief of the Mediterranean makes it possible for large currents to influence coastal water flow. The consequence of this hydrographic regime from an environmental point of view is that transportation of material and possibly pollution is enhanced.

Clearly the picture that emerges of circulation in the Mediterranean Sea is one where water mixes both vertically and laterally. Thus, contaminants introduced in one area (by wind, discharge at sea, or coastal discharges by rivers or pipes) will be mixed relatively rapidly by the strong currents. Overall, the Mediterranean Sea is thought to mix completely once every 200 to 300 years. This so-called residence time is one indicator of how long contaminants may accumulate in the basin before mixing sufficiently and leaving the basin.

Moreover, in the last 40 years, there has been a slight but noticeable increase of deep waters temperature and salinity (+0.12°C in temperature; +0.05 percent in salinity). It is probably too early to give an explanation but the possibility of a steady increase could be suggested by another observed increase of unusual occurrences in marine life that could be used as indicators of changing Mediterranean Sea conditions.

### *1.1.3 Biological diversity*

The Mediterranean's unique mixture of subtropical and temperate elements has contributed to species diversity that has few equals in the world. The Mediterranean, accounting for only 1.5 percent of the earth's surface, hosts approximately 7 percent of the known world marine fauna and 18 percent of the world marine flora, of which 28 percent are endemic to the Mediterranean Sea (Fredj. et al., 1992). A total of 10,000 to 12,000 marine species have been recorded and new species are regularly discovered and described. Biomass in the Mediterranean is low, however.

The Mediterranean coastal ecosystems and wetlands provide critical habitat for both flora and fauna species:

- Circa 150 wetland sites have been recognized as being of international importance;
- Extensive sand dunes are located around the Mediterranean;
- Thousands of islands are used by marine and migrating birds, and
- The region is reputed to have 13,000 endemic plants.

The most typical and well-known assemblage of communities is represented by the sea-grass *Posidonia oceanica* ecosystem that develops as extended meadows in the infra-littoral zone (to a depth of 25–40 m) in the whole Mediterranean basin.

There are some other important coastal ecosystems like the calcareous algal rims formed by Lithophyllum lichenoides in the medio-littoral zone; the sea caves which support several rare and endemic species (e.g., sponges and red coral) which are also found in the bathyal zone where the light condition is similar; and the coralligenous communities (circalittoral zone) which constitute the most spectacular underwater scenery in the Mediterranean Sea. On land among others the coastal wetlands and sandy beaches are worth mentioning.

The distribution of species throughout the Mediterranean Sea is not homogeneous: it is greater in the western than in the eastern part, as shown for benthic invertebrates (Figure 1.5). In addition, the distribution of Mediterranean fauna and flora varies with depth as shown in Table 1.1. This diversity is observed also at the community (biocoenosis) level. Compared with the Atlantic, the Mediterranean marine communities are rich in species with smaller individuals having a shorter life cycle.

*Fish*

More than 600 fish species have been recorded, including 81 cartilaginous fish such as sharks and 532 bony fish. The distribution of fish species is not homogeneous, however, as there are double the number of species in the western basin than in the eastern (EEA, 2002).

*Reptiles*

Three turtle species have been identified in the Mediterranean: the leatherback (*Dermochelys*

**Figure 1.5 Seascape Biodiversity Patterns in Benthic Invertebrates** *(Source: Zanatos et al., 2003)*

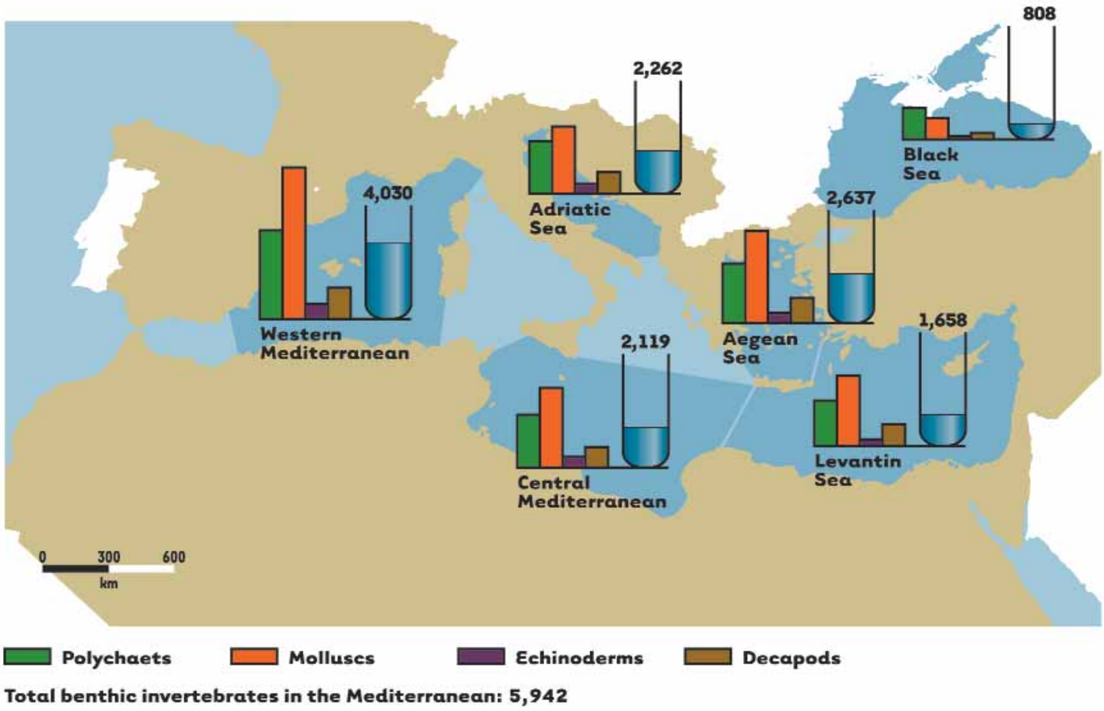



**Table 1.1 Variation of Species according to Depth Zones** *(Source: Fredj et al., 1992)*

| Zones | Depth (m) | Species (%) |
|---|---|---|
| Infralittoral zone | 0–50 | 63 |
| Circalittoral zone | 51–100 | 44 |
| Bathyal zone | 101–150 | 37 |
| Bathyal zone | 151–200 | 31 |
| Bathyal zone | 201–300 | 25 |
| Bathyal zone | 301–500 | 18 |
| Bathyal zone | 501–1,000 | 9 |
| Abyssal zone | 1,001–2,000 | 3 |

*coriacea*), the green (*Chelonia mydas*) and the loggerhead turtle (*Caretta caretta*). Because these turtle populations appear to be genetically isolated from turtle populations in the Atlantic Ocean, the unnaturally high mortality rates resulting from fishing cannot be counterbalanced by immigration (EEA, 2002).

*Birds*

There are 33 breeding colonial waterbird species along the Mediterranean coastline. Wetland loss and habitat degradation are recognised as serious threats for 9 of these species, however (EEA, 2002).

*Mammals*

Twenty-two species of whales have been sighted in the Mediterranean, but only 12 of these species occur regularly. The other 10 are probably not true inhabitants. Nineteen of the cetaceans and seals are listed in Annex II (List of endangered or threatened marine species in the Mediterranean) of the Barcelona Protocol concerning Specially Protected Areas and Biological Diversity (EEA, 2002).

*Threatened Species*

Eighty-nine marine and freshwater species (not including birds) have been identified as threatened under the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean Sea and then revised in the Berne Convention on the Conservation of European wildlife and Natural Habitats. Among the most endangered are the Mediterranean monk seal (*Monachus monachus*), with a total population not exceeding 500 specimens, dolphin species (*Delphinus delphis*, *Tursiops truncatus*, *Stenella coeruleoalba*), sperm whales (*Physeter macrocephalus*) and freshwater and marine turtles (*Chelonia mydas*, *Trionyx triunguis*, *Caretta caretta*). Annex II contains a list of threatened species in the Mediterranean, the reasons for their being threatened and actions being taken to protect them.

#### *1.1.4 Natural resources*

The Mediterranean coastal fringe is a high economic value zone, generating income in terms of tourism, agriculture, industry and fisheries. The region is also characterized by a great gap dividing the rich North from the South, GDP per capita of Mediterranean EU countries being twelve times higher that of their North African counter parts. The region on the whole faces growing problems of water scarcity and degradation of land resources, as a result of anthropogenic activity. Fisheries, another vital resource for the Mediterranean is also driven by over exploitation and unsustainable practices, adding to resource constraints imposed by man on the future of Mediterranean resources.

Although alluvial and coastal plains are few and not extensive (the Nile Delta being far the largest) most coastal plains have demographic and economic importance ranging from agriculture to industry / commerce to recreation to historical / archaeological significance. Most areas still contain partly to little-modified natural ecosystems of irreplaceable value. Because of their ecological fragility, related to the land-use transition and their economic importance, these coastal lowlands are particularly vulnerable to climatic changes that can affect hydrology, sea-level rise and ecosystems. Anthropogenic activities can also affect these areas because of pollution and sediments flows from upstream catchments.

Other resources of the Mediterranean include fossil fuels and raw materials. Libya, Algeria and Egypt are considered moderate-sized petroleum producers; Morocco is the world's third-largest producer of phosphates, Albania the third largest producer of chrome and Spain the second largest producer of mercury.

Finally, it should be pointed out that because of both climate and historical / archaeological significance, the Mediterranean continues to be the greatest tourist destination in the entire world. Conversely, tourism is the greatest consumer / user of the Mediterranean coast and the number of tourists continues increasing. Such a growth will mean an increasing demand for coastal space as well as such necessities as electric power and water. Furthermore, the impact on certain habitats (particularly sandy beaches and dunes) will increase.

## 1.2 Socio-economic Aspects

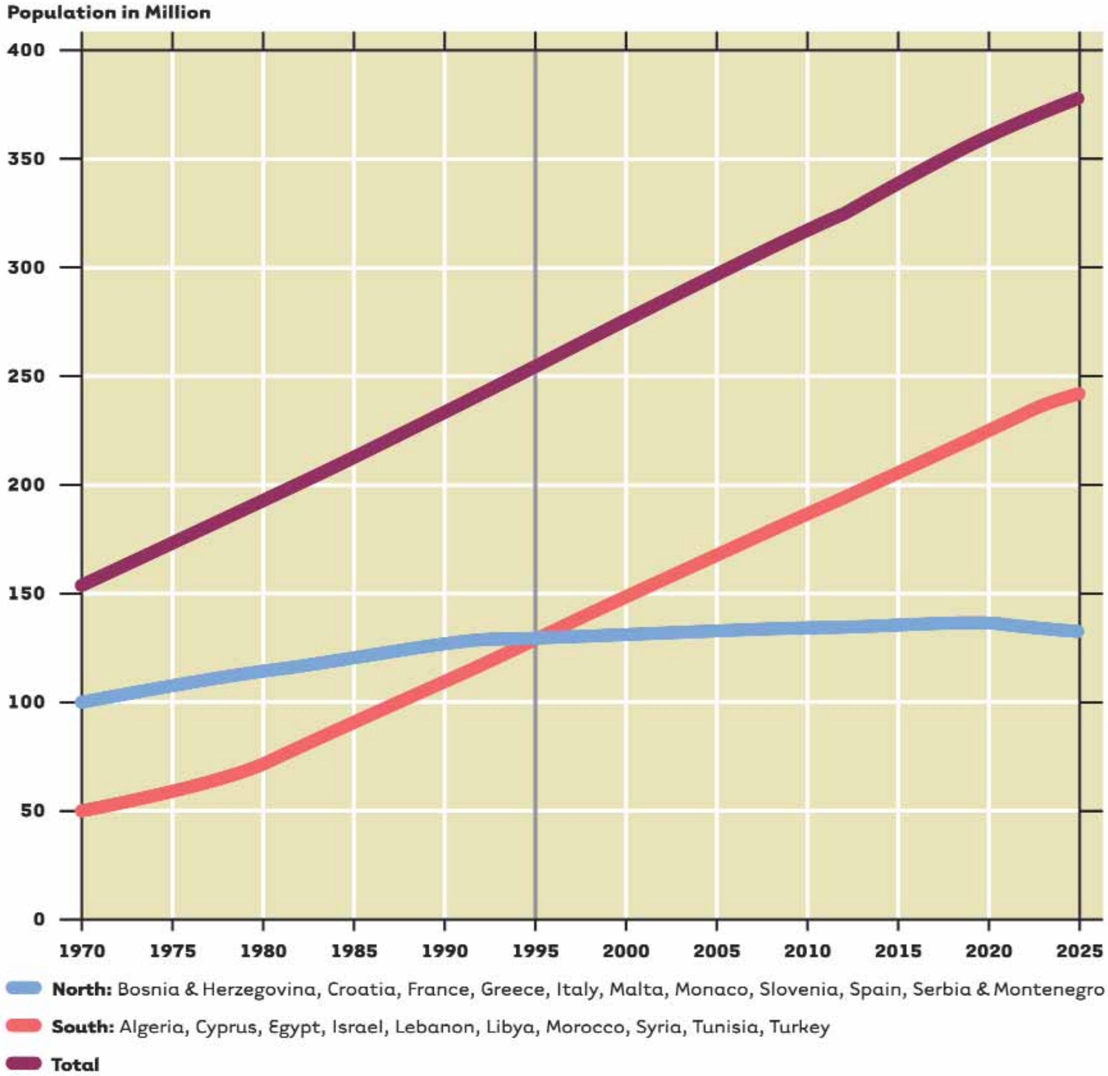
### *1.2.1 Demography and human settlements*

During the past decades, population has grown dramatically in the Mediterranean littoral countries. According to the Blue Plan (http://www.planbleu.org/indexa.htm), total population grew from 285 to 427 million from 1970 to 2000. Recent Blue Plan estimates predict a population of 523.5 million in all of the Mediterranean countries by 2025, indicating a slowing of growth in the coming years. Growth will be very uneven, however, with the EU Mediterranean countries having virtually no population growth and the southern rim countries having growth of 2 to 3 percent per year (Figure 1.6). The southern rim of the Mediterranean now contains more than 50 percent of the total population and this percentage is expected to grow to 75 percent by 2025. These projected demographic changes in the region will have significant effects on the Mediterranean environment, as demand for natural resources will dramatically increase in the south.

Population densities are much greater in coastal than in non-coastal areas, especially in the southern parts of the Mediterranean. In 2000, the combined Mediterranean coastal population was greater than 150 million. The coastal population in the North is expected to remain relatively stable, whereas the coastal population in the South is projected to increase by approximately 30 million people in 25 years. Currently there are great disparities in coastal population densities among the riparian states, with more than 1,000/$km^2$ in the Nile Delta and less than 20/$km^2$ along coastal Libya.

According to the Blue Plan, the urbanisation process is expected to continue in the Mediterranean and it is estimated that by the year 2025 approximately 75 percent of the population will be urban. The economic and environmental burden on cities, therefore, will increase substantially. This urban growth will occur primarily in the southern and eastern countries, how-

*Figure 1.6 Mediterranean Riparian Countries' Population in Cities over 10,000 Inhabitants*
*Population Retrospective and Projection from 1970 to 2025* (Source: Blue Plan, 2000)






ever. In all of the Mediterranean countries, the urban population will grow from 274.5 million in 2000 to 379 million in 2025. Of these 104.5 million new urban dwellers, more than 98 million will be in the South and East (http://www.planbleu.org/indexa.htm).

The wide variation in political and economic systems as well as historic differences have led to great discrepancies in the level of development among Mediterranean countries. The highly developed industrial countries in the North (France, Italy and Spain) and countries on the way to becoming industrialised (Greece, Serbia & Montenegro and Turkey) stand in stark contrast to the countries in the South. There is a great gap dividing the rich North from the South, with GDP per capita of Mediterranean EU countries at levels twelve times higher than those of their North African counterparts. As population continues to grow in the South, developmental discrepancies are expected to continue. Age composition is expected to differ in northern and southern countries in the future. As a result of higher population growth in southern countries in the coming years, population structures will be younger in the South. With this shift will come increasing problems concerning education and job-creation in southern countries.

Human activities pose several threats to the structure and functions of natural ecosystems, to the quality and availability of natural resources (i.e., forests, soil and water) and on the natural and man-made landscape. In particular, coastal areas are facing significant pressures mainly through the over-concentration of population and economic activities in these areas. As the coastal population grows and urbanises, pressures on the Mediterranean resources will continue to increase.

### *1.2.2 Industrial activity and trade*

According to the EEA report on the state and pressure of the marine and coastal Mediterranean environment (EEA, 1999b), the Mediterranean basin has never been a major mining region and thus was not involved in the period of industrial development based on coal and iron. Its heavy metal cycling has been largely affected by the mercury, copper, zinc and lead deposits present in the Pyrictic streap of the Iberian Peninsula, however. The region is better endowed in oil and natural gas (Algeria, Egypt, Libya, Syria and Italy), leading to the establishment of many refineries all around the Mediterranean basin.

Taking into consideration the world's sixteen most important raw materials, the Mediterranean countries' production (in decreasing order) of mercury, phosphates (Tunisia and Jordan), chromite (Turkey), lead, salt, bauxite (Bosnia & Herzegovina, Croatia, France, Greece, Slovenia, Serbia & Montenegro) and zinc (Spain and Morocco) is higher than the world average. Submarine mining in the Mediterranean comprises mainly drilling for oil and gas and dredging of gravel and sand, but this particular type of activity can be considered to be at a relatively early stage of development.

Steel manufacturing, another symbol of industrial development and military power, is concentrated in the North (Italy, France, Spain, Turkey and Greece) with a few producers in the south (Egypt, Algeria and Tunisia).

Generally, to date, the gap in industrial development between the northern and southeastern sides of the basin remains considerable. In terms of added value, within the Mediterranean basin proper Italy, France and Spain together are predominant with 87 percent more than the rest of the Mediterranean countries.

Apart from the chemical / petrochemical and metallurgy sectors, the other main industrial sectors include: waste treatment plants, paper, paints, plastics, dyeing and printing and tanneries.

*Distribution of industrial activities:*

Production activities occurring all over the Mediterranean basin can be differentiated by the different export specialisation for each country. In that respect, we can easily distinguish three groups of countries:

- The first group is highly specialised in some export products, while the rest of the commodities are being imported. This is the typical situation for oil producing countries such as Algeria, Syria, Egypt and Libya. The current status does not give any sign of change in the short term for the export trends, in spite of some exceptions like Egypt, which shows a certain diversification with some increase in the production and export of manufactured goods (textiles, shoes, etc.);
- The second group is less specialised in exporting goods even in a situation of comparative disadvantage with other countries. Thus, their exports are more diversified. This is the case for countries like Tunisia, Morocco, Turkey, Croatia, Serbia & Montenegro, Cyprus and Malta. All these countries export manufactured goods such as clothes, textiles and leather, but each one has more specific productions (chemicals, oils and lubricants in Tunisia; chemicals and fertilisers in Morocco; textile fibres, wool, cotton, paper, cement in Croatia, Turkey and Serbia & Montenegro);
- The third group is more diversified and thus much less specialised. It mainly comprises the EU Member States. As mentioned earlier, they account for the largest part of the petrochemical industry in the Mediterranean. Located fully in the Mediterranean basin, Italian industry is certainly the largest, with basic manufactured goods, machines, transport equipments, etc.

In terms of the environmental impacts of industrial activities in the Mediterranean marine environment, industry, besides occupying land area, may also use the territory to dispose of solid wastes, for example in the form of landfills. This is particularly true of mining since it often involves the dumping of mine tailings and ore slurry on land, into rivers or to the sea directly. It may also include the ash from processes such as steel making.

### *1.2.3 Agriculture and Fisheries*

Scarcity of irrigation water, already experienced in the arid and semi-arid countries of the Mediterranean is expected to become an ever more pressing concern for Mediterranean agriculture in the near future. In most of those countries with an erratic rainfall pattern, many of the available sources of water, which can be used for economic activities, have already been developed or are currently in the process of development. For example, of the 12 southern and eastern Mediterranean countries, the Blue Plan estimates that eight are now using annually more than 50 percent of their renewable water sources; two of them (the Palestinian territories and Libya) are already using more than their renewable water sources. By the year 2025 the Blue Plan estimates that eight of the 12 countries may be consuming more than the total of their renewable water sources. About 70 percent of Mediterranean water is used for agriculture.

Recent intensification of agricultural techniques in the Mediterranean has reinforced the long-term trend of desertification occurring in the region. The Mediterranean soils are an example of extreme degradation resulting from centuries of human use. Once ubiquitous forests were lost to grazing and animal husbandry, agriculture, forest cutting for timber and were thus slowly changed irreversibly over the course of thousands of years. Habitat conversion begun in the Middle East at least 9,000 years ago, resulting gradually in a loss of tree cover, drying up of streams, increasing local temperatures and erosion. Today about half of Mediterranean lands are subject to the risk of erosion. This long-term trend has been accentuated by modern agricultural methods of monocultural intensive cultivation, intensive tilling and excess watering.

The Mediterranean has highly prized demersal fish, crustaceans and molluscs. Although there are difficulties in obtaining accurate fishing statistics, changes in biodiversity among the dominant Mediterranean fish species appear to result from a combination of overexploitation of fisheries resources and coastal pollution (Caddy, 1993). Technological improvements in the fishing fleet and increased fishing capabilities ultimately resulted in a decline in the catch rate per boat (Caddy, 1993). By the 1970s, a substantial proportion of the less productive southern shelves were being harvested, including by distant-water trawlers, resulting in the harvesting of demersal resources at close to maximum sustainable yield.

### *1.2.4 Tourism*

The Mediterranean Basin is considered to be the most important tourism destination globally, attracting a third of the world's tourists. Domestic tourism has great significance for the region; of the 450 million visitors, 100 million stay on the Mediterranean coast of their host country, considerably increasing human concentration. This figure is likely to double if not triple by 2025, entailing the risk of overload-based depreciation of the tourist capital represented by this activity which is seen as vital to most countries in the region as a source of hard currency and an essential development factor for southern countries.

Tourism growth is not equally distributed among Mediterranean countries. The significance of tourism development in Mediterranean member states of the EU is higher in comparison to the rest of the Union. France, Spain, Italy and Greece remain by far the most popular destinations for international tourism. Although the traditional countries in the North today monopolize 4/5 of international tourism, a certain degree of disenchantment with over–urbanized coasts is likely to benefit the wilder hinterland and the as yet virgin coasts of southern countries. There is no doubt that this could act as a potential rebalancing factor between the two banks of the Mediterranean.

Tourism is regarded as a prevailing economic sector for the Mediterranean region. More than six million people are employed directly or indirectly in the tourism industry with forecasts showing an increase of two million by 2010. Also, tourism is currently the first foreign currency source for the Mediterranean countries and its direct and indirect contribution to Gross National Product can reach 29 percent (Cyprus) or 35 percent (Malta).

Such a growth will mean an increasing demand for coastal space as well as such commodities as electric power and water. Furthermore, the impact on certain habitats (particularly sandy beaches and dunes) will also increase. However, the economic importance of tourism for the Mediterranean is such that no riparian countries can do without this sector.

# 2

# 2.0 MAJOR ENVIRONMENTAL CONCERNS

One of the primary steps to be taken in a Transboundary Diagnostic Analysis is the identification of major perceived problems and issues (MPPIs), also known as major environmental concerns. These MPPIs represent the dominant issues of concern to the stakeholders involved in the TDA. MPPIs are supposed to reflect concerns and issues, but sometimes can be primary causes or root causes. In addition, MPPIs may sometimes be environmental effects arising from some basis problem. The MPPIs find their use in cogently expressing the major issues faced by stakeholders.

Although they may lack a full scientific basis, the MPPIs provide a stepping stone for further, in-depth analysis of their scientific underpinnings. If the MPPIs are supported by available scientific inquiry, then they may lead logically to the identification of Environmental Quality Objectives (EQOs). Once the EQOs and their related concrete targets are identified and adopted, the EQOs then lead logically to interventions for the future, to help achieve the targets within the adopted timeframe.

The MPPIs for the Mediterranean Sea TDA were developed through the years, as part of meetings held in support of the Mediterranean Action Plan. This TDA identifies four priority MPPIs:

- Decline of biodiversity
- Decline in fisheries
- Decline in seawater quality
- Human health risks

Human health risks are an overarching issue, with some items overlapping with the other MPPIs. In this section, the TDA addresses the environmental issues that contribute to human health risk. Clear overlap can be seen in that Toxic Algal Blooms, an indicator of both decline in biodiversity and decline in seawater quality, can lead to human health risks (e.g., Paralytic Shellfish Poisoning, Diarrheic Shellfish Poisoning, etc.). Similarly, decline in seawater quality arising from introduction of organochlorine pollutants could also adversely affect human health, as well as cause decline of biodiversity. In spite of these overlaps, the four MPPIs are addressed below.

## 2.1 Decline of Biodiversity

This section surveys the sensitivity and changes in biodiversity and coastal ecosystems as a response to man-induced changes and pollution in the Mediterranean. There is a perception that biodiversity has decreased in the Mediterranean Sea, although this topic is hotly debated. From a species perspective, there is no evidence of the loss of a single species in the Mediterranean Sea, whereas invasionary species contribute to add to the species list in the Sea, largely due to the Lessesspian migration through the Suez Canal. A visible loss of a flagship species has been the drastic reduction in the occurrence of dolphins (*Tursiops truncatus*) off the coast of the North-West Adriatic, which is probably due to the changes in organoleptic characteristics (colour, odour and taste) and the loss of transparency caused by eutrophy. Once common even in the waters close to the shore, presently they can only be encountered (although sometimes in large numbers) over 10–20 miles from the coast. From a habitat perspective, there is no doubt that there is loss of biodiversity. Contraction of seagrass meadows (e.g., *Posidonia* and eelgrass meadows) has been documented, and valuable coastal landforms have been lost due to development, reclamation, and other similar activities. From a genetic perspective, there are inadequate data to make a judgment on the loss of genetic biodiversity. Therefore, the greatest argument for loss of biodiversity would seem to rely on the loss and / or alteration of valuable habitats.

Diversity of marine life in the Mediterranean is high and is also largely confined within this basin making for a relatively high rate of endemism on a global level. Out of the total of 10,000 to 12,000 marine species registered for the Mediterranean Sea, 20–30 percent are assessed to be endemic, representing two to three percent of world seas' species richness. This genetic richness arising largely from the Mediterranean position between two major oceans, the Atlantic and the Indo Pacific, and the intermixing of their species is under increasing pressure from man-induced impacts. This intermixing has led to what are known as invasionary species, primarily through the Suez Canal since its opening in 1869; however, from this perspective, many species are invasionary as this migration into the Mediterranean Seas has been ongoing since the basin filled following the latest glaciation.

Although no species are known to have disappeared from the Mediterranean as a result of human activity, the status of some species is of great concern. A list of 89 marine and freshwater species (not including birds) has been established under the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean Sea and then revised in the Berne Convention on the Conservation of European Wildlife and Natural Habitats. A "red book" published in 1990 identifies a variety of species at risk in the Mediterranean.

Among the species most endangered and threatened by extinction are the Mediterranean monk seal (*Monachus monachus*), with a total population not exceeding 500 specimens, dolphin species (*Delphinus delphis*, *Tursiops truncatus*, *Stenella coeruleoalba*), sperm whales (*Physeter macrocephalus*), and freshwater and marine turtles (*Chelonia mydas*, *Trionyx triunguis*, *Caretta caretta*).

High competition for land use on the coastal fringe is forcing critical habitats to decline. Tourism, urban development, agricultural, fisheries and industrial expansion are some of the pressures faced by both marine and terrestrial coastal habitats.

The preservation of critical habitats, seagrass belts and coralligenous communities for instance, is critical for biodiversity. They serve as nursery grounds for many fish, molluscs, crustaceans, as well as habitats throughout species' life span. Nonetheless, their status is declining as a result of pollution from municipal and industrial waste as well as fishing disturbance, and in some cases, such as that of *Posidonia* meadows, they are known to have disappeared completely in certain areas. Besides *Posidonia* meadows, the most critically threatened marine habitats are *Lithophyllum lichenoides* rims and the Coralligenous communities. Some eelgrass beds (*Zostera marina*) are also at risk.

Similar concerns arise on wetlands whose capacity to provide a host of environmental services with considerable economic as well as ecological value is being eroded. Coastal wetlands have mainly been subjected to conversion to other uses leading to large losses in size and environmental degradation. Coastal wetlands are also adversely affected by aquifer mismanagement, pollution, land reclamation and diversions and loss of river flows.

Pressures exerted on Mediterranean biodiversity and coastal ecosystems can be put in the following categories:

- Overexploitation of living marine resources;
- Conversion and degradation of critical habitats;
- Introduction of alien species;
- Pollution in the form of excess nutrients; toxic waste, including oil; solid waste and litter; and
- Use of non-selective fishery gears.

### *2.1.1 Transboundary elements*

Transboundary elements of the degradation of coastal habitats and decline of biodiversity arise because of combinations of the following factors:

- Marine living resources are often migratory;
- Coastal habitats provide nursery and feeding grounds for migratory species;
- Degradation of coastal habitats contributes to overall decline of regional and global biodiversity;
- Sustainability of marine and coastal habitats depends on the integrity of the interlinked ecosystems that support trophic levels in the food chain; and
- Ecosystems are inherently transboundary in nature.

Thus, modification of habitats in some coastal areas may have basin-wide impacts due to their importance as nurseries. Eutrophication in key areas may have transboundary impacts by serving as a "source" for nuisance species (jellyfish, toxic algae and their cysts) that may spread in basin-wide currents into adjacent parts of the Mediterranean. What may appear to be merely a local action (eutrophication) may in fact have transboundary consequences.

### *2.1.2 Environmental impacts*

Casual chain analysis is used to determine the environmental impacts of the MPPIs. Figure 2.1.1 is the casual chain for Decline in Biodiversity. As the figure indicates, the environmental impacts are many and varied.

- Disruption of important biocenoses;
- Change in structure of marine communities
- Reduction of fin- and shell-fisheries;
- Decline in function and quality of critical seabed habitats, particularly nearshore;
- Ripple effects through food web as primary producers on up decline;
- Loss of unique global biodiversity resources (e.g., seagrass meadows, coralline habitat);
- Possible loss of forage, nesting, and / or resting areas for migratory species such as birds (cranes, birds of prey, etc.) and marine mammals (e.g., dolphins) and reptiles (including the three endangered turtle species); and
- Possible loss of unique wetlands habitats along critical semi-tropical zones.

### 2.1.3 Socio economic impacts

The degradation of biodiversity and coastal ecosystems leads to a host of adverse socio-economic impacts linked to the tourism and fisheries sectors. Increasing pollution of the land and marine coastal fringe, where most of the biodiversity is found, leads to the degradation of interdependent breeding habitats of marine organisms. For example, a reduction in seagrass cover can reduce fish spawning, leading to reduction in artisanal catches that may be a significant component of local economies. Some of the most important impacts are mentioned below:

- Loss of high value ecological services linked to loss and degradation of coastal wetlands.

An evaluation of the economic value of wetlands reveals that these habitats provide the overwhelming share of ecological services, compared to inland ecosystems.

The report prepared by Costanza (1997) in the framework of the European Demonstration Programme on the Assessment of the socio-economic costs and benefits of Integrated Coastal Zone Management is of relevance here as it focuses mainly on Mediterranean type of ecosystems.

According to Costanza (1997), wetlands produce nearly 75 percent of the ecosystem services, while inland ecosystems provide the remaining 25 percent. Estuaries, areas of the continental shelf and tidal marshes are included as wetlands in the report.

Although the above estimate refers to Europe rather than the Mediterranean, it is a relevant indication of the order of magnitude of economic value of wetlands.

Additional socio-economic impacts arise out of a combination of the following:

- Reduction of critical fish habitats and decline in fisheries population with subsequent income decline from fisheries;
- Changes in the employment with a shift away from fisheries;
- Loss of aesthetic value;
- Loss of income from the tourism industry;
- Loss of cultural heritage.

### 2.1.4 Causal Chain Analysis

The causes of decline in biodiversity are indicated in the Causal Chain Analysis (CCA) in Figure 2.1.1. Generally, the causal chain identifies primary causes, and ultimately addresses root causes (the level at which sustainable interventions are normally encouraged).

The primary causes of decline in biodiversity are:

- Excess supply of nutrients;
- Overexploitation of living marine resources;
- Threat to non-target species taken in by-catches;
- Threat to the fisheries' target populations due to over-fishing and large kills of juveniles;
- Competing land uses and intense river and aquifer management: degradation and conversion of critical habitats;
- Pollution;
- Introduction of alien or cultured species;
- Solid waste disposal in sea.

Important root causes include:

- Low awareness of farmers and other stakeholders;
- Lack of control of fishing effort and gear;
- Lack of investment in wastewater treatment;
- Inadequate ship ballast water control;
- Insufficient solid waste management Best Available Practice;
- Inadequate implementation of international Conventions and Agreements.

### 2.1.5 Supporting data

The section below surveys the main concerns on Mediterranean biodiversity by looking at threats facing living marine resources and critical habitats. It also presents supporting data on causes of concern focusing on eutrophication, chemical contaminants, oil pollution, introduction and invasion of alien species and solid waste and litter. The supporting data come from dozens of studies performed under the Mediterranean Action Plan, and the general literature. Special studies on marine turtles, jellyfish blooms,

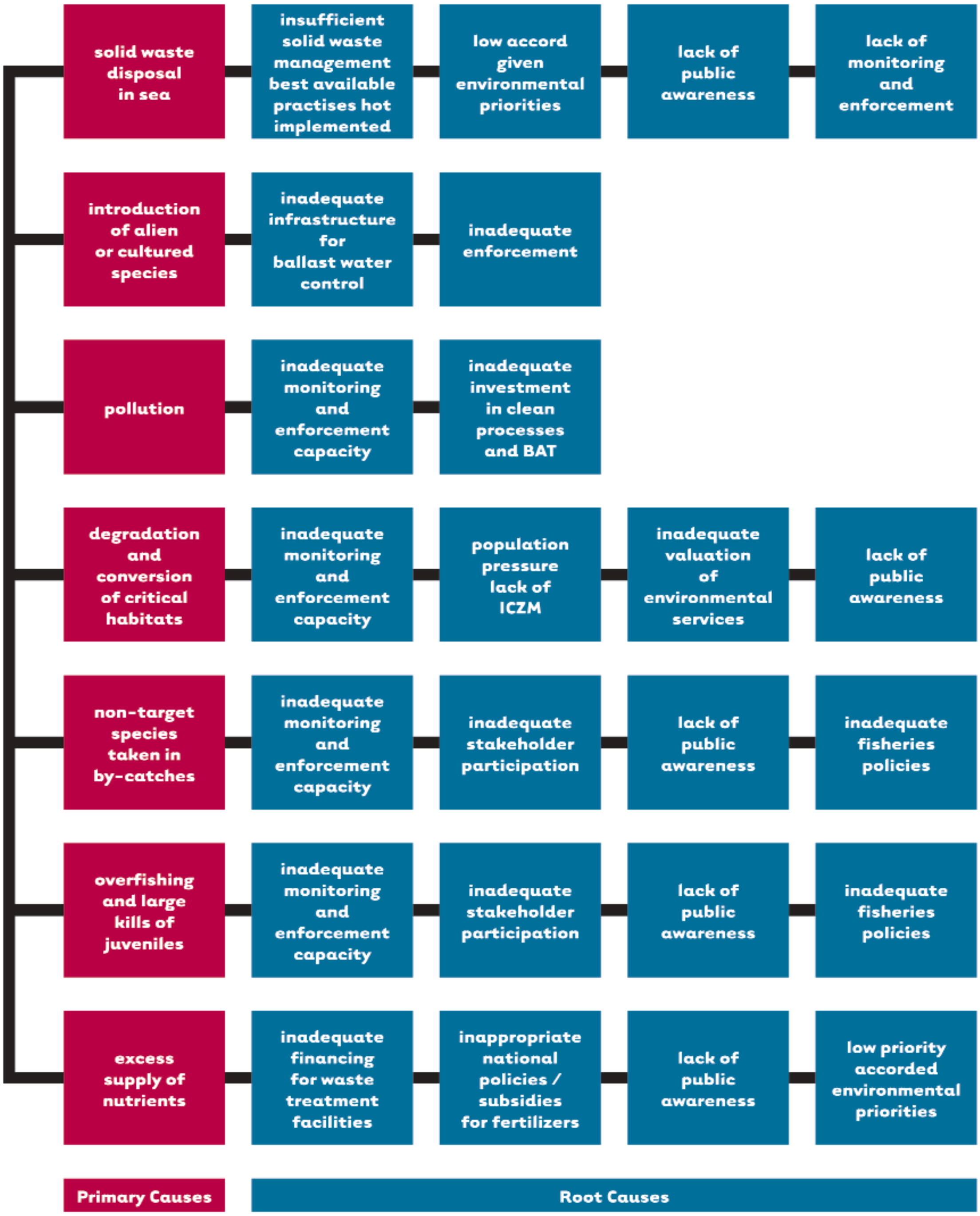
***Figure 2.1.1 Causal Chain Analysis: MPPI 1: Decline of Biodiversity***

**Environmental Impacts:**

- Disruption of biocenoses
- Change in structure of marine communities
- Reduction of fin- and shell-fisheries
- Decline in critical seabed habitats
- Ripple effects through food web
- Loss of unique global biodiversity resources
- Loss of forage, nesting, and / or resting areas for migratory species
- Possible loss of unique wetlands habitats

**Socio-economic Impacts:**

- Loss of high value ecological services from wetlands
- Income decline from fisheries
- Changes in the employment with a shift away from fisheries
- Loss of aesthetic value
- Loss of income from the tourism industry
- Loss of cultural heritage



land-based and airborne pollution, eutrophication, marine organic pollutants, and many national reports contribute to this summary section.

*2.1.5.1 Exploitation of living marine resources*

The fact that fishing grounds usually are quite close to the coast where the highest biodiversity is located results in strong impacts of fishing activities on biodiversity. The two major threats that stem from fishing are direct damage to biodiversity and damage to essential habitats.

The widespread use of small mesh fishing gear as well as excessive fishing of commercial species are the foremost means by which biodiversity is damaged. Although no data seem to indicate that any fishery resource is under threat of collapse, it is widely acknowledged that overfishing has taken place in the Mediterranean for a long time. Red coral (*Corallium rubrum*) in the western Mediterranean for instance is heavily over-exploited, as are also some edible bivalve species such as *Lithophaga lithophaga*.

Moreover, the negative impact of overexploitation of marine resources is also felt on many non-target fishery populations. High conservation priority species such as marine turtles, the Mediterranean monk seal, and marine mammals fall prey to by-catch due to lack of selective fishing gear.

As far as by-catch of protected species is concerned, conservation of the few remaining monk seals is of major importance. Protection of turtles and seabirds from longlining may in some cases be of special concern. Cetacean by-catch will be of less importance following the recent ban of driftnets, although action at the international level would be beneficial to extend the protection to all Mediterranean fisheries. However, the interaction between cetaceans and fishing activities beyond the by-catch phenomenon is a problem of growing concern that deserves careful consideration. In addition, overfishing reduces the food base on which sea mammals on higher levels of the food chain depend on for their survival.

*2.1.5.2 Degradation and conversion of critical habitats*

*a. Seagrass meadows and coralligenous habitats*

Threats to seagrass meadows, a typical type of habitat in the Mediterranean, are well recorded. The integrity of this basic habitat found primarily in coastal areas is of high priority, not least because seagrasses support high levels of marine productivity. In fact some seagrass meadows qualify as critical habitats and their status is viewed as a major biological indicator of the state of the water quality.

*Posidonia oceanica* meadows, whose loss is irreversible on a human life timescale, are a red flag for conservation efforts in the Mediterranean. In the last 50 years, there has been a major regression of *Posidonia oceanica* meadows all around the Mediterranean basin mainly due to human-induced changes to the coastal zone.

As far as damage to habitats is concerned, there is a need to protect seagrass beds (Phanerogams such as *Posidonia sp.*, *Zoostera spp.* and *Cymodocea sp.*), ham mussel beds, deep water white corals and hard bottom biocenosis in coastal areas, irrespective of depth, from the effects of trawling, dredging and similar activities. Often rigged with chains or other rock-hopper devices, these fishing devices have been identified as a main cause of both the decline of shallow seagrass meadows and deterioration of communities living on rocky bottom surfaces. *Posidonia oceanica* seagrass meadows for instance are in regression partly as a result of mooring of boats and trawling connected to fishing activities.

The impact of dredge fishing for bivalves must also be controlled since it may reduce the capacity of soft bottoms to maintain diversity in benthos.

Besides seagrass habitats, coralligenous communities are also high conservation priority marine organisms. Plants and animals, many of which are unique to the Mediterranean, thrive around these spectacular formations. Man-induced pressures linked to collection of red coral, anchoring of boats on coral grounds and trawling are subjecting coralligenous habitats to decline and degradation. High-impact harvesting techniques such as the St Andrews' cross for red coral (*Corallium rubrum*) or the exploitation of European date mussel (*Lithophaga lithophaga*) and common piddock (*Pholas dactylus*) by destroying the rocks inhabited by these bivalves have long been forbidden, but there are indications that the prohibition is not well enforced. Furthermore, there are warning signals that the illegal use of explosives and poisoning is still taking place.

Critical coastal habitats are particularly damaged around big cities. Coastal structures related to expansion of human settlement inevitably affect ecological processes and lead to a definite elimination of breeding areas, to destruction of habitats and to loss of biotopes. Sea defence measures, land reclamation, industrial and harbour installations, dredging or extraction of sediments, disposal of wastes and dredged material, recreational activities, military activities and aquaculture operations all tend to concentrate around big cities. Consequently, the shrinkage of critical habitats such as *Posidonia* meadows has been particularly strong around large industrial harbours like Athens, Naples, Genoa, Marseille, Barcelona, Algiers and the Gulf of Gabès.

*b. Wetlands and lagoons*

Although engineering works clearly cause decline of wetlands and biodiversity, lack of data prevents us from quantifying the magnitude of this man-induced impact. Wetlands are lost to a variety of man-induced changes in the land use of coastal areas. Lagoons, marshes, lakes, temporary pools, river estuaries, channels and coastal forests that shelter a rich and diversified flora and fauna have been subjected to landfilling, drainage and conversion to agriculture, urban settings and other uses. The effect of the loss and degradation of wetlands has been identified as a serious threat to nine out of the 33 breeding colonial water bird species found along the Mediterranean coastline.

Yet data on the actual state of Mediterranean wetlands are lacking. In 1995, within the framework of the European MedWet 1 project, an analysis of the existing wetland inventories in the Mediterranean was published. The study showed that detailed inventories had been completed for only five of the 22 countries reviewed and that for the majority there were lists only of some of the most important wetlands. Generally, there has been little standardization of the data collected and the results between countries are therefore difficult to compare.

In connection with wetlands, lagoons represent another important and specific habitat for a number of species. They make up approximately 40 percent of the non-rocky Mediterranean shoreline. In Mediterranean Europe as a whole, they account for some 850,000 hectares. As wetlands, many of them have been strongly impacted by human development since numerous commercial activities depend on them.

Intensified river watershed management through dams also has a great impact on coastal wetlands and aquifers that feed off their flows. The Aswan High Dam illustrates clearly the downstream impacts of a change in the upstream uses of a river. A reduction of silt load carried to the Nile Delta as a result of the dam has led to increased erosion of the deltaic coast affecting the sand bars in front of Manzalla and Burullus lagoons that now face the risk of opening to the Sea. Consequently, the deltaic lagoons harbouring great concentrations of species are threatened by seawater invasion and disturbance of the delicate ecological balance. As a result of changes in water mass movement, water level, salinity and temperature attributed to reduced silt deposit, the lagoon may become unsuitable for breeding and spawning purposes in the future.

Coastal wetlands are also adversely affected by aquifer mismanagement, thereby threatening the biodiversity dependent on them. The threats to wetlands from aquifer mismanagement are twofold. First, overuse of aquifers can result in the drying up of wetlands dependent upon them. The seepage from the coastal aquifers, estimated to be 13 billion $m^3$/yr in the UNEP/Blue Plan (http://www.planbleu.org/), accounts for about one quarter of the total freshwater inflow into the Mediterranean. Second, wetlands are degraded by the saline intrusion that occurs when coastal aquifers are over-exploited and from the pollutants introduced into the aquifers. The coastal seepage and submarine discharges are critical to the water balance and seawater quality in the marine subbasins and support wetlands and brackish water habitats with biodiversity and fishery nursery areas in the coastal zones. The karstic aquifers in particular are vulnerable to saline intrusion and surface pollution, especially in the open karst systems exposed to human-induced groundwater pollution. The seepage freshwater discharges from karstic coastal aquifers dominating large sections of the southern Mediterranean and the eastern Adriatic coasts are vulnerable to and transport agricultural-based nutrients, chemical and other pollutants into the sea, thereby degrading critical wetland habitats. Additionally, the underground karstic aquifer systems themselves form habitats for unique and threatened karst biodiversity and degradation of this habitat is a threat to biodiversity.

The drying up of coastal wetlands and coastal development result in the fragmentation of habitats. Once a habitat becomes fragmented as a result of coastal development, ecosystem processes are disrupted. This type of man-induced impact damages biodiversity by inducing inbreeding, which reduces the gene flow and therefore genetic variability.

To better understand the negative consequences of inbreeding on fitness and growth rates, levels of genetic diversity have been studied in transplants in a common location. Shoots collected in populations with higher genetic polymorphism showed higher survival and growth rates, suggesting that when genetic variability of donor populations is high, fitness is also high.

Habitat fragmentation and the associated risk of inbreeding is a particularly serious problem when it affects critical habitats such as the *Posidonia* meadows. Populations of *Posidonia oceanica*, for instance, are being sampled along the coasts of the entire Mediterranean basin and analysed with the help of DNA microsatellite markers. First results obtained along a latitudinal gradient in the Thyrrenian Sea suggested that overall genetic variability is low. Recent results, referring to more than 500 individual shoots sampled in several populations within the Western Mediterranean Basin confirmed low levels of genetic variability. Low genetic variability was found particularly within the North Adriatic where a population was reported to be completely uniclonal.

Recreational activity may interfere with the natural functioning of the coastal zone as a habitat. Through recurrent disturbance, specific areas may become unsuitable for the breeding, resting or feeding of marine organisms. Disturbances during critical periods of this kind can reduce the viability of the animal population concerned by lowering reproductive success and by increasing mortality. Since coastal tourism is highly developed in the Mediterranean, the main tourist season and its different activities probably have a significant impact on species using sand beaches or rocky shores. Endangered Mediterranean animals like turtles or the monk seal or marine mammals are subject to anthropogenic disturbance from the noise generated by speedboats. As an additional example, the development of tourist resorts on sandy beaches has frequently resulted in the restriction of space available for the reproduction of sea turtles, including those under strict protection status (green and loggerhead turtles, for instance).

The Mediterranean countries, in the framework of the implementation of the Specially Protected Area and Biodiversity Protocol, have identified a list of Specially Protected Areas of Mediterranean Importance (SPAMI, Figure 2.1) having special biodiversity concerns. At a subregional level, France, Italy and Monaco (Accord RAMOGE) set up a sanctuary for the protection of Cetaceans as shown in Figure 2.2.

*Figure 2.1 SPAMI in the Mediterranean*


1 Isla de Alboran
2 Levante de Almeria
3 Cabo de Gata-Nijar
4 Mar Menor and Murcia
5 Cap de Cresus
6 Islas Medas
7 Islas Coulembretes
8 Port-Cros
9 The Kneiss Islands
10 La Galite
11 The Zembra and Zembretta
12 The French-Italian-Monegasque Sanctuary

*Figure 2.2 Sanctuaries for Cetaceans in the Mediterranean*


### *Case Study*

**The Thau Lagoon, France: The need for sustainable shellfish farming** *(Source: Deslous-Paoli, 1993)*

The Thau Lagoon is one case study of particular interest. Almost all the typical human activities associated with lagoons are encountered here. Its natural productivity sustains commercial shellfish farming (an estimated standing stock of 35,000 tonnes with an annual production of 15,000 tonnes per year) and fish farming (40 tonnes per year), as well as commercial and recreational fishing of both fish and shells.

This shallow (< 10 m) ecosystem is sensitive to numerous inputs, both natural and anthropogenic, as well as climatic variation. At the turn of the century, when agriculture was not an important factor in the region, morphology and bathymetry were the sole determinants of nutrients' state in the lagoon. The first oyster farms appeared between 1911 and 1915. Since 1945, the increase in shell farming (700 commercial concessions) and additional human activities on the lagoon's shore led to a significant enrichment of the bottom sediments by the 1960s despite good management of the river Herault. This enrichment probably caused the strong anoxia of the 1970s that drastically affected shellfish farming and fishing in the lagoon. More enlightened development since the early 1970s and a lagoonal cleanup programme initiated in 1974 have slowly had a positive effect on the lagoon in spite of the simultaneous expansion of shellfish farming in the region. Today, the lagoon still contains high levels of silt originating from both deep water (where organic matter accumulated) and from shellfish farming which together fertilize the sediments and favours *Zostera* and macrophyte growth. This in turn probably reduces eutrophication.

The hydrodynamics of the lagoon depend on the prevalent winds, but water circulation can be strongly retarded by the shellfish farming structures that are a common feature of the area. However, water circulation between these structures (e.g., oyster tables, partitioning corridors) is of major importance for the balanced operation of this ecosystem. If filter feeders take up more particulate matters than they release (biodeposition), then regeneration processes result in the export of large quantities of organic matter to partitioning corridors. This localized enrichment can create the highest levels of phytoplanktonic productivity observed in the lagoon and the resulting production partly sustains shellfish farming needs. However, shellfish farming needs could not be sustained throughout the year without some additional exogenous source of nutrient supply. Because of this, the circulation of the lagoon as a whole plays a role in shellfish production. These exchanges occur continually except during the summer. During this season, shellfish farming needs are so important that they result in the depletion of phytoplankton inside the farming structures themselves, despite supply from outside. It is therefore also important to quantify the standing stock of dissolved organic matter and identify its role in initiating localized regenerated primary production.

Further studies will focus on the assessment of marine waters nearby in order to better understand the linkages between the lagoon and its neighbouring ecosystems, as well as evaluating the downstream socio-economic consequences of possible ecological degradation of the lagoonal system.

2.1.5.3 *Pollution*

*a. Nutrient enrichment and eutrophication*

Eutrophic waters or waters where there is abundant food (nutrients) are a major environmental concern particularly for areas close to big cities, industrial agglomerations and river deltas. Joint UNEP/FAO/WHO reviews (1996b) have identified nutrient discharge and eutrophication as a serious source of environmental degradation for Mediterranean ecosystems due to the common practice of untreated or partially treated urban sewage discharge and leaching from fertilised agricultural areas. This referenced source provides more detail on much of the material presented below.

However, the 1996 UNEP/FAO/WHO review indicated that eutrophication is primarily a problem of coastal waters. The overall input of nitrogen to the Mediterranean Sea (about 1.5 to 4.5 million tonnes per year), and of phosphorous (about 0.1 to 0.4 million tonnes per year), are quite low compared to other seas, such as the adjacent Black Sea. These inputs result in supply of about 1.5 $g/m^2$ of Nitrogen on a basin-average, and about 0.15 $g/m^2$ of Phosphorus. These values are low compared to many coastal seas but comparable to open areas such as the North Atlantic Ocean. Section 2.3.6.2 of this document discusses in greater detail the causes of eutrophication in the Mediterranean and its effect on seawater qaulity.

The transboundary aspects of eutrophication relate primarily to its effects on biodiversity. An excess of nutrients in the water gives rise to a complex chain of reactions that disrupt aquatic ecosystems. Under eutrophication, long-living (and slow-growing) plants that are important for biodiversity (and support diversified fauna) do less well and are outcompeted by fast growing opportunistic species. *Macrophytes* such as *Cystoseira spp.*, *Dictyota spp.*, and *Halymenia spp.*, for instance, are seen to decline in the Mediterranean and are replaced by short-lived nuisance algal species.

Among the most serious consequences of eutrophication for biodiversity are algal blooms or red tides. These red tides caused by several species of microscopic plant-like cells or phytoplankton that produce potent chemical toxins result in fish kills and contamination of shellfish. Red tide populations well below the fish kill level pose a serious problem for public health through shellfish contamination. Bivalve shellfish, especially oysters, clams and coquinas can accumulate so many toxins that they become toxic to humans. Fish exposed to lower (sublethal) concentrations are also vulnerable to red tides, as they may accumulate toxins in their body. Current research suggests that such bioaccumulation in fish eaten by dolphins may be responsible for high mortality rates among dolphins.

For marine animal and plant communities, oxygen depletion that sometimes accompanies eutrophication may be fatal. Eutrophication triggers two biological processes that bring about an increase in the demand for oxygen. First, the growth of algal populations means less light permeates bottom layers. Second, when algal blooms die out, their carbon is exported to the bottom where decay processes strip oxygen from the water. Taken together, these changes reduce oxygen levels, which in turn make aquatic life impossible in extreme cases. In the Mediterranean, many instances of fish and shellfish kills have been recorded, as these species are the first to be affected by oxygen limitation (see Table 2.1 and Figure 2.3).

Eutrophication has already led to the disappearance of species in disturbed areas of the Mediterranean. Benthic communities are among the first to disappear under heavy stress conditions. Their bioturbating activities are of considerable importance for the benthic ecosystem and hence their loss is a liability to the ecosystem as a whole. In undisturbed areas in the eastern Mediterranean, benthic communities present high species diversity consisting of polychaetes (50–65 percent), molluscs (15–25 percent), crustaceans (10–20 percent), echinoderms (5–8 percent), and miscellaneous taxa. By contrast, in areas ranging from heavily disturbed (e.g., sewage outfall vicinity) to polluted (e.g., urbanized bay), echinoderms, crustaceans and miscellaneous taxa largely disappear, while a small number of polychaetes species account for 70–90 percent of the total abundance. The same applies to the western Mediterranean communities, where increasing disturbance also leads to reduction in species richness.

When organic enrichment and / or balance effects exceed the potential for remineralisation by benthic organisms, anoxic zones are created and bacterial mats cover the seabed. Although this type of ecosystem change is in general reversible, there could be severe and long-lasting consequences when the affected seabed is a critical habitat like the meadows of the seagrass *Posidonia oceanica*.

***Figure 2.3 Areal Mapping of Trophic Conditions of the Adriatic Sea***

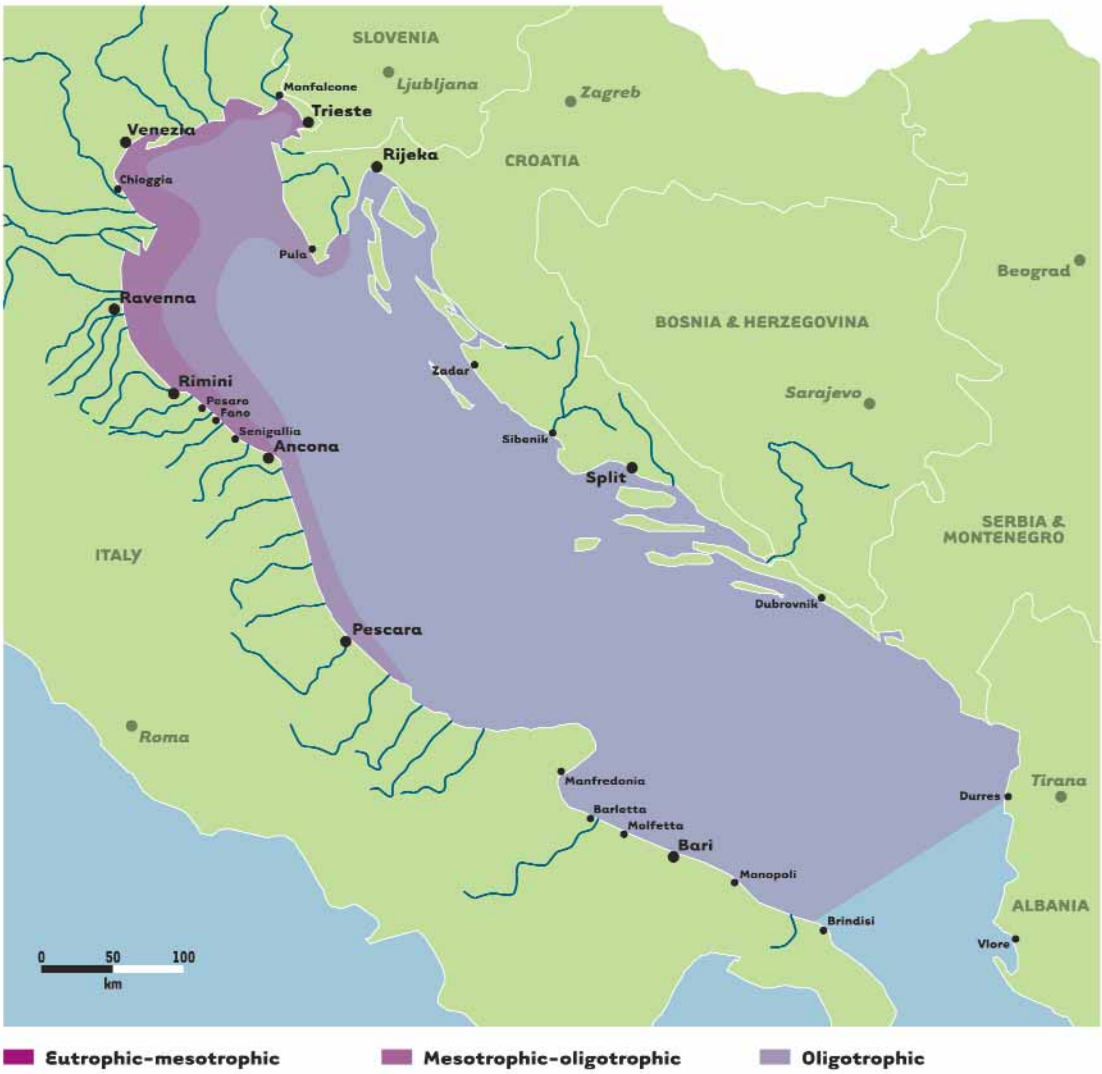


**Table 2.1 Serious Eutrophication Incidents in the Mediterranean** *(Source: UNEP/FAO/WHO, 1996b)*

| Countries | | Hypoxia / Anoxia | Algal Blooms (AB) and other effects | Dominant species * | Cell number (cells/l) |
|---|---|---|---|---|---|
| Croatia | Northern Adriatic | Yes | AB, red tides, fish and bottom fauna mortality | 7, 12, 15, 28, 31, 34, 41, 42, 53 | — |
| Egypt | Costal waters and ports | Yes | AB, water discoloration, HS | 17 | — |
| | Lagoons in the Nile Delta | Yes | AB, water discoloration, HS | — | — |
| Greece | Saronikos Gulf | Yes | AB, water discoloration, fish mortality | 7, 11, 16, 32, 34, 46, 55 | $3x10^5$—$6x10^7$ |
| | Gulf of Thermaikos | Yes | AB, water discoloration, fish mortality | 1, 3, 8, 10, 12, 14, 15, 16, 39, 41, 42 | 1—$7.5x10^7$ |
| | Other Aegean Gulfs and bays | No | AB, water discoloration | 5, 6, 11, 20, 28, 33 | $12x10^6$—$10^7$ |
| France | Western Zone | Yes | AB, dystrophy | 24, 30, 34, 35, 42, 54 | — |
| | Eastern Zone | Yes | AB, DSP, PSP, dystrophy | 24, 30, 34, 35, 42, 54 | — |
| Italy | Tyrrhenian Sea, Lagoons | Yes | AB, PSF, fish mortality, mucus | 33 | $6x10^6$ |
| | Gulf of Naples | ? | AB | 2, 9, 15, 48 | 3.5—$112x10^6$ |
| | Sardinia | Yes | AB, fish and molluscs mortality | 13, 14 | — |
| | Sicily | Yes | AB, DSP, fish mortality | 23, 24, 49 | — |
| | Ionian Sea | ? | AB | 52 | — |
| | Southern and Central Adriatic | Yes | AB, putrefaction, bottom fauna mortality, dystrophy | 34, 37, 52 | — |
| | Emilia-Romana | Yes | AB, DSP, PSP, dystrophy, fish and bottom fauna mortality, mucilage, water discoloration, poor transparency, smell | 4, 11, 15, 16, 18, 24, 25, 26, 27, 28, 34, 36, 41, 44, 45, 46, 52, 53 | 1—$230x10^6$ |
| | Gulf of Venice | Yes | AB, HS, hypertrophy | 4, 9, 13, 14, 15, Ulva | $36x10^6$ |
| | Gulf of Trieste | Yes | AB, bottom fauna, mortality | 28, 38, 40, 46, 53 | 5—$7x10^6$ |
| Malta | — | No | AB, poor transparency | — | — |
| Slovenia | — | Yes | AB, poor transparency, benthos mass mortality, mucilage, hypertrophy | — | — |
| Spain | Alboran Sea | — | AB, PSP, toxins | 33, 53 | > $3x10^3$ |
| | East Coast and Balearics | — | AB, PSP, toxins | 4, 16, 17, 21, 33 | $7.2x10^6$—$2.8x10^7$ |
| | Lagoons, Bays, Estuaries | Yes | AB, dystrophy | 52, Ulva | 10—$2x10^6$ |
| Tunisia | Lagoon of Ichkeul | Yes | AB | — | — |
| Turkey | Western Coasts | Yes | AB, bottom fauna mortality, PSP | 17, 28, 29 | — |

*AB: Algal Blooms*
*DSP: Diarrhoic Shellfish Poisoning*
*PSP: Paralytic Shellfish Poisoning*
* *The numbers of the dominant species refer to Table 2.2.*

*b. Chemical contaminants*

As our understanding of effects of toxic substances improves, the notion of 'stress' has emerged. Stress helps to explain why fitness and growth of animals and plants will suffer even at low concentrations of chemical contaminants. The important point about such toxic substances even at low levels is that they still give rise to biochemical reactions that put pressure on living resources. Amongst the results of pro-

**Table 2.2 Algal Species reported to cause Algal Blooms in Mediterranean Waters**
*(Source: UNEP, 1999)*

| * | Algal Species |
|---|---|
| | **a. Microalgae** |
| | **Diatoms** |
| 1 | *Cerataulina bergoni* |
| 2 | *Chaetoceros sp.* |
| 3 | *Chaetoceros Socialis* |
| 4 | *Chaetoceros Simplex* |
| 5 | *Cyclotella sp.* |
| 6 | *Cyclotella subtilis* |
| 7 | *Leptocylindrus ssp.* |
| 8 | *Leptocylindrus minimus* |
| 9 | *Leptocylindrus danicus* |
| 10 | *Nitzschia closterium* |
| 11 | *Nitzschia delicatissima* |
| 12 | *Nitzschia seriata* |
| 13 | *Rhizosolenia firma* |
| 14 | *Rhizosolenia Fragilissima* |
| 15 | *Skeletonema costatum* |
| 16 | *Thalassiosira sp.* |
| | **Dinoflagellates** |
| 17 | *Alexandrium minutum* |
| 18 | *Alexandrium tamarensis* |
| 19 | *Amphidimium curvatum* |
| 20 | *Cachonina niei* |
| 21 | *Chattonella subsalsa* |
| 22 | *Dinophysis acuminata* |
| 23 | *Dinophysis ssp.* |
| 24 | *Dinophysis sacculus* |
| 25 | *Glenodinium foliaceum* |
| 26 | *Glenodinium lenticula* |
| 27 | *Glenodinium quadridens* |
| 28 | *Gonyaulax sp.* |
| 29 | *Gonyaulax spinifera* |
| 30 | *Gonyaulax polyedra* |
| 31 | *Gymnodinium sp.* |
| 32 | *Gymnodinium aureolum* |
| 33 | *Gymnodinium adriaticum* |
| 34 | *Gymnodinium breve* |
| 35 | *Gymnodinium catenatum* |
| 36 | *Katodinium rotundatum* |
| 37 | *Peridimium depressum* |
| 38 | *Peridimium ovum* |
| 39 | *Prorocentrum dentatum* |
| 40 | *Prorocentrum lima* |
| 41 | *Prorocentrum micans* |
| 42 | *Prorocentrum minutum* |
| 43 | *Prorocentrum scutellum* |
| 44 | *Prorocentrum triestinum* |
| 45 | *Protogonyaulax tamarensis* |
| 46 | *Scrippsiella trochoidea* |
| | **Coccolithophores** |
| 47 | *Coccolithus pelagicus* |
| 48 | *Emiliania huxlei* |
| | **Other flagellates** |
| 49 | *Chlamydomonadacae* |
| 50 | *Cryptomonas sp.* |
| 51 | *Cyanobacteria* |
| 52 | microflagellates |
| 53 | *Noctiluca miliaris* |
| 54 | *Noctiluca scintillans* |
| 55 | *Pyramimonas sp.* |
| 56 | *Spirulina jenneri* |
| | **b. Macroalgae** |
| 57 | *Ulva sp.* |

** The numbers of the algal species refer to Table 2.1.*

### *Case Study*

**Eutrophication:**

**The case of the North Adriatic Sea**

The serious deterioration that has occurred in the northern area of the Adriatic for more than twenty years is attributable to the nutrient input in amounts that exceed the basin's natural assimilative capacity. The Po River, carrying some 100,000 tonnes/year of inorganic nitrogen and some 6,000 tonnes/year of inorganic phosphorus, contributes most of the total nutrient load of the northern Adriatic basin. The next largest of the rivers flowing into the northern Adriatic, the Adige, contributes about 14,000 tonnes/year of total nitrogen and 1,200 tonnes/year of total phosphorus, although its mean nutrient concentrations are lower than those of the Po. The total nitrogen and total phosphorus discharged into the northern Adriatic from Italy alone amounts to some 270,000 and 24,000 tonnes/year, respectively. To these must be added the inputs from Istria, estimated at 12,600 and 600 tonnes/years of total nitrogen and total phosphorus, respectively.

Eutrophication phenomena, with a distribution and persistence much greater than in any other part of the Mediterranean, have occurred and continue to occur in the coastal waters of Emilia-Romagna to the south of the Po Delta. The first cases reported date back to 1969. These were followed by a relatively long period in which the phenomenon was not observed until it returned in 1975, when an immense bloom of flagellates caused widespread anoxia in the bottom waters, accompanied by bottom fauna kills and the beaching of large quantities of bottom fish (7,000 tonnes in the Municipality of Cesenatico alone). Subsequent events succeeded one after another in the summer of almost all the following years.

The recurrent anoxia in the bottom waters caused profound modifications in the benthic ecosystem; there were considerable reductions in the original populations of the least mobile bottom organisms (molluscs, crustaceans and polychaetes) most sensitive to oxygen deficiency. Repetition of these dystrophies has led to the disappearance of about fifteen species of mollusc and three species of crustacean.

Considering that the eutrophication phenomena are no longer occasional events, but are induced by structural deficiencies on land, there is a need to eliminate such deficiencies, which are mostly linked to tourism, agriculture, animal husbandry and municipal sewerage. There is ample scientific evidence of the increased spread and intensity of eutrophication in several areas of the Mediterranean endangering the natural equilibrium of the basin. The status of the Adriatic is in fact only a mirror of a situation more and more worrying for the entire Mediterranean.

longed stress is the suppression of the immune system, which therefore increases sensitivity to infection. Natural factors, such as temperature extremes and fluctuations of salinity, or anthropogenic activities, can aggravate stress. Although new techniques measuring the total response of organisms to all possible factors now exist, none of them can give an accurate estimate of the level of acute or the sublethal toxicity of the contaminant. Therefore there is a real need for sensitive in situ bioassays to measure sediment toxicity using organisms that normally live in sediments.

Numerous reports address the contamination of the waters of the Mediterranean Sea. Additional data and discussion of the status of pollution in the Mediterranean Sea may be obtained from this publication. Sections 2.3.6.2 and 2.3.6.3 below discuss in greater detail the sources of persistent toxic substances and heavy metals in the Mediterranean and their effects on seawater quality. The section below discusses the levels of chemical contaminants in biodiversity and their potential effects.

Due to the lack of data on stress evaluation of species *vis à vis* chemical contaminants, it is seen that the level of concentration of the contaminants and / or its upward trends could be considered as a potential indicator of adverse impacts of contaminants on the animal species (see, for example, Figures 2.4 and 2.5).

The following multi-boxplot, arranged from west to east, illustrates the influence of natural and anthropogenic activities on total mercury concentrations in red mullet, *M. barbatus* (Figure 2.6).

***Figure 2.4 Logarithmic Values of Total Mercury Mass Fraction in Mullus Barbatus respectively by Year at Station GOKSU in Turkish Coastal Waters***

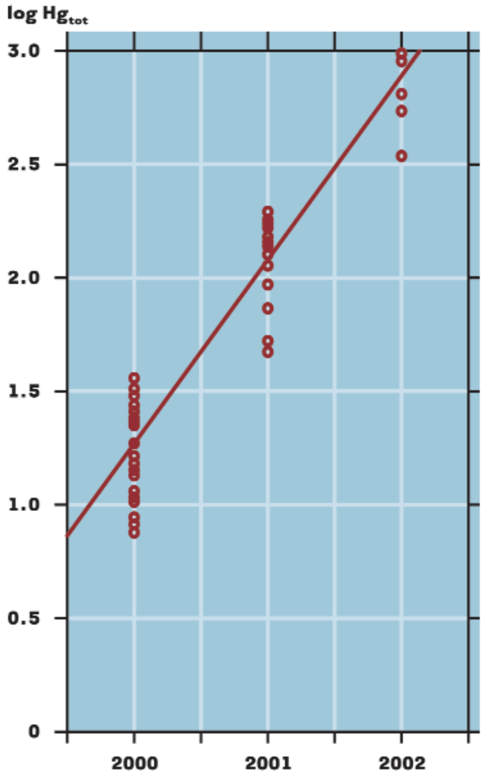



***Figure 2.5 Logarithmic Values of Total Mercury Mass Fraction in Mullus Barbatus respectively by Year at Stations ISRTMH2 and HMF2 in Israeli Coastal Waters***

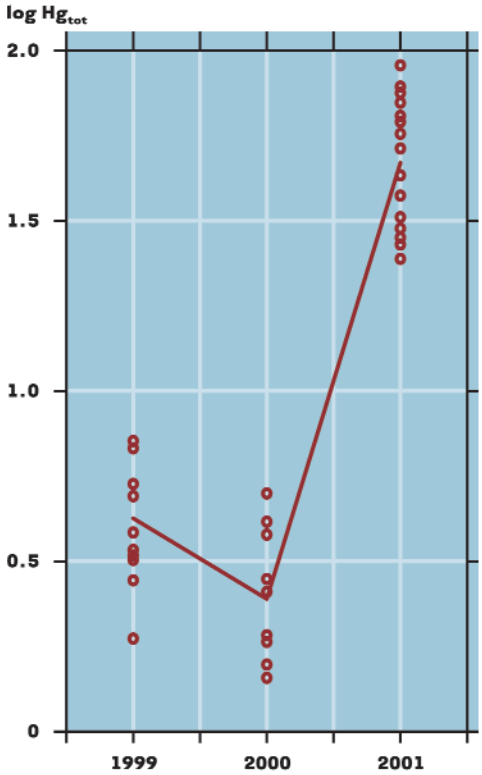
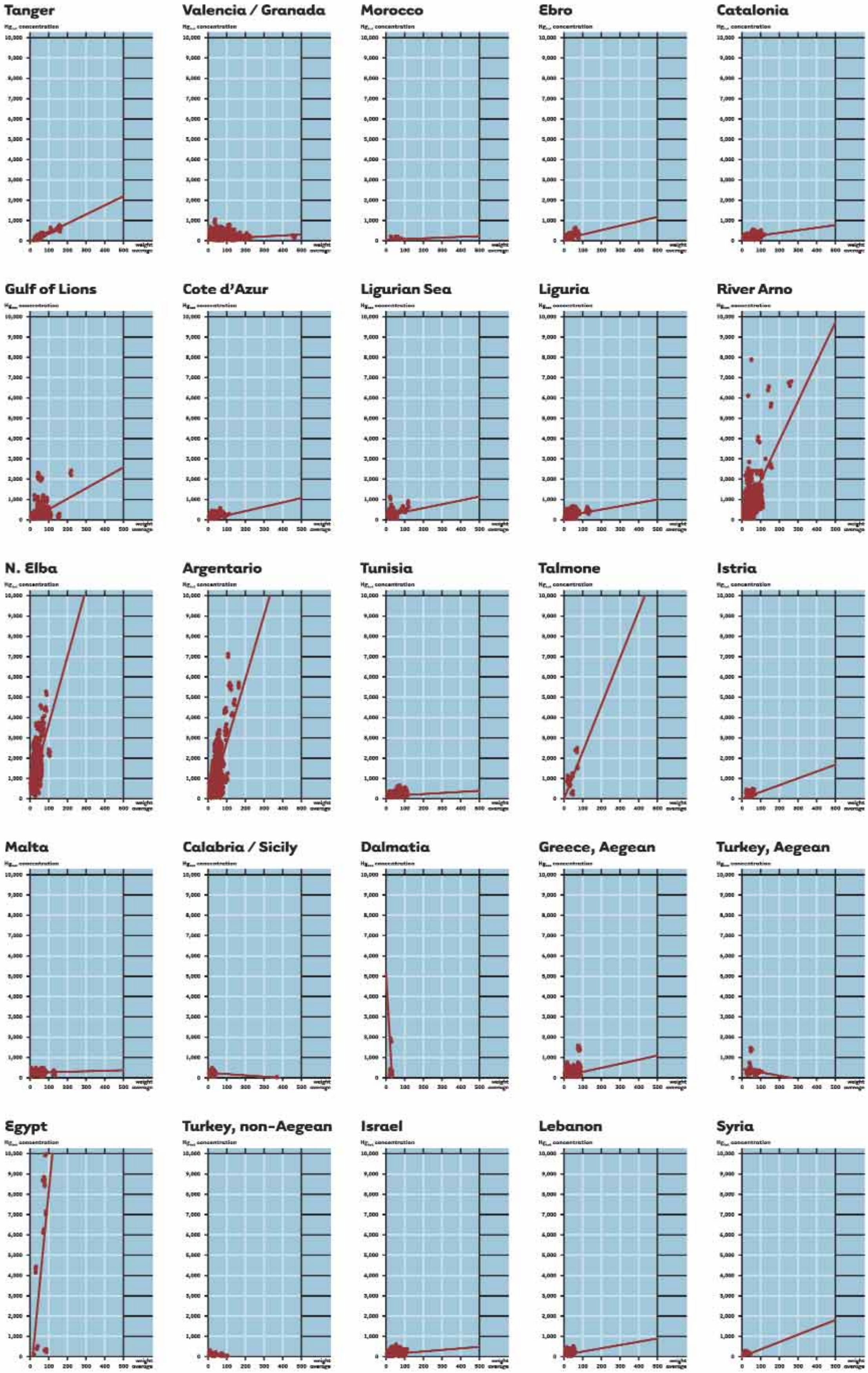


*Figure 2.6 Multi-Boxplot (arranged from West to East), the Total Mercury Concentrations in Red Mullet,* **Mullus Barbatus**



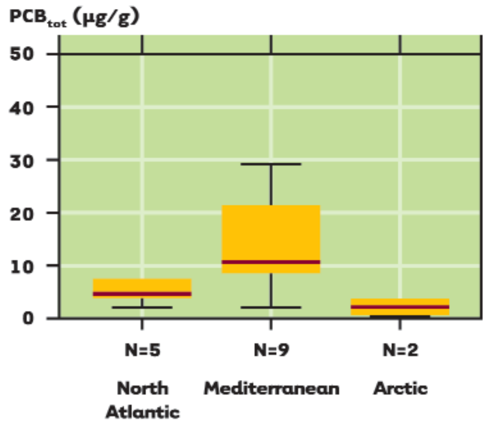
Other studies have examined, for instance, levels of organochlorines in gull's eggs (Figures 2.7 through 2.9). This is one approach to ecotoxicology.

Among the most promising new ways of assessing biological damage to marine organisms are biomarkers. Since their first adoption by Mediterranean Member States France and Italy at the end of the 1980s, biomarkers have been increasingly used as tools for assessing sublethal effects on marine organisms in the region. In 1994–1995, a series of international coastal monitoring programs started (BIOMAR 1994–1998, MED POL 1995–now, BEEP 2000–2003) involving the measurement of a range of biomarkers in bivalves (mussels) and benthic fish (*Mullus barbatus*, *Serranus cabrilla* and *Dicentrachus labrax*) in Mediterranean areas exhibiting significant pollution gradients (e.g., harbours, urban and industrial waste outfalls, etc.) in comparison with cleaner areas (e.g., Corsica and Sardinia). Following the same strategy, a monitoring network (REMER) was recently initiated in Morocco.

A type of biomarker known as lysosomal alterations has indicated that marine animals are under stress from PAHs and PCBs pollution in various parts of the basin. Mussels along the Spanish coast (Porte et al., 2001), the Adriatic Sea (Petrovic et al., 2001), and Venice Lagoon (Lowe and Fossato, 2000) are among other areas where pollution damages to marine life have been detected. DNA damage in molluscs inhabiting contaminated areas has been reported in the Orbetello Lagoon (Frenzilli et al., 2001).

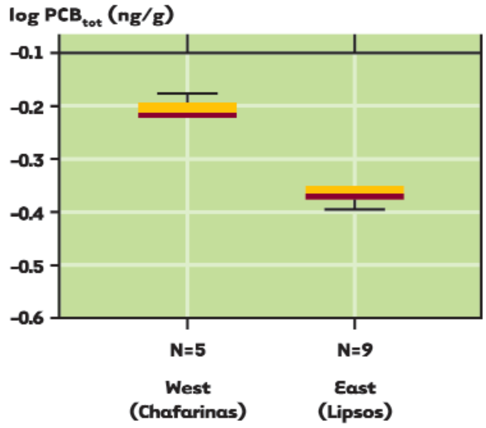
In the case of marine mammals, several hypotheses have attempted to link disease outbreaks to environmental degradation. Frequently, immunorepression is the link identified between pollution and disease. High levels of organochlorines have been noted in dolphins that died in several

***Figure 2.7 PCBs in Audouin's Gull Eggs***



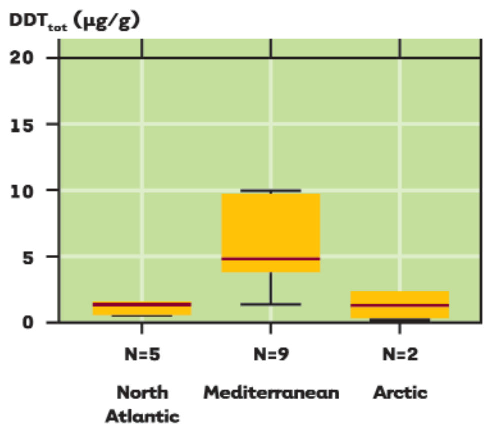

N: Number of Samples

***Figure 2.8 PCBs in Audouin's Gull Eggs in the Mediterranean***




N: Number of Samples

***Figure 2.9 DDTs in Audouin's Gull Eggs***




N: Number of Samples

mass mortality incidents. Aguilar and Borrell (1994) compared PCB levels in striped dolphins *Stenella coeruleoalba* that died during the Mediterranean mobillivirus epizootic in 1990 with biopsies taken from live dolphins in 1987–89. The authors suggest that PCBs left the blubber during mobilisation of fat reserves and large quantities reached the liver shortly before the epizootic. This may have increased the dolphins' susceptibility to the morbillivirus.

High concentrations of butyltin residues have been found in harbour porpoise from bottlenose dolphins in the Mediterranean (Kannan and Falandysz, 1997). Organotin compounds (bis(tri-n-butyltin)oxide) have been shown to exhibit immunorepressive and endocrine modulating activities in rodents (Vos et al., 1984). In particular, long-term exposure reduced resistance to infectious diseases (Vos et al., 1990).

Bacteria that under certain conditions become virulent caused a severe sponge disease epidemic in the beginning of the 1990s in the Mediterranean.

Several studies indicate disruption of normal endocrine function in the Mediterranean area. A series of field investigations with marine invertebrates suggests that tributyl- and triphenyltin compounds can induce imposex. The monitoring of a gastropod (*Bolinus brandaris*) along the Catalan coast (NW Mediterranean) showed that imposex was a widespread phenomenon (Solé et al., 1998). Imposex has also been described in the gastropod *Nucella lapillus* collected in the Galicia coast (Ruiz et al., 1998), in the whelks *Stramonita haemastoma* and *Hexaplex trunculus* in Israel (Rilov et al., 2000) and Italy (Terlizzi et al., 1998), and in Malta (Axiak et al., 2000). Four *neogastropod* species (*Hexaplex trunculus*, *Ocenebra erinacea*, *Ocinebrina aciculata* and *Nassarius reticulatus*) collected in a TBT-polluted site, near the port of Faro (Portugal), were examined in 1996 for imposex with positive results (Gibbs et al., 1997). Imposex was also found in the species *Hinia reticulata* in Portuguese coastal waters and on the south part of the Tagus River (Pessoa et al., 1997). Also, in Portugal, oyster shell anomalies in *Crassostrea angulata* were found in the Sado and Tagus estuaries (Phelps and Page, 1997).

A wide variety of compounds (e.g., DDT, PCBs, nonylphenols and phthalates considered here) have been associated with potential reproductive anomalies in fish, and there has been a growing awareness of the need to detect and assess the adverse effects. Recently, new evidence based on monitoring hormone and vitellogenin levels together with gonad histology indicates that in the central Mediterranean male swordfish (*Xiphias gladius*) are undergoing sex inversion (14 %) (Fossi et al., 2001). There is no evidence, however, of reproduction impairment. The effect on other large pelagic predators or on marine mammals is unknown.

Despite the difficulty in directly attributing population responses to pollutants, there are some indications that coastal fish assemblages respond to the impact caused by sewage discharge on mussel fisheries in Southeast Italy. However, the link between these epizootics and chemical pollution still remains an open issue. More data are required at the population, community and ecosystem level to assess the health of the Mediterranean. While in their infancy, biomarkers could help in that direction and to obtain answers as to whether these diseases are unpredictable episodic events or symptoms of ecosystem degradation.

Among chemical contaminants, copper is highly toxic for marine life and is a source of concern in the Mediterranean. The ionic component of total dissolved copper in seawater has been shown, through experimental studies, to have a deleterious effect on some phytoplankton and bacterial species at levels of 0.1–0.2 µg/l. In the wild, this toxic effect is somewhat mitigated by the metal being bound to natural ligand (soluble organic carbon). In the Mediterranean, an important source of copper is fungicide used in vineyards and copper-based anti-fouling paints. Although rather high concentrations may be observed in "hot spot" areas, the mean value of concentration in marine organisms remains well below the maximum permissible limit (20 µg/g).

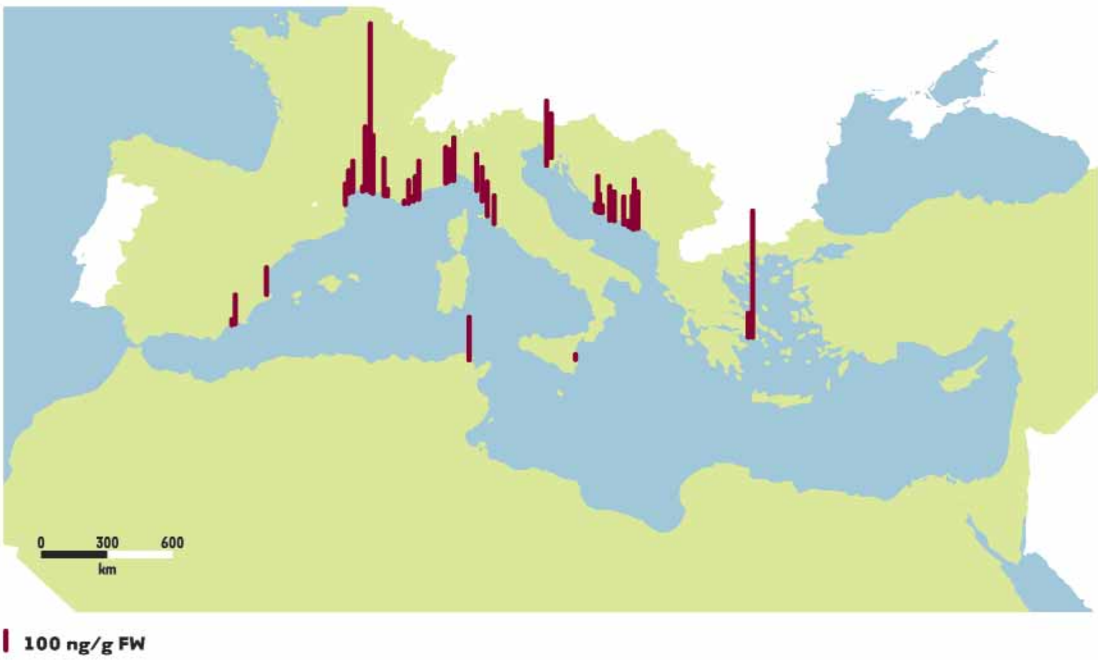
Great risks to Mediterranean ecosystems also stem from the effect of cadmium (Figure 2.10) on top predators and from lead on predators of shellfish. High values of cadmium concentrations in the surface sediments may be found in polluted lagoons and other so called "hot spot" areas. Mean concentrations of inorganic lead in marine organisms are high in the vicinity of industrialised coastal areas in the Mediterranean.

Regarding the sources of data for chemical contaminants, there is a marked difficulty in obtaining comparable data on surface sediments though these are the ultimate sink for most contaminants. By contrast, significant intercalibration of data on contamination levels in marine species has been made through MED POL efforts.

Pesticide residues carried through rivers or deposited by air in the sea cause damage to invertebrates and young fishes. The thinning of the egg-shells of seabirds is also a symptom of organochlorines on marine organisms. DDT, Aldrin and Dieldrin have significant effects on invertebrates. They can increase mortality rate in fish eggs and cause premature pupping in seals. They may also affect species composition in phytoplankton community. Phytoplankton photosynthesis has also been affected by thiazines.

Data on the bioaccumulation of chemical contaminants in Audouin's gull eggs (Figures 2.7, 2.8 and 2.9) show that the concentration of PCBs and DDT in the Mediterranean is 2–3 fold higher than its concentration in

***Figure 2.10 Medians of Cadmium Concentrations in* Mytilus Galloprovincialis**



the gull eggs taken from the North Atlantic and the Arctic. This is a relevant indicator of the transboundary transport of chemical contaminants throughout the Mediterranean.

Chemicals used in mariculture, in particular organophosphate ectoparasites, are toxic to invertebrates and larvae of crustaceans (Egidius and Moster, 1987). Unintended effects of pesticides on non-target species may also occur as suggested by evidence on crab kills in oyster farms in the north-western United States (WDF/WDOE, 1985).

Pigments and vitamins used in mariculture can lead to altered growth rates of certain phytoplankton, thus leading to interrupted aquatic ecosystems. Biotin has been shown to stimulate growth of certain phytoplankton species and is implicated in the toxicity of the dinoflagellate *Cymnodinium aureoles* (Gowen and Bradbury, 1987). Vitamin B12 has been shown to be one of the growth-promoting factors of the alga *Chrysochromulina polylepis* and the dinoflagellate *Heterosigma alashivo* (Graneli et al., 1993; Honjo, 1993).

Transfer of resistance to non-target species is also a source of concern related to the use of antibiotics in mariculture. Indiscriminate use of drugs to control or prevent fish diseases in coastal fish farms has resulted in some native aquatic microbial communities developing antibiotic resistance (GESAMP, 1991) and the possibility of transfer of resistance to human pathogen has also raised concern, (Dixon, 1991). The development of resistant bacterial population in the sediment has been documented. For example, up to 100 percent of oxytetracycline-resistant bacteria have been recorded from marine sediments near fish farms after medication and resistance persisted for more than 13 months afterwards (Torsvik et al., 1988; Samuelsen et al., 1992).

As regards the impact from antibiotics use for mariculture purposes, there is a significant lack of data. Although oxytetracycline is the most commonly used antibiotic in seabream and seabass cage culture, there are no reports on its effect on the Mediterranean.

*c. Oil pollution*

The effects of oil pollution can be far reaching and pose a threat to the health of ecosystems. Offshore marine life as well as coastal ecosystems, marine birds that feed at sea, and mariculture are all exposed to risk from oil spillages mainly from offshore oil extraction and oil transport. Although little information is available on oil spillage effects on Mediterranean biodiversity, worldwide information suggests the type of threat oil pollution represents for biodiversity.

*Effects on marine animals*

Marine mammals bioaccumulate hydrocarbons in their bodies, which leads to long-term sublethal effects or even death. Larger cetaceans such as dolphins are more likely to suffer by ingestion of contaminated food rather than by direct contact with oiled water as they can swim away from pollution. However, a school of dolphins was observed swimming into oil slicks in Genoa (Italy) suggesting that larger mammals may not necessarily avoid oil slick contamination. Such contact would endanger dolphins' health through oil entering blowholes. In addition, inhalation of toxic compounds can inflame lung membrane rendering dolphins susceptible to congestion and pulmonary infection.

As for smaller mammals such as seals, risks from oiling can include death. Following exposure to oil slicks, a reduction in thermoinsulation has been reported to occur for as long as two months after the incident (Deere-Jones, 1996), reducing the animal's capability to regulate body temperature. Nervous system impairment and eye, lung and nasal irritation have also been recorded as a result of oiling, sometimes resulting in acute respiratory illness (Hall et al., 1993).

Oil slicks will have fatal consequences for any fish eggs and larvae located under the spill. Shellfish are at risk from bioaccumulation of hydrocarbons that leads to reduction in feeding efficiency and growth reduction. Crustaceans exposed to hydrocarbons show increased mortality. This is linked to diminished ability to assimilate food as well as suffering a decrease in the respiration rate (Overton et al., 1994).

*Effects on coastal flora and fauna*

When an oil slick reaches the shoreline, it smothers coastal habitats and resources and exerts a toxic effect. Areas with low water mass movement, such as biodiversity-rich estuaries, will be at higher risk from oil slicks due to low 'self-cleaning' ability.

The immediate effect of oil spill on estuarine environment is the massive mortality of intertidal fauna (limpets, razor shells, finfish, red macroalgae), which has been recorded in the case of the Sea Empress spill. The long-term effects concern the incorporation of oil into sediments, for most of 90 percent of un-recovered hydrocarbons (Murphy et al., 1988), facilitated also by the adsorption of oil to the suspended particles in the water column. These particles may settle rapidly in a high-deposition area, become buried under more than 5 cm of sediments, where the anoxic conditions slow the biodegradation process (Deere-Jones, 1996). Burns et al. (1994) report that hydrocarbons incorporated into sediments may persist at least for a period of 20 years. Moreover, this condition may facilitate re-oiling events caused by the oil leaching from sediments (Clark, 2001), as shown after the Amoco Cadiz spill.

The impact of oil on the estuarine flora is heavy. The saltmarsh plants are affected mainly in flowering season, reducing also seed production and seed germination (Deere-Jones, 1996). Moreover, oiling rapidly kills some types of plants, such as shallow-rooted plants. The changes in plant cover may also modify the sedimentation and erosion dynamics of the entire estuarine area. Finally, oil spills and hydrocarbon sedimentation affect the eelgrass beds, which are important breeding, nursery and feeding habitats for a number of fish and birds. Walker and McComb (1992) report that the *Zostera* bed recovery may take some 80–120 years.

The impacts on shellfish and crustacean in a high-energy estuarine environment concern the alteration of the ecological structure of the community, passing through the elimination of the main herbivore species and the subsequent seaweed growth. The re-colonization of rock-associated species (i.e., barnacles) is also inhibited. These ecological changes appear to be persistent, as shown in the case of the Torrey Canyon spill, where more than 10 years after the spill the community biodiversity was reduced (Clark, 2001). In low energy environments, filter-feeder organisms, such as bivalve molluscs, dominate the shellfish community. An oil spill may cause heavy juveniles and adults' shellfish mortality, reducing the recovery capability of the environment, due also to the high persistence of the buried hydrocarbons. In the long-term, sublethal effects and biodiversity reduction may be recorded (Levings et al., 1994; Deere-Jones, 1996). The NSA (National Shellfish Association) (1976) and Jackson et al. (1981) reported that the active breeding populations of crabs and oysters are more sensitive to hydrocarbons, because of the depletion of energy reserves during breeding time.

The impact of oil spills on estuarine finfish populations is the same as the effects that have been discussed earlier. In particular, PAHs are persistent and tend also to bioaccumulate through the food chain, causing skin ulceration, tissue disorders and liver cancers in bottom-dwelling fish (Philips et al., 1992; Stegeman et al., 1991).

The immediate impact on wildlife in a bay environment is similar to impacts on the estuarine environments, resulting in high mortality of intertidal and subtidal species. Deere-Jones (1996) reported that, in Carmarthen Bay, high mortality of razor shells, echinoderms and marine worms was recorded, followed by heavy necrosis and mortality for tellins, soft clams and mussels. At the same time, mortality of over-wintering populations of bird species was observed.

The long-term impacts on bay environments are linked with the deposition and inclusion of hydrocarbons in the deep sediments, likewise observed for estuaries. Moreover, the higher sedimentation rate, the richness of particulate matter (with high organic carbon content) in the water column and the predominance of low-energy environment increase the potential for hydrocarbon retention. Chasse et al. (1978) and Holme (1978) conducted studies in the Marleux and in Lannion Bay, reporting that after the Amoco Cadiz spill, rocks around the bay were oiled, in some cases through the intertidal zone, and the beach sediments were apparently clean, but oil was found at 10–15 cm depth in the sand. One month after the Amoco Cadiz spill, the Total Hydrocarbon Concentration (THC) recorded in inshore interstitial waters and sediments was 16 ppm, versus the 0.05 ppm of THC measured in offshore waters. Sandy beaches may contain 7.5 kg of buried stranded oil per square meter, mostly in the form of chocolate mousse (Deere-Jones, 1996), representing the major reservoir of long-term impacts (Vander Meulen et al., 1979).

The long-term impacts on fauna and flora recorded for estuarine environments are the same for bay environments. Dauvin (1982) reported that after the Amoco Cadiz spill in the Bay of Morleaux, ecological damage was observed, with the reduction of bowser and grazer species, favouring a high growth of opportunistic species and an increase of detritivoure species. Long-term effects may be observed after 5 years, with reduced biodiversity of the nematode community in subtidal sediments (Boucher, 1984).

A report on hydrocarbon pollution for the Mediterranean Sea was finished in1988, wherein it was estimated that approximately 716,000 tonnes of hydrocarbons enter the Sea each year due to normal activity (absent a major oil spill). No more recent data or estimates appear to be available for the Sea. Major sources of hydrocarbon pollution are shipping, port and harbour operations, ballast water, and marine discharges from shore (outfalls and rivers).

*d. Solid waste and litter*

Pollution caused by discharge of solid waste and litter into the sea (especially plastic packaging) is a significant cause of degradation of both the land and marine coastal fringe in the Mediterranean. Non-biodegradable plastic and tar balls build up on beaches and the whole of the Mediterranean coast.

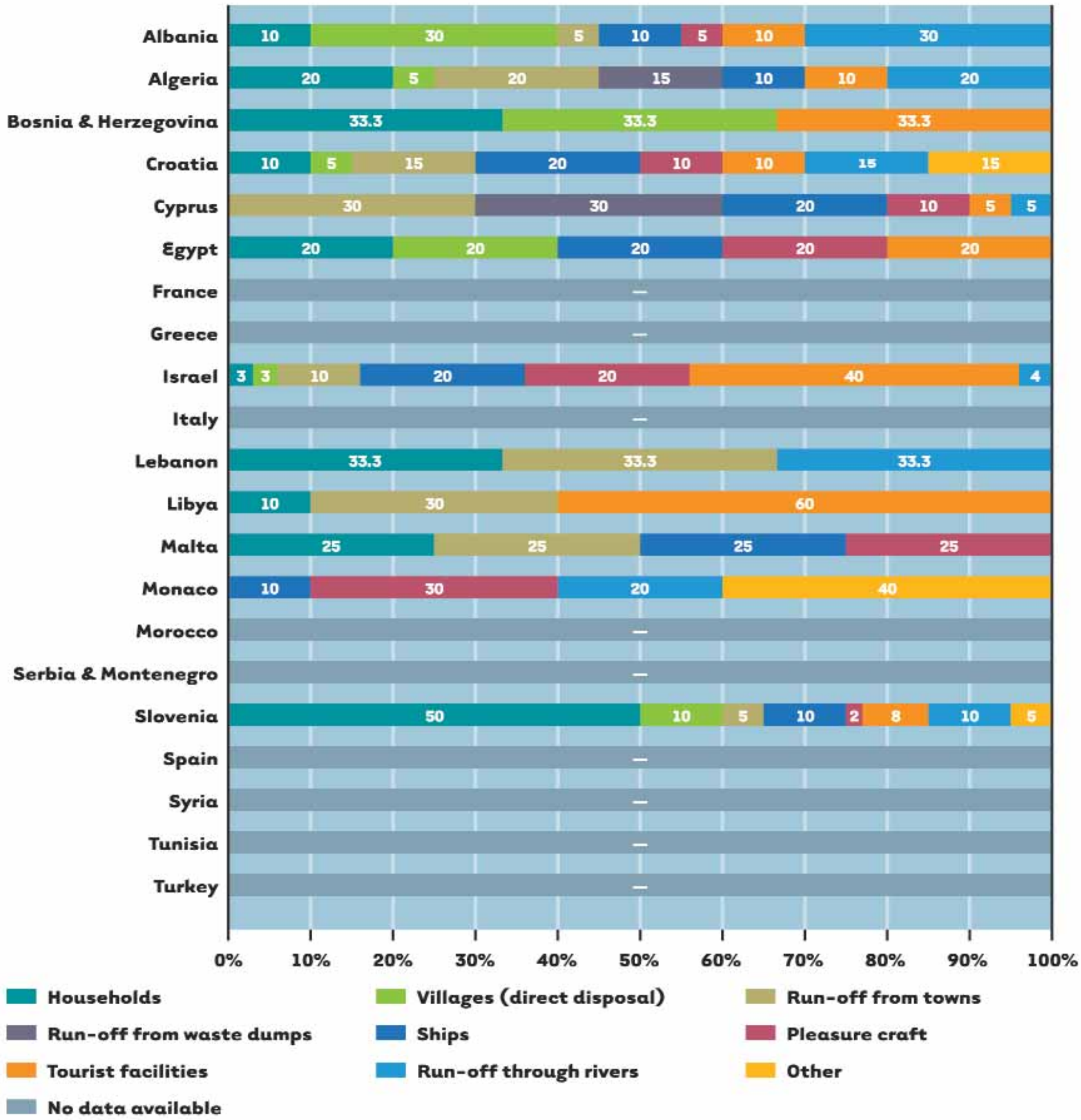
However, the degree of awareness and response varies according to the source of litter. The proximity of the land and the control of litter exercised from the land, together with concerns regarding visual pollution, mean that this waste receives the greatest attention, as it is harmful for beaches, ports and coastal zones. Litter management in relation to merchant ships, pleasure craft and marinas is not neglected. The necessary facilities and units are often placed under the responsibility of port authorities and managers of marinas. By contrast, management of marine litter, particularly that on the seabed, is virtually ignored by the majority of the countries consulted and only four of them include it in their policies. In Monaco, this issue is dealt with at the sectoral rather than the specific level.

Studies show that around 30 to 40 million tonnes of municipal solid waste of coastal origin are generated annually. The random siting of waste dumps encourages the transfer of solid wastes into the marine environment. In the Mediterranean, plastic alone accounts for 75 percent of the waste on the sea surface and the seabed.

The main source of marine waste in the Mediterranean is direct disposal by households (see Figure i.8), followed by the impact of tourist facilities and run-off from waste dumps (waste from land sources). This means that, in fact, the majority of marine waste comes from coastal areas.

The sources of marine waste vary from one country to another and Figure 2.11 shows the sources and origin of waste per country.

***Figure 2.11 Sources of Marine Solid Waste in each Mediterranean Country*** *(Source: UNEP/MAP, 2001b)*



#### *2.1.5.4 Introduction and invasion of alien species*

The introduction and invasion of new organisms in the form of exotic species or highly cultivated strains of endemic species nearly always poses a risk to the ecosystem involved. It is estimated that about 500 Indo-Pacific species have entered the Mediterranean since the construction of the Suez Canal in 1869, to which more than 50 exotic species passing through the Gibraltar Strait have to be added. The Suez migration has been given the term Lessepsian, in honor of the French designer and constructor of the Suez Canal.

Mediterranean ports are key sites in the introduction of alien species in the region. Indeed, many cases of spectacular "invasion" of alien species have been observed in the vicinity of the ports and the major ecological change is affecting the port areas. Exotic species are usually transported in the ships' ballast water or cling to the surface of submerged hulls.

Some of the most spectacular examples of ship-borne alien species in ports are:

- The benthic gene algae *Codium fragile*, introduced from the Atlantic during the second half of the 20th century, actually dominate elements of the marine vegetation in many Mediterranean ports (West and East basin).
- The marine Angiosperm *Halophila stipulacea*, introduced from the Red Sea after the opening of the Suez Canal, is actually a common element of the marine vegetation in the ports of eastern Mediterranean.
- The dinoflagellates *Alexandrium spp.* (and other related genera), introduced from the Indo-Pacific Ocean after the opening of the Suez Canal, are actually common elements of the plankton flora in the ports of the Mediterranean and the Adriatic.

Of the 61 well-established macrophyte species in the Mediterranean, one worth mentioning is the Chlorophycea *Caulerpa taxifolia*, distributed in tropical seas and recorded for the first time in the northwestern Mediterranean in 1984. Its spreading patterns and high-density fronts have been well documented in the Mediterranean. Besides *C. taxifolia*, its con generic *C. racemosa*, probably a Lessepsian species introduced in the 1930s, is now expanding in the eastern Mediterranean and more recently in the northwestern Mediterranean and the Adriatic. The distribution of both species and their impact on the marine ecosystem were thoroughly discussed by experts from the MAP countries. (UNEP, 1999).

Among the Lessepsian migrants, fishes have always received great attention. Their expansion is continuous without any sign of decline, especially in the Eastern Mediterranean. As said before, although it must be assumed that the colonisers compete with some of the native species, there is no evidence of a drastic change in abundance of any of the Mediterranean commercial fishes that could be attributed to a new competitor. However, there are observations indicating changes in abundance of species among the migrants.

Mollusca is one of the leading taxa of Lessepsian migrants with more than a hundred species presently settled in the Mediterranean. One of the most striking examples can be seen in the gastropod *Rhinoclavis Kochi*, initially reported from Haifa Bay in 1963 and now collected in large numbers not only along the Israeli coasts, but also along the coasts of southern Turkey and Cyprus.

Within the Decapoda and Stomatopoda species, another example of strong settlement and diffusion is given by the portunid crab *Callinectes sapidus*, a western Atlantic species commercially fished along the coasts of North America and which was first recorded in the Bay of Biscay (1901) and then probably introduced with ballast waters into the Mediterranean Sea. It has proved to be a successful coloniser and became of local economic importance in the Mediterranean.

Generally speaking, 80 percent of the introduced species have no visible effect on the indigenous communities. On the other hand, a minority of introduced species do have an impact on the indigenous communities. According to Boudouresque and Ribera (1994), the biotopes most affected by marine species (other than Lessepsian migrants) in the Mediterranean are the lagoons and ports. Equilibrium with native species often becomes established in due course, but sometimes not without changes at the community level due to shifting in ecological niches.

Such changes in the composition of Mediterranean marine ecosystems due to introduced species have been described in:

- Haifa Bay, with the massive penetration of four Indo-Pacific species;
- Izmir Bay and Thessaloniki Gulf where the bivalve *Scapharca demiri* became dominant;
- The western coast of the Middle Adriatic Sea with the massive development of *Scapharca inaequivalvis* and *Rapana venosa*;
- Since the beginning of the 90s, in the northwestern Mediterranean and the Adriatic with

the rapid development of *Caulerpa taxifolia* rejoined nowadays by the northern expansion of *Caulerpa racemosa*.

Is the Mediterranean Sea a hot spot of non-native marine plants?

A comparison of the number of exotic marine plants among different geographical areas shows that the Mediterranean Sea possesses the highest number with 98 species, followed by the European Atlantic coast with 49 species. Other zones have a lower number of indigenous species: 26 on the Australian coast, 20 on the North American Atlantic coast, 20 on the New Zealand coast, and 19 on the North American Pacific coast.

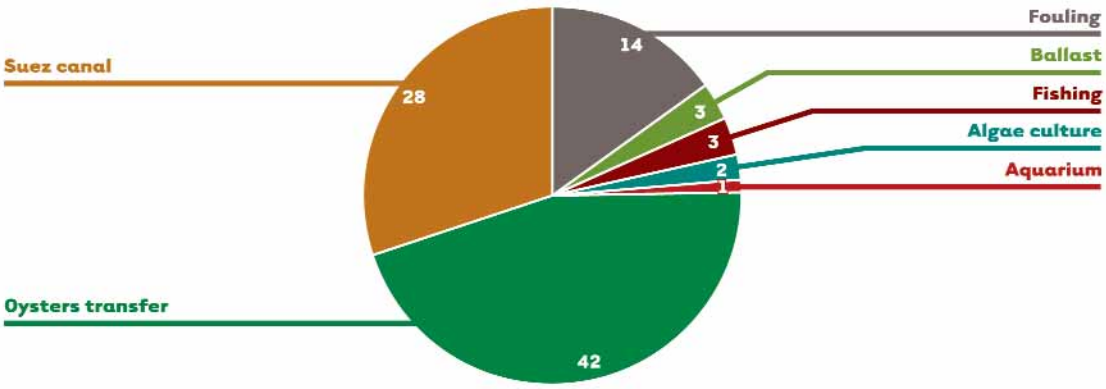
Therefore, in comparative terms, the Mediterranean is an exceptional nucleus for non-native species because it is subject to greater pressure from the vectors of introduction or because it accepts potential alien immigrants more easily. Figure 2.12 shows the number of non-native plants introduced by each pathway in the Mediterranean Sea and the total number of non-native plants by group.

At least eight species can be assigned to the category of invasive organisms in the Mediterranean. They play a conspicuous role in the recipient ecosystems, becoming the dominant species and / or taking the place of keystone species: *Acrothamnion preissii* in western Italy, *Aaparagopsis armata* in the northwestern basin, *Lophocladia lallemandii* in the Balearic islands, *Womersleyelly setacea* in western Italy, *Sargassum muticum* in Thau Lagoon, *Stypopodium schimperi* in the eastern Mediterranean, *Caulerpa racemosa* in various localities in the Mediterranean, *Caulerpa taxifolia* along the French and Italian Riviera and additional specie *Halophila stipulacea* in the eastern Mediterranean.

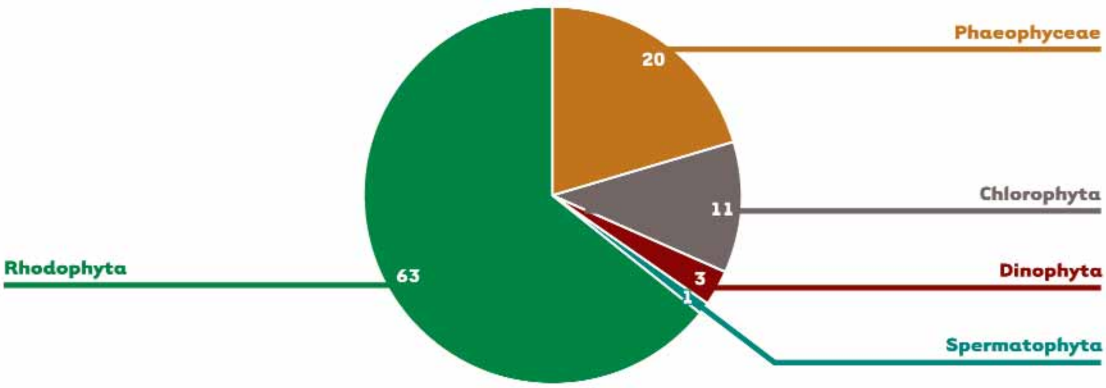
*Caulerpa racemosa* and *Caulerpa taxifolia* are the two species currently colonizing the coasts of the Mediterranean. By the year 2000, *Caulerpa taxifolia* had colonized 131 km$^2$ of bottom areas in 103 localities along 191 km of coastline in six countries and was actively expanding. *Caulerpa* invasion appears to be successful when seagrass meadows are already experiencing a decline.

***Figure 2.12 Number of Non-Native Plants in the Mediterranean Sea***

***a. Number of Non-Native Plants introduced by each Pathway in the Mediterranean Sea***




***b. Total Number of Non-Native Plants in the Mediterranean Sea, separated into Systematic Groups***



*Posidonia oceanica* decline in the Mediterranean is a known problem, recognized by the scientific community well before the introduction of *Caulerpa spp.* There are various causes leading to the decline of this important ecosystem endemic of the Mediterranean Sea, directly or indirectly related to the increasing of anthropogenic pressure that the coastal zone has been experiencing such as wastewater discharge, bottom trawling and anchoring. These general human pressures played a leading role in lowering competitive ability of native seagrasses, permitting the invader to dominate in the environment.

*2.1.5.5 Destruction of habitats by fishing pressure*

Fishing is one of the major activities that contribute to the destruction of habitat in the Mediterranean Sea. Data from Marseille (France), Ischia (Italy) and a French marine protected area (Port-Cros, Corsica) show that the most obvious effect on habitat is the decrease in the mean weight of individuals in fished areas compared to the protected areas (Table 2.3). The density and biomass are also lower in fished seagrass beds.

Similar impacts of fishing on habitat are shown also in rocky zones in protected areas and fishing areas (Macpferson, 2000). Table 2.4 indicates that fishing modifies the age structure of many species, whereas Table 2.5 shows the modification of the general structure of the community.

### 2.2 Decline in Fisheries

According to the FAO, a temporary slump in 1980s' Mediterranean fish landings gave way to recovery and, in the 1990s, fish production increased by more than 30 percent (Figure 2.13). However, recovery in catch masks the underlying problem of long-term depletion in Mediterranean marine catches. In fact, most of the Mediterranean fishery resources, be they demersal, small pelagic or highly migratory species, have long been considered over-exploited.

***Table 2.3 Differences in Mean Density (S.D.), Mean Biomass and Mean Individual Fish Weight for Seagrass Fish Bed Assemblages in Marine Reserves and in Areas open to Fishing***

| | **Marine reserves** | | **Fished areas** | |
|---|---|---|---|---|
| Mean density (ind. 100m$^2$) | 20.01 | (2,051) | 14.84 | (11.08) |
| Mean biomass (g/100m$^{-2}$) | 331.08 | (330.60) | 180.71 | (147.99) |
| Mean individual fish weight | 17.58 | (3.11) | 11.87 | (3.83) |

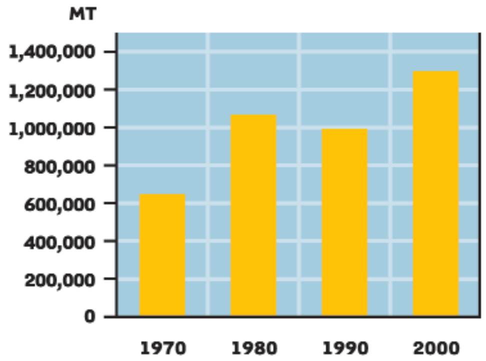
***Table 2.4 Age Structures of* Diplodus Annularis *taken from a Protected Area (Medias Islands) and a Non-Protected Area (Port da la Selva)***

| **Age** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| Protected | 40 % | 24 % | 10 % | 10 % | 10 % | 5 % |
| Non-protected | 70 % | 24 % | 5 % | 0 % | 0 % | 0 % |

***Table 2.5 Percentage Contribution to the Total Biomass by Different Trophic Groupings in Mediterranean Rocky Zones, Protected (Meded islands) and Non-Protected (Tossa)***

| **Trophic groups** | **Herbivores (HER)** | **Mesocarnivores (PE)** | **Microcarnivores (PI)** | **Omnivores (OMN)** | **Ichtyophagous (ICT)** |
|---|---|---|---|---|---|
| Protected | 3 % | 24 % | 10 % | 20 % | 40 % |
| Non-protected | 14 % | 60 % | 9 % | 10 % | 2 % |

*Figure 2.13 Total Marine Catches in MT in the Mediterranean*
*(Source: FAO Fishery Statistics)*




Besides decline of target species, some of which are becoming rarer, fishing interacts with the environment in a number of adverse ways. High numbers of by-catches of non-target migratory or wide-ranging species are a major cause of decline of fish populations. Discard rates as high as 60 percent are regular practice, reflecting the pronounced role fishing plays in the decline of Mediterranean fishery resources. Moreover, lack of selective fishing gear means that species of high conservation status may be included in the by-catch making fishing responsible for loss of biodiversity. Cetaceans seen to be in competition and being killed by fishermen add more complexity to the issue of fishing as a cause of decline in Mediterranean fishery resources.

Decline in fisheries also occurs locally as a result of eutrophication incidents. While fishery production is positively influenced by moderate levels of nutrient inputs, a risk of fish-kill arises at excessive levels of eutrophication. Red tides and lack of oxygen both linked to high nutrient input are two ways in which eutrophication may lead to a decline in fishery resources. Shellfish poisoning in Spain in 1993, for instance, caused by red tides, was responsible for a drastic drop in mussel production from 247,000 MT in 1986 to 90,000 MT in 1993.

Depletion of Mediterranean marine resources has serious socio-economic repercussions due to the traditional importance played by the fishing sector in the basin. As economic opportunities become worse due to overexploitation of stocks, fishermen have to give up their trade. In 2000, 8,000 Italian fishermen, representing about 16 percent of the country's labour employed in fishing, lost their jobs. The Mediterranean Member States as a whole generated more than 600,000 jobs directly related to fishing in the late 1990s, while the total including those employed in related sectors is even greater. Fisheries have clearly high social and economic importance in the region and any further decline of Mediterranean fisheries would therefore have serious consequences for the basin.

This section surveys the status of main fish stocks in the Mediterranean, the overall characteristics and main pressures arising from fishery activities, as well as the international dimension of fisheries in the context of conservation of the Mediterranean environment.

### *2.2.1 Transboundary aspects*

Fisheries issues are transboundary both because of the presence of highly migratory stocks (such as tuna) and extensive shared stocks. The fragmentation of the Mediterranean area by so many Exclusive Economic Zones (EEZ) bordering each other virtually assures that many stocks are transboundary and / or shared. Fisheries issues have strong transboundary environmental aspects as well as socio-economic aspects. Fish play important roles in the ecotones of the Mediterranean Sea, in both coastal and pelagic areas. Loss of fish from these ecotones has, and will continue, to change the ecological balance in these ecotones, changing their very nature. In addition, fisheries activities themselves cause mortality for endangered species (such as sea turtles and some dolphins), destroy bottom habitat due to dredging (such as seagrass beds and possible coralline hard bottoms), and have ecologically-harmful bycatch.

The extent of international waters in the Mediterranean makes it inevitable and essential to address fisheries on an international level, at least in the field of highly migratory stocks. This task is complex in the Mediterranean as there is a high number of riparian states at varying stages of development in the management of fisheries. Future progress in terms of fisheries management, however, will be based on the ability to build a multilateral dimension into national practices.

Although fishing in international waters is the exception rather than the rule in the Mediterranean, the perception of shared stocks and fisheries has been advancing rapidly. This is due both to clearer scientific opinions and to the development of new fisheries extending their operative ranges outside national waters. The number of shared fisheries has increased in several areas like the Alboran Sea, the Gulf of Lions, the Northern Tyrrhenian Sea, the Adriatic Sea, the Ionian Sea, the Aegean Sea, the Sicily Strait and the Gulf of Gabes. In addition to the highly migratory species, that can be found in the whole Mediterranean basin, a minimum list of shared stocks has been agreed both within the General Fisheries Commission for the Mediterranean (GFCM) framework and FAO subregional programs. The list might be expanded in the future. A sample of shared fishery resources is shown in Table 2.4. However, the number of shared fisheries identified already at this stage justifies common action to be taken for those stocks at the international level.

### 2.2.2 Environmental impacts

Fishing activites affect the environment directly through their effects on target species as well as indirectly through their effects on the marine ecosystem. Among the indirect environmental impacts of fishing on the ecosystem the following ones can be identified:

- Alteration and destruction of benthic habitat, such as seagrass beds and hard-bottom coralline areas;
- Effects on non-target populations due to bycatch, discarding, ghost-fishing, etc.
- Effects on other non-commercial and often endangered species incidentally captured in the fishing process (such as sea turtles, dolphins and others);
- Effects on the food web of the marine ecosystem by the harvesting of top predators. Lack of top predators will alter the food chain and cause unanticipated imbalances in the food web.

### 2.2.3 Socio-economic impacts

The future of the Mediterranean fishery sector is far from certain. Current pressure on stocks and restricted access to third party waters make any increase in production highly unlikely in many Mediterranean countries. Moreover, Mediterranean EU Member states have had to comply with additional fishing capacity restrictions instituted under the European Community Multiannual Guidance Programmes in the mid-1980s.

In terms of volume of landings, the Mediterranean accounts for a modest five percent of total world landings. However, the economic value of the landings is much higher. This is explained by the fact that most of the catches landed in the Mediterranean are for human consumption, even catches of small fish, which generate higher value.

The total export value of the fishery sector has also been increasing from 1985 to today. The vitality of the sector is based, as shown in Figures 2.14 and 2.15, on expanding international as well as domestic demand

*Figure 2.14 Fish and Fisheries Exports in Million US$ from the Mediterranean (Source: FAO Fishery Statistics)*

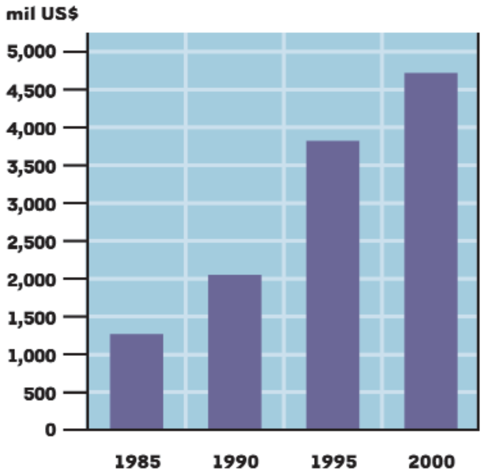
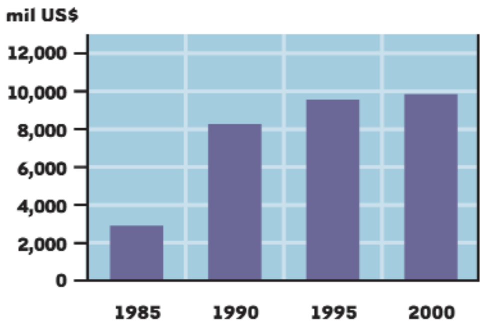



*Figure 2.15 Fish and Fisheries Imports in Million US$ to the Mediterranean (Source: FAO Fishery Statistics)*




for fish and fish products shown through total export and import volumes for the period 1985–2000. An important source of demand for fish is the tourism industry in the Mediterranean.

Moreover, the expanding size of total catches indicates that the sector is one of growing economic and social importance. Figure 2.13 shows total landings of marine fish in the Mediterranean over the past four decades. As can be seen, apart from a slow down in the 1980s partly due to a collapse of anchovy stocks, marine fish catches have been growing continuously. In 2000 total marine fish catches were recorded at 1.3 milion MT.

The socio-economic impacts of the decline of fisheries in the Mediterranean could therefore be summarized as follows:

- Unsustainable practices threaten high value Mediterranean fisheries;

- Future growth potential of Mediterranean fisheries sector made uncertain by current overfishing;
- Loss of fisheries a liability to the Mediterranean tourism industry;
- Loss of employment linked to decline of fisheries;
- Decline of rural fishery-based economies;
- Loss of food stability may cause social unrest in some areas;
- Structural decline of fisheries causes unemployment and occupational dislocation.

### *2.2.4 Causal Chain Analysis*

The Causal Chain Analysis (CCA, Figure 2.2.1) summarizes the major causes of Decline in Fisheries. These causes are linked to a variety of factors, some technological, some socio-economic, and some legal / regulatory. In general, a legal / regulatory framework exists in the Mediterranean Sea to help govern the fisheries activities. The General Fisheries Commission for the Mediterranean (GFCM), a regional fisheries body, was established in 1952, and strengthened several times following that time (1963, 1976, and 1997). It provides a regional framework for addressing fisheries issues, including marine conservation. In addition, FAO has several sub-regional bodies focusing on fisheries resource management. The fisheries in the Northern Mediterranean are subject to additional fishing capacity restrictions instituted under the European Community Multi-annual Guidance Programmes in the mid-1980s.

Primary causes for decline in fisheries include:

- Excessive fisheries effort in some areas of the Mediterranean;

***Case Study***

**The status of the French fishing industry:**

**Vulnerable to foreign competition and exchange rate volatility** *(Source: FAO, 2003)*

The relative stable level of landings in recent years masks the growing economic difficulties facing the French fishing fleet. One set of problems is linked to the growing scarcity of resources. Apart from its direct effect on fishery yields, this scarcity has led both national and European Union authorities to impose strict measures in order to monitor and restrict catches, notably by adopting quotas according to species, zone and country and through programmes to modify fishing capacity.

Other problems are linked to the globalization of trade, which facilitates access of low-priced products to the French market. Another problem is monetary deregulation within Europe, which in 1993 and again in 1994 led to marked falls in producer prices (-16 percent at constant franc-denominated prices between 1992 and 1994) and cast many fleet operators into severe financial straits. Consequently, many vessels have had to increase their effort (number of days at sea) in order to make up in part for the resulting fall in turnover by increasing landings.

In 1993, the number of people directly employed covered barely 0.3 percent of the active population. However, political and economic decision makers are becoming increasingly aware of the essential economic role that fisheries and related activities play in certain regions.

***Case Study***

**The Italian fishing sector: Distribution leads the way to restructuring sector** *(Source: FAO, 2003)*

Current pressure on stocks and restricted access to third party waters make any increase in Italian fishery production highly unlikely. Only a few sectors (tuna fishing in particular and exploitation of new species such as deep-sea species) offer some avenues for expansion. As regards fishing activities themselves, the retirement of vessels, whether voluntary or from a shutdown of activities, should be offset by increased productivity and greater fishing effort by the most modern and efficient parts of the fleet. Apart from this, the structure of the fleet itself should change little. After the extensive renewal and heavy investments of the late 1980s, the current difficulties of many operators are not likely to encourage further investment. The main changes should concern the structure and functioning of the sector under the combined pressure of market liberalization and greater large-scale distribution.

Fisheries-related activities seriously influence the economy of coastal communities, employing more than 44,500 people in fisheries, 6,000 in aquaculture, 7,900 in the processing industry and 12,460 for distribution and sales. Some regions are more involved in certain activities, such as Sicily, where marine fisheries employ more than a quarter of all Italian fishermen; about 4,500 people work in lagoon management and related fisheries.

- Use of harmful fishing practices, including non-selective catch techniques and use of bottom trawls that lead to excessive by-catch, as well as the development of more efficient technologies (ships and fish-finding gear) that could possibly lead to over-exploitation if not carefully monitored and controlled;
- Loss of shallow-water habitats for some life stages of critical fisheries; and
- Adverse water quality from rivers, coastal aquifers, sewage discharges, dredging, and non-point source discharges.

Root causes for decline in fisheries include:

- Ineffective stakeholder awareness in some parts of the Mediterranean area;
- Inadequate stakeholder involvement in environmental issues in some parts of the Mediterranean;
- Insufficient enforcement of some regional and national legislation;
- Insufficient budget for environmental improvements, including sewage treatment, source control, agricultural control, etc.

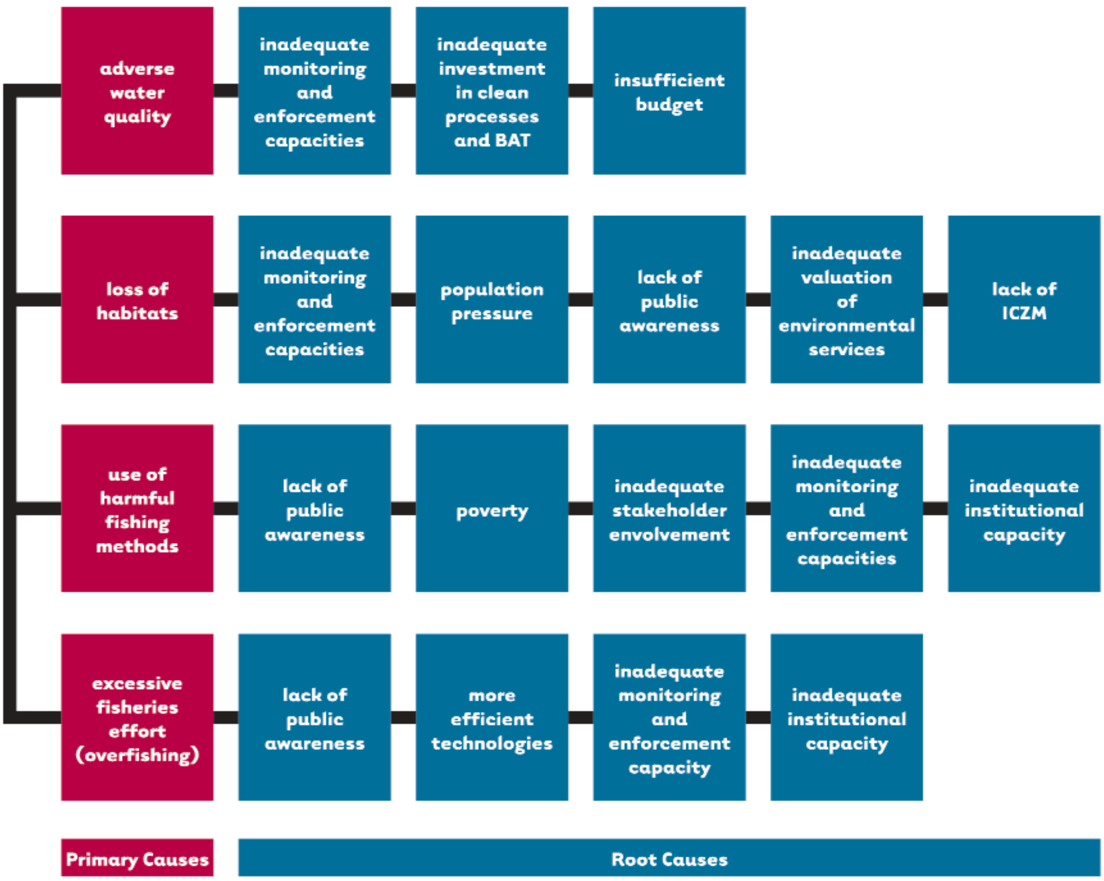
*Figure 2.2.1 Causal Chain Analysis: MPPI 2: Decline in Fisheries*

**Environmental Impacts:**

- Alteration and destruction of benthic habitat
- Effects on non-target populations due to by-catch, etc.
- Effect on endangered species incidentally captured in the fishing process (such as sea turtles, dolphins, and others)
- Effects on the food web of the marine ecosystem

**Socio-economic Impacts:**

- Unsustainable practices threaten high-value Mediterranean fisheries
- Future growth potential of fisheries made uncertain by current overfishing
- Loss of fisheries aliability to tourism industry
- Loss of fishery-related employment
- Decline of rural fishery-based economies
- Loss of food stability may cause social unrest in some areas



### *2.2.5 Supporting data*

*2.2.5.1 State of the resources*

Most of Mediterranean fishery resources whether they are demersal, small pelagic or highly migratory species, have long been considered overexploited. Figure 2.13 above shows the total marine catches for the past several decades. Although giving the overall impression of stability in fisheries resources, a close look reveals changes in the composition of the fisheries, in the underlying structure of the fisheries, of the pressure on fisheries, etc.

With regard to highly migratory species, the eastern bluefin tuna stock has been assessed in the past by the International Commission for the Conservation of Atlantic Tunas (ICCAT), which has indicated heavy over exploitation. Although the thoroughness of these evaluations is arguable due to considerable uncertainties resulting from the lack of data, there is little doubt that the stock is overexploited. The level of bluefin tuna being caught and put in cages in the Mediterranean area for rearing purposes and often outside a framework of regulated and reported catches, is also a source of concern. This fishing activity is believed to increase the pressure on the stocks.

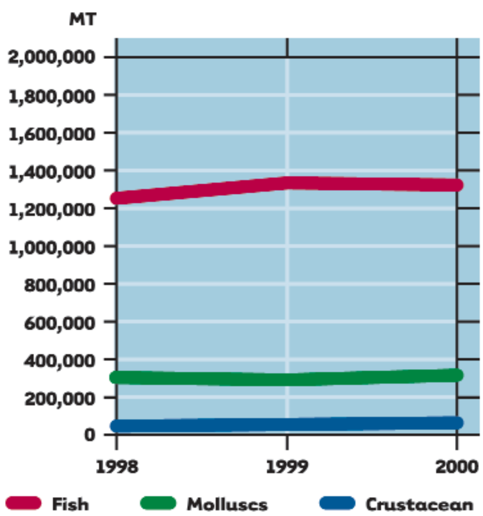
Similar considerations on over-exploitation apply to swordfish in the Mediterranean where there is evidence of an exploitation pattern, which results in large quantities of juveniles and recruits of the year present in the catches. Major efforts in data collection are required to get a clear picture of the status of the key stocks, although indications based on current data paint an extremely negative picture.

Catch statistics on demersal and small pelagics species have shown a negative trend in the 1990s for the most important species or groups of species. The decline in demersal fish catches overall for the 1990s exhibited a slight positive trend starting from 1998 as shown in Figure 2.16. Although the catch trend is positive, its quality, both in terms of species and size composition, has declined (ref. to chapter 2.3). Long lifespan species and bigger size specimens have practically disappeared from demersal catches in several areas and fisheries. Daily catch rates per vessel have fallen dramatically when compared to catch rates of some decades ago despite the fact that power and efficiency of fishing vessels have increased in recent times.

The current evaluations of demersal, small and large pelagic fisheries, carried out within the GFCM and ICCAT frameworks, confirm this picture of overexploitation of several resources and highlight the need to reduce the mortality on juveniles as well as the overall fishing effort by about 15–30 percent for those fisheries focused on overexploited stocks.

Despite the recognized overexploitation of several resources, there are few scientifically reported cases of stocks at risk of collapse. Anchovy in the Northern Spanish coast, black spot bream in the Alboran Sea and hake in the Gulf of Lions are among those documented cases, however. This long-term resilience of Mediterranean fisheries, without so far detected dramatic collapses of target resources, except for anchovy in the mid-1980s, is usually explained by the fact that some proportions of adult stocks have most probably remained consistently unavailable to small mesh trawling. This feature of Mediterranean fisheries, as determined by fishing practices, has led to the creation of enclaves within the normal range of distribution of several species that allows a proportion of the stock to survive to maturity, thus preventing the collapse of the population. However, the situation has changed rapidly in the last decade, with the increasing efficiency of fishing methods both in terms of vessel engine power, the size of gear and vessel characteristics, and above all, the development of fixed gear fisheries targeting spawners of several long-lived species in areas that have not been able to be trawled effectively until recently. Furthermore, widespread illegal trawl fisheries in coastal areas have reduced the refuge effect, resulting from the poor enforcement of the current regulation limiting the use of towed gears at depths greater than 50 meters or at a distance from the coast greater than 3 miles if depth is less than 50 meters.

***Figure 2.16 Total Landings in MT of Marine Catches by Mediterranean and Black Sea Countries***



#### 2.2.5.2 *Interactions of fishing with non-commercial resources*

Mediterranean fishing grounds are usually found quite close to the coast where the highest biodiversity is located. There is an increasing awareness and concern about fishing impact both on habitats and non-commercial resources.

Apart from legal obligations concerning environmental protection, there is a clear interest to ensure the conservation of the target species, but also of species belonging to the same ecosystem or associated with or dependent upon the target species. This approach is basic to preserve the biodiversity and integrity of marine ecosystems and hence, the production of essential fish habitats for the sake of the fisheries sector too.

The main threats to marine resources posed by fisheries in the Mediterranean can be divided into two major groups: damages to biodiversity and damages to habitats.

To the first group belongs the widespread use of small mesh size fishing gears as well as excessive fishing of commercial species. As for other resources, sustainable use by curtailing catches is bound to have a positive impact on the environment.

Nowadays many non-target species are under threat, such as sea-mammals, birds, reptiles and non-commercial stocks. High by-catch and discard rates are the main sources of threat for these populations. Due both to the low selectivity of small mesh size trawl gear and to mismatching between legal mesh size and minimum landing size by-catch rates as high as 60 percent are known to occur. Given also that about half of discarded species constitute edible biomass with commercial value, the inefficiency of current fishing practice is large. Estimates computed in the Aegean and the Greek Ionian Seas pointed out that bottom trawl discards range between 13,000 to 22,000 tonnes annually, which is about 12 percent of the total landings.

#### 2.2.5.3 *Eutrophication*

While on a moderate scale eutrophication can sustain more marine life in the Mediterranean, on an excess level it will lead to decline and degradation of living resources. Episodes of anoxia in the Northern Adriatic and elsewhere (see Table 2.1), have led to localized fish kills showing that oxygen depletion due to high nutrient inputs can be devastating for local fisheries. That is the case of the coastal areas of Emilia Romagna in Italy, where repeated toxic poisoning by dinoflagellates have led to bans in the harvesting and sale of mussels (*Mytilus galloprovincialis*).

Areas most prone to the negative impact of eutrophication on fisheries are semi-enclosed basins, estuaries and lagoons where an excessive level of nutrients is likely to remain undispersed. In these areas, such as the Northern Adriatic, one may expect that further increase in nutrients will lead to a decline in fisheries production with damaging repercussions for the local economy.

Although eutrophication in the Mediterranean Sea is not the priority cause of decline in environmental quality that it is in the adjacent Black Sea, eutrophication is a wide-spread local problem that appears to be increasing, and that has transboundary impacts through loss of habitat for shared and migratory fish resources.

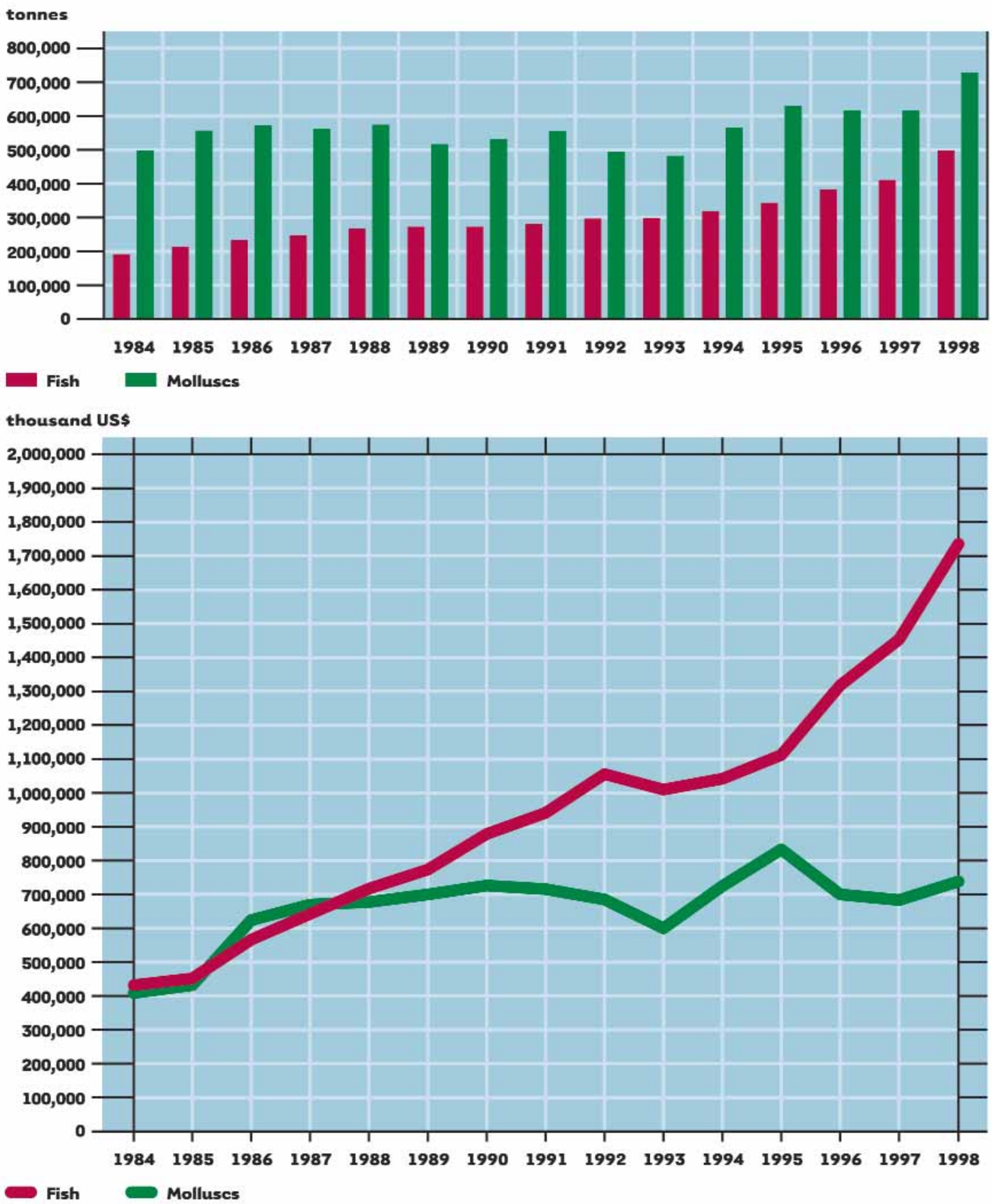
#### 2.2.5.4 *Interaction of mariculture with fisheries*

Mariculture is a relatively new source of pressure on the marine environment and fisheries. The boom in regional aquaculture production from 78,180 tonnes in 1984 to 248,460 tonnes in 1996 (Figure 2.17) has produced a number of additional environmental concerns. The overall impact of mariculture on the Mediterranean Sea environment is so far limited compared to other pollution sources; however, in view of the probable expansion of these activities their impacts are included in this report. This is an area of possible future threat if not regulated adequately at this early stage.

Mariculture is in direct competition with other uses of coastal areas, including fisheries' breeding grounds. Mariculture is concentrated in the coastal zone and therefore particular attention must be paid to site selection in order to ensure that local ecosystems can absorb impacts without harmful lasting effects. The effects of introducing aquaculture activities in a marine or brackish environment vary according to an area being closed, semi-closed or open. The effects of phosphorus and nitrogen released from aquaculture in the form of animal excreta or uneaten feed are estimated to be relatively small compared to total discharges from agriculture, urban and industrial sources. However, discharge from intensive mariculture often represents a localized, point source pollution form whose impact on oligotrophic waters could be significant. The consequences for fisheries could include eutrophication and resulting depletion of oxygen levels which if severe, could lead to fish kills in the vicinity of aquaculture stations.

Use of antibiotics by aquaculture may affect the fitness of fish populations by stimulating antibiotic resistance in microbial communities. GESAMP (1991)

*Figure 2.17 Fish and Molluscs Aquaculture Production in the Mediterranean and its Value* (Source: Georgiou, 2001)




identified indiscriminate use of drugs as a source of concern in the prevention of fish diseases. Bacteria found near fish farms have been reported showing total resistance to oxytetracycline, the most commonly used antibiotic in mariculture (Torsvik et al., 1988; Samuelsen et al., 1992).

Toxicological effects of non-target species may be associated also with the use of chemicals. Among the pesticides that may have toxicological effects on the surrounding invertebrate fauna are the organophosphate ectoparasites. Organophosphate bath treatments result in the release into the surrounding waters of significant quantities of toxic material liable to affect crustaceans particularly in their larval stages. For instance the use of carbaryl pesticides to eliminate burrowing shrimp from oyster beds in the northwestern United States results in the unintended mortality of Dungeness crab, a commercially exploited species.

The environmental effects of pigments and vitamins are poorly known. Biotin has been shown to simulate growth of certain phytoplankton species and is implicated in the toxicity of the dinoflage Mate *Gymno-*

*dinium aureoles*. Vitamin B12 has been shown to be one of the growth-promoting factors of the alga *Chrysochromulina polylepis* and the dinoflagellate, *Heterosigma alashivo*.

The development of resistant bacteria population in the sediment has been documented. For example, up to 100 % of oxytetracycline-resistant bacteria have been recorded from marine sediments near fish farms after medication and resistance persisted for more than 13 months (UNEP/MAP/MED POL, 2004a).

Further, the risk of introducing new organisms and alien (exotic) species into the sea increases with the expansion of mariculture. As breeding and biotechnological techniques are increasingly used to produce varieties for mariculture purposes, there is a serious potential of escape of cultured stocks into the open sea. This presents unforeseen risks to the health and survival of wild stocks as shown by the case of the Asian clam (*Tapes semidecussatus*). Production of this clam increased rapidly in the North Adriatic in the period 1985–1996. Owing to its rapid growth and resistance to anoxic conditions, this species undermined the autochthonous species (*Tapes decussates*) so much that it could also be fished in other coastal areas.

The kuruma shrimp (*Penaeus japonicus*) that was introduced to the Mediterranean provides a similar example due to its rapid growing in aquaculture. Presently, owing to its presence in natural stocks, and because it entered through the Suez Canal, it can be considered a Mediterranean species.

Benthic enrichment is another aspect of the impact of mariculture on marine ecosystems. The general picture emerging from the existing studies indicates that the impact from intensive culture is on the seabed and that the most widely known effect is benthic enrichment beneath the sea farms. The existing studies for the Mediterranean, although small in number, have covered different Mediterranean areas.

A seasonal survey combining sediment geochemistry and macrofauna was carried out in three fish farms in Greece, situated at a depth of 20–30 m, in areas having different types of substratum and with varying intensity of water currents. The results of this study indicated that the impacts of fish farming on the benthos in the Mediterranean could vary considerably depending on the specific characteristics of the farming site. At the sampling stations under and near the cages, redox potential was found to decrease but reached negative values only at the silt bottom site. The organic Carbon and Nitrogen contents of the sediment near the cages were found to increase by 1.5 to 5 times, and ATP content by 4 to 28 times. No azoic zone was encountered in any of the stations, but the macrofaunal community was affected at distances of up to 25 m from the edge of the cages. At the coarse sediment sites, abundance and biomass increased by more than 10 times and at all sites diversity indicated that the affected ecotone extended a distance of 25 m from the cages (UNEP/MAP/MED POL, 2004a).

In the eastern Mediterranean, Environmental Impact Studies (EIS) on three fish cage farms in Cyprus, situated at depths of 25 to 30 meters, have shown that the areas below the cages displayed a gradient of biotic enrichment being reflected in changes of macrofauna diversity and abundance.

#### *2.2.5.5 Overall characteristics of the Mediterranean fishing sector*

One of the consequences of the competition for the resources at a global level, but which has also made itself felt in the Mediterranean area, has been the over-capitalisation of the fishing fleets which has lead to much greater capacities than the resource's potential. Data provided by the FAO suggest that there was almost a 20 percent increase in the number of vessels in the Mediterranean in the period 1980–1992. Although data for some Mediterranean Member States is missing, the evidence suggests that fishing effort has been intensifying in the basin.

Most Mediterranean fishing vessels are artisanal in terms of scale. More than 80 percent of the vessels are smaller than 12 m in length, and therefore catches are quite low compared to other regional seas. A specificity of the Mediterranean regional fisheries is the relatively high importance of sport or leisure fishing activity that represents as much as 10 percent of total fisheries production.

In terms of fishing gear, the number of trawlers is increasing dramatically in the Southern Mediterranean. Algeria and Morocco, for instance, experienced an increase of 137 percent and 170 percent, respectively, in the number of fishing trawls in the period 1980–1992. In the Northern Mediterranean, trawlers increased in France (+22.3 percent) and Greece (+10.2 percent) for the same period, but decreased in Spain and Italy. In terms of composition, multi-purpose vessels account for 22 percent, trawlers at 16 percent, followed by gill-netters at 13 percent, seiners at 7 percent, long-liners at 3 percent, and reap setters at 1 percent. The remaining 39 percent are other fishing vessels including dredgers, lift netters, vessels using pumps for fishing, platforms for mollusc culture, and recreational fishing vessels.

***Table 2.6 Some Shared Stocks and Fisheries in the Mediterranean***

| **Common name (scientific name)** | **Areas** | **Countries sharing the resource** |
|---|---|---|
| Albacore (*Thunnus alalunga*) | All Mediterranean | Several countries |
| Anchovy (*Engraulis encrasicholus*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| | Gulf of Lions | Spain, France |
| | Aegean Sea | Greece, Turkey |
| Blackspot seabream (*Pagellus bogaraveo*) | Alboran Sea | Spain, Morocco |
| Bluefin Tuna (*Thunnus thynnus*) | All Mediterranean | Several countries |
| Blue whiting (*Micromesistous poutassou*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| Common Pandora (*Pagellus erythrius*) | Tyrrhenian, Corsican and Sardinian Seas | France, Italy |
| | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| Common spiny lobster (*Palinurus elephas*) | Tyrrhenian Corsican and Sardinian seas | France, Italy |
| Deepwater rose shrimp (*Parapenaeus longirostris*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| | Strait of Sicily | Italy, Libya, Malta, Tunisia |
| Dolphinfish (*Coryphaena spp.*) | All Mediterranean | Several Countries |
| Eel (*Anguilla anguilla*) | All Mediterranean | Several Countries |
| European hake (*Merluccius merluccius*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| | Aegean Sea | Greece, Turkey |
| | Gulf of Lions | Spain, France |
| | Strait of Sicily | Italy, Libya, Malta, Tunisia |
| | Tyrrhenian, Corsican and Sardinian Seas | France, Italy |
| Flounder (*Platicthys flesus italicus*) | Adriatic | Croatia, Italy, Slovenia |
| Great scallop (*Pectin jacobeus*) | Adriatic | Croatia, Italy, Slovenia |
| Large pelagic elasmobranches (*Isurus oxyrinchus, Lamna nasus, Prionace glauca*) | All Mediterranean | Several Countries |
| Norway Lobster (*Nephrops nervegicus*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| | Strait of Sicily | Italy, Libya, Malta, Tunisia |
| | Tyrrhenian, Corsican and Sardinian Seas | France, Italy |
| Red mullet (*Mullus barbatus*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| Red mullet (*Mullus surmuletus*) | Tyrrhenian, Corsican and Sardinian Seas | France, Italy |
| Red shrimps (*Aristeus antennatus, Aristeomorpha foliacea*) | Alboran Sea | Morocco, Spain |
| | Ionian Sea | Greece, Italy |
| | Strait of Sicily | Italy, Libya, Malta, Tunisia |
| | Tyrrhenian, Corsican and Sardinian Seas | France, Italy |
| Sardine (*Sardina pilchardus*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| | Gulf of Lions | Spain, France |
| | Aegean Sea | Greece, Turkey |
| Sparids, several species | Tyrrhenian, Corsican and Sardinian Seas | France and Italy |
| Sprat (*Sprattus sprattus*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| Sturgeons (*Acipenser spp., Huso huso*) | Adriatic | Albania, Croatia, Serbia & Montenegro, Italy, Slovenia |
| | Ionian Sea | Greece, Italy |
| | Aegean Sea | Greece, Turkey |
| Swordfish (*Xiphias gladius*) | All Mediterranean | Several Countries |

## 2.3 Decline of Seawater Quality

The introduction of high levels of persistent toxic chemicals, nutrients as well as pathogenic micro-organisms into the Mediterranean is a major source of national, regional and international concern. The resulting decline in seawater quality is manifested as increasing incidences of eutrophication accompanied with reduced transparency and frequent algal blooms, high concentrations of heavy metals and persistent toxic substances (PTS) in the seawaters as well as high microbiological contaminant loads.

This section sets out to identify substances that are particularly important in terms of transboundary pollution impacts in the Mediterranean. Nitrogen and phosphorus compounds, heavy metals (mercury, cadmium, arsenic, copper / zinc, lead), persistent pesticides, polychlorinated biphenyls (PCBs) and oil-related polycyclic aromatic hydrocarbons (PAHs) are the focus of this survey. In addition, concentration data are provided where available and an assessment of major pathways of transport of the substance into the sea is attempted.

Decline in seawater quality in the Mediterranean is often a localized phenomenon. Mediterranean coasts are dotted by pollution hot spots, usually located in semi-enclosed bays close to big cities, harbours and industrial areas. Eutrophication affecting the ecological balance of the marine food web and resulting in animal kills is mainly a coastal problem while the open sea remains relatively healthy.

In addition there are stark differences in seawater quality concerns between the North and South Mediterranean. Population growth, still occurring in the southern Mediterranean, is a major force that will increase urban and industrial pollution problems of the region in the future. Southern countries may also be exposed to imports and consumption of persistent pesticides, which have become obsolete in the north but whose remaining stockpiles are a source of concern.

On the other hand, stockpiles of PCBs-containing equipment are mainly found in the North as PCBs production is linked to economic development. Decontamination of materials and oils containing PCBs, therefore, is a burden affecting mostly the northern Mediterranean. The Northwestern Mediterranean is also potentially a hotspot for anti-fouling paint pollution released in the process of ship maintenance.

Oil shipping operations continue to be the main source of PAHs causing significant decline in seawater quality in the Mediterranean. The sweeping and ongoing increase in freight passing through Mediterranean ports over the last decades calls for safer and cleaner shipping operations to mitigate environmental costs.

As far as urban pollution is concerned, lack of sewage infrastructure is still the greatest problem. Virtually 60 percent of urban wastes, including microbiological, nutrient and chemical contaminants, are discharged untreated into the sea, according to 1999 information.

### *2.3.1 Transboundary elements*

Pollutants often travel great distances through air, sea currents and rivers before their effects can be traced. The objective of this section is to highlight transboundary movement of pollutants relevant to Mediterranean seawater quality concerns. Persistent toxic substances dispersed by atmospheric circulation patterns, transboundary transport of PAHs, as well as Mediterranean seawater exchange and evidence of long-range biological pollution impacts on sea birds will be the main focus areas.

#### *a. Long-range transport of PTS via the atmosphere*

Differential heating between the land of North Africa (almost bare soil), the Mediterranean waters and the land of South Europe produces a typical Mediterranean atmospheric flow with a strong northerly flow. This northerly flow is pronounced during the warm period of the year.

A particularly well identified and significant pattern of atmospheric circulation in the Eastern basin is the consistent flow directed from South and Eastern Europe towards the North African Coast and the Middle East which results in the transport of polluted air masses from Europe towards North Africa and the Middle East. The time scales for such transport processes are approximately 2–4 days. The air quality in urban areas of Southeastern Europe, North Africa and the Middle East is affected significantly by the long-range transport patterns described because the time scales are still within the life span of most air pollutants. By implication, seawater may also be affected in Southeastern Europe from atmospheric deposition of PTSs.

***b. Mediterranean seawater exchanges***

The Mediterranean Sea is a semi-enclosed basin having interactions with the adjacent Atlantic Ocean and Black Sea through the Gibraltar and Turkish straits, so that seawater exchanges may play a role in the transboundary transport of PTS.

The Eastern Atlantic has a permanent exchange of waters with the Mediterranean Sea through the Strait of Gibraltar. This exchange results from the evaporation of the Mediterranean waters, which become more dense than those of the North Atlantic, and generate an inflow of fresher and lighter Atlantic upper waters into the Mediterranean and an outflow of more saline and denser deep Mediterranean water to the Atlantic (Hopkins, 1999). Despite its initially very high density, the Mediterranean water outflow does not reach the bottom of the North Atlantic because it entrains a substantial volume of the overlying Atlantic waters while still in the Gulf of Cadiz. Thus, the resultant mixed Mediterranean waters become neutrally buoyant at depths between 900 and 1,200 m and finally reach the open North-central Atlantic, in the form of water lenses (eddies).

On the other hand, the Black Sea is connected with the Mediterranean through the Sea of Marmara where there is a surface outflow of less saline waters from the Black Sea and an inflow of denser Mediterranean waters, which results in the formation of a permanent halocline / pycnocline at depths of 100–150 m in the Black Sea. The annual volume of the outflow (658 $km^3$/y) from the Black Sea is nearly twice that of the salty water import (337 $km^3$/y) via the Bosphorus undercurrent, but this counterflow system is balanced at the Dardanelles exit (1,331 $km^3$/y upper flow; 1,010 $km^3$/y underflow).

The Black Sea has significant pollution levels. The Black Sea has a very large catchment area, receiving extraordinary amounts of nutrients, pollutants as well as fresh water and sediment inputs from the rivers draining half of Europe and some parts of Asia. Moreover, during recent years, the number of tankers as well as the amount of hazardous materials transported across the Sea and through the Turkish Straits has increased (from 4,248 in 1996 to 6,093 in 2000), and this will continue as the amount of oil production from the Caspian region increases.

Taking into account these particular hydrogeographical conditions, a major question has been raised concerning the significance of these water exchanges in the transboundary transport of pollutants.

***c. Biological indicators of long-range transport of PTS in seabirds within the Mediterranean basin***

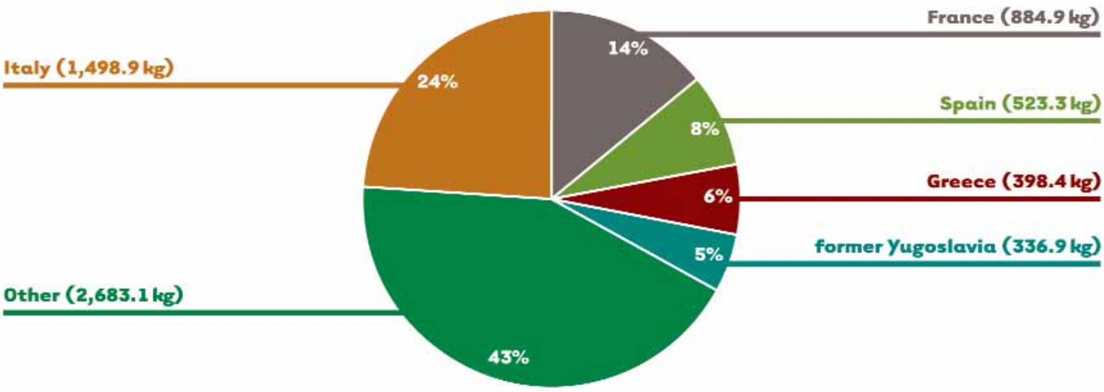
Levels of total DDT in seabirds (ref. to chapter 2.1) in the Mediterranean have been reported to be significantly higher than those of North Atlantic and Arctic birds, indicating a regional / local pollutant source.

Median PCB levels are also significantly higher in the eggs of Mediterranean seabirds than elsewhere; only the Herring Gull (*Larus argentatus*) in the North Atlantic reached higher levels, similar to those found in Audouin's Gull (*Larus audouinii*) eggs from Capraia Island in the Tuscan archipelago (Italy) (Leonzio et al., 1989). However, when considering the DDT / PCBs ratios, the Mediterranean shows an intermediate position between the heavily industrialised North Atlantic and the pristine Arctic, where DDTs are the predominant chlorinated pollutants.

### *2.3.2 Transboundary source-receptor relationships in PAH deposition*

An evaluation of transboundary transport of PAHs between countries of the region has been carried out for 1998 on the basis of the "source-receptor" approach. Calculations have been performed for B[a]P as the most representative component of this class of

*Figure 2.18 Deposition of B[a]P to the Mediterranean Sea*




compounds. A summary of the contributions of depositions of B[a]P to the Mediterranean Sea is shown in Figure 2.18. It is shown that most depositions are derived from Italy (1,499 kg, 24 %), France (885 kg, 14 %) and Spain (523 kg, 8 %).

### 2.3.3 Environmental impacts

- Eutrophication incidences in coastal waters resulting in algal blooms, red tides, water discoloration, putrefication, fish mortality, dystrophy, mollusc mortality, bottom fauna mortality, poor transparency;
- Adverse impact on water quality from presence of mercury implicated in inhibition of growth and harmful effects on fitness of marine plants and animals;
- Degradation of seawater quality from presence of cadmium linked to growth retardation of marine organisms, decrease in invertebrate survival rates, decalcification of marine animals and seabird skeletons;
- Seawater quality decline from presence of zinc / copper in seawater associated to risks of reproductive capacity impairment for sea organisms;
- Environmental degradation of seawaters by presence of lead implicated in central nervous system disorders, motor abnormalities and blindness of marine organisms;
- Disruption of seawater ecological quality by the presence of chlorinated hydrocarbons associated to high bioaccumulation with potentially lethal effects for marine mammals and seabirds;
- Degradation of waters by increased microbiological content.

### 2.3.4 Socio-economic impacts

- Fish kills and toxin-contaminated shellfish linked to eutrophication reduce fisheries' base;
- Loss of income in the fisheries sector;
- Unemployment rise induced by the decline in fisheries;
- Loss of aesthetic value linked to eutrophication events;
- Loss of tourism;
- Loss of employment and income related to tourism;
- Loss of cultural heritage.

The most important cases of eutrophication are found along the northern and western coasts of the Adriatic Sea. Starting in the 1970s, eutrophication phenomena such as algal blooms and the production of mucilage have given rise to great concern, particularly in the northern Adriatic, because of their new considerable frequency, intensity and geographical extension.

The decline of seawater quality in the northern Adriatic compounded problems in tourism development, a vital economic activity for the region. Broadly speaking, in the region two types of tourism dominated until the early 1990s: (a) a hotel based, mass type of tourism attracting mainly national tourists and visitors, and (b) a type of tourism based on private houses, flats for rent and camping sites attracting foreign tourists. However, trends in tourist behaviour characterized by a reduction in the average length of holidays and greater attention to the quality of the natural environment, services offered and value for money as well as the emergence on the market of new seaside holiday resorts, the impact of large tour operators and air transport on tourist flow patterns, affect tourism development in the northern Adriatic Sea and have led to a restructuring process in major upper-Adriatic resorts aiming to combat three major issues: (a) environmental degradation and overcrowding, (b) the need to improve the quality of existing services, and (c) the need to diversify services and resources offered.

During the late 1980s, early 1990s, this already complex picture was further complicated by the issues of eutrophication which first started gaining importance in the Italian Seas in the mid-1970s. This form of pollution is caused by the large inflow of freshwater to the basin from the catchment area of the northern Adriatic Sea, a great part of which is Italian territory. On a national scale, coastal and inland waters receive about 48,000 tonnes/year of phosphorus and 660,000 tonnes/year of nitrogen. The most critical situation is encountered south of the Po river delta near Ravenna in a marine area for about 100 km, where the polluting effects of Po's waters are serious, especially during summer months. Furthermore, the widespread appearance of phenomena of mucilage (mucillagine), associated with cloudy sea or marine snow in many parts of the upper Adriatic coastal waters in the summers of 1988 and 1989, resulted in the significant reduction of the number of tourists to the area on the order of 20–30 percent, which has been reversed since that time. Also the figure of total night stays for the province of Rimini declined from 17.777 thousands (1988) to 11.724 thousands (1989) and has not fully recovered since, possibly indicating a trend for shorter length of stay. In fact, eutrophication and mucilage worsened a situation that was already becoming critical since many northern Adriatic resorts were entering the maturity stage. However, the extent to which eutrophication was a result of transboundary pollution and the degree to which tourism development in the region was affected by transboundary pollution or by the dominant trends in the tourism market cannot by fully appraised and needs further investigation (Zanetto and Soriani, 1996).

Further, the recurrent phenomena of eutrophication and the general deterioration of water quality in the northwestern Adriatic have had serious negative repercussions on fisheries. With regard to fishing and mollusc farming in particular, considerable damage has been done by the dinoflagellate of the genus *Dinophysis*, which produces (DSP) toxins. The occurrence of these flagellates, which have become more plentiful during the last decade, has led to temporary and prolonged bans on the harvesting and sale of mussels (*Mytilus galloprovincialis*) farmed in the coastal and lagoon areas of Emilia-Romagna. Further, *Alexandrium tamarensis*, a dinoflagellate capable of producing (PSP) toxins, has been observed in the waters of the northern Adriatic, although no pathologies in the resident populations attributable to PSP intoxication have ever been encountered.

Considering that the eutrophication phenomena are no longer occasional events, but are induced by structural deficiencies on land, there is a need to eliminate such deficiencies, which are mostly linked to agriculture, animal husbandry and municipal sewerage. During the 1980s, important laws, decrees and norms were approved at the European Community and the national levels mostly addressing the reduction of phosphorus in the detergents produced, bringing the limit down to 1 percent. As a result, it has been possible to quantify a decrease of 10,000 t/year in the input of phosphorus to the sea. In contrast, no important reduction of nitrogen in the sea has been monitored in spite of a 1991 Community norm in that direction. This is mostly due to the difficulty of applying the norm (e.g., lack of economic incentives) and the lack of controls.

The major socio-economic impacts of decline in seawater quality therefore can be summarized as:

- Reduced fish production due to fish kills and toxin-contaminated shellfish linked to eutrophication, leading to loss of income;
- Rise in unemployment caused by the decline in fisheries;
- Possible increase in social instability due to loss of livelihoods;
- Loss of aesthetic value linked to eutrophication events;
- Loss of employment and income related to tourism, especially in the sports-fishing industry;
- Loss of cultural heritage.

#### *2.3.5 Causal Chain Analysis*

Figure 2.3.1 presents a causal chain analysis (CCA) for decline in seawater quality, indicating the primary and root causes of decline in sea water quality, as well as the socio-economic and environmental impacts arising from the decline in quality.

The CCA depicts the primary causes for decline in seawater quality as:

- Inadequate sewage treatment in large portions of the Mediterranean Sea (only 40 % of the sewage is treated to acceptable levels);
- Lack of best practices in agriculture use of fertilizers and pesticides / insecticides;
- Inadequate controls on atmospheric emissions of heavy metals and persistent organic pollutants from European industrial sources;
- Inadequate source controls and discharge control for industries along the sea;

- Increases in shipping traffic across the Mediterranean with consequent increase in accidental and purposeful discharge of harmful pollutants.

The CCA identifies the root causes of decline in seawater quality as:

- Inadequate stakeholder participation in governance of the commons;
- Lack of public awareness of environmental matters in some portions of the Sea;
- Low priority accorded environmental protection in some regions of the Mediterranean;
- Insufficient institutional and human capacity for monitoring and enforcement in some countries of the Sea;
- Lack of budget.

***Figure 2.3.1 Causal Chain Analysis: MPPI 3: Decline in Seawater Quality***

**Environmental Impacts:**

- Algal blooms, red tides, etc.
- Reproductive, developmental and other effects from heavy metals
- Effects from chlorinated hydrocarbons
- Increased disease from microbiological pollution
- Disruption of coastal ecotones
- Loss of endangered species

**Socio-economic Impacts:**

- Reduced fish production
- Rise in fisheries unemployment
- Increase in social instability
- Loss of cultural heritage
- Loss of aesthetic value
- Rise in tourism-related unemployment

### *2.3.6 Supporting data*

*2.3.6.1 Eutrophication*

Eutrophication in waters or waters where one can find abundant food (nutrients) is no longer an occasional occurrence but a chronic problem in the Mediterranean. From 1965 to 1995 nutrient levels in the Western Mediterranean have increased annually, with the highest concentrations found close to river deltas and estuaries or near large urban agglomerations, as shown on the satellite image illustrating chlorophyll concentration in surface waters of the Mediterranean Sea in Figure 2.19.

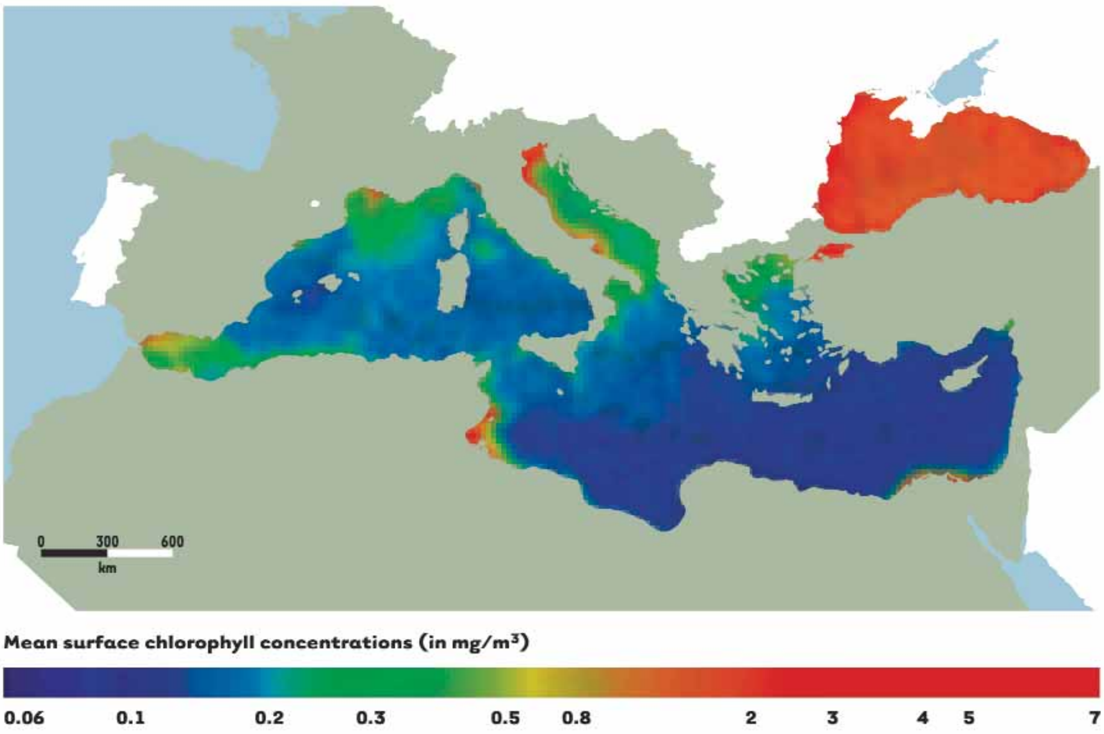
As can be seen in Figure 2.19, the problem of eutrophication, severe though it may be locally, is limited to specific coastal and adjacent offshore areas. Northern shores are most affected, but South and Southeast Mediterranean countries are not excluded from the affected area. Rather, data on Mediterranean eutrophication should be read with caution since relatively lower incidences reported in the South may be linked to less active monitoring networks.

The mechanism of eutrophication is complex and depends on additional factors other than high nutrient input. The main effect of eutrophication is changes in the food web leading to increases in phytoplankton biomass. The main consequence of eutrophication is rapid consumption of oxygen in the bottom layers. Put simply, the factors that combine to set off the process of eutrophication may be grouped in two categories: those that affect the dispersion of nutrients in the water, such as water movement, or the oxygen cycle near the bottom layer of the sea, such as light permeability.

Eutrophication is used in the context of ecological quality of waters to refer to a decline in ecological water quality. The visible effects of deterioration in water quality caused by eutrophication are algal blooms or red tides, algal scum, enhanced benthic algal growth and, at times, a massive growth of submerged and floating macrophytes. Occasionally, these manifestations are accompanied by cycles of visible bacterial blooms and fungal growth leading to oxygen depletion in bottom waters and fish kill. A table of eutrophication effects recorded in different coastal areas of the Mediterranean is provided in Table 2.12.

As an example, recurrent lack of oxygen or anoxia in the bottom waters of the Northern Adriatic basin caused profound modifications in the benthic ecosystem. There were considerable reductions in the original populations of the least mobile bottom organisms (molluscs, crustaceans, and polychaetes) most sensitive to oxygen deficiency. Repetition of these dys-

***Figure 2.19 Mean Chl-a Concentrations in Autumn 1998*** *(Source: NASA Sea WiFS Project and ORBIMAGE Inc.)*




*Note: A composite of all data received during September, October and November derived from the Sea WiFS ocean colour sensor.*

trophies has led to the disappearance of about fifteen species of mollusc and three species of crustaceans. The effects of eutrophication on Mediterranean biodiversity are discussed in more detail in section 2.1.5.3.a of this document.

During eutrophication, the ratio of nitrogen to phosphorus compounds, which is basic to the development of aquatic life, changes. In some cases, one of the two nutrients will be bound to aquatic life and will not be available for further algal growth. This element is then called the limiting factor. Understanding which element is the limiting factor is important in order to control algal growth.

According to Krom et al. (1991) primary production in the eastern Mediterranean (data from the Levantine basin) is limited by phosphorus. On the other hand, recent data from the eastern basin seems to suggest that nitrogen is the limiting factor in offshore waters. In surface waters of the Ligurian sea, Bethoux et al. (1992) report values indicating a slight tendency for nitrogen to be the limiting factor. Other authors (Marchetti, 1985) show phosphorus limitation in the Adriatic Sea, an area often subjected to eutrophication events, while Mingazzini et al. (1992) suggest that phosphorus is the limiting factor in the coastal waters off Emilia-Romagna.

Overall, the degree of phosphorus limitation increases from west to east across the entire basin. However, a more precise estimate on nutrient limitation is not possible based on the restricted number of local measurements. That is partly because seasonal factors change the situation at different times of the year.

Furthermore, when evaluating eutrophication effects, it should be remembered that reliable figures are still rare because of the inherent difficulties of measuring anthropogenic eutrophication under conditions of high natural variability. Moreover, the few phytoplankton time series available for the Mediterranean are mostly land-based and thus monitor only near-shore waters, with the exception of some rare time series like the one in the Corso-Ligurian Sea (offshore from Villefranche). Given current limits of knowledge, it is impossible to predict the appearance of eutrophication effects and how harmful they may be.

*a. Origins of eutrophication*

Human activity has contributed dramatically to nutrient enrichment in the Mediterranean. Agriculture, followed by domestic and urban activities, are the two main sources of high nutrient loads that trigger eutrophication. Although it is difficult to determine to what extent each anthropogenic factor is the cause of eutrophication, an attempt to do so has been made by EEA (1999a) and the results are shown in Figure 2.20 and Figure 2.21.

*Agriculture*

Run-off water and eroded soil of agricultural areas are among the main causes of eutrophication in the basin. This non-point form of pollution concerns basins draining into the Mediterranean covering a total area of about 1.9 million km$^2$ not counting the upper Nile basin, and include 24 countries (UNEP, 1997). As the Mediterranean basin is receiving waters from the Black Sea, there is also a remarkable effect of the Black Sea on the Eastern Mediterranean, mainly the Aegean Sea.

**Figure 2.20 Phosphorus Load into the Mediterranean Sea**

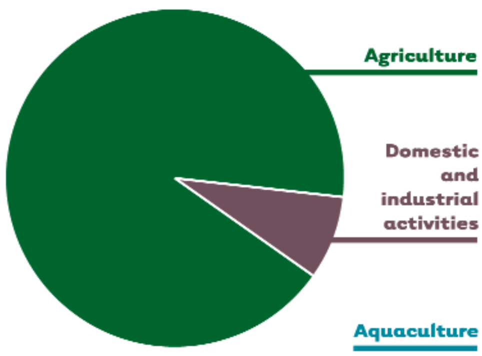
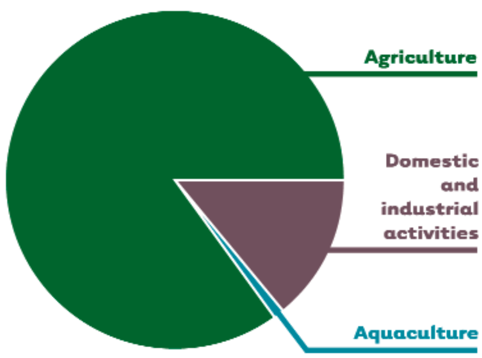



**Figure 2.21 Nitrogen Load into the Mediterranean Sea**

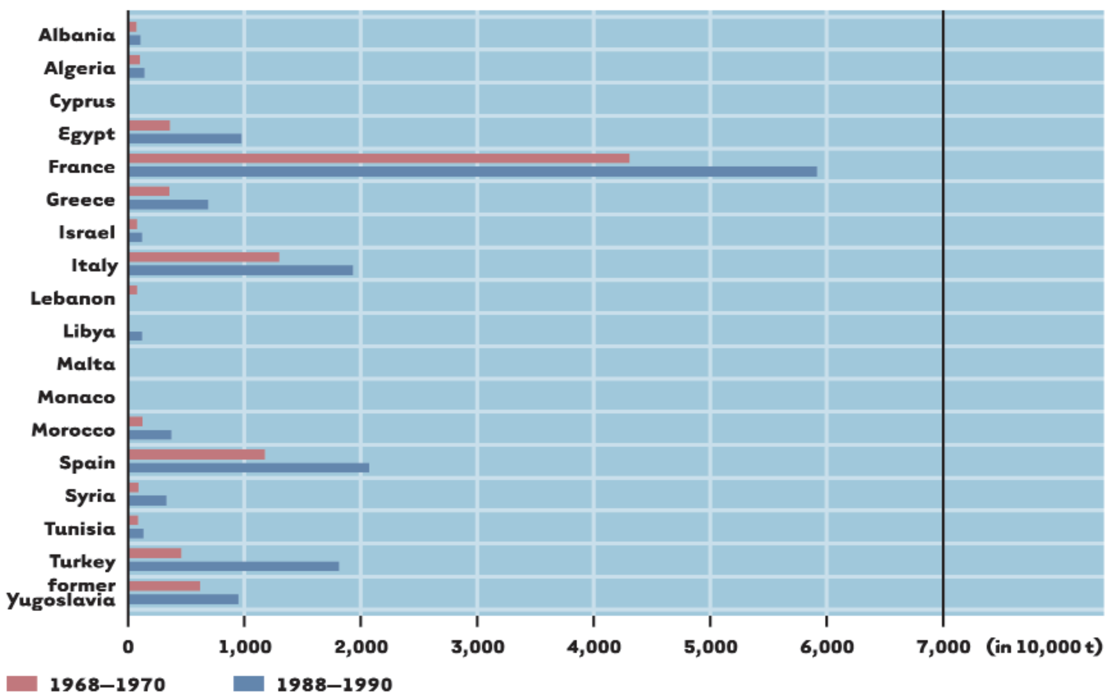


Through the mechanisms of leaching and sediment transport, phosphorus, nitrogen and organic carbon in soils are carried into ground waters, wetlands, rivers and lakes and finally reach the sea. A further issue is ammonia ($NH_3$) emissions released in connection with the production and spreading of animal manure. The issue of ammonia ($NH_3$) pollution stemming from agriculture has attracted more attention in environmental political debate in recent years. As a result, steps have been taken to remedy the poor state of data on ammonia emissions in the framework of the United Nations Economic Commission for Europe (UN/ECE) to combat acidification and eutrophication and ground-level ozone, as well as the EU Directive on national emissions ceilings (NEC Directive). The only reliable data available concern EU Mediterranean countries and suggest a decline in total $NH_3$ emissions for the period 1990–1994. Agriculture is the main source of ammonia emissions according to Tarasson et al. (2000).

Increasing intensification of agricultural practices taking place in the Mediterranean basin contributes to high amounts of nutrients in run-off and transported sediments. Particularly on the southern coast, the pressure to use more fertilizer in the catchment basin and along the coastal zones is very strong. Moreover, an increasing area of arable land is lost to urbanization and other infrastructures. In the countries on the Northern and Western coasts, specialized monocultures achieve good yields and induce a gradual abandonment of marginal land. Therefore, increases of land under irrigation are observed in the North and West. In the South and East, demographic pressure constantly increases and cultivated surfaces continue to expand at the expense of forests and grazing land.

Figure 2.22 shows the increase in fertilizer consumption used in agricultural lands in all Mediterranean countries in the 1960s and 1980s. Although in terms of total quantities applied the northwestern countries lead the re-

*Figure 2.22 Consumption of Fertilizers in Mediterranean Countries 1970–1990*



cord, in terms of quantity of fertilizer per hectare some southeast Mediterranean countries are catching up with the North.

In addition, run-off waters cause a remarkable transport of sediments, mostly in regions with a higher degree of soil erosion. Besides the large river basins of the Rhone and the Po, a tentative ranking of the risk of soil erosion and nutrient losses (UNEP/MAP, 1997) lists the first six drainage regions discharging the largest amount of nutrients into the sea in peninsular Italy, Sicily, Sardinia, Greece and Spain.

Inadequate management practices can increase the amount of pollutants transferred to the sea and can decrease productivity of soil and economic efficiency of agriculture. The control of phosphorus is closely connected to run-off and erosion phenomena. In fact, this nutrient is often associated with the sediment and run-off losses directly linked to erosion. Intensive agriculture systems determine the risk of nitrogen pollution in surface and ground waters. Such risks increase in irrigated crops.

*Municipal*

A major consequence of urban waste discharge into the sea is eutrophication of waters. Urban sources of pollution are potentially important as they tend to be characterized by geographical concentration in catchment basins or the coastal environment. A concentrated source is particularly harmful where it is liable to give rise to rapid effects before being dispersed by the processes of dilution and dispersion.

For example, the impact of urban areas in terms of the deoxygenization of rivers rapidly became very evident. Organic material and molecules that are potential consumers of oxygen (particularly ammonium) when released into the sea cause degradation of the marine environment by decreasing seawater oxygen levels. In extreme cases such as the Seine and the Escault or the Ebro delta, oxygen levels are very low or even zero.

The impacts of urban areas on eutrophication are less clear cut, partly because other sources of nutrients also make a major contribution to trophic dysfunctions, and also because the pace of development of an algal bloom is slower than that of a bacteriological bloom (oxygen consumption).

The state of information on discharge of urban sewage outfalls is far from complete. Within the framework of the MED POL Programme, information gathered through different projects such as "The Survey on Land-Based Sources of Pollution" (UNEP/WHO, 1996b), and the "Identification of Priority Pollution Hot Spots in the Mediterranean" (UNEP/WHO, 1999) cover a significant portion of coastal cities. The data reveal that despite substantial improvement in some countries, about 33 percent of the population is not yet served by municipal sewage treatment. A fuller discussion of the state of municipal sewage treatment is given in the section on microbiological pollution.

The difficulty in collecting data through different programmes, however, has resulted in fragmented information with findings of little practical use. In order to improve the situation, a particular activity related to the state of wastewater treatment plants in the Mediterranean has commenced.

*b. Assessment of major pathways of nutrients*

*Discharges via rivers*

About 80 rivers contributing significantly to pollution inputs to the Mediterranean Sea have been identified. The nutrient levels found in Mediterranean rivers are about four times lower than those in western European rivers. In all documented cases, nitrate levels are increasing, although the trend for ammonia is variable depending on the method of sewage collection and treatment carried out. Phosphate concentrations may increase dramatically, as seen in Greece, or steadily, as found in France, or decrease when phosphate restriction measures are imposed (phosphate ban on detergents as in Italy). Although some local coastal eutrophication events do occur (as in the northern Adriatic), the main body of the Mediterranean as a whole was not seriously damaged with eutrophication over the last decade. Depending on the river size and location, the concentration ranges are enormous, over an order of magnitude for nitrate and more for ammonium and phosphate.

The available data on the average nutrient concentrations in the Mediterranean rivers are presented in Table 2.7. More than 30 rivers are documented for nitrate with average values.

Elevated concentrations among the rivers listed in Table 2.7 are found in the intensely cultivated river basins of Italy, Spain, and / or Greece, such as the Arno, Po, Ebro and / or Pinios rivers Also the Nile River has one of the highest average nitrate concentrations,

*Table 2.7 Documented Rivers for Dissolved Nutrients*

| Rivers | Qact $km^3/yr$ | $N\text{-}NO_3^-$ g/l | $N\text{-}NO_2^-$ mg/l | $N\text{-}NH_4^+$ mg/l | $N_{tot}$ mg/l | $P\text{-}PO_2^{-3}$ | $P_{tot}$ mg/l |
|---|---|---|---|---|---|---|---|
| Adige | 7.29 | 1.25 | — | 0.111 | — | 0.03 | 0.1126 |
| Akheloos | 5.67 | 0.60 | — | 0.035 | — | 0.02 | 0.0151 |
| Aliakmon | 1.168 | 0.395 | — | 0.05 | — | 0.10 | 0.0168 |
| Argens | 0.38 | 0.74 | 0.02 | 0.09 | 0.5 | 0.11 | 0.22 |
| Arno | 2.10 | 0.912 | — | 0.042 | — | 0.500 | 0.01 |
| Aude | 1.31 | 1.42 | 0.03 | 0.09 | 1.2 | 0.09 | 0.49 |
| Axios | 4.90 | 1.584 | — | 0.0658 | — | 0.48 | 0.48 |
| Besos | 0.130 | 1.9 | 0.3 | 31 | — | — | 12.7 |
| Buyuk-Menderes | 4.70 | 1.44 | — | — | — | 0.55 | — |
| Ceyhan | 7.10 | — | — | — | — | — | 8.68 |
| Ebro | 9.24 | 2.3 | — | 0.1672 | — | 0.029 | 0.243 |
| Evros | 6.80 | 1.9 | — | 0.05 | — | 0.36 | — |
| Fluvia | 0.36 | — | — | 0.054 | — | — | 0.35 |
| Gediz | 1.87 | 1.65 | — | 0.05 | — | 0.19 | — |
| Goksu | 2.50 | — | — | — | — | — | 8.87 |
| Herault | 0.92 | 0.61 | 0.012 | 0.06 | — | 0.045 | 0.22 |
| Kishon | 0.063 | — | — | — | — | — | 20 |
| Krka | 1.61 | 0.45 | 0.001 | 0.031 | — | 0.029 | — |
| Llobregat | 0.466 | 1.9 | 0.5 | 3.2 | — | 1.2 | 1.53 |
| Metauro | 0.43 | 1.366 | — | 0.0 | — | 0.005 | 0.119 |
| Neretva | 11.01 | 0.269 | — | 0.029 | — | — | 0.050 |
| Nestos | 1.03 | 1.24 | — | 0.071 | — | — | 0.127 |
| Nile | 6.00 | 3.00 | — | — | — | — | — |
| Orb | 0.86 | 0.67 | 0.045 | 0.44 | 0.9 | 0.14 | 0.45 |
| Pinios | 0.672 | 2.323 | — | 0.167 | — | — | 0.2431 |
| Po | 48.90 | 2.03 | — | 0.21 | — | 0.084 | 0.2393 |
| Rhone | 48.07 | 1.48 | 0.033 | 0.124 | 0.80 | 0.101 | 0.14 |
| Semani | 3.02 | 0.24 | — | — | — | — | 0.002 |
| Seyhan | 7.20 | 0.59 | — | 0.31 | 0.27 | 0.01 | — |
| Shkumbini | 1.94 | 0.73 | — | — | — | — | 0.01 |
| Strymon | 2.59 | 1.236 | — | 0.053 | — | 0.11 | 0.125 |
| Tavignano | 0.06 | 0.34 | 0.045 | (0.003) | — | (0.005) | — |
| Ter | 0.84 | — | — | 1.2 | — | — | 2.15 |
| Tet | 0.40 | 1.8 | 0.18 | 1.5 | 2.7 | 0.47 | 0.8 |
| Tevere | 7.38 | 1.37 | — | 1.04 | — | 0.26 | 0.355 |
| Var | 1.57 | 0.18 | 0.003 | 0.031 | 1.5 | 0.006 | 0.13 |

although this value has been derived from only a few published values and it is not clear whether this value really is representative for this river.

Ranking the Mediterranean rivers in Table 2.7 according to their average phosphorous concentrations does therefore not exactly follow the ranking of nitrate pollution. Highest P values are typical for the rivers suffering from organic pollution due to urban wastewater inputs such as the Besos and Llobregat in Spain, the Axios in Greece, the Tet in France and / or the Arno in Italy. Lowest phosphorous concentrations are also found in the rivers with low nitrate concentrations (e.g., the Krka and Neretva rivers) indicating that these rivers are probably the closest to a pristine state.

The lowest nitrate concentrations of clearly less than 1 mg N/l are typical for rivers where agriculture may be less intense in the catchments, and / or accompanied by crops that do not require much fertiliser (such as the Var, Tavignano and Herault rivers in France). Also the rivers of Croatia seem to have rather low nitrate values that may at least partly also be a dilution effect. Nitrogen inputs may be more diluted due to the often-high drainage intensities in these rivers.

Seepage from coastal aquifers and submarine groundwater discharges serve as other pathways of nutrients into Mediterranean coastal waters. Coastal aquifers (e.g., karstic or unconfined sedimentary aquifers) are vulnerable to surface-induced pollution and provide transport of agricultural nutrients critical to eutrophication of enclosed coastal areas into the sea. Although data on levels of nutrients are not known, they are believed to be significant, especially given that the seepage from coastal aquifers accounts for about one quarter of the total freshwater inflow into the Mediterranean.

*Airborne deposition of nutrients*

The atmosphere carries significant quantities of nitrogen, mainly in the form of nitrogen oxide (NO). Via a number of different atmospheric reactions, some nitrogen oxides are removed from the atmosphere through wet and dry deposition processes. The effect on the marine ecosystem is eutrophication through nitrogen fertilization.

Emissions of nitrogen oxides arise mainly from anthropogenic combustion sources. In this context, road transport and other mobile sources (sea and air transport) are increasingly important sources of pollution compared to stationary sources (industrial combustion). According to Tarasson (2000), mobile sources account for 63 % of $NO_x$ emissions in the Mediterranean basin; a breakdown of $NO_x$ emissions into sectors in the Mediterranean region is given in Table 2.8.

***Table 2.8 Sector-Based Emissions of $NO_x$ in the Mediterranean Region (kton N $yr^{-1}$)*** *(Source: Tarrason et al., 2000)*

| | **Energy production** | **Non-industrial combustion** | **Combustion in manufacturing** | **Production process** | **Road transport** | **Other mobile sources** | **Waste treatment** | **Agriculture** | **Other** |
|---|---|---|---|---|---|---|---|---|---|
| France | 134 | 103 | 135 | 16 | 728 | 397 | 16 | — | 3.8 |
| Croatia | 14 | 3.8 | 8.6 | 1.6 | 29 | 15 | 0.04 | — | — |
| Italy | 186 | 79 | 156 | 11 | 748 | 286 | 18 | 1 | 1 |
| Slovenia | 15 | 3.1 | 3.1 | — | 36 | 0.5 | — | — | — |
| Turkey | 173 | 192 | 173 | 11 | 361 | — | — | — | — |
| Cyprus | 6.2 | 1.2 | 2 | — | 11 | — | — | 0.9 | — |
| Serbia & Montenegro | 40 | 1.6 | 4.4 | — | — | — | — | — | — |
| **Total** | **569** | **384** | **482** | **40** | **1,912** | **698** | **34** | **1.9** | **4.8** |

Emission data for countries of the northern Mediterranean is inventoried by the UNEC/EMEP database, but this does not include emissions from countries on the Southern and Eastern coast. Emission data for these countries was obtained from different sources.

Mediterranean emissions did not change significantly between 1980 and 1999, but the relative contribution of the Mediterranean region to total European emissions has increased in the last 20 years, particularly for $NH_3$ (27 % in 1980 to 36 % in 1999). The increase in the share of the Mediterranean region in the emissions of both nitrogen species is due to decrease in these emissions in Europe. Based on EMEP projections, $NO_2$ and ammonia emissions in the Mediterranean region are expected to account for 17 % and 34 % of European emissions, respectively, in the year 2010.

The negative impacts of nitrogen oxide are likely to remain a source of concern in the future as the underlying cause of the problem, road transport, continues to expand. Despite improvements brought by catalytic treatment of car exhausts, emissions have increased as a result of increase in distances travelled as well as growth in the number of vehicles.

Emissions of NO in the Mediterranean are uneven. France, Italy and Spain emit most of the $NO_x$ in the region. These three countries accounted for 78 % of $NO_x$ emissions in the basin in 1999. However, emissions from South and Eastern countries of the Mediterranean are likely to increase rapidly in the future following increases in car ownership linked to increased living standards. Data reveal that the relative contribution of central and eastern Mediterranean countries have increased by approximately 10 percent in the last 20 years. This increase is due to doubling of $NO_x$ emissions (from 6,800 in 1980 to 12,900 tones $NO_x$ in 1995) in Turkey.

Phosphorus is deposited through the atmosphere to a much lesser extent than nitrogen. That is because a large fraction of this total P input originates from crystal material transported from North Africa and is insoluble. Bergametti et al. (1992) estimated soluble input as 30 percent of total inorganic P input to the Western Mediterranean Sea. Measurements of atmospheric P cover the entire basin. Guerzoni et al. (1999) reviewing these concluded that the atmospheric input of inorganic P is 40 mg P $m^{-2}yr^{-1}$ in the Western Mediterranean and 20 mg P $m^{-2}yr^{-1}$ in the Eastern basin.

*c. Building information capacity on eutrophication*

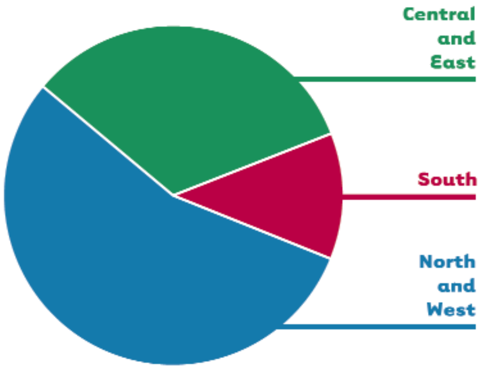
Over the last 30 years, MED POL has played a considerable part in improving information available on trends of nutrient enrichment in the Mediterranean. During the first phase (1975–1981), MED POL contributed towards upgrading the technical facilities of many Mediterranean research centres and laboratories involved with the programme. The MED POL phase II (1982–1996) was characterized by the development of national monitoring projects in the Mediterranean region. MED POL has now entered the third phase shifting the emphasis from pollution assessment to pollution control. A database was organized during the MED POL phase II and nutrient values are available for a number of Mediterranean countries.

#### *2.3.6.2 Heavy metals*

The presence of heavy metals in the sea is of great concern as most heavy metals are toxic to plants and animals. The levels found in and effects of heavy metals on Mediterranean biodiversity are discussed in greater detail in section 2.1.5.3.b above. The toxicity depends on the degree of concentration and in fact many metals play a key role in different life processes and are released in great volumes in natural ways. However, man's share of heavy metal pollution in the Mediterranean grew sharply by 300 percent between 1950 and 1990 and this trend has only lately been reversed.

Metal-containing particulate matters are emitted from different kinds of industries and subject to long-range transport via air or rivers before their effects are recognized in the ecosystem. Six metals were chosen for their transboundary impacts (mercury, cadmium, arsenic, zinc, copper and lead). By far the biggest source region for four of these is the Northwest basin, accounting for about half the total emissions of lead, cadmium, zinc and copper. Figure 2.23 below shows the variations in heavy metal discharges by various regions of the Mediterranean.

**Figure 2.23 Average of Mediterranean Regional Shares in Emissions of Lead (Pb), Cadmium (Cd), Zinc (Zn) and Copper (Cu)**




The last decade saw a pronounced decrease of emissions of lead by the Mediterranean countries (1990–1999). Emissions have decreased from 14,300 tonnes in 1990 to 5,900 tonnes in 1999. Mercury and cadmium emissions also decreased in the same time period, but not as much as lead. Mercury emissions decreased from 102 tonnes/yr to 70 tonnes/yr in 1999 (31 percent) and Cd emissions decreased from 114 tonnes/yr in 1990 to 82 tonnes/yr in 1999 (27 percent). The decrease observed in these three metals can also be seen in other anthropogenic elements like Ni, As, etc. However, emissions data for the other elements are too fragmentary to derive percentages. Metal emissions have decreased not only in the Mediterranean region, but also in most parts of Europe since the 1980s. As a result, for all three elements the share of Mediterranean emissions in total emissions in Europe is gradually increasing because the decrease in the region is not as fast as in other parts of Europe. Even in the Mediterranean region the decrease in emissions is not uniform. The decrease in reported emission values in Western Mediterranean countries (Spain, France and Italy) is more pronounced compared to countries located in the Central Mediterranean. Unfortunately, such long-term emission data are not available for the Eastern Mediterranean basin.

*a. Origins of heavy metals and concentration data*

*Mercury*

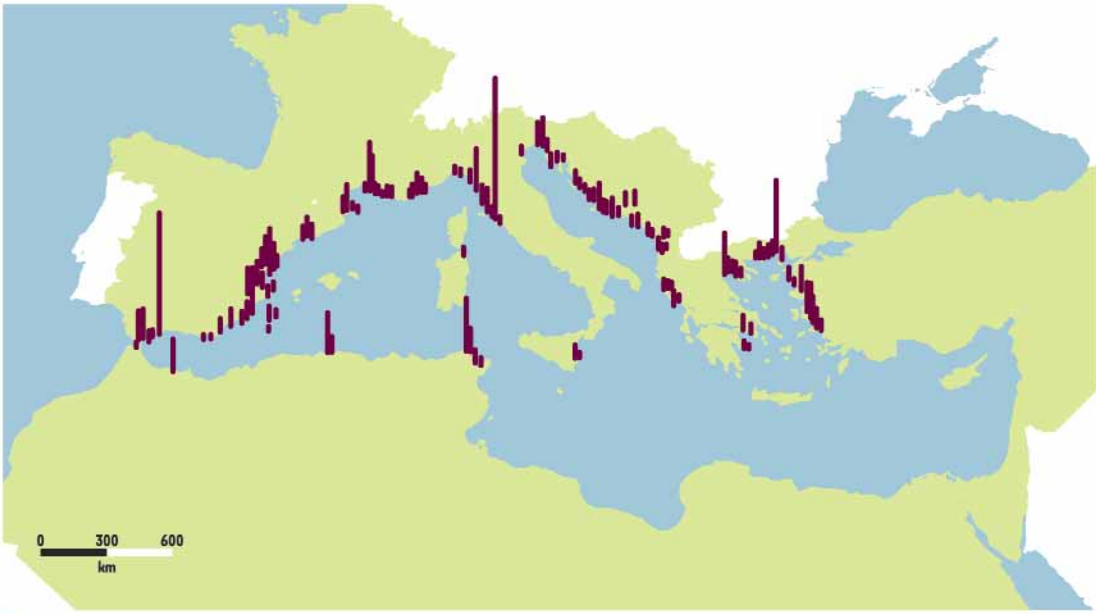
The major toxic action of mercury is the inhibition of enzymatic processes, which can affect the reproduction and the nervous system of birds and mammals. In fish, the effects of mercury also include a decreased sense of smell, damage to gills and blindness. High concentrations of mercury lead to reduced growth of plants. One important hazardous effect of mercury in the aquatic environment is that it biomagnifies in the food chain.

Mercury comes from rocks (mainly as sulphide ores), degassing (of elemental mercury) from the Earth's crust and oceans, volcanoes, chlor-alkali plants, the petrochemical industry and sewage outfalls.

- *Levels*

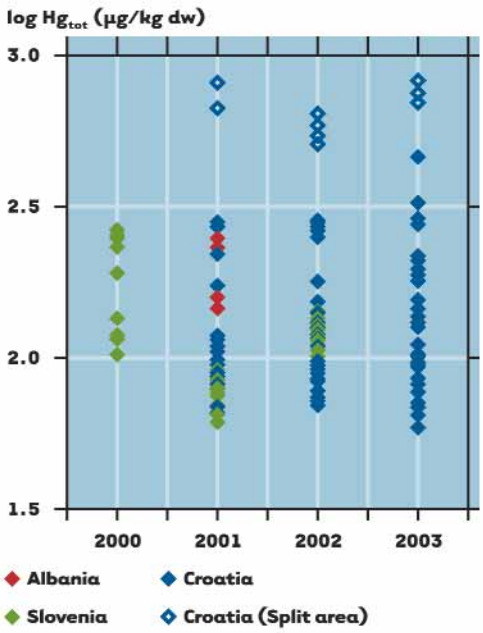
The levels of total mercury (HgT) in the Mediterranean marine environment seem to be decreasing in many areas, mainly due to the fact that analytical procedures have improved and more attention has been paid to the problem of sample contamination. Earlier results indicated high values, with concentrations in seawater in the so-called 'open' sea areas reaching 140ng/l, and in coastal areas, 520ng/l. However, more recent data indicate that open-sea concentrations are only a few nanograms per litre, and those in coastal areas affected by pollution sources do not exceed 50ng/l. That is, in general, mercury levels in seawater are no higher, on average, than elsewhere (UNEP/FAO, 1996c).

*Figure 2.24 Total Mercury Concentrations in* Mytilus Galloprovincialis *in the Mediterranean*




Recent raw data from MED POL Phase III on levels of total mercury, HgT, from Albanian, Croatian and Slovenian hot spots (Figure 2.25) show pronounced land-based impacts in the Split area from a chlor-alkali plant. MED POL historical data indicate the following conclusions. There are two populations of Tuna exhibiting 'low' and 'high' concentrations of HgT. The Atlantic population displays low levels of HgT, whereas the levels are high for the Mediterranean population. This is the pronounced impact of Hg mines existing in the Mediterranean and local impacts of hot spots. HgT in sardines from the northwest coast of the Mediterranean is 3–4 times higher than in sardines from Gibraltar. HgT distribution from west to east Mediterranean illustrates the Mt Amiata Hg anomaly.

*Figure 2.25 Levels of Total Mercury in* Mytilus Galloprovincialis *from Adriatic Hot Spots*




• *Loads*

In general, human emissions are substantially less than natural ones; ratios of 1:4 up to 1:30 have been derived, admittedly from very rough raw data (UNEP/FAO, 1996c).

On the basis of published data and modelling results, in UNEP/WHO (1998) the following data on mercury loads are presented:

- the pollution of the Mediterranean Sea by mercury and its compounds is brought about mainly via the atmosphere and riverine run-off;
- the total input from anthropogenic sources through the atmosphere is 10–40 tonnes per year. The contribution of riverine run-off varies within the range of 50–200 tonnes per year (mainly in particulate form);
- a portion of riverine run-off of mercury (about 10–40 tonnes per year) and the bulk of atmospheric deposition come to the Mediterranean Sea as soluble mercury compounds which can be assimilated by the marine biota and thus would affect the marine life.

- *Impact*

Special attention should be paid to coastal zones where higher concentrations of mercury are observed due to riverine run-off, intensive sedimentation and atmospheric deposition. In addition these zones are characterized by enhanced biological productivity. The Western Mediterranean, the Tyrrhenian and Adriatic Seas are believed to be the most vulnerable regions (UNEP/WMO, 1998).

*Cadmium*

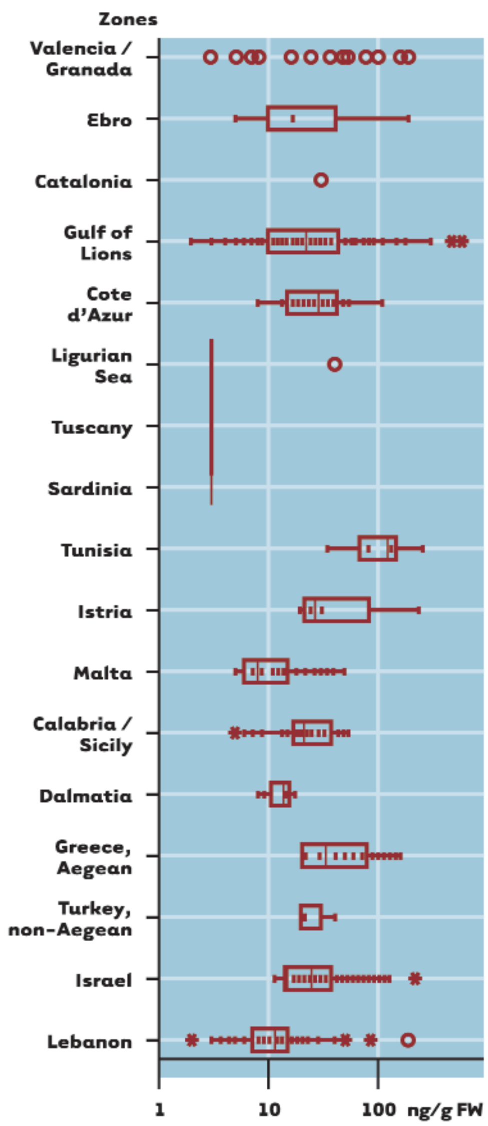
Critical effects of cadmium contamination on plants are a decrease in productivity, reduced rates of photosynthesis and transpiration, and altered enzymatic activities. In seawaters, cadmium levels greater than 7 mg/l can initiate toxic effects for animals, including growth retardation and decreased survival of invertebrates, and kidney damage and decalcification of the skeleton for higher marine animals and seabirds.

Cadmium comes from copper refining (as a by-product); lead processing; electroplating; solders; batteries; production of alloys, pigments and PCBs, and; sewage sludges.

- *Levels*

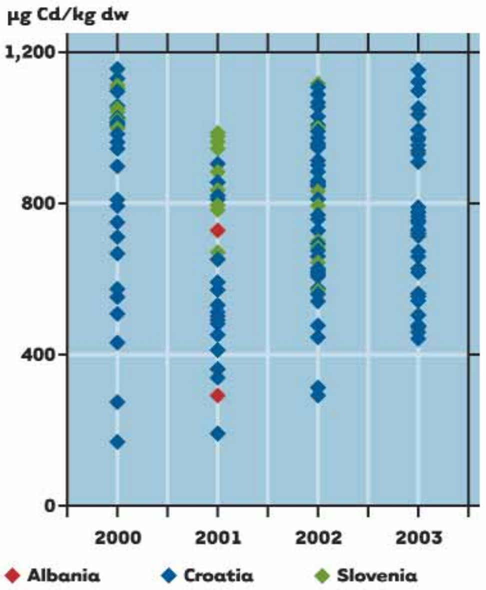
The levels in seawater cover a wide range of values: open sea 0.004–0.06 mg/l (recent and probably more reliable data); coastal sea < 0.002–0.90mg/l, with a tendency for high values to be related to sources (estuaries, coastal mining) (UNEP 1996a). Levels of Cadmium in *Mullus Barbatus* depend on the LBS activities in different Mediterranean sub-basins (Figure 2.26).

***Figure 2.26* Cadmium Concentration in Mytilus Barbatus sorted by Zones and arranged from West to East**



Recent raw data of MED POL Phase III on total cadmium (Cd) from the Albanian, Croatian and Slovenian hot spots (Figure 2.27) showed that the background concentration levels for the Mediterranean in *Mytilus galloprovincialis* during 2000–2003 were significantly higher than those found from MED POL historical data of two decades (50–150 µg Cd/kg dw). This is most probably a strong indication of local impacts of land-based contamination from hot spot sites in the Adriatic region.

**Figure 2.27 Levels of Cadmium in Mytilus Galloprovincialis from Adriatic Hot Spots**




*Arsenic*

Arsenic is a by-product or waste of non-ferrous metal processing (copper, zinc, lead, gold and cobalt), of fossil-fuel burning and the processing of phosphate rock and bauxite (for aluminium).

• *Levels*

The levels of total dissolved arsenic in seawater, in the western Mediterranean below the photic zone (since arsenic is metabolized by phytoplankton), are 1.3–1.4 mg/l. In estuaries and rivers the values are much more variable: 1.5–3.75 mg/l in the Rhone delta (UNEP/FAO, 1996c).

Although arsenic itself is insoluble, many of its compounds are soluble in water, leading to average seawater concentrations of 2.0–3.0 µg/l (UNEP/FAO, 1996c).

• *Loads*

There is no accurate information available as to the amounts of arsenic reaching the Mediterranean Sea through domestic and industrial effluents (UNEP/FAO, 1996c).

• *Impact*

Marine organisms, especially invertebrates, are able to concentrate arsenic from seawater to high levels. Most of the arsenic is in the organic form in marine organisms, which is much less toxic than the trivalent inorganic compounds (UNEP 1996d).

*Copper / Zinc*

Zinc and copper constitute a hazard to aquatic life in polluted waters where other much more hazardous metals like lead, mercury and cadmium are also present because its toxicity with the other metals is additive. It has been reported that sublethal concentrations of Zn impair the reproduction of salmon and some marine invertebrates.

Copper comes from mining; alloys; metal plating; electricals; catalysts; jewellery; algicides, and; wood preservatives.

Zinc comes from smelting; alloys; steel-making; metal-plating and galvanizing; paints and dyes; batteries; organic chemical production; oil refining; fertilisers; paper pulp, and; viscose rayon production. A ratio of 2.5:1 for industrial: domestic discharge has been calculated.

• *Levels*

The levels of copper in seawater cover a wide range of values: open sea 0.04–0.70 mg/l (recent and probably more reliable data); coastal sea < 0.01–50 mg/l, with a tendency for high values to be related to sources (Nile discharge, coastal mining) (UNEP/FAO, 1996c). Levels of Cu in *Mytilus galloprovincialis* are shown in Figure 2.28.

The levels of zinc in seawater cover a wide range of values: open sea 0.24–0.56 mg/l; coastal sea 0.20–210 mg/l. A wide range of 0.016–48 mg/l for a variety of Mediterranean waters has been reported (UNEP/FAO, 1996c).

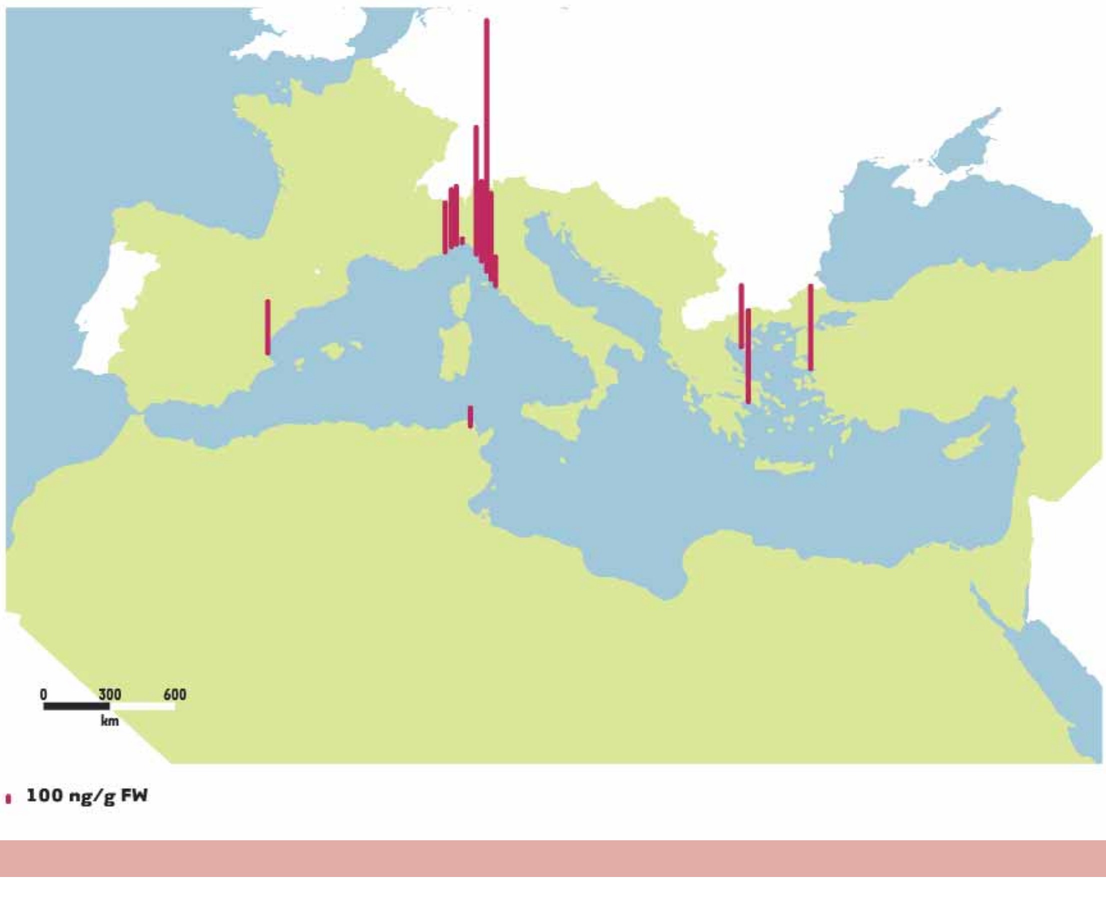
• *Loads*

The amounts of copper discharged into the Mediterranean Sea through domestic and industrial effluents have been estimated at 2.3 and 6.0 tonnes x 103 per annum, respectively (UNEP/WHO, 1996a).

Zinc and copper loads are specifically assessed based on information provided by Scoullos and Constantianos (1996). In this study it is highlighted that zinc and copper loads entering the Mediterranean are significant and are considerably higher than those reported in the past, as a result of the inclusion of marine (via Gibraltar and Dardanelles) and atmospheric inputs, which were not taken into account in previous assessments.

It is clear that although both the marine and atmospheric inputs into the Eastern Mediterranean were assessed indirectly, they are of the same order of magnitude. This has been confirmed in the Northwest Mediterranean. The atmospheric inputs are also considerably higher than the riverine and direct discharges, and thus could have a strong effect on concentrations in offshore waters and even in deep-sea sediments.

***Figure 2.28 Copper Medians in* Mytilus Galloprovincialis *in the Mediterranean***



*Lead*

Effects of lead on plants are limited to areas where relatively high concentrations of lead are found, like areas near mines or smelters. For animals, the signs of lead poisoning are central nervous system disorders, high excitivity, motor abnormalities and blindness. In fish, lead accumulates primarily in gills, liver, kidney and bones, causing blackening of the tail, damage to the spine and reducing larvae survival.

- *Sources*

Lead comes from: mining; smelting; steel-making; production of alloys; batteries; pigments; combustion of leaded (by lead tetraethyl) petrol. A ratio of 7:1 for industrial: domestic discharge has been calculated (UNEP/WHO, 1996b).

- *Levels*

The levels in seawater cover a wide range of values: open sea 0.018–0.14 mg/l (recent and probably more reliable data); coastal sea 0.016–20.5 mg/l, with a tendency for high values to be related to sources (lead tetraethyl production and estuaries) (UNEP/FAO, 1996c). Lead is bioaccumulated in *Mytilus galloprovincialis* with higher levels in the western Mediterranean (Figure 2.29).

- *Loads*

The amounts of lead discharged into the Mediterranean Sea through domestic and industrial effluents have been estimated at 200 and 1,400 t/yr, respectively. These figures apply to discharges from the coastal zone and do not include river inputs (UNEP/WHO, 1996).

*b. Assessment of major pathways of heavy metals*

*Discharges via rivers*

Atmospheric deposition, including rainwater loads, is overwhelmingly the largest source of metals in the Mediterranean. Riverine inputs are lower by comparison to atmospheric deposition as shown in Table 2.9.

*Figure 2.29 Histograms of Lead Medians for* Mytilus Galloprovincialis *in the Mediterranean*

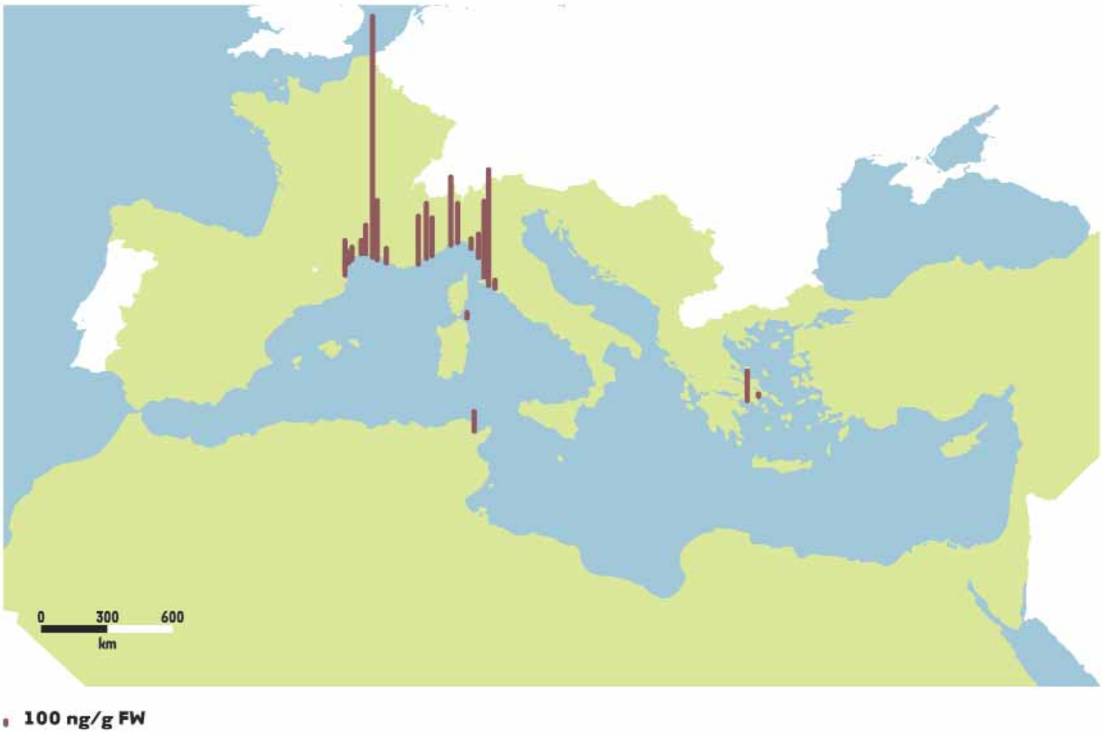


*Table 2.9 Atmospheric versus Riverine Inputs of Lead and Zinc to the Mediterranean (tonnes/yr)*

*(Source: Guerzoni et al., 1999)*

| | | Lead | | | Zinc | |
|---|---|---|---|---|---|---|
| | **River input** | **Atmospheric input** | **%** | **River input** | **Atmospheric input** | **%** |
| WMED | 2,200 | 2,800 | 56 | 9,200 | 31,700 | 78 |
| EMED | 2,650 | 3,700 | 58 | 15,500 | 28,000 | 64 |
| **Total** | **4,850** | **6,500** | **57** | **24,700** | **59,700** | **71** |

Transport of heavy metals in Mediterranean rivers is the second largest factor in the redistribution of these contaminants from land to the sea. For the most part, heavy metals under normal water acidity conditions do not dissolve in water and once discharged attach to a particle and either sink to the bottom or remain suspended for some time. This particulate phase is what monitoring is focused on and therefore pollution is indicated by particulate metal content to one gram of suspended sediments (µg/g).

The following focuses on a review of 17 Mediterranean rivers based on data with different reference periods. Studies on heavy metals in general face an important difficulty in distinguishing the human input from the natural background. However, Mediterranean rivers are affected by man-induced heavy metal pollutants, especially mercury, cadmium and lead.

The Po and Rhone rivers, for instance, show elevated concentrations for all of the heavy metals reviewed here (Cd; Cr; Cu; Hg; Zn —Po; Ni; Pb —Rhone), especially for Po.

An assessment of the average metal contents and loads in Mediterranean rivers is more difficult for heavy metals than for other pollutants, such as nutrients, because it can hardly rely on the data regularly collected by national monitoring programs. Two reasons are responsible for that. On the one hand, many monitoring programs only measure total metals without filtering the sample, although the utility of this information is restricted. As we have seen above, by far most of the heavy metal transport occurs in the particulate phase, and a spatial and temporal inter-comparison of data requires a sampling strategy that is representative for the total suspended sediment transport. This is almost impossible with the sampling frequency normally applied by national monitoring agencies. Including one high-turbid sample or not in a data set may completely change the resulting averages.

On the other hand, one has also to point out that the contamination problem is still a major problem for the analysis of heavy metals. National monitoring agencies usually charge public laboratories for the analytics, doing routinely a great number of samples of different origins. In fact, the analysis of drinking or surface water may be followed by the analysis of wastewater or sewage sludge in the same place with the same instrument, which can lead to a great deal of invalid data and misinterpretation of the environmental process.

For these reasons, we refer in this study mainly to studies that were conducted by independent research institutions, applying ultra-clean techniques for the analytics.

The loads of lead and cadmium for coastal city treatment plants are as low as one percent of the loads carried through atmospheric contamination. Zinc discharges of wastewater plants are an exceptional case where cities' share of pollution is relatively more significant than for other elements, although still less than 25 percent of atmospheric contamination.

*Atmospheric deposition*

It should be noted that for metals, rainwater data is very scarce probably because of the difficulties involved in the analysis of the extremely low levels. The existing data on metal composition of rainwater and wet deposition fluxes of metals are confined to Northwestern Mediterranean. Unfortunately, very few data on the metal concentrations in rainwater exist for the rest of the Mediterranean Sea. This is a serious drawback for a basin-wide assessment of wet deposition fluxes of metals.

There is a relatively even pattern of deposition of Cd, Cu, Pb, Zn and Hg between the West and East Mediterranean. Pb concentrations show increased values close to coastal waters because of road traffic emissions. Roads are very close to the coast in the Mediterranean region and coastal sites are therefore impacted from Pb emissions.

Not all of the metal load deposited will be available for use by marine organisms, however. Although the exact degree of metal solubility remains an open question, according to Guerzoni et al. (1999), approximately 49–82 % of Cu, 68–76 % of Zn, 21–65 % of Pb and 75–92 % of Cd deposited to the Mediterranean Sea are in soluble form and can be readily utilised by organisms.

As regards basin-wide deposition of metals, the only information on quantitative source-receptor relationship comes from EMEP modelling exercises.

Based on the modelling results, the main contributors to Pb deposition in the Mediterranean Sea are Spain, France, Italy and Greece. These four countries account for approximately 70 % of Pb deposited in the whole basin. Both European countries and countries located around the Mediterranean Sea contribute to observed deposition levels. Approximately 65 % of Pb deposited to the basin can be accounted for by the emissions in the Mediterranean countries and the remaining 35 % is from emissions in non-Mediterranean countries in Europe. Among these countries Bulgaria, which contributes 5 % to total atmospheric Pb input to the Mediterranean, Romania, which accounts for 3 % of total Pb deposition and Ukraine, which accounts for 5 %, are the most important ones. It should be noted that contribution of these countries to Pb input to the Mediterranean are higher than contributions of many Mediterranean countries.

Spain, Italy and France account for 63 % of total Cd deposition to the Mediterranean. Most of the Cd deposited to the Mediterranean is emitted in the Mediterranean region. Non-Mediterranean European countries account only for approximately 10 % of Cd deposition in the entire basin.

The contribution of countries outside the Mediterranean basin to Hg deposition in the Mediterranean Sea is significant. These countries account for approximately 40 % of Hg deposited to the Mediterranean Sea. The remaining 60 % of deposited Hg is emitted from Mediterranean countries. Spain, Italy and France account for 56 % of Hg deposition, with the remaining 44 % of annual Hg deposition contributed by the other 16 countries.

This discussion shows that more than half of the annual metal deposition in the Mediterranean region is due to emissions from Mediterranean countries. Among the Mediterranean countries, France, Spain and Italy are the highest contributors. Greece, Turkey, Serbia and Montenegro make up the second group. The remaining Mediterranean countries do not contribute to metal deposition significantly. However, it should be noted that the model study from which the data are obtained does not provide information on different regions in the Mediterranean basin. This grouping of countries may change in different sub-regions depending on the proximity of that particular area to emissions.

Countries outside the Mediterranean region also contribute to metal deposition to the Mediterranean Sea. Among these, Bulgaria, Romania and Ukraine appear to be the most important.

*2.3.6.3 Persistent toxic substances (PTSs)*

This section discusses the sources of PTSs in the Mediterranean and their effects on seawater quality. The levels of PTSs found in biodiversity are discussed in Section 2.1.5.3.b above.

*a. Chlorinated pesticides*

*Chlorinated hydrocarbons sources and concentration levels*

Organochlorines are a group of organic compounds containing chlorine. They are by far the most important group of persistent organic pollutants (POPs), since they are characterized by high resistance to photolytic, biological or chemical degradation. This fact, in combination with their low water and high lipid solubility, leads to their accumulation in fatty tissues of marine organisms. They are widespread in the environment and it is unlikely that any significant part of the biosphere is uncontaminated by them. The two main categories of the organochlorines measured in the MED POL programme are chlorinated pesticides and polychlorinated biphenyls (PCBs).

The most widely distributed group of chlorinated pesticides is that of the DDT family. Apart from DDT, its metabolites (DDE and DDD) are also widely observed in the marine environment and may sometimes have a greater environmental impact. Starting in the 1940s, these compounds were produced and utilised in vast quantities all over the world as insecticides. Subsequently in the 1950s and 1960s there was an alarming decrease in bird and marine mammal populations. This fact, in combination with evidence from laboratory experiments indicating toxic effects on organisms exposed to organochlorines led many countries in the northern hemisphere to ban or strictly regulate the use of such compounds in the 1970s. Most Mediterranean countries reported to DAO that in 1985 no chlorinated pesticides were used for agricultural purposes, with the exception of gamma-HCH (Lindane), which is considered one of the least persistent organochlorines and is still used.

According to GESAMP (1990), the major route of entry of organochlorines into the marine environment is through the atmosphere.

***Table 2.10 Concentrations (in ng/g ww) of Organochlorinated Compounds in Samples of Fish Tissues collected in the NW Mediterranean***

| Fish species | Habitat | DDTs (DDT+D) | HCB | PCBs (Σ7) | References |
|---|---|---|---|---|---|
| *Mullus sp.* | Coastal | 4.4—16.8 | 1.6—6.7 | 8.7—20.3 | — |
| *Dicentratchus sp.* | — | 2.6—4.0 | 0.6—0.8 | 4.4—6.2 | — |
| *Lepidorombus sp.* | Mesopelagic | 0.8±0.2 | — | 2.1±0.3 | — |
| *Physics sp.* | — | 0.4±0.1 | — | 1.0±0.2 | — |
| *Lepidion sp.* | Deep sea | 6.0—7.1 | 0.14—0.17 | 8.3—9.4 | Porte et al., 2001 |
| *Coryphaenoides sp.* | — | 1.9—4.3 | 0.25—0.67 | 2.5—4.6 | — |
| *Bathypterois sp.* | — | 5.0—10.2 | 0.12—0.25 | 6.0—10.0 | — |
| *Mora moro* | — | 7.4—12.6 | — | 9.0— | Solé et al., 1998 |

Among specific uses of DDT still in practice is its production as input to Dicofol as well as application to floriculture and plant cultures (UNEP/GEF, 2002).

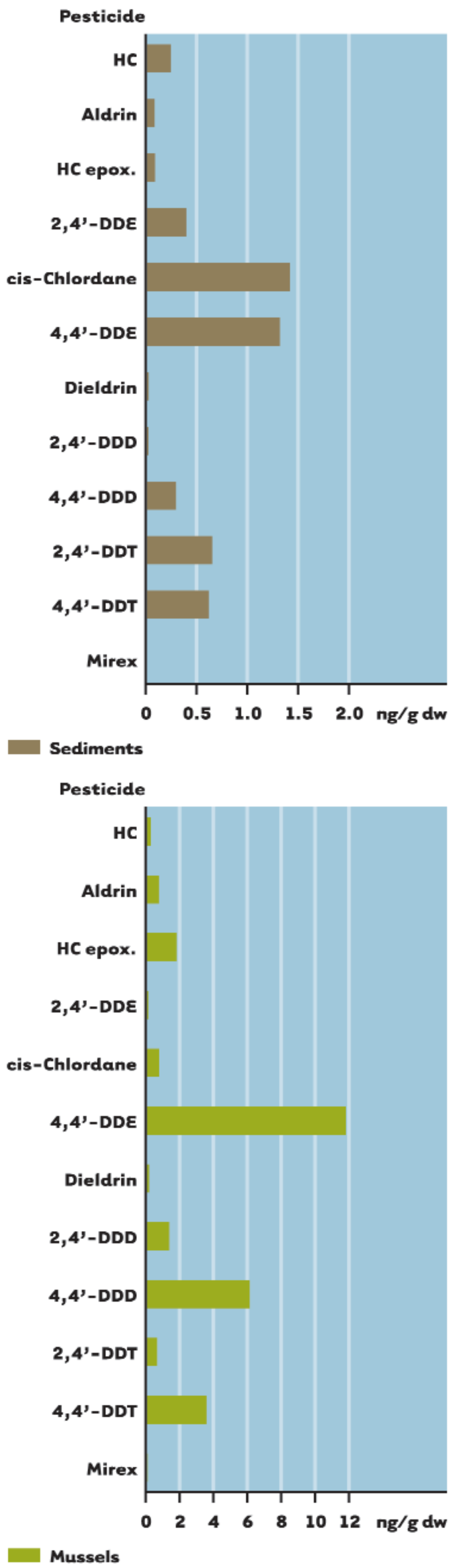
• *Levels / Loads*

Concentrations of dissolved DDTs in water samples collected in 1993 in the Western Mediterranean (0.8–4.3 pg $L^{-1}$) were one order of magnitude higher than in the corresponding particulate phase (0.16–0.98 pg $L^{-1}$). Suspended particulate matter at the Ebro and Rhone River mouths exhibited a surface enrichment indicating a certain riverine input to sea. However, about 80 percent of the input consisted of DDE, indicating a large prevalence of weathered residues (Dachs et al., 1997). Concentrations were slightly higher in the continental shelf waters than in the open sea surface. A vertical gradient was also observed in the Straits of Sicily and Gibraltar, which has implications in the exchanges of pollutants with the adjacent seas.

Concentrations of dissolved DDT metabolites 2,4'-DDT, 4,4'-DDD and 4,4'-DDE were detected in significant amounts in estuarine water samples of Axios, Loudias and Aliakmon rivers as well as of Thermaikos Gulf during 1992 and 1993 (5–31 ng/l) (Albanis et al. 1994; Albanis et al., 1995a). Similar concentrations (1–29 ng/l) were also detected in estuaries of Louros and Arachthos rivers as well as in marine wetlands of Amvrakikos Gulf in Northwest Greece during the period from March 1992 to February 1993 (Albanis et al. 1995a; Albanis et al., 1995b).

Figure 2.30 shows data on PCBs and DDT in sediments according to published literature.

***Figure 2.30 Concentrations of O.C. Pesticides in Sediments and Mussels from the Adriatic Sea***
*(Source: BIOMAR IV, 1998)*



*Hexachlorobenzene (HCB)*

HCB is predominantly an industrial product, although its sources (as a marine contaminant) are still not precisely known (UNEP/MAP, 1996a). It is mainly used as a fumigant and a fungicide in grain storage. HCB was also used in some countries in the production of fireworks and to manufacture synthetic rubber. Nowadays these uses are banned in most countries. HCB is also formed as a by-product, impurity or residue in some industrial processes. For example it is generated as by-product during the manufacturing of chlorinated solvents, it is found as impurity in some pesticides, and it is formed during the incineration of municipal and hazardous wastes. HCB emissions also take place during coating application and curing processes in metal surfaces, during the production of silicone-based products, during the manufacturing of hydrochloric acid, etc.

- *Levels / Loads*

  Western Mediterranean coastal waters exhibited concentrations of dissolved HCB in the range of 0.9–4.3 pg/l, with higher values offshore the Rhone River (10 pg/l) (Grimalt et al., 1988; Burns et al., 1987). The concentrations in the dissolved and particulate phases found at the bays of the Ebro delta, were in the range of 1.0–4.1 and 12–31 pg/l, respectively (Grimalt, et al. 1988).

*Hexachlorohexanes*

HCHs are a mixture of isomers of which one (gamma-HCH, lindane) is an insecticide. The atmosphere is the main pathway (99 percent of total input) in the global distribution of HCHs, but they are highly soluble in water so they may be washed out of the atmosphere by rain and accumulate in aquatic biota (UNEP/MAP, 1996a).

- *Levels*

  Lindane levels off shore in the Eastern Mediterranean basin ranged from 0.06 to 0.12 ng/l, whereas values one order of magnitude lower were found in the Western basin. Higher concentrations were observed near terrestrial run-off and river inputs. Particulate matter had higher concentration than the seawater dissolved phase (Jeftic et al., 1989).

  Concentrations of dissolved α-HCH, β-HCH and lindane were detected in significant amounts in estuarine water samples of Axios, Loudias and Aliakmon rivers as well as of Thermaikos Gulf during 1992 and 1993 (1–30 ng/l) (Albanis et al. 1994). Similar concentrations (2–11 ng/l,) were also detected in estuaries of Louros and Arachthos rivers as well as in marine wetlands of Amvrakikos Gulf in Northwest Greece during the period from March 1992 to February 1993 (Albanis et al., 1995a; Albanis et al. 1995b).

*Dieldrin, Aldrin and Endrin*

The main uses of Aldrin are to control insects on cotton, corn and citrus crops, as a wood preservative and for termite control. In EU countries, its uses are very restricted (for some of them written authorisation is required) and some of them are banned (i.e., plant protection use is banned since 1995).

Dieldrin is easily derived from Aldrin. Dieldrin is used to control soil plagues and for the treatment of seeds. Several countries of the region have adopted measures to ban this compound including Israel, Portugal, Turkey and the European Union.

Endrin is not included in the PIC Convention, so there are few data available. The main uses of Endrin are as a pesticide on cotton, rice, sugar cane and corn, but at present its use is banned or restricted in most of the countries. In the Mediterranean region, Algeria, Cyprus, Israel and Greece have banned all uses, while France, Italy, Portugal and Spain allow very limited applications.

- *Levels / Loads*

  Several studies have been carried out in the mouth of some rivers (see section 4.2.7) but no data are available for seawater.

b. *Assessment of major pathways of PTSs*

*Discharges via rivers*

High pesticide concentrations have been found in some specific studies and are believed to occur in many small rivers that are affected by intensive agriculture. The type of pesticides may vary from one river to another and from one country to another. However, most rivers are not adequately monitored for PTS in order to assess loads, even though they are very important.

During MED POL Phase I (1975–1980), it was attempted through the project MED X to estimate the quantity and nature of riverine inputs in the region. The project met with considerable difficulties. Country responses were geographically almost restricted to the Northern Mediterranean. Sampling frequency, sample pre-treatment, analytical methods and reporting formats varied widely. Some pollutants were rarely analysed (metals, specific organics, organochlorines). Field measurements of domestic sewage and industrial wastewater were very limited. No field measurements on agricultural run-off were available. Among 68 rivers registered, only 30 were adequately monitored except for PTS.

In view of the limitations and difficulties encountered, assessments of the pollution loads from land-based source (LBS) categories have been carried out, largely, by indirect computations and extrapolations. They have been worked out taking into account demographic statistics, the GNP of the countries, industrial production and manpower, and agricultural data. The time allowed for this ambitious project was too short for any in-depth study of each and all pollution sources in the Mediterranean. For this reason and by the fact that the results were pooled for each of the eleven UNEP Mediterranean regions, the project did not fulfil the requirements of its first objective, to provide the basis for national management and control plans.

Due to the difficulties and the uncertainties involved in the complex computations and extrapolations carried out, the results could not be better than rough estimates reliable within an error margin of one order of magnitude. Some of these results were proved, at a later stage, to be even worse. Only a comparative assessment of the regional contributions to the pollution load could be made. The results showed that the heaviest loads are discharged into the northwestern basin with one-third of the total pollution load. The Adriatic Sea receives about one-quarter of the total load. Moderate pollution loads are encountered in the Tyrrhenian and the Aegean Seas, as they receive each about 10 % of the total load. The other Mediterranean Sea areas each account for no more than 5 % of the total.

More recently, accurate estimates have been obtained for some French rivers using linear regression and average weighted flow models. A survey was carried out during 1994–95 at the lower course of the Rhone River, far from the any marine influence. An important conclusion was that the large supply of fresh water (> 70 %) and consequently of dissolved species, corresponds to the medium-low flow regimes, whereas the contribution of large flows (> 5000 $m^3/s$) represents less than 10 % of the total input. On the contrary, these regimes contribute with about 80 % of the total input of suspended particles. All pollutants, and notably PTS attached to the particles, are carried to the sea in such episodic events. A preliminary survey has also been recently conducted in the Seine River, only for dissolved PTS.

The calculation included dieldrin, aldrin, endosulfan, heptachlor, HCB, α-HCH, γ-HCH, pp'-DDE and PCBs (seven congeners) as reported in Table 2.11. The load of Lindane was consistent with the use of this compound in the preceding years (1,500 tonnes/yr) but the DDE is reflecting the leaching of the existing environmental stock.

Similar calculations performed in the Ebro River in the 1980s gave inputs one order of magnitude lower, consistent with the difference in water flows (dieldrin and aldrin, 1 kg/yr; DDTs, 8 kg/yr; chlordane, 2 kg/yr; PCBs, 12–25 kg/yr; HCB about 30 kg/yr; and endosulfan, 1.5 kg/yr) (Cid et al., 1990). An input of 157 kg/yr of PCBs (Σ 7 congs) has been reported in 1999 for the Guadalquivir (OSPAR, 2001). A study carried out in 1993 in Turkey to assess the riverine pollutant loads to the Black Sea has provided figures in the order of 11 tonnes of aldrin, 31 tonnes of dieldrin, 180 tonnes of endrin and 500 tonnes of DDT per year, with the Sakarya river being the most important source. Considering the other data, it is possible that these figures are largely overestimated. In fact, the determination of river inputs requires not only reliable analytical data, but also an optimisation of the sampling strategy and statistical evaluation of data (modelling), due to the large variability of hydrologic regimes of the Mediterranean rivers.

*c. PCBs*

PCBs have been produced industrially since 1929 and were manufactured in many industrial countries, including some on the Mediterranean. They are complex mixtures of biphenyl compounds with different degrees of chlorination. 209 homologues and isomers exist. In the past they were used as dielectric fluids in transformers and capacitors and in hydraulic and heat transfer fluids, but now there are restrictions in their use. The elimination of old electric appliances remains an important source of environmental pollution by these compounds. Combustion of PCBs can lead to the formation of toxic chlorinated furans and dioxins.

PCBs, as other organohalogens, enter the sea by and large through atmospheric deposition accounting for 80 percent of loads (UNEP/MAP, 1996a) and through rivers for the remaining part.

• *Levels / Loads*

PCB concentrations in the northwestern Mediterranean were comparable to those of other regional seas, such as the North Sea, the Pacific, Indian and Antarctic oceans according to 1990 reports (Tolosa, 1996).

Even though PCBs exhibit high particle / dissolved concentration ratios, the low levels of suspended particles in Mediterranean waters (0.4–1 mg/l) make the dissolved phase of the open sea the dominant reservoir of PCBs. In vertical profiles meas-

***Table 2.11 PTS Inputs (in kg/yr) of the Rhone and Seine Rivers into the Sea***

| River | | Dieldrin | Aldrin | DDTs | PCBs (Σ 7 congs) | HCB | α-HCH | γ-HCH |
|---|---|---|---|---|---|---|---|---|
| Rhone (1994–95)* | Dissolved | — | — | 230 | — | 14 | 124 | 360 |
| | Particulate | 33 | — | 51 | 304 | 157 | 23 | 21 |
| Seine (2000) | Dissolved | 13 | 6.3 | 6.3 | — | 6.5 | 79 | 85 |

* *Qualité des Eaux du Rhône, Évolution 1969–1995, July 1999, Agence de l'Eau Rhône-Méditerranée-Corse.*

ured in the Gulf of Lions in 1982–83, PCBs recovered from the particulate fractions of surface samples ranged from 32–65 percent, whereas in deep waters with lower suspended particle loads, the fraction was from 11–19 percent (Burns and Villeneuve, 1987).

Finally, a large water sampling was carried out in 1993–94 in the Western Mediterranean, including the straits of Sicily and Gibraltar (Dachs et al., 1997). Concentrations of dissolved PCBs were almost one order of magnitude higher than in the corresponding particulate phase. Suspended particulate matter at the Ebro mouth exhibited higher concentrations than at the Rhone River mouth. A spatial gradient was also observed from the continental shelf (3.5–26.6 pg/l) towards the open sea (1.7–6.6 pg/l). A relatively important enrichment (8.4 pg/l) was found in open sea stations located in higher productivity frontal zones.

*d. TBTs*

The main source of TBTs in the region is through their release from antifouling paint in ships. In January 2003, however, the new IMO Convention banning the use of TBT compounds in ship paints entered into force, changing the situation. As far as the present is concerned, there are no available data about the annual amount of TBT released to the Mediterranean Sea. An effort has been made in this report to estimate the releases of TBTs to the Mediterranean Sea due to maritime activities.

The total discharges of TBT may be estimated on the basis of leaching rates. The IMO has recommended a maximum leaching rate of 4 $mg/cm^2/day$ at 25°C. Therefore, the first step was to estimate the number of ships longer than 25 metres. The sea traffic of ships that met the requirements was considered. On one hand, it was accorded that roughly 20 % of merchant marine sail across the Mediterranean Sea; this represents some 17,000 ships. On the other hand, it is supposed that more than 4,000 ships smaller than 500 tonnes but longer than 25 metres also circulate in this area. Thus the number of ships considered in this study amounts to a total of 21,000. The average surface in touch with the water that has been considered for each unit is about 700 $m^2$, so the surface susceptive of discharging is 14,700,000 $m^2$.

It must be remarked that the discharge rate considered for the estimation of losses of TBTs into the sea, it has been chosen upward, bearing in mind that the leaching rate given in the IMO regulations is the maximum value. So, having considered the former rate, as well as the total surface of ships we obtain the following approximate release rate: 588 kg/day. This results in an approximate annual release of 214 tonnes of TBT from commercial shipping.

According to previous discussions, the hot spots for TBT release in the Mediterranean are associated with the major commercial harbours in the Region. We can stretch further the previous calculations and deduce where the Mediterranean areas, particularly around harbours, where larger inputs are in fact located.

Following the MED POL practice, the Mediterranean Sea has been divided into different areas because of the difficulty of estimating the exact percentage discharged in the main harbours. Then, an estimation of the sea traffic in each zone for ships larger than 25 m and with a metallic boat hull has been done; the results are shown in Table 2.12.

*Table 2.12 Estimated Distribution of TBTs in the Mediterranean Sea*

| Zone | Countries (main harbours) | Sea traffic / Annual TBT release |
|---|---|---|
| North / West | Spain (Marbella, Alacant, Valencia, Balearic Islands, Barcelona), Monaco, France (Marseille, Nice, Toulon), Italy (Genoa, La Spezia, Livorno) | 26 % / 56 tonnes |
| Centre / North | France (Corsica), Italy (Cagliari, Catania, Palermo, Civitavecchia, Napoli, Venice, Trieste), Slovenia, Croatia, Serbia & Montenegro, Albania | 28 % / 60 tonnes |
| North / Oriental | Greece (Piraeus, Iraklion), Turkey (Istanbul, Izmir, Anatolian Peninsula) | 16 % / 34 tonnes |
| South / East | Syria, Israel (Haifa), Lebanon (Beirut), Cyprus (Famagusta, Limassol), Egypt (Port Said, Alexandria) | 13 % / 28 tonnes |
| South / Central | Libya (Banghazi, Marsa al Burayqah, Tripoli, El Brega), Malta (La Valletta), Tunisia (oriental coast) | 3 % / 6 tonnes |
| South / West | Tunisia (Tunis), Algeria (Alger), Morocco (Ceuta, Melilla, Algeciras) | 14 % / 30 tonnes |

*e. Polycyclic aromatic hydrocarbons (PAHs)*

*Origins and major pathways of PAHs*

Sea transportation appears to be one of the main sources of PAHs pollution into the Mediterranean. It has been estimated that about 220,000 vessels of more than 100 tonnes each, cross the Mediterranean each year and about 250,000 tonnes of petroleum hydrocarbons are discharged due to shipping operations such as deballasting, tank-washing, dry-docking, fuel and bilge oil, etc.

*Accidental pollution*

Between 1987 and the end of 1996 an estimated amount of 22,000 tonnes of oil entered the Mediterranean Sea as the result of shipping incidents. This figure was derived by REMPEC from reports on all spill incidents in the Mediterranean region that are regularly received from its National Focal Points and from Lloyd's Casualty Reporting Service. On an annual basis there are about 60 maritime accidents in the Mediterranean of which 15 involve ships causing oil and chemical spills.

The land-based discharges are both industrial and urban. These oil discharges seem to be constant since the last ten years (EEA, 2002). There are no figures or estimates available regarding the amount of petroleum hydrocarbons carried directly through land run-off into the Mediterranean. Lipiatou et al. (1997) estimated that the total PAH riverine inputs amount to about 5.3 to 33 tonnes per year from the Rhone river and 1.3 tonnes from the Ebro river. The difference in these riverine fluxes is due to differences in the annual water discharges and upstream land use.

An additional source of PAHs is the result of the sewage sludge management strategies. The three major sludge producer countries, France, Italy and Spain generate an annual load of 2.9 tonnes of PAHs. Of those, some 1.2 tonnes are spread in the fields due to the use of sludge in agricultural applications, and an additional 1.2 tonnes per year are input in the soil via landfilling, while some 180 kg/yr are returned to the atmosphere mainly through sludge incineration in France. An additional 220 kg/yr are dumped into the Mediterranean through sludge dumping in Spain.

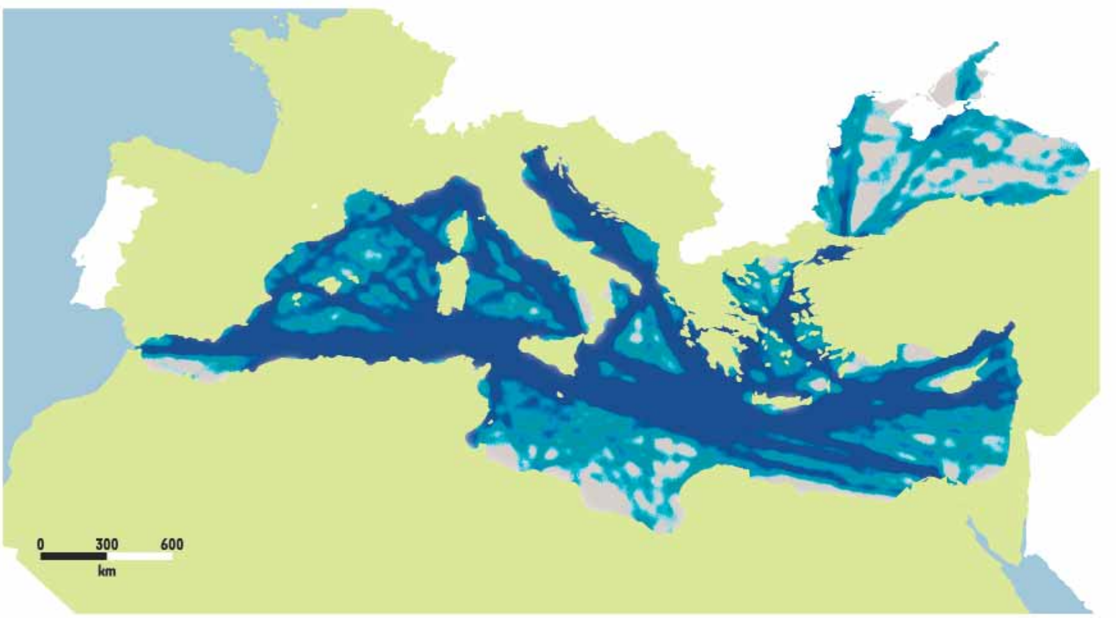
As regards atmospheric inputs, Lipiatou et al. (1997) reported a total PAH input ranging from 35 to 70 tonnes per year with a mean value of 47.5 tonnes (wet / dry mean ratio of ~2–3).

Accidental pollution is usually related to oil tanker major casualties, such as foundering, grounding, fire and explosion, collision at sea with another vessel, contact in a port with a quay, a pier or a bridge. These cargo oil spills, often involving large quantities of hydrocarbons, attract the attention of the public through their wide coverage by the media, showing terrific pictures of blackened beaches and of dead or dying oily birds, otters or seals.

It should be reminded here that oil accidental pollution may also be generated by similar casualties involving any other type of ship whose bunker tanks and / or luboil ones happen to be fractured and release their contents in the sea. The volume leaked in most of these oil bunker spill cases is normally much smaller than the one spilled from one of several cargo tank(s) of a damaged oil tanker, but the quantity of pollutant entering the sea is only one of the factors to be taken into consideration to evaluate the seriousness of a given pollution event for the marine and coastal environment. Bunkers are at present mainly composed of heavy fuel that is classified as a "persistent" and consequently dangerous pollutant. In fact heavy fuel used to feed most of the high-powered so-called "diesel" marine engines is not different from the heavy fuel carried in the cargo tanks of the ill-fated ERIKA. Therefore, a spillage from the bunkers of a very large and relatively fast ship such as the most recent post-Panamax container cargo vessel of 7,000 to 8,000 TEU with a propulsive engine in the range of 80,000 bhp, may cause more serious damages to the marine environment than the total shipment of gasoline or even naphtha of a 20,000 dwt product tanker. The total bunker capacity of such a vessel is in the range of 11,000 tonnes of which nearly 90 percent is heavy fuel.

Out of a world total of 8,395 registered events, 1,246 have taken place in a geographical area covering the Mediterranean and Black Seas as well as the Suez Canal. The corresponding percentage of the world total (14.8) is only exceeded by the Northwestern European area —21 percent— and the wide Far East and Australia area: 18.4 percent.

*Figure 2.31 Major Routes of Maritime Traffic*



From the same major casualties statistical analysis it appears that, among the "Fire / explosion" events recorded all over the world during the period, 21.7 percent took place in the Mediterranean / Black seas area. The corresponding percentage for "Foundered vessel" events was 16.9 percent, and the one for "Collisions" was 16.3. Thus, the frequency of the above casualty categories that are more likely to provoke cargo and bunker spills was higher for the considered area than the world average. The especially high percentage of "Fire and explosions" in the Mediterranean Basin should probably be related to the importance of oil and chemical tanker trades in this area, as the ships of these types are particularly exposed to this category of casualty. Such a global and regional Marine casualty analysis has not been repeated for a more recent period; however, when the yearly number of major casualties at the world level happily has been on the decrease, there is no indication that neither their geographical distribution nor their typology has been much modified during the last decade.

Obviously, detailed knowledge of the distribution by cargo categories volumes and geographical routes of the merchant ships' traffic flows and marine casualties is required to ascertain the environmental risks generated by Maritime Transport activities in ports, coastal areas and open sea in a given marine area. This requirement is not well addressed in the present state of collection and dissemination of sea-borne trade statistics, as it will be explained hereafter.

In general, the direct ecological impact is mainly on birds and marine mammals, less so on fish and invertebrates. From the economic point of view, the most directly affected activities are fishing, fish farming and tourism.

*Routine operation pollution*

Over and above accidental oil spills, the Mediterranean receives high amounts of operational oil pollution. Due to limited regular aerial surveillance in the region compared to other "Special Areas" such as the Baltic Sea and the Northwest European waters, and the resulting lack of regional statistics on pollution arising from routine ship operations, estimating operational oil pollution in the Mediterranean has been incomplete. A recent study by the EU (EC, 2001), using reconnaissance carried out over the entire Mediterranean region through the analysis of ERS-1 and SAR images presents the following data for the year 1999.

A considerable number of the detected oil spills (38.5 percent) during the year 1999, were considered to represent without doubt spilling in action. The total area of the 1,638 detected spills was estimated to be 17,141 km$^2$. An estimated 13,858 metric tones of spilled oil was estimated from the satellite images. This amount, considered by many researchers to be a conservative estimate, is already four times greater than the average amount of oil spilled in the region due to shipping accidents (REMPEC, 1998).

Taking into account the volumes of oily wastes received daily in the Mediterranean port facilities and the number of ships operating in the region, it appears clear that dumping in sea of oily wastes remains the favourite option of the ship Masters in the Mediterranean. There are many reasons for such behaviour:

- Waste oil receiving facilities are absent in many Mediterranean ports;
- The access to the receiving facilities is usually time consuming;
- The Mediterranean Port States are not able to identify small oil spillage;

- Even if an oil spillage is identified, a cost-benefit analysis between the money paid as penalty and the loss of time for oily waste disposal in the port is in favour of the dumping in the sea.

Most operational pollution causes are common to all types of merchant ships (and to many non-merchant ones). Some are related to propulsion plants: oily water and wastes collected in machinery space bilge tanks, nitrogen acid and other pollutants in machinery exhaust fumes; others to the crew and passengers: garbage and sewage; others to the ship's maintenance and operation: cleaning of tanks and piping before repairs, antifouling organotin paints, unwanted aquatic organism and pathogens fund in ships' ballast water and sediment discharges.

However, some well-publicised pollution causes are specific to the operation of a certain ship type / cargo category combination. The most infamous is the operational discharge of oil and / or oily wastes at sea as the consequence of the washing of cargo-tanks of an oil tanker after unloading a shipment of crude or petroleum products and before loading the next one or undertaking a maintenance or repair operation. The same kind of problem exists for tank cleaning in chemical and LPG tankers which has to be carried-out each time a cargo change occurs in a given tank or group of tanks.

Fishing and pleasure craft are also sources of operational pollution and the latter are particularly numerous along the Northern shores of the Mediterranean Sea. A possible, but practically not documented, pollution source derives from warship operations in the Mediterranean Sea. In fact, the NATO navies units are well equipped and their crews well trained to avoid operational pollution, not primarily to protect the environment, but rather for a tactical discretion purpose.

The major source of petroleum hydrocarbon pollution in the marine environment results mainly from discharge of oily water and residues resulting from the washing and deballasting at sea of the cargo tanks. Similar problems exist for chemical tankers carrying hazardous substances. The operational discharge of oil comprises also effluents of oily bilge water and residues from the machinery space of all ships.

According the IMO MARPOL Convention, the Mediterranean Sea has been designated as a "Special Area" and harmful discharge of hydrocarbons is not permitted. Nevertheless, the problem of operational oil pollution persists.

The estimated volume of oily wastes from tanker operations (especially deballasting) reaches 450,000 metric tonnes. Discharges of "oily bilge waters, sludge and used luboils from ships" are supposed to represent a further 60,000 metric tonnes (UNEP/MAP, 1997).

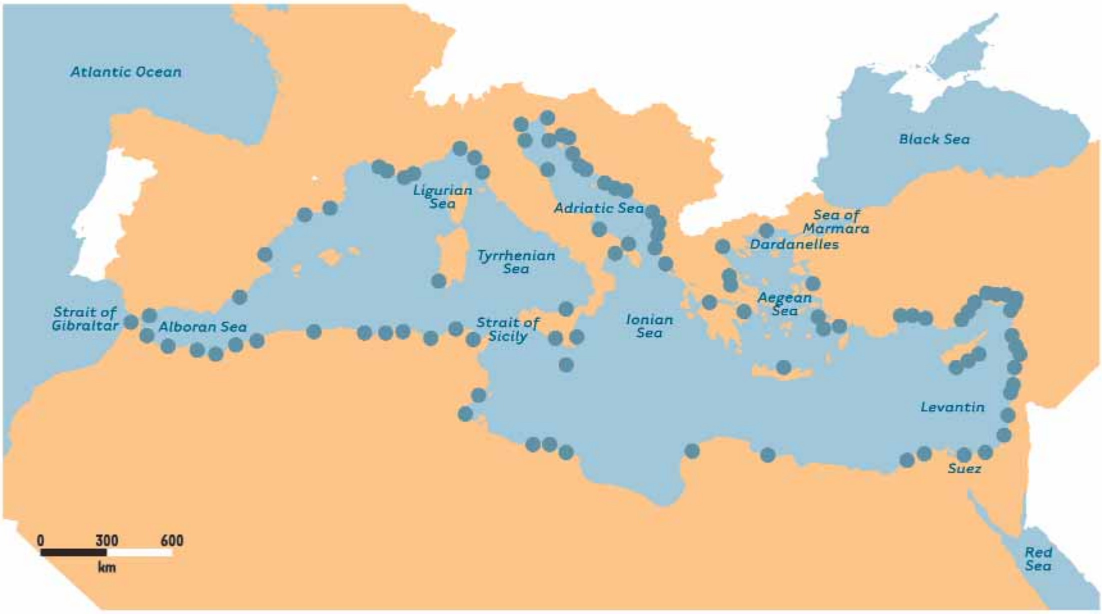
#### *2.3.6.4 Pollution Hot Spots*

The MED POL report on priority pollution hot spots and pollution sensitive areas developed in 1997 includes the list of pollution hot spots and sensitive areas not only in GEF-eligible countries, but in all Mediterranean countries. In 2002 a revised list of pollution hot spots and sensitive areas was developed taking into consideration the potential transboundary effect of those hot spots, if any. For the selection of pollution hot spots for pre-investment studies, the aim was to prepare a list of such hot spots taking fully into account the transboundary potential effect of pollution according to established and agreed criteria. The updated list of pollution hot spots and pollution sensitive areas is shown in Annexes III and IV. These hot spots are shown on Figure 2.32, together with pollution sensitive areas.

*Definition of Pollution Hot Spots*

- Point sources on the coast of the Mediterranean Sea which potentially

*Figure 2.32 Emergence of Pollution Hot Spots and Pollution Sensitive Areas*




● **Pollution Hot Spots and Pollution Sensitive Areas**

affect human health, ecosystems, biodiversity, sustainability or economy in a significant manner. They are the main points where high levels of pollution loads originating from domestic or industrial sources are being discharged;

- Defined coastal areas where the coastal marine environment is subject to pollution from one or more points or diffused sources on the coast of the Mediterranean that potentially affect human health in a significant manner, ecosystems, biodiversity, sustainability or economy.

*Pollution Hot Spots Indicators (primary)*

- BOD, COD;
- nutrients (phosphorus, nitrogen);
- total suspended solids;
- oil (petroleum hydrocarbons);
- heavy metals;
- persistent organic pollutants;
- radioactive substances (whenever applicable);
- litter;
- microorganisms (faecal coliforms, *E. coli*).

*Pollution Sensitive Areas in the Mediterranean Countries*

Pollution sensitive areas of the Mediterranean basin are of great importance because of their potential capacity to become, if not protected, future pollution hot spots. If such a development takes place, sensitive areas will require huge investments for their rehabilitation, instead of very moderate ones for their actual protection.

In the document on the "Identification of Priority Pollution Hot Spots and Sensitive Area in the Mediterranean Sea" (UNEP/WHO, 1999), sensitive areas are defined:

*"Estuaries and coastal waters of natural or socioeconomic value are considered sensitive areas if they are at higher risk to suffer negative impacts from human activities. Natural characteristics may determine the vulnerability of a coastal system, for example a bay with low flushing rates is more sensitive to pollution impacts than one, which is well flushed. Human activities determine the level of risk; hence planned devel-*

*opment may increase the risk of environmental degradation. Both vulnerability and risk contribute to the sensitivity of a particular area or system in the context of this assessment".*

It has to be clarified that sensitive areas are not protected areas of great ecological value. Sensitive areas are aquatic environments already polluted, which will become hot spots if no action is taken. Their "sensitivity" refers to their imminent environmental degradation.

Annex IV exhibits the list of pollution sensitive areas per Mediterranean country together with the type of pollution and the proposed actions to be considered to prevent the development of the area into a Hot Spot.

## 2.4 Human Health Risks

Environmental degradation of the Mediterranean ultimately affects the health of humans who rely on it for fishing, for food supply, and for recreation. This section surveys the risks to human health tied to microbiological and chemical contamination of the waters, the main routes by which the pollution affects human health, and the state of information currently available. Although GEF actions are addressed primarily at ecosystem effects, the stakeholders involved in preparing the TDA felt that human health risks were a major priority in the region. Hence its inclusion as one the MPPIs. The human health risks discussed here are linked to the social-economic impacts of the third MPPI: decline in water quality. However, in this section they are described in more detail, with specific linkages to the contaminant issues raised in the previous section (2.3).

The damage marine pollution might inflict on human health is a highly sensitive topic since the sea plays a major socio-economic role in all Mediterranean states. Apart from the approximately 130 million inhabitants living permanently along the coastline and interacting frequently with the water, another over 100 additional million tourists visit the area annually. During the summer months, the sea constitutes the main recreational amenity for local and tourist populations alike and tourism is a significant economic lifeline for many areas. Seafood harvested from the Mediterranean is an important part of the diet in the region with consumption of finfish (imported and homegrown) estimated at about 3 million tonnes and shellfish at more than 12,000 tonnes annually. Health risks that may stem from consumption of contaminated fish / shellfish or ingestion of contaminated water while bathing are therefore important public health concerns that extend beyond the boundaries of the basin.

Although there has been significant progress in combating health-threatening pollution in the Mediterranean, the quality of recreational and shellfish waters still gives rise to concerns. A wide disparity exists between regions in data available on the extent of damage to human health resulting from waterborne contaminants. The lack of data makes it difficult to accurately assess the overall situation at present. However, existing evidence suggests that there is a basis for justification of action on an international level to mitigate adverse health outcomes arising from marine pollution.

### *2.4.1 Transboundary elements*

The human health aspects related to the Mediterranean Sea have transboundary aspects to them. Although, as for pollution, much of the input is local and therefore more or less identifiable, the transport of the pollutants may achieve transboundary character. For instance, currents may move pollutants from place-to-place. Migratory fish (such as tuna and swordfish) may bioaccumulate contaminants and then translate human health risks to other parts of their range. Fish products are distributed from country-to-country in and out of the Mediterranean, so any exports may affect other countries. Finally, vacation-goers may take disease back to their countries from illnesses caught while swimming in the Mediterranean (hepatitis A being one example).

In summary, the major transboundary elements of the Human Health issue are:

- Export trade of contaminated seafood diffuses health concerns both throughout and beyond the Mediterranean basin;
- Demand for seafood linked to foreign travel to the Mediterranean exposes tourists to health risks from contaminated seafood;
- Risks of adverse health impacts from bathing in contaminated seawater, including diseases such as gastroenteritis, ear, skin and eye infections, and viral diseases like hepatitis A and cholera; and
- Superficial or deep mucoses from contact with contaminated beach sand while vacationing in Mediterranean coastal zones.

#### 2.4.2 Environmental impacts

There are no known environmental impacts arising from human health issues, other than perhaps introduction of pathogens from the Mediterranean to other areas of the Mediterranean due to consumption or other human or animal exposure to pathogens from the Mediterranean. There has been no documentation of such instances, however, to merit this as a great environmental concern.

#### 2.4.3 Socio-economic impacts

Major socio-economic impacts arise from specific problems related to human exposure to viral or pathogenic agents, such as:

- Transmission of viral, bacterial and other infections from polluted waters to man with short-term adverse health impacts;
- Public health risks of methylmercury poisoning linked to high seafood consumption with long-term impacts;
- Public health risks from toxic effects of PCB and dioxin linked to high seafood consumption with long-term impacts;
- Public health risks from cumulative unknown effects of chemical contaminants as well as their combined unknown action on humans in the long run;
- Public health risks from consumption of toxin-contaminated fish and shellfish

Any increase in health risks from marine pollution can have adverse economic consequences, mainly for the tourism, recreation and fisheries sectors in the Mediterranean.

- Loss of income from tourism related to health concerns associated with travel in the Mediterranean.

Concern about actual as well as potential health effects could make the basin less attractive as a tourist destination. The nature of tourism characterized by prolonged exposure to waters and long bathing season exacerbates risks of exposure to marine pollution. Another concern arises from overcrowded beach conditions known to facilitate transmission of infectious diseases.

- Seafood causes significant rise in health care expenditure among tourists to the Mediterranean.

In terms of infections linked to consumption of contaminated seafood, adverse effects on tourism in the region are also conceivable. Large numbers of sporadic cases, particularly among tourists, of various infections linked to travel in the Mediterranean give grounds for such concerns. Stille et al. (1972) estimated that as many as 19 percent of infectious hepatitis cases occurring in Frankfurt were attributable to consumption of contaminated oysters and mussels in the Mediterranean by German tourists.

- Particular seafood consumer groups exposed to risks of adverse health outcomes, personal distress in addition to high healthcare costs.

Another group of socio-economic concerns arises from public health risks and associated health care costs for particularly exposed population groups. Occupational exposure of individuals employed in the fisheries sector is much higher for substances such as methylmercury and PCBs. The effects of these persistent toxic substances would cause individual distress and represent an economic cost to society in terms of increased health care expenses.

- Occupational hazards posed by marine pollution pose public health and social welfare issues.

Moreover, in case toxicity of certain seafoods rises further, the whole fisheries sector would be subject to adverse large-scale repercussions. The consequences of potential decline in demand due to health concerns on seafood consumption, loss of employment and regional decline in some areas would have multiple adverse socio-economic consequences.

#### 2.4.4 Causal Chain Analysis

The causal chain analysis for this issue is essentially the same as for the third MPPI: decline in seawater quality. In order for risk to human health to occur, two criteria must be satisfied. First, there must be a toxicity associated with the contaminants of concern. Second, there must be some exposure pathway. Without toxicity there is no risk. Without pathway for exposure, there is no risk.

Hence, the causal chain analysis for this human health factor can be summarized by the mechanisms that generate toxicity. This is the same mechanistic framework as that generating decline in seawater quality. Second, there must be a mechanism leading to exposure. The exposure pathways are:

- Ingestion of seafood
- Ingestion of water while swimming
- Contact with contaminated seafood products (e.g., methyl mercury and the like)
- Contact with seawater contaminated with pathogens or viral agents

The causal chain analysis in Figure 2.4.1 basically mirrors the exposure pathway. It also links the exposure to various socio-economic impacts (but not environmental impacts).

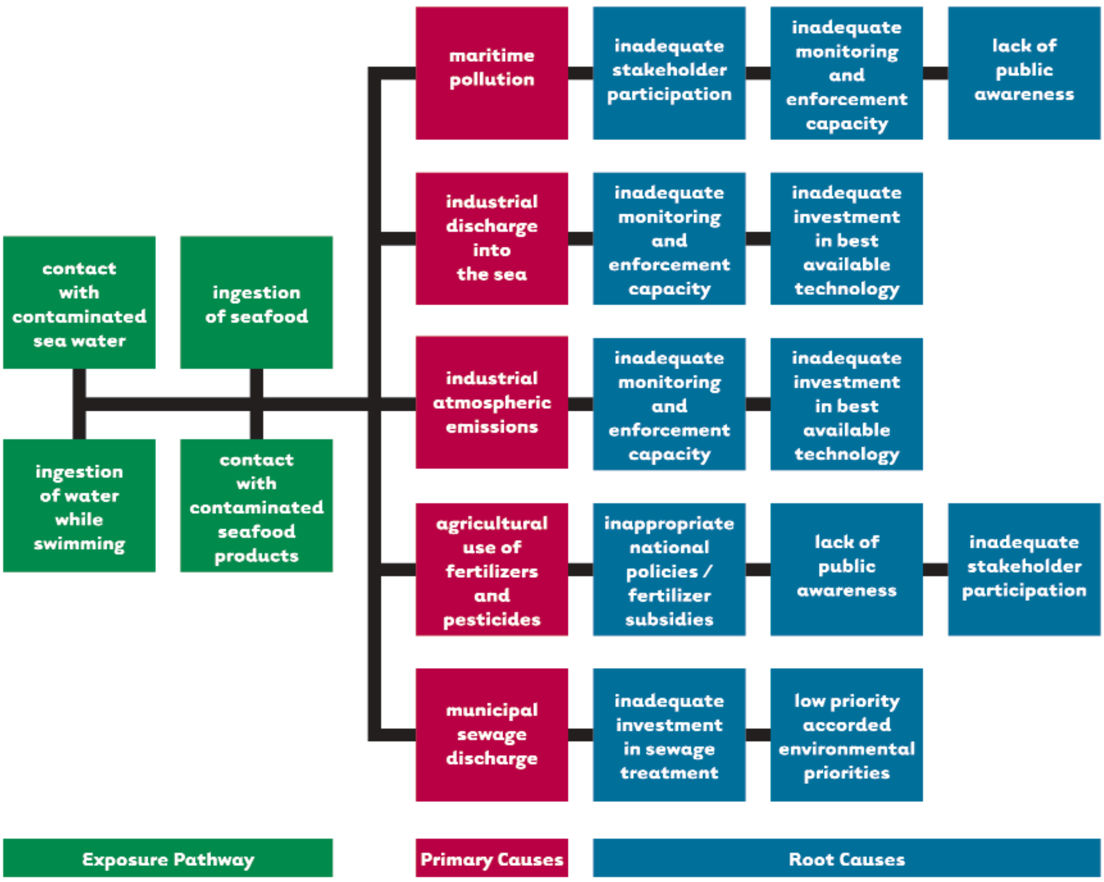
***Figure 2.4.1 Causal Chain Analysis: MPPI 4: Human Health Risks***

**Environmental Impacts:**

None

**Socio-economic Impacts:**

- Transmission of infections from polluted waters to man with short-term adverse health impacts
- Methylmercury poisoning linked to high seafood consumption with long-term impacts
- Toxic effects of PCB and dioxin linked to high seafood consumption with long-term impacts
- Cumulative unknown effects of chemical contaminants on humans in the long run;
- Public health risks from consumption of toxin-contaminated fish and shellfish
- Loss of income from tourism related to health concerns associated to travel in the Mediterranean
- Seafood causes significant rise in health care expenditure among tourists to the Mediterranean
- Particular seafood consumer groups exposed to risks of adverse health outcomes, personal distress in addition to high healthcare costs
- Occupational hazards posed by marine pollution pose public health and social welfare issue



### *2.4.5 Supporting data*

*2.4.5.1 Chemical contamination*

*a. Intake of persistent toxic substances (PTSs) and associated health risks*

In spite of the wide distribution of PTS in the Mediterranean, data on the human health effects in the region show remarkable paucity. Since diet, including seafood consumption, accounts to up to 95 percent of human exposure to PTS, however, the presence of PTS in various foodstuffs provides an initial estimate and relevant indicator of the risks to human health from pollution of the sea by PTS. Based on a recent study (UNEP/GEF, 2002), a selection of PTS and their related effects on human health are presented here as particularly relevant to this analysis.

Whereas bacterial or viral pollution produces relatively short-term effects, some chemical pollutants are known to cause long-term effects. Local populations are more susceptible to health damage from chemical contaminants, due to chronic exposure (as contrasted to a one-time exposure of a tourist). Moreover, in contrast to microbiological pollution, individuals are more likely to be exposed to chemical contamination unknowingly and for prolonged time periods. Relatively high levels of chemical pollutants in seafood may have no noticeable effect on its smell or taste, and the earliest symptoms of accumulation in the human body are not, as a rule, specific for chemical poisoning and therefore hard to detect. The presence of such pollutants can only be determined through relatively sophisticated clinical and biochemical tests, which, however, may reveal a health problem well into its development stage.

From a variety of toxic chemical substances in the Mediterranean, among the most serious effects for human health are linked to methylmercury, a synthetic toxic compound of the naturally occurring mercury. Eating relatively high amounts of seafood may expose consumers to wide-ranging health risks due to methylmercury poisoning. Disturbed sensory motor and cognitive functions, acute fatigue, and mild learning difficulties in infants borne to infected mothers are among the possible health consequences of methylmercury poisoning.

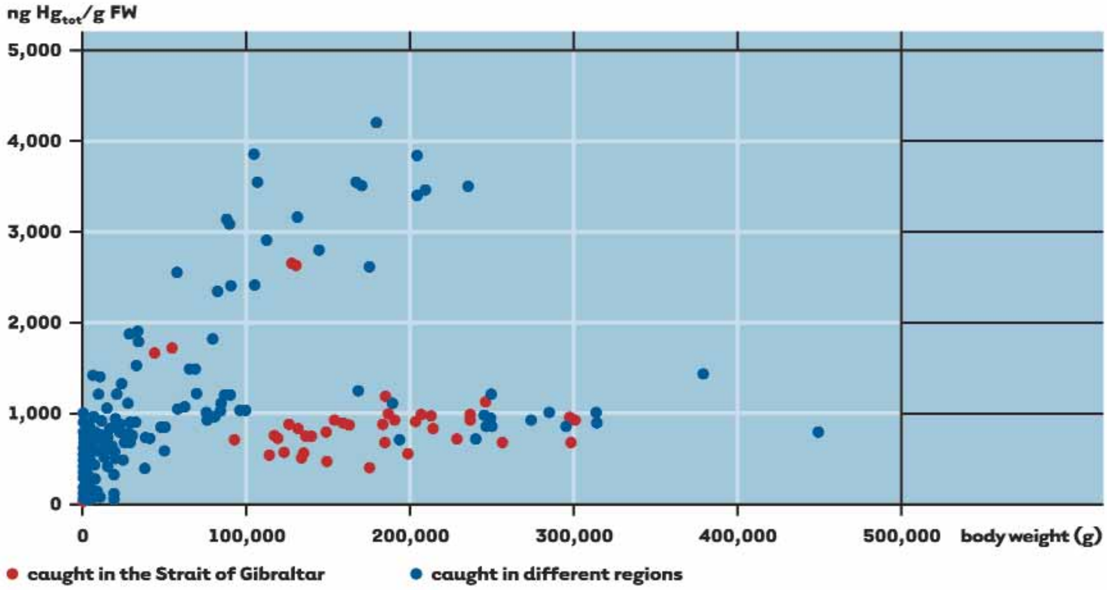
Diet is the main route of exposure to methylmercury as to other PTS, accounting for up to 90 percent of exposure. As can be seen in Table 2.14, the risks to public health from methylmercury poisoning affect particular groups but are not significant for the general public whose intake is below the Tolerable Daily Intake (TDI). A study by MED POL in early 1980s, covering Italy, Croatia and Greece, by

***Table 2.13 Intakes of Persistent Toxic Substances and Corresponding Safety Thresholds***

| PTS | TDI xg/kg/day | Organisation | Food intake (mean / adults) | Source |
|---|---|---|---|---|
| HCHs | 0.3 μg | WHO | 5.3 ng (1.8 %) | Italy |
| Chlordane | 0.5 μg | WHO | — | — |
| Dioxins (I-TEQ) | 1 pg | WHO | 1 pg (100 %) | Italy |
| | — | — | 1.03 pg (103 %) | France |
| | — | — | 3.5 pg (350 %) | Spain (Catalonia) |
| PCB-DL (I-TEQ) | 1.3 pg | WHO | 2.5 pg (192 %) | EU |
| PCB (Aroclor 1260 Eq) | 0.02 μg | WHO | 36.8 ng (180 %) | Italy |
| PAHs (BaP Eq) | 14 ng | DVS $10^{-4}$ RIVM | 5 ng (36 %) | France |
| Hg | 0.7 μg | WHO | 0.25 μg (36 %) | France |
| Me Hg | 0.47 μg | WHO | 0.34 μg (72 %) | France |

*TDI: tolerable daily intake*

*Figure 2.33 Total Mercury Content of Sardines caught in the Strait of Gibraltar and in different Regions of the Mediterranean Sea*

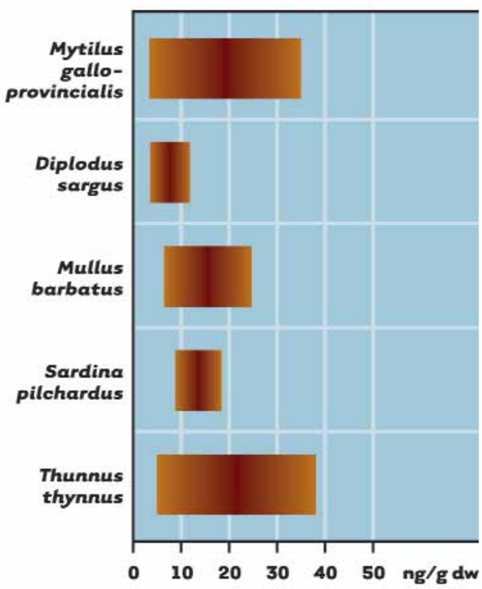



contrast, showed that individuals who consume high quantities of seafood, such as fishermen and their families are susceptible to health risks from methylmercury poisoning. Young children are also a high-risk group for methylmercury poisoning.

Infants and fish consumers are also high-risk groups due to weakening of the immune capacity and a wide range of other adverse health effects caused by PCB and dioxin intake from seafood. PCBs induce various enzymes in the liver and can produce changes in the immune system, behavioural alterations, impaired reproduction, liver, stomach, and thyroid gland injuries. Some PCBs can mimic or block the action of hormones from the thyroid and other endocrine glands. Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Both EPA and IARC have determined that PCBs are probably carcinogenic to humans. However, the most commonly reported health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes.

These population groups (infants, fish consumers) may exceed TDIs (3–4 times as reported by AFSSA). For instance, infants exposed through lactation in Serbia and Montenegro showed intakes of 1.75 ng the daily tolerable intake of PCBs (Vukavic et al., 1997).

*Figure 2.34 PCBs in selected Marine Species with Nutrition Values in the Mediterranean*



For dioxin-like PCBs (DL-PCBs) expressed as Total Equivalent (TEQ), the food exposure is twice the WHO (1998) TDI for dioxins and DL-PCBs. For total PCBs the dietary intake based on Italian TDIs study is about two times the TDI recently revised by the WHO and given in Aroclor equivalent. This observation is well correlated with the over-exposure found for DL-PCBs. Thus, the new TDI of PCBs revised by the WHO appeared to be pertinent for risk-assessment of total PCBs. The EU SCOOP report indicated that fish and fish products contributed to 70 % of the food exposure of DL-PCBs.

*b. Intake of persistent toxic substances (PTSs) and associated health risks: Other PTS of concern in the region*

- *Polychlorinated dioxins and furans (PCDD/Fs)*

PCDD/PCDFs occur as trace contaminants in a variety of industrial and thermal processes. As a consequence, dioxins from so-called primary sources can be transferred to other matrices and enter the environment. Such secondary sources are sewage sludge / biosludge, compost, or contaminated areas.

More than 90 % of human exposure to PCDDs and PCDFs is estimated to occur through the diet, with food from animal origin, including seafood, being the predominant source. The daily intake of PCDDs and PCDFs from food has been estimated to be 210 pg I-TE per person in Spain (Domingo et al. 1998) and 97 per person in France. For Italy, a daily intake of 45 pg I-TE per person has been calculated considering the only contributions from food of animal origin (a daily intake of about 60 pg I-TE may be assumed when contributions from the other foodstuffs are added).

Toxicological effects reported for PCDDs and PCDFs refer to the 2,3,7,8-substituted compounds. A variety of effects have been reported in animal studies following exposure to these compounds (WHO, 1998). The most extensive data set is available for 2,3,7,8-TCDD; less information is available for the other congeners. Among the most sensitive endpoints of 2,3,7,8-TCDD are endometriosis, neurobehavioral, developmental and reproductive effects, and immunotoxic effects.

The lowest doses giving rise to statistically significant effects in the most sensitive endpoints following exposure have resulted in body burdens (3 to 73 ng of TCDD/kg) in the exposed animals that overlap, at the lower end, the range of body burdens expressed as TEQ that are found in the general population in industrialised countries exposed to background levels of PCDDs and PCDFs.

Of the many non-cancer effects evaluated in exposed adult populations (e.g., herbicide producers and subjects exposed in incidents like Seveso, Italy), many were transient effects disappearing after the end of exposure. The only effect that correlates consistently with high exposure of humans to TCDD was chloracne. A few conditions appear to be in excess among the exposed cohorts when compared to unexposed reference groups including alterations in metabolic parameters, as well as mortality from cardiovascular and non-malignant liver disease.

PCDDs and PCDFs have been classified as substances for which there is evidence of endocrine disruption in an intact organism (COM, 1999). 2,3,7,8-TCDD has been shown to be carcinogenic in several species of laboratory animals at multiple sites. In humans, the epidemiological evidence from the most highly exposed cohorts studied produces the strongest evidence of increased risks for all cancers combined, along with less strong evidence of increased risks for cancers of particular sites. IARC concluded that 2,3,7,8-TCDD is carcinogenic to humans (Group 1). Other polychlorinated dibenzodioxins and dibenzofurans are not classifiable as to their carcinogenicity to humans.

- *Polycyclic aromatic hydrocarbons (PAHs)*

Sources of general population exposure to PAHs include contaminated food and seafood in particular. The calculated total daily intake of PAHs from food has been estimated to be 3 µg/day (1.4 µg/day carcinogenic PAHs) per person in Italy (Lodovici et al., 1995).

The acute toxicity of PAHs appears to be moderate-to-low (EHC). Short-term studies showed adverse haematological effects. Systemic effects caused by long-term treatment with PAHs have been described only rarely because the end-point of most studies has been carcinogenicity.

Significant toxic effects are manifested at doses at which carcinogenic responses are also triggered. In studies of adverse effects on the skin after dermal application, non- or weakly carcinogenic PAHs were inactive, whereas carcinogenic compounds caused hyperkeratosis. Benz[a]anthracene, benzo[a]pyrene, dibenz[ah]anthracene, and naphthalene are embryotoxic to mice and rats. Benzo[a]pyrene also has teratogenic and reproductive effects.

PAHs have also been studied extensively in assays for genotoxicity and cell transformation; most of the PAHs are genotoxic or probably genotoxic. The only compounds for which negative results were found in all assays were anthracene, fluorene, and naphthalene. Owing to inconsistent results, phenanthrene and pyrene could not be reliably classified for genotoxicity. PAHs have generally been reported to have immunosuppressive effects.

Because of the complex profile of PAHs in the environment and in workplaces, human exposure to pure, individual PAHs has been limited to scientific experiments with volunteers, except in the case of naphthalene that is used as a moth-repellent for clothing. After dermal application, anthracene, fluoranthene, phenanthrene and benzo[a]pyrene induced specific skin reactions, which were classified as neoplasic proliferations.

- *Alkylphenols*

Exposure to alkylphenols occurs mainly from food including seafood. The dietary daily intake of alkylphenols has been estimated to be 80 µg/day per person in Italy in 1995 (Ferrara et al. 2001). The acute oral toxicity of alkylphenols is usually low. Long-term oral exposure causes an increase in liver and kidney weight without significant histopathological alterations. Alkylphenols are not genotoxic. Nonyl-phenol and 4-tert-octylphenol have been classified as substances for which “there is evidence of endocrine disruption in an intact organism” (COM 1999) because of their estrogenic activity.

- *Aldrin, Dieldrin, Endrin and Heptachlor*

Exposure to these pesticides mostly happens from eating contaminated foods, including seafood. Human breast milk may be a major route of exposure for nursing infants. The total daily intake of aldrin and dieldrin from food has been estimated to be 0.5 µg/day (aldrin + dieldrin) per person in Spain in 1990-91 (Urieta et al. 1996); in one study in Egypt in 1995 (Zeinab et al. 1998) aldrin and dieldrin were found to be completely absent in the composite diet. In the same studies, the daily intake of endrin, heptachlor and heptachlor epoxide were found to be completely absent in the composite diet.

At high levels of exposure, aldrin, dieldrin and endrin mainly affect the central nervous system (EHC). Ingesting moderate levels of aldrin or dieldrin over a long period may also cause convulsions as a consequence of their bioaccumulation. The effects of exposure to low levels of aldrin or dieldrin

***Case Study***

**PCB contamination after the conflicts in Former Yugoslavia**

The long conflict between the different nations of the Former Republic of Yugoslavia in the 1990s and NATO's Kosovo intervention in spring 1999, had not only dramatic humanitarian consequences, but also detrimental effects on the environment. The burning or damaging of industrial and military targets resulted in the release of a large number of hazardous chemical substances, including PTS. It was estimated, for example, that more than 1,000 electro-transformer stations, containing PCB oil, were damaged during the war.

The karst area of the coast of Croatia was of particular concern for groundwater pollution. A large number of transformer stations were damaged in Delnice, Zadar, Sibenik, Split and Dubrovnik. In a study performed in 1996, significant levels of PCBs were found in soils from Sibenik (exceeding 2,000 mg/kg dw), Zadar and Dubrovnik areas. Daily PCB and DDT intakes were studied among fishermen and their families who consume fish from the coast of Zadar in significant quantities. It was found that many of them (especially those assumed to consume fish caught from the Marina and Vruljica stations, in the Zadar area) ingested more than the acceptable daily PCB intake of 1 µg/kg/day (Picer and Picer, 1998).

The cities of Pancevo, Novi Sad, Belgrade, Kragujevac, etc., in Serbia, were also severely attacked during NATO's intervention, causing numerous industrial accidents. For example, after the heavy bombardment of Kragujevac, 2,500 kg of PCB-based oil from the transformers of the automobile industry ZASTAVA were spilled. High levels of PCBs and PCDD/Fs were found in samples taken around the transformers of the power plant (70–74 g/kg of PCBs and 10,200 ng ITEQ/kg of PCDD/F). Underground water reservoirs were found to contain 0.7 mg/L of PCBs, but there were no traces in drinking water in this locality. On the other hand, sediments from the Lepenica river (close to the factory) contained high levels of PCBs (2.4 mg/kg), and the content in water was 18.7 ng/L. The factory is still storing 5–6 tonnes of waste oil containing PCBs.

The oil refineries of Pancevo and Novi Sad were also destroyed and around 150,000 tonnes of crude oil and oil products were burnt or leaked. Average contents of total PAHs in soils of the Novi Sad region were of 5.5 mg/kg two years after the aggression (2001), a value that is above the lowest risk level and could affect the safety of the crops grown in the area. Residues of DDTs were also found in all soil samples in levels that exceeded the Maximum Tolerable Concentration, according to the Official Register of the Republic of Serbia (11/1990), although this area was already heavily polluted before bombing (Vojinovic-Miloradov et al., 2002).

Water quality of the Sava and the Danube rivers was also assessed right after the accidents by monitoring the PCB levels in freshwater fish. The concentrations of PCBs in fish tissues from the Sava river were in the range of 8–177 µg/kg ww, and from the Danube 2–196 µg/kg ww, which is well below the maximum residue limit for PCB in fish (3 mg/kg). However, PCB have a long half-life in the environment, and it can be expected that concentrations in fish will rise due to bioaccumulation.

In order to collect and analyse the consequences for the environment and human settlements of the military actions in the Balkans region, the joint UNEP/UNCHS Balkans Task Force (BTF) was established in early May 1999. The BTF studied the impact of the conflict on the environmental situation in three countries: Serbia and Montenegro, FYR of Macedonia and Albania, and identified the main environmental concerns. More recently, the European Commission has recognised these problems and approved the research proposal APOPSBAL, to be developed in 12 institutions of Croatia (3), Slovenia, Bosnia & Herzegovina, Kosovo, Serbia & Montenegro (3), Austria, Czech Republic and Greece. These investigations will provide more precise data about the pollution, especially by PCBs, of the war-damaged area in Serbia and Montenegro.

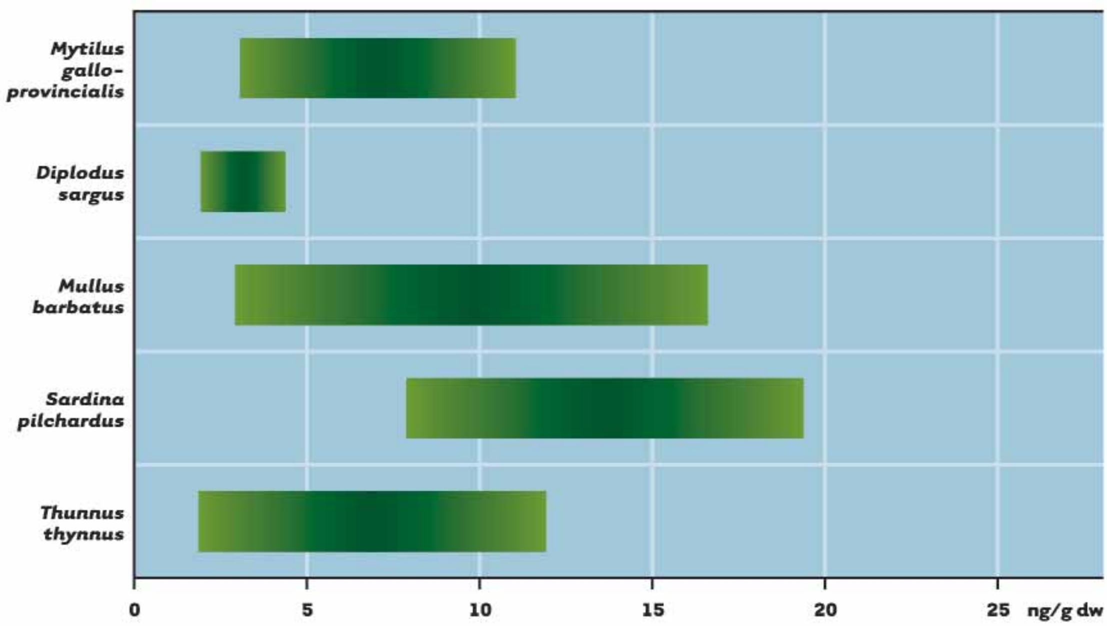
over a long time are not known. Some workers exposed to these insecticides had reversible nervous system effects with excitation leading to convulsions. Studies in animals indicated that these compounds may be immunotoxic. The International Agency for Research on Cancer (IARC) determined that aldrin, dieldrin and endrin are not classifiable as to their carcinogenicity to humans.

Heptachlor and heptachlor epoxide are moderately toxic to humans and animals and can damage the nervous system (EHC). There are some human data on brief exposures to high levels. A few reports showed that people who accidentally swallowed pesticides containing heptachlor, or who spilled pesticides on their clothes became dizzy, confused or had convulsions. IARC has classified heptachlor as possibly carcinogenic to humans.

A substantial amount of information exists on the distribution of PTS in the different environmental compartments of the region. In consequence, some areas of concern have been identified, which include estuaries (e.g., Seine, Rhone, Ebro, Po and Nile), coastal enclosures (e.g., Izmit Bay, Venice Lagoon, etc.), coastal areas (e.g., Northwest Mediterranean and Northern Adriatic), inland waters (e.g., Po, Ebro, Seine, Kupa and Lepenica rivers), and dumpsites (e.g., Durres, Skopje, Alger, Mustaganem, etc.). Apart from areas of intense local contamination, compounds of regional concern are PCBs, DDT, HCH, PAHs, HCB and TBTs. Other compounds, e.g., phthalates, alkylphenols and PBDE/PBBs, are suspected to be ubiquitous but data are lacking.

Few spatial and long-term temporal trends monitoring of fish, mussels and seabird eggs have been carried out in the Northern Mediterranean. A general decline of DDTs has been reported for marine biota along the Mediterranean coast of France and Italy, and from the Adriatic Sea between the 1970s and 1990s, which is consistent with the regulatory restrictions on production and use of this compound. PCBs, in general, do not exhibit such a clear trend.

*Figure 2.35 DDT in selected Species with Nutrition Values in the Mediterranean*



Despite the extensive information existing on PTS levels and trends, data are often missing for some compartments, particularly, atmosphere, ground and drinking waters, sewage sludges and soils, and storages (industrial products, pesticides). Moreover, significant geographical data gaps occur particularly in the South and Southeastern Mediterranean basin.

Apparently, data obtained are mainly the result of research projects rather than the existence of monitoring networks. When data exist, particularly in governmental agencies or institutions, they are not easily available and, in many occasions, data series are discontinued and have not been quality assessed. Most of the data for chlorinated pesticides, for example, were obtained in the 1980s and levels usually show an extremely large span of concentrations, which may reflect more the result of analytical inconsistencies than real differences of levels of pollution.

Available data on PTS levels in human tissues show a substantial paucity which appears even more striking if compared to the amount of data available for environmental matrices: biota and food. A representative study of a general healthy population living in a wide geographic area has never been conducted in any country of the region. Most countries in the region lack population indicators on the impact that environmental contamination has on human health.

A major step towards the filling of the existing data gaps in the Region will be the activation of monitoring programs at three levels:

- Analysis of abiotic samples or sentinel species to identify hot spots and transport pathways. Monitoring activities should be established in the corresponding countries to fill the geographical data gaps and ensure the continuation of existing time trend series. Regional surveys of emerging PTS and compounds actually on the market or those difficult to analyse (e.g., PCDD/F) should be particularly envisaged.
- Analysis of food to evaluate the general exposure of the population and to detect abnormal increases due to different cases of contamination. Monitoring design should allow to assess any correlation of PTS body-burden with factors as age and gender groups, dietary habits, occupation and education. In this context, total diet studies taking into account regional habits are of primary interest.
- Analysis of human tissues (blood, milk) for human body burdens estimation and risk evaluation. Human tissues are also exposure sources for developing organisms. Although this kind of assessment poses a series of technical and ethical problems, monitoring of human tissues provides the best information on human exposure to PTS. The data obtained should allow the validation of exposure models.
- Domestic and regional monitoring efforts should continue to study multi-media transport across air, rivers, seas, and soil, and the resultant environmental and human concentration levels.
- According to the regional experts, future-monitoring strategies should address the following:
- Intensive monitoring of temporal trends in appropriate abiotic and biotic media at a few key locations, and occasionally over wider areas, and continuation of existing time trend series that have proven to be useful and informative.

- Standardised sampling and analytical methods in order to compare results in the studies carried out in different countries must be implemented. Monitoring programs should include improved quality assurance / quality control protocols, possibly linked to other international programs, and contain reporting procedures and analysis of data.
- Monitoring strategies need to be adequate to the technical and economical possibilities of the different countries. Regional accredited laboratories may assist contracted monitoring institutions in the development of quality assurance systems. In any case, a regional network of national intercalibrated laboratories contributing to regional monitoring could better improve data quality and fill data gaps.

The achievement of these goals requires national / regional strategies, which should provide the basic support for an adequate environmental management of PTS.

*c. Regional data availability and gaps on ecotoxicology*

For humans, the lack of solid data on food PTS intakes strongly limits the risk-assessment. There is an urgent need for extensive food exposure study, taking as example the best studies performed in some countries (market basket and TDS), and the areas more heavily contaminated. Moreover, epidemiological population survey must take into account not only the morbidity data but also more subtle effects such as parameters linked to reproduction (histological and functional aspects) and neurologic functions, especially in young children (brain development, behaviour, etc.).

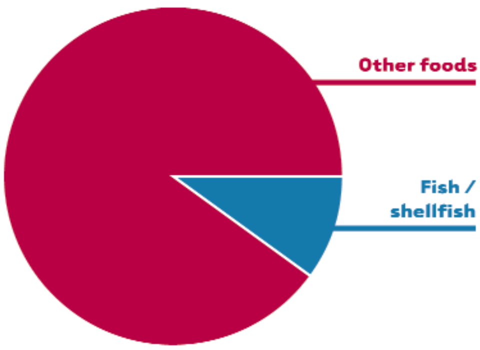
According to UNEP 2002 the main gaps in currently available ecotoxicologic data in the Mediterranean region are as follows:

- There is a lack of toxicological and ecotoxicological data for many PTS in the region. This holds not only for new classes of PTS (e.g., alkylphenols, PBDEs, phthalates, PAHs,) but also for those that have been under focus for many years. Special attention should be paid to chronic toxicity studies and to the incorporation of biomarkers / bioassays in environmental quality indices.
- There is a need for a uniform approach and framework for evaluation and monitoring of receiving waters in the region. Water Quality Indices should be improved (various types of indices have been developed which need to be evaluated and integrated). Multidisciplinary approaches should be applied, especially for estuaries and deltas.
- Specific research to quantify the role of PTS on the impacts observed on endangered species and ecosystems is considered urgent for setting the programmes for maintaining the biodiversity of the Region.
- Sediment exposure (reservoirs) and effects to aquatic biota are important to be assessed by the particular hydrogeographical characteristics of the region. In this respect, mesocosm studies (validation of biological parameters and biomarkers) should be encouraged.
- Modelling is a complementary tool for risk assessment and is barely applied in the region. Monitoring and modelling will require much attention in particular for improving the estimates of the fate and effects of emissions and pools of existing PTS. A task of particular impor-

tance will be the improvement of communication between existing chemical and toxicological information for PTS and ecosystem and trophic web models.

The experience in recent decades in the European Union and the UN/ECE has demonstrated the advantages of an integrated science-based approach, linking population, activities, emissions, transport and effects in a coherent international co-operative risk assessment framework. Such an approach is cost effective in making better use of available scientific and technical resources and in helping policy makers to design effective environmental policy.

**Figure 2.36 Percentage of Foodborne Disease Outbreaks caused by Fish and Shellfish in Italy, Spain and France 1993–98** *(Source: WHO)*




Humans are exposed to marine pollutants mainly through the consumption of fish and other seafood, the ingestion of seawater while swimming or bathing, and direct contact with sand or seawater. The contribution of each of the two routes of transmission is an open issue. However, when looking at foodborne disease outbreaks data suggest that consumption of shellfish and fish continued to be a significant cause of short-term health risk in the 1990s in the Mediterranean (Figures 2.36 and 2.37).

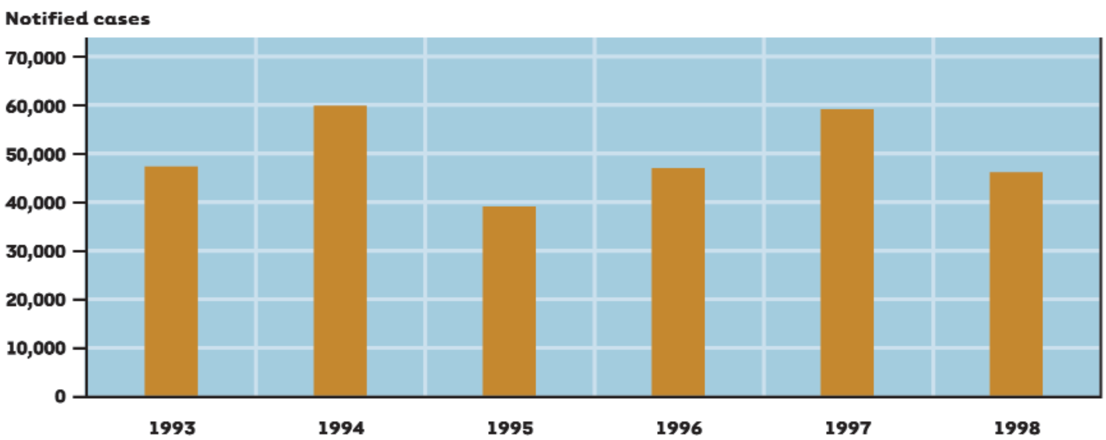
### *2.4.5.2 Microbiological pollution*

#### *a. Health risks from microbiological pollution*

Microorganisms present in the Mediterranean coasts are known to give rise to two sorts of health problems: those that affect the gastrointestinal tract and those that affect other parts of the body. Gastrointestinal infections are spread mainly in areas that receive untreated sewage loads (Cabelli, 1983). Infections can be broadly grouped into three categories according to whether the cause is a bacterium or a virus or a variety of protozoan and metazoan parasites such as Amoebic dysentery.

WHO reports for the Northern Mediterranean indicate that salmonella, the principal type of foodborne

**Figure 2.37 Notified Cases of Food Borne Disease Outbreaks in Spain, Italy, Greece and France 1993–98** *(Source: WHO)*



disease in the northern basin, was significantly linked to consumption of fish and shellfish for the period 1993–1998. Figure 2.36 shows that fish and shellfish accounted for 10 percent of notified salmonella-related cases in France, Spain and Italy in the period 1993–98. Based on conservative estimates fish and shellfish consumption therefore gave rise to approximately 5,000 cases of disease annually within that period. Moreover, this figure is suspected by national authorities to conceal biases due to underreporting linked to regional interests.

In addition to bacterial infection shellfish is the main transmission channel for enteric viruses. Numerous epidemics have been described, caused mainly by the gastro-enteritis and hepatitis viruses found in all sorts of shellfish, generally eaten raw or insufficiently cooked. The shellfish concerned comes either from unhealthy breeding areas or areas which are normally unpolluted but which have been temporarily polluted, or else the shellfish itself has been insufficiently depurated.

The main viruses implicated in recent epidemics of viral aetiology transmitted by molluscs are the gastro-enteritis viruses (Norwalk virus and the "small round viruses") and the hepatitis A virus.

The transmission of enteric viruses via molluscs is easy to understand when one looks at their eating habits; shellfish filter up to 20 litres per hour of water which means that they accumulate pathogenic micro-organisms present in seawater.

The potential of shellfish to carry viral disease is magnified many-fold by the ability of viruses to survive a long time in the shellfish. Viral diseases reported apart from hepatitis A include enteroviruses (coxsackie viruses A and B, echoviruses, reoviruses and adenoviruses). The length of time these viruses survive in immersed shellfish and the temperature of the water, but it can be more than 60 days. Storing contaminated varies according to the microbiological quality, shellfish, whether fresh or frozen, does not greatly reduce its viral content.

Shellfish quality standards vary widely throughout the Mediterranean region. Production is largely concentrated in three states, Italy, France and Spain which somewhat reduces the difficulty of risk control. These states have legislation that makes shellfish depuration mandatory prior to marketing. Decontamination techniques, based on the immersion of bivalves for 24 to 72 hours in good quality seawater or seawater that has been disinfected, give good bacteriological results when they are properly applied. On the other hand however, a considerable amount of shellfish all over the Mediterranean is still not subject to strict depuration procedures or proper control of storage after harvest (WHO/UNEP, 1995b). Moreover, from a virological point of view, these techniques are not wholly satisfactory since the shellfish still sometimes contains viruses after decontamination, particularly when the shellfish is heavily contaminated. The third type of disease causing microorganisms is a variety of protozoan and metazoan parasites such as Amoebic dysentery, giardiasis, ascariasis etc. The pathogenic microorganisms present in the Mediterranean raw sewage are given in Table 2.18.

In so far as ingestion of water during swimming or bathing is relatively limited, the diseases mentioned above are more likely to be contracted through the consumption of raw or partially cooked shellfish.

Raw fish and mussels are possible sources of infection for a number of pathogenic bacteria biocaccumulated in the flesh. Microorganisms endemic to seawater, such as *Vibrio parahaemolyticus*, *Clostridium pergringens*, Hepatitis A virus and Norwalk viruses

**Table 2.14 Pathogens and Indicator Organisms commonly found in Raw Sewage** (Source: Bartram and Rees, 2000)

| Pathogen or indicator | Disease or role | Number per litre |
|---|---|---|
| **Bacteria** | | |
| *Campylobacter spp.* | Gastro-enteritis | 37,000 |
| *Clostridium perfringens* | Indicator organism | $6x10^5$—$8x10^5$ |
| *E. coli* | Indicator organism | $10^7x10^8$ |
| *Salmonella spp.* | Gastro-enteritis | 20—80,000 |
| Shigella | Bacillary dysentery | 10—10,000 |
| **Viruses** | | |
| Polioviruses | Indicator | 1,800 — 5,000,000 |
| Rotaviruses | Diarrhoea, vomiting | 4,000 — 850,000 |
| **Parasitic protozoa** | | |
| *Cryptosporidium parvum oocysts* | Diarrhoea | 1—390 |
| *Entamoeba histolytica* | Amoebic dysentery | 4 |
| *Giardia lamblia cysts* | Diarrhoea | 125—200,000 |
| **Helminths** | | |
| *Scaris spp.* | Ascariasis | 5—110 |
| *Ancyloistoma spp.* | Anaemia | 6—190 |
| *Trichuris spp.* | Diarrhoea | 10—40 |

have been associated with epidemics worldwide (WHO/UNEP, 1995b).

Cholera is one of the main diseases associated with the consumption of sewage-contaminated shellfish and a major epidemic occurred in Italy in 1973 causing 277 cases and 24 deaths (WHO/UNEP, 1995b). Between October and December 1994, a total of 12 indigenous cases of cholera were registered in the southern Italian region of Puglia.

Apart from diseases that affect the gastrointestinal tract, a number of disorders affect the eye, ear, upper respiratory tract and other areas in connection to bathing in contaminated waters. Microorganisms such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Clostridium welchii* and Candida albicans particularly affect individuals with skin lesion or ruptured ear or nose membrane.

The most common infection cause due to contact with contaminated sand is *Candida albicans*. It has been isolated in the south of France, Israel and Greece. Infection is highest where crowded beach conditions exist. *Candida* as well as a number of other fungi species causes more or less deep mucoses depending on the location of the pathogen within the host.

*b. Origins of the problem*

Microbiological pollution of coastal waters and of shellfish is according to experts a major problem of the Mediterranean. Pathogenic and other microorganisms enter the marine environment through untreated or partially treated municipal wastewater. Although pathogenic contamination from city wastewater is the most serious dimension of city pollution for seawater, it is also the least well known. Except for specific studies pathogenic contamination of wastewater is only monitored for faecal, coliform and streptococci content.

Faecal contamination, indicating contamination by animal and human excreta is one of the most direct ways to assess the hygienic quality of water. One way to detect faecal contamination is to investigate Biological oxygen demand (BOD) of the water. Microbiological organisms use oxygen in the process of oxidation of the polluting matter so a test on oxygen requirements, referred to as $BOD_5$, can yield estimates of faecal concentration. As shown by Figure 2.40, a mere 18 cities contribute half of urban waste containing BOD in the Mediterranean, and five account for one quarter of this waste. These cities are Alexandria, Naples, Izmir, Barcelona and Beyrouth. Fortunately, significant sewage and sanitation programmes are under way in several of the cities, although it is clearly urgent to extend these efforts to others.

Wastewater discharge into the sea is the most common manner of final wastewater disposition in coastal urban and industrial zones. Lack of treatment even on a basic scale is therefore the biggest cause of pollution in terms of $BOD_5$. Currently it is estimated that half of untreated pollution in terms of $BOD_5$ originates from direct discharges. Less than one-third of BOD pollution comes from the discharges of treatment plants and the remainder from storm water during periods of rain.

Figure 2.38 shows the percentage of coastal cities (with over 10,000 inhabitants) with wastewater treatment, while Figure 2.39 shows the type of treatment encountered in coastal areas in the Mediterranean (UNEP/MAP/WHO, 2004). BOD values are greatly reduced only at the secondary treatment level (70–90 percent reduction) while a lesser reduction (20 percent) is also achieved through primary treatment (Figure 2.41).

***Figure 2.38** Coastal Cities (with over 10,000 Inhabitants) with Wastewater Treatment Facilities in the Mediterranean*
*(Source: UNEP/MAP/MED POL, 2004)*

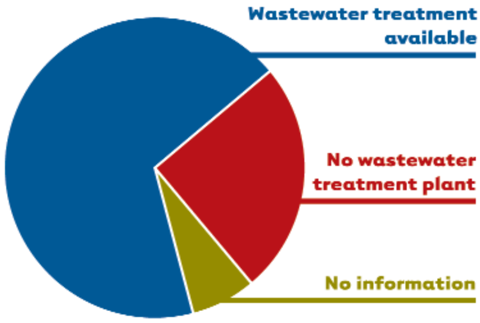



***Figure 2.39** Type of Wastewater Treatment in Mediterranean Coastal Cities*
*(Source: UNEP/MAP/MED POL, 2004)*

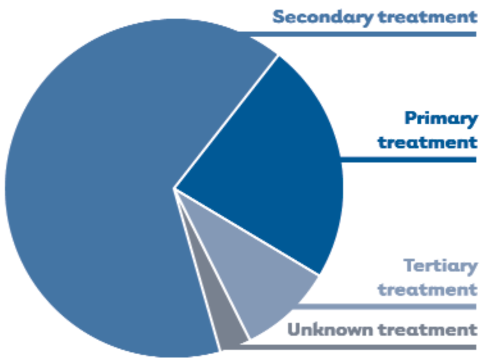



***Figure 2.40** Water discharged by Mediterranean Coastal Cities*

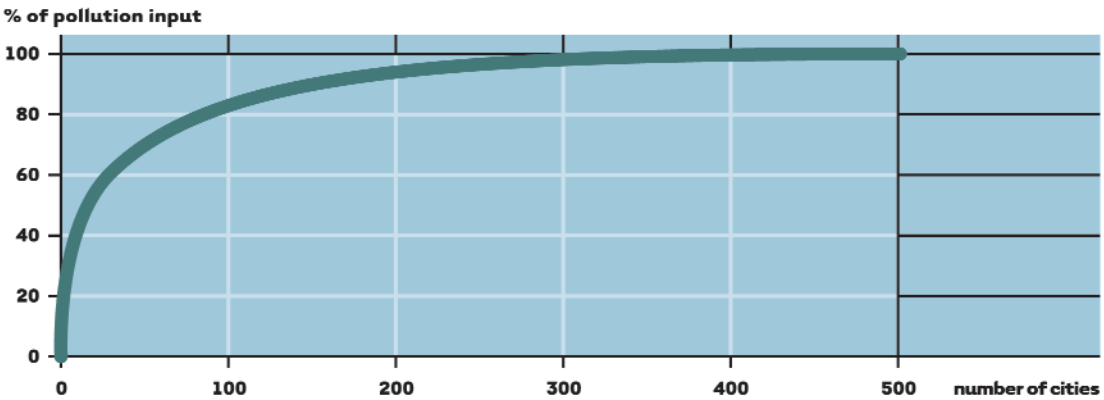
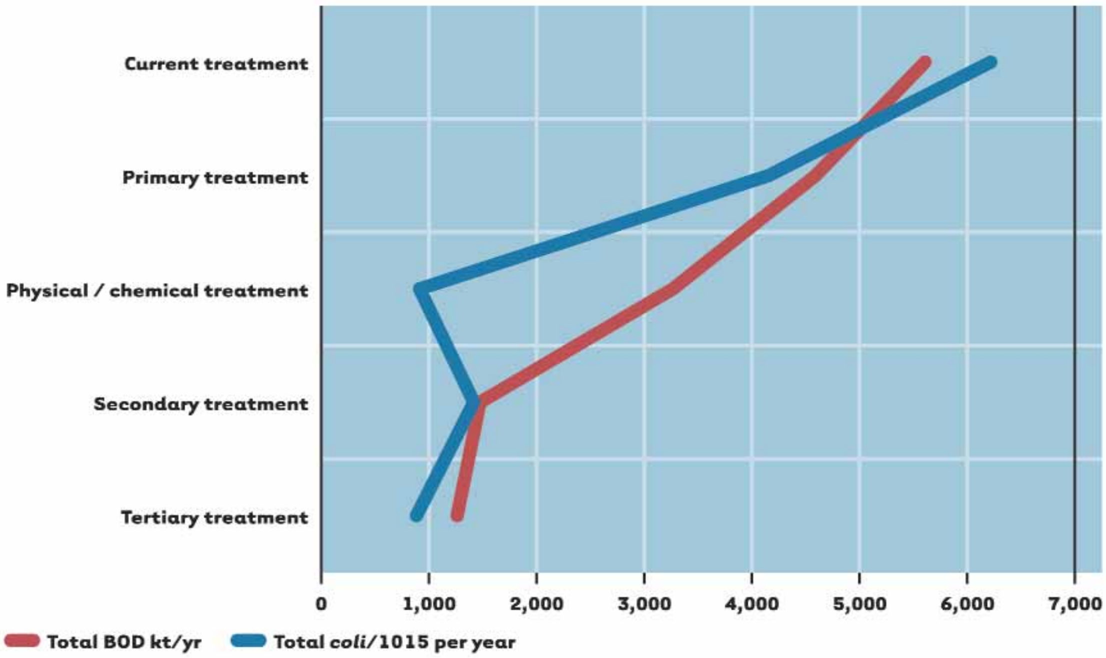


**Figure 2.41 Potential for Microbiological Pollution Reduction following Expansion of Waste Treatment in the Mediterranean**




*c. Cross regional differences in waste treatment in the Mediterranean*

This estimate conceals high variability between countries, however. As large differences in the sanitation systems as well as total effluent volumes differ largely among countries, but also partly due to the quality of the information. This estimate should be treated as an indicative statement in need of further qualification.

Based on recent regional assessment of municipal wastewater treatment data (UNEP/MAP/MED POL, 2004), Italy is by far the country with the highest volume discharged (almost 40 percent of the total). Further, the data provided shows that many cities do not have treatment plants and that their systems discharge wastewater directly into the sea. This situation weighs heavily in the assessment. Spain comes in second place, as many treatment plants have been planned, with their size being given in the survey, so that the situation should improve once they are constructed. Egypt is in third place, with an evident problem of an insufficient number of treatment plants and a major problem posed by the city of Alexandria. France is the country which discharges the least untreated waste water only because the replies supplied do not mention this type of discharge, but only the size of the treatment plants. However, in contrast with Spain, the treatment plants are all constructed, with one exception, which is a positive point. It is nevertheless almost evident that certain direct discharges persist in reality, even if only through the erroneous connection of domestic wastewaters to storm water systems. Bad connections exist everywhere, but they are all the more significant where the connection rate is high.

In a recent regional assessment of municipal wastewater treatment plants in the region (UNEP/MAP/WHO, 2004), an updated list of cities with > 50,000 inhs. and < 900,000 inhs. to (total population of 4,239,110) was developed and shown in Table 2.19.

The overall wastewater system efficiency in the Mediterranean is mediocre (42 percent). Two countries have no wastewater treatment plants (Albania and Syrian Arab Republic) and several others eliminate as low as 10 percent of $BOD_5$ and that at most (Croatia, Lebanon, Morocco, Slovenia, Turkey and Egypt). It is clear that an effort is required to install treatment plants where they do not exist and to supplement primary treatment systems by secondary and more refined techniques.

Where wastewater treatment plants do exist, individual countries' performance varies widely from the average efficiency levels. Countries with primary treatment plants only expectably show the lowest rates of wastewater treatment efficiency. By contrast, countries with secondary and tertiary treatment facilities show high performances approaching 90 percent, which is 23 percent higher than the average.

The higher the coastal population and the lower the level of treatment, the higher will be load of waste treatment plants. High population countries with inadequate secondary and tertiary treatment plants, as Greece for instance, will show high levels of treatment plant loads compared to others such as France and Spain where similar population pressure exists but is met with better provision of secondary and tertiary wastewater treatment facilities. Naturally other countries such as Turkey with lower population levels will show correspondingly lower loads of treatment plant loads, despite relative lack of secondary and tertiary treatment.

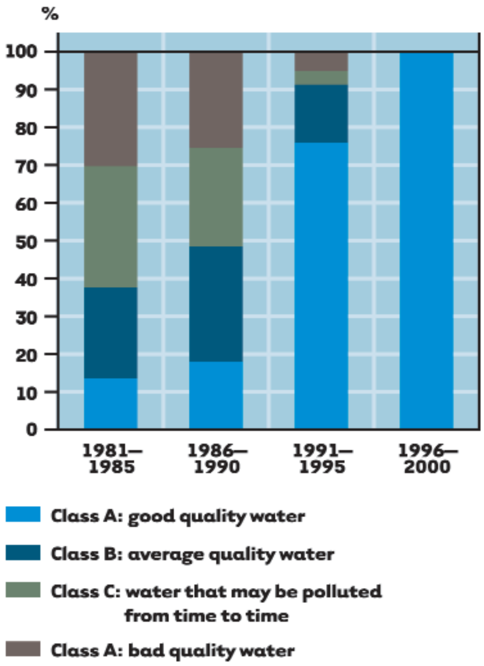
A vivid illustration of the large potential to redress coastal pollution by treating urban wastewater is provided in the example of the city of Marseille. Bathing water quality around the large port city in the northeast coast of France improved dramatically within 20 years due to action taken to combat urban wastewater pollution. As can be seen in Figure 2.42, in the early to mid 1980s the percentage of water that classified as good quality represented only about 16 percent. By contrast twenty years later the entire coastal area of Marseille qualified as good quality water.

Linking all inhabitants to wastewater treatment systems would have great impacts in decreasing pathogenic pollution loads in the Mediterranean. A glimpse at how large the size of benefit that would follow from providing various levels of treatment is shown in Figure 2.42.

***Table 2.15 Cities (> 50,000 and < 900,000 inhs.) without WWTP in the Mediterranean***

| Country | City | Population (in 1,000) |
|---|---|---|
| Albania | Vlora | 130.00 |
| Albania | Durres | 140.00 |
| Algeria | Arzew | 66.19 |
| Algeria | Taher | 72.50 |
| Algeria | El Milia | 75.60 |
| Algeria | Jijel | 124.94 |
| Algeria | Mostaganem | 141.31 |
| Algeria | Skikda | 166.76 |
| Algeria | Oran | 831.34 |
| Croatia | Sibenik | 67.20 |
| Croatia | Zadar | 80.30 |
| Greece | Elefsina | 120.00 |
| Lebanon | Batroun | 51.00 |
| Lebanon | Jubayl (Jbail, Byblos) | 66.00 |
| Lebanon | Sour (Sur or Tyre) | 181.00 |
| Lebanon | Jounieh | 200.00 |
| Lebanon | Saida / Ghaziye (Sidon) | 205.00 |
| Lebanon | Tripoli (Tarabalus) | 353.00 |
| Libya | Al Garabulli | 80.00 |
| Morocco | Fnideq | 52.47 |
| Spain | Ceuta | 73.20 |
| Spain | Algeciras | 100.60 |
| Syria | Jableh | 58.60 |
| Syria | Tartous | 107.00 |
| Syria | Lattakia | 387.73 |
| Turkey | Dortyol | 53.60 |
| Turkey | Silifke | 64.83 |
| Turkey | Canakkale | 75.81 |
| Turkey | Kiziltepe | 113.14 |

*Figure 2.42 Changes in the Quality of Bathing Water on the Marseille Coast since the Beginning of the 1980s*




Urban stormwater is another way in which coastal waters adjacent to cities may become polluted. Despite being considered as unpolluted or only slightly polluted it may become a significant source of pollution, especially where wastewaters infiltrate storm water drainage systems. Unfortunately as all waters are often drained in the same system, urban wastewaters may overflood in rainy periods when drainage capacity is saturated.

*d. Assessment of major pathways of microbiological pollution*

- *Discharge through rivers*

Rivers may add a considerable amount of microbiological pollution mainly from upstream wastewater discharges. Animal feedlots and domestic wastewater often contain great numbers of bacteria and viruses that are pathogenic for humans and aquatic organisms.

An overview of 13 Mediterranean rivers (Table 2.17) mainly in Greece and Italy in the late 1980s provides a ranking of rivers in terms of microbiological pollution content (Agence de l' Eau Rhône — Méditerranée). According to it, the most polluted rivers are the Po and Tiber rivers in Italy and the Ebro river in Spain. According to more recent data however, bacterial pollution has been declining with best results observed in the Rhone River.



*Table 2.16 Bacteriological Water Quality in some Mediterranean Rivers*
*(Source: "Agence de l'Eau Rhône — Méditerranée — Corse: http://www.rdbrmc.com/)*

| Rivers | Country | Coli-faecal (n/100 ml) | | | Coli-total (n/100 ml) | | | Strepto-faecal (n/100 ml) | | | Period | Sample nb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mean | min | max | mean | min | max | mean | min | max | | |
| Rhone | France | | | | 2,100 | 30 | 11,700 | 515 | 1 | 6,000 | 88–92 | 52 |
| Akheloos | Greece | 133 | 0 | 4,600 | 301 | 0 | 4,600 | 32 | 0 | 266 | 84–92 | 71 |
| Aliakmon | Greece | 3,520 | 0 | 240,000 | 12,423 | 6 | 1,000,000 | 765 | 0 | 24500 | 82–92 | 103–104 |
| Axios | Greece | 5,320 | 240 | 46,000 | 10,740 | 450 | 46,000 | 1,892 | 0 | 11,000 | 83–89 | 51 |
| Nestos | Greece | 1,696 | 0 | 11,000 | 3,106 | 23 | 24,000 | 905 | 0 | 8,000 | 82–92 | 55 |
| Pinios | Greece | 1,159 | 0 | 11,000 | 2,677 | 0 | 37,000 | 78 | 0 | 700 | 82–91 | 72–91 |
| Strymon | Greece | 14,830 | 43 | 1,000,000 | 20,395 | 110 | 1,000,000 | 2,883 | 0 | 30,000 | 82–92 | 116–117 |
| Adige | Italy | 2,335 | 0 | 36,300 | 14,007 | 200 | 90,200 | 409 | 0 | 4,200 | 87–92 | 74 |
| Arno | Italy | 2,752 | 50 | 9,180 | 7,355 | 200 | 24,000 | 393 | 20 | 2,300 | 88–92 | 42 |
| Metauro | Italy | 5,549 | 10 | 36,000 | 6,146 | 30 | 100,000 | 783 | 0 | 9,180 | 84–92 | 55–58 |
| Po | Italy | 26,636 | 1,000 | 330,000 | 57,203 | 1,000 | 1,000,000 | 10,133 | 700 | 302,000 | 82–92 | 113 |
| Tevere | Italy | 188,454 | 4,300 | 2,000,000 | 284,024 | 7,500 | 4,000,000 | | | | 89–91 | 17–18 |
| Ebro | Spain | 11,790 | 7 | 456,000 | 106,756 | 38 | 810,000 | 138 | 0 | 2,500 | 87–92 | 69–75 |

# 3

# 3.0 LEGAL AND INSTITUTIONAL FRAMEWORK ANALYSIS

Transboundary issues require cooperation among states to define policies, targets and actions at the appropriate levels for assessment, control, prevention and / or mitigation of sources and impacts. Transboundary environmental problems and their associated impacts must therefore be addressed on multiple levels: regional, sub-regional, as well as national. Due to the nature of transboundary issues, the relevant cooperation requires regional and national integrative structures and capacities.

Addressing transboundary issues requires adequate and appropriate international and national legal and institutional arrangements. The international legal / institutional framework must provide the legal basis for cooperation among interested / affected countries and define the procedures to be applied and their institutional aspects. In addition, the role of the said international framework is to promote / require the adoption of relevant national legal and institutional arrangements, and to provide support, assistance and training when needed and requested.

The national legal and institutional transboundary related framework is supposed to comply with the transboundary international framework. The nature of transboundary issues requires coordination and integration of relevant activities at both regional and national levels, as well as between the two levels. Of utmost importance is also the participation in transboundary activities of interested / affected stakeholders.

The following sections review relevant legal, institutional and policy frameworks for transboundary environmental protection in the Mediterranean. It is generally viewed that the national legal provisions for addressing the priority issues identified in this document are adequate, with some exceptions. Although transboundary cooperation is not explicitly provided for in national legislation, it is implicit in the texts. The main problem, however, lies with the institutional capacity to enforce the legislation and regulations. Many of the countries of the South and East do not have currently the means to enforce compliance with environmental provisions. Below, the major issues associated with the national legal and institutional frameworks are briefly outlined.

At the regional level, great strides have been made with the adoption and then revision of the Barcelona Convention and its protocols. While all of the amended protocols are not yet in effect, this convention is considered to be by far the most significant regional policy concerning the transboundary environmental problems in the Mediterranean. The Barcelona Convention is described in greater detail in Section 3.2, in addition to other relevant subregional, regional and global legal and policy instruments.

## 3.1 Major problems identified with legal and institutional frameworks in the Mediterranean

During the past decades, significant laws and policies have been adopted at the national, regional and global levels that directly or indirectly address the transboundary environmental concerns in the Mediterranean region. The most important of these regional and global laws and policies related to the Mediterranean MPPIs are discussed in Section 3.2.2 below. The existing legal and institutional frameworks have flaws, however, which hamper efforts to address these transboundary concerns. General observations on areas that require improvement are discussed below. Activities under the SAP should seek to address these existing problems.

### *3.1.1 Major problems identified with legal arrangements for addressing transboundary environemental issues*

The following legal and institutional issues have been identified at the regional and national levels that could hinder effective action to address transboundary environmental concerns in the Mediterranean region.

*3.1.1.1 Issues at the national level*

The following issues at the national level are considered to be of major importance in the Mediterranean region:

- Absence of appropriate national transboundary-related institutional arrangements. In many cases in the region and to a varying degree, the institutional arrangements and management in CZ, consequently regarding also the transboundary issues, are dispersed, fragmented and not CZ specific. The responsibility for transboundary issues is unclear or shared by various authorities. Sectoral, often non-integrated CZ related decisions, result in transboundary impacts; the relevant remedial initiatives are either not implemented in a timely fashion or have poor results, or result in failure. The final consequence is pollution, misuse of resources, overexploitation, loss of habitats and decline in biodiversity. Since one single national institution / agency cannot address alone those issues, the need of a National high level Coordinative Body and of a Lead Agency is evident. In most cases in the countries of the region there are no transboundary related specific arrangements of this kind.
- Absence of legal / institutional arrangements securing participation of the interested / affected general public, NGOs, scientific community and stakeholders in transboundary initiatives in parts of the Southern and Eastern Mediterranean. In many cases, the interested groups are neither properly, fully nor timely informed, educated on transboundary related issues, nor are there provisions for: securing such participation, the right of requesting information, and raising issues at national and international level. Public hearings, if any, are not fully informative and / or not transparent. Consequently, public support for initiatives addressing transboundary issues is weak or nonexistent.
- Absence of legal provisions for monitoring, securing compliance and enforcement of transboundary related regulations and obligations. In most cases, and in particular related to non-ECE member states, there are no such provisions.
- Insufficient institutional / human capacity of authorities responsible for transboundary issues. The lack of integrative capacity and poor implementation of ICZM as a framework for addressing transboundary issues is present in many cases. Monitoring of these causes and impacts and their assessment is not consistent, efficient or adequate, and the remedial programmes are not integrated within the necessary larger context, resulting in absence of control of causative factors and failure of remedial measures.

*3.1.1.2 Issues at the regional level*

The following are major issues related addressing transboundary environmental concerns at the regional level:

- Absence of or insufficient transboundary provisions within relevant regional or global legal documents. Many of the global and regional legal documents are not sufficiently transboundary specific or precise, leaving room for arbitrary interpretations, providing escape clauses, lacking provisions regarding the enforcement mechanism, lacking clear targets and deadlines. There is a need for a more specific, clear and integrated regional transboundary legal framework.
- Need to better define and strengthen the role and involvement of international institutions coordinating transboundary-related initiatives. The absence or weak implementation of the coordinating and integrating role of relevant international agencies, absence of assistance when needed and requested, and of providing resource commitments for transboundary initiatives and remedial actions in developing countries involved —calls for legal identification of the relevant regional body to take the role of lead agency. This role should be, and up to a certain level has been already, assigned to MAP in the case of the Mediterranean region.
- Absence of provisions in regional transboundary related documents for compulsory application of successful procedures and tools such as EIA and SEA in the transboundary context, and of ICZM as a basic prerequisite and tool securing the larger integrated and proactive approach. This issue is related both to the national and international levels.

#### *3.1.2 Major problems identified with institutional arrangements and capacity for addressing transboundary environmental issues*

The existing institutional arrangements relevant to addressing transboundary environmental issues differ among the littoral countries due to their differences in the degree of development, length of coastline, level of development and urbanization of the coast, wealth and ways of exploitation of resources, political system, form and manner of governance, among others. Other factors must also be taken into consideration, such as historic, national, cultural, religious and other aspects.

Despite the differences mentioned above, there is a general scheme of institutional arrangement relevant to ICZM and transboundary environmental issues in the Mediterranean. That scheme can be defined as multi-level and multisectorial, frequently with specific arrangements within individual sectors and in a certain number of cases with specific arrangements of intersectorial integration. It could generally be said that:

- from the point of view of policy structure variables, there is a wide array ranging from strong administrative control to pronounced, but not exclusive, rights of private interest groups;
- administrative variables range from prevailingly sectorial planning to, often insufficiently developed, broad functional responsibilities;
- policy orientation is increasingly turning from the sectoral towards the integrated approach within the concept of sustainable development.

The sectorial governance arrangement follows, more or less, the standard sectorial classification, which is, as a rule, more diversified in developed countries. Due to various reasons, in many countries the sectoral activities most relevant for transboundary issues are organized in larger sectorial units, such as fisheries and aquaculture within the ministry of agriculture, land-use planning and / or environmental protection within the ministry of building, tourism within the ministry of industry, ministry of economy, or even within the ministry of interior, or maritime transport within the ministry of transports, communications and maritime affairs.

Functions important for transboundary issues are sometimes located in "non-standard" administrative bodies and agencies. A considerable number of ministries and agencies have sub-national or local branches with delegated authority important for Coastal Management and transboundary issues. The "local" level units might have considerable authority, such as urban planning, issuing building permits, inspection, monitoring, control, etc.

The existing institutional arrangements establish a large number of administrative and decision-making entities responsible and or authorized for transboundary issues. Under such conditions, without adequate integration it is not possible to avoid overlapping and / or conflicting decisions, which are neither environmentally sound nor meet the requirements of sustainable development and in many cases have serious transboundary impacts. That is why the implementation of ICZM procedures and tools relevant for transboundary issues has to be considered as a prerequisite for successfully addressing transboundary environmental issues in a timely and cost-efficient manner, and has to be secured through appropriate institutional and legal arrangements.

### 3.2 Existing Legal and Policy Frameworks in the Mediterranean

The following sections outline the most important of the many subregionals, regional and global laws and policies that address the priority environmental concerns in the Mediterranean region identified in this document. The most significant of these, the Barcelona Convention along with its protocols, is described in Section 3.2.1. Additional legal and policy instruments relevant to the issues of seawater quality, biodiversity and fisheries in the Mediterranean are discussed in the sections following.

#### *3.2.1 The Barcelona System*

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (as amended in 1995), or the Barcelona Convention, is the most important regional policy concerning the transboundary environmental problems in the Mediterranean. Under the United Nations Convention on the Law of the Sea (Montego Bay, 1982; hereinafter UNCLOS) "States have the obligation to protect and preserve the marine environment" (Art. 192) taking measures "necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life" (Art. 194, para. 5).

The Barcelona Convention on the Protection of the Mediterranean Sea against Pollution (the original convention which entered into force on 12 February 1978) is a notable instance of such cooperation. Concluded under the auspices of UNEP, the Convention involved a considerable degree of legal imagination, such as opening up membership to regional groupings sharing the objectives of the Convention, albeit not necessarily wholly contained within the Mediterranean basin. In fact, the European Community is a Contracting Party to the Convention and its protocols, together with seven States, which are today members of the Community (Cyprus, France, Greece, Italy, Malta, Slovenia and Spain) and provides a significant contribution to the functioning of the Barcelona system.

Since 1994, several components of the Barcelona system have undergone important changes. The objective of the revision was to modernise the Convention to bring it into line with the principles of the Rio Declaration, the philosophy of the new Convention on the Law of the Sea and the progress achieved in international environmental law in order to make it an instrument of sustainable development. The revised Convention also aimed to progress from an essentially proclamatory form of law to a much more prescriptive law setting out obligations. The scope of its protocols was extended and new protocols were adopted either to replace the existing ones or to cover new fields of co-operation. In addition, in order to ensure the effectiveness of the new provisions, the need for new capacities as well as public participation and access to information including the adoption of a reporting procedure were part of the revision process.

The structure of the present Barcelona legal system includes the following instruments (see Annex V):

- the Convention which, as amended in Barcelona on 10 June 1995, changes its name to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, hereinafter "the Convention" entered into force on 9 July 2004;
- the Protocol for the Prevention of the Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (Barcelona, 16 February 1976; in force since 12 February 1978), which, as amended in Barcelona on 10 June 1995, changes its name to the Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea, hereinafter "the Dumping Protocol" (the amendments are not yet in force);
- the Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency (Barcelona, 16 February 1976; in force since 12 February 1978), which is intended to be replaced by the Protocol Concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea, signed in Valletta on 25 January 2002, hereinafter "the Emergency Protocol" (not yet in force);
- the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (Athens, 17 May 1980; in force since 17 June 1983), which, as amended in Syracuse on 7 March 1996, changes its name to the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities, hereinafter "the LBS Protocol" (the amendments are not yet in force);
- the Protocol concerning Mediterranean Specially Protected Areas (Geneva, 1 April 1982; in force since 23 March 1986), which has been replaced by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean, signed in Barcelona on 10 June 1995, hereinafter "the SPA and Biodiversity Protocol" (in force since 12 December 1999);
- the Protocol Concerning Pollution Resulting from Exploration and Exploitation of the Continental Shelf, the Seabed and its Subsoil, signed in Madrid on 14 October 1994, hereinafter "the Offshore Protocol" (not yet in force); and
- the Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal, signed in Izmir on 1 October 1996, hereinafter "the Hazardous Wastes Protocol" (not yet in force).

The recent updating of the Barcelona legal framework shows that the Parties consider it to be a dynamic system capable of being subject to re-examination and improvement, if appropriate.

It is a disappointment to note that the amendments to the two protocols adopted in 1995 and 1996 have not yet entered into force. But this is not necessarily due to a lack of political will by the States called upon to become Parties to the updated instruments. In fact it is rather the great number of amendments involving considerable technicality in their final provisions, as well as the high threshold of acceptance necessary for their entry into force that have been a factor of delay.

### 3.2.2 Regional Protocols and Policy Instruments

This section surveys the policy responses adopted to address the MPPIs identified in the Mediterranean. The first type of concern generally referred to as pollution here, spans diverse activities causing pollution including land-based activities, marine transport and seabed exploitation. The second type of concern relates to the conservation of biodiversity. The third type of environmental concern is linked to the sustainable exploitation of fishery resources in the Mediterranean. Policy responses on a regional, global and EU level are presented for each type of the three above concerns, while some subregional approaches are also considered.

*3.2.2.1 Pollution*
*Regional Agreements and Policy Instruments related to the Barcelona Convention*

The major regional agreement related to pollution control in the Mediterranean is the Barcelona Convention and its association Protocols. In this section, these and other policy instruments relating to land and sea-based pollution are discussed. Additionally, the similarities and differences of the EU WFD and the SAP MED, the two most important regional action plans for addressing land-based sources of pollution, are outlined.

*Protocols:*

• The Land-Based Sources (LBS) Protocol is a regional policy response, applying to discharges originating from land-based point and diffuse sources and activities in the Mediterranean. Such discharges reach the sea through coastal disposals, rivers, outfalls, canals or other watercourses, including ground water flow, or through run-off and disposal under the seabed with access from land.
The Protocol, as amended in 1996, takes into account the objectives laid down in the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, adopted in Washington on 3 November 1995 by a UNEP intergovernmental conference.

• The Emergency Protocol
The 2002 Emergency Protocol, which is intended to replace the 1976 Protocol, is the latest entry into the Barcelona legal system. The new Emergency Protocol aims at introducing the provisions necessary to implement the Regional Strategy on Prevention of Marine Pollution of the Marine Environment by Ships, adopted by the Parties in 1997.
While it can hardly be denied that pollution from ships is a typical area where global regulation is most appropriate as provided within UNCLOS, it should also be added that, for certain aspects of the matter, regional co-operation also has a role to play. For instance, it is evident that prompt and effective action in taking emergency measures to fight against pollution arising from maritime accidents needs to be organized at the national, sub-regional and regional levels.
But the Emergency Protocol is not limited (as the former instrument was) to dealing with emergency situations. It also covers the aspect of the prevention of pollution from ships with the purpose of striking a fair balance between action at the global and action at the region-

al level. The Emergency Protocol acknowledges in the preamble the role of IMO, which is generally considered the competent international organization in the field and the importance of co-operating in promoting the adoption and the development of international rules and standards on pollution from ships within the framework of IMO. This is a clear reference to the various conventions which are already in force at the global level, such as the International Convention for the Prevention of Pollution from Ships as Amended by the Protocol (London, 1973–1978; the so-called MARPOL) or the International Convention on Oil Pollution Preparedness, Response and Co-operation (London, 1990) and the more recent instruments which are expected to enter into force in the future, such as the International Convention on the Control of Harmful Anti-fouling Systems on Ships (London, 2001). It is also a reference to the competences that IMO already exercises as regards the safety of shipping (such as decisions on traffic separation schemes, ships' reporting systems, areas to be avoided, etc.). All such instruments and competences are in no way prejudiced by the Emergency Protocol.

The Emergency Protocol also recognizes that regional co-operation is important in promoting the effective implementation of international regulations in this field. A notable instance of such a spirit of harmonization of the global and regional levels of regulation and action is Art. 15, dealing with the environmental risk of maritime traffic. It provides that "in conformity with generally accepted international rules and standards and the global mandate of the International Maritime Organization, the Parties shall individually, bilaterally or multilaterally take the necessary steps to assess the environmental risks of the recognized routes used in maritime traffic and shall take the appropriate measures aimed at reducing the risks of accidents or the environmental consequences thereof".

The Emergency Protocol also acknowledges "the contribution of the European Community to the implementation of international standards as regards maritime safety and the prevention of pollution from ships". In fact, the Community has enacted a number of legal instruments relating to the control and prevention of marine pollution from ships that apply in addition to rules adopted under the aegis of IMO. The most recent ones are Directive 2001/106 of 19 December 2001 concerning the enforcement, in respect of shipping using Community ports and sailing in the waters under the jurisdiction of Member States, of international standards for ship safety, pollution prevention and shipboard living and working conditions (port State control); Directive 2002/6 of 18 February 2002 on reporting formalities for ships arriving in and / or departing from ports of the Member States of the Community; and Regulation 417/2002 of 18 February 2002 on the accelerated phasing-in of double hull or equivalent design requirements for single hull oil tankers. Other Community legislation is in the process of elaboration. The

European Commission, the institution of the Community mandated to negotiate treaties, played an active role during the negotiations for the Emergency Protocol.

The "added value" brought by the new Protocol may be found in several of its provisions. It covers not only ships but also places where shipping accidents can occur, such as ports and offshore installations. The definition of the "related interests" of a coastal State has been enlarged to include also "the cultural, aesthetic, scientific and educational value of the area" and "the conservation of biological diversity and the sustainable use of marine and coastal biological resources". A detailed provision on reimbursement of the costs of assistance has been elaborated.

The Emergency Protocol sets forth some obligations directed to the masters of every ship sailing in the territorial sea of the Parties (including ships flying a foreign flag), namely to report incidents and the presence, characteristics and extent of spillages of oil or hazardous and noxious substances; to provide the proper authorities, in the case of a pollution accident and at their request, with detailed information about the ship and its cargo and to cooperate with these authorities. The obligations in question, which have a reasonable purpose and do not overburden ships, do not conflict with the right of innocent passage provided for in the UNCLOS.

Where the Parties cannot agree on the organization of an operation to combat pollution, REMPEC may, with the approval of all the Parties involved, co-ordinate the activity of the facilities put into operation by these Parties. The issue of port reception facilities, which has considerable economic implications, is already the subject of provisions set forth in the MARPOL and a recent European Community directive. Under the Emergency Protocol, Parties shall ensure that such facilities are available and are used efficiently without causing undue delay to ships. The lessons arising from the Erika accident are particularly evident in the provision according to which the Parties shall define strategies concerning reception in places of refuge, including ports, of ships in distress presenting a threat to the marine environment.

Finally, the Emergency Protocol does not affect the right of Parties to adopt stricter domestic measures or other measures in conformity with international law in the matters covered by the Protocol. This provision may apply also to rules adopted by the European Community and binding on its member States.

• The Offshore Protocol

The Offshore Protocol relates to pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil. All activities in the Offshore Protocol area, including the erection of installations on site, are subject to the prior written authorization of the competent authority of a party. Before granting authorization, the authority must be satisfied that the installation has been constructed according to international standards and practice and that the operator has the technical competence and financial capacity to carry out the activities. Authorization shall be refused if there are indications that the proposed activities are likely to cause significant adverse effects on the environment that could not be avoided by compliance with specific technical conditions. This obligation can be seen as an application of the precautionary principle. Special restrictions or conditions may be established for the granting of authorizations for activities in specially protected areas.

• The Dumping Protocol

The Dumping Protocol applies to any deliberate disposal of wastes or other matter from ships or aircraft, with the exception of wastes or other matters deriving from the normal operations of vessels or aircraft and their equipment (which fall under the label of pollution from ships). The Protocol, as amended in 1995, presents two major changes with respect to the previous text.

First, the Protocol applies also to incineration at sea, which is prohibited (Art. 7). It is defined as "the deliberate combustion of wastes or other matter in the maritime waters of the Mediterranean Sea, with the aim of thermal destruction and does not include activities incidental to the normal operations of ships and aircraft".

Second, the Protocol is based on the idea that the dumping of wastes or other matter is in principle prohibited, with the exception of five categories of matters specifically listed (such as dredged materials, fish waste, inert uncontaminated geological materials). On the contrary, the previous text of the Protocol was based on the idea that dumping was in principle permitted, with the exception of the prohibited matters listed in Annex I (the so-called black list) and the matters listed in Annex II (the so-called grey list) which required a prior special permit. The logic of the previous text is thus fully reversed in order to ensure better protection of the environment.

On the world level, the 1996 Protocol to the 1972 Convention on the Prevention of Marine Pollution by Wastes and Other Matter introduces a similar reversal of the logic followed in the parent convention. It is also based on the assumption that the Parties shall prohibit the dumping of any wastes or other matter with the exception of those listed in an annex. In the 2000 report of the Secretary-General of the United Nations on oceans and the law of the sea, the 1996 Protocol was seen as a "milestone in the international regulations on the prevention of marine pollution by dumping of wastes" and "a major change of approach to the question of how to regulate the use of the sea as a depository for waste materials" (United Nations General Assembly document A/55/61 of 20 March 2000, para. 159). The same could be said of the Mediterranean Dumping Protocol.

*Policy Instruments:*

• The MED POL Strategic Action Programme to Address Pollution from Land-Based Activities (SAP MED)

For the implementation of the LBS Protocol to the Barcelona Convention, the Strategic Action

Programme (SAP MED) was established. The SAP MED is an action-oriented MAP/MED POL initiative identifying priority target categories of substances and activities to be eliminated or controlled by the Mediterranean countries. The timetabled schedule for the implementation of specific control measures and interventions extends over 25 years.

The key land based activities addressed in the SAP MED are linked to the urban environment, (particularly municipal wastewater treatment and disposal, urban solid waste disposal and activities contributing to air pollution from mobile sources) and to industrial activities, targeting those responsible for the release of toxic persistent and bioaccumulative (TPB) substances into the marine environment, giving special attention to persistent organic pollutants (POPs).

Also addressed are the release of harmful concentrations of nutrients into the marine environment, the storage, transportation and disposal of radioactive and hazardous wastes and activities that contribute to the destruction of the coastline and coastal habitats.

*Additional Regional Agreements and Policy Instruments*

- EU Water Framework Directive (WFD)

On the EU level, the legal instrument provided to safeguard the ecological status of waters from land-based point and diffused sources is the Water Framework Directive (2000/60/EC) (WFD) designed to integrate a number of earlier directives tackling water pollution into a single piece of legislation. The SAP MED and the WFD are similar in their approach so that it may be considered that in implementing their obligations under the WFD the EU-Mediterranean countries would in effect be fulfilling their general obligations under the SAP MED.

The Water Framework Directive adopts a combined approach, including both measures involving controls that concentrate on what is achievable at source through the application of technology, as well as measures involving controls that deal with the needs of the receiving environment in the form of quality objectives.

Both the SAP MED and the WFD, in its "Strategy against pollution of water", establish a list of priority substances for which water quality standards and emission controls must be applied. Of these priority substances, certain will be subject to cessation or phasing out of discharges, emissions and losses within an appropriate timetable. In general these include toxic, persistent and bio accumulative substances, subject to phasing out at the latest around 2025(SAP)–2027(WFD).

For the remaining priority substances the SAP has predetermined percentage reductions to be achieved within a specified time schedule. The Water Framework Directive on the other hand has as a requirement the achievement of "good status" of waters, involving both good ecological status and good chemical status. As already mentioned good ecological status is defined in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics that would be expected to exist in conditions of minimal human impact. Good chemical status is defined in terms of compliance with all the quality standards established for chemical substances at European level. Good ecological status as defined in the WFD is a requirement that the SAP does not tackle with directly. As regards good chemical status the specific requirements will be dealt with in greater detail in the forthcoming sections of the analysis.

*International Conventions and Policy Instruments*

The following multilateral environmental agreements (MEAs) interact with the existing regional and international agreements aiming to combat pollution in the Mediterranean. The following are particularly relevant to reducing pollution from PTS:

- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, (MARPOL 73/78)

  The MARPOL Convention is a combination of two treaties adopted in 1973 and 1978. It covers all technical aspects of pollution from ships, except the disposal of waste into the sea by dumping, and applies to ships of all types. The Convention has five annexes covering oil, chemicals, sewage, garbage, and harmful substances carried in packages, portable tanks, freight containers, etc.

- Stockholm Convention on Persistent Organic Pollutants (POPs)

  The convention was adopted at the meeting of the intergovernmental negotiating committee for an international legally binding instrument for implementing international action on certain persistent organic pollutants in Johannesburg (December 2000). The objective of this Convention is to protect human health and the environment from persistent organic pollutants. The selected list of POPs is of direct relevance to the UNEP assessment of PTSs. The Convention was opened for ratification signatures on 23 May 2001 in the Intergovernmental Conference held in Stockholm. The protocol will enter into force as soon as it is ratified by 50 countries (23 ratifications registered in October 2002, none from the Region).

- The Basel Convention strictly regulates the transboundary movements of hazardous wastes and provides obligations to its Parties to ensure that such wastes are managed and disposed of in an environmentally sound manner when moved across national boundaries.

  The so-called Ban Amendment to the Basel Convention bans the export of hazardous wastes for final disposal and recycling from Annex VII countries (Basel Convention Parties that are members of the EU, OECD, Liechtenstein) to non-Annex VII countries (all other Parties to the Convention).

  The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989 and entered into force on 5 May 1992.

  Most countries of the Region comply with the Basel convention although some of the southern countries lack the appropriated management structures to implement the convention.

- <u>The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade</u>

The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was adopted at a Conference of Plenipotentiaries in Rotterdam on 10 September 1998. The Convention enables the world to monitor and control the trade in very dangerous substances and according to the Convention, export of a chemical can only take place with the prior informed consent of the importing party. The Convention covers a list of five industrial chemicals and 22 pesticides, including aldrin, chlordane, DDT, dieldrin, heptachlor, HCB and PCBs.

- <u>International Code of conduct on the distribution and use of pesticides</u>

This Code of Conduct, adopted by FAO and its member countries in 1985, recognises that: "In the absence of an effective pesticide registration process and of a governmental infrastructure for controlling the availability of pesticides, some countries importing pesticides must heavily rely on the pesticide industry to promote the safe and proper distribution and use of pesticides. In these circumstances foreign manufacturers, exporters and importers, as well as local formulators, distributors, repackers, advisers and users, must accept a share of the responsibility for safety and efficiency in distribution and use."

The Prior Informed Consent (PIC) is an important component of the Code of Conduct. Under the Rotterdam convention on PIC, "pesticides that are banned or severely restricted for reasons of health or the environment are subject to the Prior Informed Consent procedure. No pesticide in these categories should be exported to an importing country participating in the PIC procedure contrary to that country's decision."

Implementation of the PIC Convention is carried out jointly by FAO and the International Register of Potentially Toxic Chemicals (UNEP/IRPTC) and includes almost all countries of the region. Pesticides under national review for PIC (FAO, 1990) are: Aldrin, Chlordane, Heptachlor, DDT, Dieldrin and HCHs (mixed isomers).

*3.2.2.2 Conservation of Biodiversity Protocols and Policy Instruments Associated with the Convention of Barcelona:*

- <u>The Specially Protected Areas and Biodiversity Protocol</u>

According to Agenda 21, States, acting individually, bilaterally, regionally or multilaterally and within the framework of IMO and other relevant international organizations, should assess the need for additional measures to address degradation of the marine environment. This should be done, inter alia, by taking action to ensure respect of areas that are specially designated, consistent with international law, in order to protect and preserve rare or fragile ecosystems. Agenda 21 stresses the importance of protecting and restoring endangered marine species, as well as preserving habitats and other ecologically sensitive areas, both on the high seas (para. 17.46, e, f) and in the zones under national jurisdiction (para. 17.75, e, f). In particular, "States should identify marine ecosystems exhibiting high levels of biodiversity and productivity and other critical habitat areas and provide necessary limitations on use in these areas, through, inter alia, designation of protected areas" (para. 17.86).

The 1995 SPA and Biodiversity Protocol which implements the objectives of Agenda 21, extends the geographical application of the previous 1976 Protocol to all Mediterranean waters irrespective of their legal condition, as well as to the seabed, its subsoil and to the terrestrial coastal areas designated by each party, including wetlands.

In view of the lack of exclusive economic zones across the Mediterranean the new protocol includes two very elaborate disclaimer provisions (Art. 2, paras. 2 and 3) that have a simple aim. On the one hand, the establishment of intergovernmental co-operation in the field of the marine environment cannot prejudice all the legal questions that are of a different nature. On the other hand though, the very existence of such legal questions should not jeopardize or delay the adoption of measures necessary for the preservation of the ecological balance of the Mediterranean basin.

The SPA and Biodiversity Protocol provides for the establishment of a List of specially protected areas of Mediterranean interest (the SPAMI List). The SPAMI List may include sites that "are of importance for conserving the components of biological diversity in the Mediterranean; contain ecosystems specific to the Mediterranean area or the habitats of endangered species; are of special interest at the scientific, aesthetic, cultural or educational levels". The procedures for the establishment and listing of SPAMIs are specified in detail in the Protocol. For instance, as regards the areas located partly or wholly on the high seas, two or more neighbouring Parties concerned" must make the proposal and the decision to include the area in the SPAMI List is taken by consensus by the Contracting Parties during their periodic meetings.

Once the areas are included in the SPAMI List, all the Parties agree "to recognize the particular importance of these areas for the Mediterranean" and —this is also important— "to comply with the measures applicable to the SPAMIs and not to authorize nor undertake any activities that might be contrary to the objectives for which the SPAMIs were established".

With respect to the relationship with third countries, the Parties shall "invite States that are not Parties to the Protocol and international organizations to co-operate in the implementation" of the Protocol. They also "undertake to adopt appropriate measures, consistent with international law, to ensure that no one engages in any activity contrary to the principles and purposes" of the Protocol. This provision aims at facing the potential problems arising from the fact that treaties, including the SPA and Biodiversity Protocol, can produce rights and obligations only among Parties.

The new Protocol is completed by three annexes, which were adopted in 1996 in Monaco. They are the Common criteria for the choice of protected marine and coastal areas that could be included in the SPAMI List (Annex I), the List of endangered or threatened species (Annex II) and the List of species whose exploitation is regulated (Annex III).
Important tasks for the implementation of the Protocol, such as assisting the Parties in establishing and managing specially protected areas, conducting programmes of technical and scientific research, preparing management plans for protected areas and species, formulating recommendations and guidelines and common criteria, are entrusted with the Regional Activity Centre for Specially Protected Areas, located in Tunis.
It was a remarkable achievement for the XIIth Meeting of the Contracting Parties (Monaco, 2001) when the first twelve SPAMIs were inscribed in the List. They were the island of Alboran, the sea bottom of the Levante de Almeria, the cape of Gata-Nijar, Mar Menor and the oriental coast of Murcia, the cape of Cresus, the Medas islands, the Coulembretes islands (all proposed by Spain), Port-Cros (proposed by France), the Kneiss islands, La Galite, Zembra and Zembretta (all proposed by Tunisia) and the French-Italian-Monegasque Sanctuary (jointly proposed by the three States concerned). The last SPAMI covers also areas of high seas.

- The Strategic Action Programme for Biodiversity in the Mediterranean Region (SAP BIO)

The Strategic Action Plan for Biodiversity (SAP BIO) currently under development establishes a measurable framework of actions for the implementation of the 1995 SPA Protocol.
The SAP BIO assesses the status of marine and coastal biodiversity, evaluates the main problems affecting biodiversity and identifies concrete remedial actions at national and regional level.
The basic objective of this Strategic Action Programme is to be used within the context of the SPA/BIO Protocol to (i) improve the management of existing and favour the creation of new Marine and Coastal Protected Areas; (ii) favour the implementation of SAP BIO NAPs and Priority Actions; (iii) enhance the protection of endangered species and habitats; (iv) contribute to the reinforcement of relevant national legislation and national and international capacity building; (v) foster the improving of knowledge of marine and coastal biodiversity and (vi)contribute to fund raising efforts.
The Rio Principles adopted by the United Nations Conference on environment and Development, UNCED Rio 1992, should be considered as the basic ones taken into account by SAO/BIO. In line with the WSSD targets, the SAP BIO's operational targets include: (i) to contribute to achieving the WSSD targets concerning establishing by 2004 a regular process under the United Nations for global reporting and assessment of the state of the marine environment, including socio-economic aspects, both current and foreseeable building on existing regional assessments; (ii) to contribute to achieving the WSSD targets concerning the establishing of marine protected areas consis-

tent with international law and based on scientific information, representative networks, by 2012 and time area closures for the protection of nursery grounds and periods, proper coastal land use; (iii) to contribute to achieving the WSSD targets concerning the achievement by 2010 of a significant reduction in the current state of loss of biological diversity.

In addition SAP BIO targets include improving the scientific understanding and assessment of marine and coastal ecosystems; to strengthen cooperation and coordination among global observing systems and research programmes for integrated global observations, taking into account the need for building capacity and sharing of data from ground based observations, satellite remote sensing and other sources among all countries. In terms of building public support for the conservation of biodiversity, SAP BIO includes public awareness and public participation among the areas where further investment should be made.

*Other regional Agreements and Policy Instruments:*

- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1979).

- A special Agreement for the Conservation of Small Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic area (ACCOBAMS) was made in 1996 under the Bonn Convention.

- The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) (1979)

  The Bern Convention is being implemented in all the European countries, and the EU birds and habitats directives are implemented in the EU countries.

- Action plan for the conservation of cetaceans in the Mediterranean Sea

- Action plan for the management of the Mediterranean monk seal (*Monachus monachus*)

- Action plan for the conservation of Mediterranean marine turtles

- Action plan for the conservation of marine vegetation in the Mediterranean Sea

*EU Community Legislation on Biodiversity*

The legislation on specially protected areas of the Mediterranean States that are members of the European Community must conform with EC Council Directive No. 92/43 of 21 May 1992 on the conservation of natural habitats and wild fauna and flora. The directive was enacted having regard, inter alia, to the fact that 'the preservation, protection and improvement of the quality of the environment, including the conservation of natural habitats and of wild fauna and flora, are an essential objective of general interest pursued by the Community as stated in Article 130r of the Treaty' establishing the EC (Rome, 25 March 1957 and subsequently amended).

The directive aims to achieve conservation of natural habitats and species of wild fauna and flora. Its geographical scope includes the internal waters and the territorial sea along the coasts for the four EC Mediterranean countries.

The Directive sets up a coherent ecological network of special areas of conservation under the title 'Natura 2000'. This network is composed of sites hosting the natural habitat types of Community interest listed in Annex I, and habitats of the species listed in Annex II (species of wild fauna and flora of Community interest) whose conservation requires the designation of special areas of conservation. However, under Art 4, para 1, for aquatic species that range over wide areas, such sites will be proposed only where there is a clearly identifiable area representing the physical and biological factors essential to their life and reproduction.

*International Conventions*

- Global Convention on the Protection of Biological Diversity

  The Convention on Biological Diversity negotiated under the auspices of the United Nations and in force since 1993, enlists among its parties all Mediterranean littoral states. As the Strategic Action Plan for conservation of Biodiversity (SAP BIO) has taken into account the Jakarta Mandate, where principles of the CBD relating to marine and coastal biodiversity were considered, it is expected that its implementation will enhance synergies with the CBD.

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

  CITES is an international agreement between Governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

- RAMSAR Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971)

### *3.2.2.3 Fisheries*

*Regional and Subregional Policies*

- FAO General Fisheries Commission for the Mediterranean (GFCM) and FAO ADRIAMED and COPEMED Projects

  On a regional level the FAO General Fisheries Commission for the Mediterranean (GFCM), in force since 1952, is a regional body aimed at establishing management measures for fishery resources. More specifically it aims to promote the development, conservation and management of living marine resources occurring in the Mediterranean, the Black Sea and connecting waters, both in areas under national jurisdiction and on the high seas. In order to achieve its foal, the GFCM, can, by a two thirds majority, adopt recommendation on the measures for the conservation and rational management of living marine resources. These measures may regulate fishing methods and gear, prescribe the minimum size of species of fish, establish open and close fishing seasons and areas and determine the amount of total catch and fishing effort as well as their allocation among member states. Member states must give effect to these recommendations, unless they object to doing so, within 120 days from the date of notification.

  It was not until 1995 that the GFCM formulated binding recommendations. It adopted ICCAT management measures regarding the taking and landing of bluefin tuna Thunnus thynnus (Resolution No. 95/1). This resolution specifies, for instance, inter alia, the size of vessels and the time of the year for which fishing are allowed.

Three other binding recommendations were adopted in 1997. They concern the type of driftnet (Resolution No 97.1) on vessels flying the flag of a GFCM Contracting party, the banning of purse seine fishing for bluefin tuna during August, as well as the use of helicopters and planes in support of fishing operations in the month of June (Resolution No 97/3). Furthermore, the GFCM calls upon states which are not members of the GFCM, but whose vessels engage in fishing activities in the region, to become members of the GFCM or otherwise cooperate in implementing the recommendations made by the Commission. It also urges the member states to report to the Commission on any fishing activities by vessels flying the flag of non member states which undermine the effectiveness of GFCM recommendations (Resolution No 97/2).

The establishment of the GFCM Scientific Advisory Committee (SAC) in 1999 represented a significant step in coordinating scientific efforts on fisheries and resources with a view to supporting policy-making. Prior to the creation of the SAC despite the availability of scientific research and knowledge of a considerable level in the basin, its integration into policy making for fishery resources was weakened by the lack of an overarching scientific forum.

Other FAO projects on a subregional level in the Mediterranean include ADRIAMED, fostering scientific cooperation to promote responsible fisheries in the Adriatic. FAO COPEMED, another Mediterranean Project focuses on advice, technical support and establishment of cooperation networks to facilitate coordination to support fisheries management in the Mediterranean. COPEMED area covers the Western and Central sub-regions of the Mediterranean. Morocco, Algeria, Tunisia, Libya, Malta, Italy, France and Spain have adhered to the Project. The project began at the end of 1996. With an initial duration of 5 years, the project has been extended up to 2004.

- <u>International Commission for the Conservation of Atlantic Tunas (ICCAT)</u> of the Convention for the Conservation of Atlantic Tunas, in force since 1969, is designed to ensure the sustainable exploitation of Atlantic tuna and tuna-like species not only in the Atlantic ocean but in adjacent seas and therefore in the Mediterranean too. Among the Contracting Parties to the Convention for the Conservation of Atlantic Tunas are France, Morocco, Libya, Croatia, Tunisia and the EU. On the basis of scientific research ICCAT can make recommendations aiming at ensuring the maximum sustainable catch. These recommendations, if not objected to by a majority of Parties, are binding on all Parties, except those that register formal objections.

*EU Common Fisheries Policy*

The Community has exclusive competence in international relations in the domain of fisheries. It is empowered to undertake international commitments towards third countries or international organisations in matters relating to fisheries. The European Commission, on behalf to the Community, negotiates fisheries agreements with third countries and participates in various regional fisheries organisations (RFOs).

At the Earth Summit in Rio in 1992, States agreed to ensure rational and sustainable fishing. The Community accordingly was involved in the drafting of the United Nations Food and Agriculture Organisation code of conduct for responsible fishing. It has also participated in the United Nations Conference on the Conservation of Straddling Fish Stocks and Highly Migratory Fish Stocks —stocks that are found both in international waters and exclusive economic zones.

The common fisheries policy (CFP), in operation since 1983, is the European Union's instrument for the management of fisheries and aquaculture. It was created to manage a common resource and to meet the obligation set in the original Community Treaties.

The CFP has to take into account the biological, economic and social dimension of fishing. It can be divided into four main areas dealing with conservation of fish stocks, structures (such as vessels, port facilities and fish processing plants), the common organisation of the market and an external fisheries policy which includes fishing agreements with non-Community members and negotiations in international organisations.

The first CFP review in 1992 showed that if there are too many vessels for the available resources, technical measures and control alone cannot prevent overfishing. The amount of fishing has to be regulated too. In order to make the common fisheries policy more effective the link between its component parts was reinforced. Control measures were also developed to ensure that rules are respected throughout the industry. New technologies are being used to transmit data to the authorities and to monitor larger vessels through satellite tracking systems.

The Common Fisheries Policy of the EU recently underwent extensive changes launched on the occasion of the regular review of 2002. Among others a plan to ensure the sustainability of fisheries in the Mediterranean was adopted in October 2002. The measures foreseen in the Action Plan include: a concerted approach to declaring fisheries protection zones, the use of fishing effort as the main instrument in fisheries management, improving fishing techniques so as to reduce the adverse impact on stocks and the marine ecosystem and promoting international co-operation.

*Global Policy Framework*

- FAO Code of Conduct for Responsible Fisheries

This Code adopted in 1995, sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity.

The Code is global in scope and is directed toward members and non-members of FAO, fishing entities, subregional, regional and global organizations, whether governmental or non-governmental and all persons concerned with the conservation of fishery resources and management and development of fisheries, such as fishers, those engaged in processing and marketing of fish and fishery products and other users of the aquatic environment in relation to fisheries.

While the Code is voluntary, certain parts of it are based on relevant rules of international law, including those reflected in the United Nations Convention on the Law of the Sea of 10 December 1982. The Code also contains provisions that may be or have already been given binding effect by means of other obligatory legal instruments amongst the Parties, such as the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, 1993, which, according to FAO Conference resolution 15/93, paragraph 3, forms an integral part of the Code.

One of the basic principles on which the Code is established is the obligation of states and users of living aquatic resources should conserve aquatic ecosystems. According to the Code, the right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources. The Code also articulates that fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development. In addition, management measures, according to the Code, should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species. Moreover, States, according to the Code, should prevent overfishing and excess fishing capacity and should implement management measures to ensure that fishing effort is commensurate with the productive capacity of the fishery resources and their sustainable utilization. States should take measures to rehabilitate populations as far as possible and when appropriate.

# 4.0
# STAKEHOLDER ANALYSIS

The following sections briefly discuss the role of stakeholders in the Mediterranean environment and, more specifically, in MAP activities.

## 4.1 Mediterranean Stakeholders

In the Mediterranean, the pursuit of participatory structures of environmental governance is often an uphill struggle. This is largely because the concept of delinking economic growth from environmental damage still exerts only a limited influence on the policies of many partners in the Mediterranean. Economic efficiency continues to prevail over sustainable development in most Mediterranean countries, while current international trends associated with globalisation and technological progress only intensify the pressure towards this end.

Despite these difficulties, the Mediterranean region has embarked upon a number of local, national and regional initiatives involving civil society through its multitude of stakeholder groupings aiming to shape the governance of environmental resources.

A number of public constituents, such as those discussed below, are included as stakeholders of the Mediterranean environment. These stakeholders have varying degrees of involvement in environmental decisionmaking in different regions of the Mediterranean, as is discussed in more detail in Section 4.3. Each one of them has the potential to play a unique role in the region's environmental debate.

***Local authorities***

Local authorities are set to play an increasingly important role as Mediterranean countries are following the global trend for decentralized power and increased privatization. They facilitate positive changes while benefiting from any visible improvement to the environment.

***NGOs***

NGOs provide an energizing, critical and demanding vision that adds to the quality of the regional debate on the environment and sustainable development. They broaden its audience, taking these concerns out to the public upon whom effective environmental protection depends.

Recent years have witnessed a proliferation of NGOs with specific concerns as well as pan-Mediterranean NGO networks. In itself, this growth reflects the rising grassroots concern for the Mediterranean environment. NGOs are key partners for other stakeholders because of their specialist knowledge and their outreach potential. They have also proved competent at highlighting examples of good practice.

***Business actors***

Business actors are obvious key players in the drive to tie commerce to conservation concerns. It is crucial to mobilize them for long-term sustainable development in the region, as all activities and initiatives depend on the autonomous decisions of economic actors and governments. While some groups are well organized with a history of participating in public affairs, the prevalence of SMEs and the strong presence of multinationals make networking harder.

Raising awareness among entrepreneurs about the need to integrate environmental concerns into business development is vital, however, to halting economies from expanding without due regard for the environmental repercussions of economic growth.

***Other socio-economic actors***

Other socio-economic actors included as stakeholders in the Mediterranean are those who have a financial stake in the protection of the environment or whose economic activities affect the Mediterranean environment. Often these are one and the same. This category includes fishermen, tourists and those engaged in the tourism industry, farmers, etc.

***Universities and research institutes***

Universities and research institutes have a strong ability to influence other parties due to the knowledge-based character of their intervention. Moreover, their recommendations in natural, social and economic issues play a key part in the shaping of the debate on environmental protection.

***Intergovernmental institutions***

Several intergovernmental institutions and agencies, particularly of the UN and the EU families, play an effective role in participating in and stimulating dialogue and partnerships or providing finance and technical assistance to projects involving the public.

***Religious groups and churches***

Traditionally religious groups and churches have participated only rarely in public dialogues on issues related to environmental problems, such as land-based sources. Many of them are becoming increasingly active, however, and are keen to participate in a dialogue on sustainable development issues related to moral and ethical values.

### 4.2 MAP Civil Society Partners

Since its launch in 1976, MAP has endeavoured to include the various stakeholders listed in Section 4.1 in its activities. Recognizing the potential pivotal role of wider Mediterranean society in the area's future rehabilitation, MAP has established concrete partnerships with civil society actors as a prerequisite to action. This cooperation with civil society actors has been formalized with the development of a list MAP Partners. The list of MAP Partners serves to identify the most appropriate partner for participation in its activities, recognize the relevance of the partner to MAP's objectives and programmes, and to allow the partners to get to know each other better through contacting one another.

MAP has embarked upon a regular revision of the list of NGOs, research institutes and business partners that form its link to civil society. When the list is revised every two years, the partners are ranked according to a set of established criteria that were adopted in the Twelfth Ordinary Meeting of the Contracting Parties to the Barcelona Convention(Monaco, November 2001). The most recent version of the Directory of MAP Partners published in November 2003 lists 70 official MAP Partners.

### 4.3 Suggestions for Improving Cooperation with MAP Civil Society Partners

In October 1997, the MAP Secretariat called for action to enhance the participation of civil society partners when it was realized that more than 80 percent of its NGO partners were from the Northern part of the Mediterranean, and that those from the Southern and Eastern parts did not participate sufficiently in MAP activities. In response to these concerns, a report was prepared on "MAP cooperation with its partners in civil society" (UNEP, 2001) based on MAP documents and interviews with NGOs. Much of the following information is taken from this report.

It is recognized that the differing levels of participation between the Northern and the Southern and Eastern civil society partners results largely from two factors: supervised freedom of association in some countries and lack of resources and capacity of NGOs.

Civil society in the Southern and Eastern regions of the Mediterranean is far from homogeneous. While there is supervised freedom of association in certain countries, still in others there is greater freedom. The components of civil society in its broadest sense (associations, NGOs, socio-economic actors, local authorities) hardly can be considered to constitute real collective forces capable of influencing development and the future of their societies in the Southern and Eastern parts of the Mediterranean.

A second problem is that many of these civil society organizations in the region lack adequate financial resources to fully participate as partners. The difficulty in mobilizing financial resources is among the major obstacles to full participation. Rare are the NGOs from the South and East that have found solid and independent sources of financing; most of them continue to depend on foreign sources.

To address the abovementioned and other hindrances to full participation by MAP Partners, a set of recommendations was developed. These include:

1. Reducing differences in levels of development
   - Taking into account the specific characteristics of partners from the South and East
   - Strengthening assistance to partners in the South and East
   - Improving the capacities of partners in the South and East
2. Improving MAP's operational tools
   - Improving current partnership tools
   - Strengthening MAP as a focal point for partnership
3. Promoting concerted action by the partners
   - Further defining the role of the partners
   - Promoting partnership networks
   - Including new partners

It was concluded that efforts needed to be made by both MAP and its partners in the North to enhance the cooperation of partners in the Southern and Eastern sections of the Mediterranean.

5

# 5.0

# ENVIRONMENTAL QUALITY OBJECTIVES (EQOs)

In order to facilitate and organize the identification of interventions to address the MPPI, this TDA has used the tool of Environmental Quality Objectives.

In this section, we address the major EQOs for the Mediterranean Sea, Provide specific targets for making progress towards those EQOs, and then recommend specific regional and national activities to achieve those targets. The EQOs address the specific MPPIs and root causes.

There are three overarching EQOs, listed below with their primary linkage to the MPPIs.

1. Reduce the impacts of LBS on Mediterranean Marine Environment and Human Health: addresses MPPIs 3 and 4, and to a lesser extent MPPIs 1 and 2.
2. Sustainable Productivity from Fisheries: addresses MPPI 2.
3. Conserve the Marine Biodiversity and Ecosystem: Addresses MPPI 1.

## 5.1 Objective 1: Reduce the Impacts of LBS on Mediterranean Marine Environment and Human Health

Targets and needed activities at regional and national level are identified by the SAP MED, structured in two areas (urban and industrial) and a number of categories within each area as highlighted within the following tables.

### *5.1.1 The Strategic Action Programme to address pollution from LBS*

***a. Urban environment:***

(i) Municipal sewage;
(ii) Urban solid waste; and
(iii) Air Pollution

***Table 5.1 SAP Urban Environment EQOs***

| Issue | Targets 2005 | Targets 2025 | Regional Activities | National Activities |
|---|---|---|---|---|
| Municipal sewage | dispose sewage from cities > 100,000 in conformity with LBS Protocol | dispose all sewage in conformity with LBS Protocol | • update guidelines<br>• develop programmes for sharing and exchanging technical information and advice for sewage treatment<br>• promote research programmes | • update national regulations<br>• develop national plans and programmes for the environmentally sound management of sewage<br>• connection to sewer<br>• outfalls siting<br>• tertiary treatment<br>• good housekeeping<br>• reissue of treated wastewater<br>• separate collections<br>• reuse of sludge<br>• prohibit discharge of sludge into seawater |
| Urban solid waste | solid waste management system in cities > 100,000 | solid waste management for all urban agglomerations | • guidelines for SWM<br>• develop reduction of recycling | • national plans for reduction and recycling<br>• national SWM systems for cities > 100,000 |
| Air pollution | cities > 100,000 ambient air quality conform to standards | cities ambient air quality conform to standards | • formulate and adopt air quality objectives | • promote traffic management<br>• lead free petrol<br>• inspection of vehicles<br>• use of national gas<br>• public transport |

***b. Industrial development:***

(i) Toxic, Persistent and Liable to Bio-accumulate substances (TPBs): Persistent Organic Pollutants (POPs); Heavy metals (Hg, Cd, Pb) and Organometallic compounds;

(ii) Other Heavy metals (Zn, Cu, Cr);

(iii) Organohalogen compounds;

(iv) Radioactive substances;

(v) Nutrients and suspended solids; and

(vi) Hazardous waste.

***Table 5.2 SAP Industrial Development EQOs***

| Issue | Targets 2005 | Targets 2010 | Targets 2025 | Regional Activities | National Activities |
|---|---|---|---|---|---|
| Industrial pollution | — | 50% reduction of TPB | point sources discharge and emissions conformity with LBS Protocol and standards | • guidelines for WWT<br>• EQO for point sources<br>• information programme<br>• research programme<br>• guidelines for BEP, BAT<br>• environmental management | • inventory of point sources<br>• national regulations<br>• priority to SME<br>• environmental management |
| TPB / POPs | 50% reduce of inputs collect and dispose all PCBs | phase out inputs of POPs | — | • provide technical information<br>• guidelines for BEP and BAT<br>• emission values for point source discharges for PAH | • inventory of POPs and PAHs<br>• phase out use of pesticides<br>• safe disposal of PCBs and pesticides<br>• reduce emissions of HCB, dioxins, furans |
| | — | 25% reduction of PAH inputs | phase out inputs of PAH | — | • apply BEP & BAT |
| • *Heavy metals (Hg, Cd, Pb)* | 85% reduction | 50% reduction | phase out discharges emissions | — | • apply BAT & BEP<br>• national programmes<br>• adopt emissions of 0.5 g Hg/t of chlorine or 5 g Hg/t depending on process 2 g Hg total releases and losses |
| • *Organo Hg, Pb, Sn compounds* | phase out organo Hg | 50% reduction of discharges | phase out organo Pb, organo Sn | • guidelines for BAT & BEP<br>• EQO and standards | • inventory of organometallic<br>• phase out the use of organotin as antifouling and cooling systems<br>• apply BAT & BEP and environmental management |
| • *Zinc, copper, chromium* | — | reduce discharges | eliminate discharges | • guidelines for BAT & BEP<br>• EQO and standards | • adopt 1 mg/l of zinc 0.5 mg/l of copper releases into the sea<br>• apply BAT, BEP and environmental management |
| Organo-halogen compounds<br>• *Halo-genated Aromatic hydro-carbons*<br>• *Halo-genated aliphatic hydro-carbons*<br>• *Chlorinated phenolic compounds*<br>• *Organo-halogen pesticides* | — | reduce discharges | eliminate discharges | • guidelines for BAT & BEP<br>• EQO and standards | • apply BAT, BEP and environmental management<br>• adopt 1 kg/t of pulp of AOX release<br>• inventory of pesticides<br>• adopt national programmes for reduction<br>• reduce uses of chlorinated solvent<br>• reduce and control use of 2.4D and 2.5T and chlorophenols<br>• participate in regional and international related programmes |

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| Issue | Targets 2005 | Targets 2010 | Targets 2025 | Regional Activities | National Activities |
|---|---|---|---|---|---|
| Radioactive substances | — | — | eliminate inputs | • information system | • environmental management of radioactive waste<br>• apply BAT, BEP to reduce input<br>• reporting |
| Nutrients and suspended solids | | | | | |
| • *Urban and industrial waste water* | — | 50% reduction form industry | all waste disposed according to LBS protocol | • guidelines for BAT & BEP<br>• EQO and standards | • reduce discharge<br>• environmental management of waste water<br>• apply tertiary treatment<br>• good housekeeping<br>• reuse of treated waste water<br>• environmental management of sludges |
| • *Agriculture* | — | — | reduce inputs | • guidelines for rational use of fertilizers and losses of nutrients<br>• participate to FAO related programmes | • assess fertilizers<br>• assess quantities of ma…<br>• rational use of fertilizers<br>• good agriculture practices<br>• participate to FAO related programmes<br>• implementation of convention on desertification |
| • *Atmo-spheric emissions* | — | — | — | — | — |
| Hazardous wastes | — | 20% reduction of generation of hazardous waste<br>50% safely disposed | dispose in safe environ-mental sound manner | • prepare Mediterranean strategy for management of hazardous wastes<br>• adopt common antipollution measures | • national strategy for the management of hazardous wastes<br>• national plans for management of hazardous wastes<br>• environmental sound disposal of hazardous wastes<br>• ratify hazardous wastes protocol |
| • *Obsolete chemicals* | collect and dispose in a safe environ-mental manager | — | — | • programmes for information exchange | • training programmes for recycling, collection treatment, disposal<br>• inventories |
| • *Luboil* | 50% collect and dispose in a safe environ-mental manner | — | — | • adopt standards for PCB content (50 mg/kg) | • inventories<br>• pilot programmes for recycling, collection treatment, disposal |
| • *Batteries* | — | 20% reduction of generation<br>50% disposed in an environ-mental manner | dispose all batteries in an environ-mental manner | — | • nation inventories<br>• pilot programmes for recycling, collection treatment, disposal<br>• special programmes for public and military sectors |

***c. Physical alterations and destruction of habitats.***

### 5.2 Objective 2: Sustainable Productivity from Fisheries

In most of the countries, sea fisheries have not been sustainably developed; disturbing effects have been noticed in many areas. This being so, there has recently been a general recognition of the need to lighten the pressure of fishing on the resource by reducing the effort and improving the quality of fishing gear and its use in terms of time and place.

Fishing practises themselves should also be improved by developing fishing that is as rational as possible.

So far, the failure of traditional management measures (quotas, restrictions on size controlling the effort, period closure…) to halt the over-exploiting of stocks and degrading of habitats must be recognised.

The principle of the Code of Conduct for responsible Fishing, is accepted by the Mediterranean countries. But strengthening this Code requires real political will. Practical indicators and measures must still be elaborated and put into effect. For the purpose of this TDA, the Code of Conduct is considered as the EQOs for fisheries issue in the Mediterranean. Selected chapters of Code are enumerated hereafter.

### *5.2.1 Code of Conduct for Responsible Fisheries*

- Article 2: Objectives of the Code
- Article 3: Relationship with other international instruments
- Article 4: Implementation monitoring and updating
- Article 5: Special requirements of developing countries
- Article 6: General principles
- Article 7: Fisheries management
- Article 8: Fishing operations
- Article 9: Aquaculture development
- Article 10: Integration of fisheries into coastal area management
- Article 11: Post-harvest practices and trade
- Article 12: Fisheries research

### *5.2.2 Objectives of the Code*

The objectives of the Code are to:

- establish principles, in accordance with the relevant rules of international law, for responsible fishing and fisheries activities, taking into account all their relevant biological, technological, economic, social, environmental and commercial aspects; b. establish principles and criteria for the elaboration and implementation of national policies for responsible conservation of fisheries resources and fisheries management and development;
- serve as an instrument of reference to help States to establish or to improve the legal and institutional framework required for the exercise of responsible fisheries and in the formulation and implementation of appropriate measures; d. provide guidance which may be used where appropriate in the formulation and implementation of international agreements and other legal instruments, both binding and voluntary;
- facilitate and promote technical, financial and other cooperation in conservation of fisheries resources and fisheries management and development;
- promote the contribution of fisheries to food security and food quality, giving priority to the nutritional needs of local communities;
- promote protection of living aquatic resources and their environments and coastal areas;
- promote the trade of fish and fishery products in conformity with relevant international rules and avoid the use of measures that constitute hidden barriers to such trade;
- promote research on fisheries as well as on associated ecosystems and relevant environmental factors; and
- provide standards of conduct for all persons involved in the fisheries sector.

### *5.2.3 Relationship with other International Instruments*

The Code is to be interpreted and applied in conformity with the relevant rules of international law, as reflected in the United Nations Convention on the Law of the Sea, 1982. Nothing in this Code prejudices the rights, jurisdiction and duties of States under international law as reflected in the Convention.

The Code is also to be interpreted and applied:

- in a manner consistent with the relevant provisions of the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks;
- in accordance with other applicable rules of international law, including the respective obligations of States pursuant to international agreements to which they are party; and
- in the light of the 1992 Declaration of Cancun, the 1992 Rio Declaration on Environment and Development, and Agenda 21

adopted by the United Nations Conference on Environment and Development (UNCED), in particular Chapter 17 of Agenda 21, and other relevant declarations and international instruments.

### 5.2.4 Implementation, monitoring and updating

All members and non-members of FAO, fishing entities and relevant subregional, regional and global organizations, whether governmental or non-governmental, and all persons concerned with the conservation, management and utilization of fisheries resources and trade in fish and fishery products should collaborate in the fulfilment and implementation of the objectives and principles contained in this Code.

FAO, in accordance with its role within the United Nations system, will monitor the application and implementation of the Code and its effects on fisheries and the Secretariat will report accordingly to the Committee on Fisheries (COFI). All States, whether members or non-members of FAO, as well as relevant international organizations, whether governmental or non-governmental should actively cooperate with FAO in this work.

FAO, through its competent bodies, may revise the Code, taking into account developments in fisheries as well as reports to COFI on the implementation of the Code.

States and international organizations, whether governmental or non-governmental, should promote the understanding of the Code among those involved in fisheries, including, where practicable, by the introduction of schemes which would promote voluntary acceptance of the Code and its effective application.

### 5.2.5 Special requirements of developing countries

The capacity of developing countries to implement the recommendations of this Code should be duly taken into account.

In order to achieve the objectives of this Code and to support its effective implementation, countries, relevant international organizations, whether governmental or non-governmental, and financial institutions should give full recognition to the special circumstances and requirements of developing countries, including in particular the least developed among them, and small island developing countries. States, relevant intergovernmental and non-governmental organizations and financial institutions should work for the adoption of measures to address the needs of developing countries, especially in the areas of financial and technical assistance, technology transfer, training and scientific cooperation and in enhancing their ability to develop their own fisheries as well as to participate in high seas fisheries, including access to such fisheries.

### 5.2.6 General principles

States and users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources.

Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development. Management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species.

States should prevent overfishing and excess fishing capacity and should implement management measures to ensure that fishing effort is commensurate with the productive capacity of the fishery resources and their sustainable utilization. States should take measures to rehabilitate populations as far as possible and when appropriate.

Conservation and management decisions for fisheries should be based on the best scientific evidence available, also taking into account traditional knowledge of the resources and their habitat, as well as relevant environmental, economic and social factors. States should assign priority to undertake research and data collection in order to improve scientific and technical knowledge of fisheries including their interaction with the ecosystem. In recognizing the transboundary nature of many aquatic ecosystems, States should encourage bilateral and multilateral cooperation in research, as appropriate.

States and subregional and regional fisheries management organizations should apply a precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment, taking account of the best scientific evidence available. The absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment.

Selective and environmentally safe fishing gear and practices should be further developed and applied, to the extent practicable, in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems and protect fish quality. Where proper selective and environmentally safe fishing gear and practices exist, they should be recognized and accorded a priority in establishing conservation and management measures for fisheries. States and users of aquatic ecosystems should minimize waste, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species.

The harvesting, handling, processing and distribution of fish and fishery products should be carried out in a manner that will maintain the nutritional value, quality and safety of the products, reduce waste and minimize negative impacts on the environment.

All critical fisheries habitats in marine and fresh water ecosystems, such as wetlands, mangroves, reefs, lagoons, nursery and spawning areas, should be protected and rehabilitated as far as possible and where necessary. Particular effort should be made to protect such habitats from destruction, degradation, pollution and other significant impacts resulting from human activities that threaten the health and viability of the fishery resources.

States should ensure that their fisheries interests, including the need for conservation of the resources, are taken into account in the multiple uses of the coastal zone and are integrated into coastal area management, planning and development.

Within their respective competences and in accordance with international law, including within the framework of subregional or regional fisheries conservation and management organizations or arrangements, States should ensure compliance with and enforcement of conservation and management measures and establish effective mechanisms, as appropriate, to monitor and control the activities of fishing vessels and fishing support vessels.

States authorizing fishing and fishing support vessels to fly their flags should exercise effective control over those vessels so as to ensure the proper application of this Code. They should ensure that the activities of such vessels do not undermine the effectiveness of conservation and management measures taken in accordance with international law and adopted at the national, subregional, regional or global levels. States should also ensure that vessels flying their flags fulfil their obligations concerning the collection and provision of data relating to their fishing activities.

States should, within their respective competences and in accordance with international law, cooperate at subregional, regional and global levels through fisheries management organizations, other international agreements or other arrangements to promote conservation and management, ensure responsible fishing and ensure effective conservation and protection of living aquatic resources throughout their range of distribution, taking into account the need for compatible measures in areas within and beyond national jurisdiction.

States should, to the extent permitted by national laws and regulations, ensure that decision-making processes are transparent and achieve timely solutions to urgent matters. States, in accordance with appropriate procedures, should facilitate consultation and the effective participation of industry, fishworkers, environmental and other interested organizations in decision making with respect to the development of laws and policies related to fisheries management, development, international lending and aid.

International trade in fish and fishery products should be conducted in accordance with the principles, rights and obligations established in the World Trade Organization (WTO) Agreement and other relevant international agreements. States should ensure that their policies, programmes and practices related to trade in fish and fishery products do not result in obstacles to this trade, environmental degradation or negative social, including nutritional, impacts.

States should cooperate in order to prevent disputes. All disputes relating to fishing activities and practices should be resolved in a timely, peaceful and cooperative manner, in accordance with applicable international agreements or as may otherwise be agreed between the parties. Pending settlement of a dispute, the States concerned should make every effort to enter into provisional arrangements of a practical nature that should be without prejudice to the final outcome of any dispute settlement procedure.

States, recognizing the paramount importance to fishers and fishfarmers of understanding the conservation and management of the fishery resources on which they depend, should promote awareness of responsible fisheries through education and training. They should ensure that fishers and fishfarmers are involved in the policyormulation and implementation process, also with a view to facilitating the implementation of the Code.

States should ensure that fishing facilities and equipment as well as all fisheries activities allow for safe, healthy and fair working and living conditions and meet internationally agreed standards adopted by relevant international organizations.

Recognizing the important contributions of artisanal and small-scale fisheries to employment, income and food security, States should appropriately protect the rights of fishers and fishworkers, particularly those engaged in subsistence, small-scale and artisanal fisheries, to a secure and just livelihood, as well as preferential access, where appropriate, to traditional fishing grounds and resources in the waters under their national jurisdiction.

States should consider aquaculture, including culture-based fisheries, as a means to promote diversification of income and diet. In so doing, States should ensure that resources are used responsibly and adverse impacts on the environment and on local communities are minimized.

### *5.2.7 Fisheries management*

#### *Management objectives*

Recognizing that long-term sustainable use of fisheries resources is the overriding objective of conservation and management, States and subregional or regional fisheries management organizations and arrangements should, *inter alia*, adopt appropriate measures, based on the best scientific evidence available, which are designed to maintain or restore stocks at levels capable of producing maximum sustainable yield, as qualified by relevant environmental and economic factors, including the special requirements of developing countries.

Such measures should provide *inter alia* that:

- excess fishing capacity is avoided and exploitation of the stocks remains economically viable;
- the economic conditions under which fishing industries operate promote responsible fisheries;
- the interests of fishers, including those engaged in subsistence, small-scale and artisanal fisheries, are taken into account;
- biodiversity of aquatic habitats and ecosystems is conserved and endangered species are protected;
- depleted stocks are allowed to recover or, where appropriate, are actively restored;
- adverse environmental impacts on the resources from human activities are assessed and, where appropriate, corrected; and
- pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species are minimized, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques.

States should assess the impacts of environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks, and assess the relationship among the populations in the ecosystem.

#### *Management framework and procedures*

To be effective, fisheries management should be concerned with the whole stock unit over its entire area of distribution and take into account previously agreed management measures established and applied in the same region, all removals and the biological unity and other biological characteristics of the stock. The best scientific evidence available should be used to determine, *inter alia*, the area of distribution of the resource and the area through which it migrates during its life cycle.

States seeking to take any action through a non-fishery organization which may affect the conservation and management measures taken by a competent subregional or regional fisheries management organization or arrangement should consult with the latter, in advance to the extent practicable, and take its views into account.

***Data gathering and management advice***

When considering the adoption of conservation and management measures, the best scientific evidence available should be taken into account in order to evaluate the current state of the fishery resources and the possible impact of the proposed measures on the resources.

Research in support of fishery conservation and management should be promoted, including research on the resources and on the effects of climatic, environmental and socio-economic factors. The results of such research should be disseminated to interested parties.

Studies should be promoted which provide an understanding of the costs, benefits and effects of alternative management options designed to rationalize fishing, in particular, options relating to excess fishing capacity and excessive levels of fishing effort.

States should ensure that timely, complete and reliable statistics on catch and fishing effort are collected and maintained in accordance with applicable international standards and practices and in sufficient detail to allow sound statistical analysis. Such data should be updated regularly and verified through an appropriate system. States should compile and disseminate such data in a manner consistent with any applicable confidentiality requirements.

In order to ensure sustainable management of fisheries and to enable social and economic objectives to be achieved, sufficient knowledge of social, economic and institutional factors should be developed through data gathering, analysis and research.

States should compile fishery-related and other supporting scientific data relating to fish stocks covered by subregional or regional fisheries management organizations or arrangements in an internationally agreed format and provide them in a timely manner to the organization or arrangement. In cases of stocks which occur in the jurisdiction of more than one State and for which there is no such organization or arrangement, the States concerned should agree on a mechanism for cooperation to compile and exchange such data.

Subregional or regional fisheries management organizations or arrangements should compile data and make them available, in a manner consistent with any applicable confidentiality requirements, in a timely manner and in an agreed format to all members of these organizations and other interested parties in accordance with agreed procedures.

***Precautionary approach***

States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.

If a natural phenomenon has a significant adverse impact on the status of living aquatic resources, States should adopt conservation and management measures on an emergency basis to ensure that fishing activity does not exacerbate such adverse impact. States should also adopt such measures on an emergency basis where fishing activity presents a serious threat to the sustainability of such resources. Measures taken on an emergency basis should be temporary and should be based on the best scientific evidence available.

***Management measures***

States should ensure that the level of fishing permitted is commensurate with the state of fisheries resources.

When deciding on the use, conservation and management of fisheries resources, due recognition should be given, as appropriate, in accordance with national laws and regulations, to the traditional practices, needs and interests of indigenous people and local fishing communities which are highly dependent on fishery resources for their livelihood.

In the evaluation of alternative conservation and management measures, their cost-effectiveness and social impact should be considered.

The efficacy of conservation and management measures and their possible interactions should be kept under continuous review. Such measures should, as appropriate, be revised or abolished in the light of new information.

States should take appropriate measures to minimize waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and negative impacts on associated or dependent species, in particular endangered species. Where appropriate, such measures may include technical measures related to fish size, mesh size or gear, discards, closed seasons and areas and zones reserved for selected fisheries, particularly artisanal fisheries. Such measures should be applied, where appropriate, to protect juveniles and spawners. States and subregional or regional fisheries management organizations and arrangements should promote, to the extent practicable, the development and use of selective, environmentally safe and cost effective gear and techniques.

### *5.2.8 Fishing operations*

***Duties of all States***

States should ensure that only fishing operations allowed by them are conducted within waters under their jurisdiction and that these operations are carried out in a responsible manner.

States should maintain a record, updated at regular intervals, on all authorizations to fish issued by them.

States should maintain, in accordance with recognized international standards and practices, statistical data, updated at regular intervals, on all fishing operations allowed by them.

States should, in accordance with international law, within the framework of subregional or regional fisheries management organizations or arrangements, cooperate to establish systems for monitoring, control, surveillance and enforcement of applicable measures with respect to fishing operations and related activities in waters outside their national jurisdiction.

States should ensure that health and safety standards are adopted for everyone employed in fishing operations. Such standards should be not less than the minimum requirements of relevant international agreements on conditions of work and service.

States should make arrangements individually, together with other States or with the appropriate international organization to integrate fishing operations into maritime search and rescue systems.

States should enhance through education and training programmes the education and skills of fishers and, where appropriate, their professional qualifications. Such programmes should take into account agreed international standards and guidelines.

States should, as appropriate, maintain records of fishers which should, whenever possible, contain information on their service and qualifications, including certificates of competency, in accordance with their national laws.

States should ensure that measures applicable in respect of masters and other officers charged with an offence relating to the operation of fishing vessels should include provisions which may permit, *inter alia*, refusal, withdrawal or suspension of authorizations to serve as masters or officers of a fishing vessel.

States, with the assistance of relevant international organizations, should endeavour to ensure through education and training that all those engaged in fishing operations be given information on the most important provisions of this Code, as well as provisions of relevant international conventions and applicable environmental and other standards that are essential to ensure responsible fishing operations.

In the event of an accident to a fishing vessel or persons on board a fishing vessel, the flag State of the fishing vessel concerned should provide details of the accident to the State of any foreign national on board the vessel involved in the accident. Such information should also, where practicable, be communicated to the International Maritime Organization.

***Port State duties***

Port States should take, through procedures established in their national legislation, in accordance with international law, including applicable international agreements or arrangements, such measures as are necessary to achieve and to assist other States in achieving the objectives of this Code, and should make known to other States details of regulations and measures they have established for this purpose. When taking such measures a port State should not discriminate in form or in fact against the vessels of any other State.

Port States should provide such assistance to flag States as is appropriate, in accordance with the national laws of the port State and international law, when a fishing vessel is voluntarily in a port or at an offshore terminal of the port State and the flag State of the vessel requests the port State for assistance in respect of non-compliance with subregional, regional or global conservation and management measures or with internationally agreed minimum standards for the prevention of pollution and for safety, health and conditions of work on board fishing vessels.

***Fishing activities***

States should ensure that fishing is conducted with due regard to the safety of human life and the International Maritime Organization International Regulations for Preventing Collisions at Sea, as well as International Maritime Organization requirements relating to the organization of marine traffic, protection of the marine environment and the prevention of damage to or loss of fishing gear.

States should prohibit dynamiting, poisoning and other comparable destructive fishing practices.

States should make every effort to ensure that documentation with regard to fishing operations, retained catch of fish and non-fish species and, as regards discards, the information required for stock assessment as decided by relevant management bodies, is collected and forwarded systematically to those bodies. States should, as far as possible, establish programmes, such as observer and inspection schemes, in order to promote compliance with applicable measures.

Research on the environmental and social impacts of fishing gear and, in particular, on the impact of such gear on biodiversity and coastal fishing communities should be promoted.

***Fishing gear selectivity***

International cooperation should be encouraged with respect to research programmes for fishing gear selectivity, and fishing methods and strategies, dissemination of the results of such research programmes and the transfer of technology.

***Protection of the aquatic environment***

States should introduce and enforce laws and regulations based on the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).

Owners, charterers and managers of fishing vessels should ensure that their vessels are fitted with appropriate equipment as required by MARPOL 73/78 and should consider fitting a shipboard compactor or incinerator to relevant classes of vessels in order to treat garbage and other shipboard wastes generated during the vessel's normal service.

Owners, charterers and managers of fishing vessels should minimize the taking aboard of potential garbage through proper provisioning practices.

The crew of fishing vessels should be conversant with proper shipboard procedures in order to ensure discharges do not exceed the levels set by MARPOL 73/78. Such procedures should, as a minimum, include the disposal of oily waste and the handling and storage of shipboard garbage.

***Protection of the atmosphere***

States should adopt relevant standards and guidelines that would include provisions for the reduction of dangerous substances in exhaust gas emissions.

Owners, charterers and managers of fishing vessels should ensure that their vessels are fitted with equipment to reduce emissions of ozone depleting substances. The responsible crewmembers of fishing vessels should be conversant with the proper running and maintenance of machinery on board.

Competent authorities should make provision for the phasing out of the use of chlorofluorocarbons (CFCs) and transitional substances such as hydrochlorofluorocarbons (HCFCs) in the refrigeration systems of fishing vessels and should ensure that the shipbuilding industry and those engaged in the fishing industry are informed of and comply with such provisions.

Owners or managers of fishing vessels should take appropriate action to refit existing vessels with alternative refrigerants to CFCs and HCFCs and alternatives to Halons in fire fighting installations. Such alternatives should be used in specifications for all new fishing vessels.

States and owners, charterers and managers of fishing vessels as well as fishers should follow international guidelines for the disposal of CFCs, HCFCs and Halons.

***Harbours and landing places for fishing vessels***

States should establish an institutional framework for the selection or improvement of sites for harbours for fishing vessels that allows for consultation among the authorities responsible for coastal area management.

***Abandonment of structures and other materials***

States should ensure that the standards and guidelines for the removal of redundant offshore structures issued by the International Maritime Organization are followed. States should also ensure that the competent fisheries authorities are consulted prior to decisions being made on the abandonment of structures and other materials by the relevant authorities.

***Artificial reefs and fish aggregation devices***

States, where appropriate, should develop policies for increasing stock populations and enhancing fishing opportunities through the use of artificial structures, placed with due regard to the safety of navigation, on or above the seabed or at the surface. Research into the use of such structures, including the impacts on living marine resources and the environment, should be promoted.

States should ensure that, when selecting the materials to be used in the creation of artificial reefs as well as when selecting the geographical location of such artificial reefs, the provisions of relevant international conventions concerning the environment and safety of navigation are observed.

States should, within the framework of coastal area management plans, establish management systems for artificial reefs and fish aggregation devices. Such management systems should require approval for the construction and deployment of such reefs and devices and should take into account the interests of fishers, including artisanal and subsistence fishers.

States should ensure that the authorities responsible for maintaining cartographic records and charts for the purpose of navigation, as well as relevant environmental authorities, are informed prior to the placement or removal of artificial reefs or fish aggregation devices.

### 5.2.9 Aquaculture development

***Responsible development of aquaculture, including culture-based fisheries, in areas under national jurisdiction***

States should establish, maintain and develop an appropriate legal and administrative framework that facilitates the development of responsible aquaculture.

States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information.

States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities.

States should ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected by aquaculture developments.

States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities.

***Responsible development of aquaculture including culture-based fisheries within transboundary aquatic ecosystems***

States should protect transboundary aquatic ecosystems by supporting responsible aquaculture practices within their national jurisdiction and by cooperation in the promotion of sustainable aquaculture practices.

States should, with due respect to their neighbouring States, and in accordance with international law, ensure responsible choice of species, siting and management of aquaculture activities which could affect transboundary aquatic ecosystems.

States should consult with their neighbouring States, as appropriate, before introducing non-indigenous species into transboundary aquatic ecosystems.

States should establish appropriate mechanisms, such as databases and information networks to collect, share and disseminate data related to their aquaculture activities to facilitate cooperation on planning for aquaculture development at the national, subregional, regional and global level.

States should cooperate in the development of appropriate mechanisms, when required, to monitor the impacts of inputs used in aquaculture.

***Use of aquatic genetic resources for the purposes of aquaculture including culture-based fisheries***

***Responsible aquaculture at the production level 9.4.1 States should promote responsible aquaculture practices in support of rural communities, producer organizations and fish farmers.***

States should promote active participation of fishfarmers and their communities in the development of responsible aquaculture management practices.

States should promote efforts that improve selection and use of appropriate feeds, feed additives and fertilizers, including manures.

States should promote effective farm and fish health management practices favouring hygienic measures and vaccines. Safe, effective and minimal use of therapeutants, hormones and drugs, antibiotics and other disease control chemicals should be ensured.

States should regulate the use of chemical inputs in aquaculture which are hazardous to human health and the environment.

States should require that the disposal of wastes such as offal, sludge, dead or diseased fish, excess veterinary drugs and other hazardous chemical inputs does not constitute a hazard to human health and the environment.

States should ensure the food safety of aquaculture products and promote efforts which maintain product quality and improve their value through particular care before and during harvesting and on-site processing and in storage and transport of the products.

### 5.2.10 Integration of fisheries into coastal area management

**Institutional framework**

States should ensure that an appropriate policy, legal and institutional framework is adopted to achieve the sustainable and integrated use of the resources, taking into account the fragility of coastal ecosystems and the finite nature of their natural resources and the needs of coastal communities.

In view of the multiple uses of the coastal area, States should ensure that representatives of the fisheries sector and fishing communities are consulted in the decision-making processes and involved in other activities related to coastal area management planning and development.

States should develop, as appropriate, institutional and legal frameworks in order to determine the possible uses of coastal resources and to govern access to them taking into account the rights of coastal fishing communities and their customary practices to the extent compatible with sustainable development.

States should facilitate the adoption of fisheries practices that avoid conflict among fisheries resources users and between them and other users of the coastal area.

States should promote the establishment of procedures and mechanisms at the appropriate administrative level to settle conflicts that arise within the fisheries sector and between fisheries resource users and other users of the coastal area.

**Policy measures**

States should promote the creation of public awareness of the need for the protection and management of coastal resources and the participation in the management process by those affected.

In order to assist decision-making on the allocation and use of coastal resources, States should promote the assessment of their respective value taking into account economic, social and cultural factors.

In setting policies for the management of coastal areas, States should take due account of the risks and uncertainties involved.

States, in accordance with their capacities, should establish or promote the establishment of systems to monitor the coastal environment as part of the coastal management process using physical, chemical, biological, economic and social parameters.

States should promote multi-disciplinary research in support of coastal area management, in particular on its environmental, biological, economic, social, legal and institutional aspects.

*Regional cooperation*

States with neighbouring coastal areas should cooperate with one another to facilitate the sustainable use of coastal resources and the conservation of the environment.

In the case of activities that may have an adverse transboundary environmental effect on coastal areas, States should:

- provide timely information and, if possible, prior notification to potentially affected States; and
- consult with those States as early as possible.

States should cooperate at the subregional and regional level in order to improve coastal area management.

*Implementation*

States should establish mechanisms for cooperation and coordination among national authorities involved in planning, development, conservation and management of coastal areas.

States should ensure that the authority or authorities representing the fisheries sector in the coastal management process have the appropriate technical capacities and financial resources.

### 5.2.11 Post-harvest practices and trade

*Responsible fish utilization*

States should adopt appropriate measures to ensure the right of consumers to safe, wholesome and unadulterated fish and fishery products.

States should establish and maintain effective national safety and quality assurance systems to protect consumer health and prevent commercial fraud.

States should ensure that international and domestic trade in fish and fishery products accords with sound conservation and management practices through improving the identification of the origin of fish and fishery products traded.

States should ensure that environmental effects of post- harvest activities are considered in the development of related laws, regulations and policies without creating any market distortions.

*Responsible international trade*

The provisions of this Code should be interpreted and applied in accordance with the principles, rights and obligations established in the World Trade Organization (WTO) Agreement.

International trade in fish and fishery products should not compromise the sustainable development of fisheries and responsible utilization of living aquatic resources.

States should ensure that measures affecting international trade in fish and fishery products are transparent, based, when applicable, on scientific evidence, and are in accordance with internationally agreed rules.

Fish trade measures adopted by States to protect human or animal life or health, the interests of consumers or the environment, should not be discriminatory and should be in accordance with internationally agreed trade rules, in particular the principles, rights and obligations established in the Agreement on the Application of Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade of the WTO.

States should further liberalize trade in fish and fishery products and eliminate barriers and distortions to trade such as duties, quotas and non-tariff barriers in accordance with the principles, rights and obligations of the WTO Agreement.

States should not directly or indirectly create unnecessary or hidden barriers to trade that limit the consumer's freedom of choice of supplier or that restrict market access.

States, aid agencies, multilateral development banks and other relevant international organizations should ensure that their policies and practices related to the promotion of international fish trade and export production do not result in environmental degradation or adversely impact the nutritional rights and needs of people for whom fish is critical to their health and well being and for whom other comparable sources of food are not readily available or affordable.

***Laws and regulations relating to fish trade***

States, in accordance with their national laws, should facilitate appropriate consultation with and of industry as well as environmental and consumer groups in the development and implement at participation ion of laws and regulations related to trade in fish and fishery products.

#### *5.2.12 Fisheries Research*

States, as appropriate in cooperation with relevant international organizations, should encourage research to ensure optimum utilization of fishery resources and stimulate the research required to support national policies related to fish as food.

States should conduct research into, and monitor, human food supplies from aquatic sources and the environment from which they are taken and ensure that there is no adverse health impact on consumers. The results of such research should be made publicly available.

States should ensure that the economic, social, marketing and institutional aspects of fisheries are adequately researched and that comparable data are generated for ongoing monitoring, analysis and policy formulation.

States should carry out studies on the selectivity of fishing gear, the environmental impact of fishing gear on target species and on the behaviour of target and non-target species in relation to such fishing gear as an aid for management decisions and with a view to minimizing non-utilized catches as well as safeguarding the biodiversity of ecosystems and the aquatic habitat.

States should ensure that before the commercial introduction of new types of gear, a scientific evaluation of their impact on the fisheries and ecosystems where they will be used should be undertaken. The effects of such gear introductions should be monitored.

Relevant technical and financial international organizations should, upon request, support States in their research efforts, devoting special attention to developing countries, in particular the least developed among them.

### 5.3 Objective 3: Conserve the Marine Biodiversity and Ecosystem

#### *5.3.1 SAP Bio objectives and targets*

This section is derived from the SAP BIO. The SAP BIO is a comprehensive document that should be reviewed for more detail of the attached items.

***Objectives of the SAP BIO***

- Improve the management of Marine and Coastal Protected areas;
- Enhance the protection of endangered species and habitats;
- Reinforcement of relevant national legislation;
- Forster the improving knowledge of marine and coastal biodiversity.

***Interventions***

Implementation of the Strategic Action Programme for Mediterranean Biodiversity (SAP BIO) including Investment Portfolio.

## *Table 5.3 SAP BIO EQOs*

### *I. Inventorying, Mapping and Monitoring of Mediterranean Coastal and Marine Biodiversity*

***General objective***

*"Contribute to achieving the WSSD targets concerning establishing by 2004 a regular process under the United Nations for global reporting and assessment of the state of the marine environment, including socio-economic aspects, both current and foreseeable, building on existing regional assessments." (Extract from Paragraph 34b, Plan of Implementation of the World Summit on Sustainable Development — Johannesburg, September 2002)*

***Specific targets***

*GIS-based mapping of sensitive habitats by 2008 (relevant objective/s: 1a)*
*Mediterranean Checklists of species by 2006 (1b,d)*
*Standard monitoring protocols for socio-economic impacts, global trade, endangered species, effectiveness of protected areas by 2004 (2a; 3a; 4a; 5a)*
*SAP BIO indicators by 2006 (6 a,b,c,d,e)*

| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Make a complete and integrated inventory (by sub-region) of Mediterranean coastal, wetland, and marine sensitive habitats | Description and GIS-based mapping of the spatial distribution of the sensitive habitats | Increase availability of GIS technology<br>Enhance national capabilities and support national and sub-national programmes to map sensitive habitats<br>Undertake international Mediterranean campaigns with oceanographic boats of cartography of sensitive habitats<br>Facilitate exchange of and access to maps by scientists and managers | MT | B |
| | Complete checklist of species associated with each sensitive habitat | Form regional workgroups of specialists by taxon and / or habitat<br>Set up regional programmes to make such checklists by sub-region and / or country (cf. Target d below) | MT | B |
| | Long-term routine monitoring programmes, in order to define temporal variability of abundance, biomass and other assemblage variables within sensitive habitats | Convene thematic workshops by types of habitat, to elaborate standardised regional monitoring programmes<br>Support monitoring programmes at national level, to be implemented by national workgroups in selected sites by types of habitat (at undisturbed sites, e.g., marine and coastal protected areas) | ST | A |
| | Elaborate national checklists for marine and coastal species for all the Mediterranean countries | Form national workgroups of specialists by taxon and / or habitat (assisted by regional workgroups when necessary)<br>Set up national programmes to undertake national checklists | ST | A |
| Establish of a monitoring system of endangered and threatened species | Implement a monitoring system for endangered species at regional level | Establish standard adequate monitoring techniques and methods of endangered and threatened species<br>Determine sampling protocols (spatial and temporal allocation of sampling, number of samples, etc.)<br>Implement standard monitoring protocols | ST | A |
| | Establish and update the health and risk status of endangered populations | List specific threats affecting each endangered species<br>Model population dynamics in order to forecast different scenarios concerning each species<br>Revise periodically the conservation status of each species | MT | B |
| Promote the adequate monitoring and survey of the effectiveness of marine and coastal protected areas | Implement sound scientifically-based monitoring programmes on the effectiveness of marine and coastal protected areas | Define planned objectives of existing protected areas to be monitored taking into account the methodology of the Aphrodite project, already ongoing on several MPAs<br>Elaborate a regional monitoring booklet defining sampling and experimental principles, as well as standardised sampling protocols established to acquire useful, comparable data<br>Implement standardised sampling programmes in selected protected areas spanning a representative set at regional level (taking into account the methodology of the Aphrodite project)<br>Undertake a comparative analysis of protected areas results at regional level | ST | A |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| | Improve methods of management planning, implementation and monitoring | Evaluate, at regional level, effectiveness of management measures in relation to planned objectives<br>Analysis of the applicability of new management measures<br>Refine management measures | ST | A |
| Identify, develop, and validate adequate biological and socio-economic indicators to assess the ecological health of sensitive habitats and species, and to evaluate the effectiveness of management measures | Elaborate a regional strategy on SAP BIO indicators | Convene a regional workshop on SAP BIO indicators<br>Form a working group in charge of elaborating and validating a set of SAP BIO indicators | ST | A |
| | Elaborate a list of useful SAP BIO indicators | Define objectives of the set of indicators to be used<br>Elaborate a catalogue of indicators (taking into account the indicators proposed by other international institutions)<br>Specify the methodological constraints linked to each indicator<br>Select useful indicators | ST | A |
| | Existing and new data collected to construct selected SAP BIO indicators | Evaluate the availability of existing data<br>Elaborate standardised protocols to collect new data<br>Decide periodicity and implementation calendar of selected indicators<br>Undertake sampling programmes to collect new data where necessary | ST | B |
| | Construct SAP BIO indicator set starting from the collected data | Gather regional data<br>Construct indicators<br>Publish the results at regional level | MT | B |
| | Validate selected SAP BIO indicators | Establish the states of SAP BIO implementation<br>Evaluate the usefulness, accuracy and precision of selected indicators<br>Possibly, refine list of SAP BIO indicators | MT | B |

*LT: Long Term*
*MT: Medium Term*
*ST: Short Term*
*A: High level. Immeditate applicability*
*B: Medium level*
*C: Low level, logistic / economic, institutional conditions are not met*

### *II. Conservation of Sensitive Habitats, Species and Sites*

***General objective***

*Contribute to achieving the WSSD targets concerning the establishing of Marine Protected Areas consistent with international law and based on scientific information, representative networks, by 2012, and time / area closures for the protection of nursery grounds and periods, proper coastal land use (Extract from Paragraph 31c Plan of Implementation" of the World Summit on Sustainable Development — 4 September 2002, Johannesburg)*

***Specific targets***

*Effective protection of endangered species by 2012 (relevant objectives 7a, b; 8d)*
*Increase (50%) by 2012 the surface area covered by MPAs (10 a, b, c, f)*
*Attain the protection of 20 % of the coast as marine fishery reserves by 2012 (10 e)*
*Set up a representative Mediterranean network of marine and coastal protected areas by 2012 (11 a, b)*

| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Update, coordinate and enforce legislation to conserve biodiversity | Fill in existing gaps in national legislation about the protection of such habitats, species and areas | Ensure that measures adopted within the framework of regional conventions, arrangements or organizations to which countries are party are incorporated in national legislations<br>Clarify at national level competencies regarding the management of littoral areas | MT | A |
| | Ensure the completion, enforcement and implementation of existing and updated legislation | Assess the general level of compliance with current legislation in the region<br>Develop guidelines on root cause analysis of non-compliance that would help to identify the real problems in various non-compliance scenarios<br>Set up of a specific national police body, for the protection of biodiversity in coastal areas (any other police task being excluded) | LT | C |

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| **Activity (Priority Actions)** | **Objective** | **Specific Action** | **Time Framework** | **Imp.** |
|---|---|---|---|---|
| Develop actions to conserve threatened and endangered (coastal and marine) Mediterranean species | Coordinate the implementation of National Action Plans (NAPs) for threatened and endangered species elaborated within the SAP BIO Project | Organize subregional workshops<br>Prepare common guidelines, documents to assist countries in the implementation of the NAPs<br>During the implementation phase assure the flow of information among the NAPs<br>Refine NAPs to protect threatened and endangered species | ST | A |
| | Increase knowledge on these species | (cf. priority #4.a,4.b) | — | — |
| | Establish a monitoring system for these species | (cf. priority #4) | — | — |
| | Harmonise, update, implement and enforce adequate legislation | (cf. priority #7) | — | — |
| | Habitats on which selected species depend protected | (cf. priority #10, target d) | — | — |
| Protect marine and coastal sites of particular interest | Develop and coordinate protection actions for priority sites and areas identified by National Reports | Campaign of collection of data using the Standard Entry Data Form in identified site<br>Prepare detailed Action Plans to protect identified sites<br>Coordinate protection actions at regional level (cf. Priority #11, Target b below) | — | — |
| Declare and develop new coastal and marine protected areas including in the high seas | Identify of new areas deserving protection measures in the south and eastern Mediterranean | Identify key sites important for harbouring representative, well-conserved marine and coastal habitats (links with cf. priority # 1) further to their identification as priority sites by National Reports (cf. priority # 9)<br>Fill in the SDF for each identified area | ST | A |
| | Set up of new protected marine and coastal areas in the south and eastern Mediterranean | Countries declare new M&CPA<br>Provide the new M&CPA with all the necessary tools to assure their functioning<br>Establish of a sub-regional network of south and eastern Mediterranean representative habitats (cf. Target 11.b below) | MT | C |
| | Increase the number of C&MPAs or reserves to conserve sensitive, highly endangered species | Define habitat features of selected endangered species<br>Define the minimum area needed to fully protect highly endangered species<br>Select areas to protect these species<br>Prepare detailed Action Plans for these areas (declaration of MPA or implementation of other measures of protection) | LT | C |
| | Identify and protect of new areas offshore (including the high seas) deserving protection measures | Identify key sites important for harbouring representative, deep marine habitats and / or important pelagic ecosystem (links with cf. priority # 1)<br>The involved countries declare and set up offshore protected areas | MT | C |
| Develop existing Marine and Coastal Protected Areas | Enhance the management of existing Protected Areas | Dedicate resources to funding the management of existing Protected Areas<br>Convene workshops of C&MPA managers to harmonise and improve management issues<br>Integrate specific protection measures into large-scale networks (cf. Target b below) | MT | B |
| | Establish and support protected area networks | Integrate specific protection measures at particular locations into wider management plans, as well as into large-scale networks of Coastal and Marine Protected Areas<br>Coordination and harmonisation between management plans and structures of particular existing Protected Areas<br>Undertake specific research, monitoring and assessment under a networking scheme (cf. priority #5) | MT | B |

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*MT: Medium Term*
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*B: Medium level*
*C: Low level, logistic / economic, institutional conditions are not met*

## *III. Assessing and Mitigating the Impact of Threats on Biodiversity*

***General objective***

*Contribute to achieving the WSSD targets concerning significant reduction by 2010in the current rate of loss of biological diversity (Extract from Paragraph 42 Plan of Implementation of the World Summit on Sustainable Development — 4 September 2003, Johannesburg)*

***Specific targets***

*Updated assessment of the potential impact of threats on Mediterranean marine and coastal biodiversity by 2008 (12a, b; 13a)*
*Maintain or restore fishery stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 201520 (21 a, b, c, d, e, f ,g, h, i)*
*Urgently develop and implement national and plans of action, to put into effect the FAO international plans of action, in particular the international plan of action for the management of fishing capacity by 2005 and the international plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing by 2004 (relevant objective/s: 21f). Establish effective monitoring, reporting and enforcement, and control of fishing vessels, including by flag states, to further the international plan of action to prevent, deter and eliminate illegal, unreported and unregulated fishing20 (21a, c, e, f, h, i)*
*Control and regulate the urban development of coastal area, land use planning and aquaculture practices within a wider management plan by 2010 (16a; 17a; 20a, b, c)*
*Legal regulation of recreational activities by 2008 (18 b)*
*Reinforce control and mitigation of the introduction and spread of alien species by 2006 (15 a, b, c)*

| **Activity (Priority Actions)** | **Objective** | **Specific Action** | **Time Framework** | **Imp.** |
|---|---|---|---|---|
| Monitor of global trade and economic policies and trends from a Mediterranean perspective, to analyse their scope and probable effects on biodiversity | Implement monitoring systems for consequences of global trade and economic policies | Establish monitoring protocols and standards, in order to evaluate the effects of international trade on Mediterranean biodiversity<br>Implement standard monitoring protocols<br>Propose recommendations at regional level to undertake specific actions to counter trade effects on biodiversity and sustainable development<br>Coordinate monitoring and action plans at regional and international level (e.g., UNCTAD/UNDP, ICTSD, etc.) | ST | A |
| Establish a regional monitoring programme following up the socio-economic impact of changes in biodiversity | Implement monitoring systems for socio-economic impacts of changes in biodiversity | Establish monitoring protocols and standards, in order to evaluate the socio-economic effects of changes in biodiversity<br>Implement standard monitoring protocols | ST | A |
| Assess the potential impact of climate change and rise in sea level on Mediterranean coastal and marine biodiversity | Inventory and monitor of biodiversity elements and / or areas likely to be impacted by climate change | Geographical identification of priority areas likely to be threatened by climate change and rise in sea level<br>Establish a monitoring network to describe long-term change | ST | A |
| | Acquire the necessary knowledge to model and forecast likely effects of climate change | Ascertain the relationship between the Mediterranean Sea and the global ocean atmosphere and its response to local forcing<br>Monitoring long-term variability of the thermo-haline circulation, biogeochemical content and transport in the whole Mediterranean Sea<br>Quantify and accurately model regional hydrological cycles (evaporation, precipitation, river run-off, groundwater)<br>Fill in geographical gaps on key processes in the Mediterranean Sea | MT | B |
| Assess the potential impact of threats on Mediterranean coastal and marine biodiversity | Inventory of biodiversity elements and / or areas likely to be impacted by threats on biodiversity | Geographical identification of priority areas likely to be affected by threats on biodiversity<br>Establish a monitoring network to describe long-term change | MT | B |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Mitigate the direct impact of international trade in endangered species | Improve research and control on the impact of harvesting wild species | Improve monitoring of international trade, focusing especially on species not included in CITES<br>Update CITES lists with Mediterranean threatened and endangered species not yet included | ST | A |
| | | Set up a specific national police body, for the protection of biodiversity (cf. priority # 7b) | LT | C |
| | Adopt market and awareness measures targeting stakeholders in the chain of catching and trade in alien species (from harvesters to consumers) | Create an eco-label to certify that wildlife products have been legally harvested and exported<br>Make consumers and potential purchasers sensitive to international wildlife-trade issues, through adequate awareness measures | ST | B |
| Control and mitigate the introduction and spread of alien and invasive species | Develop appropriate institutional measures to fight against particular sources of alien species | Regional project to reduce transfer of aliens via aquaculture and aquaria practices (cf. Priority #20)<br>Regional project to reduce transfer of alien species via ships' ballast water and sediments and hull fouling<br>Regional project to reduce transfer of alien species via plastic debris<br>Regional project to reduce transfer of alien species via fishing practices | ST | B |
| | Implement a regional coordination network to mitigate introduction and spread of alien species | Elaborate and adopt at regional level guidelines intended to assist the relevant national authorities<br>Coordinate the actions taken by neighbouring states to prevent and control the introduction of non-indigenous species<br>Support cooperation at international level | ST | B |
| | Fill in existing gaps in knowledge about alien species | Carry out research work, data collection, monitoring, etc. aimed at improving the available knowledge<br>Coordinate the actions that are necessary for the regular provision of supplementary information for the national and Mediterranean-wide reference lists of non-indigenous species<br>Support information exchange and concerted action at regional level<br>Encourage the implementation of scientifically-backed regionally-harmonised measures of prevention and control | ST | B |
| Control and mitigate coastal urbanization and construction of coastal infrastructure | Insert urban development of coastal areas into wider integrated management plans | Carry out evaluations of destination sites' carrying capacity and take the necessary steps to ensure that the offer is limited to the carrying capacities thus defined<br>Strengthen or establish legislative tools, regulations and property management to control tourist urbanisation and protect sensitive species, habitats and sites<br>In particular, control the proliferation of marinas and sport harbours<br>Prohibit the construction of artificial beaches<br>Implement programmes enabling the rehabilitation of mature destination areas favouring the environment<br>Implement mechanisms enabling (whenever possible) a financial contribution from the tourist sector for protecting and managing natural and cultural sites | MT | C |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Control the effect and mitigate of changes in land use | Promote the integration of land used planning into wider integrated management plans | Carry out evaluations of carrying capacity of the littoral zone concerning l and use, and take the necessary steps that the offer is limited to the carrying capacities thus defined<br>Define (at national and sub-regional level) interference, incompatibility and synergy between different land uses in the littoral zone<br>Undertake the zoning of littoral areas at sub-national level<br>Define and promote adequate, environmentally-friendly agricultural practices<br>Define and promote adequate, environmentally-friendly water management practices<br>Define and promote adequate, environmentally-friendly reforestation practices<br>Regulate and control mining activities under an integrated management scheme | MT | C |
| Promote eco- and soft tourism, control and mitigate impact of recreational activities | Increase sustainable tourism, including non-consumptive and eco-tourism taking into account the spirit of the International Year of Eco-tourism 2002, the United Nations Year for Cultural Heritage in 2002, the World Eco-tourism Summit 2002 and its Quebec Declaration, and the Global Code of Ethics for Tourism as adopted by the World Tourism Organization *(taken from paragraph 41, "Plan of Implementation" of the World Summit on Sustainable Development, 4 September 2002, Johannesburg)* | Promote eco-labelling and other quality environmental procedures (e.g., certification, charters, etc.) at regional level<br>Support private eco-tourism initiatives<br>Awareness programmes among tour operators, tourist businesses (travels, hotels, sport facilities, etc.) and public sector administrations on the benefits of environmentally-friendly tourist practices<br>Avoid ghetto-like, high-standing tourist facilities unconnected with local conditions<br>Promote respect for local architecture and the historical heritage<br>Facilitate the exchange of tourists and local populations and cultures<br>Minimize waste production, and energy and water consumption by tourist facilities<br>Promote the use of public transport<br>Develop all means that may lead to spreading the tourist season over the entire year<br>Develop international, regional cooperation | LT | B |
| | Control and mitigate the impact of recreational activities on coastal and marine Mediterranean biodiversity | Make an analysis and collect information on the most significant environmental impacts of recreational activities and tourism<br>Geographical identification of priority areas likely to be affected by recreational activities<br>Regulation and enforcement of recreational practices, in particular of high-impacting activities (e.g., 4x4, diving, motor navigation, hunting, recreational fishing, sea-watching, etc.)<br>Management and regulation of access and use of beaches by the public as well as their use by professionals, in accordance with environmental factors<br>Study and promote the use of eco-taxes for the general public visiting protected areas, as well as other economic and financial tools to protect biodiversity<br>Develop the alternative use of coastal and marine areas, based on the utilization of natural landscapes | MT<br><br>MT | C<br><br>C |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
| --- | --- | --- | --- | --- |
| Assess and elaborate of strategies to prevent the environmental impact of sources of pollution | Assess and prevent the impact of desalination techniques | Establish a regional programme to quantify and characterize the environmental impact of coastal desalination plants<br>Define and evaluate technical measures to minimize the impact of the desalination process (e.g., construction of pipelines for disposal of reject flow, ameliorate desalination technology, etc.)<br>Promote clean-energy desalination plants (e.g., solar); avoid desalination projects to mask environmentally-unfriendly energy projects (e.g., power plants, incinerators of toxic waste, etc.)<br>Insert the planning of new desalination plants into wider integrated water and coastal management plans | MT | C |
| | Control the proliferation of floating plastic objects and debris | Establish a regional programme to quantify plastic proliferation in the Mediterranean<br>Geographical identification of priority areas likely to be affected by the proliferation of plastic debris in the sea<br>Support international agreements about the dumping of plastics in the sea<br>Enhance recuperation and recycling of plastics<br>Promote the research and application of technology to produce photo- and bio-degradable plastics<br>Promote and support beach-cleaning initiatives<br>Establish awareness campaigns (oriented to users and the general public) about the use and waste of plastic debris in the sea | LT | C |
| | Achieve non-pollutant marine transport and navigation techniques;<br>pay special attention to noise and hydrocarbon pollution | Enhance and support activities under international agreements on environmental impacts of maritime casualty, concerning pollution from ships<br>Enhance and support activities and regulations under international agreements on the environmental impacts of oil spills<br>Undertake a Regional Programme to minimize the impact of noise from ships and military engines, as well as other sources of noise pollution (mineral production, pingers, ringers, etc.)<br>Regulations for ballast water management to prevent the transfer of harmful aquatic organisms<br>Support the International Maritime Organization (IMO) convention prohibiting the use of harmful organisms anti-fouling paints used on ships; establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems<br>Support the declaration of PSSA (Particularly Sensitive Sea Areas, as defined by the IMO) | LT | C |
| | Integrate of aquaculture practices into wider integrated management plans | Carry out evaluations of carrying capacity of the littoral zone concerning aquaculture, and take the necessary steps to ensure that the offer is limited to the carrying capacities thus defined<br>Define (by country, and at sub-national level) interference, incompatibility and synergy between aquaculture projects and plans, and other uses of the littoral zone<br>Undertake the zoning of littoral areas at sub-national level<br>Identify zones suitable for aquaculture<br>Adapt aquaculture technology to be used in a case-by-case approach, taking into account zoning | LT | B |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| | Develop research and measures to minimise the impacts of aquaculture practices on the marine and coastal environment | Standard environmental impact assessment procedures convened<br>Regulate of the use of pingers<br>Regional programme to reduce the invasion of alien species from aquaculture<br>Regional programme to minimise pollution caused by organic matter and nutrient enrichment from aquaculture farms<br>Regional programme to minimise the impact of wild seed to stock fish farms (e.g., red tuna)<br>Regional programme to minimise genetic pollution<br>Regional programme to minimise chemical pollution; disinfectants, anti-foulants, flesh colorants and medicines (including vaccines) | ST | B |
| | Adopt measures to avoid the impacts of aquariology on the marine and coastal environment | Prohibit in all the Mediterranean countries the use of potentially invasive species (e.g., caulerpas) in open or semi-open aquarium systems | ST | A |
| | Improve fishing statistics | Identify the main problems and gaps in getting accurate fishing statistics<br>Propose mechanisms to improve fishing statistics at regional level<br>In particular, design, implement and evaluate data collecting systems at national level<br>Establish a network of institutions responsible for acquiring statistics at national level | ST | C |
| | Mediterranean strategy for the conservation and sustainable management of vulnerable fish and invertebrates, including sustainable related fisheries | Assess the status of vulnerable fish and invertebrate populations subject to commercial fisheries<br>Determine adaptive and precautionary management schemes for the preservation of vulnerable populations<br>Assess the suitability of a complete ban on the exploitation of certain particularly vulnerable species at regional level<br>Assess (and eventually implement) the inclusion of species listed in the annexes of the SPA Protocol in the appropriate CITES lists<br>Develop selected case studies for different vulnerable species / groups carried out in different parts of the Mediterranean in order to draw up guidelines on vulnerable species management and conservation valid for the region | ST | A |
| | Improve inter- and intra-specific selectivity of gear and fishing practices, addressing particularly the problems of by-catch, discard, and ghost-fishing | Carry out research on effects of by-catch, discard and ghost-fishing on threatened and endangered species<br>Enhance research on fishing technology, fishing strategies and possible gear modifications to avoid by-catch, discards and ghost-fishing<br>Favour new consumption habits and technology to process unavoidably by-catched, under-consumed species | MT | A |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| | Mediterranean strategy to reduce fishing-related mortality of marine mammals, turtles and sea birds | Geographical identification of priority areas with significant impacts on cetaceans, monk seals, sea turtles and sea birds<br>Detailed analysis of the threat, and its significance with respect to the viability of impacted populations, based on the above and other complementary information obtained at the national level<br>Develop Mediterranean-specific approaches to counter the negative effects of fishing on vulnerable groups<br>Assess the potential relevance of existing technical improvements<br>Assess the applicability of spatial and temporal restrictions on impacting gear<br>Assess the possible implementation of no-take zones or areas with severe fishing restrictions<br>Assess the reliance of sea birds on discard from fishing fleets in the region<br>Establish an adaptive methodology based on pilot studies affecting different groups / species and implemented in selected sites around the Mediterranean | ST | A |
| | Mediterranean strategy to reduce the impact of trawling and other towed gear on critical habitats | Geographical identification of priority areas with a verified high impact of towed gear<br>Identify shortcomings in legislation, and develop drafts for suitable improve by current deep-water fishing practices, including likely short-term developments, on deep sea ecosystems in the region<br>Assess the effectiveness of artificial reefs to prevent illegal trawling<br>Assess the effectiveness of new prevention measures (cf. target h below) | ST | A |
| | Mediterranean strategy to eliminate particularly harmful fishing practices | Geographical identification of priority areas with a significant occurrence of:<br>Identify of problems associated with the eradication of these practices<br>Geographical identification of priority areas with high levels of drift-net fishing<br>Ascertain the real level of damage inflicted on vulnerable species caught as by-catch in legal drift-nets<br>Identify problems associated with the eradication of legal drift-nets<br>Adopting measures leading either to the total banning of legal driftnets, depending on their effects on vulnerable species, or to possible remedies<br>Promote regional policy initiatives at GFCM level, including binding decisions regarding harmful fishing practices | ST | A |
| | Develop and refine "traditional" control measures | Organize working groups (coordinated with FAO and other regional institutions) to develop and refine measures acting on "inputs" (e.g., closed areas, closed seasons, limits on fishing time, number of vessels authorized in the fishery, characteristics of the fishing gear and equipment used, etc.)<br>Organize working groups (coordinated with FAO and other regional institutions) to develop and refine measures acting on "outputs" (e.g., weight of catch or quota, minimum size of fish-mesh size, species, sex or sexual maturity of fish that may be legally harvested, etc.)<br>Support the implementation of refined management measures | ST | A |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| | Develop new management techniques | Organize working groups (coordinated with FAO and other regional institutions) to develop and refine new management techniques (e.g., marine protected areas, artificial reefs, temporal closures —by season, area, etc.— market tools, remote location and positioning of fishing ships, etc.)<br>Support the implementation of refined management measures | ST | A |
| | Increase the number of marine fishery reserves to manage fishery stocks to attain the protection of 20% of the coast | Calculate total surface per country to be protected to reach the 20% threshold<br>Decide location, habitats included, size and number of marine fishery reserves based on participative schemes, taking stakeholders' needs and experience into account<br>Involve stakeholders in planning, managing, monitoring and exploitation issues; support their participation in the whole protection process<br>Undertake socio-economic and biological planning and monitoring of adopted measures<br>Define adaptive / flexible mechanisms to manage such areas<br>Coordinate management issues at regional level (cf. Target 11.b below) | LT | C |
| | Control recreational fishing activities | Identify the main problems and gaps in getting accurate recreational fishing statistics<br>Propose mechanisms to improve recreational fishing statistics at regional level<br>In particular, design, implement and evaluate data collecting systems at national level<br>Establish a network of institutions responsible for acquiring statistics at national level<br>Regulate and enforce recreational fishing | MT | B |

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*B: Medium level*
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## *IV. Developing Research to complete Knowledge and fill in Gaps on Biodiversity*

***General objective***

*Improve the scientific understanding and assessment of marine and coastal ecosystems (From paragraph 34 of "Plan of Implementation" of the World Summit on Sustainable development — Johannesburg, September 2002)*

***Specific targets***

*Launch research programmes before 2006 in order to fill in identified gaps (22a, b)*
*Increase more than 50 the number of PHD taxonomists in the Mediterranean region by 2010 (23 a, b, c)*

| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Improve and coordinate biodiversity research | Convene a workshop (under the UNEP MAP coordination) to identify gaps in knowledge of Mediterranean coastal and marine biodiversity (at genetic, species and communities / ecosystems level) | Identify potential organisers<br>Identify potential participants<br>Agree about objectives of the workshop<br>Organisation of a workshop to identify gaps in knowledge of Mediterranean coastal and marine biodiversity | ST | A |
| | Create and fund research programmes at regional level, aiming at filling in gaps and completing knowledge of coastal and marine biodiversity, as well as transfer knowledge between countries | Set up a network of excellence of national institutes of research on the issues identified through a workshop (cf. priority # 22 a)<br>Elaborate research programme on the issues identified through a workshop (cf. priority # 22 a) | ST | B |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Improve taxonomic expertise in the region | Implement training programmes for modern taxonomists covering all groups, in order to increase the number of specialists | Promote and co-ordinate MSc and PhD programmes<br>Encourage the establishment of bilateral and / or multinational grants programmes<br>Organise the exchange of students and specialists | MT | B |
| | Gather and circulate taxonomic bibliographic information | Systematise exhaustive and well classified bibliographic information<br>Organise Internet-based information-exchange platforms | ST | A |
| | Creation of sub-regional biodiversity centres to store of representative collections of Mediterranean biodiversity, coupling published work, Internet-available descriptions and pictures of both preserved and live specimens, publication of genetic sequences identifying the species, etc. | Set up sub-regional biodiversity centres<br>Recruit permanent staff for these centres | ST | C |

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### *V. Capacity Building: Coordination and Technical Support*

***Objective:***
*Strengthen cooperation and coordination among global observing systems and research programmes for integrated global observations, taking into account the need for building capacity and sharing of data from ground-based observations, satellite remote sensing and other sources among all countries (23a, b; 24 a, b)*
*(taken from paragraph 119a, "Plan of Implementation" of the World Summit on Sustainable Development — 4 September 2002, Johannesburg)*

| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Achieve "clearing-house" mechanism marine and to focus on coastal conservation activities | The available clearing-house mechanisms (nationals, CBD, SPA/RAC, etc.) reinforced and developed within the framework of UNEP MAP | Organize the organisms and institutions involved (determining roles and responsibilities)<br>Establish networking systems and exchange protocols<br>Recruit permanent staff covering diverse skills and knowledge, to ensure completion of the clearing-house mechanism<br>Devote funds to organize the needed infrastructure<br>Co-ordinate the different conventions and related initiatives (e.g., CBD, GPA)<br>Provide start-up assistance to countries to develop participation in clearing-house mechanism | ST | A |
| | Ensure permanent updating of the Mediterranean clearing-house mechanism | Promote the use of clearing-house mechanism at the regional level<br>Establish funding strategies in the medium- and long-term<br>Establish a quality-control, evaluation system | MT | A |
| Coordination and development of common tools to implement National Action Plans (NAPs) | Coordinate the implementation of NAPs elaborated within the SAP BIO Project (regarding the NAPs on threatened and endangered species cf. priority # 8) | Organize subregional workshops on NAPs dealing with common issues<br>During the implementation phase assure the flow of information among the NAPs<br>When and if necessary refine NAPs<br>Establish procedures in the framework of the clearing-house mechanism to coordinate the implementation of NAPs (cf. Priority #24, Target a above) | ST | A |

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### *VI. Information and Participation*

***Objective:***
*Increased public participation in conservation initiatives*

| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Facilitate the access to information for managers and decision-makers, as well as stakeholders and the general public | Enhance capacity building to ensure free access to Mediterranean environmental information | Provide the clearing house mechanism (cf. Priority # 24) with capability to ensure access to information<br>Coordinate national, regional and international agencies aiming at providing and promoting the free access to environmental information *(e.g., INFOTERRA)* | ST | B |
| | Update and encourage right of access to environmental information | Harmonise national legislations on access to environmental information<br>Encourage public authorities of countries to provide public access to the environmental information | ST | B |
| Promote public participation, within an integrated management scheme | Promote public participation | Encourage countries public authorities of countries to facilitate public participation in environmental decision-making processes with significant environmental implications<br>Build up adequate mechanisms to facilitate participation by NGOs and the general public in environmental decision-making processes<br>Implement effective training programmes of public officials to improve their understanding of their responsibilities in granting the public access to information and facilitating public participation in environmental decision-making<br>Update and harmonise national legislation concerning public participation in environmental decision-making<br>Coordinate regional initiatives regarding public participation with other comparable national, regional and international initiatives and Conventions | MT | C |
| Preserve the traditional knowledge of stakeholders | Preserve, as heritage, traditional knowledge about marine and coastal elements | Form a working group specifically addressing this issue at regional level, trying to recuperate, compile and publish traditional knowledge<br>Promote national and regional legislation to preserve traditional knowledge<br>Involve local communities in management actions for the conservation of Mediterranean biodiversity<br>Coordinate regional actions with other regional and international, related initiatives (e.g., UNEP, CBD, WIPO, WRI, etc.) | MT | B |

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*B: Medium level*
*C: Low level, logistic / economic, institutional conditions are not met*

### *VII. Awareness Raising*

***Objective:***
*Increase awareness raising on marine and coastal biodiversity conservation*

| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Develop international collaboration in order to enhance regional public awareness | International cooperation and coordination on educational and awareness programmes | Coordinate regional action with other subregional, regional, and international, related activities<br>Coordinate awareness actions at regional level (e.g., through the UNEP/MAP clearing-house mechanism) (cf. Priority # 24) | ST | C |

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| Activity (Priority Actions) | Objective | Specific Action | Time Framework | Imp. |
|---|---|---|---|---|
| Organise coordinated Mediterranean-level campaigns focusing on specific regional biodiversity issues (addressed both to specific stakeholders and to the general public) | Raise awareness on key themes | Undertake studies to identify needs and gaps in public knowledge concerning threats to biodiversity, in particular: responsible tourism; trade in rare species; illegal or irresponsible fishing<br>Produce material (leaflets, brochures, posters, CDs, TV documentaries, etc.) for circulation<br>Produce educational material to be used in the framework of formal education<br>Organize and / or encourage regional and sub-regional international, more-or-less specialized, youth work-camps dealing with environmental issues (e.g., restoring disturbed habitats, mapping sensitive habitats, collecting socio-economic information, compiling traditional knowledge, extracting invasive species, measuring pollution, informing tourists, etc.)<br>Encourage national and sub-national governments about the importance of education issues to conserve biodiversity and support national NGOs in this field<br>Involve scientific institutions and researchers in awareness actions and initiatives<br>Organise general public, itinerant exhibitions, conferences and dissemination seminars | MT | B |
| | Main issues discussed in SAP/BIO brought to the attention of a wide public, including decision-makers, NGOs, scientists and researchers, tourist operators, fishing industry | Produce brochures and posters in relevant languages on SAP/BIO themes including threats; species and sites; international cooperation<br>Produce a regional electronic newsletter about SAP BIO and biodiversity conservation issues<br>Convene a regional workshop to educate managers and other stakeholders, to promote critical, adaptive and flexible management approaches | ST | A |

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### *5.3.2 SAP BIO Portfolio*

This section presents:

- Summary information and assessment of all actions needing investments, per three basic categories and per countries.
- The investment strategy.
- Approaches to funding strategies at regional and national levels.

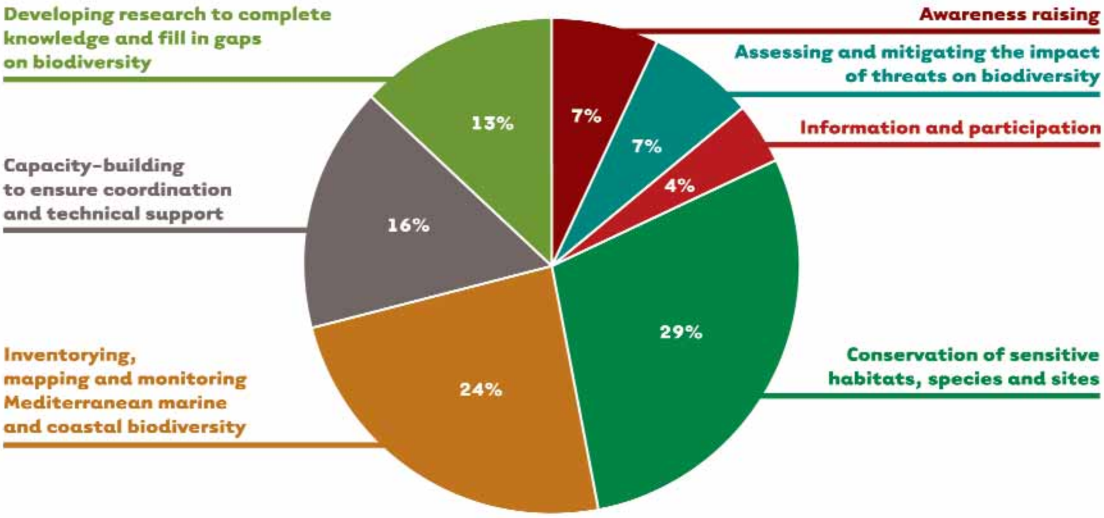
For the purpose, all priority actions are grouped in three categories:

a) National Action Plans for specific priority issues (NAPs), as prepared by national teams
b) National Priority Actions, other than those included in NAPs (ONPAs), identified by the National Reports,
c) Regional Actions (RAs), as identified by the regional process of SAP BIO elaboration. Information presented in this chapter is a synthesis of the respective more extensive documents:

***Number of Actions and Total of Investment needed (per Category)***

| Category | Number of Actions | Investments estimated (US$) |
|---|---|---|
| a) National Action Plans | 57 | 38,795,000 |
| b) Other National Priority Actions | 168 | 57,848,000 |
| c) Regional Priority Actions | 30 | 40,055,000 |
| **Grand Total** | **255** | **136,698,000** |

Figure 5.1 Breakdown of Investment needed according to the Seven Categories of Action




- "Extensive SAP BIO Investment Portfolio", presenting all individual investments per category and country in tabular form,
- "Summary of National Action Plans", and
- "Breakdown of costings for Regional Actions".

Lists of National Action Plans for the Conservation of Biodiversity and Regional Biodiversity Priority Actions are given in Annex VI.

# 6

# 6.0 REFERENCES & SELECTED BIBLIOGRAPHY

In addition to the works referred to in the text the following list includes a number of selected background readings that were relevant to the preparation of this report.

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# Annex I
# Contributors to Report

The concept of TDA was elaborated in an expert meeting held in Athens 29–30 January 2003, where a background document "Assessment of the Transboundary Pollution Issues in the Mediterranean", was presented and discussed. The document was prepared by Mr. J. Albaiges.

The list of experts who attended the meeting is as follows:


**Mr. Albaiges, Joan**

Department of Environmental Chemistry
CID-CSIC

Post: Jordi Girona Salgado, 18–26
08034 Barcelona
Spain

Tel.: (+34) 93 4006152

Fax: (+34) 93 2045904

E-mail: albqam@cid.csic.es

**Mr. Ben Sari, Driss**

LAPR-EMI

Post: 1, Rue Amir Sidi Mohamed
Souissi
Rabat
Morocco

Tel.: (+212) 37 752249

Fax: (+212) 37 752249

E-mail: sibensari@iam.net.ma

**Mr. Baric, Ante**

GEF Project Manager

Post: c/o Coordinating Unit for the Mediterranean Action Plan
48 Vassileos Konstantinou Avenue
11635 Athens
Greece

Tel.: (+30) 210 7273102

Fax: (+30) 210 7253196/7

E-mail: abaric@unepmap.gr

**Mr. Civili, Francesco Saverio**

MED POL Coordinator

Post: c/o Coordinating Unit for the Mediterranean Action Plan
48 Vassileos Konstantinou Avenue
11635 Athens
Greece

Tel.: (+30) 210 7273106

Fax: (+30) 210 7253196/7

E-mail: fscivili@unepmap.gr

**Mr. Benoit, Guillaume**

Director, BP/RAC
Blue Plan / Regional Activity Centre

Post: 15, Avenue Beethoven
Sophia Antipolis
06560 Valbonne
France

Tel.: (+33) 4 92387130/33

Fax: (+33) 4 92387131

E-mail: gbenoit@planbleu.org

**Mr. Friaa, Jafaar**

METAP
Middle East and North Africa Region

Post: 1818 H. Street
N.W. 20433
Washington D.C.
USA

Tel.: (+1) 202 4737315

Fax: (+1) 202 4771374

E-mail: sarif@worldbank.org

**Mr. Gabrielides, Gabriel**

Director, Department of Fisheries
Ministry of Agriculture, Natural Resources and Environment

Post: 13 Aeolou Street, Nicosia, Cyprus
Tel.: (+357) 22 807867
Fax: (+357) 22 775955
E-mail: ggabriel@cytanet.com.cy

**Mr. Malester, Ilan**

Coordinator, Land-Based Sources
Marine and Coastal Environment Division
Ministry of the Environment

Post: 3 Khayatt Street, P.O. Box 33583, 31333 Haifa, Israel
Tel.: (+972) 2 6553745/6
Fax: (+972) 2 6553752
E-mail: ilanm@sviva.gov.il

**Mr. Kamizoulis, George**

WHO/EURO Scientist
World Health Organization

Post: c/o Coordinating Unit for the Mediterranean Action Plan, 48 Vassileos Konstantinou Avenue, 11635 Athens, Greece
Tel.: (+30) 210 7273105
Fax: (+30) 210 7253196/7
E-mail: whomed@hol.gr

**Mr. Mamaev, Vladimir**

Senior Programme Officer,
International Waters / GEF Facility

Post: c/o UNEP, UNEP/GEF Coordination Office, P.O. Box 30552, Nairobi, Kenya
Tel.: (+254) 2 624607
Fax: (+254) 2 623557
E-mail: Vladimir.Mamaev@unep.org

**Mr. Lakkis, Sami**

Director, Laboratory of Oceanography and Marine Ecology
Lebanese University

Post: P.O. Box 138, Byblos, Lebanon
Tel.: (+961) 9 540580
Fax: (+961) 9 540580
E-mail: slakkis@inco.com.lb

**Mr. Rais, Chedly**

Scientific Director, SPA/RAC
Specially Protected Areas / Regional Activity Centre

Post: B.P. 337, 1080 Tunis cedex, Tunisia
Tel.: (+216) 71 783034
Fax: (+216) 71 797349
E-mail: car-asp@rac-spa.org.tn

**Mr. Laubier, Lucien**

Université de la Méditerranée (Aix Marseille II)
UMS2196 Centre d'Océanologie de Marseille (COM)

Post: Station Marine d'Endoume, Marseille, France
Tel.: (+33) 491041601
E-mail: laubier@com.univ-mrs.fr

**Ms. Rautalahti-Miettinen, Elina**

Coordinator, Northern Hemisphere
Global International Waters Assessment (GIWA)
UNEP/GIWA Coordination Office

Post: University of Kalmar, 39182 Kalmar, Sweden
Tel.: (+90) 324 5213434
Fax: (+90) 324 5212327
E-mail: Elina.Rautalahti@giwa.net

**Mr. Romana, Louis Axel**

Centre IFREMER de Toulon-La-Seyne
Département Polluants Chimiques

Post: B.P. 330
83507 La Seyne sur Mer
France

Tel.: (+33) 4 94304902

Fax: (+33) 4 94065529

E-mail: Axel.Romana@ifremer.fr

**Mr. Uslu, Orhan**

Department of Environmental Engineering
Faculty of Engineering
Dokuz Eylul University

Post: Kaynaklar Kampusu
Buca 35160
Izmir
Turkey

Fax: (+90) 2324 534279

E-mail: orhan.uslu@deu.edu.tr

**Mr. Scoullos, Michael**

President, MIO/ECSDE
Mediterranean Information Office
for the Environment, Culture
and Sustainable Development

Post: 28 Tripodon Street
10558 Athens
Greece

Tel.: (+30) 210 3247267

Fax: (+30) 210 3225240

E-mail: mio-ee-env@ath.forthnet.gr

**Mr. Skourtos, Michalis S.**

Department of Environmental Studies
University of Aegean

Post: Alkaiou 1
81100 Mytilini
Greece

Tel.: (+30) 251 36252, 36271, 36222

Fax: (+30) 251 36252

E-mail: mskour@env.aegean.gr

**Mr. Trumbic, Ivica**

Director, PAP/RAC
Priority Actions Programme /
Regional Activity Centre

Post: Kraj Sv. Ivana 11
21000 Split
Croatia

Tel.: (+385) 21 343499

Fax: (+385) 21 591171

E-mail: ivica.trumbic@ppa.tel.hr

# Annex II

# Threatened Species in the Mediterranean



***Ecology, Distribution, Status, Threats and Current Protection***

| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Magnoliophyta** | | | |
| *Posidonia oceanica* | *Posidonia* meadow is a pole of biodiversity for the Mediterranean; it also plays an important role in controlling sedimentary flows (stability of the coastline). Endemic to the Mediterranean, present along most of the coastline (except for Israel). | Deeply in regression, pollution, lowering of water transparency, mooring of boats, trawling, explosives illgally used for fishing. At a human time scale, the destruction of *Posidonia oceanica* meadows is irreversible. | Protected by law in several Mediterranean countries. Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Zostera marina* | Rare and very localized in the Mediterranean. It plays an important role in some Mediterranean coastal lagoons. | It regressed considerably in the Atlantic and in the Mediterranean. Disappeared from sites where it was abundant. | Protected by law in Catalonia (Spain) and in Côte d'Azur (France). Listed in Appendix I to the Bern Convention (Mediterranean only). |
| *Zostera noltii* | It plays an important ecological role in some Mediterranean lagoons. Rare and very localized in the Mediterranean, where it is found mainly in coastal lagoons. | Its rarity and localization makes it vulnerable to habitat loss or degradation. | Protected by law in France and Spain. |
| **Chlorophyta** | | | |
| *Caulerpa ollivieri* | Endemic to the Mediterranean (France, Lybia, Spain, Turkey). | Sites are extremely isolated, usually of less than one hectare. Two of the three French sites have indeed already disappeared. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| **Phaeophyta** | | | |
| *Cystoseira amentacea* | Infralittoral Endemic to the Mediterranean. Species with three varieties: *amentacea* (eastern Mediterranean), *spicata* (Adriatic) and *stricta* (western Mediterranean). | Highly sensitive to pollution, the species has receded considerably close to all large urban areas. It is appreciated by several micro-herbivores, making it liable to overgrazing. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Cystoseira mediterranea* | Infralittoral Endemic to the Mediterranean. Species replacing *Cystoseira amentacea* (phenomenon of vicariousness) in certain regions of the western Mediterranean. | Status and threats are the same as for *Cystoseira amentacea*; however *Cystoseira mediterranea* is rarer and more localized than *Cystoseira amentacea*. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
| --- | --- | --- | --- |
| **Phaeophyta** | | | |
| *Cystoseira sedoides* | Distribution restricted to the coasts of Algeria (from around Algiers to El Kala), Tunisia and the extreme south of Italy (island of Pantelleria). | Its limited area of distribution and the rarity of sites make *Cystoseira sedoides* a threatened species. Probably sensitive to pollution and overgrazing. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Cystoseira spinosa* | Endemic to the Mediterranean, with a subspecies in the Adriatic, *Cystoseira spinosa adriatica*. | The species seems to have formed until the sixties large forests, which have now disappeared almost everywhere, leaving at best, isolated individuals. Suggested causes for the rarification of *Cystoseira spinosa* include pollution, uprooting by nets and trawlers and also overgrazing by sea urchins. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Cystoseira zosteroides* | Found in deep water at the bottom of the infralittoral level and mainly in the circalittoral level (down to depths of 100 m) on hard substrates, mainly in sectors with unidirectional currents. Endemic to the Mediterranean. | The species has become rare in many sites where it was once abundant. Threats: increase in water turbidity, increase in sedimentation and overgrazing by sea urchin. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Laminaria rodriguezii* | Lives at great depths (60 to 150 m) and requires cold and very clear water, swept by seabed currents. Endemic to the western Mediterranean. Highly localized sites. | The threat is the reduction of water transparency, resulting from eutrophization and / or increased turbidity. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| **Rhodophyta** | | | |
| *Goniolithon byssoides* | Endemic to the Mediterranean. Highly localized sites (Corsica, Sicily, Algeria, Adriatic). | Rare species, its cushions are vulnerable to trampling (fishermen on foot, sea bathing) and to pollution (hydrocarbon film on the surface of the sea). | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Lithophyllum lichenoides* | In a few sites, it builds up small mounds (better known as “pavements”), up to 2 m wide, in formations unique to the Mediterranean. | Threats mainly concern the mounds through surface pollution (hydrocarbons?) and trampling. The building up of a mound takes about a thousand years; its destruction is therefore irreversible at a human level. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Ptilophora mediterranea* | Endemic to a limited area of the Mediterranean (between mainland Greece and Crete). | The threat is mainly from reduction of water transparency, either from eutrophization and / or turbidity. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Schimmelmannia schousboei* | Algae of a rare beauty. Species with highly localized sites (Southern Italy and Libya). | The very rare sites of *Schimmelmannia schousboei* are susceptible of destruction by coastal development. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Porifera** | | | |
| *Asbestopluma hypogea* | Small *Cladorhizidae* sponge species able to catch and feed on small preys (*Crustacea*). Known only in one underwater cave (France). | Since it constitutes a zoological curiosity (carnivorous sponge), it may be feared that its single site may be visited by divers who may involuntarily cause damage or gather it to try and raise it in aquaria or as a curiosity. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Aplysina cavernicola* | Endemic to the Mediterranean. Reports especially from the Marseille region (France), from Cap Corse and from the North Adriatic. | Relatively rare species. It is dependent on special biotope (underwater caves). | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Axinella cannabina* | Beautiful large ramified sponge, yellow in colour. Lives between the sea level and 50 m depth, mainly on muddy bottoms at the circalittoral level. Endemic to the Mediterranean lives mainly in the southern Mediterranean. | As for the other *Axinella* species, the growth is very slow making the species unsustainable on bottoms where trawling is regular. | — |
| *Axinella polypoides* | Large ramified sponge, living on rocky bottoms between 30 and 100 m depth. Its distribution range include the Mediterranean and the Atlantic (Senegal and Mauritania). | Relatively rare. Susceptible of being collected by scuba-divers for decoration purposes. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Geodia cydonium* | Lives on sandy and muddy bottoms, in particular coarse sand bottoms, between 20 and 25 m depth. | Its slow growth makes the species vulnerable to trawling. | — |
| *Ircinia foetida* | Large massive sponge, reaching 50—80 cm in diameter. Living in deep waters, below 45—50 m. Present in the Mediterranean and the near Atlantic. | — | — |
| *Ircinia pipette* | Encrusting species living is semi-dark caves. Endemic to the Mediterranean. | Rare species. | — |
| *Petrobiona massiliana* | It is a living fossil. Lives in dark zones of underground caves, between the surface and a depth of 30 m. Endemic to the Mediterranean, known in some sites the Western Basin and in the Adriatic. | The species is rare and is only known in a limited number of underwater caverns. The increasing frequentation of these caverns by underwater divers and the fact that it is a zoological curiosity are additional threats. | Listed in Appendix I to the Bern Convention (limited to the Mediterranean). |
| *Tethya sp. plur.* | Small round species, mainly living in sciaphilous infralittoral biotopes. | Rare species. | — |
| **Cnidaria** | | | |
| *Astroides calycularis* | Spectacular species due to its bright orange colour, living in sciaphilous biotopes between 2 and 70 m depth. Its distribution in the Mediterranean is restricted to the southern part of the western basin. | The Mediterranean range of the species is reducing. Its aesthetic value makes it susceptible of being collected by scuba-divers for decorative purposes. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
| --- | --- | --- | --- |
| **Cnidaria** | | | |
| *Errina aspera* | Nearly endemic to the Mediterranean. Only two sites are known, the Straits of Gibraltar and their environs (Atlantic coast) and the Straits of Messina (Italy). | Rare species, the threat comes from the very limited area of distribution. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Gerardia savaglia* | Lives on secondary hard substrates, often the dead trunk of another gorgon, towards depths of (25) 40—50 m. Mediterranean and near Atlantic. | Sometimes caught up and brought up to the surface in fishing nets. Also harvested by divers for decoration. The species has probably never been very abundant, but today it seems to be increasingly rare. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| **Echinodermata** | | | |
| *Asterina pancerii* | Small starfish dependent on deep *Posidonia oceanica* meadows. Endemic to the Mediterranean. Reported from France, Italy, Greece, Libya and Spain. | It now seems to be in decline. The threat comes from trawling in *Posidonia oceanica* meadows. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Centrostephanus longispinus* | Very rare in the northwestern Mediterranean, a little more common in the eastern Mediterranean. | Rare species, the threat is from collection by divers for decoration. | Protected in France (1992). Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Ophidiaster ophidianus* | Known in the southwestern Mediterranean (from Morocco to Sicily and to the southern Italian mainland) and in the Adriatic, is rarer in the northwestern and eastern Mediterranean. | Rare species, the threat comes from its collection by divers. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| **Bryozoa** | | | |
| *Hornera lichenoides* | Colony-forming species on muddy coastal sites. Found in Northern Atlantic and in North-Western Mediterranean. | Colonies are susceptible to be damaged by trawling. | — |
| **Mollusca** | | | |
| *Charonia lampas lampas* | It is the largest gastropod from the Mediterranean sea and reaches up to 30 cm in length. It feeds mainly upon large echinoderms. | The shell is very appreciated in decoration; trawling and decoration are the main origin of threat. Its populations have been strongly diminished over the last years; the species almost disappeared in some polluted coastal zones of the NW Mediterranean and Tyrrhenian sea. | The species is included in "Livre rouge des espèces menacées en France. Tome 2" (Beaufort & Lacaze, 1987). Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Charonia tritonis variegata* | *Gasteropoda* species, which was recorded exclusively in the eastern basin (Russo et al., 1990). According to these authors, the sill between Sicily and Tunisia is the only geographical area where the distribution of both Mediterranean species of triton may overlap. | The isolated populations of the eastern basin of the Mediterranean may be consider as vulnerable and will probably soon move into the "endangered" category. Decoration and collection are the main origin of threat. | The nominal subspecies, *Charonia tritonis tritonis* is included in the IUCN invertebrate red data book. Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Mollusca** | | | |
| *Dendropoma petraeum* | Endemic species of the Mediterranean, where it is only present in the warmest areas (north Africa, eastern Mediterranean, southeast Spain, Sicily and Malta). The bioconstructions built by this *Gasteropoda* species are very important from different points of view: they can be considered as modulators of geomorphological processes in the coast line, as indicator of the recent sea level changes, as biological engineers that creates new habitats on the narrow intertidal fringe. | The main threat are the surface pollution, trampling and the development of the littoral. The destruction of these biogenic constructions is irreversible on a human scale. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Erosaria spurca* | In the Mediterranean its number has been strongly diminished during the last decade. | The species of this family are among the most appreciated by shell collectors all over the world. Collection is the main origin of threat. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Gibbula nivosa* | Endemic species of Malta. Lives in shallow water (0—10 m), in bottoms with algae or marine *phanerogames* (*Cymodocea nodosa* and *Posidonia oceanica*). It presents nocturnal habits. | Due its very restricted geographical range, *Gibbula nivosa* must be considered as vulnerable, becoming endangered by the human pressure (development of the littoral) over the few bays where it is present. Another origin of threat are the shell collectors. | This species is protected by law in Malta. Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Lithophaga lithophaga* | Rock-boring bivalve drilling tunnels in *calcareus substrata* where it lives. Because its peculiar mode of life, its capture implies the destruction of the entire habitat. The species ranges from Portugal to Morocco, in western Atlantic and the entire Mediterranean. | It is becoming rare in many areas because of its high market value. The harvesting of this species is highly destructive, by using underwater pneumatic drills (and explosives in some places), causing considerable damage to the infra-littoral hard *substrata biocenosis* as a whole. | Protected by law in Italy and France. Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Luria lurida* | This species ranges throughout Mediterranean and west African coast. It lives mainly in shallow water (0—20 m) and more rarely deeper. | Its populations are under a pressure by shell collectors. Its populations have been strongly diminished during the last decade. It may be considered vulnerable. Collection is the origin of threat. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Mitra zonata* | It lives semi-buried in detritic bottoms mixed with sand and mud between 10 and 60 m. It ranges from the western Mediterranean to west African coast. It has been recently recorded from Algarve (south of Portugal), Azores and Madeira. In the Mediterranean it is most common in the Adriatic sea. It has been also found in Sicily, Sardinia, Tyrrhenian and Alboran sea. Some isolated records exist from France. It has not been recorded in the eastern basin. | This species is rare in its whole area of distribution and it must be considered as vulnerable. The main origin of threat are collection and trawling. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Mollusca** | | | |
| *Patella ferruginea* | At the present times *Patella ferruginea* is limited to some areas of the south-western part of the Mediterranean. Its most viable populations are located in some areas of north African coast, from Morocco to Tunisia. Relict populations are present in Corse, Sardinia and south Spain. It lives in the upper mid-littoral fringe over vertical rocky surfaces. | It is the Mediterranean species most seriously threatened with rapid disappearance. Its numbers have fallen drastically in a few years, at least in some places such as Corse, Sardinia and southern Spain. Its reproductive potential and dispersal abilities are very low. It is possible that its numbers are below the critical threshold in some areas. The main threats are the human consumption and its use as bait for amateur fishing, but also the littoral development. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Patella nigra* | It is basically a west African species that reaches the Alboran sea as the northern limits of its area of distribution. It is common in the upper sublittoral level (0—5 m in depth) of rocky shores from Morocco south to Angola. The only European populations are located in south Spain (coasts of Cadiz and Malaga). | No evidence of danger exists, considering the whole area of distribution and the Mediterranean populations seem to be stable up to date. The need to protect it is related to its resemblance to *Patella ferruginea*, which would make it illusory to protect only one of the two species. Populations of both species overlap in the Mediterranean. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Pholas dactylus* | It is a burrowing species, boring into compacted sand and mud, limestone and schists, from the mid-littoral down to a few meters deep. It ranges from the British Isles south to Morocco and the entire Mediterranean, including Black Sea. | In the Mediterranean it is a common species in some places, but becoming scarce and vulnerable in most part of its area of distribution, due to the increase of exploitation for human consumption. Its harvesting causes a considerable damage, because implies the destruction of the entire habitat. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Pinna nobilis* | Endemic species from the Mediterranean, where is widespread all around. It is the largest *Mollusc* species of the Mediterranean and one of the largest of the world. Reaches up to 80 cm in length. | Its populations have been continuously decimated during the last decades along with the decline of *Posidonia oceanica* meadows and with the development of the littoral. It is highly appreciated as souvenir by tourists and has been overfished by local people and divers. The breakage by boat anchors and trawling is another origin of threat. *Pinna nobilis* have disappeared in wide areas, but is still common in a few unaltered zones. | Fan shell is protected by law in Croatia and France. Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Mollusca** | | | |
| *Pinna rudis* | In the Mediterranean it is only present in the warmest area of the western basin. It lives mainly in fissures and crevices of rocky substrates, between 5 and 30 m deep. | Rare and vulnerable in the Mediterranean. *Pinna rudis* is very appreciated by shell collectors. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean) (as *Pinna pernula*). |
| *Ranella olearia* | In the Mediterranean it is common in the Alboran sea and scarce in other areas. | Very appreciated by shell collectors. The main threats are trawling, collection and decoration. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Schilderia achatidea* | In the Mediterranean it is mainly restricted to the Alboran sea. Some isolated records exist in other areas of the western Mediterranean. It lives in detritic bottoms with mud (from 50 to 100 m deep). | Its restricted area of distribution in the Mediterranean and its high value for shell collectors make it a very vulnerable species. Collection, decoration and trawling are the main threats. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Tonna galea* | In the Mediterranean it is only relatively frequent in the Adriatic and Maltese and Greek coasts. It can be found semi-buried in sandy or muddy bottoms between 20 and 80 m. | Becoming rare because this shell is very appreciated for decorative purposes. Therefore, decoration and trawling are the main threats. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Zonaria pyrum* | In the Mediterranean it is more frequent in southern Greek islands and in some localities from north Africa. | The species is very rare and has to be considered as vulnerable. The shell collectors constitute the main threat. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| **Crustacea** | | | |
| *Ocypode cursor* | Lives on sandy beaches in the eastern part of the Mediterranean. Known as predator of newly hatched sea turtles. | Threats come from the use of its habitat by tourists. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Pachylasma giganteum* | Small species living on hard substrate in relatively deep sites. Endemic to the Mediterranean. Species known in Sicily (Straits of Messina, Italy). | Rare species, the threat being related to its restricted range. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| **Pisces** | | | |
| *Acipenser naccarii* | Known in Adriatic. Lives on sandy and muddy bottom not exceeding a depth of 40 m. Heads upriver in spring to spawn and returns to the sea after laying. | Rare species with restricted range. | — |
| *Acipenser sturio* | Present in the Black Sea and along the northern coasts of the Mediterranean. | The species has become rare in the Mediterranean, main threats being fisheries and habitat degradation. | Its exploitation is forbidden in some countries. Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Aphanius fasciatus* | Small species living mainly in coastal lagoons of the eastern Mediterranean and the eastern part of the western basin (Corsica, Sardinia, mainland Italy, Eastern Algeria, Tunisia). | The species is rare, the main threat being the degradation of its habitat. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Pisces** | | | |
| *Aphanius iberus* | Endemic to the Mediterranean: south and southwest of Spain and west of Algeria. Lives in fresh and brackish waters and feed on small invertebrates. | The threat comes from its rarity, its extremely restricted geographical area and the reduction of its habitat. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Carcharodon carcharias* | Present throughout the basin, including the Adriatic and Aegean Seas. | Rare throughout the region. It has been incidentally caught in semi-industrial fisheries.<br>IUCN status is: vulnerable Ia Ibcd+2cd. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Cetorhinus maximus* | Reported from the entire Mediterranean except for the waters adjacent to Libya, Egypt and the Levantine basin. | There are presently no directed fisheries for this species in the Mediterranean, although it was occasionally captured in the past, particularly off southern France.<br>Accidental captures are reported in pelagic driftnets and longlines as well as in bottom gillnets and purse seines.<br>IUCN status is: vulnerable Ia Iad+ 2d. | — |
| *Hippocampus hippocampus* | Lives at the infracoastal level in alga populations on hard substrates and in marine *Magnoliophyte* meadows. | The species has probably never been very common but has now become genuinely rare. Its similarity with *Hippocampus ramulosus* makes it necessary to associate them in the protection. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Hippocampus ramulosus* | Lives at the infracoastal level, in rock alga populations and especially in *Posidonia oceanica* meadows; can penetrate coastal lagoons. | Once very common, it has become less so and in places rare, especially in the northwestern Mediterranean.<br>The threat comes from the regression of its biotope and trawling in meadows. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Huso huso* | Lives in the sea at depths between 70 and 180m, penetrates fresh water (rivers) to reproduce.<br>Lives mainly in the Black Sea and the Caspian Sea.<br>Rare in the Mediterranean, where it is known for the Aegean and Adriatic seas. | Vulnerable because of its rarity. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Lethenteron zanandreai* | Fresh water lamprey species endemic to Po basin. | Rare and vulnerable. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Mobula mobular* | Found in pelagic waters throughout the Mediterranean, including the Aegean Sea and the eastern basin.<br>Rare in the Adriatic. | High mortality rates are reported from accidental catches in pelagic driftnets. It is also accidentally captured in longlines, purse seines and trawls. | — |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Pisces** | | | |
| *Pomatoschistus canestrini* | Small species living in fresh and brackish waters. Reported in Dalmatia (Croatia) and in the Venice lagoon (Italy). | Rare and vulnerable. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Pomatoschistus tortonesei* | Small species living in brackish lagoons in shallow water. Present in Sicily (Marsala) and in the extreme west of Libya (Farwah). | Rare and very localized species. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| *Valencia hispanica* | Lives in fresh and brackish waters. Endemic to eastern part of Spain and French Catalonia. | Rare species with very restricted range. | — |
| **Reptiles** | | | |
| *Caretta caretta* | Found throughout the Mediterranean, nesting reported on sandy beaches along the coast of the eastern basin. | Mediterranean population is diminishing. Main threats are incidental catches in fishing gears and loss of nesting sites. | Protected in several Mediterranean countries. Listed in Appendix II to the Bern Convention, Appendices II and IV of the Habitat Directive, on the list of protected species (class A) of the Algiers Convention, in Appendix I of the Washington Convention and in Appendix II of the Bonn Convention. |
| *Chelonia mydas* | In the Mediterranean it occurs mainly in the eastern part. Nesting in a limited number of sites mainly in Cyprus and Turkey. Genetic studies found evidence of the isolation of the Mediterranean population from a reproductive point of view (deme). | The main threat to the Mediterranean population comes from the loss of nesting sites due to development of the coastal area. Catches in fisheries, either incidental or deliberate and pollution are additional threats. | Protected in several Mediterranean countries. Listed in Appendix II to the Bern Convention, Appendix IV of the Habitat Directive, on the list of protected species (class A) of the Algiers Convention, in Appendix I of the Washington Convention and in Appendix I and II of the Bonn Convention. |
| *Dermochelys coriacea* | Large species, regularly occurring although rare in the Mediterranean. Its nesting in the Mediterranean is questionable. | Catches in fishing gears are reported. | Protected in several Mediterranean countries. Concerning international treaties, same as *Chelonia mydas*. |
| *Eretmochelys imbricata* | Occurring only occasionally in the Mediterranean. | Catches in fishing gears are reported. | Protected in a few Mediterranean countries. Concerning international treaties, same as *Chelonia mydas*. |
| *Lepidochelys kempii* | Its occurrence in the Mediterranean is exceptional. | Catches in fishing gears are reported. | Protected in a few Mediterranean countries. Concerning international treaties, same as *Chelonia mydas*. |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Reptiles** | | | |
| *Trionyx triunguis* | Lives in Nile basin and coastal hydrographic networks of the eastern Mediterranean (from Israel to Turkey). *Trionyx triunguis* is essentially a freshwater turtle, but it also frequents coastal saltwater lagoons and even seems to use the sea environment for its dispersion from one estuary to another. | The species has died out in Egypt. It is on the edge of extinction in Israel and Syria. Main threats are (i) habitat loss or degradation due to human development, (ii) pollution, (iii) incidental catches, (iv) deliberate killing by fishermen, (v) collisions with boats. | Listed in Appendix II to the Bern Convention (limited to the Mediterranean). |
| **Mammalia** | | | |
| *Balaenoptera acutorostrata* | Very rare in the western Mediterranean, where the species is an occasional visitor from the North Atlantic. Specimens were sighted or stranded off Spain, France (continental and Corsica), Italy (Ligurian and Tyrrhenian coasts, Sicilian Channel), Algeria and Tunisia. | There have been some cases of accidental capture in driftnets in the Mediterranean. IUCN status: Lower risk: near threatened. | The species is listed in Appendix III of the Bern Convention, in Appendix I and Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Balaenoptera borealis* | Extremely rare in the Mediterranean, where this species is vagrant from the North Atlantic. | No viable population of this species exists in the Mediterranean. IUCN status: Endangered / A1abd. | The species is listed in Appendix III of the Bern Convention, in Appendices I and II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Balaenoptera physalus* | The second largest *cetacean*, reaching 27 m (southern hemisphere) and 75 t. In the Mediterranean, reliable length measurements are considerably smaller (< 22 m) Abundant in the western and central (Ionian Sea) Mediterranean, rare in the eastern region. | Recent genetic evidence supports the hypothesis that fin whales in the Mediterranean are a resident population, reproductively isolated from the Atlantic. IUCN status: Endangered / A1abd. | The species is listed in Appendix II of the Bern Convention, in Appendices I and II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Delphinus delphis* | Once common everywhere in the Mediterranean, it is now rare throughout the region except than in the Alboran Sea and in the coastal waters of western Greece (Ionian Sea). Small communities may also persist in yet unexplored areas of the eastern and southern portions of the Mediterranean. | The causes of this species' sharp decline in the region are unknown. The Mediterranean population(s) should be considered endangered and is regarded as a conservation priority by the IUCN 1996–1998 Action Plan for the Conservation of *Cetaceans*. Common dolphins are accidentally caught in fishing gear and their tissue contaminant levels are often very high. | The species is listed in Appendix II of the Bern Convention, in Appendix II (limited to western Mediterranean, North and Baltic Seas, Black Sea and eastern tropical Pacific populations) of the Bonn Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Eubalaena glacialis* | The species is exceptional in the Mediterranean, certainly reflecting its status of near extinction in the eastern North Atlantic. | There is no viable northern right whale population in the Mediterranean. The northern right whale is the most endangered of the large whale species. IUCN status is: Endangered / C1, D1. | The species is listed in Appendix II of the Bern Convention, in Appendix I of the Bonn Convention, in Appendices I and II of the Washington Convention and in Annex IV of the EU Habitats Directive. |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Mammalia** | | | |
| *Globicephala melas* | Common in the region of Gibraltar and in the deepest portions of the Alboran Sea, Balearic waters and waters west of Sardinia, pilot whales become rare in the Tyrrhenian Sea and are virtually absent from the Adriatic Sea and the eastern basin. | Pilot whales are known to occur in pelagic driftnet bycatch even in mass captures. Some individuals have been affected by hydrocarbon spills. | The species is listed in Appendix II of the Bern Convention, in Appendix II (limited to North and Baltic Seas populations) of the Bonn Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Grampus griseus* | A common Mediterranean *odontocete*, particularly frequent in waters over steep continental slopes throughout the basin. | There have been some instances of accidental capture in fishing and some individuals have been affected by hydrocarbon spills. IUCN status is: Data deficient. | The species is listed in Appendix II of the Bern Convention, in Appendix II (limited to North and Baltic Seas populations) of the Bonn Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Kogia simus* | Its known occurrence in the Mediterranean is limited to the stranding of one specimen in central Italy. | No viable population in the Mediterranean. | The species is listed in Appendix III of the Bern Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Megaptera novaeangliae* | Extremely rare in the Mediterranean (limited to the northwestern basin). | No viable population of humpback whales in the Mediterranean, where the specimens observed were certainly vagrants from a now very reduced eastern North Atlantic population. IUCN status is: vulnerable / A1ad. | The species is listed in Appendix II of the Bern Convention, in Appendix I of the Bonn Convention, in Appendices I and II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Mesoplodon densirostris* | Only one certain occurrence of the species in the Mediterranean. | No viable population of Blainville's beaked whales in the Mediterranean. IUCN status is: Data deficient. | The species is listed in Appendix III of the Bern Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Monachus monachus* | The overall population, estimated to 300 to 500 specimens, is divided in a few scattered groups mainly located along the coasts of Greece, Turkey and, to a lesser extent, North Africa in the Mediterranean and in the Madeira archipelago and Cap blanc in the Atlantic. | The monk seal is today exceedingly rare in the Mediterranean and among its most endangered vertebrates. IUCN status is: Critically endangered / C2a. | The species is listed in Appendix II of the Bern Convention, in Appendices I and II of the Bonn Convention, in Appendices I and II of the Washington Convention and in Annex IV of the EU Habitats Directive. |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Mammalia** | | | |
| *Orcinus orca* | Uncommon in the Mediterranean, where it is considered an occasional visitor from the North Atlantic. | No viable population of killer whales in the Mediterranean. The species is known to have been accidentally captured in fishing gear. IUCN status is: Lower risk: conservation dependant. | Listed in Appendix II of the Bern Convention, in Appendix II (limited to eastern North Atlantic and eastern North Pacific populations) of the Bonn Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Phocoena phocoena* | Despite its regular occurrence in the Black Sea (*Phocoena phocoena relicta*) and in the eastern North Atlantic (*Phocoena phocoena phocoena*), this species is virtually absent from the Mediterranean. | The presence of the harbour porpoise in the Mediterranean is highly questionable. IUCN status is: Vulnerable / A1cd. | The species is listed in Appendix II of the Bern Convention, in Appendix II (limited to North and Baltic Seas, western North Atlantic and Black Sea populations) of the Bonn Convention, in Appendix II of the Washington Convention and in Annexes II and IV of the EU Habitats Directive. |
| *Physeter macrocephalus* | Found throughout the Mediterranean in deep waters, particularly where the continental shelves slope is steepest. Although the species appears to be more frequent in the western basin and in the Ionian Sea, it is present in the eastern basin as well. | Considered common in the Mediterranean in the older literature, sperm whales are currently infrequent. | The species is listed in Appendix III of the Bern Convention, in Appendices I and II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Pseudorca crassidens* | Quite rare in the Mediterranean, as a vagrant from the North Atlantic. | No viable population in the Mediterranean. | The species is listed in Appendix II of the Bern Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Stenella coeruleoalba* | Today the commonest pelagic *cetacean* in the Mediterranean, the striped dolphin is found throughout the region in deep waters. | High mortality rates are reported for this species from accidental takes in driftnets, considered unsustainable. Mediterranean striped dolphins were affected by a severe outbreak of *morbillivirus epizootic* in 1990—91, possibly linked to high levels of contamination by PCBs and other organochlorine compounds. IUCN status is: Lower risk: conservation dependant. | Listed in Appendix II of the Bern Convention, in Appendix II (limited to western Mediterranean and eastern tropical Pacific populations) of the Bonn Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |

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| Species | Ecology / Distribution | Status / Threats | Protection |
|---|---|---|---|
| **Mammalia** | | | |
| *Steno bredanensis* | Rare in the Mediterranean Sea, where it is considered a vagrant from the North Atlantic. | No viable population in the Mediterranean. IUCN status is: Data deficient. | The species is listed in Appendix II of the Bern Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |
| *Tursiops truncatus* | The commonest coastal marine mammal in the Mediterranean. | This species' coastal habits expose it to extremely high levels of contamination from organochlorine compounds and trace elements (Anon., 1992) and make bottlenose dolphins particularly vulnerable to human encroachment on the coastal environment. IUCN status is: Data deficient. | The species is listed in Appendix II of the Bern Convention, in Appendix II (limited to western Mediterranean, Black Sea and North and Baltic Seas) of the Bonn Convention, in Appendix II of the Washington Convention and in Annexes II and IV of the EU Habitats Directive. |
| *Ziphius cavirostris* | Found throughout the Mediterranean Sea, in deep pelagic waters, particularly where the continental slope is steepest. | Known to occur in the driftnet bycatch. Contaminant levels in their tissues appear to be relatively low. IUCN status is: Data deficient. | The species is listed in Appendix II of the Bern Convention, in Appendix II of the Washington Convention and in Annex IV of the EU Habitats Directive. |

# Annex III

## List of Regional Pollution Hot Spots

with Potential Risk of Transboundary Effect

### *Albania*

| Pollution Hot Spot | Type |
|---|---|
| Durres | Domestic waste |
| Durres | Industrial waste |
| Vlore | Industrial solid waste |

### *Algeria*

| Pollution Hot Spot | Type |
|---|---|
| Alger | Urban and industrial waste |
| Annaba | Urban and industrial waste |
| Oran | Urban and industrial waste |
| Skikda | Urban and industrial waste |
| Bejaia | Urban and industrial waste |
| Mostaganem | Urban and industrial waste |
| Ghazaouet | Urban and industrial waste |

### *Bosnia & Herzegovina*

| Pollution Hot Spot | Type |
|---|---|
| City of Konjic | Domestic, industrial and solid waste |
| City of Mostar | Domestic and industrial waste |
| Alumina factory, Mostar | Industrial waste |
| City of Bileca | Domestic and industrial waste |
| City of Neum | Domestic waste |

### *Croatia*

| Pollution Hot Spot | Type |
|---|---|
| Rijeka | Domestic and industrial waste |
| Kastela Bay | Domestic and industrial waste |
| Dubrovnik | Domestic waste |
| Split | Industrial and domestic waste |
| Sibenik | Domestic and industrial waste |
| Pula | Domestic and industrial waste |
| Oil Refineries, Mlaka and Urinj | Industrial waste |
| Neretva River | Domestic and industrial waste |
| Ston | Domestic and industrial waste |
| Zadar | Industrial and domestic waste |

### Cyprus

| Pollution Hot Spot | Type |
|---|---|
| ETKO | Winery and Distillery |
| SODAP | Domestic waste |
| LOEL | Domestic waste |
| KEO | Domestic waste |
| KEO B | Brewery |
| Dhekelia Desalination Plant | Brine |

### Egypt

| Pollution Hot Spot | Type |
|---|---|
| Lake Manzala | Domestic and industrial waste |
| El-Mex Bay | Domestic and industrial waste |
| Alexandria | Domestic waste |
| Abu Qir Bay | Industrial waste |
| Port Said | Domestic and industrial waste |

### Greece

| Pollution Hot Spot | Type |
|---|---|
| Thermaikos gulf | Municipal and industrial waste |
| Inner Saronic gulf | Municipal and industrial waste |
| Patraikos gulf | Municipal and industrial waste |
| Pagasitikos gulf | Municipal and industrial waste |
| Gulf of Heraklion | Municipal and industrial waste |
| Elefsis bay | Municipal and industrial waste |
| North-Western Saronic gulf | Municipal and industrial waste |
| Nea Karvali bay | Industrial waste |

### Israel

| Pollution Hot Spot | Type |
|---|---|
| Haifa Bay | Mixed (industrial discharges; river discharges) |
| Shafdan (Tel-Aviv region), Yalmachim outfall | Activated sludge from sewage treatment plant discharged 5 km out at sea |
| Akko | Municipal discharge |
| Nahariya | Municipal discharge |
| Ashdod | Industrial discharge |
| Naaman | Municipal discharge |

### *Italy*

| Pollution Hot Spot | Type |
|---|---|
| Genova | Port, mixed |
| La Spezia | Port, mixed |
| Livorno | Port, industry |
| Rosignano Solvay | Cl-NaOH, ethelene |
| Golfo di Napoli | Port, refinery, domestic waste |
| Milazzo | Port, refinery, domestic waste |
| Gela | Port, refinery, domestic waste |
| Augusta-Melilli | Port, refinery, domestic waste |
| Taranto | Port, refinery, domestic waste |
| Brindisi | Port, refinery, domestic waste |
| Bari-Berletta | Domestic waste |
| Manfredonia | Port, industry, domestic waste |
| Ancona-Falc. | Port, refinery |
| Ravenna | Port, refinery |
| Porto Marghera (VE) | Port, industry, domestic waste |

### *Lebanon*

| Pollution Hot Spot | Type |
|---|---|
| Greater Beirut | Municipal, industrial and agricultural waste |
| Saida (Sidon) Gazieh | Municipal, industrial and agricultural waste |
| Tripoli | Municipal and agricultural waste |
| Jbail (Byblos) | Municipal and agricultural waste |
| Sour (Tyr) | Municipal and agricultural waste |
| Batroun-Selaata | Municipal, industrial and agricultural waste |

### *Libya*

| Pollution Hot Spot | Type |
|---|---|
| Abo-Kammash | Chemical waste |
| Zawia City | Municipal and industrial waste |
| Janzour City | Municipal and industrial waste |
| Tripoli City | Municipal waste |
| Misratah City | Municipal and industrial waste |
| Ras-Lanouf | Petroleum fertilizer |
| Benghazi | Municipal waste |
| Tobruk | Municipal waste |

### *Malta*

| Pollution Hot Spot | Type |
|---|---|
| Wied Ghammieq | Mixed |
| Cumnija | Mixed |
| Ras il-Hobz | Mixed |

### *Monaco*

| Pollution Hot Spot | Type |
|---|---|
| — | — |

### *Morocco*

| Pollution Hot Spot | Type |
|---|---|
| Tanger | Domestic and industrial waste |
| Tetouan | Domestic and industrial waste |
| Al Hoceima | Domestic and industrial waste |
| Nador | Domestic and industrial waste |

### *Slovenia*

| Pollution Hot Spot | Type |
|---|---|
| River Rizana | Domestic and industrial waste |
| Izola | Domestic and industrial waste |
| Piran | Domestic waste |
| Badasevica | Domestic and industrial waste |
| Dragonja | Domestic and agricultural waste |

### *Spain*

| Pollution Hot Spot | Type |
|---|---|
| Barcelona | Mixed |
| Tarragona | Mixed |
| Valencia | Mixed |
| Cartagena | Mixed |
| Algeciras | Mixed |

### *Syria*

| Pollution Hot Spot | Type |
|---|---|
| Banias | Municipal and industrial waste |
| Lattakia | Municipal and industrial waste |
| Tartous | Municipal and industrial waste |
| Jableh | Municipal and industrial waste |

### *Tunisia*

| Pollution Hot Spot | Type |
|---|---|
| Gabès | Domestic and industrial waste (fertilisers, phosphates) |
| Sfax Sud | Domestic and industrial waste (fertilisers, phosphates) |
| Lac Sud de Tunis | Domestic and industrial waste (oil, textiles) |
| Lac de Bizerte | Domestic and industrial waste (metal-working, oil, cement) |

### *Turkey*

| Pollution Hot Spot | Type |
|---|---|
| Mersin | Mixed |
| Erdemli | Mixed |
| Silifke | Domestic waste |
| Tarsus | Domestic waste |
| Antalya | Domestic waste |
| Alanya | Domestic waste |
| Side | Domestic waste |
| Manavgat | Domestic waste |
| Adana | Mixed |
| Ceyhan | Domestic waste |
| Antakya | Domestic waste |
| Iskenderun | Domestic waste |
| Dortyol | Domestic waste |
| Kirikhan | Domestic waste |
| Bodrum | Domestic waste |
| Marmaris | Domestic waste |
| Datca | Domestic waste |
| Foca | Domestic waste |
| Cesme-Alacati | Domestic waste |

# Annex IV

# List of Regional Pollution Sensitive Areas (2002)

The Table below exhibits the list of pollution sensitive area per Mediterranean country together with the type and the proposed actions to be considered to prevent the development of it into Hot Spot.

| Country | Revised Sensitive Areas | Origin of Pollution | Remedial Action |
|---|---|---|---|
| Albania | Kuna-Vain lagoons | Domestic, industrial | WWTP and construction of a sewerage system with establishment of proper management |
| | Karavasta lagoon | Domestic | Establishment of proper management with appropriate monitoring program |
| | Narta lagoon | Agriculture runoff, water extraction | Dredging of outlet channel and establishment of proper management with appropriate monitoring programme |
| Algeria | Gulf of Ghazaouet | Urban, industrial | WWTP: Construction<br>PTIW: Implementation |
| | Gulf of Arzew-Mostaganem | Urban, industrial | WWTP: Construction<br>PTIW: Implementation |
| | Bay of Algiers | Urban, industrial | WWTP: Construction<br>PTIW: Implementation |
| | Bay of Annaba | Urban, industrial | WWTP: Reorganization<br>PTIW: Implementation |
| | Gulf of Skikda | Urban, industrial | WWTP: Reorganization, Expansion<br>PTIW: Implementation |
| | Bay of Béjaia | Urban, industrial | WWTP: Construction<br>PTIW: Implementation |
| | Bay of Zemmouri | Urban, industrial | WWTP: Construction<br>PTIW: Implementation |
| Croatia | Krka estuary | Domestic, industrial | Needs action to improve status |
| | Malostonski Bay | Domestic, industrial | Require regular monitoring |
| | Limski channel | Industrial | Require regular monitoring |
| Cyprus | Liopetri and Ay. Napa bay | | Needs action to improve the environmental status |
| | Vassilikos bay | | Needs action to improve the environmental status |
| Egypt | Lake Bardaweel | | Monitoring |
| France | | | |
| Greece | Amvrakikos gulf | Municipal, agricultural | To be identified |
| | Lagoon of Mesologgi | Municipal | To be identified |
| Italy | Vado Ligure | | Action needed on the near power station |
| | Secche della Meloria | | Avoid damping of materials from harbour, increasing efficiency of WWTP in the area near by |
| | Pesaro Cervia | | Increasing efficiency of WWTP in the area near by; WWTP on the Po river basin to avoid high content of Nutrients and organic compound |
| | Venice and its lagoons | | Delocalization of Industrial District of Porto Marghera; Adequate WWTP for all areas; Soil remediation around Venice lagoon |
| | Grado, Marano, Torviscosa, etc. | | Soil Remediation of all area, Delocalization of Caffaro implant |
| | Naples Gulf | | WWTP for all area |

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| Country | Revised Sensitive Areas | Origin of Pollution | Remedial Action |
|---|---|---|---|
| Lebanon | Jbail (Byblos) | Municipal, agricultural | |
| | Sour (Tyr) | Municipal, agricultural | |
| Malta | Anchor Bay | Construction of Sewage Treatment Plant | Construction of Sewage Treatment Plant |
| | Marsamxett Harbour | Better monitoring and control of maritime-related activities | Better monitoring and control of maritime-related activities |
| | Marsaxlokk Bay | Better monitoring and control of maritime-related activities | Better monitoring and control of maritime-related activities |
| Morocco | Tanger bay | Municipal | To be identified |
| | Smir Bay | Municipal | To be identified |
| | Moulouya estuary | Municipal | To be identified |
| Slovenia | Koper Bay | | |
| | Piran Bay | | |
| Spain | Albufera de Valencia | | Control of agricultural development |
| | Mar Menor | | Control of discharges and tourism development |
| | Albufera de Mallorca | | Control of tourism and agricultural development |
| | Aiguamolls de l'Emporda | | Control of tourism development |
| | Delta del Llobregat | | Monitoring of urban and industrial development |
| | Lagunas de la Mata y Torrevieja | | Monitoring of tourism development |
| | Delta del Ebro | | Monitoring of land reclamation |
| | Cabo de Gata | | Regular monitoring |
| Syria | Umit Tiur | | Protection from urban development, prohibition of excavation of sand, designation as public beach |
| | Arwad island | | Management plan for organizing tourism activities, removal of illegal buildings |
| | Wadi Qandeel | | Rehabilitation plan, prohibition / control of illegal fishing, preservation of submarine life |
| | Lattakia beach (southeast) | | Characterization as specially protected area suitable for passive recreation only (bathing, sightseeing boat tours) |
| | Rasl Fassouri | | Management plan for tourism activities, restoration of surrounding environment |
| Tunisia | Ghar El Melh | Domestic, industrial (various) | (Network + WWTP) tertiary pretreatment |
| | Estuaire de Oued Miliane | Domestic | To be identified |
| | Canal de rejet Choutrana | Domestic | To be identified |
| Turkey | Adana, Seyhan River Mouth, Ceyhan River Mouth | Heavy pollution load discharged into the Mediterranean Sea | To be identified |
| | Izmir Bay, Bakirçay River Mouth, Gediz River Mouth, Küçük Menderes River Mouth | Heavy pollution load discharged into the Aegean Sea | To be identified |
| | Içel, Göksu River Mouth, Lamas River Mouth, Tarsus River Mouth | Heavy pollution load discharged into the Mediterranean Sea | To be identified |
| | Mersin-Kazanli | Marine pollution, coastal erosion and breeding dunes for *Chelonia mydas* and *Caretta caretta* | To be identified |
| | Hatay-Samandag | Transboundary marine pollution, especially solid waste, endangered species | To be identified |
| | Aydin, Büyük River Mouth, Mugla, Dalaman Stream Mouth | Heavy pollution load discharged into the Aegean Sea | |

# Annex V

# Status of Signatures and Ratifications to the Barcelona Convention and its Protocols (14.09.2004)

| | **BARCELONA CONVENTION**[1] | | | **DUMPING PROTOCOL**[2] | | | **EMERGENCY PROTOCOL**[3] | | **NEW EMERGENCY PROTOCOL**[4] | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Contracting Parties*** | **Signature** | **Ratification** | **Acceptance of Amendments** | **Signature** | **Ratification** | **Acceptance of Amendments** | **Signature** | **Ratification** | **Signature** | **Ratification** |
| **Albania** | – | 30.05.90 [AC] | 26.07.01 | – | 30.05.90 [AC] | 26.07.01 | – | 30.05.90 [AC] | – | – |
| **Algeria** | – | 16.02.81 [AC] | 09.06.04 | – | 16.03.81 [AC] | – | – | 16.03.81 [AC] | 25.01.02 | – |
| **Bosnia & Herzegovina** | – | 01.03.92 [SUC] | – | – | 01.03.92 [SUC] | – | – | 01.03.92 [SUC] | – | – |
| **Croatia** | – | 08.10.91 [SUC] | 03.05.99 | – | 08.10.91 [SUC] | 03.05.99 | – | 08.10.91 [SUC] | 25.01.02 | 01.10.03 |
| **Cyprus** | 16.02.76 | 19.11.79 | 15.10.01 | 16.02.76 | 19.11.79 | 18.07.03 | 16.02.76 | 19.11.79 | 25.01.02 | – |
| **European Community** | 13.09.76 | 16.03.78 [AP] | 12.11.99 | 13.09.76 | 16.03.78 [AP] | 12.11.99 | 13.09.76 | 12.08.81 [AP] | 25.01.02 | 25.06.04 |
| **Egypt** | 16.02.76 | 24.08.78 [AP] | 11.02.00 | 16.02.76 | 24.08.78 [AP] | 11.02.00 | 16.02.76 | 24.08.78 [AC] | – | – |
| **France** | 16.02.76 | 11.03.78 [AP] | 16.04.01 | 16.02.76 | 11.03.78 [AP] | 16.04.01 | 16.02.76 | 11.03.78 [AP] | 25.01.02 | 02.07.03 |
| **Greece** | 16.02.76 | 03.01.79 | 10.03.03 | 11.02.77 | 03.01.79 | – | 16.02.76 | 03.01.79 | 25.01.02 | – |
| **Israel** | 16.02.76 | 03.03.78 | – | 16.02.76 | 01.03.84 | – | 16.02.76 | 03.03.78 | 22.01.03 | – |
| **Italy** | 16.02.76 | 03.02.79 | 07.09.99 | 16.02.76 | 03.02.79 | 07.09.99 | 16.02.76 | 03.02.79 | 25.01.02 | – |
| **Lebanon** | 16.02.76 | 08.11.77 [AC] | – | 16.02.76 | 08.11.77 [AC] | – | 16.02.76 | 08.11.77 [AC] | – | – |
| **Libya** | 31.01.77 | 31.01.79 | – | 31.01.77 | 31.01.79 | – | 31.01.77 | 31.01.79 | 25.01.02 | – |
| **Malta** | 16.02.76 | 30.12.77 | 28.10.99 | 16.02.76 | 30.12.77 | 28.10.99 | 16.02.76 | 30.12.77 | 25.01.02 | 18.02.03 |
| **Monaco** | 16.02.76 | 20.09.77 | 11.04.97 | 16.02.76 | 20.09.77 | 11.04.97 | 16.02.76 | 20.09.77 | 25.01.02 | 03.04.02 |
| **Morocco** | 16.02.76 | 15.01.80 | – | 16.02.76 | 15.01.80 | 05.12.97 | 16.02.76 | 15.01.80 | 25.01.02 | – |
| **Serbia & Montenegro** | – | 16.07.02 | – | – | 16.07.02 | – | – | 16.07.02 | – | – |
| **Slovenia** | – | 15.03.94 [AC] | 08.01.03 | – | 15.03.94 [AC] | 08.01.03 | – | 15.03.94 [AC] | 25.01.02 | 16.02.04 |
| **Spain** | 16.02.76 | 17.12.76 | 17.02.99 | 16.02.76 | 17.12.76 | 17.02.99 | 16.02.76 | 17.12.76 | 25.01.02 | – |
| **Syria** | – | 26.12.78 [AC] | 10.10.03 | – | 26.12.78 [AC] | – | – | 26.12.78 [AC] | 25.01.02 | – |
| **Tunisia** | 25.05.76 | 30.07.77 | 01.06.98 | 25.05.76 | 30.07.77 | 01.06.98 | 25.05.76 | 30.07.77 | 25.01.02 | – |
| **Turkey** | 16.02.76 | 06.04.81 | 18.09.02 | 16.02.76 | 06.04.81 | 18.09.02 | 16.02.76 | 06.04.81 | – | 04.06.03 |

*[AC] Accession*
*[AP] Approval*
*[SUC] Succession*

[1] **The Convention for the Protection of the Mediterranean Sea against Pollution (*Barcelona Convention*)**

*Adopted (Barcelona): 16.02.1976*
*Entry into force*: 12.02.1978*

[2] **The Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (*Dumping Protocol*)**

*Adopted (Barcelona): 16.02.1976*
*Entry into force*: 12.02.1978*

[3] **The Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and other Harmful Substances in cases of Emergency (*Emergency Protocol*)**

*Adopted (Barcelona): 16.02.1976*
*Entry into force*: 12.02.1978*

[4] **The Protocol concerning Co-operation in Preventing Pollution from Ships and, in cases of Emergency, Combating Pollution of the Mediterranean Sea (*New Emergency Protocol*)**

*Adopted (Malta): 25.01.2002*
*Entry into force*: 17.03.2004*

* *The amendments to the Barcelona Convention, adopted in 1995, have come into force on 09.07.2004.*

| LBS PROTOCOL[5] | | | SPA PROTOCOL[6] | | SPA & BIODIVERSITY PROTOCOL[7] | | OFFSHORE PROTOCOL[8] | | HAZARDOUS WASTES PROTOCOL[9] | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Signature** | **Ratification** | **Acceptance of Amendments** | **Signature** | **Ratification** | **Signature** | **Ratification** | **Signature** | **Ratification** | **Signature** | **Ratification** |
| — | 30.05.90 [AC] | 26.07.01 | — | 30.05.90 [AC] | 10.06.95 | 26.07.01 | — | 26.07.01 | — | 26.07.01 |
| — | 02.05.83 [AC] | — | — | 16.05.85 [AC] | 10.06.95 | — | — | — | 01.10.96 | — |
| — | 22.10.94 [SUC] | — | — | 22.10.94 [SUC] | — | — | — | — | — | — |
| — | 12.06.92 [SUC] | — | — | 12.06.92 [SUC] | 10.06.95 | 12.04.02 | 14.10.94 | — | — | — |
| 17.05.80 | 28.06.88 | 12.10.01 | — | 28.06.88 [AC] | 10.06.95 | 15.10.01 | 14.10.94 | 15.10.01 | — | — |
| 17.05.80 | 07.10.83 [AP] | 12.11.99 | 30.03.83 | 30.06.84 [AP] | 10.06.95 | 12.11.99 | — | — | — | — |
| — | 18.05.83 [AC] | — | 16.02.83 | 08.07.83 | 10.06.95 | 11.02.00 | — | — | 01.10.96 | — |
| 17.05.80 | 13.07.82 [AP] | 16.04.01 | 03.04.82 | 02.09.86 [AP] | 10.06.95 | 16.04.01 | — | — | — | — |
| 17.05.80 | 26.01.87 | 10.03.03 | 03.04.82 | 26.01.87 | 10.06.95 | — | 14.10.94 | — | 01.10.96 | — |
| 17.05.80 | 21.02.91 | — | 03.04.82 | 28.10.87 | 10.06.95 | — | 14.10.94 | — | — | — |
| 17.05.80 | 04.07.85 | 07.09.99 | 03.04.82 | 04.07.85 | 10.06.95 | 07.09.99 | 14.10.94 | — | 01.10.96 | — |
| 17.05.80 | 27.12.94 | — | — | 27.12.94 [AC] | — | — | — | — | — | — |
| 17.05.80 | 06.06.89 [AP] | — | — | 06.06.89 [AC] | 10.06.95 | — | — | — | 01.10.96 | — |
| 17.05.80 | 02.03.89 | 28.10.99 | 03.04.82 | 11.01.88 | 10.06.95 | 28.10.99 | 14.10.94 | — | 01.10.96 | 28.10.99 |
| 17.05.80 | 12.01.83 | 26.11.96 | 03.04.82 | 29.05.89 | 10.06.95 | 03.06.97 | 14.10.94 | — | 01.10.96 | — |
| 17.05.80 | 09.02.87 | 02.10.96 | 02.04.83 | 22.06.90 | 10.06.95 | — | — | 01.07.99 | 20.03.97 | 01.07.99 |
| — | 16.07.02 | — | — | 16.07.02 | — | — | — | — | — | — |
| — | 16.09.93 [AC] | 08.01.03 | — | 16.09.93 [AC] | — | 08.01.03 | 10.10.95 | — | — | — |
| 17.05.80 | 06.06.84 | 17.02.99 | 03.04.82 | 22.12.87 | 10.06.95 | 23.12.98 | 14.10.94 | — | 01.10.96 | — |
| — | 01.12.93 [AC] | — | — | 11.09.92 [AC] | — | 10.10.03 | 20.09.95 | — | — | — |
| 17.05.80 | 29.10.81 | 01.06.98 | 03.04.82 | 26.05.83 | 10.06.95 | 01.06.98 | 14.10.94 | 01.06.98 | 01.10.96 | 01.06.98 |
| — | 21.02.83 [AC] | 18.05.02 | — | 06.11.86 [AC] | 10.06.95 | 18.09.02 | — | — | 01.10.96 | 03.04.04 |

[5] **The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources (*LBS Protocol*)**

*Adopted (Athens): 17.05.1980*
*Entry into force*: 17.06.1983*

[6] **The Protocol concerning Mediterranean Specially Protected Areas (*SPA Protocol*)**

*Adopted (Geneva): 03.04.1982*
*Entry into force*: 23.03.1986*

[7] **The Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (*SPA & Biodiversity Protocol*)**

*Adopted (Barcelona): 10.06.1995*
*Entry into force*: 12.12.1999*

[8] **The Protocol for the Protection of the Mediterranean Sea against Pollution resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (*Offshore Protocol*)**

*Adopted (Madrid): 14.10.1994*
*Entry into force*: —*

[9] **The Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal (*Hazardous Wastes Protocol*)**

*Adopted (Izmir): 01.10.1996*
*Entry into force*: —*

# Annex VI

# Overview of National and Regional Activities for the Conservation of Biodiversity

***National Action Plans for the Conservation of Biodiversity per Country: Titles and Costing (US$)***

| Country | Title | Costing (US$) |
|---|---|---|
| Albania | 1. Action Plan for the proclamation of the Marine National Park of Karaburuni area | 638,000 |
| | 2. Action Plan for the rehabilitation of the Kune-Vain lagoon system | 745,000 |
| | 3. Action Plan for the Dalmatian pelican in Albania | 893,000 |
| | 4. Action Plan for building and exploitation of artificial reefs for the fisheries along the Albanian coast | 908,000 |
| Algeria | 1. Action Plan for setting up a network for monitoring of Posidonia oceanica meadows | 49,000 |
| | 2. Action Plan for setting up a programme to the collect of data on the Monk seal | 69,000 |
| | 3. Action Plan for reducing fishing activity pressure on coastal area biodiversity hot spots | 181,000 |
| | 4. Action Plan for inventorying and setting up marine and coastal protected areas in Algeria | 1,254,000 |
| Bosnia & Herzegovina | 1. Action Plan for the identification and preservation of endangered marine, freshwater and terrestrial habitats and plant communities in the Mediterranean zone of Bosnia & Herzegovina | 275,000 |
| | 2. Action Plan for the sustainable development of the marine and adjacent waters of Bosnia & Herzegovina: cross border co-operation issue | 160,000 |
| Croatia | 1. Action Plan for a network of Mediterranean wetlands in Croatia: Management and restoration | 400,000 |
| | 2. Action Plan to combat negative Impact of hunting, poaching and commercial collecting on coastal zone biodiversity, including introduction of new game species on islands | 300,000 |
| | 3. Action Plan for mapping, assessment and protection of submerged karstic phenomena | 120,000 |
| | 4. Action Plan on biodiversity conservation as a part of integral coastal zone management planning | 1,025,000 |
| Egypt | 1. Bio-resources assessment of Mediterranean coastal waters of Egypt, development of Mediterranean Bio-Diversity Database, and public awareness for bio-conservation | 2,753.000 |
| | 2. Development and maintenance of the Matruh Nature Conservation Sector (MNCZ) | 1,701,000 |
| | 3. Bedouin operated bio-diversity conservation and restoration programme | 2,855,000 |
| Israel | 1. Action Plan for the conservation of marine and coastal birds in Israel | 127,000 |
| | 2. Action Plan for the conservation of fish along the Israeli coast of Mediterranean | 420,000 |
| Lebanon | 1. Action Plan for organising awareness campaigns for the Lebanese coastal communities and the public sector | 534,000 |
| | 2. Action Plan for updating of legislation and development of guidelines for marine and coastal conservation | 180,000 |
| | 3. Action Plan for determining the physical parameters of the Lebanese marine environment | 2,750,000 |
| | 4. Action Plan for establishing conservation strategies for coastal habitats | 1,040,000 |
| | 5. Action Plan for developing monitoring strategies for coastal and marine biodiversity; | 416,000 |
| | 6. Action Plan for Palm Islands & Tyre Coast Nature Reserves | 412,000 |

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| Country | Title | Costing (US$) |
|---|---|---|
| Libya | 1. Action Plan for the conservation of marine and coastal birds in Libya | 420,000 |
| | 2. Action Plan on proposed new marine and coastal protected areas and national parks | 320,000 |
| | 3. Action Plan for the conservation of marine turtles and their habitats in Libya | 133,000 |
| Malta | 1. Action Plans for the conservation of cetaceans in Maltese waters | 901,000 |
| | 2. Action Plan for estimating the sustainability of grouper fishing in Malta | 797,000 |
| | 3. Action Plan for the conservation of sharks, rays and skate in the Maltese Islands | 260,000 |
| | 4. Action Plan for the micro-cartography, mapping and surveillance of the *Posidonia oceanica* meadows in the Maltese Islands | 86,000 |
| Morocco | 1. Action plan for mapping Morocco's Mediterranean coast | 103,000 |
| | 2. Action Plan for a research programme on Morocco's Mediterranean biodiversity | 225,000 |
| | 3. Action Plan for elaborating programmes and projects on education and awareness, and elaborating a guide to Morocco's endangered species and ecosystems | 510,000 |
| | 4. Action Plan for improving the national legislation | 12,000 |
| | 5. Action Plan for making best use of the Mediterranean marine biodiversity | 10,000 |
| Slovenia | 1. Action Plan on Habitat cartography supported by the Geographic Information System with special emphasis on seagrass meadows | 155,000 |
| | 2. Action Plan for biological invasions and possible effects on biodiversity | 30,000 |
| | 3. Action Plan on the impact of alien populations used in mariculture on genome of wild populations of same species | 33,000 |
| | 4. Action Plan on Slovene commercial fishery by-catch | 48,000 |
| | 5. Action Plan for Sensitive ecosystems: *Posidonia oceanica* meadow ecological conditions, cartography and monitoring based on the GIS Posidonie methodology | 79,000 |
| Syria | 1. Action Plan for the conservation of sea turtles along the Syrian coast | 1,550,000 |
| | 2. Action Plan for marine and coastal protected areas | 2,575,000 |
| | 3. Action Plan on invasive species and their impacts on marine biodiversity | 1,125,000 |
| | 4. Action Plan for determination of physical parameters of national marine waters | 1,750,000 |
| Tunisia | 1. Action Plan for the impact of fishing activity on littoral biodiversity | 615,000 |
| | 2. Action Plan for a pilot monitoring of *Posidonia* meadows | 440,000 |
| | 3. Action Plan for Protecting coralligenous communities | 450,000 |
| | 4. Action Plan for the co-ordination and training on legal and institutional aspects | 280,000 |
| | 5. Action Plan for studying invasive species | 200,000 |
| | 6. Action Plan on awareness raising and education on biodiversity | 430,000 |
| | 7. Action Plan for establishing Centre for the protection of sea turtles | 400,000 |
| Turkey | 1. Conservation of marine turtles in Turkey | 2,450,000 |
| | 2. Creation of marine protected areas along the Turkish coasts | 375,000 |
| | 3. Reducing the negative impacts of detrimental fishing practices (trawl, purse seine, spear fishing, use of explosives) on sensitive ecosystems and on vulnerable species | 183,000 |
| | 4. Conservation of cetacean species in the Turkish water of the Aegean and Mediterranean Sea | 645,000 |

### *Regional Biodiversity Priority Actions*

| **Biodiversity Priority Actions** | **Estimated Investment (US$)** | **Issue Category *** |
|---|---|---|
| Make a complete and integrated inventory (by sub-regions) of Mediterranean coastal, wetland, and marine sensitive habitats | 1,150,000 [H] | I |
| Establish a monitoring system of endangered and threatened species | (180, 000)<br>30,000 [H]<br>150,000 [M] | I |
| Promote the adequate monitoring and survey of the effectiveness of marine and coastal protected areas | (50,000)<br>40,000 [H]<br>10,000 [M] | I |
| Identify, develop, and validate adequate biological and socio-economic indicators to assess the ecological health of sensitive habitats and species, and to evaluate the effectiveness of management measures | 115,000 [M] | I |
| Update, coordinate and enforce legislation to conserve biodiversity | 20,000 [H] | I |
| Develop actions to conserve threatened and endangered (coastal and marine) Mediterranean species, as identified by National Reports | 110,000 [H] | I |
| Assist countries to protect marine and coastal sites of particular interest | 1,000,000 [H] | II |
| Declare and develop of new Coastal and Marine Protected Areas including in the high seas | (16,300,000)<br>15,000,000 [H]<br>1,300,000 [M] | II |
| Assist countries in the development of existing marine and coastal protected areas | (5,500,000)<br>5,000,000 [H]<br>500,000 [L] | II |
| Monitor global trade and economic policies and trends from a Mediterranean perspective, to analyse their scope and probable effects on biodiversity | 35,000 [M] | II |
| Establish a monitoring regional programme following up the socio-economic impact of changes in biodiversity | 10,000 [M] | II |
| Assess the potential impact of climate change and rise in sea level on Mediterranean coastal and marine biodiversity | 40,000 [L] | III |
| Assess the potential impact of threats on Mediterranean coastal and marine biodiversity | 115,000 [L] | III |
| Mitigate the direct impact of international trade in endangered species | 510,000 [M] | III |
| Control and mitigate the introduction and spread of alien and invasive species | 6,000,000 [H] | III |
| Control and mitigate coastal urbanization and construction of coastal infrastructure | 50,000 [L] | III |
| Control and mitigate the effect of changes in land use | 100,000 [L] | III |
| Promote eco- and soft tourism, control and mitigate impact of recreational activities | 3,100,000 [M] | III |
| Assess and elaborate of strategies to prevent the environmental impact of sources of pollution | (125,000)**<br>75,000 [M]<br>50,000 [L] | III |
| Control and regulation of aquaculture practices | 75,000 [M] | III |
| Assessment, control and elaboration of strategies to prevent impact of fisheries on biodiversity | (1,370,000)**<br>370.000 [H]<br>1,000,000 [L] | III |
| Improve and coordinate biodiversity research | 100,000 [H] | IV |
| Improve taxonomic expertise in the region | 1,280,000 [H] | V |

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| Biodiversity Priority Actions | Estimated Investment (US$) | Issue Category * |
|---|---|---|
| Achieve "clearing-house" mechanism to focus on marine and coastal conservation activities | 400,000 [H] | VI |
| Coordinate and develop common tools to implement National Action Plans (NAPs) | 50,000 [H] | VI |
| Facilitate access to information for managers and decision-makers, as well as stakeholders and the general public | 20,000 [H] | VI |
| Promote public participation, within an integrated management scheme | 700,000 [H] | VI |
| Preserve traditional knowledge of stakeholders | 100,000 [H] | VI |
| Develop international collaboration in order to enhance regional public awareness | 100,000 [H] | VI |
| Organise coordinated Mediterranean-level campaigns focusing on specific regional biodiversity issues (addressed both to specific stakeholders and to the general public) | (1,250,000)<br>250,000 [H]<br>1,000,000 [L] | VI |
| **Total** | **40,055,000** | |

[H] *High, first priority rank*
[M] *Medium, second priority rank*
[L] *Low, third priority rank*
* *Issue Categories:*
*I Inventorying, mapping and monitoring Mediterranean coastal and marine biodiversity*
*II Conservation of sensitive habitats, species and sites*
*III Assessing and mitigating the impact of threats to biodiversity*
*IV Developing research to complete knowledge and fill gaps in biodiversity*
*V Capacity-building to ensure coordination and technical support*
*VI Information and participation, and awareness raising*
** *Support for other programmes*

### *Regional Biodiversity Priority Actions: Structure of Investment needed per Priority Ranking*

| Priority Rank | Respective Totals (US$) | % of Grand Total |
|---|---|---|
| High priority | 31,720,000 | 79.3 |
| Medium priority | 5,980,000 | 14.9 |
| Low priority | 2,355,000 | 5.8 |
| **Total** | **40,055,000** | **100.0** |

### *Regional Activities to support National and other Actions in the Preparatory Phase*

| Activity | Costing Estimate (US$) |
|---|---|
| 1. Assistance to countries for further refining of costings | 60,000 |
| 2. Preparation of the operational strategy for funding and implementation of SAP/BIO at national and regional levels (strategy, preparation of funding requests, contacts with donors and partners, etc.) | 75,000 |
| 3. Information, co-ordination, capacity building workshops | 60,000 |
| 4. Launching Conference (preparatory activities, preparation of national and regional reference documents, resource persons, participants expenses) | 75,000 |
| 5. Co-ordination costs | 25,000 |
| **Total** | **295,000** |

*National Biodiversity Action Plans (Totals per Countries)*

| Country | Number of NAPs | Estimated Investment (US$) |
|---|---|---|
| Albania | 4 | 4,184,000 |
| Algeria | 4 | 1,553,000 |
| Bosnia & Herzegovina | 2 | 435,000 |
| Croatia | 4 | 1,845,000 |
| Egypt | 3 | 7,309,000 |
| Israel | 2 | 547,000 |
| Lebanon | 6 | 5,332,000 |
| Libya | 3 | 873,000 |
| Malta | 4 | 2,044,000 |
| Morocco | 5 | 860,000 |
| Slovenia | 5 | 345,000 |
| Syria | 4 | 7,000,000 |
| Tunisia | 7 | 2,815,000 |
| Turkey | 4 | 3,653,000 |
| **Total** | **57** | **38,795,000** |

*Other National Priority Actions (Totals per Countries)*

| Country | Number of ONPAs | Estimated Investment (US$) |
|---|---|---|
| Albania | 22 | 7,290,000 |
| Algeria | 6 | 748,000 |
| Bosnia & Herzegovina | 11 | 4,520,000 |
| Croatia | 29 | 7,590,000 |
| Cyprus | 9 | 3,100,000 |
| Egypt | 1 | 2,500,000 |
| Greece | 27 | 20,505,000 |
| Israel | 3 | 460,000 |
| Italy | (5) | — |
| Libya | 5 | 1,200,000 |
| Malta | 17 | 4,540,000 |
| Slovenia | 13 | 375,000 |
| Syria | (13) | — |
| Turkey | 25 | 3,705,000 |
| **Total** | **168** | **57,848,000** |

**Investment and Implementation Strategy**

In order to define a realistic and fact-based investment strategy, the summary of investment data presented in the previous sub-chapter should be considered from various points of view, in particular concerning: a) the present level of actions programmes elaboration, b) readiness for implementation, excluding funding aspects, and c) the rank of priority.

Due to funding aspects, capacity for implementation, and from an operational point of view, implementation of SAP BIO needs to be phased, at regional and national level. After the adoption of SAP BIO, a short-term preparatory phase is needed, to allow the preparation of inputs for launching and implementing the regional and national SAP BIO components.

This preparatory phase should consist of:

- immediate contacts and preliminary agreements with partners and donors,
- refining of national investment portfolios,
- defining of funding and implementation strategies,
- provision of assistance to countries to meet the needed prerequisites, and
- harmonization of all respective activities.

In all cases provision of permanent sources for implementation, such as market instruments for SAP BIO and private sponsorship should be considered.

In principle, the potential national sources to be looked for are: budgets and funds at national and local level, private partnership and/or sponsorship, economic instruments and mechanisms, fund-raising, and other national or issue specific sources, if any. Providing proper approaches are applied, and if classic unattractive, outdated forms and mechanisms are abandoned, large national funds might be secured in almost all countries.

Among potential external sources to be analysed, the following might be mentioned:

a) sub-regional or multi- or bilateral co-operation (N/S or N/E type, not excluding the S/S type),
b) international funding programmes, pending eligibility: GEF, UNDP, WB, METAP, etc.
c) international foundations, private partnerships, sponsorships, grants, etc.
d) various EU sources, pending eligibility
e) other international funds, if appropriate.

Previous experience related to the implementing of similar large international programmes indicates as realistic the formulation of an outline for a large SAP BIO Umbrella Project, where as components are envisaged:

a) regional component including: (i) regional actions to be implemented at regional level, (ii) regional actions to be implemented in the countries themselves, and (iii) assistance to countries,
b) the countries' related components, composed of the set of national programmes.

***Facts relevant to the SAP BIO Investment Strategy***

| Category | Number of Actions | Total Costing (US$) | Costing: justified | Programme Elaboration | Implementability Pending Funding | Priority Rank |
|---|---|---|---|---|---|---|
| 1. NAPs | 57 | 38,800,000 | Yes | Satisfactory | Implementable | H |
| 2. RPAs<br>(RPAs/H) | 30 | 40,000,000<br>(31,700,000) | Yes | Satisfactory | Implementable | H/M/L<br>H |
| RPAs/M | | (6,000,000) | Yes | Satisfactory | Not yet implementable | M |
| RPAs/L | | (2,300,000) | Yes | Satisfactory | Not yet implementable | L |
| 3. ONPAs | 168 | 57,800,000 | Rough estimates | Not yet elaborated | Most not yet implementable | — |

*H: High, first priority rank*
*M: Medium, second priority rank*
*L: Low, third priority rank*