BLACK SEA TRANSBOUNDARY DİAGNOSTİC ANALYSIS

May 2007

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EXECUTIVE SUMMARY

Introduction

The Black Sea covers an area of 423,000 km^2, is over 2 km deep and drains an area of 1.9 million km^2 (one-third of continental Europe) containing over 160 million inhabitants. The coastal zone[1] contains a poulation of some 20 or 39 million people, depending on whether the Istanbul administrative unit is included in the total. This has a short Black Sea coastline. The Sea has six coastal countries: Bulgaria, Georgia, Romania, the Russian Federation, Turkey and Ukraine.

The Sea is enclosed by land; its only connection with the World's Oceans being via the Turkish Bosphorus Strait, which links it with the Mediterranean (via the Sea of Marmara). Some 90% of the Sea is naurally anoxic (contains no oxygen), but the top 150 m layer represents an area of great biological productivity, providing the employment basis for hundreds of thousands of people.

This report represents the second Black Sea transboundary diagnostic analysis (TDA), the first of which was produced in 1996. It assesses the environmental status of the Sea, focusing on the major transboundary problems, their causes and what should be done to improve its status in the future. The structure and content of this document are different to that of the 1996 TDA, since guidance on TDA production has changed in the intervening years and instead of the original seven major transboundary problems, it now focuses on only four:

- Eutrophication/nutrient enrichment
- Changes in marine living resources
- Chemical pollution (including oil)
- Biodiversity/habitat changes, including alien species introduction

For each of these a causal chain analysis is included, to assist in the identification of solutions for each of the problems. The emphasis of this document is on changes that have occurred since the original TDA was produced. However, socio-economic developments and environmental data over a longer period of time are also considered to place the current status in context, and describe the reasons underlying changes observed.

Socio-economic changes

The Black Sea Region has undergone major socio-economic changes over the past 20 years. The regional economic collapse at the end of the 1980s, with the resulting break-up of the Soviet Union and birth of the CIS[2] countries, together with a much less dramatic but still influential economic slow-down in 1997-98 have had major social and environmental implications. Since 2000, personal wealth has increased, but not as rapidly as inflation. Furthermore, this increase in wealth has been concentrated in the hands of a small number of very rich individuals. The size of the middle class remains small. The economies and infrastructure of all countries have been struggling with the problem of rural-urban migration since the 1960s, a trend which is continuing and has led to the development of Istanbul, spanning the Bosphorus Strait, as a city which now contains about 15 million people. The lack of data provided on pollution inputs (nutrients and toxic substances) to the Black Sea

[1] Defined as one 'administrative unit' inland from the Sea
[2] Commonwealth of Independent States.

from both the Bosphorus and Kerch straits is considered a major weakness of this assessment.

As the economies have changed, so has the importance of different sectors in contributing to national wealth. In particular, agriculture has slumped as a contributor to national GDP since 1994 (most dramatically in Georgia), with a less dramatic fall in manufacturing industry, but these have been more than offset by the increase in importance of the service sector (again, most notably in Georgia).

Ecological changes
For management and reporting purposes it is useful to consider environmental changes in carefully-defined steps, stages or classes. Indeed, classification schemes are used in this report. However, in reality the shift from pristine to catastrophic damage is a perfect glissando; a smooth transition; albeit one in which the rates of change are different in different areas of the Sea, with emphasis having been placed on the NW Shelf. The Sea is still degraded, but substantial improvements have occurred over the past 10-15 years. This is demonstrated by changes in the plankton, fish and benthic invertebrate communities. In addition, the area affected by oxygen depletion (hypoxia) is now much smaller than in the 1980s and early 1990s, and those areas which are still affected by hypoxia are impacted to a lesser extent. Ecological change was very rapid in the 1990s and has continued through the early 2000s, with the emphasis of this change having been on both adaptation and recovery. The introduction of so many exotic species has meant that even if the chemical environment of the Sea is restored to its 1960s status, the ecology of the Sea would not return to its former state.

Eutrophication/nutrient-enrichment
This decrease in the importance of agriculture as an economic powerhouse of the region has been clearly shown by decreasing trends in livestock numbers and a shift from major livestock farms to small-scale or subsistence-level farming. Livestock numbers (excluding poultry) in 2004 were about two-thirds of those present 1997, and about one-third of the numbers recorded in 1998. Likewise, inorganic fertiliser application rates in Romania in 2004 were about one-third of what they were prior to the collapse of the Soviet Union. During the early years of this century fertiliser application rates were substantially higher in Turkey than in other Black Sea countries; Bulgaria, Georgia and Romania formed a middle group; and the lowest fertiliser application rates were found in the Russian Federation and Ukraine. Indicators suggest that the decline in agriculture may have bottomed-out, so a gradual re-intensification of agricultural practices may begin in the near future.

Direct discharges from large municipal/industrial plants to the Sea account for only about 2% of the inorganic nitrogen and 13% of the phosphate load discharged to the Sea via rivers, of which the Danube is by far the most important. This accounts for about 84% of the river-borne inorganic nitrogen load and 49% of the river-borne phosphate load, from a river accounting for 67% of the freshwater input. Available information suggests that atmospheric deposition of nitrogen to the Sea may be of a similar order of magnitude to river loads, but there is considerable uncertainty over the data used.

Between 1996 and 2005 river-borne loads of both inorganic nitrogen and phosphate fell by 30. This is very encouraging for the future status of the Sea, but this decrease in nutrient loads is overwhelmingly the result of economic decline and slump in agricultural productivity rather than due to improved regional environmental management. For these improvements to be maintained in the future it is essential that procedures and legislation are put in place to prevent the situation from reversing as regional economic improvements occur.

The following recommendations are made:

- Improve routine Black Sea nutrient monitoring/reporting in at least 3 countries: Bulgaria, Georgia and Ukraine. All countries should monitor the Black Sea with the same sampling frequency to improve data comparability.
- Measure riverine and municipal/industrial nutrient discharge concentrations (for the estimation of loads) as total N and total P. Inorganic nitrogen and ortho-phosphate measurements are a poor substitute for calculating loads.
- Place a much greater emphasis on nutrient management in agriculture, notably the development, adoption and enforcement of best agricultural practice guidelines, including revised guidance on fertiliser (organic and inorganic) fertiliser application rates, together with a robust soil nutrient testing programme.
- Standardise and harmonise the quantification of river loads. Procedures giving comparable results should be adopted for the assessment of loads at the most downstream points in all major rivers discharging into the Black Sea.
- Develop a nutrient source apportionment model for the whole Black Basin to improve existing understanding of nutrient sources.

Commercial marine living resources

Due to over fishing in the early 1970s-1980s, the structure of catches has shifted significantly. Declining stocks of predatory species such as bonito, horse mackerel and bluefish resulted in an increase in non-predatory species such as anchovy and sprat. Consequently, fishing fleets have increasingly targeted these smaller species, resulting in increased by-catches of larger, less abundant fish species.

Commercially important marine living resources have been greatly affected by alien species introductions, eutrophication, over-fishing and habitats change/damage. Annual total fish catch statistics show an improving situation, but these figures are dominated by catches of anchovy and sprat. There have been recent improvements in catches of some other fish, such as bonito, but turbot, dogfish and whiting catches have either shown no improvement or have fallen over the past decade-or-so. Sturgeons remain endangered. There is an absolute need to develop a regionally agreed fishery policy, for which background work on the development of a legally binding document has started. This needs to include agreed methods on and participation in: (i) regional stock assessment exercises, since those countries which currently undertake these use different methodologies and many of the assessments are out of date; and (ii) catch per unit effort (CPUE) assessments. No robust CPUE methodology exists for the same assessments to be made by all coastal countries.

The importance of *Rapana*, the Japanese Snail has increased and has helped to off-set the decline in mussel and clam landings (the decline being due, in large part, to predation by *Rapana* anyway). The seafood industry is a major coastal employer, particularly in Turkey which is responsible for some 80% of the total catch from the Sea. Aquaculture is not strongly developed in the region and there is scope for this to be expanded, providing environmental considerations are taken into account.

There contribution of illegal fishing activities to damage/change of marine living resources is not clearly understood, but there a general acceptance that this is a causative factor. One example cited from Romanian waters shows that this is, indeed, a considerable issue which needs to be addressed.

The following recommendations are made:

- A regionally agreed system needs to be developed to match fishıng effort to stocks (prohibition periods, minimum admissible fish length, etc).
- Harmonise the methodologies for collection and collation of fisheries statistics at a regional level
- Establish regionally agreed national fishing zones in all Black Sea countries
- Prohibit the use of non-sustainable fishing technologies (notably dragging and bottom trawling).
- All countries should take greater effort to combat illegal fishing practices.
- Encourage expansion of the mariculture sector, but only if account is taken of environmental considerations. The precautionary principal should be applied.
- Place a higher emphasis on ecological factors when making decisions on coastal development.

Chemical pollution

Available data on individual pollutants in the water column an sediments are mapped out, illustrating large differences in the number of sites for which results of individual parameters are available. In general terms, considerable amounts of data were made available from the Western edge and NW Shelf, of the Sea, with good spatial coverage but limited sampling frequency and period of coverage along the Turkish cosat. Data from a surprisingly high number of Georgian coastal sites were made available, albeit with a low number of determinations for each site. Relatively few Russian or Ukrainian data were available.

An assessment of pollutant loads from river and large direct municipal/industrial discharges is also presented. However, the pollution loads data are very incomplete, BOD_5 being the only parameter (apart from nutrients) that is routinely monitored from major point sources and rivers. Relatively high contamination levels of some pesticides, heavy metals and PCBs are present at specific sites in the Black Sea. The concentrations of some substances are in or above the ranges used as Ecotoxicological Assessment Criteria by OSPAR, wıth ıllegal dumpıng/dıscharges (particularly of agrochemicals) being recognised as a particular problem. The historical poor enforcement of discharge standards and a failure to consider the Sea itself as a receiving waterbody for discharges to river are considered to be the principal reasons underlying the pollution status of the Sea.

A huge increase in the volume of oil being transported across the Black Sea and oil/gas extraction from beneath the Sea itself have greatly increased the risk of oıl pollutıon. Thıs presents two types of problem: (i) localised chronic pollution stemming from frequent but minor releases of oil; and (ii) acute pollution resulting from major oils spills. Remote sensing data show that the majority of oil spills occur along major shipping routes, showing that shipping, rather than land-based oil installations are the principal cause of concern. In particular, where ships eneter the Sea through the Bosphorus Strait appears to be an area of frequent ship-derived oil spills, with sediment total petroleum products results supporting the remote sensing imagery data.

The following recommendations are made:

- Develop a regionally agreed list of priority pollutants for monitoring purposes.
- Develop robust national quality assurance programmes for the intercomparation/intercalibation of chemical concentration and flow data from point sources.
- Harmonise environmental standards (discharge and environmental water/sediment quality standards) throughout the Region.
- Produce a regional manual for data handling.
- Establish national plans to reduce/prevent pollution of the Black Sea.
- Build the capacity of environmental authorities to enforce existing regulations on the discharge of priority pollutants from both point and diffuse sources.
- Develop national/regional public awareness programmes to promote bottom-up pressure on decision makers in order to improve the environmental status of the Black Sea
- Establish an inter-state ministerial mechanism to enable a quick response to major pollution events.
- Develop/adopt an agreed transboundary environmental impact assessment methodology to assist with transboundary projects in the region
- Reduce pollution loads by the application of best available technology and introduction/enforcement of best agriculture practice.
- Provide assistance to industrial sectors (including mining enterprises) to develop Environmental Management Systems and practice cleaner production activities
- Develop a network of farmer support services for raising awareness in the application of fertilizers, pesticides and herbicides.
- Production of a code of practice for data handling and transfer for use by all national institutions reporting to the BSC and the Premanent Sectretariat itself.

Biodiversity
The structure of marine ecosystems differs from that of the neighbouring Mediterranean Sea in that species variety is lower and the dominant groups are different. However, the abundance, total biomass and productivity of the Black Sea are much higher than in the Mediterranean Sea. Plankton community composition and biomass suggest that improvements are taking place, albeit that a reduction in organic enrichment is key to this recovery.

Formerly “dead” areas of the NW Shelf sediment are once again colonised by biota, with evidence of biodiversity continuing to increase. The once massive area dominated by Zernov’s *Phyllophora* (a red seaweed) field has decreased hugely in area, having been replaced by other, opportunistic macroalgae. Similarly, during the last two decades, the area covered by eelgrass (*Zostera*) has decreased tenfold in shallow waters.

The *Phyllophora* field once provided a habitat for 118 species of invertebrates and 47 species of fish. The Black Sea macrozoobenthos is represented by approximately 800 species, and the fish fauna by 171 species. There are 320 bird species in the Danube Delta and 4 species of Mammals are found in the Sea.

Higher species richness in shallower waters is associated with good dissolved oxygen conditions whilst in deeper areas there is lower diversity due to natural oxygen depletion with increasing depth in the Black Sea. Consequently, the number of macrobenthic species decreases rapidly with increasing depth - only the polychaete worm *Notomastus profundus* is found below a depth of about 120 m.

The invasion of *Mnemiopsis leidyi* (a comb jelly) contributed to a catostrophic decline in fish productivity in the 1980s. The subsequent invasion of a another comb jelly (*Beroe ovata*), which feeds on the original invader, means that opinions are now split as to whether *Mnemiopsis* is still has a major impact on fish communıtıes and catches.

The number of registered alien species at the regional level amounts to 217 (parasites and mycelium excluded). Nearly half of them (102) are permanently established, a quarter - highly or moderately invasive (20 and 35 species respectively). This high ratio of invasive aliens suggests a serious impact on the Black Sea native biological diversity, with negative consequences for human activities and economic interests.

Between 1996 and 2005 a total of 48 new alien species were recorded, which represents over 22 % of all registered aliens. The majority belong to phytoplankton (16) and zoobenthos (15), followed by zooplankton (8), fish (5), macroalgae (3) and mammals (1).

Habitat status is a critical component of maintaining high levels of biodiversity within the Black Sea. The status of marine habitats is therefore assessed. All 5 habitats within the coastal margin ecotones category are considered to be in a critical status in at least one country; both types of benthic pelagic habitat (neritic and open sea) are considered critical in at least one country; and 13 of the 37 types of benthic habitat are considered to be critical in at least one country. No data were available on Russian Black Sea habitats. The ecosystem(s) of the Black Sea are, therefore, seriously damaged and in need of legal protection. Those habitats most at risk include the neritic water column, coastal lagoons, estuaries/deltas and wetlands/saltmarshes.

The following recommendations are made:

- Continue capacity-building and training of marıne scientists.
- Allow environmentalists greater access to key decision-makers in organisations throughout the Black Sea region.
- Undertake regular re-evaluations of major marine systematic (biological) groups in each of the BS countries, using the latest IUCN criteria and guidelines for application at the regional level.
- Develop a habitat- and ecosystem- oriented approach to biodiversity management. Often it is clearer which impacts are responsible for the deterioration of habitats than it is for individual species
- Once national Red Lists on habitats and biota have been completed, a Red Book of Habitats, Flora and Fauna of the Black Sea should be created. This should serve as a tool for conservation management at the regional level.
- Increase the number and area of Marine Protected Areas.
- Improve and back-up management strategies to prevent the introduction of new invasive species. These should target the priority vectors of introduction – ships (ballast water) and aquaculture.

Causal chain analyses

Many of the immediate, underlying and root causes of individual problems are shared with other problems. In particular, the causal chain analyses for nutrient enrichment and chemical pollution are very similar, since the majority of sources of chemical pollution are also sources of nutrients. For biodiversity, the failure to adequately treat ship ballast water is regarded as being an important cause of the problem, and for changes commercial marine living resources the remaining three major problems are clearly contributory factors. For biodiversity-related problems, the importance of eutrophication is considered to have been greatly under-estimated, both by stakeholders and, indeed, by contributors to this report.

It is clear, therefore that the four transboundary problems cannot be dealt with individually. Improvements in management of one problem will have knock-on effects for other problems, and addressing individual causes is likely to improve the situation with regard to at least two, if not more, of the four environmental problems. For example, one of the causes of all four of the environmental problems covered in this report is that of poorly regulated coastal development. A brief tour around the Region reveals the huge scale of this, with the economic importance of tourism increasing rapidly. The six countries all agree with the 'ecology tenet' underlying integrated coastal zone management, i.e. that coastal development should take account of marine ecology, conservation and biodiversity, but the underlying institutional structures vary considerably between countries. There are many examples where money has spoken louder than words.

Hot-spots analysis

A review of planned and proposed capital investments on pollution point sources identified from the 1996 TDA has shown disappoint results. Of the 50 investments initially identified, only 12 have been completed and 2 are no longer required (mis-identification as the reason for one site, and a change in use of the facility as the reason for the other). A decade later, work is in progress on another 10 point sources, but over half of the capital investments originally identified have either been insufficiently funded or not funded at all. Capital investment costs to address the identified 50 hot-spots were originally estimated to be almost $400 million. By the end of 2005 at least $143 million had been spent on addressing these point sources, with a further $340 million planned to be spent by the end of 2015.

Legal and institutional analysis

The results of a legal and institutional analysis of the region are also presented. The major regional document for protecting the Black Sea is the Bucharest Convention. This now appears out-dated and is unusual in that it excludes the Sea of Azov, but protocols to the Convention can (and do) include it. The Convention established a Permanent Secretariat (PS), which has worked under difficult conditions with respect to the level of staffing and the uncertainty created by the lack of consistency in receiving national annual contributions. The PS is supported by sixteen subsidiary bodies: six activity centres (only two of which have funding to support the PS), seven advisory groups and three *ad hoc* working groups.

The aims of the Permanent Secretariat have been over-ambitious, given its resources, with the result that little progress has been achieved. There has been a lack of focus on outputs from the Advisory Groups, and to date there has been little accountability. The outputs of Advisory Groups are not generally used by decision makers in the Black Sea countries because they are seen as being irrelevant to policy making or because national funding/political back-up has been insufficient. One example of this is the development and undertaking of the Black Sea Integrated Monitoring and Assessment Programme. Outputs of this programme, robust monitoring results of the environmental status of the Black Sea, should be one of the most important deliverables of the PS, but national funding of the laboratories, staff and equipment to undertake this work has been lacking in a number of countries.

National environmental legislation is relatively strong, but the enforcement of this legislation has been weak. In Bulgaria and Romania, the EU Accession process has been (and is continuing to be) good news for the environment. The capital investments (hot-spots) analysis shows this to be the case, despite the fact that the majority of planned investments are still to come on-line in the two EU Member States. Turkey is in the initial stages of its EU accession negotiations and appears keen to comply with the capital investments and best agricultural practice regulations required, so further environmental improvements should accrue in the future. However, there is a need for improved cooperation between the Environment and other Ministries in all countries.

Stakeholders analysis

Environmental management is complex, with huge numbers of individuals, ministries and organizations involved; political changes further complicate the picture. The level of complexity is illustrated in a Stakeholders analysis, which involved questioning representatives of 42 stakeholder groups. This analysis revealed that 61% of respondents considered the Black Sea to be unhealthy and, surprisingly, over 70% of people thought the environmental health of the Black Sea region to be more important than economic development. The vast majority of respondents agreed that the Sea was polluted and that regional cooperation was important to address this issue. A considerable majority also agreed that preserving endangered fish species was more important than meeting market demand for seafood

Some 80% of respondents thought that if people knew more about the causes of environmental problems they would want to make changes to improve matters, but overall, they considered eutrophication to be less important than any of the other three transboundary problems addressed in this document. The results are encouraging, but reveal that further environmental education is required.

The following recommendations are made:

- Develop focused stakeholder involvement strategies for livestock industry and port and harbour administrators to help them recognize and remedy actions that adversely impact the Black Sea ecosystem.
- Target activities towards helping groups to adjust their current practices to more environmentally sustainable approaches, in all areas and issues.
- Increase outreach efforts that emphasize the importance of biodiversity and habitat conservation.
- Target efforts to inform stakeholder groupss about nutrient loading and eutrophication, and provide alternative approaches to current waste water and nutrient management practices.
- Develop an outreach programme that includes stakeholders from all fisheries sectors to take steps towards addressing the causes of over-fishing.
- Develop targeted interventions for the tourism and recreation industry to help it to take steps to avoid negatively impacting the waters of the Black Sea.
- Develop an outreach component for the BS Commission that links the economic well-being of the region with the health of the Black Sea.

1. INTRODUCTION

The Black Sea is one of the most remarkable regional seas in the world. It is almost cut off from the rest of the world's oceans, is over 2200 m deep and receives the drainage from a 1.9 million km^2 basin covering about one third of the area of continental Europe. Its only connection is through the Bosphorus Strait, a 35 km natural channel, as little as 40 m deep in places. This channel has a two layer flow, carrying about 300 km^3 of seawater to the Black Sea from the Mediterranean along the bottom layer and returning a mixture of seawater and freshwater with twice this volume in the upper layer. Every year, about 350 km^3 of river water enters the Black Sea from an area covering almost a third of continental Europe and including significant areas of seventeen countries: Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Germany, Hungary, Moldova, Slovakia, Slovenia, Romania, Russia, Turkey, Ukraine, Yugoslavia. Europe's second, third and fourth largest rivers (the Danube, Dnipro and Don) all flow to the Black Sea.

Isolation from the flushing effects of the open ocean, coupled with its huge catchment, has made the Black Sea particularly susceptible to eutrophication (the phenomenon that results from an over-enrichment of the sea by plant nutrients). Eutrophication has led to radical changes in the Black Sea ecosystem in the past three decades with a major transboundary impact on biological diversity and human use of the sea, including fisheries and recreation.

Prior to the 1990s, little or no action had been taken to protect the Black Sea. Political differences during the Soviet era, coupled with a lack of general knowledge of the environmental situation resulted in an absence of effective response. In 1992 the Black Sea countries signed the Bucharest Convention followed closely by the first Black Sea Ministerial Declaration (the Odessa Declaration) in 1993. This inspired the GEF and other donors, particularly the European Union, to provide more than US$17 million support to the region to help implement the Odessa Declaration and to formulate the longer-term Black Sea Strategic Action Plan (BS SAP).

The Black Sea Environmental Programme (BSEP) was launched in June 1993. The Programme included a number of interventions by the GEF, including the development of the first Black Sea Transboundary Diagnostic Analysis (TDA), finalised in June 1996. On the basis of this comprehensive report senior government officials negotiated the Black Sea Strategic Action Plan (BS-SAP), signed on October 31st at a Ministerial Conference in Istanbul.

Following the signature of the BS-SAP, GEF funding was sustained in order to enable countries to complete National Black Sea Strategic Action Plans and for the negotiations on the institutionalisation of the Istanbul Commission's Secretariat to be completed. This was a very protracted three-year process as countries struggled to overcome technical and legal issues of establishing the Secretariat. In the meantime however, progress was made in implementing part of the BS-SAP due to GEF seed money and considerable support from the European Commission. In October 2000, the Secretariat for the Black Sea Commission became operational.

Further GEF Full Project funding was secured in 2002 with the commencement of the Black Sea Ecosystem Recovery Project (BSERP). The project was split into two implementation phases - Phase I (Apr 2002 - Oct 2004) and Phase II (Nov 2004 - Oct 2007). The project supports regional aspects of the Black Sea Partnership for Nutrient Control and assists and strengthens the role of the Black Sea Commission.

Further, the project was set up to ensure the provision of a suite of harmonised legal and policy instruments for tackling the problem of eutrophication, and release of certain hazardous substances, and to facilitate ecosystem recovery. An important feature of the project has been its encouragement of broad stakeholder participation.

A cornerstone of this project is the development of a revised Black Sea TDA and SAP based on the existing 1996 documents. This document is an objective, non-negotiated analysis using best available verified scientific information and examines the state of the environment and the root causes for its degradation. It will provide the factual basis for the formulation of a Black Sea Strategic Action Programme (BS SAP), which will embody specific actions (policy, legal, institutional reforms or investments) that can be adopted nationally, usually within a harmonized multinational context, to address the major priority transboundary problems identified in the TDA, and over the longer term, enable the sustainable development and environmental protection of the Black Sea.

2. METHODOLOGY

2.1 The 1996 Black Sea TDA

The 2006 Black Sea TDA is the first significant update of the original Black Sea TDA finalized in June 1996 under the GEF Black Sea Ecosystem Protection (BSEP) project.

The 1996 Black Sea TDA was a technical document which examined the root causes of Black Sea degradation and options for actions which could be taken to address them. It examined each major environmental problem, the stakeholders involved in the problem and the uncertainties in the information describing the problem. It then proposed solutions, time frames and costs.

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The development of the 1996 TDA was a carefully implemented technical process spanning more than two years. Initially, a series of thematic analyses were conducted at a national level and then integrated by a group of regional and international specialists in order to construct the Transboundary Diagnostic Analysis (TDA) of the Black Sea[3]. On the basis of this document, senior government officials negotiated the Black Sea Strategic Action Plan (BS-SAP) which was signed on October 31st 1996, at the Black Sea Ministerial Conference in Istanbul.

2.2 The 2006 Black Sea TDA

The 2006 Black Sea TDA was expected to build on the existing 1996 document and it was anticipated that it wouldn't adhere to the traditional TDA development process (as generally used in 1st phase International Waters projects). However, current GEF requirements for TDA development mean that the process needed to follow the GEF IW TDA/SAP "best practice" approach[4]. This required careful management of the process between the Black Sea Project Implementation Unit (PIU) and the Secretariat of the Black Sea Commission.

Consequently, the 2006 Black Sea TDA, developed between 20th December 2005 and xxth November 2006, is an objective, non-negotiated assessment using best available verified scientific information which examines the state of the environment and the root causes for its degradation. It will provide the factual basis for the formulation of the revised Black Sea SAP, which will embody specific actions (policy, legal, institutional reforms or investments) that can be adopted nationally, usually within a harmonized multinational context, to address the major priority transboundary problems, and over the longer term restore or protect the Black Sea ecosystem.

The process proceeded according to the following 'Best Practice' steps:

- **Identification and initial prioritisation** of transboundary problems
- Gathering and interpreting information on **environmental impacts** and **socio-economic consequences** of each problem
- **Causal chain analysis** (including root causes)
- Completion of an **analysis of institutions, laws, policies and projected investments**

[3] Full reference of 1996 TDA
[4] Full reference of the GEF best practice approach

The TDA focuses on transboundary problems without ignoring national concerns and priorities and identifies information gaps, policy distortions and institutional deficiencies. The analysis is cross-sectoral and examines national economic development plans, civil society (including private sector) awareness and participation, the regulatory and institutional framework and sectoral economic policies.

2.3 Identification of priority transboundary issues

The first step in the TDA process was to agree on an initial list of transboundary problems in the Black Sea, examine their transboundary relevance and scope, and determine preliminary priorities.

At the first TDA TTT meeting (11th April 2006), the TTT, made up of 22 experts from the Black Sea countries[5], brainstormed the list of 23 common GEF transboundary problems in order to determine their relevance and transboundary nature in the context of the Black Sea.

The priority transboundary problems were identified by assigning a score to each problem of between 0 (no importance), 1 (low importance), 2 (moderate importance) and 3 (high importance) to determine the relevance of the problem from the perspective of the *present day* and *10-15 years in the future*. When examining future change the TTT were asked to consider the effects of climate change. The scoring activity was based on the following suite of criteria:

- Transboundary nature of a problem.
- Scale of impacts of a problem on economic terms, the environment and human health.
- Relationship with other environmental problems.
- Expected multiple benefits that might be achieved by addressing a problem.
- Lack of perceived progress in addressing/solving a problem at the national level.
- Recognised multi-country water conflicts.
- Reversibility/irreversibility of the problem

2.4 Development of thematic reports

Thematic Reports were drafted by selected members of the TTT (Team Leaders). The list of the Thematic Reports is shown below:

1. Thematic report on Habitat loss/ Biodiversity
2. Thematic report on Causal Chain Analysis
3. Thematic report on Fisheries
4. Thematic report on pollution loads
5. Thematic report on pollution assessment
6. Stakeholders Analysis
7. Socio- economic Assessment
8. Governance Analysis

Each review and report used a similar structure and the Team Leaders were asked to produce reports that: described the particular problem; identified any gaps in knowledge; identified the environmental impacts and socio-economic consequences; detailed the immediate and

[5] A full list of the TTT experts is shown in Annex <>.

underlying causes of the impacts and consequences; and listed proposed options for addressing the identified problem. Consequently, the Thematic Reports constituted the main sources of information for the TDA.

2.5 Development of causal chains for priority transboundary problems

The CCA methodology developed for this TDA was based on that described in the GEF 'Best Practice' approach and tried to relate the transboundary problems with their impacts, immediate physical causes, underlying causes (divided into resource uses and socio-economic causes) and root causes. A simple step by step guide to the process is shown in Figure 2.1.

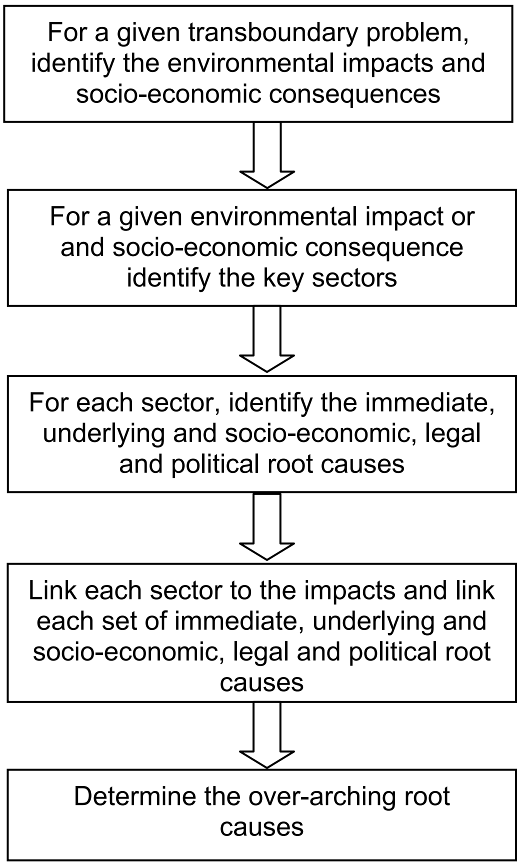

Figure 2.1 Stepwise sectoral analysis approach to developing a causal chain

The CCA process was iterative and consultative, with several versions being developed by the CCA team leader after successive consultations with the international consultant, the Black Sea Project Implementation Unit (PIU), the TDA TTT and CCA National Experts.

Draft CCAs were presented at the second TDA TTT Meeting (July 6th, 2006) and a Delphi Exercise was performed during the meeting to help identify further causes. Based on this input, sectoral CCAs were re-drafted.

The revised versions were reviewed by the PIU and the International Consultant and were then sent to the TDA TTT leaders for further approval. These versions were checked by the CCA National Experts for relevance in the 6 Black Sea countries.

2.6 Hot-spots analysis

The hot-spots analysis presented ın thıs TDA does not include an update of the list of 50 hot-spots identified in the 1996 TDA, but rather an assessment of progress made in addressing the original list of pollution sources in terms of undertaking the capital investments originally identified. In addition, where data have been provided, the measured pollution loads from individual hot-spots are calculated. The loads cited in the 1996 TDA were modelled using the Rapid Assessment Methodology.

2.7 Stakeholder analysis

The Black Sea Stakeholder Analysis involved conducting quantitative surveys of stakeholders throughout the region. This analysis identifies stakeholders of the Black Sea Ecosystem Recovery Project and provides insights into the concerns, priorities, capacities and perceptions of stakeholder groups throughout the region in regards to specific transboundary environmental issues. This also identifies where tensions or potential tensions could emerge as a result of different expectations and priorities for Black Sea resource uses.

The stakeholder analysis methodology involves identifying stakeholder groups through desk studies, consultation with project staff, and review of issues, thematic reports, historical project materials socio-economic and government structures throughout the region. Following this the survey was developed following consultation with earlier stakeholder analyses in the region, surveys conducted by NGOs, reports from the project. The conclusions of these were combined with findings of the Causal Chain Analysis conducted within the scope of the current TDA and based on these sources, survey questions were developed.

The survey was conducted in all six Black Sea countries among 42 different stakeholder groups. Surveys were translated into local languages and were administered by national level stakeholder consultants throughout the region. A total of 368 surveys were collected and statistically analyzed for trends among and between groups. Areas of notably high and low priority concern or high levels of variation within groups were detailed and analyzed for the potential causality and significance of these trends. Issues which showed potential for conflict between groups were highlighted.

2.8 Governance analysis

The Governance Analysis involved a regional assessment of the institutional and policy/legal instruments based on the existing analysis/reports under the Black Sea Ecosystem Recovery Project. This analysis identifies institutional involvement in Black Sea related environmental problems, as well as the existing global/regional/national policies and provides insights into the coordination mechanisms, enforcement capacity and implementation results at regional level in respect to the priority Black Sea transboundary problems. It also identifies the gaps and obstacles in adapting or reforming the policy/legal framework.

The Governance Analysis methodology involved a review of the thematic reports as well as desk studies and consultation with national experts. The Stakeholders Analysis findings and the Causal Chain Analysis results conducted within the scope of the current TDA are also included.

A questionnaire was developed in order to review the actual national institutional structures capacity and resources, together with the current relevant legal instruments, with special emphasis on their actual implementation, compliance and enforcement. The review was conducted in all six Black Sea Countries by the TDA TTT National Experts.

Box 2.1: Comparative analysis of the 1996 and 2006 TDA components

A comparison between the 1996 and 2007 was always going to be difficult to undertake, not least because the two methodologies are quite different and much has been learnt about TDA design since the original TDA was produced. However, the table below outlines the key differences between the two approaches. The 1996 TDA uses a tabular approach with linked tables and a small amount of supporting information. The methodology, although logical, is difficult to navigate and lacks detail. The 2007 TDA follows a more conventional approach, in line with GEF 'best practice'.

Components	1996 TDA	2006/7 TDA
Description of the Black Sea region	• No Description of the Black Sea region was presented.	• A detailed description of the Black Sea region was produced. • This included the physical and geographical characteristics,, the socio-economic situation, biodiversity and ecosystem health, the status of nutrient and toxic pollutants, the institutional setting and stakeholders, and the public perception of environmental status, causes and responsibilities • This description set the scene for the more detailed analysis of the priority problems
Transboundary Problems	• Seven Major Perceived Problems were identified. These were: • Decline in Black Sea Commercial Fish Stocks • Loss of habitats, notably wetlands and shelf areas, supporting important biotic resources • Loss or imminent loss of endangered species and their genomes • Replacement of indigenous Black Sea species with exotic ones Degradation of the Black Sea landscape • Inadequate protection of marine and coastal resources from maritime accidents • Unsanitary conditions in many beaches, bathing and shellfish-growing waters.	• Four Priority Transboundary Problems were identified. These were: • Nutrient over-enrichment/eutrophication • Decline in natural resources (e.g. fisheries) • Chemical pollution • Habitat and biodiversity changes - including alien species introduction
Environmental impacts and socio-economic consequences	• No analysis of environmental impacts or socio-economic consequences was carried out	• An analysis of environmental impacts and socio-economic consequences was undertaken • This was dependent on the level of information and data available and varied from problem to problem
Causal Chain Analysis	• No Causal Chain Analysis was undertaken. • Five main root causes were identified and briefly described	• A detailed Causal Chain Analysis was carried out. This focused on: • Immediate causes • Underlying causes • Underlying socio-economic drivers • The level of information and data available varied from problem to problem
Knowledge gaps	• Uncertainties were identified in the problem matrices	• Knowledge gaps were identified for each transboundary problem
Stakeholder Analysis	• A stakeholder analysis was not presented in the TDA	• A detailed quantitative survey of stakeholders throughout the region was presented in the TDA • The analysis identified the stakeholders and provided insights into the concerns, priorities, capacities and perceptions of stakeholder groups throughout the region in regards to specific transboundary environmental issues.
Governance Analysis	• A detailed governance analysis was not undertaken	• A detailed governance analysis was presented in the TDA • The analysis identified institutional involvement in Black Sea related environmental problems, as well as the existing global/regional/national policies and provided insights into the coordination mechanisms, enforcement capacity and implementation results at regional level in respect to priority transboundary problems. • It also identifies the gaps and obstacles in adapting or reforming the policy/legal framework.
Actions and recommendations	• Detailed actions were outlined in the TDA. The actions were also costed, and products and milestones identified	• The 2007 TDA was developed using current GEF 'best practice' which states that the TDA should be a non-negotiated technical document. Consequently, recommendations were briefly outlined but further actions, costings and milestones were consigned to the SAP.

3. DESCRIPTION OF THE BLACK SEA REGION

3.1 Physical and geographical characteristics

The geographical scope of the Convention on the Protection of the Black Sea against Pollution is applied to the Black Sea proper, with the Southern boundary constituted, for the purposes of this Convention, by a line running between Capes Kelagra and Dalyan[6].

3.1.1 Geographic boundaries

The Black Sea is an inland Eurasian sea bordering Ukraine and the Russian Federation to the north, Bulgaria and Romania to the west, Georgia to the east and Turkey to the south (Fig. 3.1). The Black Sea is located between latitudes 40° 56'N and 46° 33'N, and longitudes 27° 27'E to 41° 42'E. It is located in the east-west depression between two alpine fold belts, the Pontic Mountains to the south and the Caucasus Mountains to the northeast. The topography of the north western coast (except for Crimea) is relatively low and flat.

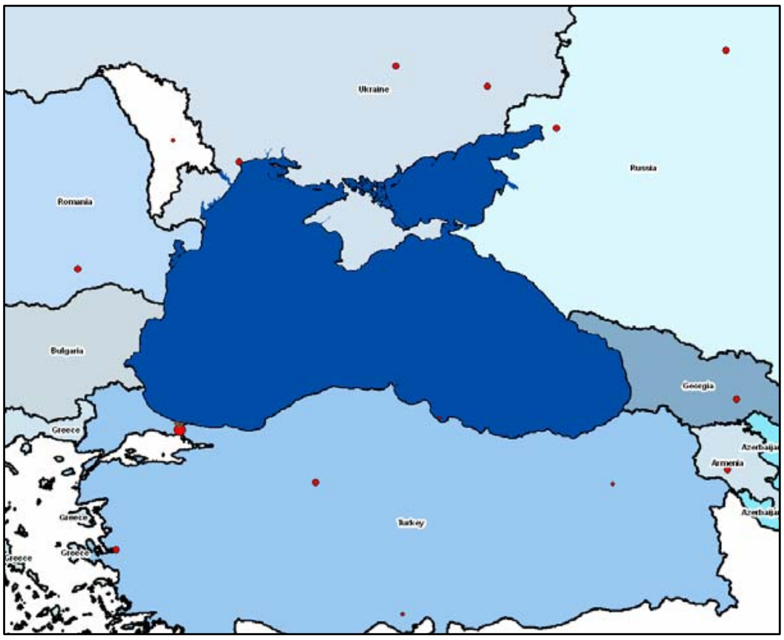

Figure 3.1 Geographical boundaries in Black Sea Region

The Black Sea is a semi-enclosed sea connected to the shallow (10–20 m) Azov Sea through the Kerch Straits and to the Mediterranean Sea through the Bosporus Straits, the Marmara Sea and the Dardanelles Straits. The flat abyssal plain (20% of free surface, depth. 2000 m) rises to the continental shelves. The northwestern shelf (mean depth 50 m) has a shelfbreak at about 100 m between the Crimean peninsula and Varna in the South. The Danube and the Kerch fans are gentle continental slopes. The other portions of the shelf are narrow (20 km), fractured by canyons, abrupt ridge extensions and steep continental slopes.

The only connection to other marine water bodies is through the winding Istanbul (Bosporus) Straits, a 35 km natural channel, as little as 40 m deep in places. The Black Sea is up to 2212 metres deep (North of İnebolu) and receives the drainage from a 1.9 million km^2 basin, covering about one third of the area of continental Europe. The Bosporus has a two layer

[6] http://www.blacksea-commission.org/main.htm

flow, carrying about 300 km^3 of seawater to the Black Sea from the Mediterranean along the bottom layer and returning a mixture of seawater and freshwater with twice this volume.

3.1.2 Bathymetry

The seabed is divided into the shelf, the continental slope and the deep-sea depression (Figure 3.2). The shelf occupies a large area in the north-western part of the Black Sea, where it is over 200 km wide and has a depth ranging from 0 to 160 m. In other parts of the sea it has a depth of less than 100 m and a width of 2.2 to 15 km. Near the Caucasian and Anatolian coasts the shelf is only a narrow intermittent strip. The thin upper layer of marine water (up to 150 m) supports the unique Black Sea ecosystem. The deeper and more dense water layers are saturated with hydrogen sulfide that has accumulated over thousands years as a by-product of decaying organic matter (Figure3.3). Due to the unique geomorphological structure and specific hydrochemical conditions, very specific organisms, including protozoa, bacteria, and some multi-cellular invertebrates, inhabit the deep-sea waters. Knowledge about forms of life in the deep waters of the Black Sea is very limited, but it is clear that disturbance of the natural balance between the two layers could trigger irreversible damage to the people and ecosystem of the Black Sea.

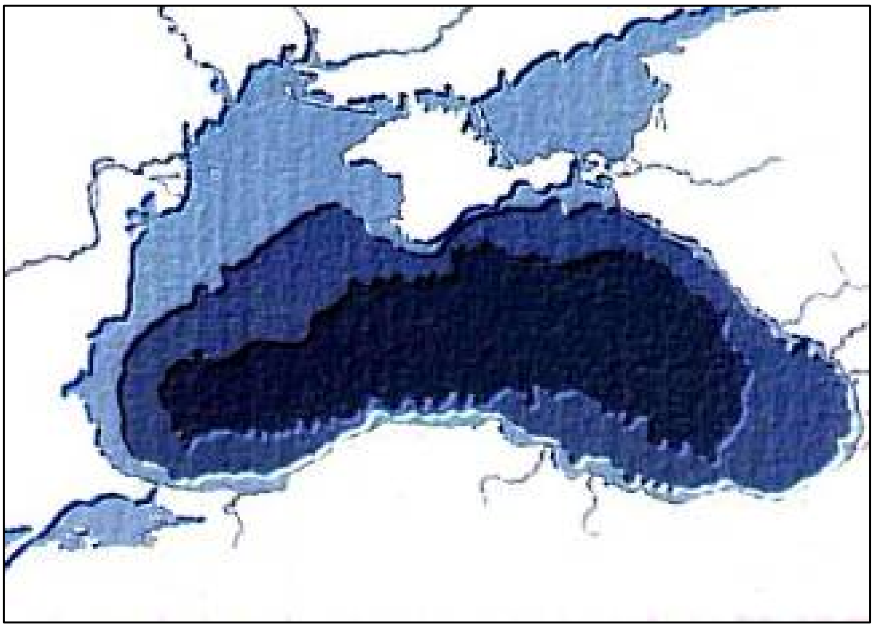

Figure 3.2 Black Sea bathymetry

3.1.3 Coastline characteristics

The length of the Black Sea shoreline is approximately 4,340 km (Table 3.1). The Black Sea has similar geological properties as the major oceans, and is classified geomorphologically into three key sections namely: (i) the continental shelf, (ii) the continental side, and (iii) the abrasion platform (2).The continental shelf covers 24.1% of the Black Sea surface area and has a 0.5-5‰ slope. This area generally extends 0-90 m depth from the shoreline. The continental shelf is very important for fishing, although it is quite narrow along the Anatolian and Caucasus coasts.

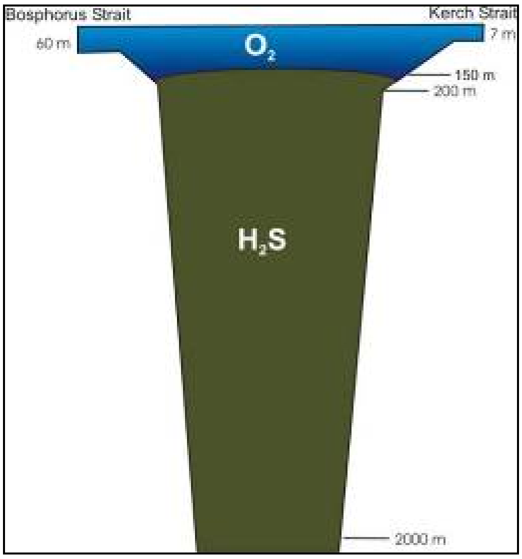

Figure 3.3 Profile of the hydrogen sulfide zone in the Black Sea

The length of national Black Sea costlines is presented in Table 3.1, Ukraine having the longest coast and Romania the shortest.

Table 3.1 Black Sea shoreline length (km)

Country	Length (km)
Bulgaria	300
Georgia	310
Romania	225
Russian Federation	475
Turkey	1,400
Ukraine	1,628
Total	4,338

3.1.4 River discharge

The main rivers in the Black Sea Region are the Danube, Dnipro, Rioni, Kodori, Inguri Chorokh, Kizilirmak,Yeshilirmak, Sakarya, Southern Bug and Dnister. Every year, some 350 km^3 of river water flows into the Black Sea. Discharges from the main rivers are presented in Table 3.2, with inflows of water from the Sea of Marmara (via the Bosphorus Strat) and the Sea of Azov (via the Kerch Strait) shown in Table 3.2. The areas of national Black Sea sub-basins are shown in Table 3.3.

3.1.5 Climate, agricultural production and river discharge

In a major part of the Black Sea Basin, the climate is similar to the Mediterranean (warm humid winters and hot dry summers) because the geography and macro circulation processes existing in the Mediterranean influence the climate of the Black Sea Basin. The south-eastern part, surrounded by the mountains, is characterized by a humid subtropical climate (abundant precipitation, warm winter, hot summer). Average periods of sunshine vary throughout the region – 2,432 hours in the Bosporus area, 2,237 hours in the Varna area and 2,223 hours per year in the Yalta area. The total amount of precipitation from the Bosporus to Varna is about 500-700 mm per year, in the north, near Odessa – 300-400 mm, in the southern coast of Crimea (Yalta) – 586 mm. The amount of annual precipitation increases eastward – 1,600 mm between Novorossiysk and Sukhumi, to 2,465 mm – in Batumi. In general, the Black Sea Basin climate is very favorable for tourism and recreation.

Table 3.2 Annual river discharge into the Black Sea (m^3/s)[7]

Country	River	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bulgaria	Kamchia									10.3	5.7	46.8
	Aheloy									0.1	0.0	0.3
	Veleka									4.1	2.2	18.3
	Ropotamo									0.1	0.1	0.5
	Batova									0.1	0.1	0.7
	Diavolska									0.0	0.0	0.1
	Dvoinitza									0.2	0.1	0.9
	Hadjiska									0.1	0.1	0.6
	Karaach									0.2	0.1	0.7
	Rezovska									1.8	1.0	7.9
Georgia[8]	Rioni	406.0	406.0	406.0	406.0	406.0	406.0	406.0	406.0	406.0	406.0	406.0
	Supsa	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0
	Chorakhi	409.0	409.0	409.0	409.0	409.0	409.0	409.0	409.0	409.0	409.0	409.0
	Natanebi	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
	Khobi	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5	50.5
	Kubastskali										0.3	0.3
Romania	Danube	6223.7	7035.8	6684.2	6654.1	7952.0	6580.6	6304.3	6837.1	5021.0	6524.0	8695.0
Russian Federation	Sochi	25.6	15.7	20.1	14.6	15.4	13.6	27.7	18.8	14.4	16.8	14.3
	Mzimta	66.4	49.0	55.1	-	42.8	48.4	63.1	70.9	54.5	60.2	72.3
	Khosta	6.9	4.2	5.3	4.6	4.7	4.0	6.7	5.6	4.6	5.9	5.8
	Tuapse	24.3										
Turkey	Sakarya	124.2	94.5	177.8	234.1	117.4	188.3	30.6	217.4	106.0	148.1	138.8
	Kızılırmak								21.0	21.0	2.9	21.0
	Filyos					53.7	139.8		21.0	97.5	21.3	97.0
	Yeşilırmak	161.7	182.0	121.1	211.2	99.7	105.7	165.0	165.0	165.0	165.1	165.1
	Coruh			219.8	279.9	185.9	170.0	151.6	215.0	215.0	210.0	215.0
Ukraine	Dniepro	1149.0	916.0	1160.0	1850.0	1820.0	1290.0	1390.0	1050.0	1100.0	1460.0	1460.0
	Southern Bug	70.1	121.0	97.8	109.0	93.7	88.5	94.7	80.5	121.0	81.6	103.0
	Dniester	213.0	295.0	303.0	420.0	342.0	249.0	303.0	265.0	175.0	205.0	269.0

Table 3.3 Annual river discharge into the Sea of Azov (m^3/s)

Country	River	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Russian Federation	Kuban	421.0	382.0	626.0	439.0	317.0	367.0	306.0	544.0	311.0		
	Don	666.0	837.0	637.0	679.0	733.0	680.0	648.0	599.0	766.0		

[7] Data provided by in-country national experts
[8] Discharge based on long-term investigations carried out before 1993

Table 3.4 Catchment area of the Black Sea (km^2) Russian Federation and Ukraine are only partially included

Country	Catchment Area (km^2)
Bulgaria	22,244
Georgia	32,816
Romania	90,894
The Russian Federation	49,8260
Turkey	246,525
Ukraine	367,230
Total	1,257,969

Because of its climate the Black Sea region is a productive farming area, where many varieties of plant crops are grown. Thus, for those countries having only a part of their territory included in the Basin, these national sub-basins represent important components of their respective national agricultural production balance sheets For example, in Bulgaria, land draining into the Black Sea contains.about 85% of the national cereal farmland, 76% of the land on which oil bearing crops are grown, 37% of the land used for forage crops and 47% of the area of national vineyards (Petkova, 2005). The agricultural area in the Turkish Black Sea sub-basin contains approximately one third of the total agriculture area of Turkey, supporting the production of a wide range of agricultural crops. For example, all of the tea grown in Turkey is produced in this area, 71% of national nut production, 57% of tuber crops, 39% of industrial crops, 33% of cereals, 24% of pulses and vegetables, 18% of fruits and 9 5% of oil seed production (Ulger 2005). For further comparison about one third of the agricultural area of Georgia is contained in its Black Sea sub-basin, where all of its national tea and citrus fruit ptoduction occurs, the vast majority (98%) of the country's volatile oil bearing plant production, about 80% of nuts, over 50% of other fruits, 40% of cereals, and over 30% of national vineyard production (Lagidze 2005 – data exclude statistics from the breakaway republic of Abkhazia). Similarly, the Black Sea coastal administrative areas of the Russian Federation, particularly Krasnodar Krai, constitute a nationally important agricultural region.

In addition to arable farming, the Black Sea Basin is also an important area for livestock farming. This is dealt with in more detail in Section 4.2.4.2.

Ocean current circulation in the Black Sea is characterized by a cyclonic system of currents Fig. 3.4). The dynamic system of the Black Sea has a distinct yearly cycle, with maximum circulation activity occuring during winter and spring.

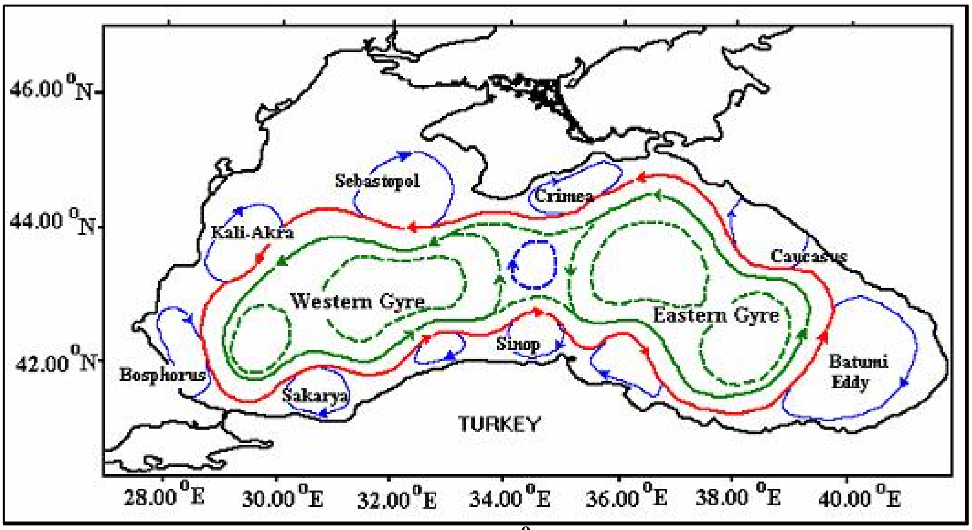

Figure 3.4 Schematic of Black Sea currents[9]

3.2 *Socio-economic situation*

Social and economic changes within the Black Sea Basin both impact the ecosystem and are impacted by many of the environmental changes that have been brought about during the last century. The historical socio-economic conditions of the Black Sea have largely shaped practices that continue to date. The shift from the Soviet economic system to a more free market system in the Warsaw Pact States, the movement towards EU accession of some countries, and economic fluctuations in the 1990s have influenced the ecosystem of the Black Sea.

The Black Sea countries coastal zones[10] are estimated to contain about 20 million people in their coastal areas. However, the situation with regard to Istanbul is confusing, since the coastal administrative unit which includes Istanbul has a short Black Sea coastline. Thus, if the population of this area is also included, the value increases to over 39 million people.

The proportion of national populations living within Black Sea coastal administrative areas varies widely: 0.6% in Russia, 4.5% in Romania, 10.5% in Turkey (excluding Istanbul), 14.4% in Ukraine, 26.5% in Bulgaria, 37.1% in Turkey (including Istanbul) and 38.6% in Georgia.

Available data suggest the proportions of populations living in coastal administrative areas which are connected to sewerage systems range from about 53% in Russia, through 70% in Turkey (excluding Istanbul) to >90% in Bulgaria, Georgia and Romania. (No information available for Ukraine). However, intuitively these values do appear to be on the high side, and bear no relationship to the level of treatment that is applied to the wastewater produced. A coastal population of some 7 million inhabitants are connected to sewerage systems discharging directly into the Sea.

3.2.1 Demographic trends

The population growth statistics in Fig. 3.5 demonstrate that the populations of the countries of the Black Sea Basin are experiencing a negative growth rate, with the exception of

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[9] Data source: Tugrul and Besiktepe (2006) after Oğuz *et al*, (1993)
[10] One national administrative unit (oblast, municipal area, etc.) inland from the coast.

Turkey. Even Turkey has shown a slowing growth rate since 1995. The years around 1998 and 1999 show a dramatic decline in Bulgaria, and Romania with a recovery in 2001 and 2002. Russia and Georgia both show increasing rates though the increase in Georgia slowed significantly in 1998. Trends in population growth rate generally reflect the over all optimism about social and economic development prospects, with people having more children as they feel more confident about economic development. However in many industrialized societies, a decline in population growth suggests that costs of living are increasing, and families are having fewer children in order to provide for those they have. The regional average (mean of all 5 countries regardless of total country population size) is low, although with the larger population in Russia and Turkey the overall rate may be slightly positive. Specific settlement patterns will be addressed below, as they pertain to urban populations as well as coastal growth rates.

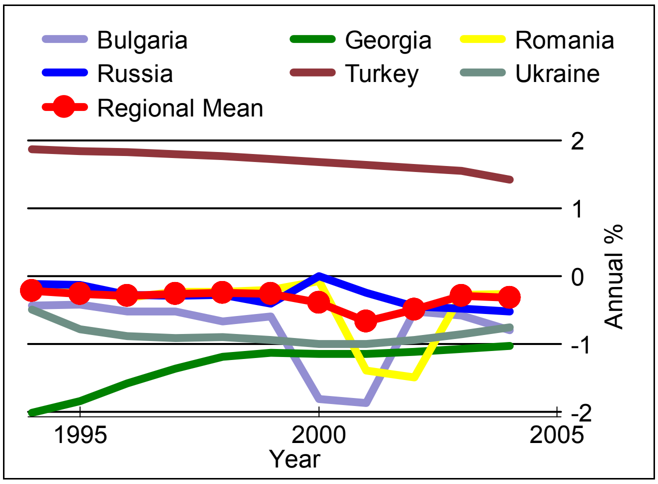

Figure 3.5 Annual regional population growth statistics[11]

Table 3.5 shows the total population of the Black Sea countries, and percent of the population under the age of 15, as well as the density of the populations. While Bulgaria, Georgia, Romania, Russia and Ukraine have youth populations commensurate with most industrial developed countries, Turkey's large youthful population (as nearly one third of the total population) indicates that the country's population is likely to continue to increase within the coming 20–40 years, putting additional pressures on natural resources.

The size of the urban population is increasing in all Black Sea countries (Figure 3.6), and as many towns and cities are in coastal areas, this will continue to result in increased pressure on the Sea itself. It should be noted that the increase in Turkey is especially stark, giving Istanbul the status of a "coastal mega-city" with an estimated population of about 15 million people. As the populations in Turkey is expected to expand, it is likely that this will have further impacts on the Sea if more stringent management of marine/coastal resource uses and better control of pollutant emissions from land do not occur.

[11]Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

Table 3.5 Regional population statistics (2005)[12]

Country	Total Population (millions)	Percentage of population aged 0-14 yrs	Country population density (people/km^2)	Total Population in the coastal zone (millions)	Population density in the coastal zone (people/km^2)
Bulgaria	8	14.1	70	2.1	60
Georgia	4	19.5	64	1.7[13]	76
Romania	22	15.9	94	0.97	62
Russia	143	15.7	9	0.89[14]	100
Turkey	73	29.5	94	7.6 (without Istanbul) 19.3 (Istanbul included)	74 (without Istanbul) 187 (Istanbul included)
Ukraine	47	15.4	81	6.7	60

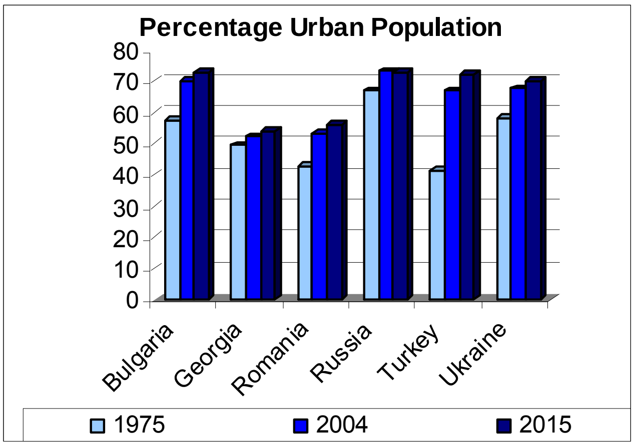

Figure 3.6 Regional urban population statistics[15]

The impacts of these populations are felt through activities that affect the Black Sea, as they are also impacted by conditions of the Black Sea and the Black Sea basin. The economic indicators provide an overview of how these populations are impacting the ecosystem of the Black Sea.

3.2.2 Economic indicators

Economic development indicators for the region provide a sense of how anthropogenic activities are driving resource use and therefore impacting ecological conditions.

[12] Date source: World Bank World Development Indicators at http://www.worldbank.org and national statistics provided by in-country experts
[13] Excluding Abkhazia
[14] Data only for Krasnodar Krai
[15] Data source: UN 2006 World Urbanization Prospects, the 2005 revision

Gross national income (GNI) *per capita*, provides a comparable standardized measure of the changes in the economic conditions across the region (Figure 3.7). There was a positive trend over all, although the 1997-1998 economic down turn which impacted Russia also had regional repercussions that slowed down growth. The current trend shows a positive increase which seems to portend well for populations the region as a whole.

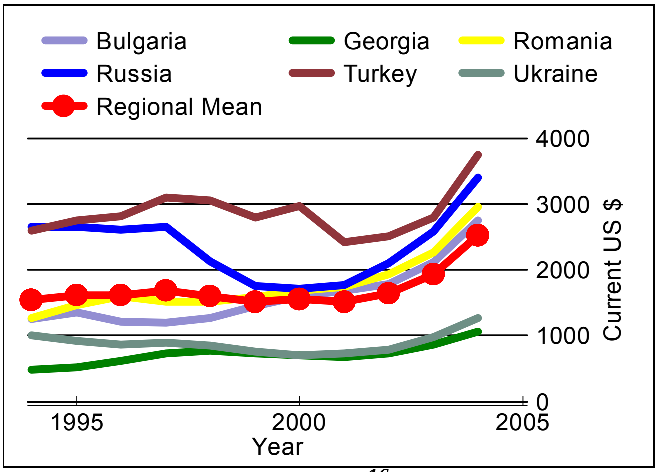

Figure 3.7 Gross national income *per capita*[16], Atlas method

While the economic measure of GNI *per capita* above appears to support significant economic growth in the region, this must also be compared to the rate of inflation as indicated through the Consumer Price Index (Figure 3.8). This suggests that inflation throughout the region is a significant concern, which will have resounding impacts on government revenues. This is especially significant for Turkey where the cost of a market basket of goods has more than tripled since the year 2000. While Georgia and Ukraine have experienced much lower rates of inflation, their lower rate of GNI *per capita* suggests that the increases though slight are also impacting populations and government revenues. The challenges of inflation creates environmental impacts for the Black Sea as governments must adjust budgets and meet demands for services with less value in the collected revenues than originally intended, and therefore diminishing the available resources to dedicate to environmental protection measures.

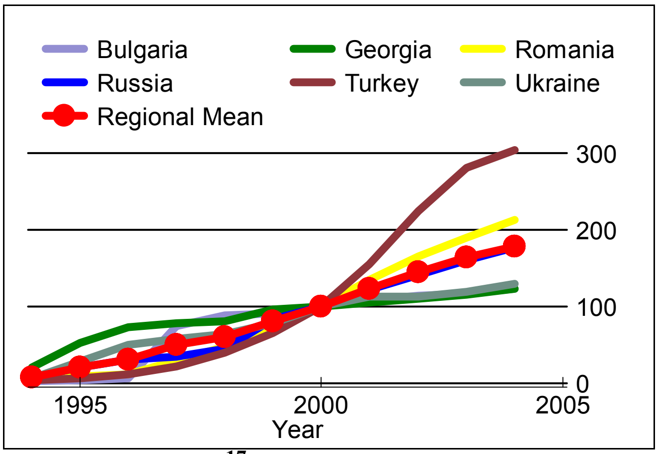

Figure 3.8 Consumer price index[17] for Black Sea countries

[16]The sum of values of all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

An overall decline in agricultural production has occurred in the region since 1994 (Fig. 3.9A). The most precipitous decrease has been in Georgia, with less severe decreases in other countries. On average, over the period shown, the importance of agriculture to the regional economy halved, with a similar, albeit less severe decline in the natural resource extraction and manufacturing industries (Fig. 3.9B), However, other sectors (notably the service industry) have increased their importance as contributors to regional GDP (Fig. 3.9C). Of all sectors, the services sector has the lowest direct environmental impact, though impacts occur indirectly through increase fuel consumption for transportation and energy. Nonetheless, this increase in the services sector suggests that the economies are shifting towards less intensive or impacting activities, and there should be an anticipated overall decline of ecological impacts in the region if this trend persists.

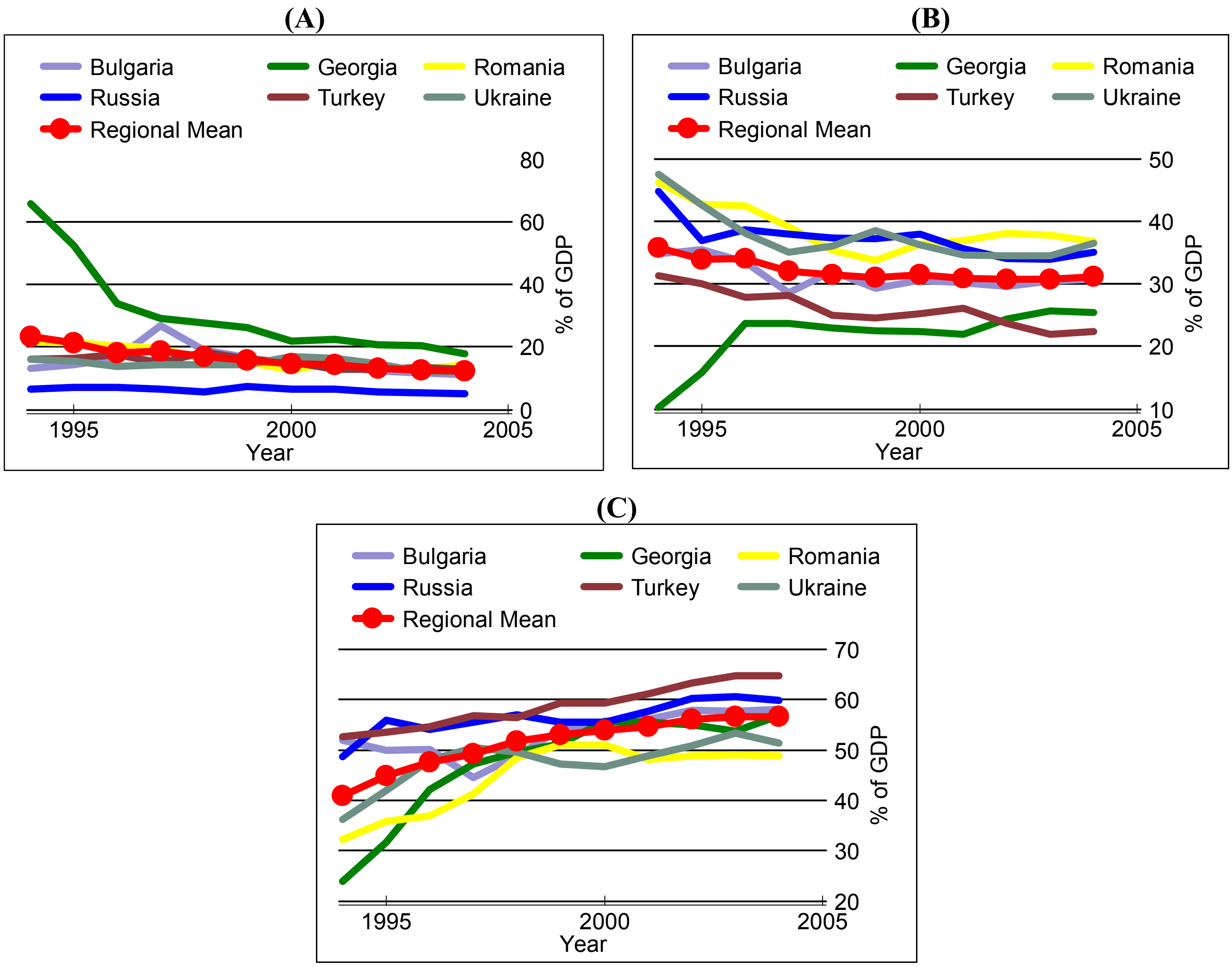

Figure 3.9 **Regional trends in (A) agricultural[18], (B) natural resource extraction and manufacturing[19], and (C) service sector[20] contributions to GDP (value added)**

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[17] Changes in the cost to the average consumer of acquiring a fixed basket of goods and services. The year 2000 = 100. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

[18] Includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

Data from World Bank Development Indicators database (http://www.worldbank.org) suggest that there has been either no change in the national areas of agricultural land, or only a minor decrease in agri-land area. This, however, could be misleading, since the classification of agricultural land used for this purpose includes that which is "temporarily" fallow. The reality is that land registered as being temporarily fallow could have been fallow for a long time. The same data source shows that a marginal decrease in inorganic fertilizers application rates occurred between 1994 and 2002, albeit with an upturn in the most recent years.

The value of livestock production has been fairly constant (Figure 3.10), though a notable increase occurred in Georgia prior to 1998, while there was a decline in Russia and Ukraine during this period. However, after this period the slight upturn in production suggests that continuation of this trend may be expected.

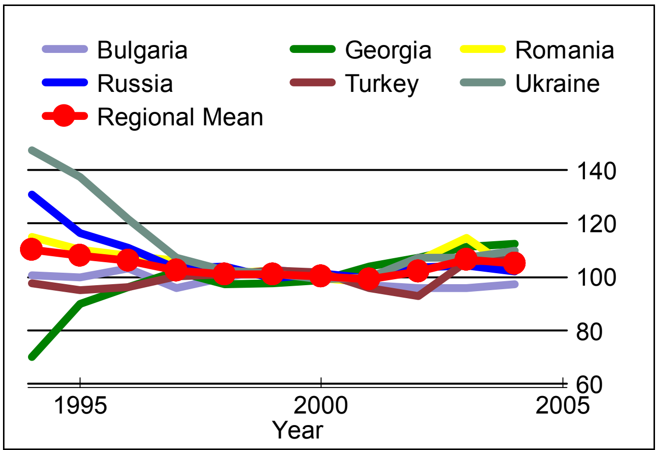


Figure 3.10 Regional livestock production index statistics[21]

By comparison, crop production index statistics have been more tumultuous (Fig. 3.11), with the disruptions of the 1998 economic downturn being evidenced in Russia, Bulgaria, Georgia and Ukraine. The Georgian rates remained suppressed, while the Romanian increased significantly since 2000. An upward trend in regional crop production since the late 1980s suggests that environmental impacts of the arable sector are likely to continue.

[19]Includes mining, manufacturing, construction, electricity, water, and gas. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

[20]Wholesale and retail trade (including hotels and restaurants), transport, government, financial, professional, and personal services (education, health care, etc.), real estate services. bank service charges and import duties. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

[21]Includes meat and milk from all sources, dairy products such as cheese, eggs, honey, raw silk, wool, hides and skins. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

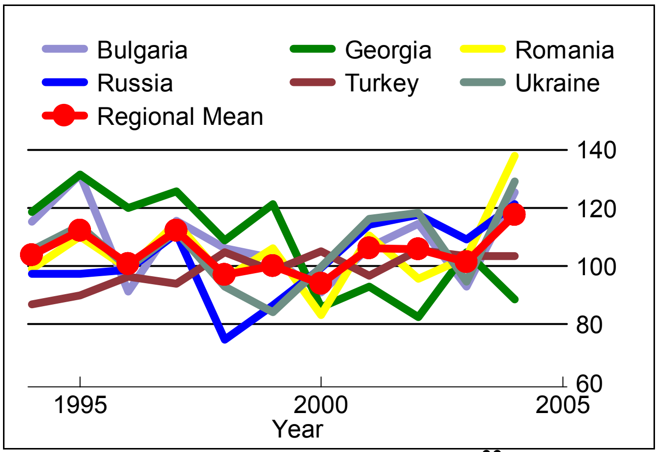


Figure 3.11 Regional crop production index statistics[22]

A particularly important trend in the Black Sea region is the growth in international tourism, particularly since 2000 (Fig. 3.12). The lack of data for Russia prior to 2001 alters the regional mean, but the rise suggests that there is a continuing increase, though this is national level data. Both standard tourism and eco-tourism within the Black Sea have the potential to gain status.

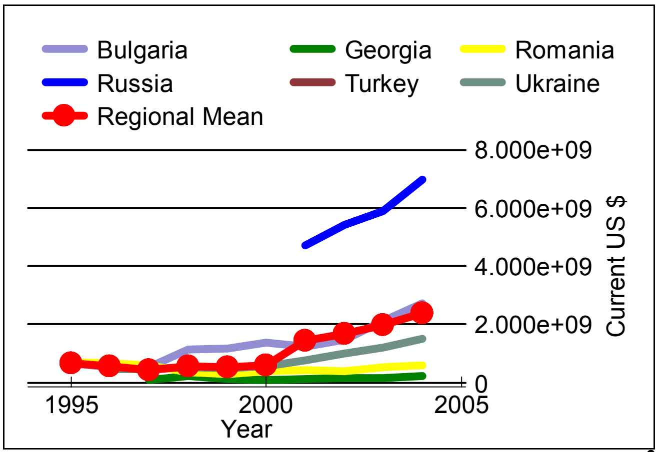


Figure 3.12 Regional trends in international tourism expenditure[23]

3.2.3 Social indicators

There has been a steady increase in human life expectancy in the region (Fig. 3.13) and a corresponding decrease in infant mortality, suggesting that overall health continues to improve. However, Russian life expectancy data took a downturn following the 1998 economic disruptions, which then leveled out, but still remains low. Infant mortality in Georgia remains higher than in other Black countries

[22]Crop production for each year relative to the base period (1999-2001). Includes all crops except fodder crops. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org
[23]Expenditures by international inbound visitors, including payments to national carriers for international transport. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

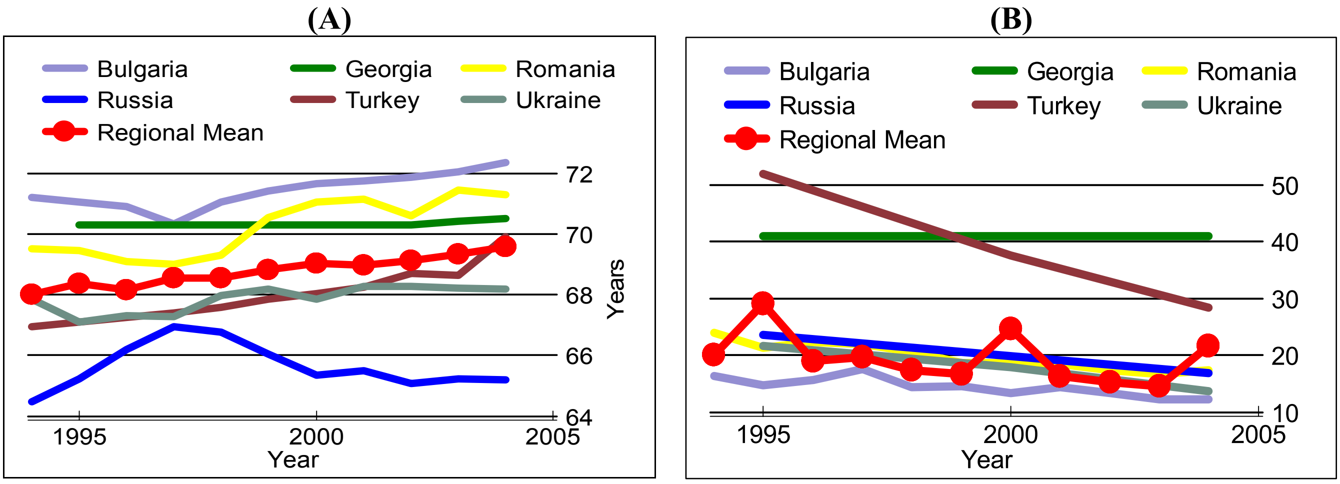


Figure 3.13 Regional trends in (A) life expectancy at birth[24] and (B) infant mortality rates[25]

The extent of basic education is a commonly accepted indicator of societal heath. Values of two indicators of this are shown in Fig. 3.14. It should be noted that in all cases the literacy rate is more than ten percent higher than it is for the US in the same time period. Thus, there is a regional norm of high literacy rates and relatively high primary completion rates. An interesting trend that could be inferred from this is the higher level of literacy rates among those over 15, compared to those in school currently. This suggests that there may be fewer students completing primary education now that during the soviet era. This trend is especially dominant in Georgia, Romania, and Ukraine, and should be monitored into the future.

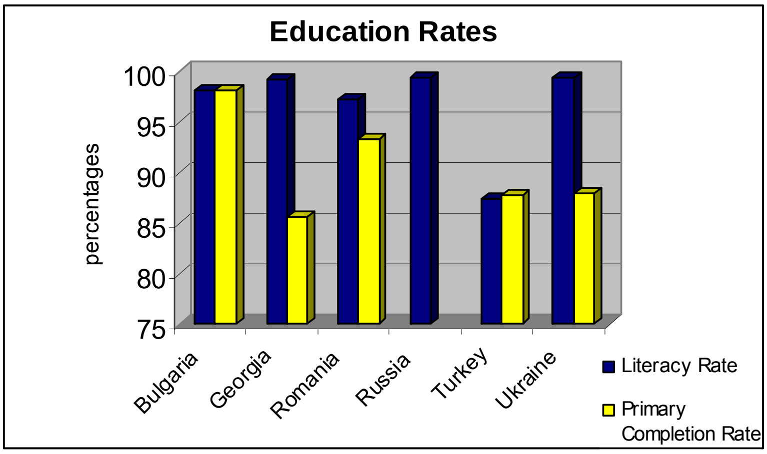


Figure 3.14 Regional statistics on the level of education (2004)[26]

The societal conditions directly influencing and impacted by water conditions in the region are reflected in Fig. 3.15. Overall the regional mean is high, although lower in Romania and Georgia. In order to come into compliance with the EU WFD, Romania is taking steps to improve these conditions in rural areas. Georgia is less able to make substantial

[24] Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org
[25] Number of infants dying before reaching one year of age. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org
[26] Includes adult literacy (age 15 years and above) and the percentage of students completing the last year of primary school. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

infrastructural ınvestments at this time, though efforts are being made at the national level to develop strategies to improve conditions.

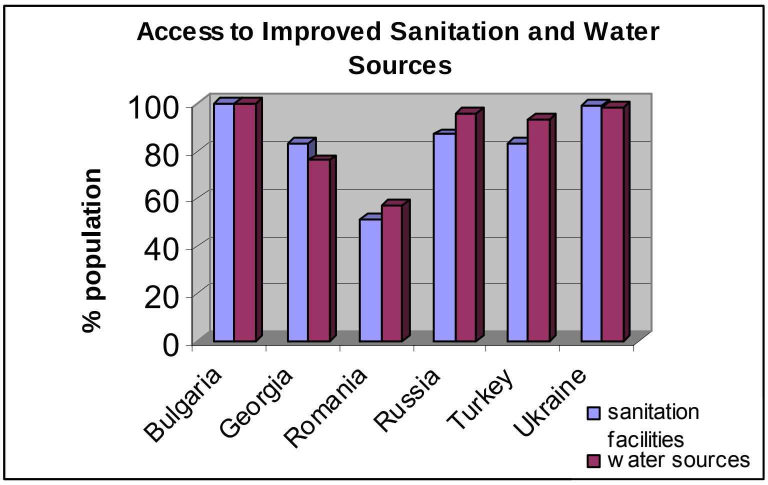


Figure 3.15 National access to improved sanitation and water sources[27]

3.3 Biodiversity and ecosystem health

3.1.1 Introduction

The ecological status of the Black Sea has varied greatly in the last 40 years, from a quasi-pristine environment in the 1960s, to a highly degraded situation in the 1980s, and more recently a situation of recovery. The following section briefly describes the status of the Black Sea ecosystem in terms of its biodiversity, habitats, alien species, protected areas and fisheries.

3.1.1 Ecosystem and habitat types

The Black Sea biota reflects the general historical processes that have influenced the ecosystem of the sea.

The main biotopes are sandy-bottom shallow-water areas, especially in the north-western part of the Black Sea and the Sea of Azov. The coasts of the southern Crimea, the Caucasus, Anatolia, some capes in the south-western part of the Black Sea (Kaliakra, Emine, Maslen Nos, Galata) and Zmeiny Island are mostly rocky. The sea beds are mostly mud in the zone between 10 to 20 m and 150 to 200 m depth. The total area of Black Sea coastal wetlands is about 10 000 km^2. There are sites of reproduction and feeding and wintering grounds of many rare and commercially valuable fish species, including the sturgeon family, and are therefore biotopes of special importance. Anoxic conditions occurring below about 120-200 m depth delimit the vertical distribution of planktonic and nektonic organisms, as well as bottom-living organisms. The structure of marine ecosystems differs from that of the neighbouring Mediterranean Sea in that species variety is lower and the dominant groups are

[27]Facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained. access to at least 20 litres/day of water from an improved source (within 1 km of the dwelling), such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Data source: 2005 World Bank Development Indicators database at http://www.worldbank.org

different. However, the abundance, total biomass and productivity of the Black Sea are much higher than in the Mediterranean Sea (Alexandrov & Zaitsev, 1998; Zaitsev & Alexandrov, 2000).

3.3.2 Phytoplankton and zooplankton

Black Sea coastal waters and the continental shelf are predominantly eutrophic (rich in nutrients), the central part is mesotrophic (medium level of nutrients) in character, and significant parts are hypertrophic (high level of nutrients). The largest hypertrophic areas are located in the north-western part of the Black Sea in the zone influenced by inflow from the Danube, Dniester and Dnieper rivers which have high levels of chlorophyll. Phytoplankton reacts to anthropogenic impacts by alterations in species composition and abundance and the timing and duration of blooming events. The status of phytoplankton and zooplankton can be assessed using a range of indicators including abundance, biomass and community composition The sections below outline briefly their current status.

3.3.2.1 Phytoplankton abundance and biomass[28]

Phytoplankton abundance and biomass have shown considerable inter-annual variability over the last two decades (Fig. 16). In 2001, when a temporary return of hypoxic conditions was observed an increase in abundance occurred equivalent to that observed in the 1980s. However, when longer-term averages are considered, an emerging pattern of reducing phytoplankton biomass can be seen. A similar pattern of decreasing phytoplankton biomass is shown throughout the Black Sea as a whole (1997-2005) by remote sensing imagery of chlorophyll-like substances[29] (http://marine.jrc.cec.eu.int/frames/archive_seawifs.htm).

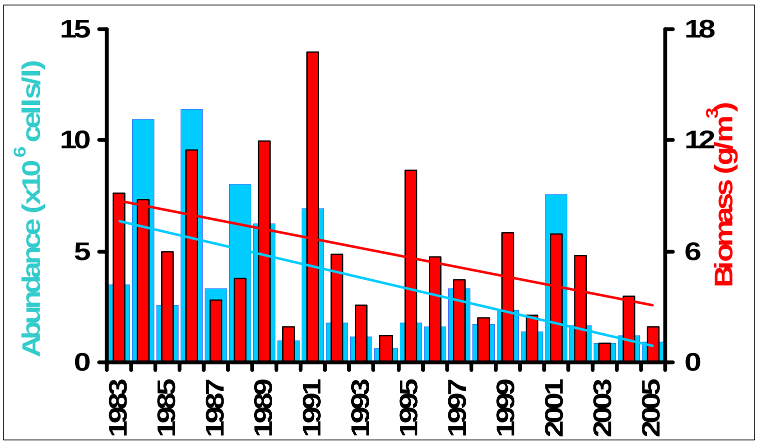


Figure 3.16 Phytoplankton cell density and biomass (average annual data) offshore of Constanta, Romania (1983-2005)[30]

[28] Phytoplankton data can be considered both in terms of major taxonomic groups and in terms of cell density and biomass-related factors. Of the latter two, biomass is the more important indicator, because of the large variability in size between different species and the fact that phytoplankton community composition changes on a seasonal basis.

[29] Chlorophyll-a typically comprises 1-2 % by dry weight of phytoplankton. Trends in satellite-derived images of chlorophyll-like substance concentrations therefore provide an indicator of changes in phytoplankton biomass in surface waters.

[30] Data source: Dr A. Cociasu, National Institute for Marine Research and Development, Constanta, Romania

3.3.2.2 Phytoplankton community composition[31]

Plankton community composition also indicates that recovery is starting to taking place. Unfortunately, taxonomic data are not available from the 1960s reference period, but it is clear that in terms of the contribution of major taxonomic groups to total phytoplankton biomass, at least, the status in recent years has returned to a situation resembling that in the 1980s. Post-2000, the situation with regard to cell counts has been rather less straightforward, since a temporary return of eutrophic conditions in 2001 was reflected very strongly in phytoplankton community composition results(Anon, 2006).

3.3.2.3 Zooplankton abundance

Phytoplankton-eating microzooplankton in the Black Sea are dominated by Cladocera and Copepoda, long-term data for which present an interesting reflection of the biological changes that have occurred since the 1960s. Figure 3.17 shows a clear long-term trend of declining abundance, with extrapolation of the long-term linear regression line suggesting that by 2006, zooplankton abundance would have been a full order of magnitude lower than that in 1967. However, there is a great deal of inter-annual variability in the figures, and when only more recent data are considered (1997-2005), these suggest that zooplankton abundance has actually levelled off or increased over the last decade.

This huge depression (and possible start of recovery) in the zooplankton community can be related to many different factors – mass development of inedible phytoplankton species, *Mnemiopsis* (Fig. 3.18) outbursts, increase in small pelagic fish population, etc. (Prodanov *et al*, 1997). Of particulat interest is the correspondingly huge increase in *Noctiluca* abundance and biomass. *Noctiluca scintilans* is a large heterotrophic dinoflagellate (and therefore technically a member of the phytoplankton community), which because of its large size is monitored as part of the zooplankton community. The growth of thsi organism is stimulated by organic enrichment, as well increased nutrient levels. During blooms *Noctiluca* can account for well in excess of 90% of zooplankton biomass in coastal areas of the NW Shelf. The first positive sign in the 1990s was a reduction in the summer biomass of phytoplankton (Mee, 1999).

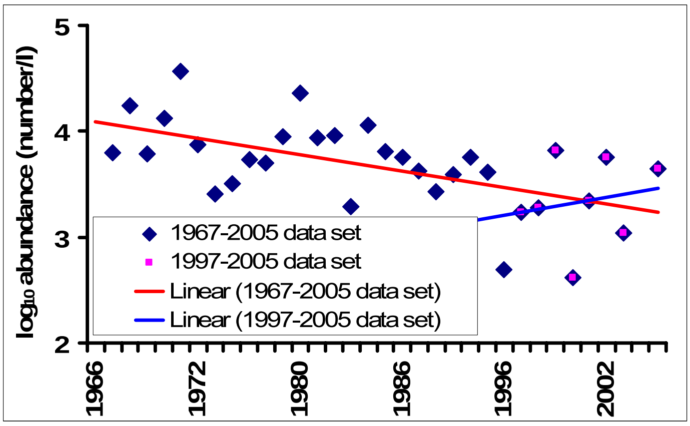


Figure 3.17 Long-term summer abundance of Cladocera and Copepoda three nautical miles offshore of Cape Galata, Bulgaria (1967-2005)[32]

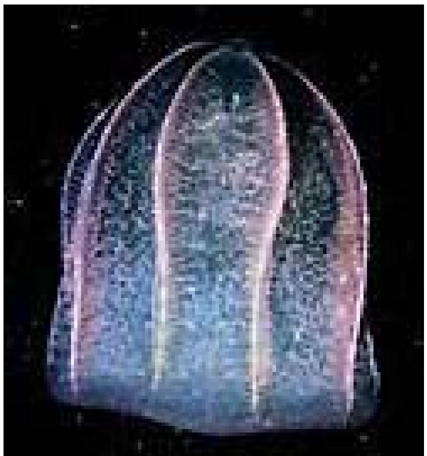
[31] The ratio between major phytoplankton taxonomic groups can also be used as an indicator of ecosystem status. As with phytoplankton biomass/abundance data there is considerable inter-annual variability. Nevertheless, grouping data from longer periods of time together can yield interesting results

[32] Data source: 1967-1994, Prof. A. Konsulov, 1994-2002, Dr. L. Kamburska; 2003-2005, Dr K Stefanova, IO-BAS. All data provided by Dr Stefanova, Institute of Oceanology – Bulgarian Academy of Sciences, Varna.

Mnemiopsis, a highly reroductive and fast-growing comb jelly which feeds on zooplankton and fish larvae, was first ıdentıfied ın the Black Sea during the early 1980s. By the mid 1990s, there was estimated to be approaching one billion tonnes of this organism in the Black and Azov seas, responsible (in part at least) for a huge decline in fish stocks and fish yields from the Sea. However, in 1997 another invasive comb jelly, *Beroe ovata* (Fig. 3.18), which feeds almost exclusively on *Mnemiopsis*, was identified in the Black Sea. Since this time, it appears that the trend of decreasing numbers of phytoplankton-eating zooplankton has begun to reverse (Fig. 3.17), possibly as a consequence of *Beroe*'s appearence, but the data are so variable that this is not possible to say with any certainty. The highly seasonal reproductive pattern of *Beroe ovata* means that long-term *Mnemiopsis* eradication due to the introduction of *Beroe ovata* is unlikely. Assessment of the comb jelly situation over the past decade is also complicated by the natural 3-4 year cycle of *Mnemiopsis* abundance/biomass, which occurs in both the NE Atlantic (from where *Mnemiopsis* originates) and the Black Sea.

Whether *Mnemiopsis* still constitutes a threat to fishery productivity is a moot point (*Mnemiopsis* competes with zooplankton-eating fish for food and also preys directly on fish larvae) . However, *Mnemiopsis* abundance values in NW Shelf waters were high during summer 2006, and conversations with Turkish fishermen suggest that the 2007 anchovy season was of a shorter duration than usual, resulting in reduced catches (albeit unquantified at this time). Since anchovy makes a far greater contribution to total fish catch statistics than any other species, 2007 total catch statistics could be low, reversing the trend of recent years (Fig. 4.5).

(A)



(B)

Figure 3.18 A tale of two jellies: (A) *Mnemiopsis leidyi* and (B) *Beroe ovata*[33]

3.3.3 Seaweeds and zoobenthos

There are a number of identified benthic habitats of transboundary importance. These include: *Mytilus galloprovincialis* habitats; *Cystoseira* habitats; *Zostera* beds; and sublittoral sands.

During the last two decades, the areas covered by eelgrass (*Zostera*) have decreased tenfold in shallow waters. The typical 'Zernov's *Phyllophora* field', in the centre of the north-west

[33]Photographs courtesy of Lyubomir Klissurov

shelf, at 20-50 m depth, is an example of a habitat destruction due to human activity. The red algae *Phyllophora* was not only an important generator of oxygen and the nucleus of a benthic community, which included 118 species of invertebrates and 47 species of fish, but was also commercially harvested for the extraction of gelatine used as an ingredient for microbiological cultures, medicine, food industry and other purposes. *Phyllophora* dominated an area of the north-west shelf with the combined size of Belgium and the Netherlands. During the 1970s and 1980s, the north-west shelf ecosystem collapsed suddenly and catastrophically due to eutrophication, silting and other factors.Eutrophication has led to an increase of some algae such as the link frond (*Enteromorpha*) and red algae (*Ceramium*).

The Black Sea macrozoobenthos is represented by approximately 800 species, the status of which can be assessed using a range of indicators including abundance, biomass, number of species present and biological indices. The information presented below is a summary of the results from the Phase I BSERP research cruises of 2003 and 2006.

3.3.3.1 Zoobenthos abundance and biomass

Although the coastal area is free of hydrogen sulphide, concentrations increase rapidly under the thermocline due to the restricted ventilation of deeper shelf water. Consequently, the number of macrobenthic species decreases rapidly with increasing depth - only the polychaete worm *Notomastus profundus* is found below about 120 m.

Abundance/biomass increases in front of the Danube delta and Constanta (Romania), with decreased abundance in front of Odessa (Ukraine), possibly due to contamination by pesticides, and at more southerly Bulgarian sites. Offshore, abundance/biomass clearly decreases due to the reduced influence of major rivers (the Danube and Dniester) which provide an import source of nutrients and organic carbon which are cycled through the food chain.

3.3.3.2 Zoobenthos species diversity

Higher species richness in shallower waters is associated with good dissolved oxygen conditions whilst in deeper areas there is lower diversity due to natural oxygen depletion with increasing depth in the Black Sea. In the shallow Danube delta and Odessa areas low benthic diversity is preconditioned by the content of silt/clay fraction in sediments and aggravated by decreased oxygen concentrations associated with anthropogenic eutrophication. The effect of toxic substances may also play a role in the Odessa area.

Figure 3.19 ıllustrates the change in zoobenthos status between 1988 and 2003 with a 1960s reference. Since the mid-1990s, the number of species has doubled although the number is still somewhat lower than the “reference” situation of the1960s.

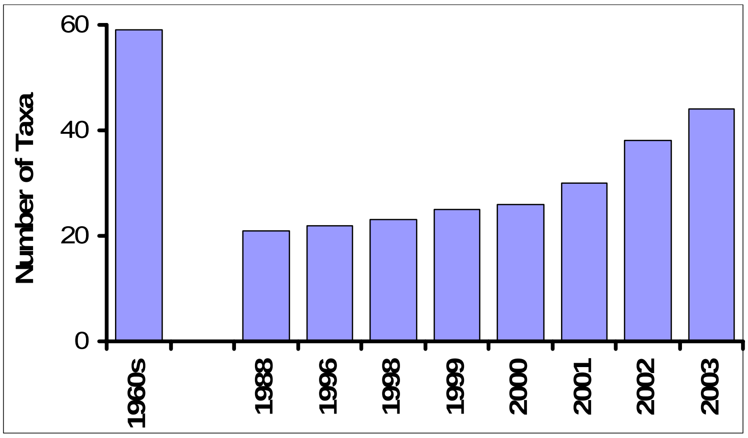


Figure 3.19 Number of macrozoobenthos species near Constanta, Romania (1960s-2003)[34]

3.3.3.2 Zoobenthos indices

The Bulgarian coastal area is distinguished by good, occasionally high zoobenthic status. The Danube plume area is characterised by moderate to poor zoobenthic status, although improving status is evident in more southerly Romanian wasters (with increasing distance from the Danube). The Dniester area coastal stations are moderately disturbed with an improving situation offshore. The zoobenthos status in the Odessa area contradicts those of other zoobenthic indicators (lowest abundance of crustaceans, lowest species richness, absence of adult molluscs, etc.). Deep area stations are generally considered to be undisturbed.

3.3.4 Large fauna

3.3.4.1 Fish and shellfish

The total fish fauna in the Black Sea was 171 species in 2002 (Zaitsev *et al*, 2002). This was an increase from previous numbers as a result of the accidental introduction of the Far-Eastern haarder *Mugil soiuy* and the carp *Oryzias latipes* after escaping from fish farms.

Bottom trawling for the shellfish *Rapana thomasiana* has become widespread along the Bulgarian Black Sea coast during the past decade, and has raised significant environmental concerns. Assessment of its impact on benthic communities reveals disruption of mussel bed and transformation of the bottom community from epifauna (mussels and crustaceans) dominated to infauna (clams and polychaetes) dominated, which is generally less diverse (Konsulova *et al*., 2003). The status of Black sea fisheries is dealt with in more detail in Section 3.3.8.

3.3.4.2 Birds

Due to the specific bio-geographic position of the Black Sea in Europe and in the Western Palaearctic, the Black Sea coasts are situated on main bird migration routes that stretch from the Arctic to South Africa, therefore the coastal waters provide nesting/wintering/roosting habitats for a variety of migratory waterfowl The wetlands of the Black Sea basin provide refuge for 25 million migrating waterfowl every year (Zaitsev *et al*, 2002). There are about 160,000 pairs of nesting waterfowl and 480,000 individual wintering birds in the Black Sea wetlands (Chernichko *et al*., 1993). The most significant habitats are situated in the coastal

[34] Data source: Dr C. Dumitrache, National Institute for Marine Research and Development, Constanta, Romania

area of Romania (Danube Delta), Ukraine and the Russian Federation from the Danube Delta to the Tamansky Peninsula in the Kerch Strait. More than 75 % of the Black Sea birds concentrate here and one third of their number inhabit the Danube Delta. There are 320 bird species in the Danube Delta. Of great importance in the Danube Delta are the pygmy cormorant *Phalacrocorax pygmeus*; the red-breasted goose *Branta ruficollis* – 275,000 - of winter winter there (over one tenth of the world's population); the white pelican *Pelecanus onocrotalus*; the Dalmatian pelican *Pelecanus crispus*; and the white-tailed eagle *Haliacetus albicilla* (eight pairs of this species in the Romanian part [Green, 1992] and three in the Ukrainian part of the delta [Zhmud, pers. comm.]). The region's sea birds include gulls (*Larus* spp) and terns (*Sterna* spp). During migration seasons, the bird fauna is diversified by numerous species of sandpipers and ducks.

3.3.4.3 Mammals

Four species of mammal occur in the Black Sea: the monk seal (*Monachus monachus*), which is on the verge of extinction, and three species of dolphins, the bottlenose dolphin (*Tursiops truncatus ponticus*), the common dolphin (*Delphinus delphis ponticus*) and the harbour porpoise (*Phocaena phocaena relicta*). At the start of the 1950s the Black Sea was home to about 1 million dolphins. Although hunting for dolphins has been banned since 1966 their population by the end of the 1980s was less than 50,000 to 100,000.

3.3.5 Alien species introduction

Economic globalisation provided unprecedented opportunities for species to overcome geographic barriers and establish in new habitats. Enclosed or semi enclosed ecosystems, as the Black Sea, seem particularly sensitive to biological invasions. With the increased shipping traffic, aquaculture and trade the Black Sea has become a major recipient of alien species. The shared marine environment contributes to the spread of alien species from one national sector to the others. Alien species can cause irreversible environmental impact at the genetic, species and ecosystem levels in ways that cause significant damage to the goods and services provided by ecosystems and thus to human interests. For this reason, they are now recognized as one of the great biological threats to the environment and economic welfare globally.

An inventory of the aquatic and semi-aquatic alien species recorded in the Black Sea marine and coastal habitats is given in Annex 6. The number of registered alien species at the regional level amounts to 217 (parasites and mycelium excluded). Nearly half of them (102) are permanently established, a quarter - highly or moderately invasive (20 and 35 species respectively). This high ratio of invasive aliens suggests serious impact on the Black Sea native biological diversity and negative consequences for human activities and economic interests.

Figure 3.20 shows the number of permanently, temporarıly and recently established alien species per decade of first occurrence or first published record. Despite the uncertainty deriving from lag time between actual introduction and first observation/publishing and many unknown alien species (esp. planktonic) due to low research effort, the figure is still indicative of the increasing introduction rates throughout the previous century and currently. During the last decade (1996-2005) a total of 48 new alien species were recorded, which represent over 22 % of all registered aliens. The majority belong to phytoplankton (16) and zoobenthos (15), followed by zooplankton (8), fishes (5), macroalgae (3) and mammals (1). The establishment success and potential impacts of those is mostly unknown yet due to short period after introduction but certainly increasing rate of alien introduction represents an issue of ecological and economic concern and needs political action and proper management.

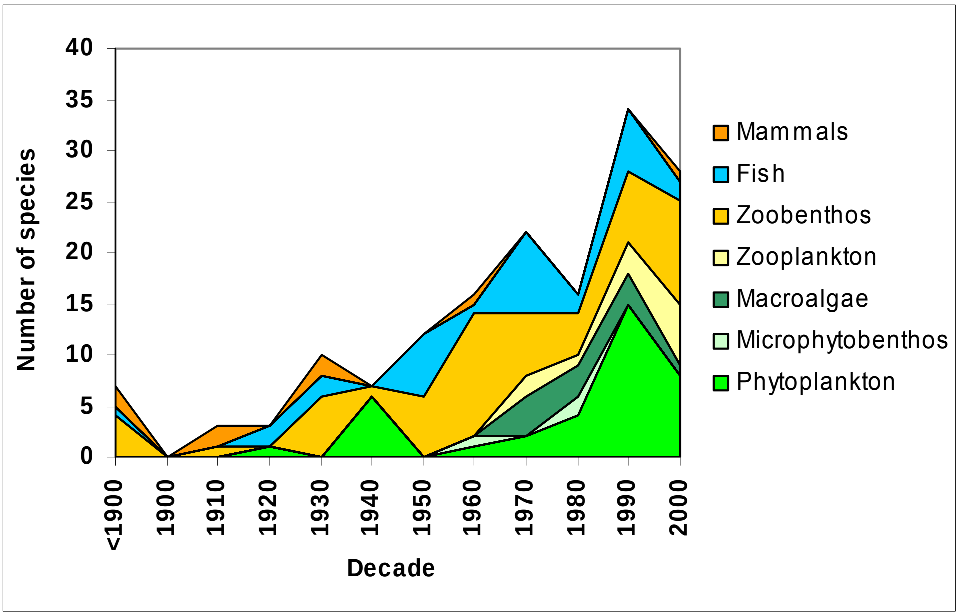


Figure 3.20 Number of new recorded alien species (Black Sea and coastal aquatic habitats) per decade

3.3.6 Loss/decline of biodiversity at the species level – IUCN red list species

Extinction is perhaps the most fundamental form of biodiversity loss that has resonance with the public and decision makers, and which has clear relevance to ecological processes and ecosystem function. Within the last 100 years, the Black Sea biota has undergone dramatic change. Since the beginning of the 20th century, species started declining and local/regional extinctions occurred as early as the 1960s. As an example, at this time (which is now considered to be the reference period for the Black Sea), commercially important bivalve molluscs like *Ostrea edulis* and *Solen marginatus* and highly prized fish like tuna and swordfish were already extinct in Romania and Bulgaria.

The list of threatened species in the Black Sea (Annex 5) is far from being complete. It is not a comprehensive list of all species which need conservation efforts around the Black Sea, but rather a compilation of what little has been evaluated until now in the surrounding countries. For most taxonomic groups, except for birds and mammals, the list badly needs significant inputs.

3.3.7 Protected areas

The Black Sea community has a global responsibility to preserve the character of its varied ecosystems and landscapes, and to conserve the migratory species that cross the region and the threatened species that it hosts. Measures taken to conserve or restore habitats and species in the Black Sea entail the establishment of protected areas as a major approach of *in situ* biodiversity conservation.

The total surface of Black Sea marine and coastal protected areas by country is given in Table 3.6. The statistics show that the largest marine protected areas (MPAs) are designated by Ukraine, while protected wetlands and coastal terrestrial areas are the largest in Romania. Romania leads in terms of protected marine area per unit shoreline, followed by Ukraine and Georgia. In Bulgaria, the coverage of MPAs is clearly insufficient. Turkey has no designated MPAs, and the least coverage of coastal protected areas compared with other Black Sea countries, albeit that Russian data were not provided.

Table 3.6 Total surface of Black Sea marine and coastal protected areas by country and marine protected areas (MPA) per unit shoreline

Country	Protected areas (ha)				Shoreline length	MPA(ha)/ shoreline(km)
	Marine	Coastal wetlands	Coastal terrestrial	Total		
Bulgaria	1160	16902.23	115589.9	**133652.13**	300	4
Georgia	15742	0	28571	**44313**	310	51
Romania	21000	339336.98	226008	**586344.98**	225	93
Russia	No data	No data	No data	**-**	475	-
Turkey	0	31335	3000	**34335**	1400	0
Ukraine	123530.7	92497.7	68658	**284686.4**	1628	76
Total	**161432.7**	**480071.9**	**441826.9**	**1083331.5**	**4338**	**-**

The majority of protected marine and coastal areas (93%) were declared during the 1990s, which is indicative of significant recent progress in *in situ* conservation of biodiversity in the Black Sea region. Romania ranks first (56%) regarding surface of protected areas designated during the 1990s, followed by Ukraine (22%) Bulgaria (10 %) and Georgia (4%), while Turkey has not declared any protected areas during this period.

3.3.8 Status of fisheries

Fisheries and aquaculture provide a vital source of food, employment, recreation and trade which supports the Black Sea region communities. Both fisheries and aquaculture are critical to the social and economic health of the region. After 50 years of rapid geographical expansion of the fishing areas, together with advances in fishing technology, increases in catches and shifts in fish populations, in combination with the impacts of invasive species, the greater Black Sea fisheries are at a critical point.

Due to over-fishing in the early 1970s-1980s, the structure of catches shifted significantly. Declining stocks of predatory species such as bonito (*Sarda sarda)*, horse mackerel (*Trachurus trachurus*), bluefish (*Pomatomus saltatrix*) and others resulted in an increase in non-predatory species such as anchovy (*Engraulis encrasicolus*) and sprat (*Sprattus sprattus)*. Consequently, fishing fleets have increasingly targeted these species.

During this period, the number of commercially (valuable) exploited fish species declined from twenty to only five. Extensive expansion of fishing fleet capacity, especially of purse seine and trawlers in the mid 1980s, led to catch rates of between 800,000-900,000 tonnes per year. Catches have increased since the mid-1990s, but are still only about half of this amount (Fig. 4.5).

The combined factors of over fishing and invasive species led to a near complete collapse of the Black Sea fisheries in the 1990's. The previous Black Sea SAP sought to address this issue through the revitalization of marine living resources. Since this time there has been a slow but continuous process of improvement in many ecosystem components of the Black Sea. The rehabilitation of marine living resources has been also noted, but it has not been symmetrical in terms of either geography or species structure.

Since the mid-1990s the number of large fishing vessels in the Black Sea has increased (Fig. 3.21). High value species, such as sturgeon (Acipenseridae), turbot (*Psetta maxima*) and spiny dogfish (*Squalus acanthias*) continue to be threatened by over fishing. Recognizing that sturgeon stocks in the BlackSea/lower Danube River have been seriously depleted, Bulgaria, Romania and Ukraine (and Serbia) have requested zero CITES quotas for these fish in 2007.

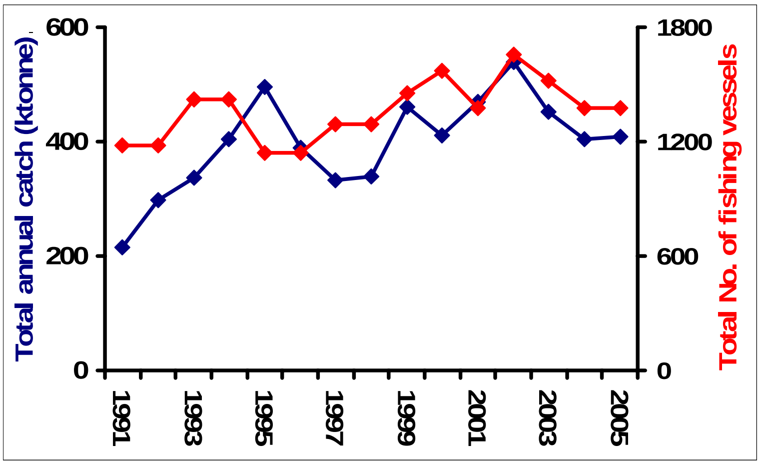


Figure 3.21 Total fish landings from and total number of fishing vessels >12 m length in the Black Sea, 1991-2005

Fish consumption within the region continues to increase and, as market demand increases, it is expected that this will result in increased pressure on fish (populations) stocks in the Black Sea. Despite these challenges, the economic importance of Black Sea fisheries remains high, contributing to employment both directly and in supporting sectors in communities around the Black Sea coast.

Recently, new "ecosystem-based fisheries management" approaches have been advocated, but these must also address issues influencing fisheries such as land based pollution, habitat deterioration, nutrient loading and eutrophication, as well as the impact of industrial fishing techniques. In addition, consideration related to biodiversity shifts, and climate change will have impacts on the health of fisheries in the Black Sea.

3.4 Status of chemical pollutants

This section, and Section 3.5, are not intended to provide a thorough overview of water quality in the Black Sea, but by focusing on specific pollutants it is intended to demonstrate which areas of the Sea have the highest levels of contamination and where there are problems in making a regional assessment of pollution status because of the lack of monitoring data collection/provision.

3.4.1 Water column

Fig. 3.22 shows average concentrations of four parameters in surface waters (0-10 m) of the Black Sea, with nitrate and phosphate displayed in Fig. 3.24. The data are not de-seasonalised and are presented with reference to a quantile (5-class) system, such that for each parameter approximately 20% of the results fall into each class. For each map, the darker the colour the greater the concentration, with class boundaries as follows:

Colour	BOD_5 (mg/l)	Dissolved copper (µg/l)	Total petroleum hydrocarbons (mg/l)	Total suspended solids (mg/l)
	<1.125	<1.000	<0.018	<1.550
	>1.125-2.137	>1.001-2.667	>0.018-0.020	>1.550-4.194
	>2.137-2.948	>2.667-3.000	>0.020-0.050	>4.194-8.031
	>2.948-4.780	>3.000-13.346	>0.050-0.180	>8.031-14.853
	>4.780	>13.346	>0.180	>14.853

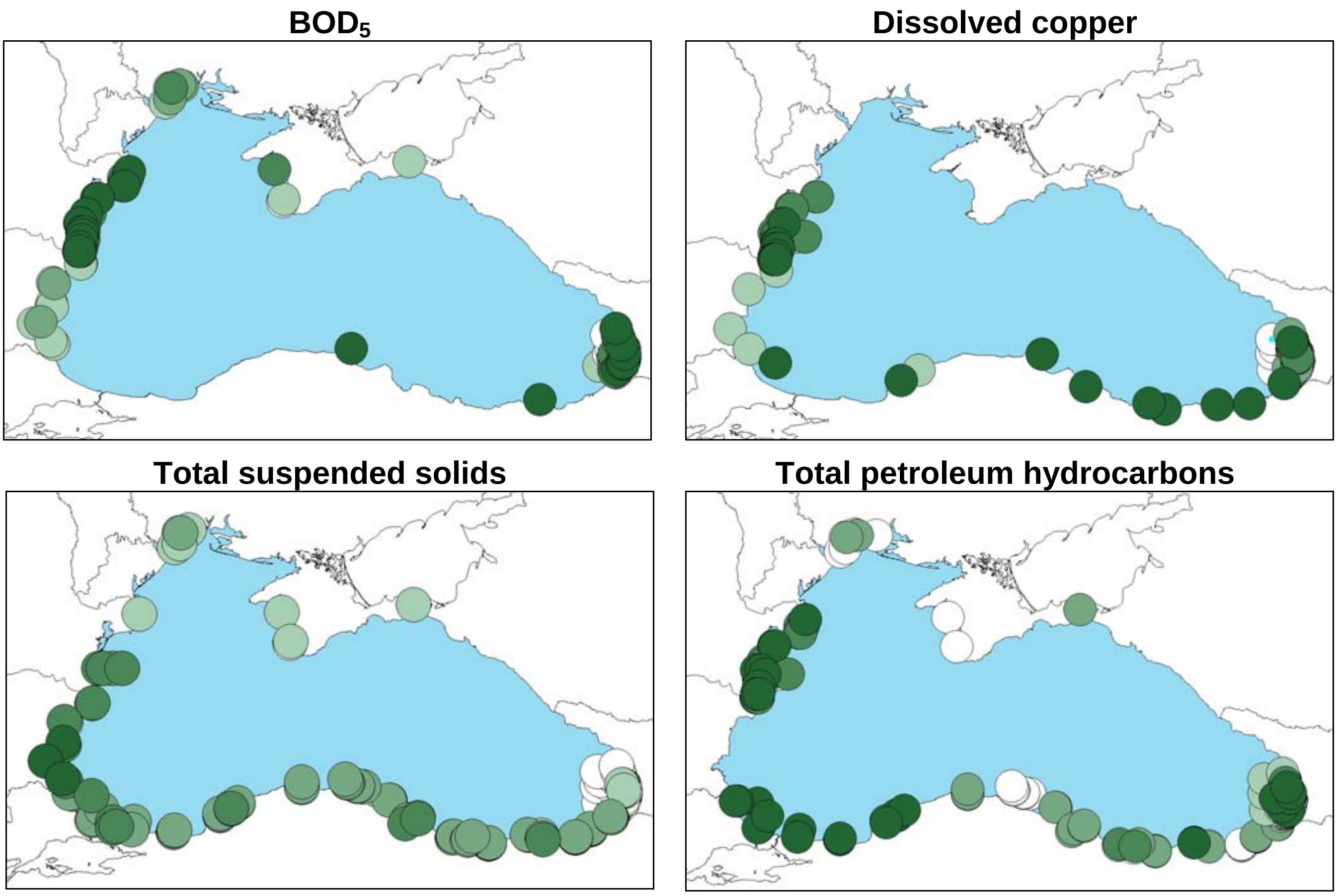


Figure 3.22 Mean concentrations of BOD_5, dissolved copper, total suspended solids and total petroleum hydrocarbons in surface waters (0-10m depth) of the Black Sea, 2000-2005

BOD_5 levels are elevated along the Romanian coasts, where discharges from the Danube and Dniester rivers exert their greatest influence, as well as at several sites along the Georgian coast, due to a combination of untreated municipal and river discharges.

Dissolved copper levels appear to be elevated along much of the Turkish coast, with with more isolated examples off the Romanian and Georgian coasts. It is not clear whether these result arise principally from point sources or are due to geological differences. No data were available for Russian or Ukrainian coastal waters.

Total suspended solids is a measure of the amount of particulate matter (of biological and geological origin) in the water column. This can be related to trophic status, since phytoplankton form a proportion of the material measured. Major river inflows tend to result in turbidity/suspended solids plumes within the Sea, although this is not clear from the scale of data shown. The pattern which emerges is interesting, however,

Petroleum hydrocarbon levels (a measure of oil pollution) are highest in three distinct areas: off the Georgian coast (important oil terminals/ports); the west Turkish coast, which ties in with the pattern of water flow shown in Fig 3.4 and the pattern of likely oil spills reported in Fig. <4.>; and at several points along the Romanian coast. The latter could be due to shipping-related oil spills, point source discharges or the influence of high levels of oil in Danube waters – highlighted as a cause of concern in the 1996 TDA, but now probably less important than it once was.

3.4.2 Sediment

Fig. 3.2.3 shows average concentrations of six parameters in surface sediments (up to 20 cm depth) of the Black Sea. Data are presented with reference to a quantile (5-class) system, such that for each parameter approximately 20% of the results fall into each class[35]. For each map, the darker the colour the greater the concentration, with class boundaries as follows:

Colour	Chromium (mg/kg)	Copper (mg/kg)	DDT (µg/kg)	Total HCHs (µg/kg)	Total organic carbon (mg/g)	Total petroleum hydrocarbons (µg/g)
	<40.00	<21.21	<3.12	<1.12	<0.85	<5.51
	40.00-64.00	21.21-32.00	3.12-9.87	1.12-2.31	0.85-1.40	5.51-26.00
	>64.00-89.00	>32.00-43.00	>9.87-35.62	>2.31-34.00	>1.40-1.94	>26-60.72
	>89.00-112.00	>43.00-68.50	>35.61-106.04	>34.00-54.00	>1.94-4.32	>60.72-190.00
	>112.001	>68.501	>106.04	>54.00	>4.32	>190.00

As with Fig 3.23, higher concentration values are plotted on top of lower values to emphasise where attention needs to be paid in terms of reducing discharges (river, municipal or industrial) to water.

[35]A potential "problem" occurs with this method of presentation when many results are the same. This usually happens when large numbers of values are at or below the limit of detection. In such cases, the values are all reported as falling into a single class. This has obviously occurred with reporting of DDT levels in ediments (Fig 3.23) and with nitrate levels in water (Fig. 3.24).

Chromium concentrations are particularly elevated along the western-central area of the NW Shelf, where the influence of the Danube and Dneister are greatest. There is also a suggestion that discharges from land in the Odessa and Samsun areas may also be potential sources.

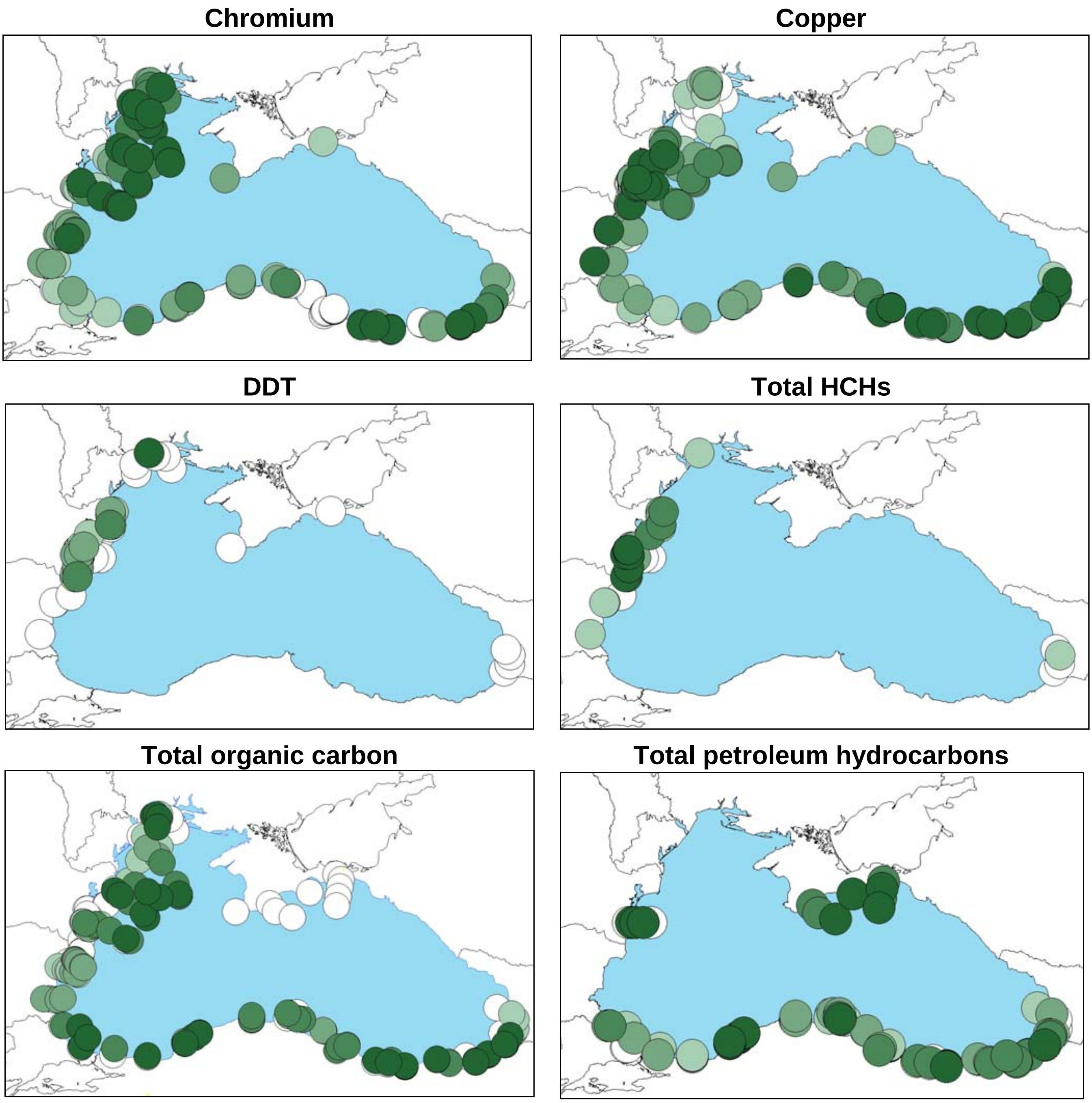


Figure 3.23 Mean concentrations of chromium, copper, DDT, total HCHs[36], total organic carbon and total petroleum hydrocarbons in sediments of the Black Sea, 1996-2006

[36] Hexachlorocyclohexanes – a chemical group of pesticides

Copper contamination in sediments mirrors that of copper levels in surface waters (Fig. 3.22), with elevated concentrations along the eastern Turkish and southern Georgian coast (possibly due to copper of geological origin, but copper mine tailings treatment at Murgul, Turkey, close to the Georgian border, has not been upgraded, despite the mine having been identified as a hot-spot in need of capital investment in the 1996 TDA (see Section 5 and Annex 11). Copper levels are also elevated along the western edge of the Black Sea, where the Danube and Dneister rivers enter the Sea. Elevated levels are also present in sediments off the Bulgarian coast, but it is not clear whether these are due to river-borne or direct municipal/industrial discharges.

DDT is distribution is very patchy in sediments, being alarmingly high at one Ukrainian coastal site, with less severe but more widespread contamination off the Romanian coast. The levels of Romanian sediment DDT contamination are mirrored in the Total HCH results.

Total organic carbon, as a measure of organic enrichment, does not follow the exact pattern that might be expected from previous analyses of zoobenthic communities (e.g. Todorova and Konsulova, 2006) and dissolved oxygen assessments. However, there is considerable contamination in the mid-NW Shelf, some way removed from land, suggesting that phytoplankton blooms are the major source of this enrichment. And, as the status of zoobenthos communities improves in a general pattern from north to south in the the NW Shelf, so does the overall level of organic enrichment reduce. Organic enrichment at several sites along the Turkish coast is also elevated. Here, phytoplankton blooms are not as intense as those found in the NW Shelf, so it appears that land-derived organic sources could be more important.

Unlike copper, sediment contamination with total petroleum hydrocarbons does not reflect the level of contamination in surface waters (*cf* Figs 2.22 and 2.23). In sediments, levels of contamination on either side of the Bosphorus are considerably less than those found in surface waters. Oil contamination in sediments along the east Crimean coast.and perpendicular to where the Kerch Strait enters the Sea is also particularly high. Presumably, the elevated Ukrainian results reflect the high level of ship traffic through the Kerch Strait. Elevated levels of sediment oil contamination at two sites off the Romanian coast do, however, mirror the high concentrations found in surface waters.

Relatively high contamination levels of some pesticides, heavy metals and PCBs have been found at sites in the Black Sea (e.g..Parr *et al*, 2005). The concentrations of some substances are in or above the ranges used as Ecotoxicological Assessment Criteria (EACs[37]) by OSPAR. Whilst the applicability to the Black Sea of EACs developed for the NE Atlantic is not known, the significance of the detected contamination should be further investigated.

3.5 Status of the nutrient regime

Fig. 3.24 shows average concentrations of nitrate and phosphate in surface waters (0-10 m) of the Black Sea. The data are presented with reference to a quantile (5-class) system, such that for each parameter some 20% of the results should fall into each category. For each map, the darker the colour the greater the concentration, with class boundaries as follows:

[37]EACs are defined as concentration levels of a substance above which concern is indicated, and have been used by OSPAR to identify possible areas of concern and to indicate which substances might be a target for priority action.

Colour	Nitrate (mg NO_3-N/l)	Phosphate (mg PO_4-P/l)
(white)	<0.0001	<0.004
(lightest green)	0.0001-0.001	>0.004-0.005
(light green)	>0.001-0.02	>0.005-0.008
(medium green)	>0.02-0.04	>0.008-0.012
(dark green)	>0.04-1.68	>0.012

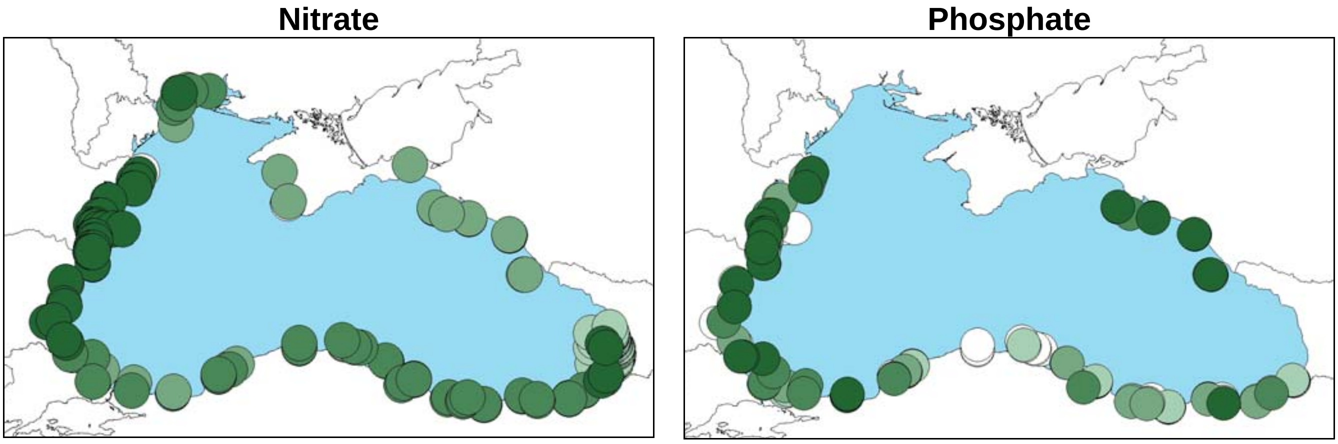


Figure 3.24 Mean concentrations of nitrate and phosphate in surface waters of the Black Sea, 200-2005

A clear pattern of nitrate enrichment occurs (despite many of the results falling below the analytical limit of detection), with high concentrations along the western edge of the sea. Levels around Odessa are also nitrate-enriched, with moderate levels of contanination along much of the east Turkish coast. A small number of sites offshore of the Turkish/Georgian border show high levels of enrichment, which are likely to be the result of either a lack of summer results (when nitrate levels are lowest) or poor analytical quality control.

A similar pattern emerges with regard to phosphate levels: high along the western edge of the Sea, albeit with isolated sites of higher contamination along the Turkish coast, presumably due to local discharges. There is no obvious reason for the elevated phosphate concentrations recorded off the Russian coast, so these could point to analytical quality control issues in the laboratory involved[38].

[38] All laboratories participating in the Black Sea Integrated Monitoring and Assessment Programme (BSIMAP) have been participating in the QUASIMEME proficiency testing programme for several years now, and results are improving, particularly with regard to nutrient analyses. However, some of the individual results used in this assessment are from samples collected before participation in the QUASIMEME scheme started.

3.6 Institutional setting and stakeholders

3.6.1 Institutional setting

Since the beginning of the 1990s, the countries of the region, with financial assistance from the international community, have started to co-operate in order to promote the sustainable use of transboundary water resources. The 1992 Bucharest Convention and its Protocols, the 1993 Odessa Declaration and the 1996 Black Sea Strategic Action Programme for the Protection of the Black Sea against Pollution provided the impetus and framework for co-operation among the six Black Sea countries. The Ministries of Environment from the six Black Sea Countries are responsible for the overall implementation, at national level, of the Bucharest Convention and the Black Sea Strategic Action Programme.

To achieve the purposes of the Bucharest Convention the Black Sea Commission was established, with one member from each of the six national governments. The Commission provides a supervisory role over its Permanent Secretariat which, in turn, co-ordinates the activities of the Commission.

The mandate of the BSC is broad and, with time, has been further expanded to include additional activities. The functions of the BSC are defined under Article XVIII of the Bucharest Convention. Existing protocols to the Convention have added some new functions to the already extensive list, or specified further responsibilities. Additional functions have also been entrusted to the Commission by two declarations adopted at regular meetings of Ministers of the Environment of Black Sea states – the 1993 Odessa Declaration and the 2002 Sofia Declaration - as well as by memoranda of understanding and cooperation between the BSC and other international bodies – the ICPDR and the European Environment Agency.

The Permanent Secretariat, which officially started operating in 2000, is supported in implementing the BSC activities by sixteen subsidiary bodies, some of which are adequately funded and other not. This is further discussed in Section 6.

For Black Sea riparian countries, ensuring a robust institutional framework is a key element in the successful protection of the Black Sea. During the last few years some of the Black Sea countries have made substantial progress in improving this framework for environmental protection, supported by major changes in the legal framework.

3.6.2 Stakeholders

A list of 42 institutional and stakeholder groups were identified (Annex 7) based on their specific involvement in/contribution to management and/or protection of the Black Sea.

Table 3.7 presents an initial overview of their level of involvement in management of the transboundary issues, and the degree to which they are impacted by the conditions. A more detailed analysis of their roles, perceptions and priorities is presented in Section 7.

Table 3.7 Summary of stakeholder involvement and management

STAKEHOLDER INVOLVEMENT AND IMPACT DESCRIPTION	Management Involvement				Degree Impacted by Issue			
Management of issue: Directly / Indirectly / Not Involved; Degree Impacted: High / Medium / Low	Nutrients	Fisheries	Pollution	Biodiversity	Nutrients	Fisheries	Pollution	Biodiversity
1. Water, Hydro-meteorological Department	Directly	Not Involved	Directly	Not Involved	Low	Low	Medium	Low
2. Environmental Ministry[39]	Directly	Indirectly	Directly	Directly	High	High	High	High
3. Industry Ministry	Not Involved	Indirectly	Indirectly	Not Involved	Low	Low	Low	Low
4. Energy Ministry	Not Involved	Not Involved	Directly	Not Involved	Low	Low	Low	Low
5. Economic Ministry	Indirectly	Indirectly	Indirectly	Indirectly	Low	High	Medium	Medium
6. Foreign Affairs Ministry	Indirectly	Indirectly	Indirectly	Indirectly	Medium	Medium	Medium	Medium
7. Defence Ministry	Not Involved	Not Involved	Not Involved	Not Involved	Low	Low	Low	Low
8. Internal Affairs Ministry	Not Involved	Not Involved	Not Involved	Not Involved	Low	Low	Medium	Low
9. Agriculture Ministry	Directly	Indirectly	Directly	Indirectly	Medium	Low	Medium	Medium
10. Fisheries Agencies	Not Involved	Directly	Not Involved	Indirectly	High	High	High	High
11. Social Welfare / Public Health Ministry	Indirectly	Not Involved	Not Involved	Not Involved	Medium	Medium	Medium	Low
12. Labour Ministry	Not Involved	Indirectly	Indirectly	Not Involved	Low	Low	Medium	Low
13. Public Administrator/ planning agency	Indirectly	Not Involved	Indirectly	Indirectly	Low	Low	Low	Low
14. Regulator agent official/ Enforcement agent	Directly	Directly	Directly	Directly	High	High	High	High
15. Shipping Agencies	Indirectly	Indirectly	Directly	Not Involved	Low	Low	Low	Low
16. Parliamentary committees[40]	Directly	Directly	Directly	Directly	High	High	High	High
17. Inter ministerial Committees/Basin Committees	Directly	Not Involved	Directly	Not Involved	Medium	Medium	Medium	Medium
18. Non Governmental Organization	Not Involved	Not Involved	Not Involved	Not Involved	High	High	High	High
19. Scientists	Indirectly	Indirectly	Indirectly	Indirectly	High	High	High	High
20. Manufacturing industry	Not Involved	Not Involved	Indirectly	Not Involved	Low	Low	Low	Low
21. Agro-industry	Directly	Indirectly	Directly	Indirectly	Low	Low	Low	Low
22. Live stock industry	Directly	Indirectly	Indirectly	Not Involved	Low	Low	Low	Low
23. Shipping industry	Indirectly	Indirectly	Directly	Indirectly	Low	High	Medium	Low
24. Fishing industry	Not Involved	Directly	Indirectly	Directly	High	High	High	Medium
25. Harbour/port administration	Directly	Indirectly	Directly	Indirectly	Low	High	Medium	Low
26. Regional government official	Directly	Indirectly	Directly	Directly	Medium	Medium	High	Medium
27. District water management official	Directly	Not Involved	Directly	Not Involved	High	Low	High	Low
28. Environmental Protection Agencies official	Directly	Directly	Directly	Directly	High	High	High	High
29. Municipal Government	Directly	Indirectly	Directly	Not Involved	Medium	High	High	Medium
30. Municipal waste manager	Directly	Indirectly	Directly	Not Involved	Medium	High	High	Low
31. Nature reserve staff	Not Involved	Not Involved	Not Involved	Directly	Medium	Medium	High	High
32. Community based organization	Not Involved	Not Involved	Not Involved	Not Involved	Medium	Medium	Medium	Medium
33. Worker on a state owned farm	Indirectly	Not Involved	Indirectly	Not Involved	Medium	Low	Medium	Low
34. Worker on a privately owned farm	Indirectly	Not Involved	Indirectly	Not Involved	Medium	Low	Medium	Low
35. Fisherman small-scale	Not Involved	Directly	Not Involved	Not Involved	High	High	High	High
36. Educator/teacher	Not Involved	Not Involved	Not Involved	Not Involved	Medium	Medium	Medium	Medium
37. Student	Not Involved	Not Involved	Not Involved	Not Involved	Medium	Medium	Medium	Medium
38. Public health care provider	Not Involved	Not Involved	Indirectly	Not Involved	Medium	Medium	High	Low
39. Member of coastal community	Indirectly	Indirectly	Indirectly	Indirectly	High	High	High	High
40. Tourism/Recreation industry	Directly	Indirectly	Directly	Directly	High	Low	High	Medium
41. Press and media	Not Involved	Not Involved	Not Involved	Not Involved	Medium	Medium	Medium	Medium
42. International Funding Inst.	Indirectly	Indirectly	Indirectly	Indirectly	Medium	Medium	Medium	Medium

[39] Natural Resources, Ecology, Water or Environmental Ministry
[40] Parliamentary committees for environmental protection

3.7 Public perception of environmental status, causes and responsibilities

In July 2006 over 400 people were randomly questioned from coastal cities and towns including: Sochi, Novorossijsk and Anapa in Russia; Odessa and Nikolaev in Ukraine; Varna in Bulgaria, Constanta in Romania; Trabzon, Ordu, and Zonguldak in Turkey; and Batumi, Kobuleti, Poti and Grigoleti in Georgia. Those questioned were not selected on the basis of gender, age or occupational considerations; and since the survey was organized through regional environmental NGOs, respondents would almost certainly have had a higher than average level of environmental awareness. Nevertheless, this represents the only recent regional survey of public opinion undertaken on the causes, status and perceived responsibilities for environmental problems of the Black Sea. Some of these results are shown in Fig. 3.25.

Encouragingly, over 90% of all respondents from coastal towns and cities around the Black Sea said the health of the Black Sea was important to them personally, with almost 70% stating that responsibility for the Sea's problems should be shared by all coastal and Danube countries. Most people felt that protecting the Black Sea was a responsibility that should be shared between national governments (27%) coastal municipalities (26%) and all individuals living along the coast (21%). However, almost a third of people questioned thought the Sea was either completely dead (14%) or the most polluted sea in Europe (19%). Nearly half of respondents (46%) felt it was "only occasionally polluted in certain places", but only 6% of respondents felt it was healthier than it used to be.

Nearly a quarter of people thought the main barrier to protecting the Black Sea was still a lack of public awareness of the problems and their impacts. Most people felt the factors having the biggest impact on the health of the Black Sea were: pollution from factories (21%), untreated sewerage (13%), rubbish and litter (13%), and the over development of coastal areas (12%). Only 9% of people felt that poor agricultural practices were having a negative impact on the health of the Black Sea.

In the survey only 7% of respondents viewed over-fishing as a leading cause of damage to the Black Sea environment and only 13% said they would consider not buying threatened fish species.

When asked why they thought the health of the Black Sea was important the highest response was because of the need to protect it for future generations (27%), followed by the need to protect marine species (23%). Another 22% of people felt it was important to protect the Sea because of holiday and recreation opportunities. Most people associated the Black Sea with holidays/recreation (34%) and fishing (20%) but, disturbingly, the next highest factor associated with the Black Sea was 'pollution and litter' (19%), ahead of marine life (18%).

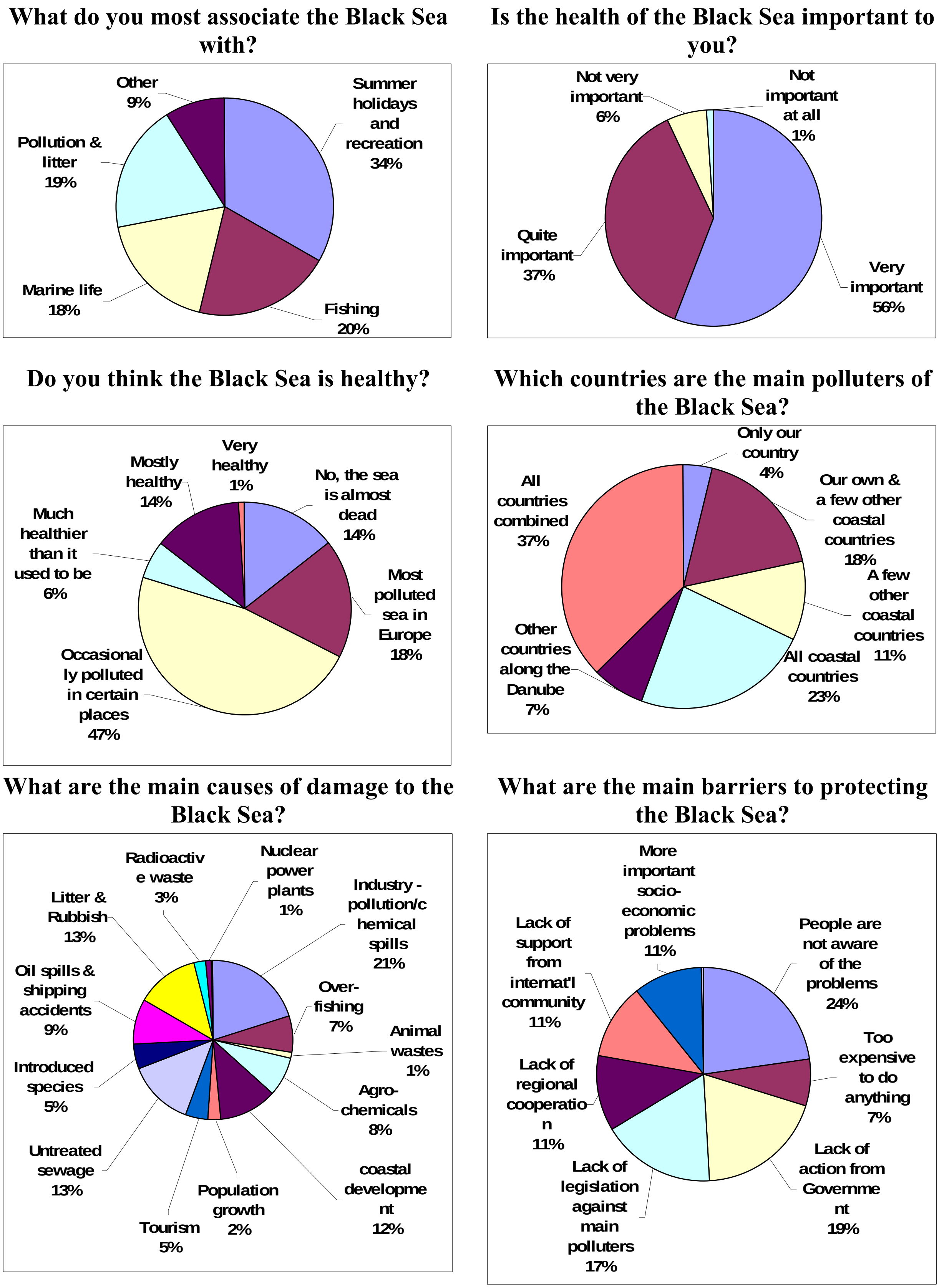


Figure 3.25 Public perception of the Black Sea[41]

[41] Data source: Steven Menzies, BSERP

4. PRIORITY TRANSBOUNDARY PROBLEMS

This chapter identifies the priority transboundary problems in the Black Sea, and then describes each transboundary problem in detail. In particular each section describes the problem and justifies its transboundary importance; details the environmental impacts and socio-economic consequences of each problem; highlights the linkages with other transboundary problems; and analyses the immediate underlying, and socio-economic, legal and political root causes.

4.1 Key transboundary problems and priority scores

Twenty-three transboundary problems were originally identified by the 22 members of the Technical Task Team (TTT) established to produce this report, in order to determine their relevance and transboundary nature in the context of the Black Sea. The group was asked to brainstorm and identify the major water related transboundary problems. This narrowed the original list down to 7 Black Sea transboundary problems:

1. Decline commercial species/fish stocks
2. Nutrient over-enrichment/eutrophication
3. Alien species introduction
4. Chemical pollution
5. Coastal erosion
6. Changes in the flow regime from rivers
7. Habitat and biodiversity changes

A further cross-cutting problem of global climate change was also identified.

This list was further refined by assigning a score to each transboundary problem of between 0 (no importance), 1 (low importance), 2 (moderate importance) and 3 (high importance) to determine the relevance of the problem from the perspective of the *present day* and *10-15 years in the future*. When examining future change the TTT were asked to consider the effects of climate change. The scoring activity was based on the following suite of criteria:

- Transboundary nature of a problem.
- Scale of impacts of a problem on economic terms, the environment and human health.
- Relationship with other environmental problems.
- Expected multiple benefits that might be achieved by addressing a problem.
- Lack of perceived progress in addressing/solving a problem at the national level.
- Recognised multi-country water conflicts.
- Reversibility/irreversibility of the problem

The outcomes of this activity are presented in Table 4.1.

Table 4.1 Priority transboundary problems in the Black Sea

Transboundary Problem*	Present day		Future (10-15 years)[42]	
	Median Score	Priority	Median Score	Priority
Decline in natural resources (e.g. fish stocks)	3.0	High	3.0	High
Nutrient over-enrichment/eutrophication	3.0	High	3.0	High
Chemical pollution	3.0	High	3.0	High
Habitat and biodiversity changes	2.0	Moderate	2.0	Moderate
Alien species introduction	2.0	Moderate	2.0	Moderate
Coastal erosion	1.0	Low	1.0	Low
Changes in the flow regime from rivers	1.0	Low	1.0	Low

Based on the prioritisation exercise, four priority transboundary problems in the Black Sea were identified for further detailed study. These were:

1. Nutrient over-enrichment/eutrophication
2. Decline in natural resources (e.g. fisheries)
3. Chemical pollution
4. Habitat and biodiversity changes - including alien species introduction

4.2 Nutrient over-enrichment/eutrophication

4.2.1 The problem

The justification for nutrient-enrichment being a transboundary problem is that once in the Sea, nutrients are cycled throughout the whole system as a result of dissolved materials being transported in water currents and by sequestration by phytoplankton which are also transported in currents. However, it is not only the problem of eutrophication which are shared by the surrounding countries, the causes of this problem are also shared. All discharge nutrients into the Sea both directly (industrial/municipal discharges), through river flows into the Sea, and indirectly via atmospheric emissions containing nitrogen oxides that contribute to atmospheric deposition. into the Sea. In addition to sharing the same types of nutrient sources, the same causal chain analysis can be applied on a regional and/or national basis.

The Black Sea is particularly prone to eutrophication because of its enclosed (land-locked) nature. During cold winters, relatively nutrient-rich water from the northern continental slope and shelf probably feeds the cold intermediate layer (CIL) that extends over much of the Black Sea and has a residence time of about 5.5 years (Stanev *et al*., 2003). Vertical mixing from the CIL may feed productivity over large areas of the Black Sea, and thus variations in winter temperatures on the shelf could have a profound effect over offshore primary production in the summer. Satellite data have also revealed significant winter phytoplankton blooms in the southern part of the sea, presumably as a result of mixing of deeper waters. This winter production may make a greater overall contribution to offshore primary production in the Black Sea than eutrophication-fuelled summer growth (Sorokin, 2002). The "natural" conditions of the Black Sea remain unknown (Mee *et al*, 2005).

[42]Including the effects of global climate change.

Nutrient enrichment by itself is not a cause of concern, since there are no toxicity or other health-related issues associated with nutrient enrichment of the Sea to current or historical levels (albeıt that unıonısed ammonıa ıs very toxıc). Rather, it is the bıologıcal response to nutrıent enrıchment that ıs the problem

The biological response occurs through a number of different mechanisms. Higher nutrient concentrations in the water column result in higher phytoplankton standing crops, with consequences higher up the food chain (see Section 4.2.3). The higher phytoplankton density decreases light penetration to submerged macroalgae, which can then only receive sufficient light to continue to grow in shallower waters. In addition, growth of epiphytic algae (those growing on the thalli/fronds of seaweeds attached to the sea floor) is also stimulated, further reducing light availability to their hosts, and so further the reducing the depth at which such species/communities can survive. The most famous of these seaweeds is the red alga *Phyllophora*, which once formed a huge meadow covering much of the Northwest shelf, but which is now to confined to a mere fraction of its former area.

However, when the increased amount of biological matter living in the sea begins to die, the sediment becomes organically-enriched and the microbiological decomposition of this organic matter strips oxygen out of the water in previously highly oxygenated areas of the NW shelf. The resulting hypoxia can result in the death of fish, although fish are usually mobile and aware enough to escape such unfavourable conditions, but the greatest impact is on those invertebrates living on/in the sediment. Thus, a single hypoxic event, even if it lasts for only a single day, has the potential to devastate the sediment faunal community for years to come. This includes shellfisheries. Odessa Bay, once nicknamed the “Kingdom of Mussels”, has some distance to go before it can resume that title, since in extensive areas of the NW Shelf, mussels have been replaced by other invertebrates (albeit belonging to the same functional group, ie. filter-feeders), notably ascidians.

Even if hypoxic conditions do not occur in the water column, the organic enrichment of both water and sediment results in ecological changes, e.g. heterotrophic phytoplankton (notably *Noctiluca* spp.) increase greatly in number and biomass and there is a shift to sediment fauna which are more tolerant of low oxygen conditions away from those requiring higher dissolved oxygen levels.

4.2.2 Environmental impacts and socio-economic consequences

Eutrophication favours the dominance of some species over others, in fish, benthic zooplankton, phytoplankton and macroalgal communities. In Zernov’s *Phyllophora* field, *Phyllophora nervosa* had previously existed in such large quantities that it was exploited commercially as a source of alginates. However, preliminary results from the July/August 2006 BSERP research cruise show that while *Phyllophora brodiaei* is present, it is rarely the dominant species. At shallow depths, the filamentous red alga *Polysiphonia* sp. becomes increasingly prevalent, sometimes growing as an epiphyte on *Phyllophora*. Huge numbers of ascidians (sea squirts; primitive filter-feeding vertebrates) are also found in deeper parts of the former *Phyllophora* field (abundances as large as 300 individuals/m^2), benefiting from the organically-enriched environment.

In other parts of the former field, *Phyllophora* has been replaced by filamentous red (*Polysiphonia*) and green (*Ectocarpus confervodes* and *Desmarestia viridis*) algae; species indicative of nutrient-enriched conditions. Excessive growth of *Cladophora sp*, another filamentous green alga indicative of nutrient-enrichment, is also reported in both western and eastern parts of the Black Sea (e.g. Karkinitsky Bay and Anapa bay, respectively).

Thus, the NW Shelf has not returned to its former (1960s) state, dominated by *Phyllophora nervosa*, but is instead now dominated by opportunistic filamentous algae, with very smaller areas of *Phyllophora.* This is not necessarily bad, since the opportunistic seaweeds may well be an intermediate step towards a more stable system. However, they still represent eutrophic conditions, albeit less serious than those represented by the monospecific phytoplankton blooms of the 1980s. Indeed the fact that there are fairly abundant benthic algae shows that transparency of the water column is sufficient to allow *Phyllophora* to re-establish, providing the level of nutrient enrichment can be reduced.

Current opinion is that too many niches have been filled by opportunistic and/or invasive species to make it likely that the Black Sea will ever recover to exactly how it was in the 1960s. The question therefore is whether or not the Black Sea ecosystem is 'healthier' than it was during the 'dark' years of the 1980s. There appears greater transparency of the water and this is leading to renewed growth of benthic algae, albeit species that may have been regarded as a nuisance at other times (but under the current circumstances have an important function). Dissolved oxygen concentrations in bottom waters are not as great a cause of concern as they once were, since hypoxic conditions no longer equate to 'dead zones'. Gelatinous organisms continue to abound in the water column, including the common jellyfish *Aurelia aurita* (just above the sea floor), the invasive comb jellies *Mnemiopsis leydi* and *Beroe ovata*, and benthic tunicates. Heterotrophic phytoplankton continue to form intense blooms, notably at the outer edges of riverine influence, but overall there appears to be a trend away from dense monospecific phytoplankton blooms to a more diverse phytoplankton community in many areas.

The NW shelf now appears to contain a heavily altered but relatively functional ecosystem when compared to the 1960s. Nevertheless, symptoms of dysfunction are still evident, such as the inability of the system to recycle the high load of organic material it receives/produces in some areas, and the continuing dominance of monospecific phytoplankton blooms in other areas. At this stage the Black Sea is a long way removed from being 'totally recovered' and requires further protection from human pressure as it adapts to the new reality and the new species that have settled in it.

Fisheries productivity almost certainly increased as a consequence of eutrophication, due to the additional energy provided by increased phytoplankton growth being transported up the food chain, so is likely to decrease as trophic status falls. The implications of this for the fishing industry, however, are not clear, since the improved oxygen status of much of the NW shelf is likely to have had a stimulatory effect on fisheries generally in terms of the expansion of available spawning nursery areas, but an even more favourable effect on demersal fish species in particular because of the greater area available for living and feeding.

The impact of improved trophic status on the existing shellfish industry is likely to have been great in the NW Shelf area because of the much greater area for shellfish production, but of lesser importance in other parts of the Black Sea. However, it is essential that bacterial pollution is tackled in shallow coastal water ecosystems if future benefits are to be accrued, that environmentally sustainable aquaculture methods are utilised and that non-destructive harvesting methods are employed. Only then will the potential socio-economic benefits be fully realised.

Available data do not provide clear evidence of whether there has been an impact on the tourist trade, but the growth of filamentous green algal beds along some shores is unlikely to have been conducive in persuading tourists to return to coastal hotels/resorts. Improved biodiversity in coastal waters and fringe wetland ecosystems as a result of reduced trophic status is likely to result in increased numbers of tourists, albeit a more specialised sub-sector of tourists than those which the Black Sea has attracted during much of the last 20-30 years. Eco-tourism advertising, whether directed at single issue customers or as a compenent of wider rest/relaxation packages, has the potential to generate a small but increasing funding stream for coastal communities.

The socio-economic impacts of changing agricultural management to control nutrient status of the Black Sea have probably had a greater impact than the changes which have occurred in any other economic sector. They therefore require special attention. Change in farmıng practices resulted in worsening trophic status during the mid-1970s to 1980s, after which a very abrupt reversal of those practices occurred. The overall result, pre- and post-1990, has been a huge population shift and major changes in rural community demographics.

Increased mechanisation/industrialisation of farming during the 1970s and 1980s required fewer workers, resulting in a large-scale migration of predominantly young male workers from rural to urban areas. This trend was exacerbated by the economic collapse of the late 80s, its bequest to the 1990s and its continuing impact. Thus, a rural-urban migration trend still continues, albeit one which has slowed in many countries. This has left a high percentage of female and older residents in rural villages. One national example of how this pattern has evolved is shown in Table 4.2 for Romania where, since 1960, the proportion of the population relying on employment within the agricultural sector has halved.

Table 4.2 Romanian population evolution (1960-2003): urban–rural distribution and percentage of population employed in agriculture

	Total population	Urban population	Rural population	Working population employed in the agricultural sector
1960	18,250,000	5,712,250 (31.3%)	12,537,750 (68.7%)	8,613,434 (69.2%)
1970	20,252,541	8,258,138 (40.8%)	11,994,403 (59.2%)	7,100,686 (49.1%)
1988	23,053,552	11,961,847 (51.9%)	11,091,705 (48.1%)	3,024,200 (28%)
1997	22,545,925	12,404,690 (55.0%)	10,141,235 (45.0%)	3,322,000 (36.8%)
2003	21,733,556	11,600,157 (53.4%)	10,133,399 (46.6%)	3,286,000 (35.7%)

4.2.3 Linkages with other transboundary problems

Nutrient over-enrichment/eutrophication in the Black Sea is closely linked to the transboundary problems of changes in marine living resources (Section 4.3), chemical pollution (Section 4.4) and biodiversity/habitat changes (Section 4.5). For chemical pollution, the explanation is simple: nutrient and (other) chemical share many of thethe same causes and sources. However, the links between nutrient enrichment and changes in marine living resources/ biodiversity are more complex.

In general terms, zooplankton feed on phytoplankton, and young fish/larvae feed on zooplankton, which are themselves eaten by other fish. Phytoplankton biomass in the 1970s and 1980s was far greater than in the 1960s, with a decreasing trend since 1990.

However, during the 1970s and 1980s, there should not only have been an increase in the standing crop of phytoplankton as nutrient levels increased, there should also have been an increase in the standing crop of zooplankton and fish, as the energy from the increased biomass of phytoplankton was carried up through the food chain. The problem with such simple explanations is that nutrient enrichment/eutrophication does not operate in isolation as an environmental problem. For example, the plankton results presented in Section 3.3.2 clearly show that invasive species impact on trophic status indicators such as phytoplankton and zooplankton biomass. In Section 4.5.4.3 it is noted that eutrophication has been underestimated as a threat to biodiversity in the Black Sea because of misunderstandings of how different factors interact to impact on biota. The *Mnemiopsis* invasion in the 1980s (Section 3.3.2) brought with it a decrease in fishery productivity, since fewer fish larvae survived to grow into adults and there was less food available for those fish that did survive.

Whilst eutrophication is considered to be the result of nutrient-enrichment, one of its most severe effects is the development of hypoxic conditions as a result of the production and breakdown of organic matter. A consequence of this is dramatically reduced benthic biodiversity. Organic matter is produced primarily as a result of photosynthesis by phytoplankton, but organic (BOD_5 and total organic carbon) loads from land, discharged to the Sea via rivers and outfalls, also exacerbate the problem.

Referring back to Section 3.3.2, organic enrichment has resulted in the development of large populations of non-phytoplankton eating *Noctiluca* along the Western edge of the Black Sea. This planktonic organism has to a large extent occupied the ecological niche formerly occupied by phytoplankton-eating zooplankton. Thus, remote-sensing imagery of chlorophyll-like substances indicate higher levels of phytoplankton in this area than in other shallow areas of the Black Sea, .e.g. Fig. 4.1.

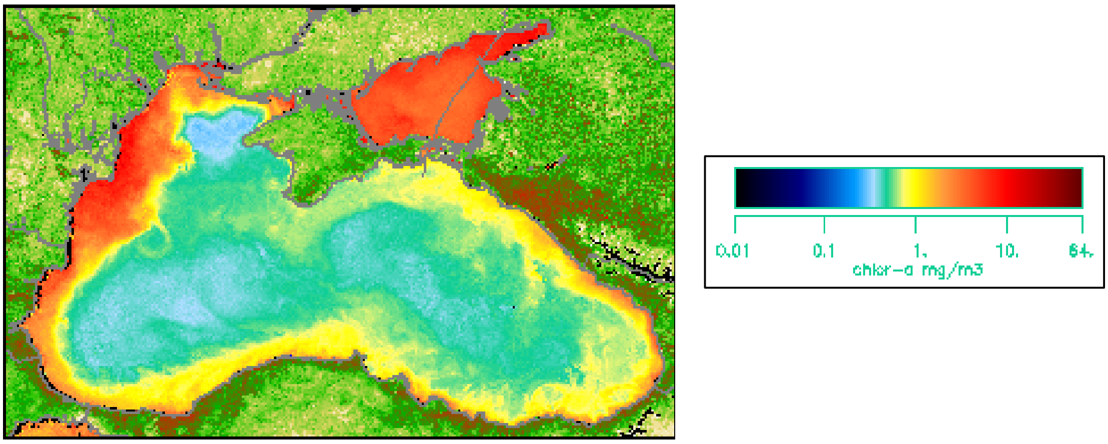


Figure 4.1 Chlorophyll-like substance concentrations in the Black Sea, May 2004[43]

All ecological communities demonstrate a resistance to change, resilience, as external pressures on them change. These pressures come in all sorts of forms, such as invasive species, nutrient and organic enrichment, toxic pollutants, changes in climatic conditions, etc. Resilience does have its limits, however, and the collapse of the benthic ecosystem in huge areas of the NW Shelf throughout the 1970s-early 1990s clearly demonstrated this.

4.2.4 Immediate causes

Fig. 4.2 shows the results of a causal chain analysis of nutrient enrichment of the Black Sea. The results of this analysis are described in Sections 4.2.4.1-4.2.4.10 and 4.2.5.

The immediate causes of nutrient enrichment are changes (increases) in the nutrient loads from different sources. Nutrients are derived from a variety of sources (Table 4.3):

Table 4.3 Sources of nutrients to the Black Sea

Nitrogen	Phosphorus
Sewage treatment works	Sewage treatment works
Livestock farming	Livestock farming
Land use-based diffuse sources (e.g. arable farming)	Land use-based diffuse sources (e.g. arable farming)
Industry	Industry
Unsewered population	Unsewered population
Natural N export	Natural P export
Atmospheric deposition	
Solid waste	Solid waste
Sediment-water exchange	Sediment-water exchange
Transboundary and national rivers	Transboundary and national rivers
Submarine discharges of groundwater	

[43] Data source: http://marine.jrc.cec.eu.int/frames/archive_seawifs.htm

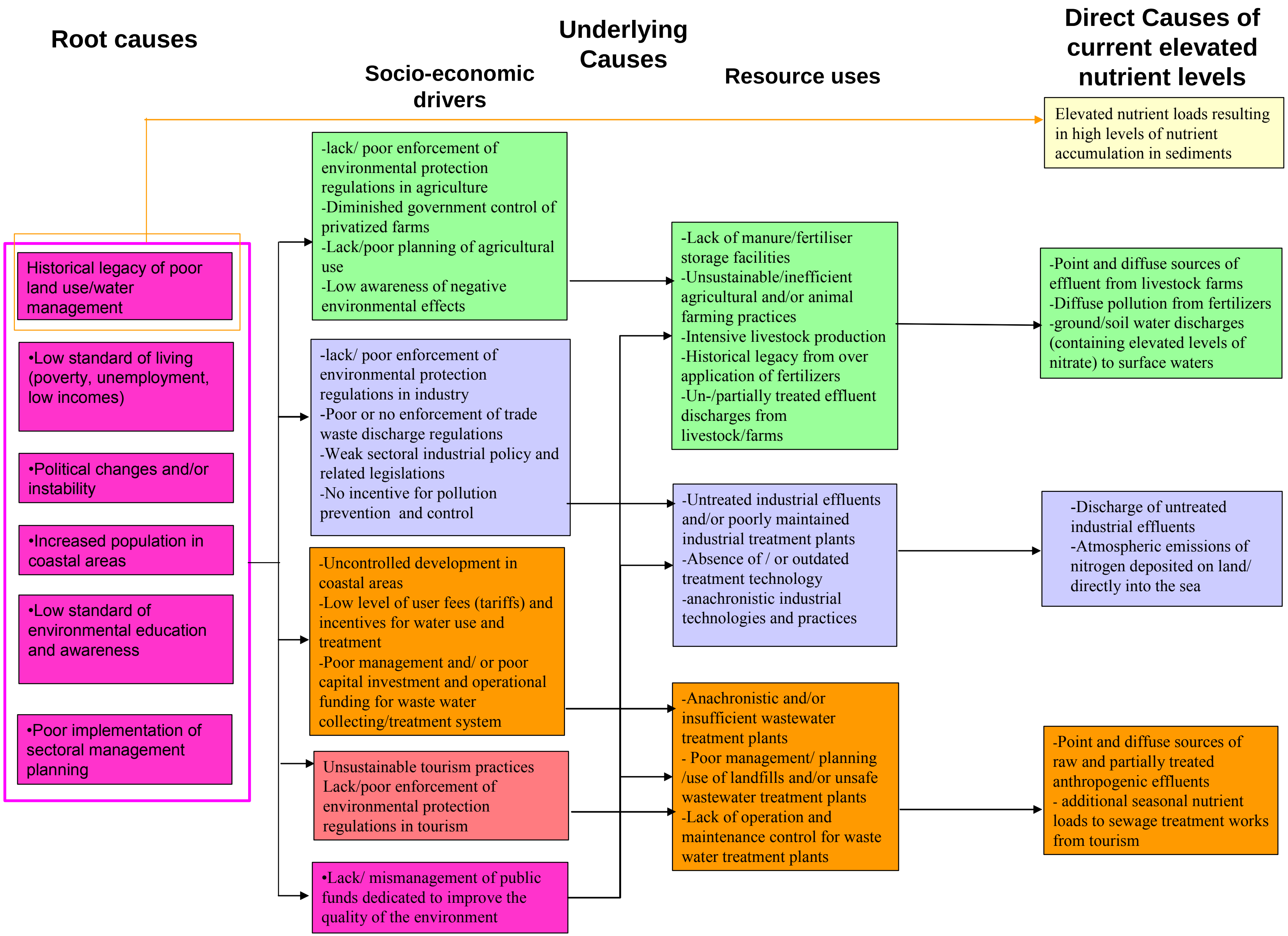


Figure 4.2 Causal chain analysis for nutrient enrichment

4.2.4.1 Direct discharges from sewage treatment works and industry

Coastal development has been recognised as a cause of environmental degradation throughout Western Europe, with the recent publication of a report by the European Environment Agency (EEA, 2006) highlighting this issue as a common European concern. This is regarded as an underlying or immediate cause of coastal habitat destruction, nutrient and toxic substance export to the sea, and therefore a contributory factor to changes in the patterns of fish/shellfish production and harvests.

A brief tour around the coast of the Sea illustrates the scale of coastal development. Existing towns are sprawling further along the coast and new small communities are being built. In the future these may form the seeds of new villages or merge into the suburbs of expanding towns. With summer populations in resorts being typically 3 times greater than winter resident populations, there is a need to build sewerage systems and treatment works that can cope with the peak seasonal demands placed on them.

The vast majority of industrial plants are connected to municipal sewerage systems, so the nutrient exported are included within the nutrient loads measured for sewage treatment works discharging to the sea. Relatively few industrial plants discharge directly to the Sea and, of these, data were requested only for major industrial discharges – those with an average discharge in excess of 1000 m^3/day. Likewise, data were requested from national experts only for municipal sewage treatment works/sewerage system discharges –serving a population of at least 5000 people (i.e. with a dry weather discharge of approximately 1000 m^3/day). Summary results of these are shown in Table 4.4. In the case of industry, perhaps, these results are not surprising, since a manufacturing/processing plant producing that volume of wastewater is likely to be a large facility and industrial discharge data were not provided by two countries. However, the load from sewage treatment works/municipal discharges probably represents the great majority of the load from *all* coastal sewerage systems, and these values appear to be relatively low. To put the calculated municipal nutrient loads into perspective, they represent the expected loads of a population of only about 1 million people, compared to a coastal population of some 7 million inhabitants that are actually connected to sewerage systems discharging directly into the Sea (Section 3.2.1).

4.2.4.2 Agriculture

In the 1960s the former Soviet countries developed cooperative agricultural farming practices, containing relatively small numbers of livestock, bred and maintained using 'traditional' animal husbandry systems. A large part of the manure/waste from these (a mixture of excreta, bedding and feed residues) was applied on cooperative land, as organic fertiliser for crops. However, during the 1970s and 1980s large stock-breeding farms were built, using industrial methods of operation. To give an extreme example of the scale of this agricultural industrialisation, a single Romanian farm contained over 1.2 million pigs.

These intensive livestock farms were usually located close to rivers, into which the manure and waste was discharged. The role of livestock excreta as a valuable organic fertilizer was therefore transformed into one of being a problematic pollution source , particularly for nutrients and biodegradable organic matter, the breakdown of which strips oxygen out of fresh and marine waters..

During the 1970s and 1980s the increase of livestock numbers in state cooperative farms (except Turkey) was often combined with changes in farming practices from farmyard manure to slurry-based systems – producing more nutrient-rich and readily biodegradable waste. Manure/slurry which was not discharged to rivers, was disposed of to land without being used as fertilizer, and so remained as a potential source of pollution. At the same time soil nutrient testing was introduced and fertilization rates were first recommended both to meet the needs of crops and to re-establish soil reserves. However, this type of crop management was in its infancy, was economically (rather than environmentally) driven and mistakes were made. The result of these changing policies and practices was to increase nutrient losses to rivers draining the fields, to ground waters and to the Black Sea itself.

Table 4.4 Nutrient loads to the Black Sea (ktonne/yr) from major direct industrial discharges and sewage treatment works

Country	Pollution Sources	DIN	PO_4-P
Bulgaria	Urban sources	0.20	0.01
	Industrial Sources	0.58	0.00
	Total Bulgarian major point sources	0.78	0.01
Georgia	Urban sources	no data	no data
	Industrial Sources	no data	no data
	Total Georgian major point sources	n/a	n/a
Romania	Urban sources	1.36	0.18
	Industrial Sources	0.49	no data
	Total Romanian major point sources	1.85	0.18
Russian Federation	Urban sources	1.39	0.19
	Industrial Sources	no data	no data
	Total Russian major point sources	1.39	0.19
Turkey	Urban sources	0.30	0.41
	Industrial Sources	0.01	0.01
	Total Turkish major point sources	0.30	0.41
Ukraine	Urban sources	2.87	1.36
	Industrial Sources	0.10	0.24
	Total Ukrainian major point sources	2.97	1.60

At about the same time, increasingly greater amounts of inorganic mineral fertilizers began to be used because they were more economic and easier to apply. Following the economic crisis, the collapse of the Soviet Union and birth of the independent countries of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine in the early 1990s, a major increase in subsistence farming occurred, with the ex-Soviet farms reducing in both number and size. This occurred in parallel with an end to centralised state subsidies for the use of inorganic fertilisers.

Table 4.5 shows that huge changes in livestock numbers have occurred in Black Sea coastal countries since 1960. For this table, attention should be diverted away from the actual values themselves, because of problems involved in obtaining data for the entire national coastal country Black Sea sub-basins (see footnotes to table). However, percentage changes in livestock numbers presented in the table can be used as a good indicator of change during the 1960-2003 period. For example, livestock numbers reached a clear maximum in 1988, just prior to the economic collapse, falling sharply to the situation in 1997, since when numbers of cattle, pigs, sheep and goats continued to fall further until 2003 (by 33, 26 and 31%, respectively). Only numbers of poultry increased (by 23% over the same period). Comparing the 1988-2003 period, numbers of cattle fell by by 64%, pigs by 62%, sheep and goats by 67% and poultry by 21%. The 2003 situation shows a major decrease in mammalian livestock numbers (44-67%) compared with the 1960 values.

Table 4.5 Dynamics of animal livestock numbers in Black Sea coastal country sub-basins[44]

	1960	1970	1988[45]	1997	2003
Cattle	47,808,957	56,196,915	65,630,247	35,285,708	23,447,582
Pigs	26,953,591	31,398,593	40,281,973	20,594,509	15,206,424
Sheep & goats	46,654,418	46,218,158	47,141,410	22,317,543	15,372,116
Poultry	207,712,371	261,990,007	452,444,272	290,550,756	356,534,451

The increasing costs of sheep production in particular have resulted in lower consumer demand for lamb products. The number of poultry has increased dramatically since 1960 due to the adoption of more intensive and cheaper production practices, bringing with them increasing demand.

When compared to the livestock figures (Table 4.5), similarly dramatic changes have happened with regard to the use of inorganic fertilisers in arable farming. This is shown dramatically by Romanian data (Table 4.6). In 1960 only very low levels of inorganic fertilisers were applied, but by 1988 the amount of inorganic nitrogen fertiliser had increased 27-fold and inorganic phosphorus fertiliser 7-fold. Following the economic collapse and independence of Romania, fertiliser application rates fell to below the levels applied in 1970, with a continuing decrease still evident in 2003. Levels applied in 2003 were about one third of those applied in 1988. Statistics from the 2005 World Bank World Development Indicators database[46] show that during the early 2000s fertiliser application rates were substantially higher in Turkey than in other Black Sea countries. Bulgaria, Georgia and Romania formed a middle group and lowest fertiliser application rates were found in the Russian Federation and Ukraine.

[44] Includes data from the whole Black Sea sub-catchments of Bulgaria, Romania, Turkey and Ukraine. Data from Abkhazia (Georgia) are not included, and for the Russian Federation only data for Krasnodar Krai are included
[45] Russian Federeatiion data for 1998 were not available, the values shown therefore include Russian Federation data from 1990
[46] http://www.worldbank.org

Table 4.6 Application of inorganic fertilizers in Romania (1960-2003)

	Total N applied (tonne)	Total P applied (tonne)	Area of agricultural land (ha)	Area of arable land (ha)	Kg N/ ha arable land	Kg P/ ha arable land
1960	24,600	46,810	14,600,000	9,797,368	2.5	4.8
1970	366,900	203,200	14,932,161	9,742,623	37.7	20.9
1988	687,300	343,500	15,098,874	10,078,530	68.2	34.1
1997	262,000	129,000	14,798,535	8,541,226	30.7	15.1
2003	252,000	95,000	14,715,447	9,402,597	26.8	10.1

An assessment of fertiliser application rates for Black Sea coastal administrative areas is effectively impossible to make because only three countries provided any information (Georgia, Romania and Russia). Even amongst these datasets there were differences in the manner in which data were reported, crop types and years for which data were available and differences in how organic/inorganic fertiliser data were combined. Nevertheless, it appears that between 1997 and 2004, inorganic fertiliser application rates have increased for cereal, oilseed and leguminous (bean and pea) crop production. So, although based on a weak data set, and with the need to develop robust arable farming indicators for use by all coastal countries, the decline in arable productivity may now be reversing. If this is true, then improved regulation of arable agriculture would be an important step in future environmental management.

However, changed nutrient applications to land are not generally mirrored by spontaneous parallel changes in nutrient export from land to rivers, groundwater and the Sea. Changed application rates are reflected in emissions only after a lag period, as excess nutrients present in the soil are gradually "flushed out" of the terrestrial system or taken up by crops. Figure 4.3 suggests that much of the excess phosphorus in soils would probably have been exported from land in surface water runoff within a few years.

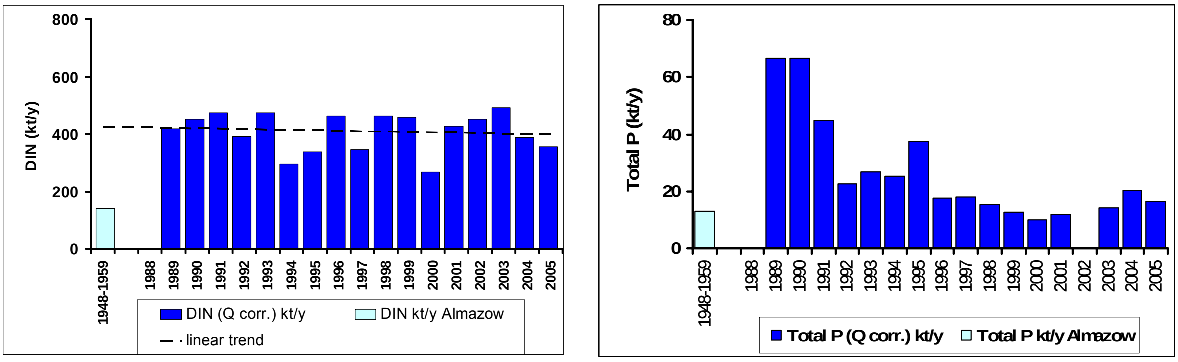


Figure 4.3 River Danube annual inorganic nitrogen and total phosphorus loads (corrected for annual discharge) to the Black Sea (1989-2005)

However, the far greater solubility of nitrogenous salts (which do not adsorb onto soil/geological substrates) has meant that much of the organic/inorganic nitrogen applied to land has leached to groundwater, rather than exported directly to surface waters (rivers, lakes and the Sea itself). Thus, the contribution of groundwater to river flows and direct submarine discharges implies that even decades after being applied to land, nitrogen from this original source could still make a large contribution to the nitrogen budget of the Sea.

Even if agricultural management practices are revised, the lengthy delay period introduced by 'storage' of inorganic nitrogen in groundwater before improvements in emissions can be realised make this a difficult source to tackle, particularly from a political viewpoint, since costs and benefits are usually assessed over a much shorter timescale. However, this is essential if eutrophication of the Black is to be tackled seriously by Regional governments.

4.2.4.3 Unsewered population

The majority of the human population in the Black Sea catchment is not connected to sewerage systems (e.g. in Turkey only about 35% of the population is connected to sewer). The vast majority of phosphorus in the wastes of this population will be retained in soils, since the waste is buried and the phosphate binds to the soil. However, where the population overlies unconfined aquifers, a relatively large proportion of the nitrogen will be released into interstitial water within the soil and can migrate to groundwaters. Groundwater acts as both a storage and transport system for inorganic nitrogen; so, once in an aquifer, it is likely that the nitrogen will eventually be transported to river or discharged directly to the sea. As with submarine discharges (Section 4.2.4.9) no estimates can be made of this contribution to the nutrient budget (Section 4.2.4.10), other than the unsewered population contribution to in-river loads discussed in Section 4.2.4.8)

4.2.4.4 Natural background export from land

Some export of nutrients from land is natural, but no estimates of this are known to have been made for the Black Sea region. However, workers in Western Europe have identified what they judge to be 'quasi-pristine' rivers, calculated the instream phosphorus loads and expressed these as export coefficients[47]. The values cited may include some contribution from a limited number of small point sources as well as from anthopogenically-derived diffuse sources in the catchment.

The larger the drainage basin, the lower the proportion of nutrients that are eventually transported to seas, so for Black Sea, real natural export coefficients will almost certainly be lower than those discussed in the footnote below. If natural export coefficients of 0.025 kg PO_4-P/ha and 0.25 kg DIN/ha are selected and multiplied by the catchment area of the Sea (drainage area minus the surface area of the Sea itself), natural annual loads are approximately 3,630 tonnes PO_4-P and 36,300 tonnes DIN can be estimated, the vast majority of which are already accounted for in river loads (Section 4.2.4.8). These values represent approximately 20% of the calculated river-borne P load and 10% of the river-borne DIN load. These results can be compared with the more complex modelling methodology employed by Kroiss *et al* (2005), who estimated natural sources of N and P to represent 8% of total nutrient emissions to the Danube River.

4.2.4.5 Atmospheric deposition

Atmospheric deposition is a substantial source of nitrogen (deriving principally from the combustion of fossil fuels [vehicles, power generation, etc] and from agricultural

[47] Billen *et al* (1991) reported export rates of 0.05 - 0.65 kg PO_4-P/ha/yr for a range of French rivers, whilst Vighi and Chiaudani (1985) produced figures of 0.07 - 0.65 kg TP/ha/yr for a range of Italian lakes (median value 0.31 kg/ha/yr). The figures of Billen *et al*. are likely to be somewhat higher if expressed in terms of total phosphorus. Background export coefficients of 0.2 kg TP/ha/yr have been used in Austria and Switzerland, with a lower value (0.1 kg TP/ha/yr) for Finland, Norway and Sweden. (e.g. Morse *et al* 1993). Much less effort appears to have focused on estimating natural/ background export of nitrogen, but Parr *et al* (1999) calculated in-stream inorganic nitrogen loads at some 200 river sites in the UK. Those sites having the very lowest export coefficients (approx 1 kg DIN/ha/yr) can be regarded as being at the upper end of natural/background nutrient export, from which a "natural" export coefficient of <1 kg total N/ha/yr could be assumed.

atmospheric emissions), but not of phosphorus. Previous monitoring studies have suggested a wide range of atmospheric nitrogen deposition rates for the Black Sea, with modelling studies also intimating that a broad range of nitrogen deposition rates could be applicable throughout the region and over the Black Sea itself.

A recent nutrient budget for the NW shelf (Mee *et al*, 2005), indicated nitrogen deposition rates of 4.8-10.2 kg N/ha, based on data provided by Sofief *et al* (1994). Multiplying these values up from the 50,000 km^2 of the NW Shelf as used by Mee *et al* to the 423,000 km^2 surface area of the whole Black Sea (excluding the Sea of Azov) provides an air-borne load estimate of 203,040–431,460 tonnes N/year.

4.2.4.6 Solid waste

Nutrients may enter the Black Sea from both authorized landfills and illegal dumping of solid waste near to the shore. Nutrients from this source could enter the Sea either in overland runoff or via groundwater discharges. However, it has not been possible to make an estimate of nutrient loads entering the Sea from such sources, since the loads from individual sites differ enormously, depending on the design criteria of authorized landfills, local topography, geology, precipitation statistics, mass/volume and type of waste dumped, etc.

4.2.4.7 Sediment-water exchange

Once in rivers and the Sea itself, during periods of elevated nutrient loading, huge reservoirs of nitrogen and phosphorus build up in the sediment and form a source for years to come. In the marine environment there is no “rule of thumb” to estimate how long this period will be, but in lakes which undergo a large sudden decrease in phosphorus loadings, a useful estimate is that it takes in the order of 5 years for sediments to switch from being a net source to a net sink of phosphorus (Sas, 1989), but for estuarine and coastal systems, and for nitrogen, the situation is more complex.

From recent (2006) measurements of sediment-water fluxes in the NW Shelf (Friedrich, 2007) the state of the benthic system along the Romanian and Ukrainian coast of the Black Sea has improved as the bottom water is now more oxygenated than about 10 years ago. However, benthic nutrient fluxes resulting from the decomposition of organic matter within the sediment are still at levels comparable with those from the mid 1990s. The release of nutrients from the sediments continues to fuel productivity within the Sea itself. Parts of the *Phyllophora* field appear to be recovering. A healthy benthic ecosystem with plants and animals in balance releases less organic and inorganic nutrients to the overlaying water than a disturbed system without macrobenthic life. *Phyllophora* (and other benthic macroalgae) play an important role in taking up nutrients released from the sediments and supplying the benthic system with oxygen (Friedrich, 2007).

Benthic nutrient recycling is a significant internal nutrient source for the pelagic system of the NW shelf, sustaining high productivity by the release of nutrients from the sediment. For phosphorus this sediment→water flux is of the same order of magnitude as river inputs, albeit that the sediment→water flux of nitrogen is only about 10% of the river-borne load (Mee *et al*, 2005). However, in 2006 only a very low phosphorus flux from the sediment to the water column was observed in front of the Dniester mouth, on this occasion/site at least, since phosphate appeared to be adsorbed by the ferric hydroxides visible at the sediment surface (Friedrich, 2007).

Despite there being quantitative estimates of sediment-water nutrient fluxes for the NW shelf, similar estimates are not available for other shelf areas around the Black Sea coast and no information is available on fluxes from deep sediments in the main body of the Black Sea. Consequently no estimates of sediment-water nutrient exchange can be produced for the Sea as a whole for comparison with other sources in Section 4.2.4.10.

4.2.4.8 River and strait discharges

Because of missing flow (See Section 3.1.5) and/or concentration data from some years, only data from a 3-year period (2003-2005) are provided to present a regional overview of nutrient loads to the Black Sea. This is the period for which most information exists, although data are still missing for some rivers. For Georgian rivers the flow data used are long-term averages measured prior to 1993[48], and flow monitoring of the Tuapse River, Russia was discontinued in 1996 (Table 3.2). Loads from other rivers are based on very few concentration data and, worryingly, estimates for other rivers (e.g. the Supsa and Khobi) are missing due to a complete absence of data. However, these are relatively small rivers and therefore likely to contribute comparatively small loads.

The absence of data for both the Kerch and Bosphorus Straits represent a major gap in our knowledge of the Region. This information is collected, but has not been provided. Moreover, different countries have provided data for different nutrient parameters. For a robust regional presentation of nutrient loads, total N and total P loads should be used, but instead values are presented only for ortho-phosphate-P and dissolved inorganic nitrogen loads (Table 4.7). To further compound this problem Russian river loads data provided as total P loads have had to be converted to ortho-phosphate loads by assuming a total P:ortho-phosphate-P ratio of 2:1. This is a very broad assumption, which may result in large errors.

Considering the emphasis placed on river and strait nutrient loads in the 1996 TDA and SAPs, it is unfortunate that substantially improved data were not provided by all countries for this analysis.

To assess trends in river-borne nutrient loads to the Black Sea since the last TDA was produced, Fig. 4.4 shows the total river loads of nutrients in those rivers for which annual load data are available for every year from 1996 to 2005. For PO_4-P, this includes the rivers Rioni, Tchorokhi, Danube, Sakarya, Dniepro, Southern Bug and Dniester; and for dissolved organic nitrogen the rivers Rioni, Tchorokhi, Danube, Sakarya, Dniepro, Southern Bug and Dniester. Assuming that the same pattern of change has applied to all rivers draining into the Black Sea, a linear regression through these combined annual loads suggests a decrease of over 30% for river-borne DIN and PO_4-P loads entering the Sea during this period.

This substantial decrease in river nutrient loads is overwhelmingly due to the decline in agricultural intensity/productivity that followed the economic collapse at the end of the 1980s, and which continued during the 1990s/early 2000s (Section 4.2.4.2).

[48] There are better methods to estimate recent flow than using long-term averages, for example, use of a linear regression plot of historical annual precipitation/river flow. The regression formula can then be applied to precipitation data for the period when flow data are not available. This is particularly useful when there has been considerable variation in inter-annual flow or an overall trend in flow, as monitored data from the Danube suggests could have occurred in other Regional rivers

Table 4.7 Mean annual river-borne loads (tonnes) of nutrients to the Black Sea (2003-2005)

Country	River	DIN load	% of total river-borne DIN load	PO_4-P	% of total river-borne PO_4-P load
Bulgaria	Kamchia	1981	0.55	198	1.11
	Aheloy	17	0.00	3	0.02
	Veleka	199	0.05	16	0.09
	Ropotamo	8	0.00	2	0.01
	Batova	31	0.01	1	0.00
	Diavolska	2	0.00	0	0.00
	Dvoinitza	28	0.01	10	0.05
	Hadjiska	5	0.00	1	0.00
	Karaach	18	0.00	6	0.03
	Rezovska	66	0.02	4	0.02
	Total Bulgarian River load	2354		240	
Georgia	Rioni	256	0.07	5	0.03
	Supsa	No data		No data	
	Tchorokhi	281	0.08	5	0.03
	Natanebi	No data		10	0.05
	Khobi	No data		No data	
	Kubastskali	No data		No data	
	Total Georgian river load	537		19	
Romania	Danube	304,093	83.88	8,796	49.42
Russian Federation	Sochi	169	0.05	39	0.22
	Khosta	36	0.01	8	0.04
	Mzimta	337	0.09	141	0.79
	Tuapse	296	0.08	131	0.74
	Total Russian river load	839		320	
Turkey	Sakarya	8,377	2.31	3,030	17.02
	Kızılırmak	812	0.22	93	0.52
	Filyos	3,108	0.86	430	2.42
	Yeşilırmak	6,719	1.85	1,137	6.39
	Coruh	5857	1.62	1,437	8.07
	Total Turkish river load	24,873		6,127	
Ukraine	Dniepro	23,635	6.52	2,169	12.19
	Southern Bug	2,547	0.70	64	0.36
	Dniester	3,667	1.01	65	0.37
	Total Ukrainian river load	29,849		2,298	
All countries	Total river load	362,545	100	17,799	100

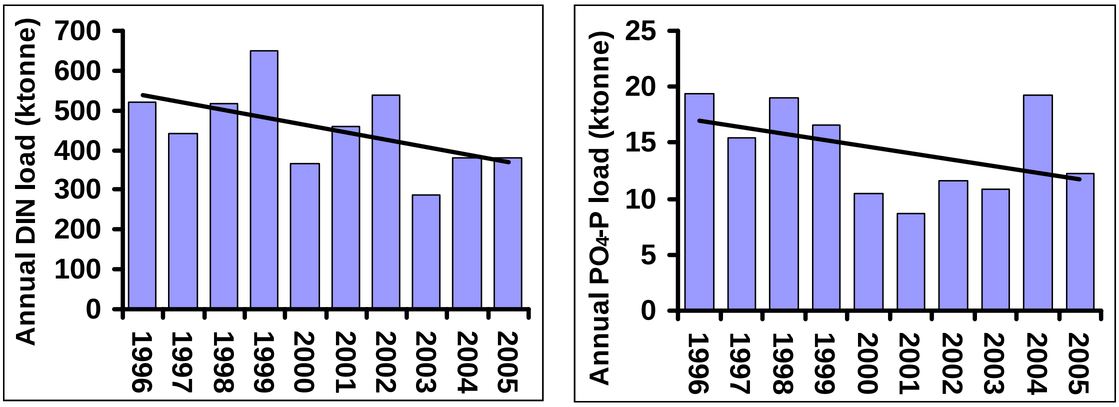


Figure 4.4 Trends in river nutrient loads to the Black Sea, 1996-2005

4.2.4.9 Submarine discharges of groundwater

No estimate of submarine groundwater discharges of nitrogen are known to have been undertaken. However, such discharges would be included in diffusive sediment-water fluxes, as discussed in Section 4.2.4.7.

4.2.4.10 Comparison of the magnitude of different nutrient sources

Table 4.8 shows a comparison of nutrient loads to the Black Sea from four major sources. The river loads include sub-loads from a variety of land-based sources (agriculture, sewered/unsewred populations, direct industrial discharges to rivers). The contribution of natural background export from land is not possible to estimate without a validated and calibrated model. Nevertheless, the table indicates a huge contribution of nitrogen from atmospheric deposition, albeit that there is considerable uncertainty about this estimate (Section 4.2.4.5).

Table 4.8 Estimates of annual nutrient loads to the Black Sea (tonnes)

Pollution Source	DIN	PO_4-P
Direct discharges from municipal waste water treatment plants serving >5000 people	6120	2150
Direct discharges from Industrial sources discharging >1000 m^3/day	1180	250
River loads	362545	17799
Atmospheric deposition	203,040–431,460	-

However, a nutrient source apportionment study using the MONERIS model for the entire Danube basin (Kroiss *et al*, 2005) provides interesting results. These show that in the Danube (which provides about 70% of the freshwater inflow to the Black Sea), 45% of the N and 33% of the P are derived from agriculture (both arable and livestock farming); 32% of N and 56% of P are derived from urban settlements (both sewered and unsewered settlements): 8% of both N and P emissions are considered to be of natural origin; and 16% of N and 3% P are derived from other diffuse sources (e.g. forestry and small unsewered communities).

4.2.5 Underlying causes

The underlying socio-economic drivers for nutrient enrichment can be divided into funding and policy development/enforcement of the major sectoral groups responsible for nutrient production and export to the sea. These can be largely grouped into two categories corresponding to point (industry and urbanisation; Section 4.2.5.1) and diffuse (agriculture, atmospheric deposition, internal loading from sediments; Section 4.2.5.2) sources.

4.2.5.1 Point sources

There are very few large direct discharges of industrial wastewater to the Black Sea, However, information on monitoring of and compliance with standards for the discharge of nutrients to sewer from industry has not been made available, so it is difficult to estimate the industrial contribution to municipal sewage treatment works effluent.

A wide variety of estimates have been made for domestic sewage treatment works around the world, but most of these methods rely on subtracting the assumed domestic loads (modelled using *per capita* nutrient export coefficients) from the load in raw sewerage entering sewage treatment works. Given that there is so much uncertainty over the selection of such export coefficients, with further uncertainties over the contribution of detergent-derived phosphate to domestic loads, as well as sewer leakage, a broad range of industry-derived nutrient load estimates is available. Alternative modelling approaches are also available, using industry-specific nutrient export coefficients. Indeed, one such method was used in the 1996 Black Sea TDA, but such approaches require detailed knowledge of all industrial operations/plants, which is rarely available.

Despite it not being possible to differentiate between the relative contributions of municipal and industrial discharges, the underlying causes for both remain similar:

- Poor understanding of the "carrying capacity" of receiving waters downstream of discharges.
- Either a low level of environmental awareness or low positioning of environmental quality on the political agenda, due to strong competition for funding from other ministries with more politically urgent requirements.
- Lack of consideration of the Sea itself as a receiving waterbody for municipal/industrial discharges to river.
- A lack of willingness to impose more stringent enforcement of legislation because of the socio-economic consequences (closure of factories, increased unemployment, etc.).
- Low penalties for failing to meet discharge standards, meaning that cost-benefit study results have been heavily weighted in favour of "no investment required" results
- For industrial discharges to sewer, poor regulation (monitoring and enforcement of existing norms) relating to nutrient loads to sewer and a lack of planning/enforcement
- Uncoordinated coastal development and associated tourism, leading to over-loaded sewage treatment facilities that are able offer only partial treatment of the effluent they receive.
- Poor financing of wastewater treatment facilities, either through low service charges to industrial or municipal users or through the re-direction of fees collected for other purposes.
- Poor investment in regulation/monitoring of discharges, meaning that quality-assured results to allow enforcement of existing legislation have often not been available.

4.2.5.2 Diffuse sources

Historically, agricultural management bore little consideration to environmental impacts; cost-efficiency and socio-economic considerations (employment) were the major drivers behind decisions that were made at policy level. Thus, state subsidies for inorganic fertiliser application were available in five of the six Black Sea countries. The amount of fertiliser applied was, sensibly, based on crop nutrient balances, but the result was widescale over-fertilisation, leaving nutrient surpluses in soil that were just too great to be contained, so increasing amounts of nutrients were either leached or exported in surface run-off. The concept of best agricultural practice, encompassing both economic and environmental considerations had not been embraced at any level.

Even though some guidance was available to promote improved environmental management (e.g. on the construction of winter manure stores, to prevent the direct application of manure to frozen land, from where nutrients and organic waste would be washed off during snowmelt, if not before) this was often not followed and rarely enforced. The emphasis was often either on guidance or a failure to enforce legislation, meaning that penalties for non-compliance were scarcely introduced, thereby stimulating a culture of non-awareness of environmental consequences. The root causes are once again financial.

Mis-management of livestock farming meant that ever increasing numbers of livestock were concentrated on fewer major farms. A failure to enforce existing legislation resulted in the manure generated being insufficiently treated, and unwisely disposed of – often by collection and dumping of large manure piles on land or discharge to rivers. The result was that the main centres of livestock and arable production became increasingly isolated from each, and it became uneconomic to transport the huge manure surpluses generated in some areas to arable farms located large distances away. Because of economic considerations, there was also a move away from solid manure-based farming practices to slurry-based systems, which further increased the nutrient content of animal waste, due to changes in animal diet/size.

Then, with the economic collapse, break-up of the Soviet Union and an end to state-subsidies, the level of inorganic fertiliser usage plummeted, almost overnight. Large-scale livestock production units decreased in size or closed down completely as the market for meat products collapsed. Customers could no longer afford this level of "luxury". Trends in GDP and GNI *per capita* statistics (Section 3.2) suggest more recent increase in personal wealth with which to purchase food, but the middle class in Black Sea countries tends be of a small size, with this increased personal wealth belonging predominantly to a very small but very wealthy upper class.

Small-scale subsistence farming (a few livestock per household) became increasingly important, and effectively impossible to regulate or manage. Many farmers on this scale lack the equipment (tractors) necessary to move the manure produced any distance and apply it to arable land where it would be useful, although many small farms do exist. The overall result has been one of diminished government control of farming. In addition to this, the manure from livestock kept in owners gardens – a common feature of urban life - is sometimes disposed of to sewer, helping to over-burden already struggling municipal sewage treatment works.

Large areas of once productive arable land were either left fallow or abandoned, with some begining to convert back naturally to scrubland. However, the new status of Bulgaria and Romania as EU Member States, combined with the low wages of agricultural workers is likely to stimulate foreign investment in the agricultural sectors of these countries to produce food for export.

It is unclear why such large changes in the agricultural sector have occurred in Turkey, when there never were such centralised state subsidies for agriculture and the population has continued to increase. The regional economic collapse would almost certainly have contributed to such changes, so once again changes in the import-export balance of agricultural products or changes in diet appear to be at the root of this change.

Currently, there is a lack of good agricultural management and poor awareness of good environmental practice. Bulgaria, Romania and Turkey intend to fully comply with the EU Nitrates Directive, requiring the introduction of Best Agricultural Practice, but the larger the number of farms and the smaller their size, the more difficult such legislation will be to enforce. The development of national soil monitoring programmes and improved advice to optimize inorganic and organic fertilizer application for arable crop production are required.

4.2.6 Knowledge gaps

- No information is known on groundwater flows or direct groundwater loads of inorganic nitrogen loads to the Black Sea. In addition, the groundwater contribution to the Danube load is estimated to be 47% of the flow, but the contribution of groundwater to the loads of other rivers to the Black Sea has not been estimated. This is important to understanding the likely effectiveness of management options to control diffuse source-derived nitrogen.
- The contribution of industry-derived nutrient loads to municipal sewage treatment works loads is unknown. Based on available data, modeling of such loads is likely to produce very inaccurate results.
- It is not clear whether the perceived increased importance of subsistence farming in the region is adequately reflected in official livestock statistics.
- There are large differences in proposed national statistics on the nutrient content of livestock manure, from which potential nutrient loads to the Black Sea are estimated.
- The contribution of different sources to river-borne nutrient loads for most rivers is unclear.
- Information on nutrient loads to/from the Black Sea via the Bosphorus and Kerch straits were not received for this report.

4.2.7 Summary and preliminary recommendations

- The river Danube is by far the single largest source of nutrients to the Black Sea.
- Relevant authorities should measure riverine and municipal/industrial nutrient discharge concentrations (for the estimation of loads) as total N and total P. Inorganic nitrogen and ortho-phosphate measurements are a poor substitute for calculating loads.
- Substantial improvements in river nutrient loads appear to have occurred between 1996 and 2005 (about a 30% reduction in both nitrogen and phosphorus). These improvements have been primarily the result of the economic downturn at the end of the 1980s and the resultant decrease in agricultural productivity. For these improvements to be sustained and built upon in future years, capital investments and improved regulation of agriculture are required.
- The contribution of the Bosphorus Strait to Black Sea is particularly important, since the majority of wastewater from Istanbul is discharged into this waterway. The Bosphorus effectively consists of two layers: an upper stratum flowing out of the Black Sea and a lower, denser layer flowing into the Sea. The contribution from

Istanbul (a city of 15 million people) could potentially outweigh the direct point source discharges calculated in this chapter for the entire Black Sea!

- The nutrient loads from coastal point sources (direct municipal and industrial discharges) are a tiny fraction of the load from rivers to the Sea. This suggests that capital investments to upgrade coastal hot-spots are likely to have only a negligible effect on transboundary pollution, although local environmental improvements are likely to be much greater. This suggest a fundamental problem in the approach of the 1996 TDA, which focused so heavily on direct marine discharges.
- Huge changes in agriculture have occurred in all Black Sea countries. The largest changes occurred between the end of the 1980s and the mid-1990s. However, since 1997 there has been a continued decrease in livestock numbers, and therefore livestock manure as a source of pollution. Agriculture is now much more extensive than it was in the late-80s, but some indicators suggest that the decline in arable agricultural productivity has bottomed-out and the region may be facing a renewed period of increasing inorganic fertiliser use.
- A much greater emphasis on nutrient management in agriculture is required, notably the development, adoption and enforcement of best agricultural practice guidelines, including revised guidance on fertiliser (organic and inorganic) fertiliser application rates, together with a robust soil nutrient testing programme.
- The environmental requirements for EU membershıp should result in substantial improvements in nutrient emissions from land for Bulgaria and Romania within the next 15 years. Turkey has only recently started EU accession talks, but it's willingness to comply with the EU Water Framework Directive, should also bring about substantial improvements.
- However, EU accession/membership is not a one-sided issue in terms of eutrophication. The EU Urban Wastewater Treatment Directive requires all populations of 2,000 inhabitants or more to be connected to sewer. For currently unsewered populations of this size, this is likely to increase nutrient emissions to rivers and the Sea itself, since the nutrient removal efficiency of sewage treatment works (for phosphorus at least) is likely to be lower than that currently provided by soil/groundwater.
- It would be of value if the quantification of riverine loads (as well as other pollution sources) could be standardised and harmonised to obtain a more accurate assessment of loads entering the Black Sea. Good examples of how this has been undertaken by other Marine Conventions are the RID and PLC guidelines produced by the OSPAR and HELCOM Commissions, respectively. The Danube has a very well established river monitoring network (TNMN) with a load assessment programme that started in 2000. All Danubian countries have agreed to use a standard operational procedure for the measurement and calculation of riverine loads from the Danube into the Black Sea. Procedures giving comparable results should be adopted for the assessment of loads at the most downstream points in other major rivers discharging into the Black Sea.
- An emphasis of the original TDA in 1996 was on nutrient source apportionment and control, as was the 1996 SAP and the updated SAP in 2003. Efforts have been made to improve the understanding of this issue, but it is still essential to collect and/or make available good quality data to quantify the various sources of nutrients in order to develop robust management plans.

Box 4.1 Comparative analysis of the 1996 and 2006 TDAs on the transboundary problem of nutrient enrichment/eutrophication

A comparison between the 1996 and 2007 TDA with regard to nutrient enrichment/eutrophication is presented in the table below. In the 1996 TDA, nutrient pollution was not considered in isolation from other pollutants, and there was no real description of this as an independent problem. The focus of the 1996 TDA was on the identification of 'point sources' of pollution, with a major focus on direct municipal/industrial discharges as sources of pollution. Little information was presented on the likely contribution of different emissions to river loads. The biodiversity focus of the 1996 TDA included eutrophication as a causative factor in ecosystem change, but not as a problem in its own right.

Issue	1996 situation	2006/7 situation
Monitoring	• No integrated regional monitoring programme available for the Sea itself or for the nutrient sources discharging to it	• Integrated monitoring programe now set up, but with a mixed response from different countries. Biological monitoring has only recently been incorporated into this programme. • A regionally coordinated chemical quality assurance scheme is in place for analysis of samples collected from within the Sea itself, but this programme does not extend to quality assurance of loads data.
Impact of eutrophication	• Described in simple terms, but with no real description of status	• Much clearer idea of how eutrophication impacts on biodiversity/habitat change, and of the effects of nutrient enrichment on the pelagic ecosystem and marine living resources • Quantification of nutrient levels within the Sea itself
River loads	• Data absent from many rivers. Estimated of nutrient inputs to the Sea from the Bosphorus Strait included • River loads are overwhelmingly the major source of nutrients to the sea	• Monitoring data (and therefore load estimates) are available for the majority of rivers, but flow measurements are not available from Georgia • Annual flow data from a large proportion of River-borne loads of N and P appear to have reduced by about 30% since 1996. • A much clearer idea of nutrient source apportionment within this individual source (River loads) is now available. • No assessment of nutrient loads to the Sea through the Kerch or Bosphorus Straits.
Direct municipal discharges	• Only modelled estimates of loads available. No specified minimum size/volume/load of dischgarge • Directunicipal discharges responsible for only a very small proportion of the total nutrient load to the Black Sea.	• Monitored loads available • Considerable effoirt made on data-checking to ensure comparability of results from individual dıscharges/countries • A comparison cannot be made between the 1996 and 2007 situations because of problems in equating modelled loads to monitored loads • Direct municipal discharges responsible for only a very small proportion of the total nutrient load to the Black Sea.
Direct industrial discharges	• Only modelled estimates of loads available. No specified minimum size/volume/load of dischgarge • Direct ndustrial discharges responsible for only a very small proportion of the total nutrient load to the Black Sea.	• Monitored loads available for industrial plants producing more than 1,000 m^3/day. • A comparison cannot be made between the 1996 and 2007 situations because of problems in equating modelled loads to monitored loads • Direct ndustrial discharges responsible for only a very small proportion of the total nutrient load to the Black Sea.
Atmospheric deposition	• No estimate provided	• Estimate provided for nitrogen, albeit with considerable uncertainty attached. This estimate suggests that atmospheric deposition may be responsible for a similar load of nitrogen to the Sea to that discharged via rivers
Other sources, notably agriculture	• Very little information. Not considered as important sources to be tackled as part of	• Much clearer idea of the contibution from diffuse sources to the Black Sea, with a far better understanding of the contribution of agricilre to this problem
Causal chain analysis	• The causal chain was clearly understood, but not considered as as a subject in its own right	• Causal chainancluded. This identifies weaknesses in policies/practices and a broader range of contrubuting factors than included in the original TDA becasue of the increased emphasis on agriculture • No regionally agreed list of priority pollutants for monitoring/assessment purposes

4.3 Changes in commercial marine living resources

4.3.1 The problem

The topic of fisheries in the Black Sea contains a bewildering array of statistics that are often either incomplete or incomparable. The exploitation of marine living resources, in particular fisheries, represents an important economic sector, but also has a substantial social impact for local communities throughout the Black Sea region. Perhaps more to the point, the issue of fisheries management seems to be a politically charged issue at national levels throughout the world, with negotiated international agreements taking many years to come to fruition and the emerging compromises often offering considerably reduced protection of these valuable resources.

However, the problem of changıng commercial marine living resources (MLR) is not simply one of resource fluctuatıons, together with theır associated socio-economic consequences. There are huge implications for marine ecology, biodiversity and the ability of the Sea to process the nutrient/pollutant loads which it receives. As will be shown later, total catch statistics by themselves reveal very little about the sustainability of existing practices/resources.

Major changes continue to occur in the underlying contribution of different species to overall "total catch" estimates, meaning that total catch statistics, reflecting human responses to the changing resource, hide an underlying problem. For example, since the early-mid 1990s, total fish catches have increased in the Black Sea, intimating that the resource has recovered during the last decade, but this is largely due to increased catches of anchovy and sprat. Catches of whiting (ımportant for the maintenance of turbot and spıny dogfish communities) and horse mackerel have declined over the same period (Fig. 4.5). Mullet catches have also fallen dramatically since 1966, but there are some positive signs: in Romanian waters at least, red and grey mullet populations appear to be undergoing some recovery, as do bluefish and horse mackerel populations. Horse mackerel and shad have recently re-appeared in Georgian waters and during the last decade indicators suggest that turbot stocks may have begun to recover in Bulgarian waters.

However, Romanian turbot catches have remained depressed and Turkish turbot catches have been very low since 2002, with only 119 tonnes landed from the Black Sea during 2003, compared to landings of about 2,000 tonnes during the mid-1990s. Likewise, Turkish spiny dogfish and whiting catches (demersal species, as is turbot) have progressively dwindled. Sturgeon, sea trout, corb and brown meagre catches are also severely depressed.

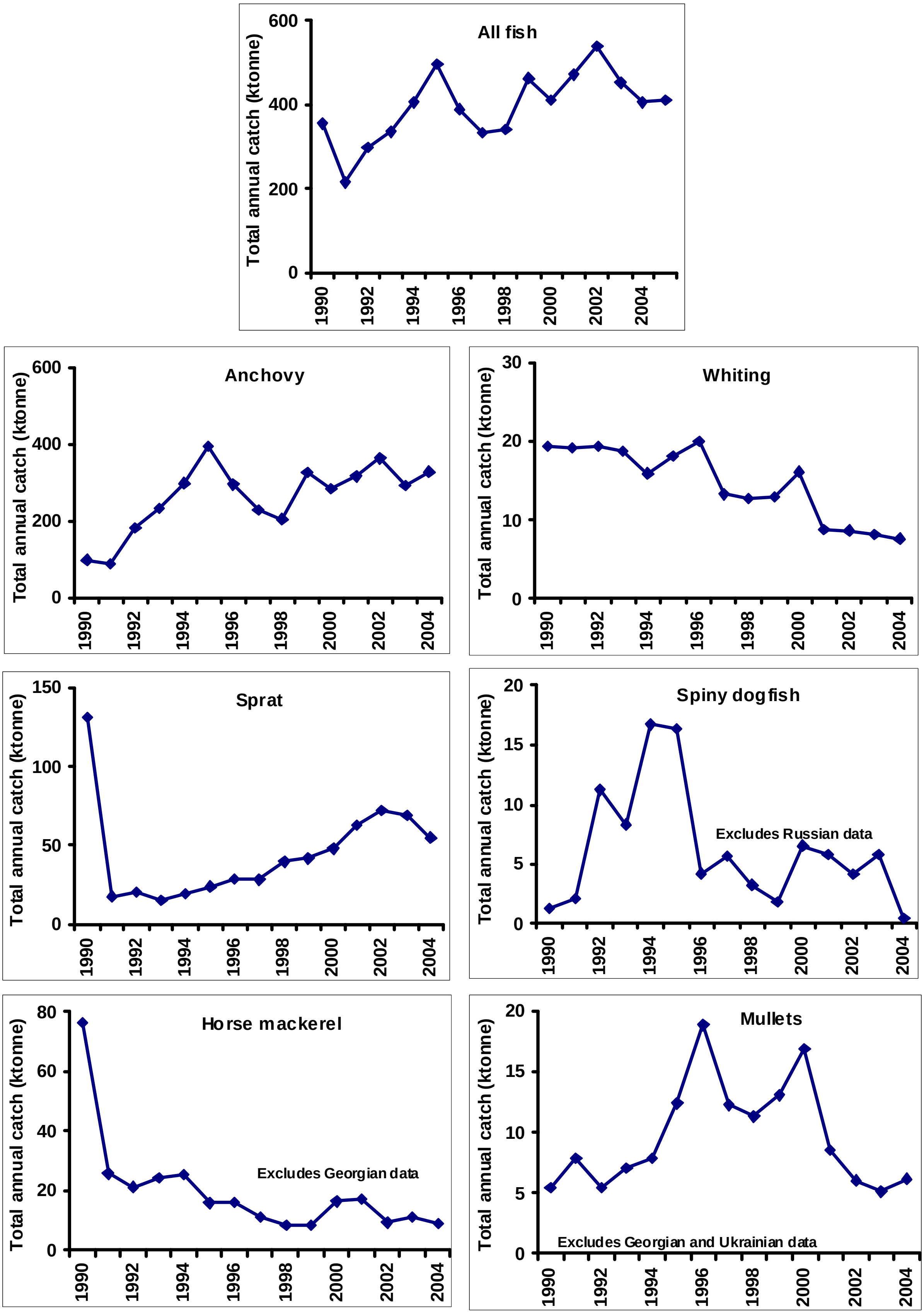


Figure 4.5 Trends in Black Sea fish catches, 1990-2004[49]

[49] Data source: 'all fish' data provided by Dr S Nicolaev. Species data provided by national experts.

Of those fish taxa found in the Sea, the following represent the major catches in terms of weight:

- Anchovies (Black Sea and Azov Sea anchovy)
- Horse mackerel
- Whiting
- Bonito
- Bluefish
- Sprat
- Mullets (red, thick lip grey, golden grey, thin-lipped, leaping grey, common grey, Pacific/haarder and striped red mullet)
- Spiny dogfish
- Turbot
- Shads (Caspian, Danube, pontic, common, twaite and pontic shad).

However, other fish, notably sturgeons (Russian, spiny, starred and common sturgeon, and sterlet) and beluga (also known as great sturgeon), are of great economic importance. Furthermore, mussels and *Rapana*, the Japanese snail, represent the most important invertebrates from a commercial viewpoint.

The transboundary importance of commercial fish species is supported by both economic and ecological factors. The majority of fish species with commercial value are shared within the Economic Exclusive Zones (EEZs) of many states such as sprat, whiting, dogfish, turbot and others. Migratory species such as anchovy, horse mackerel, bluefish and bonito have spawning, feeding and wintering areas located in the EEZs of different states depending on the time of year and lifecycle. Consequently, the management applied in exploitation of shared and migratory stocks must take into consideration appropriate levels of catches in each coastal state. The distribution of benefits by coastal countries should reflect the territorial distribution of the resources. At present, Turkey is responsible for some 80% of the reported total Black Sea fish catch, but the length of the Turkish coastline is less than one-third of the entire Black Sea coast (Table 3.1)

The scale of the problem depends over what time-scale the issue is judged, and over what geographical areas. For example, some statistics from Ukrainian waters (Table 4.9) suggest that, since the 1960s, the fishery for some species has collapsed almost completely.

Table 4.9 Average annual Ukrainian Black Sea catches of selected fish (tonne), 1950-2004

Year	Bonito	Bluefish	Mullets
1950-1969	672	19	956
1970-1995	0	21	132
1996-2004	0	0.01	35

However, such statistics take no account of fishing effort or changes in fishing practices. For example, record catches of bonito were achieved by the Bulgarian and Turkish fishing fleets in 2005 (Fig. 4.7), and Fig. 4.8 provides an illustration of how active fishing practices (trawling, etc.) have rapidly replaced passive fishing practices (long lines, pound nets, gill nets and trammel lines) in the Romanian coastal fishery. Thus catch statistics by themselves are of little use in assessing the status of the fishery (see Section 4.3.4)

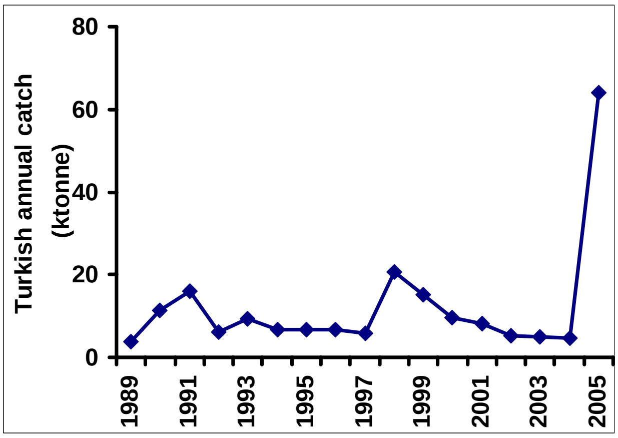


Figure 4.7 Annual Turkish Black Sea catches of bonito, 1989-2005

While the emphasis of this document is on showing changes that have occurred over the last decade, since the original 1996 Black Sea TDA was written, it is necessary not to lose sight of changes over the longer-term. This is especially important because the agreed long-term target (the EcoQO) of the 1996 SAP was "to take measures… to permit Black Sea ecosystems to recover to conditions similar to those observed in the 1960s."

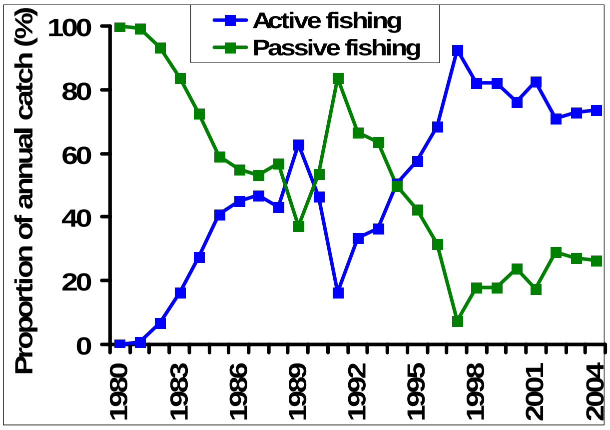


Figure 4.8 Fish catches in Romanian coastal waters by active and passive techniques expressed as a proportion of the total fishery catch, 1990-2004

4.3.2 Environmental impacts and socio-economic consequences

The recent collapse of the fisheries is directly connected with degradation of the water and sediment quality, destruction of important spawning grounds, and the outbreak of opportunistic and invasive species. In addition to these, fishing activities are also responsible for the decline in commercial fisheries, as the declining ecological condition is exacerbated by open access to resources, individual countries establishing uncoordinated management regimes, overfishing and illegal fishing in combination with non-sustainable technologies.

Although there is currently little information available of the socio-economic impacts of the decline in Black Sea fisheries as they pertain to income and employment levels, the following issues warrant consideration:

- Annual losses of catch value (each hundred thousand tons represents more than 150 million USD).
- Additional expenses for replacement of processing capacities (fish meal production plants, canning facilities, etc.) for adapting at new raw materials.
- Additional expenses for restructuring of (existing) fishing fleet capacities, due to adapting vessels to target new species.
- Losses of employment and income for local communities.
- Increased fragility of the Black Sea ecosystem from anthropogenic pressures which directly impact the status of commercial marine living resources.

The information in Table 4.10 is incomplete, but shows that seafood consumption has varied dramatically since the economic crisis and collapse of the Soviet Union at the end of the 1980s, and is once again increasing. However, demand far exceeds supply from the Black Sea, so huge volumes of seafood continue to be imported.

Nevertheless, the situation does give reason for optimism, since in some countries at least this has led to an increase in commercial marine and freshwater aquaculture, thereby providing increased employment opportunities. For example, Table 4.11 shows that in Ukraine the number of marine and freshwater fish (Odessa Region) and shellfish (Black Sea and Kerch Strait) farms has increased strongly over the last decade, as has the productivity of these farms. Because of the relatively low salinity of the Black Sea, some farmed freshwater fish can also be found in the Sea. For example, sılver carp, *Hypophthalmichthys molitrix*, whose production in freshwater farms increased over 5-fold between 2004 and 2005, is recognised as an invasive species in the Sea itself.

Of course, poor aquacultual practices, as with any kind of farming, can be a cause of serious environmental problems in their own right. It is, therefore, encouraging that robust scientific/ environmental principles have been developed for Bulgarian mussel farms (Konsulova *et al*, 2006), particularly in light of the Turkish Eastern Black Sea shellfish industry collapse (Mediterranean mussels, *Mytilus galloprovincialis* and clams) as a result of *Rapana venosa*. Considering the very under-developed status of mariculture in Bulgaria, these principles/guidelines have been developed at just the right time!

While sounding disastrous, the *Rapana* story is an example of how humans have themselves adapted to the changing ecology of the Black Sea. For example, while *Mytilus* has not been collected commercially along the Eastern Turkey Black Sea coast since 2000, landings of *Rapana* from the same waters have increased dramatically since then – from a yield of 2-3,000 tonnes/yr during the 1990s to a peak of 12,890 tonnes in 2004 (Table 4.12). From the whole Turkish Black Sea coast, landings of *Mytilus* plummeted to a mere 17 tonnes in 2001, but have since rallied to values approaching 3,000 tonnes/yr, and in one year (2003), even exceeded 4,000 tonnes. These values are higher than those recorded during the late 1990s (Table 4.12), but still considerably lower than those produced during the 1992-1995 period (approx. 6,000 tonnes/year). Clam production from Turkish Coastal waters has resumed to levels similar to those recorded in the early-mid 1990s (excluding the extremely high 1994 value; Table 4.12)

Table 4.10 Seafood production, consumption and employment statistics for Black Sea coastal countries

	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Seafood consumption *per capita*	Increased from 3 to 4.3 kg/yr (1990-2005).	25-30 kg/yr	8 kg/yr (1989), falling to 2 kg/yr 1990-2000) and rising to 3.5 kg/yr (2005), due to increasing imports	No data provided	7-8 kg/yr throughout Turkey as a whole, but >25kg/yr in the Black Sea coastal region	11-13 kg/yr (2002-2005)
Proportion of seafood imported	Import far exceeds export of fish products	17-40%	Steady increase from 12% in 1995 to 78% in 2004	No data. provided	No data. provided	>50%
Direct employment in fisheries/ aquaculture sector	Approx. 3,500 men (only 1% of fishing licences held by women), the majority on a part-time or seasonal basis	Approx. 3,200 people	Approx. 1,050 people	No data provided	Approx. 25,000 part- or full-time fishermen[50], crew, seafood traders, processing plant and transportation workers	Approx. 4,000 people
Secondary employment	12,260 people employed seasonally in seafood processing industry (2005)	2,000 people	No data provided	No data provided		See text

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[50] Turkey contains about 100,000 licensed fishermen (freshwater and marine) nationwide.

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Table 4.11 Aquacultural production in the Ukrainian Black Sea region for commercial fish farms and mussel farms, 1996-2005 (tonnes)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No of mussel farms	?	?		?	2	?	14	19	18	25
Number of fish farms					4	4	4	6	8	8
Pontic anchovys							5.5	4.3		
Mullets					0.7	4.0	2.2	7.5	15.0	11.2
Pacific mullet/haarder					0.4	1.3	0.1	185.3	228.1	573.4
European flounder									0.2	2.7
Boyer's sand smelt					3.8	7.3	5.7	14.0	17.9	26.0
Goibies					2.0	2.2	1.1	4.4	11.9	13.2
Mediterranean mussel	250.0	37.0		10.0	4.0	85.0	60.0	25.0	127.0	109.0
Baltic prawn						0.1	2.0	0.7	0.1	0.0
TOTAL for marine species	250.0	37.0	0.0	10.0	10.9	99.9	76.6	216.1	400.2	735.6

Table 4.12 Japanese snail, *Rapana venosa*, Mediterranean mussel, *Mytilus galloprovincialis* and clams, *Tapes decussatus* and *Chamelea gallina*, production (landings) from the Turkish Black Sea coast (tonnes)

Year	Japanese snail	Mediterranean Mussels	Clams
1989	10032	2637	
1990	6094	2544	
1991	3730	26	1145
1992	3439	5678	15061
1993	3668	5914	16989
1994	2599	6038	32412
1995	1198	5741	11540
1996	2447	1400	7647
1997	2020	2952	6094
1998	3997	2435	3550
1999	3588	1584	2400
2000	2140	178	10000
2001	2614	17	7497
2002	6241	2500	9996
2003	5500	4050	19692
2004	14834	2867	16892
2005	12163	2908	10819

4.3.3 Linkages with other transboundary problems

The decline of commercial fish stocks is closely linked with other transboundary problems. It impacts and is impacted by the other transboundary problems and in some cases the linkages are in both directions. From the paragraphs below, it is clear that nutrient enrichment/eutrophication (Section 4.2) and chemical pollution (Section 4.4) are immediate causes of changes in commercial marine living resources, as is habitat change (Section 4.5). In addition marine living resources are a component of biodiversity (Section 4.5)

4.3.3.1 Nutrient enrichment/eutrophication

Commercial fisheries decline is related to nutrient over enrichment and eutrophication through the loss of habitat to benthic-feeding fish and macroalgal/higher plant-dominated habitats which form spawning/nursery areas for young fish. Clearly this has a negative impact on total fishery production and brings with it a huge change in the ecological balance, raising major biodiversity issues, as does the by-catch of marine mammals (cetaceans).

Increased nutrient levels tend to result in increased phytoplankton productivity. Phytoplankton are a direct food source for very few fish species (silver carp being a notable exception), but increased phytoplankton productivity results in increased numbers and biomass of the zooplankton, which feed on them. Zooplankton are a major food source for many young fish and older sprat/anchovy, ultimately resulting in the increased photosynthetic energy being carried up the food chain and distributed throughout the whole fish community. Thus, eutrophication results in increased production of both plant and animal matter.

4.3.3.2 Habitats

The inability of the ecosystem as a whole to effectively "process" the additional organic matter produced by eutrophication results in a huge increase in organic-feeding micro-organisms (bacteria, fungi, heterotrophic phytoplankton), which strip oxygen out the water column faster than it can be replaced by diffusion from the air. The result is oxygen-deficient lower waters, incapable of supporting many, if not all economically important marine living resources. Many mobile organisms, such as fish, may move away from such hypoxic areas as they develop but sedentary organisms, such as shellfish, die.

However, decreasing trophic status throughout the 1990s has resulted in huge improvements in the dissolved oxygen content of bottom waters overlying the NW shelf. These improvements have greatly expanded the feeding areas of bottom-dwelling fish, such as turbot, flounder, whiting and spiny dogfish, as well as increasing the nursery areas available for them. The status of sediment habitats is, however, also critical to the wider fish population, since well-oxygenated bottom waters provide the spawning/nursery areas for some pelagic fish. Without these habitats either adult fish will either not be able to reproduce, or young fish will not become mature to repeat the breeding cycle.

4.3.3.3 Biodiversity

The fish population itself (including its many sub-communities: pelagic, benthic, migratory, anadromous, semi-anadromous etc., depending upon which classification systems are used) makes a very important contribution to biodiversity. This is due to the presence and abundance of different fish species themselves, as well as their impacts on other biota. The overall health of the fish community is also dependent on the presence/abundance of other organisms in the water column, the classic Black Sea example being *Mnemiopsis*.

4.3.3.4 Chemical pollution

Pollutants at both ends of the chemical spectrum can affect MLR. At one end, there are those chemicals (nutrients) which cause damage by over-stimulating plant growth, and at the other end are the toxic substances (heavy metals, pesticides, etc.) that cause damage by poisoning biota. In addition, endocrine disruptors (e.g. tributyltin, nonylphenol) can affect the reproductive ability of MLR.

MLR can accumulate some pollutants to levels orders of magnitude above those found in the marine environment. This increases stresses on fish stocks and can lead to their decline (See section 4.4.2), as well as damaging the health of organisms higher up the food chain which feed on them (including humans).

4.3.4 Immediate causes

The immediate causes of the decline in fish stocks are primarily the result of the three priority transboundary issues discussed in this document (Section 4.3.4.1-4.3.4.3, Fig. 4.9): However, alien species introduction (Section 4.3.4.4) and historical over-harvesting of MLR (4.3.4.5) are also major immediate causes (Fig. 4.9).

4.3.4.1 Nutrient over-enrichment/eutrophication

Nutrient over-enrichment/eutrophication is covered in further detail in Section 4.2. However, in relation to MLR, the following immediate causes have all been identified as contributing to this problem.

- Point and diffuse sources of effluent from livestock farms
- Diffuse pollution from fertilizers
- Ground/soil water discharges (containing elevated levels of fertilizers) to surface waters
- Discharge of untreated industrial effluents
- Atmospheric emission/deposition of pollutants (principally nitrogen) deposited onto land/ directly into the sea.

All of the above are immediate causes of nutrient-enrichment. This leads to increased primary productivity (increased growth of plants, including phytoplankton), and thus increased food availability to promote growth of all commercially important marine living resources. Thus nutrient-enrichment can be viewed in a positive light with regard to marine living resources, but the resulting changes in trophic status result in some native species being favoured over others and the ensuing ecological imbalance allows opportunistic non-native species to become established and in extreme cases to dominate whole trophic levels. These changes also result in a reduced area of seabed occupied by key macroalgal (seaweed) species – taxa which provide critical nursery areas for many fish species. For example, the *Phyllophora* field on the NW Shelf sustains more than 40 fish species. In the last 30 years, its area has decreased more than 20 times (see Sections 3.3.3, 4.2.1 and 4.2.3 for more details).

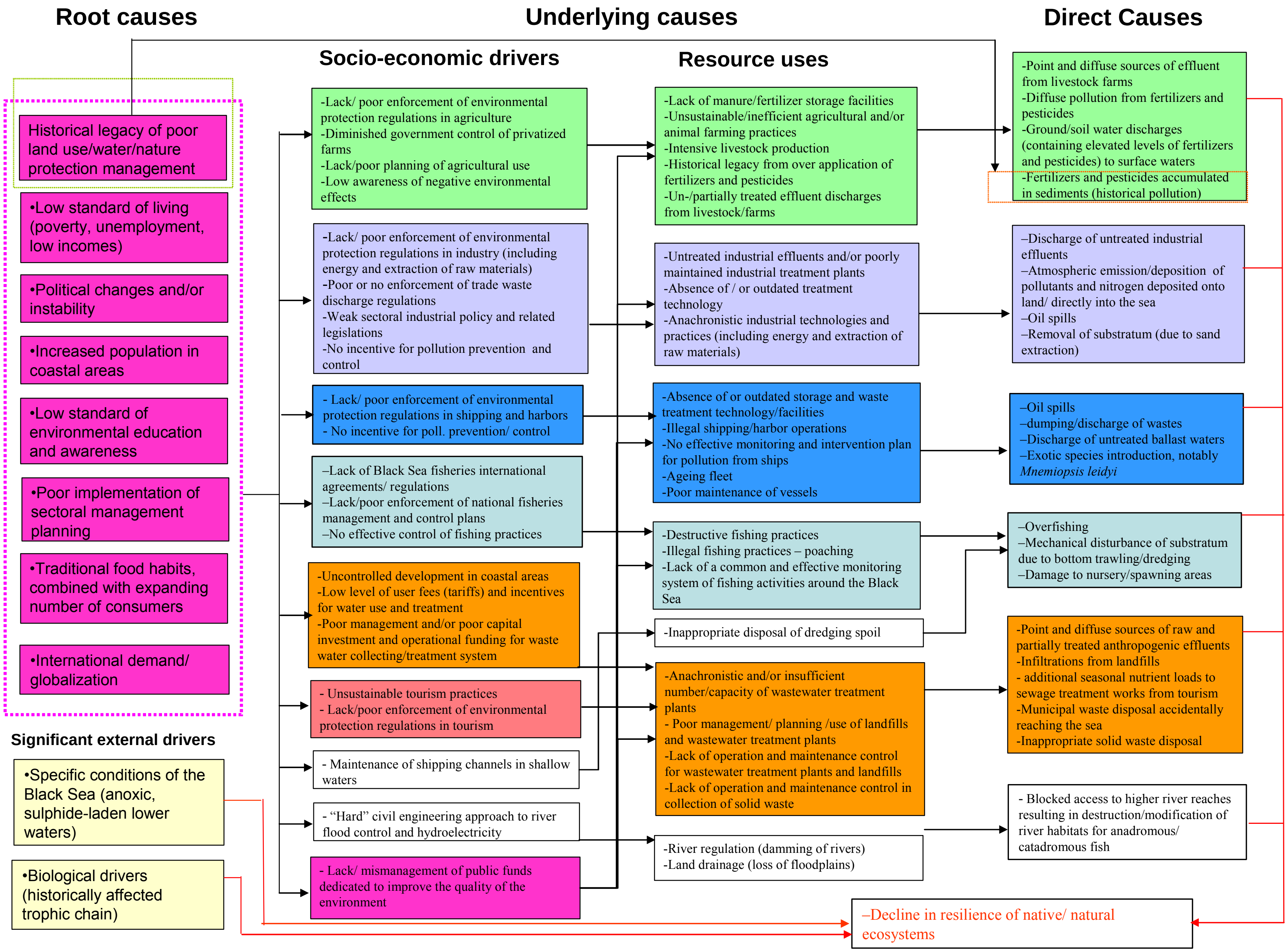

Figure 4.9 Causal chain analysis for decline in commercial fish species / stocks

4.3.4.2 Chemical pollution

Chemical pollution is covered in further detail in Section 4.4. Chemical pollution acts through a host of biochemical pathways, with many pollutants being accumulated up through the food chain to levels which are orders of magnitude higher than those found in the marine environment itself (Section 4.3.3.). When accumulated to such levels they depress the growth rate and health of marine biota (especially fauna), can alter the ability of some species to reproduce, and at high concentrations can ultimately result in localised extinctions of some species or more general localised mass mortalities in the event of toxic spills/illegal dumping. The recognised sources of these chemicals are:

- Diffuse pollution from pesticides
- Ground/soil water discharges (containing elevated levels of pesticides) to surface waters
- Discharge of untreated industrial effluents
- Oil spills
- Dumping/discharge of wastes

4.3.4.3 Habitat changes

Habitat change/loss is covered in further detail in Section 4.5. However, in relation to MLR, the following have all been identified as contributing to this problem:

- Sand extraction and habitat destruction as a consequence of land erosion
- Coastal wall and port construction
- İnappropriate disposal of dredging spoil
- Damming of rivers (starving shelf areas of fresh sediment and thereby contributing to erosion of adjacent coastal areas)
- Unsustainable MLR harvesting methodologies (e.g. dredge trawling).

4.3.4.4 Alien species introduction

The discharge of untreated ballast waters, and along with it, the introduction of alien species, about one quarter of which are regarded as either moderately or highly invasive has historically caused tremendous changes to commercial MLR. *Mnemiopsis* (Section 3.3.2.3) is considered to have been introduced to the Black Sea via this route. However, this vector of introduction is not all bad news, since international shipping is also considered to have been the introductory vector for both *Beroe ovata* (Section 3.3.2.3) and *Rapana* (Section 4.3.2). See also Annex 6.

4.3.4.5 Fishing activity

The problem of perceived over-fishing deserves special attention, since this has been a particularly important cause of major changes in commercial MLR in the past. The total catch is once again showing an increasing trend, but this still only about half of the level caught in the 1980s. However, selective fishing for rare and high value species, such as dogfish, turbot, etc. is undoubtedly damaging/preventing the recovery of these species, as are by-catches of these species when other species are targeted.

Under-reporting of actual catches is also likely to be problem, due to high taxes (in Turkey at least) and the fact that fish markets are unevenly distributed along the coast. This casts doubt on the data presented (e.g. in Figs 4.5 and 4.7). Since fisheries data collection systems (again, in Turkey at least) are not effective and cannot provide the information for robust fisheries management.

Fishing fleet over-capacity is a continuing problem in the Black. The trend shown in Fig. 3.21 is therefore a problem, since if fishing vessel operators can only make a meagre income, the tendancy will be for them to spend longer and longer at sea, resulting in unsustainably higher catches. This could help explain the increasing trend in total cath statistics shown in the same figure.

Stock assessments have been undertaken by most countries for some fish species and are used by some as the basis of their allowable catches, but not for all fish species, not necessarily for the same fish species and many of such assessments are now out of date.

The real problem with determining the extent of over-fishing, however, is the lack of evidence. A number of methods (indicators) are available, of which catch per unit effort and stock assessments are the most widely recognised. Fishing effort needs to be estimated differently for active (trawling) and passive fishing (those where stationary nets are deployed and fish are trapped within them) techniques.

Clearly more and larger trawlers/nets will catch more fish if they are operated or deployed for the same length of time, and this fails to account for potential differences in net mesh size. Thus, a wide range of different "unit effort" estimates can be made (e.g. Fig. 4.10), with little comparability between the values produced by different countries, and often between the shape of CPUE time-series plots using different unit effort criteria. A casual glance at Romanian passive fishing CPUE statistics (Fig. 4.10) provides a very obvious example of this, with the number of nets deployed varying between 29 and 123 on an annual basis. A large decrease in average net deployment time around the turn of the century resulted in a huge increase in CPUE based on net deployment days, but over the same period, there was almost no change in the average fish catch per net. It is not clear whether net size/mesh size changed over this period.

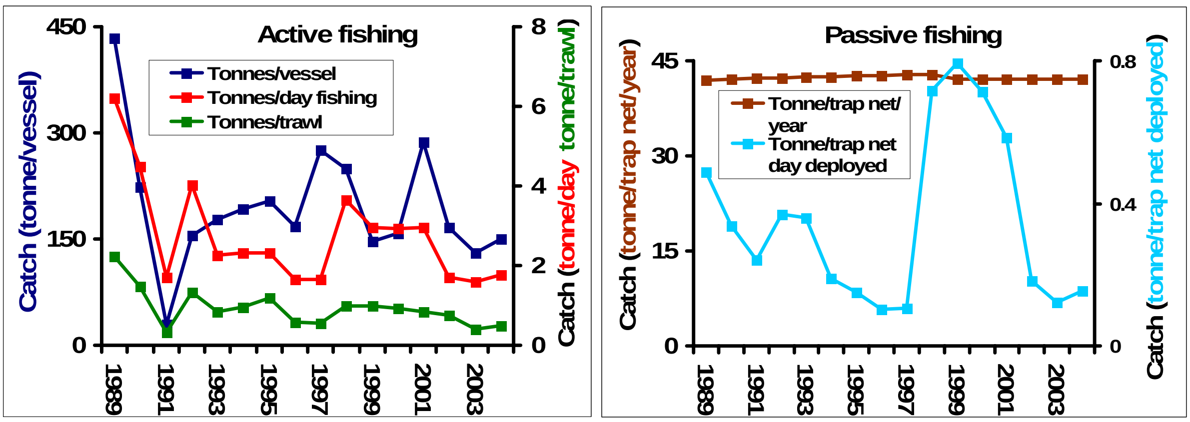

Figure 4.10 CPUE statistics (total fish catch) for Romanian coastal waters, 1989-2004

For the Black Sea as a whole, the only measure of "unit effort" available is the total number of fishing vessels >12 m in length. However, more than 7,000 Turkish fishing vessels operate in the Black Sea, of which 85 % are under 10 m overall length. Values taken from Fig.(3.21), indicate an increasing trend in CPUE between 1991 and 2005, suggesting a recovering fishery, but this is largely due to an increase in CPUE during the early 1990s when landings were very much lower than in the 1980s. When only data since 1996 are considered, there has been almost no change (Fig. 4.11).

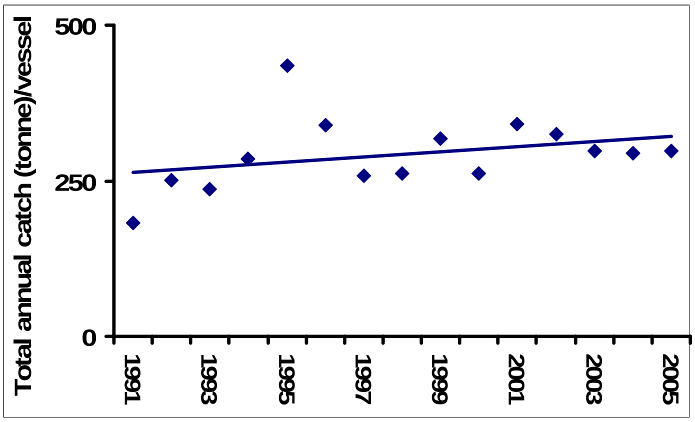

Figure 4.11 CPUE statistics (total annual fish catch/vessel >12 m length) for the whole Black Sea, 1991-2005

The reality is that despite the catastrophic decline in fish landings during the late 1980s/early 1990s, in large part due to over-fishing, no better understanding of what constitutes "sustainable" catches (total or for individual species) exists. However, for the now rare species discussed in Section 4.3.1, any targeted fishing should be classed as over-fishing.

4.3.4.6 River regulation and land management

Anadromous/catadromous, fish (e.g. eels and trout) face further problems, since parts of their lives are spent in freshwater habitats. Drainage of freshwater wetlands, damming of rivers and freshwater quality therefore affect where some species are able to spawn, survival of eggs and young fish, and whether fish are able to travel between the different freshwater and marine habitats required for the different stages of their reproductive/lifecycles.

4.3.5 Underlying causes

A number of the identified underlying causes associated with changing marine living resources are concerned with eutrophication. These are discussed in detail in Sections 4.2.4 and 4.2.5, including poor operational guidance and management of both point and diffuse sources of nutrients. This includes a failure to use appropriate technologies for the treatment/disposal of waste from point sources (municipal and industrial) and a failure to effectively manage nutrient inputs to agriculture, with an emphasis on poor recycling of nutrients between the two main agricultural sub-sectors – livestock and arable farming. The expansion of coastal populations, and particularly of seasonal resorts needs particular emphasis, since sewage treatment works and sewerage systems originally planned to serve resident (winter) populations, may end up having to serve the waste generated by three or more times the resident population during the peak summer season.

Illegal shipping/harbour operations, particularly in relation to ballast water treatment (invasive species introduction) and bilge water operations (illegal discharges of oil and other pollutants are also significant underlying causes. At present there is no effective monitoring and intervention plan for pollution from ships, and despite ballast water being highlighted in the 1996 TDA as an important vector of alien species introduction to the Black Sea, little has been done on ballast water treatment. None of the Black Sea States are party to the 2004

International Convention for the Control and Management of Ships' Ballast Water and Sediments (the BWM Convention).

Unsustainable fishing practices are also identified as an underlying cause. Such practices include a failure to link fish stocks to fishing fleeting landings, resulting in the over-fishing of the 1980s, and the direct destruction of seabed communities and habitats through the use of bottom trawling/dredging gear. The fine particles re-suspended by such practices can be transported by currents over large distances, reducing water transparency and ultimately "smothering" benthic organisms. The same effects have resulted from the inappropriate use of techniques for sand/gravel extraction and disposal of dredging spoil, which have contributed to the disturbance/destruction of benthic communities long distances from where the actual extraction took place or the spoil was deposited.

By-catches of non-target species are a continuing problem in the Black Sea, since the majority of fish caught are of such small size fishes (e.g., anchovy and sprat). Fishing gear targeting these species is therefore unselective, despite the apparent emphasis on minimum sizes of fish which are supposed to be caught (Annex 8). For example, pelagic trawl nets for sprat have a mesh size of 14-15 mm. Pound nets for anchovy and horse mackerel have the same mesh size. The catches of such fishing gear contain an important percentage of juveniles of larger size species, such as sturgeons, bonito, bluefish, spiny dogfish and turbot. Throwing live juveniles back into the water is not a common practice in the Black Sea.

There is limited data for by-catch rates in the Black Sea. Whiting, spiny dogfish, Azov anchovy and turbot may be harvested as by-catches during trawling for sprat. In contrast, the sprat catch may reach up to 60% of the Turkish total catch in February, even though anchovy is the main target. Different fishing methods may all result in relatively high by-catch rates depending upon the season. Of course, it is not only non-target species of fish which are caught in fishing nets; dolphins and porpoises are also caught in the gill nets used for turbot fishing. The main victims of these are harbour porpoises (more then 70% of stranding records), followed by young common and bottelnose dolphins.

Illegal fishing practices (poaching) focus mainly on high value species (sturgeons, turbot, spiny dogfish, etc), thereby increasing pressures on them. These practices tend to have a relatively low effect on total landings statistics, but their impact is magnified on already rare or endangered species. A secondary effect is that fishing gear from poaching activities tends to be abandoned as poachers "cut and run" to escape capture and vessel confiscation. This abandoned gear can continue to trap fish, mammals and birds. For example, during April 2002, a clamp-down by Romanian authorities on illegal fishing activities, resulted in the retrieval of some 40 km of gill nets, which were estimated to have trapped about 100 porpoises and dolphins.

During the last 50 – 60 years, the majority of rivers draining into the Black Sea have been changed, with an irreversible impact on the spawning habitats and behaviour of anadromous/catadromous fish. The building of dams and weirs has greatly reduced the breeding areas for fish such as sturgeons, concentrating them at the base of dams and increasing their vulnerability to poaching. Likewise, draining of riparian meadows has led to changes in river flows, currents and losses/blockage of freshwater spawning gravels (by in-filling with finer substrates), with consequent changes in fish behaviour. The latter leads to more rapid changes in flow following rainfall, which are countered to some extent by entrapment of rivers behind dams, but the overall effect is of greater river flow, albeit with reduced seasonality in these flows.

Important changes have also occurred in some countries at the interface between freshwaters and coastal waters provided by lagoons and limans. These are important feeding and breeding habitats for both local or migratory species. The results has been a transformation of these the lagoons/limans into freshwater reservoirs for irrigation or aquacultural reasons; once again, preventing the passage of migratory fish through them and therefore providing a physical blockage, separating the inflowing rivers from the Sea itself.

The construction of harbours/marinas has two important consequences: (i) smothering of adjacent (and further away) communities/habitats with fine sediments (see comments above regarding unsustainable fishing practices and dredging operations); and (ii) localised changes in the current regime of the area, with consequent changes in fish behaviour. The latter, in particular, is believed to have reduced the catch from fixed fishing gear (gill nets, etc) where such developments have taken place.

4.3.6 Knowledge gaps

- Regional fish stock data is missing entirely, due to a Regional assessment methodology, and the data gathering to support this, not yet having been agreed upon.
- Fisheries statistics (landings, fishing fleet statistics, etc) and monitoring activities are fragmented and irregular at national levels. At a regional level the type and quality of data make inter-country comparisons farcical.
- There is no common regional view on criteria and methodologies for evaluation of marine habitats of importance for marine living resources or for the establishment of transboundary fishing-free zones.
- National reporting on fisheries statistics to the Black Sea Commission Permanent Secretariat is very incomplete
- No quantitative or semi-quantitative estimates are known to have been made of the contribution of illegal fishing activities to actual, rather than reported, landings.

4.3.7 Summary and preliminary recommendations

- There is a contradiction between the, increase of fishing effort, lack of information about fish stocks and the purported increase in knowledge about management of fisheries in the Black Sea region.
- Marine living resources, although renewable, are not infinite and their exploitation needs to be properly managed.
- The majority of fish species with commercial value are shared or migratory species.
- Mortalities of demersal species due to eutrophication-linked hypoxic events still occur in the North West Black Sea, albeit that such events are less intense and cover much smaller areas than they previously did.
- The restructuring of fishing fleets as response to changing of fish stocks state, is very slow with very limited aid from governments.
- Fisheries management is applied individually by each coastal country. İn the case of shared and migratory species, no regionally agreed system exısts to match fıshıng effort to stocks (prohibition periods, minimum admissible fish length, etc).

- Fisheries statistics, fish stock assessment and monitoring activities are fragmented and irregular at national level; some data and methodologies used at national level are not compatible for regional purposes.
- National fishing zones are not yet established between all coastal Black Sea countries.
- The use of non-sustainable fishing technologies (notably dragging and bottom trawling) contributes directly to the deterioration of seabed biocenoses.
- The extensive use of non-selective fishing gear (small mesh size trawls and pound nets) increases by-catches of threatened species, such as sturgeon, bluefish and turbot.
- An important threat to marine mammals in the Black Sea (notably the harbour porpoise) is by the extensive use of gill nets for catching turbot.
- Ilegal fishing practicies increase the effect of inadequate fisheries management, because they are focused on high value species, increasing existing pressure.
- Some alien species (notably *Mnemiopsis leidyi*) act at the food chain level and can cause a dramatic effect on the marine living resources.
- Black Sea mariculture is currently poor developed but of increasing in importance.
- Spawning/nursery habitats for anadromous species have been drastically reduced by the damming of rivers, land drainage, sand extraction and maintenance of shipping channels.
- Many lagoon and liman habitats have been physically separated from the Sea. The quality of sediments in lagoon/liman habitats has worsened as a result of eutrophication or toxic pollution from land based sources.
- Shelf habitats are damaged by siltation from the building of ports/harbours and coastal defence works, dragging and bottom trawling. Dumping of polluted sediments dredged from ports and microbiological pollution of shallow waters is also likely to impact coastal fisheries.

Box 4.2 Comparative analysis of the 1996 and 2006 TDAs on the transboundary problem of changes in commercıal marine living resources

A comparison between the 1996 and 2007 TDA with regard to marine living resources is presented in the table below. In the 1996 TDA, this was considered as an independent problem in its own right, but the issue was divided between different sections of the document. Nevertheless, a good assessment of the problem was originally made and proposals presented to reverse the situation.

Issue	1996 situation	2006/7 situation
Stocks	• Concerns over depleted or falling stocks of venus clam, *Rapana* grey/golden mullets, sturgeons, turbot and spiny dogfish. • Haarder population expanding since its introduction in the 1970s • Mya clam unexploited, but could be in future. • Shad populations considered to be recovering. • Anchovy and horse mackerel populations believed to have partially recovered from over-fishing/*Mnemiopsis* invasion, but concerns over spawning areas and population age dynamics/fecundity • Whiting and sprat numbers believed to have remained high, particularly in NW Black Sea. • Not clear whether stock status was implied from catch data or whether assessments were routinely carried out. No mention of different stock assessment methologies being used by individual countries.	• Recovery of anchovy and sprat populations appear to have continued. However, a possible downturn in anchovy catch during 2007 raises some doubts • Assumed recovery of bonito reflected in huge increase in landings during 2005. • Concerns remain over turbot, whıtıng, spıny dogfısh, horse mackerel (albeıt wıth encouragıng sıgns ın some coastal areas), clams, and mullets (native grey/golden mullet appear to be faring less well than haarder/Pacific mullet). • Concerns remain over mussel and venus clam stocks. Mya clams still unexploited. • Catches (and export from the region) of Japanese Sea Snail have increased dramatically. Concerns over damaging harvesting practices (dredging). • Stock assessments are not undertaken by all countries and tend to be undertaken for only a small number of species. Methodologies employed vary from country to country.
Catches	• Total catches known, but no breakdown into species of commercial importance provided. • No CPUE statistics included.	• Total catches known and broken down into species of commercial importance. • Catch per unit effort (CPUE) statistics included to support total catch data, since no regionally agreed stock assessment methodologies have been decided upon. • It is worrying that that such a large percentage (approx. 70-80%) of the total catch is made up by a single species (anchovy) and that typically over 90% of this catch is made by a single country (Turkey). This does not bode well for the future if anchovy catches suddenly diminish, as experience from other parts of the world suggests they may.
Socio-economic factors	• Some statistics included, but no real idea of the importance of marine living resources as a source of regional employment.	• Importance of marine living resources as a source of regional employment provided.
Fishing fleet status	• Statistics provided on total fishing fleet (vessels >1 ton).	• Total fishing fleet (vessels >12 m long) has increased.
Fishery regulation/ management	• Fisheries management is applied individually by each coastal country. İn the case of shared and migratory species, no regionally agreed system exısts to adjust fıshıng effort to stocks (prohibition periods, minimum admissible fish length, etc)	• Still poorly regulated at an ınternatıonal level, with no regional legally binding document in place. However, negotiations have started over the production of such a document
Aquaculture	• Poorly developed.	• Still poorly developed, but of increasing importance.
Causal chain analysis	• The causal chain was clearly understood, but not considered as as a subject in its own right. Nevertheless, the root causes were (inappropriately identified) as: poor legal framework; inadequate implementation of regulatory instruments; inadequate planning; insufficient public involvement; and inadequate financial mechanisms and support.	• Causal chain analysis undertaken. Major auses include: poor management and enforcement of existing (inadequate) legislation; existing and historical sources of pollution (encompassing eutrophication); habitat destruction; alien species; coastal development; unsustainable fishing practices; inappropriate river (and lake/liman) regulation, and low levels of environmental awareness.

4.4 Chemical pollution, including oil

This section focuses on loads and sources of pollution, links with other transboundary problems and the causal factors underlying toxic pollutant loads. An overview of Black Sea toxic contaminant status is presented in Section 3.4, but no impact of contaminants on the health of Black Sea ecosystems or species can be made, since no bioaccumulation (body burden) data are available.

4.4.1 The problem

As with nutrients, the main reason for considering chemical pollutants as a transboundary problem are that once in the marine environment, these pollutants can be carried into adjacent national and international marine waters., In the case of ship-sourced pollutants (accidental or deliberate discharges), pollution events may (and do!) occur in international waters anyway. Their impacts occur not only in the immediate areas of where they originate, but throughout the Black Sea as a whole.

This section (4.4), unlike Section 4.2, is concerned with pollution by hazardous substances (toxicants, endocrine disruptors, etc.) and non-hazardous biodegradable organic discharges. Toxic pollutants can be considered to represent the opposite end of the chemical spectrum to nutrients, since rather than stimulating overall biological productivity, they inhibit growth, reproduction and contribute to reduced life-spans of biota. Concentrations of most toxicants are typically greater in sediments than in water (they adsorb directly onto the surface of particulate matter or are fat soluble and therefore concentrate in the fat component of sediments and living cells. The polysaccharide exudates of algae (phytoplankton and seaweeds) can also accumulate high levels of heavy metals. Upon death or release from the algae, organic material becomes incorporated into sediment and begins to break down. Once concentrated in algae and in sediments, filter feeders further concentrate these substances as they are digested, so increasingly higher levels of toxicants are passed up the food chain via the animals that feed on them.

Because of the problems and expense of assessing chemical pollutant loads, together with widely varying degradation rates once in the marine environment, the emphasis of assessing chemical pollution impact is more closely related to environmental status monitoring than it is to load monitoring (e.g. see Section 4.4.4.1). Impact assessment of chemical pollution can be assessed in two main ways: (i) concentration data (as shown in Section 3.4), using comparisons with agreed environmental quality standards; and (ii) biological/ecological effects. This latter group can include specialized laboratory bioassays, the use of species-specific biological effects/indicators (e.g. see Section 4.4.2) and the use of community-based biological indices, notably of benthic invertebrate communities. The latter represent the most widely used and accepted indicators of environmental status.

Even if robust methodologies are used, the direct monitoring of pollutant concentrations in sediments, water or biota, may provide misleading results because not all chemical pollutants can realistically be monitored there may be the potential additive or synergistic effects of different pollutants. Thus, ecological monitoring is also required to assess chemical and habitat status, since the results (particularly of biological indices) provides an assessment of combined toxicity.

4.4.2 Environmental impacts and socio-economic consequences

As discussed above (Section 4.4.1), land-based sources of biodegradable organic matter contribute to organic enrichment of coastal waters and sediments, in particular those under influence from waters entering the Sea from the Danube and Dniester. Additional (dissolved) organic enrichment promotes the growth and dominance of heterotrophic (non-photosynthetic) phytoplankton, particularly *Noctiluca,* which during blooms can constitute in excess of 90% of phytoplankton biomass.[51]. Particulate organic enrichment provides an additional food source for filter feeders (notably bivalve shellfish, such as mussels), so high levels of abundance/biomass could be expected in affected waters. However, the bacterial decomposition of this matter may result in reduced dissolved oxygen levels; and if this occurs, rather than an increase in zoobenthic biomass, mass mortality may result. Furthermore, not only zoobenthos are affected; fish in overlying waters that are not able to escape will also be killed. In the case of spawning/nursery areas, it is possible that entire year-classes of some fish could be severely impacted.

In animals, as in humans, hormones have many communications jobs, affecting mood and memory, reproduction and development, in fact virtually any biological process you can name. The term endocrine disruptors refers to synthetic chemicals that when absorbed into the body either mimic or block natural hormones, theerby disrupting the body's normal functions. Such chemicals can, therefore, be dangerous, even if they don't cause cancer. The list of endocrine disruptors is long, encompassing insecticides, herbicides, fumigants and fungicides, some detergents, resins, plasticizers, PCBs and dioxins. Many endocrine disruptors are persistent in the environment and accumulate in lipids/fats

Endocrine disruptors have been implicated as causative agents in diminished reproduction of some fish species, thereby contributing to low stocks of fish, such as sturgeon, in the Black Sea and rivers feeding it. However, proof of this is hard to find for the Black Sea region, even though incredibly low concentrations of some compounds have been found to have major effects in laboratory studies. Thus, the Black Sea situation with regard to endocrine disruptors is unclear, since monitoring of their concentrations is either not undertaken, further refinement of existing methodologies/adoption of new standardized methodologies is required, or indicators are not used. Perhaps the most famous example of indicators of endocrine disruptors is the measurement of imposex in gastropod populations[52].as an indicator of organo-tin concentrations, but there is no coordinated monitoring programme, unlike in other seas. For example, an EcoQO on imposex in dogwhelks or other selected gastropods requires routine monitoring to be undertaken in the NE Atlantic.

The production, sale and usage of persistent organochlorine pesticides (e.g. DDT, HCHs) or herbicides (e.g. aldrin, endrin, dieldrin) has been prohibited in the Black Sea catchment for many years. For example, in Romania the application of DDT was originally banned in 1972 and “drins” (aldrin, dieldrin, etc.) from 1995. However, such substances have a long half-life (over 30 years), so the effect on the marine environment is very much a long-term issue. Perhaps more worrying, though, are results suggesting that fresh DDT has recently been

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[51] Because of its large size, *Noctiluca* abundance and biomass are usually measured as part of the zooplankton community.

[52] Some female gastropods, including *Rapana venosa*, develop male reproductive organs (a phenomenon known as imposex), in response to organo-tin exposures (TBT and its breakdown product DBT), which results in some or all of the population becoming sterile.

dumped directly into the sea[53], dumped into rivers flowing into the sea or is still running off land to which it has been applied. The evidence for this comes from the high concentrations found in surface sediment and the high ratios of DDT to its breakdown products. Organochlorine pesticide contamination is thought to be a contributing factor to the reduced status and biodiversity of macrozoobenthos communities in northerly areas of the NW shelf, compared to more southerly sites (Todorova and Konsulova, 2006).

Nevertheless, the main environmental impacts of chemical pollution can be summarized as follows:

- Increased frequency/severity of hypoxic events.
- Sand/beaches contamination by polluted waters including accumulation of heavy metals and POPs (persistent organic pollutants) in sediment and biota.
- Degradation of aquatic ecosystems/habitat loss.
- Reduced fish stocks.
- Pollution of ecosystems, particularly coastal wetlands.

The main socio-economic consequences of the Black Sea contamination are:

- Reduced seafood yields, due to slower rates of growth/premature death and reduced fertility of biota.
- Decreased quality of seafood caught in the Black Sea, due to bioaccumulation of toxic substances.
- Reduced attraction of the Black Sea and its coastal communities for recreation and tourism.
- Increased risks to human health.

4.4.3 Linkages with other transboundary problems

Black Sea chemical pollution is closely linked to the other three identified transboundary problems: nutrient over-enrichment/eutrophication (Section 4.2), Decline in commercial fish species/stocks (Section 4.3) and habitat and biodiversity changes (Section 4.4)

Nutrients loads from rivers discharging in the Black Sea significantly increase the risk to eutrophication, considered to be an underlying cause of historical hypoxic events. However, organic over-enrichment, as measured by, TOC (total organic carbon) in sediments and BOD_5 in water is the most important immediate driver of hypoxia. The issue, here, is whether the organic carbon is derived principally from the growth and senescence of plant life (notably phytoplankton within the Sea, in which case the organic loads are generated within the Sea itself, or whether they are due to organic loads exported from land via rivers and municipal/industrial discharges. Calculations suggest for the Sea as a whole, organic loads generated by phytoplankton within the Sea far outweigh land-derived sources organic sources, but near to the coast, loadings from land can be greater than marine-derived loads.

Other pollutants such metals, pesticides and herbicides, contribute to the deterioration of sea water quality, including their accumulation in sediments and biota, with long-term effects in the marine ecosystem. Different species and different indifferent individuals within a single species can display varying levels of susceptibity to pollutants. This means that as pollutant

[53] A sediment sample from one site in the NW Shelf was so heavily polluted with DDT that in 2003 the laboratory in which the sample was analysed had to be closed down for a full week for decontamination!

concentrations increase, and those pollutants are accumulated to different levels up the food chain, communities change from being species-rich to those with very low levels of biodiversity. A similar pattern emerges with nutrient/organic enrichment – from highly diverse co-dominating benthic/pelagic communities (in shelf waters at least) to pelagic communities dominated by monospecefic algal blooms and wıdesread destructıon/loss of benthıc ecosystems.

It should also be noted that the increase of oil transportation accross the Sea and through the Bosphorus Strait will have proportionally increased the flow of ballast water into the Sea, thereby increasing the threat of novel exotic species introduction, and probably additional oil/chemical pollution. Likewise, an increase in shipped oil freight would bring with it an increase in NOx emissions from ships, and thus an increase in atmospheric deposition rates of nitrogen, particularly along major shipping routes.

4.4.4 Immediate causes

The results of a causal chain analysis for Black Sea chemical pollution is presented in Fig. 4.12. The major immediate causes of this transboundary problem are briefly discussed below (Sections 4.4.4.1-4.4.4.10). As for nutrients, the immediate causes of chemical pollution are divided into individual sources and pathways of entry into the Sea.

When discussing chemical pollutant status (Section 3.4) an important consideration is the grain size distribution of bottom sediments, since finer grained sediments tend to accumulate higher levels pollutants, especially heavy metals). Sedıment grain size distribution is also an important consideration when interpreting zoobenthos data.

4.4.4.1 River loads

Taking account of river discharges, the largest contributions would be expected from the Danube (67% of the total river flow input), Dnipro (13% of river flow input), Corakhi (4% of river flow input), Rioni (4% of river flow input), Dneister (2% of river flow input), Coruh (2% of river flow input), Yeşilırmak (2% of river flow input), Sakarya (1% of river flow input) and Southern Bug (1% of river flow input). All other rivers contribute less than 1% of the freshwater inflow to the Black Sea (Table 3.2).

River-borne BOD_5 loads are plotted in Fig. 4.13. Average values for only the two most recent years for which data are available are presented, since these are the most complete datasets. The values for Romania are those from Danube, representing 63% of the total river-borne BOD_5 load (573 ktonne/yr) and 70% of the total flow. However, the Danube BOD_5 loads during the early 2000s are reported to have decreased to about half of the level during the late 1990s (Annex 10). This represents a truly remarkable achivement if the results are to be believed, but the earlier data are from a period when analytical quality assurance procedures were not so robust as they were during the later years.

The river load for Georgia (1.85 ktonnes) represents only 0.3% of the total load, from 9% of the total river flow, which, considering the lack of biological treatment in Georgian WWTPs, appears particularly low. In contrast, the Ukrainian BOD_5 load is 29% of the total from 16% of the river flow. This appears unusually high, and while suspicions may be raised over poor analytical quality control, there are many sources of BOD_5 emissions to rivers; not least livestock farming and natural BOD_5 export from land. Many reviews have been undertaken

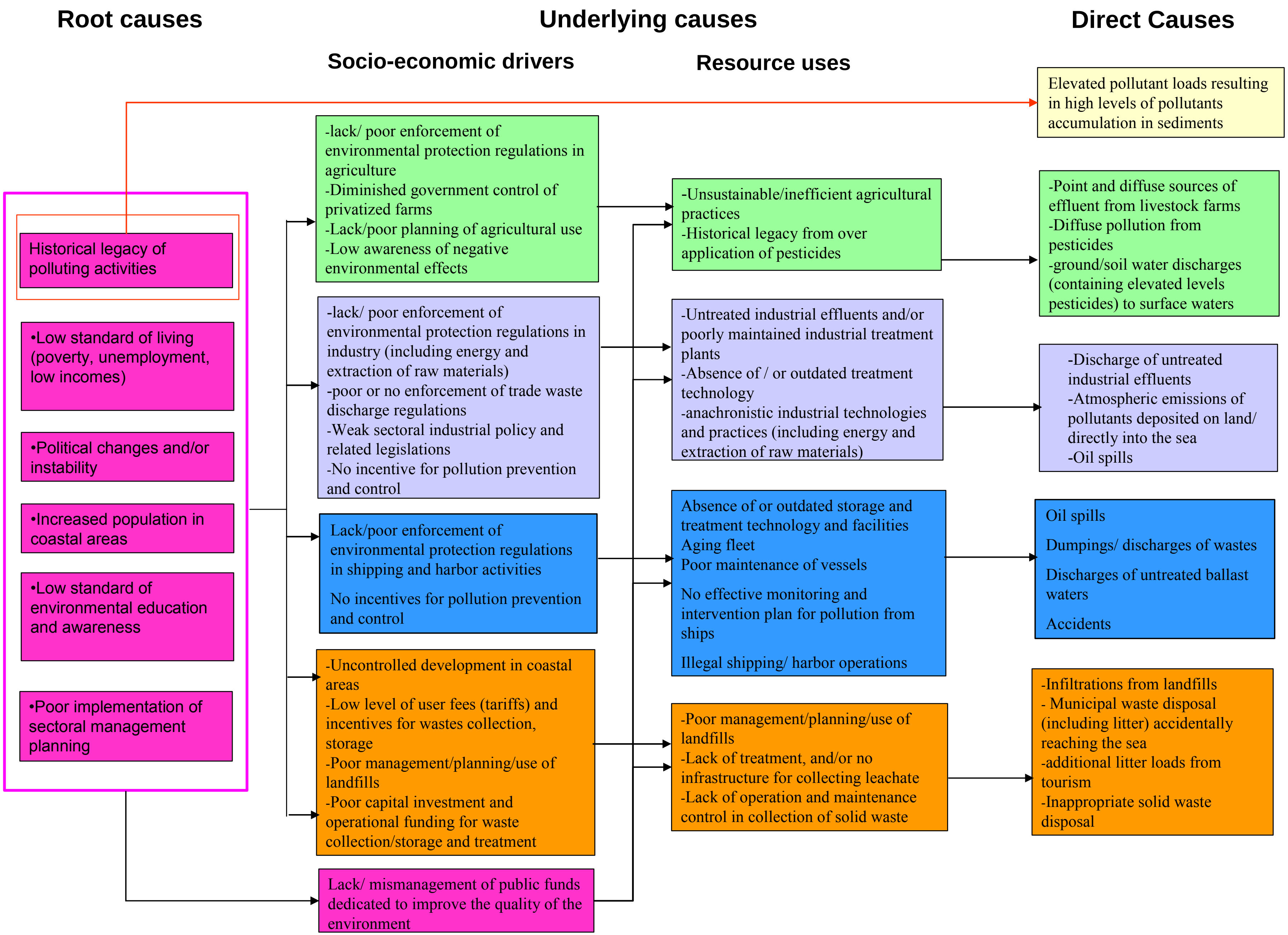
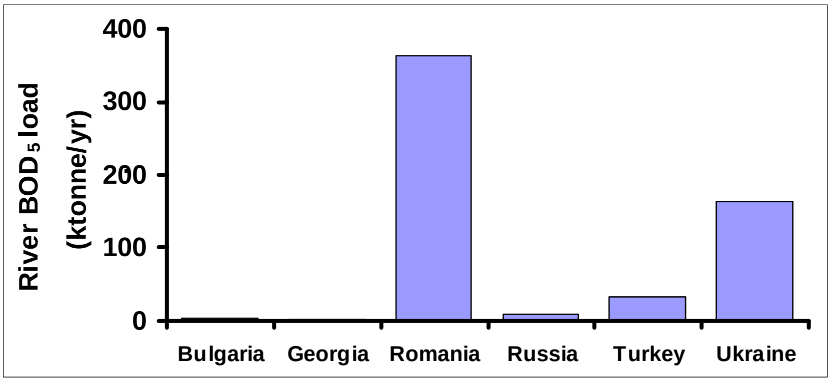


Figure 4.12 Causal chain analysis of chemical pollution

of BOD_5 as a measure of organic pollution, because of uncertainty over results obtained, and particularly over the issue of 'sliding BOD_5', but it is still widely accepted as the most pragmatic test. However, with reference to Fig. 3.22, Turkey does not monitor BOD_5 levels in the Sea as part of the BSIMAP, since its scientists have little confidence in such results.



Fgure 4.13 Average river BOD_5 loads to the Black Sea, 2004-2005

Manipulation/management of river discharges and climate changes also influence the amount of pollutants discharged into the Black Sea. Higher river flows are often associated with higher concentrations of chemical pollutants, so higher flows tend to deliver disproportionately higher levels of many chemical pollutants. Because of this, there is huge uncertainty associated with load estimation of many chemical pollutants, especially POPs. Because of this, values may differ wildly from year to year (depending on exactly when samples were collected with reference to "local" weather conditions), with confidence limits for load estimates being so wide that the values produced are meaningless. Thus load estimates of POPs are rarely made.

River discharges include land-derived loads of pollutants from historical pollution of river sediments (Section 4.4.4.2), diffuse sources to land (Sections 4.4.4.3, 4.4.4.4 and 4.4.4.6), direct industrial discharges to rivers (not included in Section 4.4.4.5) and direct municipal discharges to rivers (not included in Section 4.4.10).

4.4.4.2 Internal loading from sediments

Once in the sea, pollutants generally become associated with sediments, through binding adsorption, bioaccumulation and decay or direct dissolution in the lipids/fat content of sediments. Disturbance of the sediments by bioturbation (mixing of different layers of sediments as benthic invertebrates and bottom-living fish move and feed) and wind-induced mixing of waters re-mixes particulate matter and interstitial sediment water (containing elevated levels of pollutants) back into the pelagic system. Diffusion also plays a role in this release of pollutants.

Thus, historically deposited pollutants may be released back into the overlying water for many years after they first enter the sediment. For some pollutants, these fluxes may be exacerbated by increases in temperature and the development of anoxic conditions at the sediment-water interface. Thus, until organic pollutants break down and/or new layers of less polluted river-derived sediments cover older layers of more polluted sediment, this release of pollutants could be a major source of hazardous substances, albeit that no data are available to make such an assessment.

4.4.4.3 Point and diffuse export of POPs from agriculture

Both livestock and arable farming are potential sources of toxicants. For example, pig farms are often considered to point sources of copper; insecticides, herbicides and fungicides are applied to crops. High levels of insecticides, fumigants, fungicides and antibiotics may be used in intensive livestock farming, the waste from which is collected and discharged to surface waters, with full, partial or no treatment, depending on the type of animals farmed, national legislation and the extent of enforcement of that legislation. A wide variety of chemical types of pesticide are available (e.g. carbamates, organochlorines, copper and mercury compounds, pyrethroids, organophosphosphates, thiocarbamates, etc.), whose toxicity varies greatly and whose chemistry ensures that their "environmental behaviour" is very different. Some are therefore much more prone to leaching and to bioaccumulation than others, e.g. some bind much more readily to organic matter in soils than others, some have a greater degree of solubility in water than others, and some are much more soluble in lipids/fats. It is, therefore, almost impossible to generalize about pesticide export from catchments.

Interestingly, the Stockholm Convention "dirty dozen" POPs includes eight organochlorine pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene. Bulgaria, Georgia and Romania have signed and ratified this convention, while the remaining three Black Sea countries are signatories. Public health use of DDT is allowed under the Stockholm Convention, but only for the control of mosquitoes (the malaria vector).

4.4.4.4 Ground/soil water discharges to surface waters

Some diffuse source derived hazardous substances will be leached into soil and groundwater (as for nitrates) and are transferred through soil into groundwater or directly into rivers. There will be some breakdown of POPs in groundwater because of the slow flow of water in aquifers, but this groundwater will eventually be incorporated into rivers as base-flow or discharged directly to the Black Sea as submarine freshwater inflows.

4.4.4.5 Industrial/municipal discharges

The difficulty when calculating industrial discharges to the Black Sea, either from direct discharges, or from discharges to sewer and emission from municipal WWTPs, is that so few chemicals are routinely monitored in these discharges. Unless specific discharge permits are set for individual chemicals, it is very unlikely that they will be monitored.

A very broad range of industries produce effluents containing hazardous substances – both organic and inorganic. In addition to the EU WFD list of 33 (individual or groups of) priority hazardous substances, EU directives also contain emission limits for:1,2-dichloroethane (1,2-DCE), BOD_5, "drins" (aldrin, dieldrin and/or endrin), cadmium, carbon tetrachloride, chloroform, DDT, chemical oxygen demand (COD), mercury, pentachlorophenol, perchloroethylene, trichlorobenzene and trichloroethylene from specified industrial sectors/plants. These limits apply to Romania and Bulgaria, and will also apply to Turkey in the future, should it become an EU Member State.

Two industrial chemical groups: hexachlorobenzenes (HCBs) and polychlorinated biphenyls (PCBs); and two groups of industrial by-products: (dioxins and furans) make up the remaining four of the Stockholm Convention POP "dirty dozen" (see Section 4.4.4.2 for details of the remaining eight).

As discussed in Section 4.4.4.1, it is not possible to make good estimates of POP loads in rivers, and while more reliable estimates can be made of POP loads from selected industrial discharges, they are not often monitored. Heavy metal loads from some industrial facilities discharging directly to the Black Sea are available, but the number of sites is so few that no regional assessment can be made. Suspended solids data from a wide number of industrial and municipal sources, but in their own right these do not represent hazardous substances. Petroleum hydrocarbon loads are also available for 11 (principally Ukrainian) discharges, but once again there are insufficient data to present a regional overview.

Pollutant loads were provided by all countries for industrial discharges of > 1000 m^3/day. Of these, BOD_5 loads were available for 17 discharges in the six countries (Annex 10). The most complete datasets were available for the years 2004 and 2005, with the results shown in Fig 4.14 – a total average load of 2,837 tonnes/yr. The relatively high results for Turkey are from two industrial (copper mining/processing) plants, but direct industrial discharges are responsible for only a tiny proportion (0.5%)of the total land-derived BOD_5 load to the Black Sea (594,895 tonne/yr). Note the different units used in Fig. 4.13, compared to Figs 4.14 and 4.15. Ukraine was the only country to provide relatively complete industrial BOD_5 emissions data, and these show little change since 1995.

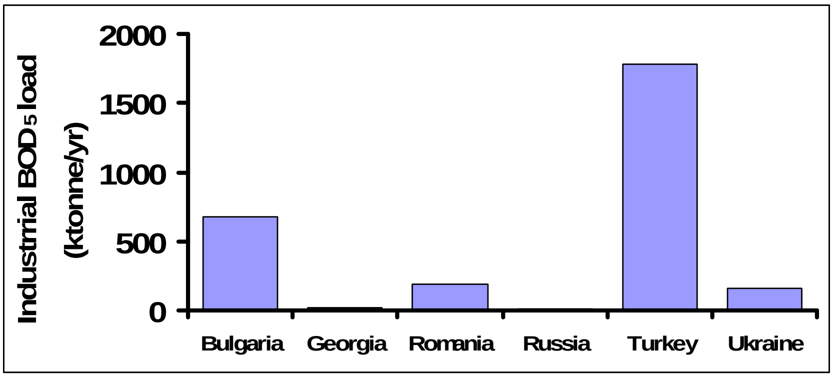


Figure 4.14 Average industrial BOD_5 loads to the Black Sea, 2004-5

For Bulgaria and Turkey, in particular, BOD_5 loads data from municipal WWTP discharges prior to 2002/2003 were not made available; so, once again, data for only 2004-5 are plotted in Fig. 4.15, representing the combined load from 48 WWTPs serving a population of >5,000 people or with a daily discharge exceeding 1000 m^3. This represents a total average load of 15,448 tonnes/yr. Substantial reductions have been achieved by some countries, with recent direct municipal BOD_5 emissions from Ukraine having fallen by about one-third and from Romania by about two-thirds since the latter 1990s (Annex 10). However, for Russia the decrease in direct municipal BOD_5 emissions has been negligible over the same time scale. Georgia does not contain a single functioning coastal sewage treatment plant, but recent finance plans include the construction of waterwater treatment plans at Poti and Batumi (Annex 11).

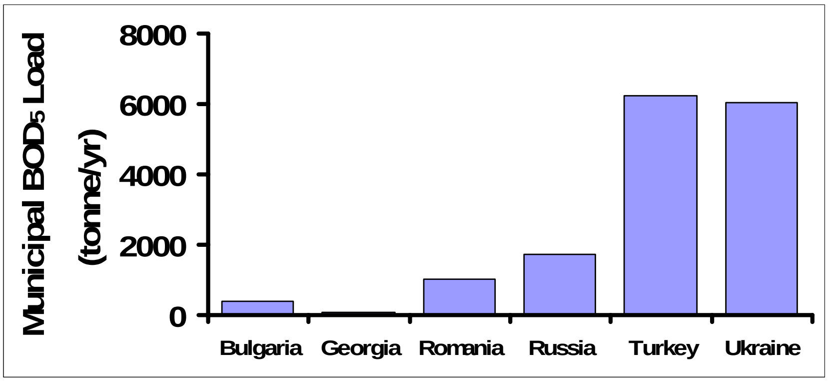


Figure 4.15 Average municipal BOD_5 loads to the Black Sea, 2004-5

However, there is no doubt that these data,are misleading. For example, the value presented for Georgia is a mere 79 tonnes/yr. The coastal poulation of Georgia is 1.7 million people, of which available data suggest over 90% are connected to sewer (Section 3.2). Based on a BOD_5 *per capita* production value of 60g/day (as specified in the EU UWWT Directive), this amounts to an annual load of over 33,000 tonnes per year. No municipal sewage treatment works in Georgia currently operate with biological treatment, so there would be little reduction of this load via that route Some of the Georgian WWTP discharges may be to rivers rather than directly to the Sea, so some degree of self-purification would occur, but the declared total Georgian value (originating only from Kobuleti Sewerage System) is probably at least 100-times lower than the real value.

4.4.4.6 Atmospheric emissions of pollutants deposited on land/directly into the sea

Many pollutants (e.g. heavy metals, PAHs and dioxins) can be released by combustion processes, including land-based incinerators, power stations and car emissions (as for nitrogen – see Section 4.2.4.5) if the combustion process is incomplete and the gas/smoke produced in not treated appropriately. These atmospheric emissions eventually return to earth. If the chimneys releasing the smoke are not tall enough, the risk of nearby re-settlement of particles greatly increases and can result in highly localized pollution hot-spots. The particulate matter released has the opposite effect of greenhouse gas emissions, since the particles help shade the land from sunlight – a phenomenon known as 'global dimming'. It is these same particles that water vapour condenses around to form raindrops.

4.4.4.7 Accidental/illicit marine oil spills

Oil pollution is a concern for the Black Sea environment, in particular due to the increasing risk of accidental spills that may result from an expected two-fold increase of oil transit by tankers. The freight flow of this oil resource from middle Asia and Azerbaijan via Georgia is gradually increasing. Over 20 million tones of oil and petroleum products are transported via these terminals in Georgia to the west through the Black Sea. The resulting discharge of ballast water in Georgian ports is estimated to have been 5 million tonnes during 2005. In terms of oil pollution two distinct threats arise:

(i) Localized chronic pollution from small but frequent spills at terminals, dockyards and from ships at sea. This is a major concern over, for example, the oil terminal currently under construction in the Kolkheti Wetlands, Georgia.

(ii) The issue of more widespread and acute pollution from a major oil spill at Sea.

Those who live in close proximity to the Bosphorus and on clear days can see the hundreds of ships moored close to either end of the channel, waiting for permission to travel through, should fully appreciate this risk. This represents a huge bottle-neck to marine transport throughout the region. While the accident record of the Strait has greatly improved in recent years, largely down to improved management, the constant stream of traffic through it provides an ever-present reminder of the scale of shipping into and out of the Black Sea, even without considering the amount of internal traffic. The development of additional overland pipelines is constantly in the news, but these are across western Black Sea countries that will not reduce the east→west flow of oil traffic from the Caspian Sea through Eastern Black Sea countries. They will help by-pass the Bosphorus bottle-neck and should help reduce pressure on this shipping channel, but the effect of overland oil transport through Bulgaria, etc. is more likely to be an increase in internal (east→west) oil traffic across the Sea.

Illicit discharges due to routine ship operations are among the main sources of marine oil pollution. The amount of oil released in any single discharge is usually not large enough to represent a great concern for its immediate impact on the ecosystem, unlike the case for massive accidental oil spills. On the other hand, illicit discharges pose a cumulative, long-term threat to the marine and coastal environment. Oil can be discharged at any time and from any location to the Sea, making remote sensing (satellite imagery) the only pragmatic monitoring tool for spill evaluation, providing images are collected and processed on a frequent-enough basis.

The EC Joint Research Centre (Tarchi *et al*., 2006) undertook an assessment of the sea-based oil pollution using remote sensing imagery for the period 1999-2004, showing a concentration of oil spills along the main shipping routes: Odessa – Istanbul and Novorossiysk – Istanbul. A substantial concentration of likely oil spills was also detected in the area north of the Bosphorus Strait (Fig. 4.16).

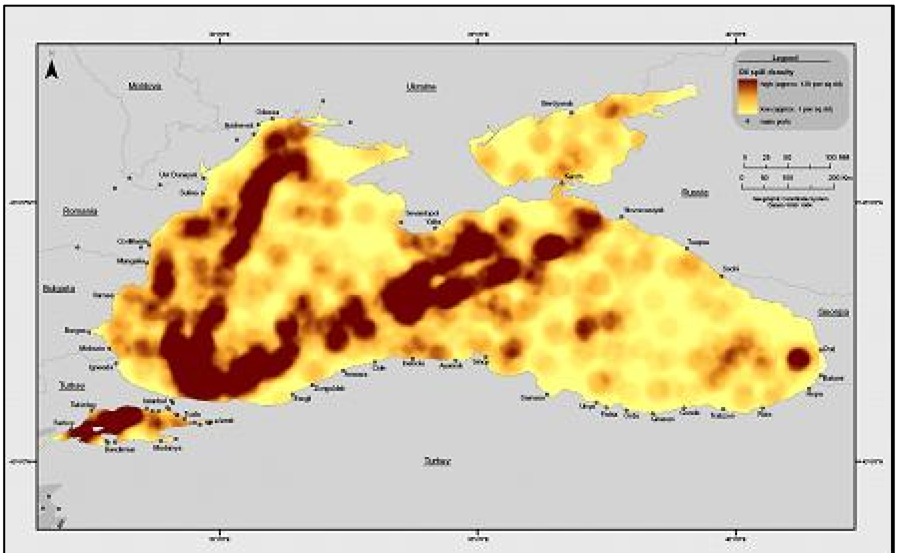


Figure 4.16 Number of likely oil spills per area of sea[54]

The annual number of likely number of spills/illicit discharges detected in this study is shown in Table 4.13. The time-scale over which the study was carried out is too short to determine whether the situation has improved or not during recent years.

[54]Remote sensing data from 2000, 2001, 2002 and 2004 (Tarchi *et al*., 2006).

Table 4.13 SAR images analyzed and likely oil spills detected for the years 2000, 2001, 2002, 2004 (after Tarchi *et al*, 2006)

Year	SAR Images analyzed	No. of likely spills detected	Spills per image
2000	710	255	0.36
2001	519	249	0.48
2002	422	200	0.47
2004	1514	523	0.35
TOTAL	3165	1227	0.39

4.4.4.8 Dumping/discharge of wastes

Dumping of wastes, particularly persistent organic pollutants, directly into the Black Sea, whether legally or illegally is a continuing problem in some countries. An example of this with regard to DDT is provided in Section, 4.4.2, and empty containers of toxic substances/waste continue to be brought to the surface during bottom trawling exercises (and research activities; Fig. 4.17). The scale of this dumping/illegal discharge is not known, but a further recent example was provided on 26 January 2007when Ukrainian television reported that up to 10,000 tonnes/day of spoiled grain were being dumped into the Sea because of a saturated domestic market, due to grain import-export quotas.

Figure 4.17 Empty drum of toxic waste picked up from the NW Shelf during the 2006 BSERP research cruise[55]

4.4.4.9 Municipal solid waste disposal

As with nutrients, hazardous substances can enter the enter the Sea from nearby landills either in surface water runoff from leachate via groundwaters. In addition, litter from the surface of landfills can be blown into the Sea; although, with litter, the problem is not so much from hazardous substances, but rather one of aesthetic pollution. There has been a historical problem of illegal dumping in all countries surrounding the Black Sea, but the extent to which this has been dealt with is not known.

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[55]Photograph courtesy of Laurence Mee.

Landfill registers exist in Bulgarıa, Romania the Russian Federation and Turkey, but data from the Turkish register was not provided for this report. Georgia is the only Black Sea country not to have undertaken a landfill census within the last 10 years (a Ukrainian census is currently underway). Monitoring of surface and/or groundwaters is required as part of landfill consent conditions in all countries.

Available data on coastal landfills is shown in Annex 9. A large proportion of these were constructed in the 1960s or 1970s, and most are still operational, but of the 25 Romanian landfills for which data were received, 14 will be closed down between 2006 and 2017. This regional data gathered includes information on a total of 91 coastal sites[56], of which location details (latitude and longitude) were provided for 65 (Fig. 4.18). Data from only two Turkish coastal landfills were provided for this report.

Of the 91 sıtes 66% are authorısed, 12% receıve hazardous waste, only 22% were constructed wıth a lıner and even fewer (8%) have a leachate treatment system, albeıt that 18% have a stormwater dıversıon system. İn only 77% of the landfills is the amount of waste routinely monıtored. This information greatly underplays the historical problem of illegal dumping of solid waste on shores around the Black Sea, since data on relatıvely few unregulated/unofficial dumping sites were included in the information provided.

4.4.4.10 Natural geological origin

The geochemical reserve of heavy metals in existing and fresh sediment transported by rivers into the Black Sea varies throughout the region. For example, copper levels along the South Georgion and East Turkish cosats are likely to be naturally elevated, since a copper ore mınes is situated close to the Sea near the Georgion/Turkish border (Section 3.4.2).

4.4.5 Underlying causes

The majority of underlying causes of chemical pollution in the Black Sea are shared with those of nutrient pollution/eutrophication and are grouped into four main categories (Fig. 4.12), based around four major sources of chemical pollution:

- Shipping/harbour operations (Section 4.4.5.1)
- Agriculture (Section 4.4.5.2)
- Industrial discharges (Section 4.4.5.3)
- Municipal discharges (Section 4.4.5.4)

In addition, a fifth over-arching issue of the lack and/or mismanagement of public funds dedicated to improve the quality of the environment is also considered in Fig 4.12.

4.4.5.1 Shipping/harbour operations

The lack (or out-dated nature) of treatment plants at ports and harbours to cope with ship-generated wastes, particularly the disposal of bilge water (from a chemical pollution perspective) is an issue. Several of the hot-spots discussed in Section 5 are port wastewater treatment works dealing with ballast and/or bilge water. Success in completing the necessary construction work has been mixed. Thus, outdated storage and treatment technology is still in place at some ports, providing only partial treatment at best. This problem is compounded by the old age of much of the Black Sea “domestic” fleet. As machinery ages, the risk of

[56]Data were requested for all landfills within 10 km of the Black Sea coast.

mechanical/structural failure increases and corrosion worsens. Older ships are more likely to pollute, particularly when those vessels have been poorly maintained.

There is also a problem of poor enforcement of regulations in shipping – the likely oil spills map (Fig. 4.16) shows this clearly. At present there is no effective monitoring and intervention plan for pollution from ships, without which enforcement of existing regulations is likely to remain very weak.

4.4.5.2 Agriculture

In some of the Black Sea countries, particularly Georgia, Russia and Ukraine, there is either a lack or poor enforcement of environmental protection regulations in agriculture. The adoption of best agricultural practice in Bulgaria, Romania and Turkey should improve matters in the future, even if it hasn't done so yet. Since the break-up of the Soviet Union, the widespread move to smaller-scale farming has diminished government control of privatized farms, with controls over land use now appearing to be considerably weaker. It is, however, difficult to effectively control an economic sector as depressed as agriculture is in the Black Sea Region. The smaller-scale of farming now practiced is a double-edged sword: it is less efficient in terms of crops or livestock produced per hectare of land, so less profitable, but should be better for the environment if managed correctly.

There is a regional legacy from the over application of agro-chemicals, so residues of historically-applied pesticides/herbicides are still being exported to the Sea from catchments; and stores of out-dated and highly toxic agro-chemicals are still thought to exist on some farms. When the economic climate for Black Sea farmers is as bleak as it currently is, the temptation to use old stocks will increase.

4.4.5.3 Industrial discharges

There is little incentive for pollution prevention and control – emissions-based trading has not started in the region and the emphasis has clearly shifted from state subsidies for failing industrial sectors. So, instead of a "carrot and stick" approach, the emphasis is firmly on a prescriptive basis. This is not sufficiently-well backed-up by monitoring, particularly of small direct discharges to surface waters and discharges to sewer.

Only a fraction of industrial discharges to sewer are monitored to ensure compliance with standards, and no comparison of these standards has been undertaken between the six Black Sea countries. In the past, at least, corruption has been a relatively common feature – those organizations which did not want their emissions to sewer monitored too closely, were able to ensure this did not happen.

For those industries discharging directly to surface waters, little or no action may have been undertaken, even if existing standards were not complied with, since socio-economic considerations (e.g. further unemployment in areas of already high unemployment) are loaded with political persuasiveness. This includes a lack/poor enforcement of environmental protection regulations in mining and other natural resource extraction sectors.

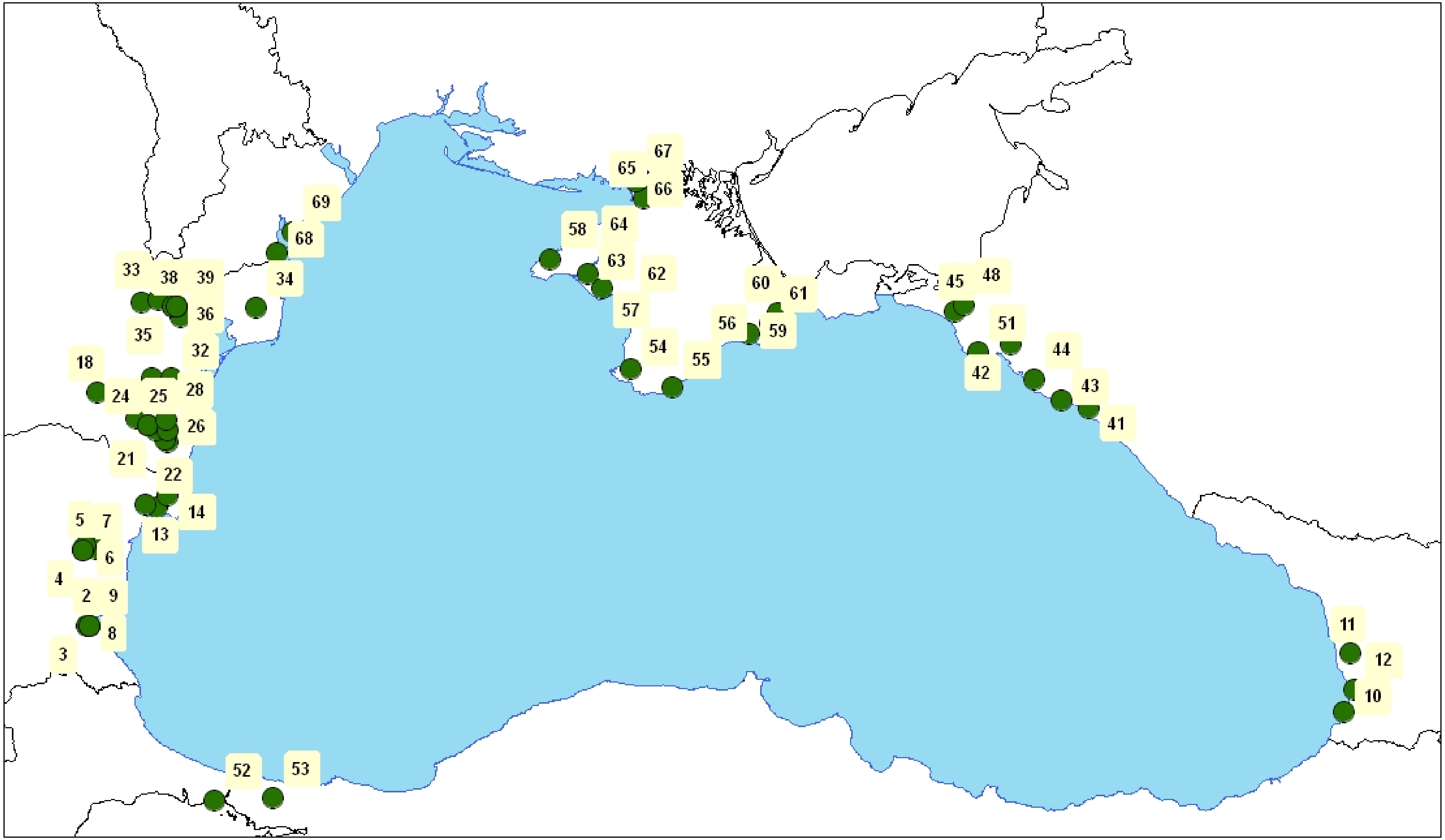

Figure 4.18 Location of known landfills around the Black Sea coast

Key to Fig. 4.18

No.	Landfill	No.	Landfill	No.	*Landfill*
1	Varna , village of Vaglen	22	Negru Voda	48	Yurovka village
2	Bourgas Bratovo	23	RAJAC WWTPs sludge deposit - Luminita	51	Glebovka village
3	Marinka (Bourgas)	24	SC Lafarge Romcim Medgidia	52	İstanbul, Kemerburgaz/Odayeri
4	Varna Beloslav	25	SC Etermed SA Medgidia	53	İstanbul, Şile/Kömürcüoda
5	Varna Solvey Sodi (ash-slug pond)	26	SC Argus SA Constanta	54	Pervomaisk gully
6	Varna Polymeri (slug pond)	28	Marway Fertilchim SA - Navodari	55	Gaspra, Yalta
7	Agrapolychim Devnjya	29	Agighiol	56	Alushta
8	Bourgas Luk Oil	30	Vararie	57	Evpatoria,
9	Bourgas Copper Mine	31	Macin	58	Chernomorskoe
10	Batumi	32	Babadag	59	Sudak
11	Poti	33	Isaccea	60	Feodosia
12	Kobuleti	34	Sulina	61	Koktebel
15	Constanta -Ovidiu	35	SC Alum SA, Tulcea	62	Saki
13	Mangalia - Albesti	36	SC Feral SRL, Tulcea	63	Novoozernoe, GKPSU Ekologia
14	Costinesti	38	Loo village	64	Krasnoperekopsk, Crimea soda plant site, Krasnoe lake
15	Constanta port	39	Adler village		Krasnoperekopsk, Brom plant, Staroe lake
16	Eforie South	40	Tuapse	66	Armyansk, Titan plant
25	Medgidia	41	Lermontovo village	67	Armyansk
18	Harsova	42	Kabardinka village	68	Primorske
19	Cernavoda	43	Tekos village	69	Primorske
20	Techirghiol	44	Dzhanhot village		
21	Basarabi	45	Krasniy village		

Comparatively weak sectoral industrial policies (or enforcement of them) exist in some countries, but the increasing acceptance of BAT (best available technique/technology; enshrined in the EU IPPC[57] Directive) by non-EU Member States is likely to make a difference in the coming years, since BAT includes both environmental and economic considerations. Many inefficient manufacturing plants closed down following the break-up of the Soviet Union, but there is still a (much-reduced) legacy of anachronistic industrial technologies and waste treatment practices within the region.

4.4.5.4 Municipal discharges

Poor management and regulation of landfills (including poor differentiation between various types of waste: hazardous, industrial, municipal, etc.), as well as the widely accepted practice of illegal dumping along the coastline, were once accepted as the norm in the Black Sea Region. However, since the first TDA was produced there has been a shift by some authorities/governments to address this problem, particularly in Romania and Bulgaria as part of their EU accession process.

The landfill data in Annex 9 show a considerable number of landfills in these countries scheduled for closure in the coming years because of non-compliance with EU standards, together with the construction of specialized cells for hazardous waste at selected sites. This development of the waste industry follows the “polluter pays” principle, but there is still

[57]Integrated Pollution Prevention and Control

overall under-development of the industry in at least three of the countries (Georgia, Russia and Ukraine), where low user fees (tariffs) mean the solid waste industry is under-funded. The infrastructure for collecting landfill leachate/stormwater runoff is absent from the vast majority of landfills, but placing the solid waste industry on a more commercial basis (particularly in Romania and Bulgaria) should continue to result in greater capital investment and operational funding to address both current and historical waste management issues.

Uncontrolled development/urbanisation of coastal areas brings with it increased generation of solid waste. Initially this will result in more rapid filling of existing landfill sites, but a future risk will be the designation/construction of further landfill sites close to the Sea.

4.4.6 Knowledge gaps

The Black Sea Commission has standardized regional methodologies for the collection and analysis of plankton and zoobenthos samples, but little guidance is offered on interpretation of the data collected. The next logical step is the development or adoption of an existing macrozoobenthos index for regional reporting purposes, the results of which are easily understood by non-specialists, including decision makers, and are more informative than simple biomass and abundance data.

At present, it is obvious that data are still missing/incomplete and of highly variable quality. This was a fundamental problem with information on nutrient and other chemical loads presented in the original 1996 Black Sea TDA, and while the situation has improved, there is still a great deal of progress to be made.

An attempt has been made to gather data on landfills in this report, following the recommendation given in the 1996 TDA, and there has been some success. The issue of landfill characterization and assessment is being taken seriously in some countries but, from the information provided, Turkey appears to be particularly weak in this area. Greater attention should be paid to this issue by the BSC Advisory Group on Land Based sources of Pollution. The same advisory group should also pay greater attention to the harmonization of environmental standards for the Black Sea – both discharge and Black Sea water/sediment quality standards. In the terms of reference for this group, this is stated as one of its primary objectives, but no progress has so far made.

Although the Black Sea Commission has standardized reporting formats for the data it collects, the formats are often not followed. A serious re-assessment is required of the indicator data that the commission collates and passes onto other organizations, notably the ICPDR and the European Environment Agency (not only on the issue of chemical loads and pollution status). Data on so-called mandatory parameters within the BSIMAP are frequently not collected and from some countries there is an unwillingness to pass on additional data which could be of use to the Commission. Data ownership is a serious problem in the Black Sea Region. For organizations which are fully or partially funded by national Ministries of the Environment this should not be a problem, but it continues to be. This situation is not acceptable.

The issue of standardizing data formats is a major one. Considerable amounts of data were received for this report which could not be used because of a failure to supply location data (latitude and longitude), or because incorrect location data were provided. It is the responsibility of the organizations which supply data to quality assure what they provide; not the receiving institution.

As with nutrients, issues of load estimation have once again surfaced[58]. There are numerous ways to calculate/estimate chemical loads and the method(s) adopted for individual rivers (and other land-based point sources) should be, but aren't compatible. Even such fundamental issues as the use of commas, spaces or decimal points in reported statistics have caused problems (e.g. in Annex 9, the surface area of Varna landfill is given as 240 km^2 and that of Bourgas landfill as 133 km^2). Then, there are issues of whether to report concentrations in mass or molar units; failing to state whether water column concentrations are for filtered or unfiltered samples; and whether sediment pollutant concentrations are reported on a dry- or wet-weight basis. These are very basic issues that should have been solved long ago.

An important problem appears to be the lack of robust quality assurance systems for pollution loads data provided by Black Sea Countries. All laboratories participating in the BSIMAP scheme also participate in the QUASIMEME quality assurance programme coordinated by the Black Sea Commission.

4.4.7 Summary and recommendations

Greater financial investments are required for (re-)construction of wastewater treatment facilities and management systems. There is a need for capacity building and institutional strengthening within government institutions in a number of coastal countries. Increasing the level of public awareness and participation in water resources management and protection is an important task in the process of resolving this issue.

The following recommendations are also suggested in order to respond to the issue of reducing and control the pollution of the Black Sea waters:

- Identification of a regionally agreed list of priority pollutants. Clearly there will need to be a considerable overlap with the EU WFD list of priority pollutants, but bearing in mind the huge capital investments required of EU countries to meet the stipulated criteria, a much reduced list should be proposed for the Black Sea. The same agreed list should be used for harmonised monitoring of the marine environment and major point sources (including rivers). Existing parameters in the BSIMAP should form the basis of this programe.
- Development of robust national quality assurance programmes for the intercomparation/intercalibation of chemical concentration and flow data for the estimation of pollutant loads.
- Environmental standards (discharge and marine water/sediment quality standards) vary from country to country. This adds a further layer of difficulty to establishing regional plans for reducing pollution loads to the Sea. The regional harmonisation of these standards is required.
- Production of a regional manual on data handling guidelines/rules is required. This should specify the formats for data exchange between the Commission and national/international bodies, as well as appropriate methodologies/statistical software for processing such data.

[58] Load calculation/estimation can have considerable levels of uncertainty. Some idea of the level of confidence which can be applied to individual loads is required.

- Establishment of national plans for the reduction of pollution loads to the Black Sea. Such plans should contain the measures required to reduce the load/concentration of each identified pollutant, the competent authority and the financial costs for implemention.
- Build capacity of environmental authorities for enforcing regulations to control the discharge of priority pollutants from both point and diffuse sources.
- A major shift in government awareness of the state of the Black Sea and the economic value of this resource is required to push environmental issues higher up the political agenda. Good environmental management costs money – lots of it – and this is a major problem in the developing economies of all six coastal countries. However, the promotion of public awareness programmes should be seen as an important first step in developing ground-up pressure on decision makers.
- Establishment of an inter-state ministerial mechanism for a quick response to emergency situations.
- Development/adoption of an agrreed transboundary environmental impact assessment methodology for developing transboundary projects in the region.
- The approaches of Best Available Technique/Technology and Best Agriculture Practice should be more widely and forcefully applied in the Region.
- Conferring assistance to the industry sectors (and mining enterprises) in developing Environmental Management Systems and undertaking Cleaner Production Activities
- Development of a network of farmer support services to increase the transfer of knowledge on appropriate application of pesticides and herbicides should be pursued, together with advice/guidance on the disposal of old pesticide/herbicide stocks

Box 4.3 Comparative analysis of the 1996 and 2006 TDAs on the transboundary problem of chemical pollution

A comparison between the 1996 and 2007 TDA with regard to transboundary pollution is presented in the table below. In the 1996 TDA, pollution was considered to be a driver of all of the Major Perceived Problems, whereas in the 2006 TDA it was considered to be a priority transboundary problem. This apparent disparity arises because the problems identified in the 1996 TDA are a combination of causes, problems and impacts. Most are related to issues of biodiversity, whereas others are more specifically causes (e.g. inadequate protection of marine and coastal resources from maritime accidents). However, it is fully recognised that a one of the drivers of biodiversity and ecosystem loss is pollution. In the 1996 TDA, excess nutrient levels in and nutrient loads to the Sea were integrated into the pollution theme, unlike the current TDA, where nutrient pollution/ eutrophication has been treated separately to highlight its importance as a problem in its own right and to help explain the links with other transboundary problems.

Issue	1996 situation	2006/7 situation
Microbiological pollution	• Significant point source discharges. • Some national and international riverine inputs considered to be significant. • Sewage pollution considered to be a major source, but no real assessment • Solid municipal waste disposal considered to represent a problem with possible transboundary dimensions. However, no supporting information provided. • No consideration of livestock as a source	• Microbiological pollution identified primarily as a significant national (rather than a transboundary) problem. No further assessment made
Land-based point source pollution	• Considered only direct municipal/industrial discharges • Direct discharge assessment based on modelled data and likely to have been inaccurate	• Considered only direct municipal/industrial discharges • Direct discharge assessment based on monitoring data • Improved quality assurance programmes required to allow regional comparison of pollutant load data • Legal landfills identified in most countries (Section <>), but no assessment of their likely contribution to pollution status
River and strait pollutant loads	• Data from a large number of rivers missing, but not reported as such.	• Data from a number of rivers is still not available, but the situation is improving. • Crucially, data for the Bosphorus and Kerch straits has not been provided. • BOD_5 still the only “chemical” pollutant (excluding nutrients) routinely monitored by all countries • Provision of flow /discharge data for the estimation of riverine loads highlighted as a topic requiring attention/capital investment
Diffuse source pollution	• Not included	• Considered, but not assessed due to lack of information. • Agrochemicals considered an increasing problem.
Dumping activities	• No official information on major dumping activities (legal or illegal) taking place in the region. It was assumed that it was taking place however, and was predominantly caused by a lack of regulation of potential dumping activities.	• No official information still available
Status assessment of the Sea	• No status assessment made • No regionally agreed monitoring programme	• Preliminary status assessment made. • The BSIMAP has been in existence for 6 years now, but national data provision is variable • BSIMAP has produced few sediment data so far, but data available from research activities
Loads assessment	• Assessment incomplete. Based partly on modelled (direct discharges) and partly on measured (riverine) data • No regionally agreed list of priority pollutants for monitoring/assessment purposes	• Assessment incomplete. Based on measured data • No regionally agreed list of priority pollutants for monitoring/assessment purposes
Operational discharges (vessels**)**	• Illegal discharge of harmful substances, especially oil, considered important, but no data presented to back up claims	• The situation is unchanged. No data provided.

4.5 Biodiversity changes, including alien species introduction

4.5.1 The problem

Land-based sources of pollution (including nutrients) alter pelagic and benthic habitats of more than one country, particularly in inland seas where water exchange with other seas and oceans is constrained. Coastal wetland habitats and communities have also been drastically modified as a result of upstream water abstraction and changes in the flooding regime.

Impacts on biodiversity extend far beyond national boundaries. A number of activities, processes, resource uses and practices across the Black Sea riparian countries impact the Black Sea, the consequences of which result in pressures on marine biodiversity, the most important of which are: eutrophication, unsustainable fishing/harvesting (overexploitation and destructive fishing practices), habitat destruction, invasive alien species and chemical pollution. Waste produced in the catchment areas disperses around the Black Sea via marine currents. Transboundary effects arise if the impacted habitats are nursery and spawning grounds for commercially important migratory fishes, marine mammals and birds.

Economic globalisation has also provided unprecedented opportunities for species to overcome geographic barriers and establish in new habitats. Enclosed or semi enclosed ecosystems, such as the Black Sea, seem particularly sensitive to biological invasions. With increased shipping traffic, aquaculture and trade the Black Sea has become a major recipient of alien species. The shared marine environment contributes to the spread of alien species from one national sector to the others. Alien species can cause irreversible environmental impact at the genetic, species and ecosystem levels in ways that cause significant damage to the goods and services provided by ecosystems and thus to human interests. For this reason, they are now recognized as one of the great biological threats to the environment and economic welfare globally.

A comparative analysis of b**iodiversity change, including alien species introduction** with the findings of the 1996 TDA is presented in Box 4.4 at the end of Sectıon 4.5.

4.5.2 Environmental impacts and socio-economic consequences

4.5.2.1 Habitat loss/degradation and community modification

Habitats of transboundary importance can be defined in a number of ways: (i) those shared by several countries; (ii) those which suffer change due to causes that originate in or are contributed by another country; and (iii) those which may or may not be localised in one country but internationally important feeding/breeding/spawning/nursery/wintering grounds for migratory organisms. Three particular habitat types have been identified as habitats of transboundary importance: (i) coastal margin ecotones; (ii) pelagic habitats; and (iii) benthic habitats. The environmental impacts and socio-economic consequences of habitat loss/degradation and community modification for each of these habitat types are described below.

Coastal margin ecotones

Due to human pressures, aquatic coastal habitats have undergone significant modification during recent decades. The following environmental impacts resulting from habitat loss/degradation have been documented: frequent and intense algal blooms, modification of community structure and changes in food webs, depletion of fish stocks, loss of migratory species using the habitat, as well as altered migration patterns, increased mortality of aquatic organisms and avian mortality, decreased native species diversity, increased proportion of threatened species, changes in ecosystem stability, alien species establishment and increased vulnerability to opportunistic invaders, ecosystem degradation.

The socio-economic consequences originating from habitat loss/degradation encompass reduced options for freshwater use, increased costs of alternative water supplies, increased costs of water treatment, loss in feral and cultured fisheries, reduced options for aquaculture development, loss of tourism, recreational and aesthetic value, loss of educational and scientific value, costs of clean-up and preventive measures, costs of restoration of modified ecosystems, loss of sanctuary and protected areas and associated wildlife.

Shared habitats utilization may bring about human conflicts at international level. The controversial construction of a large scale navigable waterway for seagoing vessels in the Ukrainian section of the Danube River has has diplomatic consequences in Romania, the principal custodian of the Danube's Black Sea flood plains. The excavation and planned damming of the mouth of the Bastroe channel of the Danube has alarmed ecologists, who fear it will drain the estuary and put out of action the present navigable Chilia waterway. Environment groups estimate the construction work will put at risk the ecosystem of the delta's two and a half million acres of wetlands, stretching across Romania and part of Ukraine.

Pelagic habitat

The major environmental impacts of pelagic habitat degradation include algal blooms, water quality impairment (reduced transparency, jelly and mucous accumulation, hypoxic events), modification of community structure and food webs (elimination of large top predators via fishing activities, predominance of small pelagic species exerting top-down control over the food web, dead ends in the food web as a result of jellyfish), alien species establishment and ecosystem instability.

The relevant socio-economic consequences of the above comprise reduced income and reduced employment opportunities in commercial fisheries, loss of recreational values and potential losses in tourism, increased risk for human health, mitigation, restoration and treatment costs, reduced capacity to meet basic human needs (food), reduced educational, scientific, cultural and aesthetic value and potential human conflicts at international level related to the shared exploitation of marine living resources.

Benthic habitats

Reduced ecosystem stability/resilience and a move towards nutrient enrichment and phytoplankton growth has had a dramatic effect on the bivalve community (e.g. the Mediterranean mussel, *Mytilus galloprovincialis)*.. When the degraded bivalve community is unable to cope with food supplies from phytoplankton blooms and detritus, the excessive supply creates a huge oxygen demand leading to bottom hypoxia. Degradation of mussel beds which support diverse epifauna, infauna and interstitial community leads to decline/loss of species and genetic diversity. Habitat degradation is associated with decrease of food resource and breeding, spawning and nursery grounds for a range of commercially important species therefore the following socio-economic consequences arise: reduced capacity to meet basic human needs (food) for local populations, changes in employment opportunities, loss of existing income and foreign exchange from fisheries. Water quality impairment is linked to a decrease in recreational and aesthetic value with implications for tourism. Human conflicts arose on the issue of *Rapana venosa* fisheries. The scientific community was alarmed by the use of mobile bottom gears due to their detrimental effect on mussel beds and ultimately, ecosystem instability (Konsulova *et al.*, 2003). On the other hand the socio-economic importance of the *Rapana* shellfishery in terms of processing and export has increased significantly during the last decade due to high external market demand and also the collapse of other commercial species stocks since the late 1980s. Clearly the problem is an issue which needs further research to assess the ecological impacts against the socio-economic benefits and suggest options for balancing the stakeholders' interests.

Over the last few decades, the reduction of key species distribution and biomass has caused a subsequent decline in species richness, density and biomass of the associated fauna and flora. Community structure was modified due to sensitive brown algae (*Cystoseira* spp.) elimination and an increased development of tolerant red and green algae (*Ceramium, Enteromorpha, Cladophora*), and epiphytic algae. In the mid 1990s the expansion of the alien species *Desmarestia viridis* in Ukrainian waters further changed the community structure. Habitat decline resulted in reduced capacity for local populations to use *Cystoseira* as a source of alginates and animal feed or fertiliser. Furthermore, its potential use as a source of bioactive pharmaceutical products (sulfopolysaccharide, anti-inflammatory drugs) was impacted. A decline in aesthetic, recreational and educational/scientific value is also a noteworthy social loss.

The decline in eelgrass (*Zostera* spp*.)* beds has resulted in the loss of a habitat and food source for a number of associated species within the habitat and in surrounding benthic communities. A consequence of this has been an increase in coastal erosion by wave energy due to the loss of sediment stabilization by seagrass beds.

Among various sandy bottom inhabitants the bivalve *Lentidium mediterraneum* has suffered the most significant decline, especially along the NW coasts of the Black Sea (mainly Ukraine). The decline in the population of valuable commercial species such as the great sturgeon, the starred sturgeon and the turbot, is partially associated with the decline in *Lentidium* population, on which they feed. The consequence of this is a potential loss in earnings from fisheries and employment opportunities have been reduced.

Increased catches of the clam *Chamelea gallina* along the Turkish coast have resulted in over-fishing at certain localities. The use of destructive fishing gear (dredges) has subsequently resulted in further habitat degradation (siltation, community modification, diversity decline).

4.5.2.2 Alien species introduction

The environmental and economic consequences of introduced species are considered generally unfavourable though beneficial effects may also occur. Nearly 10 % of the established alien species in the Black Sea and coastal aquatic habitats are considered to be highly invasive and another 16 % as moderately invasive. Highly invasive species are recognized to have a serious impact on biological diversity due to:

- Severe impacts on ecosystem structure and function (e.g. alteration of habitat, competing with native species, entering food chain, altering energy and nutrient flow etc.).
- Replacement of native species throughout a significant proportion of their range.
- Hybridization with native species.

Ultimately this has represented a significant threat to the unique biodiversity of the Black Sea. In addition to their impact on biodiversity invasive aliens also have negative consequences for human activities, including health and economic interests. They are often considered as pests, pathogens or vectors of disease, and cause declines in the populations of commercially important species either through competition or predation. Many also become nuisances through fouling hydraulic constructions, clogging waterways, reducing water quality, and reducing aesthetic and recreational value. Conversely, aliens may also integrate well in the receiver ecosystem and generate positive ecological effects as well as become valuable commercial resources. A brief overview of the impacts of selected invasive alien species in the Black Sea is given below.

Among 38 alien phytoplankton species, three are assessed as highly invasive: the diatom *Pseudosolenia calcar-avis,* the prymnesiophyte *Phaeocystis pouchettii* and the cryptogenic prasinophyte *Mantoniella squamata.* Several more are deemed moderately invasive. Algal blooms caused by the listed species have been associated with zoobenthos mortality, fish asphyxia, pelagic community change and food web disruption. Negative economic consequences derive from impaired water quality and decreased beach water aesthetics which imply losses in tourism.

Among the 33 alien zooplankton species two have become central to the Black Sea ecosystem in the last 2 decades: *Mnemiopsis leidyi* notorious for its detrimental effect on the pelagic food web and fisheries collapse; and *Beroe ovata* reputed to be assisting in the restoration of ecological balance by reducing the former through selective predation on it. However, evidence to support this is mixed (see Section.3.3.2) Competition for food resources with planktivorous fish (e.g. sprat) and predation on fish larvae, together with overfishing resulted in the collapse of the pontic horse mackerel and anchovy fisheries during the late 1980s/early 1990s. *M. leidyi* was also indirectly responsible for enhanced harmful algal blooms in the 1980s. Furthermore, it reduced water quality due to mucous/jelly accumulation that caused visual pollution and hypoxia which impacted on coastal tourism.

The establishment of *B. ovata* in the Black Sea resulted in a decline in the *M. leidyi* population, an increase of plankton fauna diversity and mesozooplankton/fish larvae density and biomass. However, *B. ovata* has only narrowed the period of *Mnemiopsis* impact on the ecosystem, as it is prone to strong seasonal and interannual fluctuations (Vinogradov *et al*., 2000). Consequently when it is not present during the summer period, *M. leidyi* flourishes (Shiganova *et al*. 2001; Kamburska *et al*., 2003a,b; Kamburska, 2004).

Alien zoobenthos comprise 63 species, which arguably makes this ecological group the most successful colonizer in the Black Sea. For example, the Janapanes snail *Rapana venosa* is a habitat generalist and exploits practically every available prey. It has occupied an empty ecological niche in the Black Sea and has exerted significant predatory pressure on the indigenous malacofauna. The impact on bivalve populations is variable and ranges from rather mild along the Romanian coast possibly due to suboptimal environmental condition, moderate in Bulgarian and Turkish Black Sea, and severe along Russian and Ukrainian coasts, where the whelk has been blamed for local exterminations or major declines in the numbers of other bivalves. *R. venosa* is well established in the benthic ecosystem of the Bulgarian, Romanian and Turkish Black Sea and has become a commercially valuable living resource. Demand for *Rapana* meat on the international market increased the commercial value of this resource initially withinin Turkey (1980s) and then in Bulgaria (1990s). In Romania, medium-large scale 'subsistence' harvesting is likely to develop into an export-oriented industrial-scale enterprise in future years. In Ukraine *R. venosa* uses are limited to local subsistence fishery and souvenir manufacture/trade.

Positive economic effects from *R. venosa* fishery are counteracted by negative ecological side-effects of destructive fishing practices used in Turkey and Bulgaria where *R. venosa* is fished with dredges and beam trawls, in the latter country illegaly. In contrast, in Romania *R. venosa* is selectively fished by SCUBA divers, a sustainable method which does not disturb the habitat or involve by-catches of other animals. However, signs of over-harvesting are already evident in some areas. A new, sustainable, method of harvesting *Rapana* is currently being trialled in Turkey, with promising results. This uses baited traps, analagous to lobster/crab pots, which offer no harm to benthic habitats, with minimal by-catches and greater control over the size/age of *Rapana* caught.

Other examples of alien zoobenthos include:

- The clam *Anadara inaequivalvis,* a habitat generalist, highly tolerant of hypoxia, long lived, with high reproductive output and having the capacity to develop massive populations where environmental conditions are optimal.
- The acorn barnacle *Balanus improvisus* which increases the self-clearing capacity of shallow hard-bottom habitats and can form nuisance fouling on underwater constructions.
- The Chinese mitten crab *Eriocheir sinensis* a benthic predator which causes considerable erosion to mud/sand banks through burrowing.

A total of 27 aquatic/semi-aquatic alien vascular plants have been identified in Black Sea wetland and coastal environments. Three are characterised as highly invasive, another 5 - as moderately invasive. For example, Nuttall's pondweed *Elodea nuttallii* grows in dense thickets, attached to the bottom of lakes and slow-flowing rivers and canals and can impede water flow and navigation. At present the species is spreading in the Danube Delta, Danube floodplain and major tributaries of the Danube.

Alien fish encompass 33 species, only 3 recognized as highly invasive in freshwater habitats. In waterbodies inhabited by valuable commercial species and/or by threatened/endemic species (like the Danube Delta) the highly invasive sunfish *Lepomis gibbosus,* the Cyprinids *Pseudorasbora parva* and *Carassius gibelio* are pests that cause fisheries nuisance and outcompete native fish. However, *C. gibelio* can also be beneficial to fisheries in degraded and/or heavily modified water bodies, where other, more valuable species do not live.

4.5.3 Linkages with other transboundary problems

Biodiversity changes in the Black Sea are closely linked to each of the other identified transboundary problems. Eutrophication is recognized among the primary causes of Black Sea marine and coastal habitats degradation. Phytoplankton blooms are associated with the decline in species/habitats sensitive to increased turbidity (light attenuation), smothering and hypoxia. (Section 4.2).

Fisheries exert significant pressure and cause the decline in abundance/biomass/stocks not only of target commercial fishes but also of non-target by-catch species, including fishes, mammals and birds. Destructive fishing practices such as the use of mobile bottom gears contribute to habitat degradation by causing physical disturbance, mortality, smothering of habitats by suspended sediments and discards. (Refer to section 4.3)

Chemical pollution may cause mortalities and sub-lethal effects in biota. Gastropods, amphipods, infaunal polychaetes and bivalves are particularly sensitive to oil contamination. The toxicity of oil and petrochemicals to fish ranges from moderate to high (Cole *et al.*, 1999). Deterioration of sea water quality and accumulation of pollutants in sediments and biota contribute to the decline in sensitive species and habitat degradation in the Black Sea (Refer to section 4.4).

4.5.4 Immediate and underlying causes

The immediate, underlying and root causes of biodiversity change/habitat loss are shown in the Causal chain presented in Figure 4.19. However, this analysis is expanded upon in Section 4.5.4.1 by considering the causes of biodiversity change in terms of major habitat types. In Section 4.5.4.2, vectors of alien species introduction (a primary cause of biodiversity change) are discussed in detail and threats to endangered "red list" species are covered in Section 4.5.4.3. Further detail on the immediate causes of biodiversity change/habitat loss can also be found in Sections 4.2, 4.3, 4.4, all of which are drivers of this transboundary problem.

4.5.4.1 Habitat loss/degradation

Coastal margin ecotones

The immediate causes of coastal aquatic habitats loss/degradation over the last decade are: (i) point and diffuse discharges, and atmospheric deposition of nutrients and COD (eutrophication); (ii) modification/loss of physical habitats including desiccation of wetlands and floodplains, modification of river flow regimes, mechanical disturbance of substratum and increased sedimentation/smothering; (iii) changes in chemical conditions - salinity and nutrient ratios; (iv) unsustainable exploitation of living resources; (v) accidental or intentional introduction of alien species; (vi) point and diffuse pollution from chemical contaminants; and (vii) litter. These pressures derive from a variety of human practices and resource uses related to:

- Agriculture: historical legacy from the over-application of fertilizers and pesticides, unsustainable/inefficient agricultural and/or animal farming practices, intensive livestock production, untreated or partially treated effluent discharges from livestock farms, water abstraction and water diversion.
- Land use: land reclamation/drainage operations, deforestation, reed-bed burning.
- Urbanization and households: anachronistic and/or insufficient wastewater treatment, municipal waste disposal (including litter), water abstraction.
- Energy: river damming/regulation, water diversion schemes and thermal pollution.
- Transport: river regulation and water diversion, navigable channel construction, maintenance of shipping waterways in shallow waters, shipping activities, introduction of alien species and associated pathogens, port/harbour development and operations, absence of or outdated storage and treatment technology/facilities in ports.
- Industry: untreated industrial effluents and/or poorly maintained industrial treatment plants, absence of/outdated treatment technology, anachronistic industrial technologies and practices (including energy and extraction of raw materials).

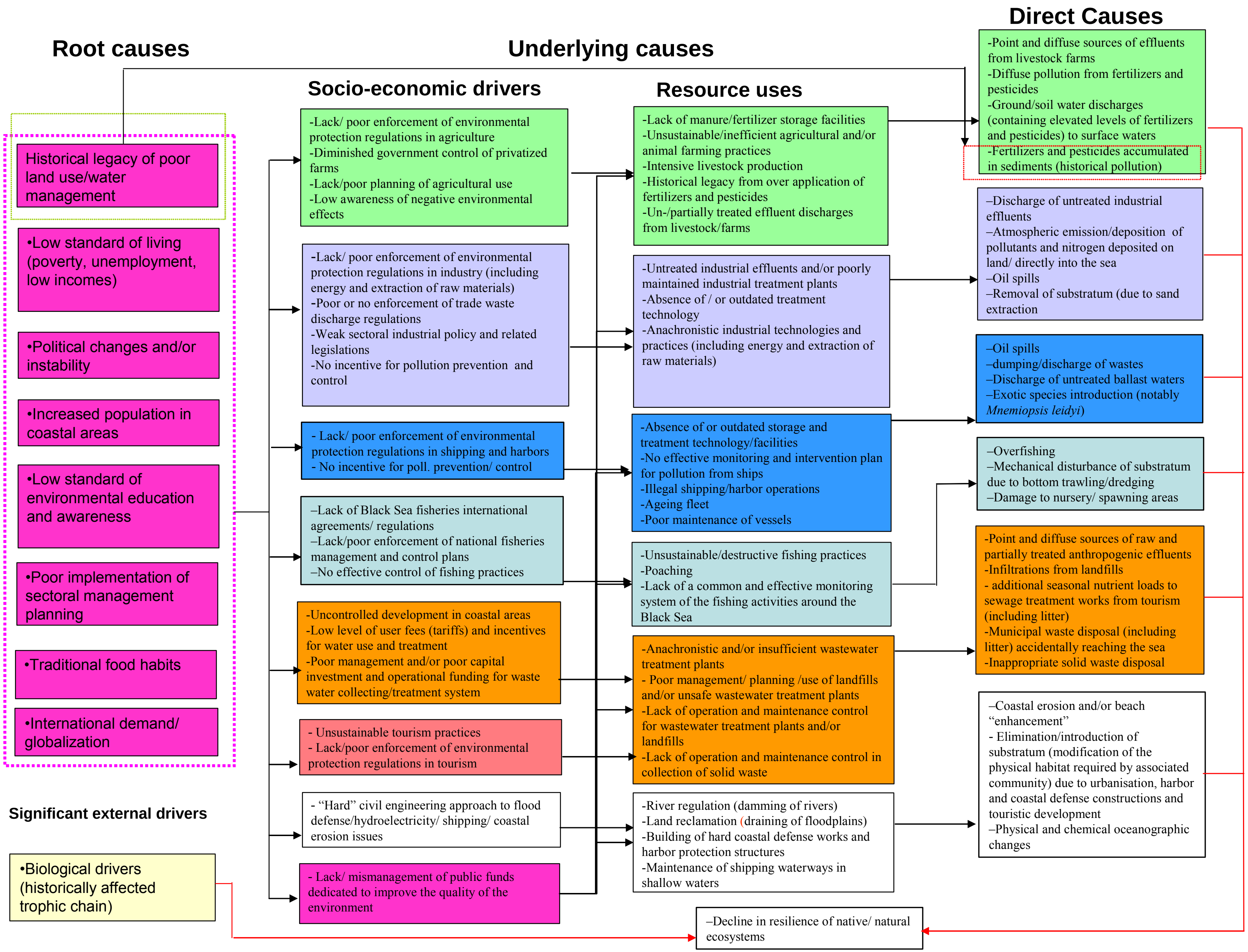

Figure 4.19 Causal chain analysis of biodiversity changes/habitats loss

- Fisheries and hunting: unsustainable/destructive fishing and harvesting practices, poaching.
- Tourism: additional seasonal nutrient loads to sewage treatment works from tourism (including litter), disturbance of wildlife.
- Aquaculture: alien species and associated pathogens introduction, aquaculture emissions (increased nutrient and organic pollution).

Pelagic habitats
The major immediate causes of pelagic habitat degradation during the recent decade include: (i) point and diffuse discharges, and atmospheric deposition of nutrients and COD (eutrophication); (ii) overfishing, by-catch and discard; (iii) invasive alien species; (iv) point and diffuse pollution from chemical contaminants (hydrocarbons, heavy metals etc.); (v) litter.

The underlying resource uses and practices by economic sectors include:

- Agriculture: historical legacy from the over application of fertilizers and pesticides, unsustainable/inefficient agricultural and/or animal farming practices, intensive livestock production, untreated or partially treated effluent discharges from livestock/farms.
- Fisheries: unsustainable/destructive fishing and harvesting practices, lack of a common and effective monitoring system of fishing activities around the Black Sea.
- Tourism: additional seasonal nutrient loads to sewage treatment works from tourism (including litter).
- Transport: introduction of alien species and associated pathogens, shipping waste/oil/ballast disposals, lack of effective monitoring and intervention plans for pollution from ships, ageing fleet and poor maintenance of vessels, port/harbour development and operations.
- Urbanization and households: anachronistic and/or insufficient wastewater treatment, municipal waste disposal (including litter), atmospheric emission/deposition of pollutants and nitrogen deposited on land/ directly into the sea, coastal defence constructions.
- Land use; changes in land cover use that may increase sediment or fertiliser runoff (erosion).
- İndustry: untreated or partially treated industrial effluents and/or poorly maintained industrial treatment plants, absence of / or outdated treatment technology, anachronistic industrial technologies and practices (including energy and extraction of raw materials), atmospheric emission/deposition of pollutants and nitrogen deposited on land/ directly into the sea.
- Aquaculture - accidental or intentional release of alien species, aquaculture by-products (increased nutrients and organic material).

Climatic variations at interannual-to-decadal time scales are superimposed on anthropogenic pressures and represent a significant external driving force shaping the processes and properties in the pelagic environment. Climate control operates on the food web by means of various physical processes (e.g., vertical mixing, upwelling), which in turn govern the rate of nutrient supply from the chemocline zone into the surface productive layer. In the Black Sea the impact of climate forcing is limited to the lowest trophic level (phytoplankton; Oguz & Gilbert, in press).

Natural expansion of alien species from the Mediterranean to the Black Sea can also be associated with climate change/warming. Thus one of the hypotheses regarding *Beroe ovata* introduction is that it was transported by the lower Bosphorus current and had a chance to acclimatize itself in the Black Sea because of the warm winters during 1997/1998 and 1998/1999 (Zaitsev & Öztürk, 2001).

Benthic habitats

The immediate causes of a decline in benthic habitats can be summarized as: (i) point and diffuse discharges/atmospheric deposition of nutrients and COD (shadowing of macrophytes and bottom hypoxia due to plankton blooms); (ii) disturbance/modification/loss of physical habitat - elimination or introduction of substratum, mechanical disturbance of substratum, increased sedimentation/smothering; (iii) physical oceanographic changes - changes in wave exposure, currents, depth, littoral drift, accretion/erosion characteristics of shores; (iv) invasive alien species; (v) unsustainable exploitation of living resources - overfishing, by-catch and discards, use of destructive fishing gears; (vi) point and diffuse pollution from chemicals contaminants (hydrocarbons, heavy metals etc.); and (vii) litter .

The underlying resource uses and practices by economic sectors include:

- Agriculture:- historical legacy from the over application of fertilizers and pesticides, unsustainable/inefficient agricultural and/or animal farming practices, intensive livestock production, untreated or partially treated effluent discharges from livestock/farms.
- Fisheries: unsustainable/destructive fishing and harvesting practices, poaching, lack of a common and effective monitoring system of fishing activities around the Black Sea.
- Transport: shipping waste/oil/ballast disposals, introduction of alien species and associated pathogens, lack of effective monitoring and intervention plans for pollution from ships, ageing fleet and poor maintenance of vessels, port/harbour development and operations, absence of or outdated storage and treatment technology/facilities in ports, maintenance of shipping waterways in shallow waters.
- Urbanization and household: anachronistic and/or insufficient wastewater treatment, municipal waste disposal (including litter), building of hard coastal defence constructions.
- Tourism: additional seasonal nutrient loads to sewage treatment works from tourism (including litter), disturbance of wildlife.
- Aquaculture: accidental or intentional release of alien species, aquaculture by-products (increased nutrients and organic enrichment).
- Industry: untreated or partially treated industrial effluents and/or poorly maintained industrial treatment plants, absence of / or outdated treatment technology, anachronistic industrial technologies and practices (including energy and exaction of raw materials), atmospheric emission/deposition of pollutants and nitrogen deposited on land/ directly into the sea.
- Land use: changes in land cover use that may increase sediment or fertiliser runoff (erosion).

4.5.4.2 Vectors of alien species introduction

The analysis of introduction vectors shows that the majority (68 %) of the introductions are human-mediated and only 13 % are a result of the natural expansion of species (Figure 4.20). A considerable portion of the aliens have no known vector (see Annex 6). However their native range excludes the option of natural expansion, therefore anthropogenic vectors are assumed as well. Among human-mediated dispersal mechanisms ships are clearly identified as the primary vector (30 %) of alien introductions in the Black Sea, followed by aquaculture (11 %).

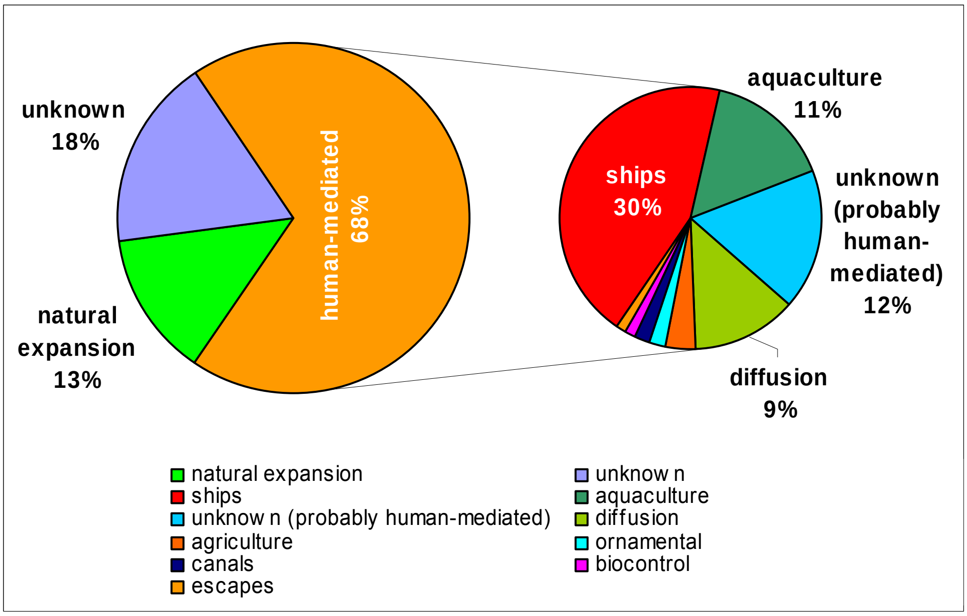

Figure 4.20 Vectors of alien species introductions in the Black Sea and coastal aquatic habitats

4.5.4.3 Major threats to IUCN red list species

Pollution, habitat destruction, exploitation (overfishing) and disturbance are recognized as important threats in all Black Sea countries (Figure 4.21).

Eutrophication is almost certainly underestimated as a threat factor, due to a misunderstanding of categories by national experts. Many entries which should have gone under eutrophication were probably listed as agriculture and pollution.

The prevalence of disturbance (due to tourism, trampling and military activity) predominantly affects waterfowl and shorebirds of the Black Sea wetlands. As birds are the most thoroughly assessed systematic group in the region, they comprise a large share of the threatened species list and hence the influence on the ranking of threat factors.

Climate change is clearly not recognized as threat factor and is not assessed properly in most Black Sea countries, although it is one of the major drivers behind biodiversity change in the Black Sea at present.

Parasitization and displacement by alien species is either largely overestimated, as it is the case in Ukraine and Georgia, or not considered at all, as in Turkey.

These inaccuracies/misinterpretations are reflected in the overall picture of threat factors in the Black Sea, where eutrophication is obviously underestimated as a threat, while minor factors like parasitisation and displacement by alien species, agriculture and forestry are overestimated (Figure 4.22).

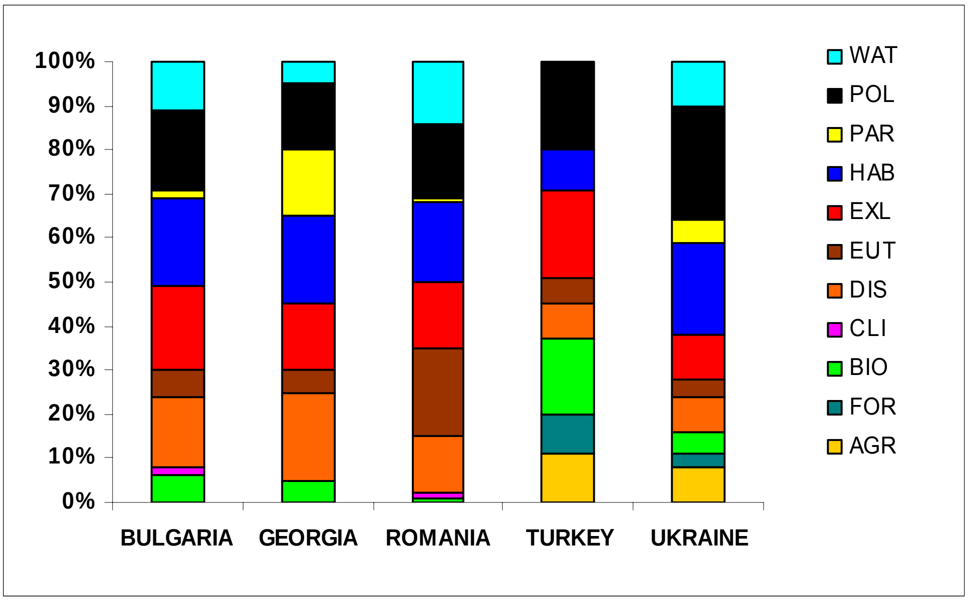

Figure 4.21 Factors of threat to red list species in each of the Black Sea countries[59]

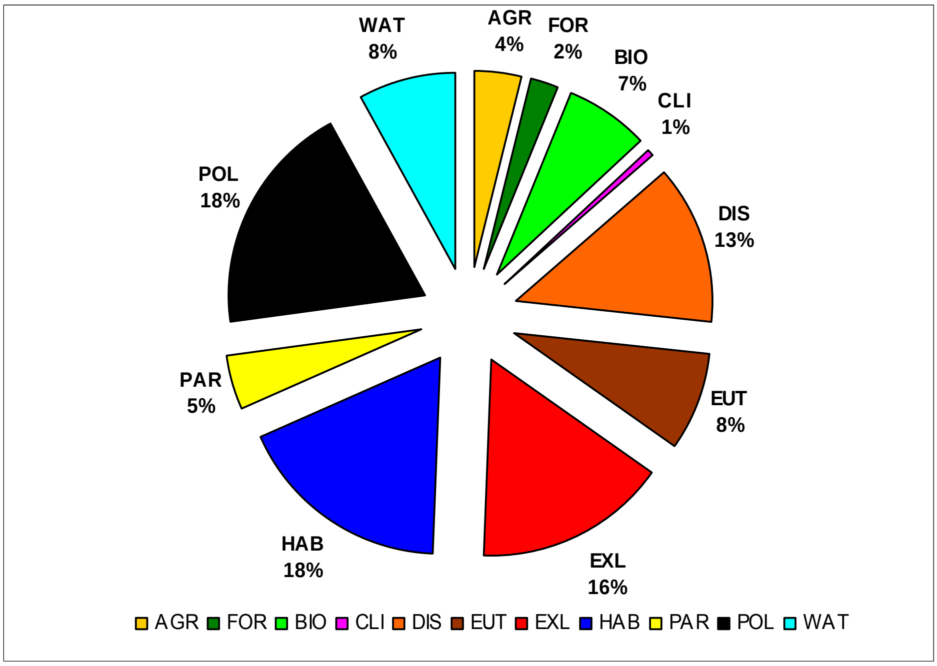

Figure 4.22 Overall picture of threat factors to Red List species in the Black Sea (legend abbreviations as in Figure 4.22)

[59] WAT= water regulation: dyking, coastal defense measures, drainage, land reclamation, rerouting, water extraction, POL= pollution (pesticides, contaminants, sewage, waste, combustion, oil pollution), PAR= parasites, diseases, competition, displacement (inclusively by alien species), HAB= loss of habitat through direct destruction, EXL= exploitation: fishing, hunting, gathering, by-catch, habitat loss or mechanical disturbance due to e.g. bottom trawling, EUT= eutrophication (including acidification and water turbidity), DIS= disturbance: tourism (including wear, trampling), traffic, military activities, CLI= climate change, BIO= biological characteristics that make the species vulnerable to other threats (low fecundity, late maturity, limited dispersal etc.), FOR= changes in forestry (only for species from paramarine wetlands and coastal dunes), AGR= agriculture: intensive, changing, stop of traditional farming (only for species from paramarine wetlands and coastal dunes)

4.5.5 Underlying socio-economic drivers

The underlying socio-economic drivers of the unsustainable practices and resource uses that cause biodiversity change in the Black Sea encompass legal and institutional incapacity in a number of sectors:

- Agriculture: lack and/or poor enforcement of environmental protection regulations in agriculture, diminished government control of privatized farms, lack and/or poor planning of agricultural land use, low awareness of negative environmental effects.
- Industry: lack and/or poor enforcement of environmental protection regulations in industry (including energy and exaction of raw materials), poor or no enforcement of trade waste discharge regulations, weak industrial policy and related legislations, no incentive for pollution prevention and control.
- Transport: lack and/or poor enforcement of environmental protection regulations in shipping and harbours, no incentive for pollution prevention/ control.
- Fisheries: lack of Black Sea fisheries international agreements/ regulations, lack and/or poor enforcement of national fisheries management and control plans, no effective control of fishing practices.
- Urbanization: uncontrolled development in coastal areas, low level of user fees (tariffs) and incentives for water use and treatment, poor management and/or poor capital investment and operational funding for waste water collecting/treatment system.
- Tourism: unsustainable tourism practices, lack and/or poor enforcement of environmental protection regulations in tourism.
- "Hard" civil engineering approach to flood defence/hydroelectricity/shipping/ coastal erosion issues.
- Lack and/or mismanagement of public funds dedicated to improve the quality of the environment.

For more details on these underlying socio-economic drivers, refer to Sections 3.2, 4.2, 4.3 and 4.4.

4.5.6 Knowledge gaps

Knowledge gaps differ among Black Sea countries depending on the variable national research effort. Georgia was identified as having most serious gaps of information regarding national habitats, threatened species and alien species. Russia did not provide any of the requested data on biodiversity change, which impeded the regional assessment.

Generally, data deficiency or knowledge gaps are recognized in the following:

- Changes in the spatial extent of habitats are largely unidentified. Habitat fragmentation is not assessed, changes over time are unknown.
- Lack of long term data sets and temporal and spatial patchiness of data on most of the quantitative indicators to assess diversity change.
- Vectors of introduction are unknown for a large number of aliens, a great deal of speculation and assumption may lead/have led to the development of weak management strategies and continue to leave invasion windows open.

- The level of threat to species according to IUCN categories and criteria is evaluated for a limited number of species. Re-evaluations at regular intervals are absent to provide assessment of the change in the level of threat over time.

4.5.7 Summary and preliminary recommendations

[This section needs some refinement]
Among the considerable diversity of Black Sea marine and coastal habitats the following were identified as being of transboundary importance: (i) the aquatic coastal margin ecotones including lagoons, estuaries, deltas, wetlands and saltmarshes; (ii) the pelagic habitat – the neritic in the NW Black Sea and the open sea in the SE Black Sea; (iii) a range of benthic habitats including *Mytilus galloprovincialis* beds, the association with *Cystoseira* spp., the *Zostera* beds and the sublittoral sands dominated by various psamophilic bivalves.

Changes in aquatic coastal habitats vary and are dependant on the intensity of environmental pressures at the sub-regional level. The Danube Delta and the Bulgarian coastal wetlands probably continue to experience diversity decline and impaired ecological status compared to the 1960s, despite the considerable reduction in habitat degradation due to the designation of extensive protected areas and the implementation of management plans aimed at biodiversity and water quality restoration. The Dnipro Delta and the Turkish coastal aquatic habitats have continued to decline due to eutrophication and pollution. Often, habitat degradation can only be inferred from increased anthropogenic pressures rather than systematic studies. A lack of research and knowledge on Georgian coastal habitats and the Dniester Delta, as well as a difficulties in obtaining national data represent have weakened this assessment of changes in the ecological status and diversity of the Black Sea.

Changes in the pelagic ecosystem towards the end of the 1990s reflects healthier conditions, especially in the NW Black Sea area, where decreased nutrient loads were coupled with favourable climatic change. However, despite the signs of recovery (rise of zooplankton and small pelagic fish stocks) the habitat shows a state of ecological instability, as well as sustained significant stock decline of large pelagic fish species. The Turkish Black Sea area is in a poor ecological state and biodiversity has decreased during the last decade. Environmental and biodiversity changes in the SE Black Sea area remain unclear either due to insufficient research (Georgia,) or a lack of provided data (Russia).

Benthic habitats show local signs of recovery but overall are still degraded compared to the pristine pre-eutrophication state of the Black Sea.

The presence of invasive alien species has modified the diversity and functioning of both the pelagic and a range of benthic habitats. Consequently it is likely that it will not be possible to revert to the ecological conditions of the 1960s, due to the practicalities of eradicating introduced alien species.

Environmental impacts related to biodiversity change encompass frequent and intense algal blooms, water quality impairment, modification of community structure and changes in food webs, depletion of fish stocks, loss of migratory species using the habitat as well as altered migration patterns, increased mortality of aquatic organisms and avian mortality, decreased native species diversity, an increased proportion of threatened species, changes in ecosystem stability, alien species establishment and increased vulnerability to opportunistic invaders, and ecosystem degradation.

The socio-economic consequences originating from habitat loss/degradation include reduced options for freshwater use, increased costs of alternative water supplies, increased costs of water treatment, loss in feral and cultured fisheries, reduced options for aquaculture development, loss of tourism, recreational and aesthetic value, reduced income and reduced employment opportunities, reduced capacity to meet basic human needs (water, food), increased risk for human health, loss of educational and scientific value, costs of clean-up and preventive measures, costs of restoration of modified ecosystems, loss of sanctuary and protected areas and associated wildlife. These are compounded by potential human conflicts at the international level related to the shared exploitation of the living resources and habitats.

The immediate and underlying causes of biodiversity change are associated mainly with eutrophication, pollution, over-exploitation of the living resources, accidental or intentional introduction of alien species, and the disturbance/modification/loss of physical habitat.

The following preliminary recommendations to decision-makers derive from the analysis of recent Black Sea biodiversity change:

- Marine researchers around the Black Sea require continued capacity building and training to increase the levels of professionalism.
- Scientists should have greater access to key decision-making positions in organisations which cover the Black Sea region.
- Thorough evaluation and regular re-evaluation of major marine systematic groups are needed in each of the BS countries, using the latest IUCN criteria and guidelines for application at the regional level. Evaluations must be based on up-to-date, distribution, population level and structure data. This will require serious funding and capacity building in all Black Sea countries.
- An integrative approach to conservation is required. This necessitates the rethinking of conservation efforts from a species-oriented to a habitat- and ecosystem- oriented approach. These often form clear management units. Protection of habitats will in most cases provide the right conditions for dependent species to survive. Species protection alone is very difficult in many cases, because of high fluctuations in the populations from year to year or because of migrations. If it can be made clear which habitat types are under pressure, these can be placed on a Red List. Often it will be clear which impacts are responsible for the deterioration of a Red List habitat, and management can act accordingly. In this way known Red List species and unknown speices at risk will be simultaneously protected.
- Once national Red Lists on habitats and biota have been completed a Red Book of Habitats, Flora and Fauna of the Black Sea can be created, which can then serve as a tool for conservation management at the regional level.
- An increase in the number and area of Marine Protected Areas including designation of transboundary reserves is essential.
- Improved management strategies to prevent new invasions should target the priority vectors of introduction – ships and aquaculture.

Box 4.4 Comparison of the 1996 and 2006 TDAs on the transboundary problem of biodiversity changes, including alien species introduction

A comparison between the 1996 and 2007 TDA with regard to biodiversity change and alien species introduction is presented in Box xx below. In the 1996 TDA, biodiversity change and alien species introduction was considered as 3 separate Major Perceived Problems. These were: *loss of habitats, notably wetlands and shelf areas, supporting important biotic resources; loss or imminent loss of endangered species and their genomes; and replacement of indigenous Black Sea species with exotic ones.*

The transboundary significance of these 3 problems as described in 1996 are very similar to those detailed in Section 4.5.*, namely: biotic resources were considered to be mobile or migratory; wetlands provide nursery grounds and were likely to assimilate transboundary pollutants; endemic and/or rare species were of regional and global significance; widespread eutrophication had altered the entire ecosystem, affecting diversity and abundance of biotic resources; exotic species were a global transboundary problem and the entire Black Sea was likely to become a vector for extra-regional contamination. It is sobering to consider that in the last decade, these MPPs are still considered to cause significant degradation of the Black Sea environment and little seems to have been done to reduce the impacts of these problems.

Issue	1996 situation	2006/7 situation
Loss or imminent loss of endangered species and their genomes	• The TDA focused on keystone species. These were considered to be at the center of communities which are highly characteristic of the local environment, and include threatened endemic as well as relict species. • These communities had dramatically decreased due to eutrophication caused by inflow of untreated sewage from point and non point sources and otherwise polluted rivers, hypoxia caused by eutrophication, increased turbidity, the use of inappropriate types of fishing gear, toxic pollution, over-harvesting and destruction of breeding grounds. • The phyllophora community was considered to be 3% of the reference level on Ukrainian shelf although there was little or no quantitative data on the standing crop in 1990s. • The Cystoseira barbata community was considered to be less than 1% of reference level on Romanian and Ukrainian shelf. • The Mediterranean Mussel (*Mytilus galloprovincialis*) was at 30 % of reference level on NWS. • Few specimens of Monk seal were left although there had been no recent comprehensive census.	• The 2007 TDA also focussed on keystone species. • Decreases in biodiversity and keystone species abundance was still a serious concern. A number of activities, processes, resource uses and practices across the Black Sea riparian countries impact the Black Sea, the consequences of which result in pressures on marine biodiversity, the most important of which are: eutrophication, unsustainable fishing/harvesting (overexploitation and destructive fishing practices), habitat destruction, invasive alien species and chemical pollution. • The community dominated by Phyllophora nervosa has not returned to its former situation but is instead dominated by opportunistic filamentous algae. Although this is not necessarily bad it still represents a eutrophic condition, albeit less serious than that represented by the monospecific phytoplankton blooms of the 1980s. Indeed evidence suggests that transparency of the water column is sufficient to allow *Phyllophora* to re-establish, providing the level nutrient enrichment can be reduced.
Loss of habitats, notably wetlands and shelf areas, supporting important biotic resources	• Although loss of habitats was identified as a MPPin the 1996 TDA, there is little data to support this , other than the information provided for the loss or imminent loss of endangered species (see above).	• The impacts on, and causes of, degradation of Coastal margin ecotones, benthic habitats and pelagic habitats were analysed in the 2007 TDA. Principly the causes of coastal aquatic habitats loss/degradation were attributed to: point and diffuse discharges, and atmospheric deposition of nutrients and COD (eutrophication); (ii) disturbance,modification/loss of physical habitats; (iii) changes in chemical conditions; (iv) unsustainable exploitation of living resources; (v) introduction of alien species; (vi) point and diffuse pollution and (vii) litter. (viii) physical oceanographic changes; and (ix) unsustainable exploitation of living resources.
Replacement of indigenous Black Sea species with exotic ones.	• Introduced opportunistic settlers e.g. ctenophore *Mnemiopsis leidyi* had shown outbreaks and had caused negative effects on fish population and environment. • Some species, which had adapted to the Black Sea environment and replaced indigenous species, were being harvested as living marine resources. • It was considered that there was a risk of exportation of opportunistic settlers from the Black Sea into other seas and the introduction of other opportunistic settlers into the Black Sea in the future. • The development of effective control of ships ballast waters and fouling organisms was recommended.	• Highly invasive species are recognized to have a serious impact on biological diversity. Nearly 10 % of the established alien species in the Black Sea and coastal aquatic habitats are deemed currently as highly invasive and another 16 % as moderately invasive. • Among 33 alien zooplankton species two has become central to the Black Sea ecosystem in the last 2 decades- *Mnemiopsis leidyi* notorious for its detrimental effect on the pelagic food web and fisheries collapse, and *Beroe ovata* reputed for restoring the ecological balance by reducing the former through selective predation on it. • The majority (68 %) of the introductions are human-mediated and only 13 % are a result of the natural expansion of species Ship ballast waters are clearly identified as the primary vector (30 %) of alien introductions in the Black Sea, followed by aquaculture (11 %). • It is still considered that not enough has been done to reduce these introductions.

5. HOT-SPOTS ANALYSIS

50 pollution point sources (hot-spots)[60] were originally identified from the 1996 TDA as requiring capital investments. These are shown in Fig. 6.1, with further details presented in Annex 9. An assessment of the relative level of success in tackling these sources is made below in terms of the investments already made and those which are planned to be made by the end of 2015. The degree of success in tackling these sources is divided into three categories: identified capital investments completed (Section 5.1), identified capital investments started (Section 5.2) and those where further work is still required (Section 5.3)[61]. In Fig 6.1 and Annex 9, hot-spots belonging to these categories are coloured green, amber and red, respectively. Three of the originally-identified Russian hot-spots (Rostov-on-Don, Taganrog, and Azov municipal WWTPs) discharge into the Sea of Azov, not the Black Sea.

Capital investment costs to address the identified 50 hot-spots were originally estimated to be almost $400 million. By the end of 2005 at least $143 million had been spent on addressing these point sources, with a further $340 million planned by the end of 2015.

5.1 Identified capital investments completed

Of the 50 hot-spots originally identified 14 can be considered to have been adequately addressed in terms of required capital investments or a re-assessment of the impacts (pollution loads) discharged from the sites. Of these the construction work has either been completed or was due to have been completed by the end of 2006 at: Rosneta oil terminal WWTP, Varna Port WWTP, Burgas Port WWTP, Asparouhovo municipal WWTP, Neftochim oil refinery WWTP, Mangalia municipal WWTP, Sheskhoris oil terminal WWTP and Gelendzhik municipal WWTP.

At Pivdenni municipal WWTP (Ukraine), over three times the original estimated investment costs have already been spent improving this facility, so pollution loads from this hot-spot are considered to have been addressed; however, it is planned to spend a further $37 million on reconstruction/updating of this plant by the end of 2015. Likewise, in Romania, at Constanta North, Constanta South and Eforie South WWTPs, greater sums of money have already been spent on modernisation/updating of the facilities than originally estimated, with considerable further investments to be spent by the end of 2015.

Closure and a change of use of the Fertilchim fertiliser manufacturing plant in Romania have greatly reduced its emissions, meaning that the $16,750,000 investment originally identified is no longer required. In the case of Dzhoubga municipal WWTP (Russia), a re-assessment of its pollution loads/impacts means that no updating of the plant is required – this is also included in the list of 14 hot-spots successes.

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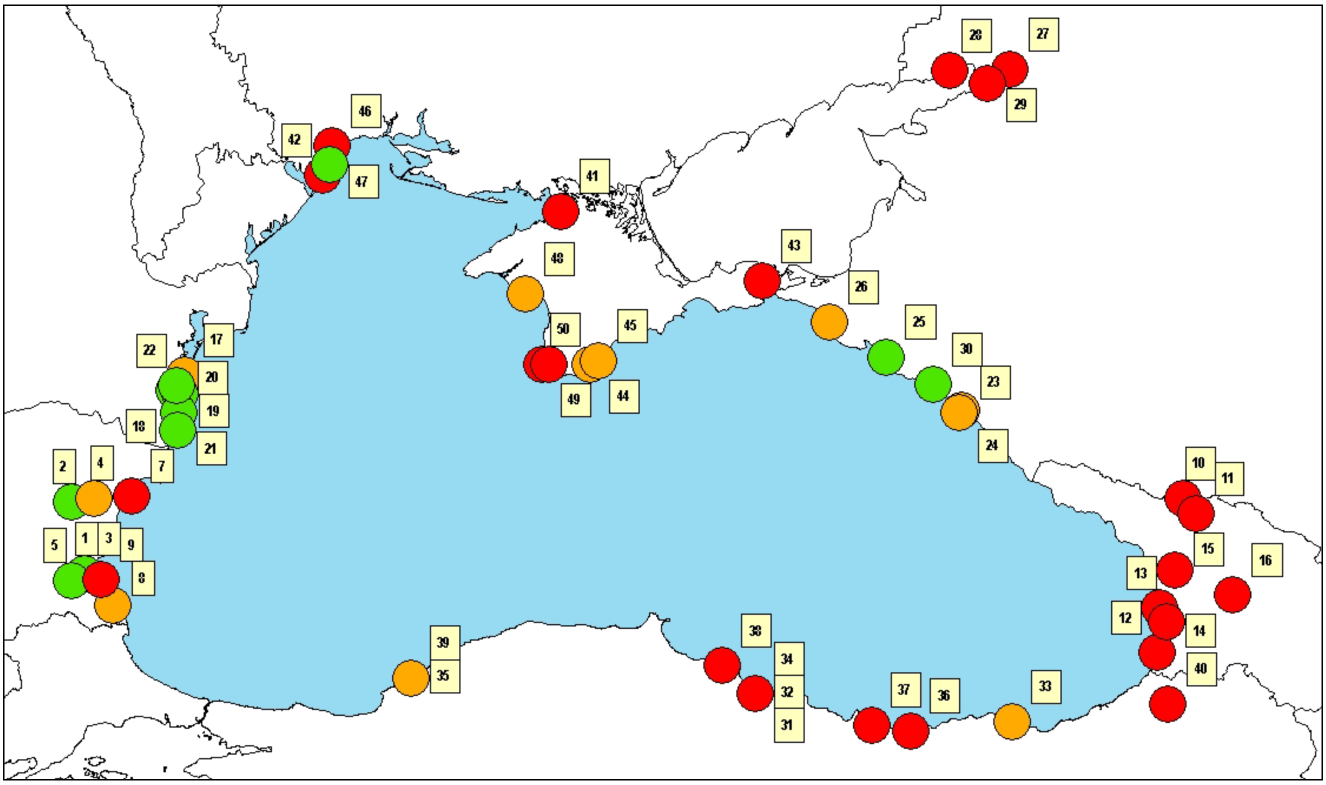
[60]The Black Sea is sometimes considered to contain 49 hot-spots, as identified from the original TDA. Reasons for the confusion over the exact number occur because Zonguldak is sometimes to be a single source, and sometimes two WWTPs serving Zonguldak are considered to be individual hot-spots.

[61]Due to a lack of supporting information, where capital investments have been made or are planned at a substantially lower cost than originally planned, it has been assumed that the original envisaged improvement in pollution loads/impacts have not been or not will not be achieved. Thus, assessments of the likely current or future level of success of some capital investments in reducing pollution loads could have been underestimated if cheaper methods of tackling pollution loads have been identified and implemented/planned since 1996.



No.	Name of pollution source	Source type	No.	Name of pollution source	Source type
1	Rosenets - oil terminal	Industrial	26	Anapa WWTP	Municipal
2	Port Varna	Industrial	27	Rostov-on-Don WWTP	Municipal
3	Port Bourgas	Industrial	28	Taganrog WWTP	Municipal
4	Solvey SODI AD	Industrial	29	Azov WWTP	Municipal
5	LUKOIL Neftochim	Industrial	30	Dzhoubga WWTP	Municipal
6	Asparuhovo WWTP	Municipal	31	KBI Samsun	Industrial
7	Balchik WWTP	Municipal	32	TUGSAS Samsun, Fertilizer	Industrial
8	Tsarevo WWTP	Municipal	33	Trabzon (Pretreatment)	Municipal
9	Sozopol WWTP	Municipal	34	Samsun WWTP	Municipal
10	Chiatura	Industrial	35	Zonguldak WWTP	Municipal
11	Zestafoni	Industrial	36	Giresun WWTP	Municipal
12	Batumi WWTP	Municipal	37	Ordu WWTP	Municipal
13	Poti WWTP	Municipal	38	Bafra WWTP	Municipal
14	Tskhaltobo WWTP	Municipal	39	Zonguldak WWTP	Municipal
15	Zugdidi WWTP	Municipal	40	KBI Murgul	Industrial
16	Kutaisi WWTP	Municipal	41	OJSC "BROM", Krasnoperekopsk	Industrial
17	Rompetrol Refinery	Industrial	42	Illichivs'k sea trade port	Industrial
18	Constanta Sud WWTP	Municipal	43	OJSC "Kamysh-Burunskıy	Industrial
19	Constanta Nord WWTP	Municipal	44	PMWSF, YALTA	Municipal
20	Eforie Sud WWTP	Municipal	45	PMWSF, GURZUF	Municipal
21	Mangalia WWTP	Municipal	46	North Odessa (Pivnichni)	Municipal
22	Fertilchim	Industrial	47	South Odessa (Pivdenni)	Municipal
23	Ballast water treatment plant, Tuapse	Industrial	48	PMWSF, Yevpatoriia	Municipal
24	Tuapse WWTP	Municipal	49	Public enterprise "Sevtownwatersewerage"	Municipal
25	Gelendzhik WWTP	Municipal	50	Balaklava WWTP	Municipal

Figure 5.1 Location of hot-spots identified from the 1996 TDA

5.2 Identified capital investments started

Upgrading of a further 10 of the originally-identified hot-spots can be considered to have been partially completed. The investment funds originally identified for upgrading/reconstructing the Bulgarian Sodi soda ash plant and Tsarevo municipal WWTP appear to have been spent, but construction (in 2006) had not been completed. Hence there is some confusion over upgrading of these sources. At the Petromidia petrochemical complex in Romania, capital investments have started, but the majority of modernisation/reconstruction work is planned for completion by the end of 2015. Similarly, in Russia, construction/modernization of Tuapse Port WWTP and Anapa municipal WWTP has started but will not be completed for some years yet.

In Turkey the situation is difficult to assess, since Trabzon municipal wastewater treatment plant was originally identified as being in need of upgrading, but which exact treatment works was never identified. Investments have begun at several WWTPs serving Trabzon, with further funding to complete this modernisation now identified in future capital investment plans. Work has been undertaken at Zonguldak WWTP, but the amount of money invested was considerably less than that originally estimated, with no further investments currently planned before the end of 2015. A similar story to Zonguldak also emerges with regard to capital investments at Yalta and Gurzuf WWTPs in Ukraine, where the construction/upgrading of Yevpatoria WWTP has started, and is planned for completion in the future.

5.3 Work still required

Upgrading/construction of the remaining 26 original hot-spots has not started and is not planned to be undertaken at Kutaisi, Chiatura, Tskhaltubo and Zugdidi municipal WWTPs, or Zestaponi industrial WWTP (Georgia). Likewise, investments at Rostov-on-Don, Taganrog and Azov municipal WWTPs in Russia have not been made and are not planned. In Turkey, no upgrading of the KBI and TUGSAS industrial WWTPs at Samsum, Murgul industrial WWTP or municipal WWTPs at Zonguldak and Bafra has been undertaken or planned. Similarly, no investments have been made or planned for Balaklava municipal WWTP, Sevastopol municipal WWTP, Kamish Burunski industrial WWTP or Illichevsk port WWTP (Ukraine).

Work has started and further work is planned to upgrade municipal WWTPs at Samsum and Giresun (Turkey), but the investments fall far below that originally envisaged. Investments at Ordu WWTP (Turkey) are completed, with no further work planned, but again at a considerably lower cost than originally estimated. Some work has also been undertaken at Krasnoperekopsk WWTP (Ukraine), albeit at a much lower cost than originally estimated, with no further work planned.

Upgrading of Balchik municipal WWTP (Bulgaria) has started and will continue. Investments at Pivnichni municipal WWTP (Ukraine) have not started but are planned.

Finally, capital investments are planned for upgrading or construction of municipal WWTPs at Sozopol (Bulgaria), Batumi (Georgia) and Poti (Georgia), but this work had not started before 2006.

6. GOVERNANCE – LEGAL AND INSTITUTIONAL ANALYSIS OF THE BLACK SEA REGION

6.1 Introduction

This chapter compiles all existing information pertaining to governance at the national level related to water, nutrient and nature management, fisheries, ICZM and integrated pollution, prevention and control policies assessing them from regional perspective.

The assessment is based on the analysis of the situation in all 6 Black Sea coastal countries: Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine and it has been made in the framework of the Black Sea Convention and of the Black Sea Strategic Action Plan. Its main objective is to identify the actual status and the progress made since 1996, as well as the deficiencies/gaps in terms of legal and institutional frameworks, policy/legal harmonization and implementation of transboundary agreements.

Bulgaria, Romania and Ukraine are also signatory parties of the Danube River Protection Convention, which forms the overall legal instrument for cooperation and transboundary water management in the Danube River Basin. The situation is complicated by the fact that Bulgaria and Romania joined the European Community in 1st of January 2007, so the Black Sea is now recognized as a European Sea.

The UE status Accession and membership and its implications, Transboundary cooperation and status of ratification/implementation of relevant international conventions and agreements have been also considered and assessed from the regional perspective.

An effort was made to emphasize the legal and institutional framework particularly related to the four identified transboundary problems: nutrient over– enrichement/ eutrophication, changes in commercial marine living resources, chemical pollution (including oil), habitat and biodiversity changes.

6.2 Institutional analysis

Since the beginning of the 1990s, the countries of the region, with the financial assistance of the international community, have started to co-operate in order to promote the sustainable use of transboundary water resources. The 1992 Bucharest Convention and the 1993 Odessa Declaration, a set of practical guidelines for which Rio's Agenda 21 supplied the model, provided the impetus and framework for cooperation among the six Black Sea countries. A similar movement has taken place among the larger group of countries in the Danube Basin – itself a major part of the Black Sea basin and a major contributor to Black Sea pollution, having as a result the signature of the Danube River Protection Convention in 1994. Bulgaria, Romania and Ukraine are signatory parties of both Conventions.

The two conventions have resulted in the establishment of several institutions that are required to develop concrete measures and inititatives to protect the water environment. The Black Sea Commision and the International Commission for the Protection of the Black Sea were set up in order to achieve the purposes of the two Conventions. Co-operation between the two commissions started in 1997 on a preliminary basis, by establishing a Joint Technical Working Group.

Both Commissions are assisted by Secretariats: the BSC Permanent Secretariat, officially opened in 2000 and the ICPDR Secretariat, officially opened in 1999. In 2000, the ICPDR has been nominated the platform for coordination of issues of international importance for the implementation of the EU Water Framework Directive. Since this time, the Secretariat supports also the cooperation/coordination between the Danube River Basin countries towards the implementation of the EU Water Framework Directive.

The ICPDR has joined forces with the Black Sea Commission to remedy the environmental degradation of the Black Sea through the Danube by establishing a Joint Technical Working Group. This body is currently drafting guidelines for achieving good environmental status in the coastal waters of the Black Sea, in line with EU legislation. Co-operation between the two commissions was reinforced by a Memorandum of Understanding signed at a ministerial meeting in Brussels in November 2001.

The Black Sea Commission and ICPDR are also members of the DABLAS Task Force, which was set up in November 2001 as a platform for co-operation between international financial institutions (IFIs), donors and beneficiaries with regard to the protection of water and water-related ecosystems along the Danube and in the Black Sea. The task force includes representatives from the countries in the region, the ICPDR, the Black Sea Commission, IFIs, the EC, interested EU Member States, and other bilateral donors, as well as other regional/ and international organisations.

6.2.1 Regional institutions

The Black Sea Commission has one member from each of the six contracting parties, Bulgaria, Georgia, Romania, Turkey, Russia and Ukraine. The Chair of the Commission is rotated on an annual basis among the Contracting Parties. The Commission holds one regular meeting each year and may hold extraordinary meetings as agreed by the Contracting Parties. The Commission's decisions are made on the basis of unanimity.

The BSC was created with the main objective "to achieve the purposes" of the Convention. Under Article XVIII, the BSC is entrusted to:

- Promote the implementation of the Convention and inform the Contracting Parties of its work.
- Make recommendations on measures necessary for achieving the aims of the Convention.
- Consider questions relating to the implementation of the Convention and recommend such amendments to the Convention and to the Protocols as may be required, including amendments to Annexes of the Convention and the Protocols.
- Elaborate criteria pertaining to the prevention, reduction and control of pollution of the marine environment of the Black Sea and to the elimination of the effects of pollution, as well as recommendations on measures to this effect.
- Promote the adoption by the Contracting Parties of additional measures needed to protect the marine environment of the Black Sea, and to that end receive, process and disseminate to the Contracting Parties relevant scientific, technical and statistical information and promote scientific and technical research.
- Cooperate with competent international organizations, especially with a view to developing appropriate programmes or obtaining assistance in order to achieve the purposes of the Convention.

- Consider any questions raised by the Contracting Parties.
- Perform other functions as foreseen in other provisions of the Convention or assigned unanimously to the Commission by the Contracting Parties.

Existing protocols to the Bucharest Convention either add some new functions to this already extensive list or specify concrete actions or activities expected from the BSC in the context of its broad mandate. Existing protocols protocols are the:

- 1992 Protocol on Protection of the Black Sea Marine Environment against Pollution from Land Based Sources (1992 LBS Protocol).
- 1992 Protocol on the Protection of the Black Sea Marine Environment against Pollution by Dumping (1992 Dumping Protocol).
- 1992 Protocol on Cooperation in Combating Pollution of the Black Sea Marine Environment by Oil and Other Harmful Substances in Emergency Situations (1992 Emergency Protocol), and
- 2003 Black Sea Biodiversity and Landscape Conservation Protocol (2003 Biodiversity Protocol; not yet in force).

Based upon the example of the Biodiversity Protocol it can be reasonably expected that the two new legal instruments – the Revised Protocol on Land-Based Sources of Pollution and, possibly, the Convention on Fisheries – will significantly expand the mandate of the Commission.

Additional functions and responsibilities have been entrusted to the Commission by the two declarations adopted by the regular Meetings of the Ministers of the Environment of the Black Sea states – the 1993 Odessa Declaration and 2002 Sofia Declaration, as well as by the memoranda of understanding and cooperation between the BSC and other international bodies – ICPDR and the European Environment Agency.

As can be seen from the above, the mandate of the BSC is fairly broad and with time it has been further expanded to include additional functions and responsibilities.

The Commission is supported by the Permanent Secretariat, headed by an Executive Director. The Commission is currently acting in a general supervisory role for the Secretariat, overseeing the activities conducted.

The Permanent Secretariat is supported in implementing the BSC activities by sixteen subsidiary bodies: six activity centres, seven advisory groups and three *ad hoc* working groups (Fig. 6.1). Each group meets regularly, up to twice per year.

The activity centres were designed as in kind contributions of the Contracting Parties (CPs). The situation in several of the countries has changed over time due to government reorganizations and changing budget priorities. Currently, only two of the original six have funding from the CPs to carry out activities to support the BSC.

The Commission for the Protection of the Black Sea Against Pollution

Permanent Secretariat

Advisory Groups

AG ESAS	AG PMA	AG LBS	AG ICZM	AG CBD	AG FOMLR	AG IDE
Environmental Safety Aspects of Shipping (AG ESAS)	Pollution Monitoring and Assessment	Control of Pollution from Land Based Sources	Development of the Common Methodologies for Integrated Coastal Zone Management	Conservation of Biological Diversity	Environmental Aspects of Fisheries and Other Marine Living Resources Management	Information and Data Exchange

***Ad-hoc* Working Groups**

WFD WG	State of Environment 2006 WG	Danube/ Black Sea Joint Technical Working Group

Regional Activity Centrres

Environmental Safety Aspects of Shipping (AC ESAS), Varna, Bulgaria	Pollution Monitoring and Assessment (AC PMA), Odessa, Ukraine	Control of Pollution from Land Based Sources (AC LBS), Istanbul, Turkey	Development of Common Methodologies for Integrated Coastal Zone Management (AG ICZM), Krasnodar, Russian Federation	Conservation of Biological Diversity (AC CBD), Batumi, Georgia	Environmental Aspects of Fisheries and Other Marine Living Resources Management (AG FOMLR), Constanta, Romania	Information and Data Exchange (AC IDE), Permanent Secretariat, Istanbul, Turkey

National Focal Points

Bg, Ge, Ro, Ru, Tr, Ua	Ua, Bg, Ge, Ro, Ru, Tr	Tr, Bg, Ge, Ro, Ru, Ua	Ru, Bg, Ge, Ro, Tr, Ua	Ge, Bg, Ro, Ru, Tr, Ua	Ro, Bg, Ge, Ru, Tr, Ua	Bg, Ge, Ro, Ru, Tr, Ua

Figure 6.1 General structure of the Black Sea Commission

The current organization is complex and inconsistent. The Advisory Groups have a number of issues which need to be addressed including: qualifications of members, continuity in membership and focus on outputs. The Advisory Groups are all supported by a single member of the Secretariat which limits the amount of support available, flexibility for meeting times and other issues. The materials produced by the Advisory Groups are not generally used by the decision makers in the Black Sea countries because they are not seen as being relevant to policy making.

The current organizational structure of the BSC is multi layered. There is little accountability within the existing organizational structure. For example, deadlines missed are often further extended and incomplete activities are rolled over to the next period. The resources, both human and financial, required maintaining such a complex organization is neither cost effective nor sustainable.

For the EU Accession countries the WFD is part of the .acquis communitaire. Since 2000, the ICPDR is the framework for basin-wide cooperation and serves as the platform for coordination to develop and establish the Danube River Basin Management Plan. The Danube River Basin District has been defined and covers: 1) the Danube River Basin; 2) the Black Sea coastal catchments on Romanian territory; and 3) Black Sea coastal waters along the Romanian and part of the Ukrainian coasts.

By the time the deadline for the completion of the River Basin Management Plan is reached in December 2009 two more Danube countries, Bulgaria and Romania, have become EU Members starting in January 1st, 2007. Although the countries have no reporting obligations until they become EU-Member States, they have fully cooperated through the ICPDR framework.

6.2.2 National institutions for regional cooperation

This assessment of the national institutions presents the situation in 2006. It was carried out by means of specially designed questionnaires and the processing of returns obtained from the national consultants. The list of institutions and their main roles/functions in addressing the four transboundary problems is presented in Tables 6.1-6.4.

Institutional arrangements differ from country to country. The overall responsibility for environmental protection at national level, in all six countries, belongs to the Ministries of Environment and their respective implementing/enforcing/controlling agencies organized at federal/regional and local level. Support is also offered by other Ministries and agencies. Even if Inter –coordination mechanisms are established in four of the Black Sea countries and different bodies were set up in order to increase the cooperation/coordination between the different agencies involved with implementation of water related policies at both national and local level, their effectiveness would remain weak. Further institutional strengthening and capacity building is needed, particularly with respect to water management, biodiversity and fisheries. Existing Inter-ministerial coordination bodies and their functions/roles are presented in Table 6.5

Table 6.1 Functions and roles of national institutions dealing with the transboundary problem of nutrient over-enrichment/eutrophication

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
International Conventions/ agreements ratification/signature…	Council of Ministers MoFA, MoEW	Parliament, MoFA MoEPNR	Parliament, MoFA MoEWM, MoAFRD	State Duma Council of Federation MoFA, MoNR	General Assembly Council of Ministers MoFA MoEF	Parliament MoFA MoEP
Formulating national laws, regulations and plans for limiting and eliminating pollution of water resources	MoEW MoAF MoRD	Parliament (Committee for Environmental Protection and Natural Resources). MoEPNR, MoA	MoEWM MoAFRD MoTCT Ministry of Administration and Interior – MoAI	*National level*: MoNR *Regional level*: Legislative Assembly of Krasnodar kray (AoKK)	SPO MoEF; Ministry of Agriculture – MoA	MoEP Environmental Committee of Ukrainian Parliament State Committee on Water Saving – ScoWT MoA
Management of Water resources	MoEW MoRD, River Basin Management Directorate - RBMD	MEPNR, MoA, Local Governments	MoEWM, NAAR & its river basin directorates	MoNR through FAWR & its territorial bodies	MoEF, General Directorate of State Hydraulic Works - GDSHW	MoEP SCoWT
Water standards development	MoEW, RBMD, REI, MoRD, MoH	MoHSWL, MEPNR	Environmental Engineering Research Institute (ICIM)	Federal Environmental, Industrial and Atomic Control Service (FEIACS) and its territorial bodies AoKK Scientific and research institutions	MoEF	MoEP CMU MoH RDEP
Issuance of concessions/permits/licenses on water use and Integrated permits for operational plants and facilities and projects, including livestock farms	RBMD MoEW + MoAF	MEPNR + Sectoral Ministries	National Administration Apele Romane and its branches (NAAR) Environmental Protection Agencies - EPAs	FAWR & its territorial bodies MoA AoKK	MoEF Water Supply and Sewerage Administrations (WSSA), General Directorate of State Hydraulic Works (GDSHW) MoH, MoA, MoEF	MoEP, CMU, RA, SCWM MoH MoEP, SES, RA Ministry of Construction, Architecture and Municipal Economy of Ukraine - MoCAME
Monitoring of surface waters, including: • bathing waters • groundwaters • pollution discharge • air emmissions	 REI, & MoH MoRD, WSC & Municipalities REI	 MEPNR MoHSWL	NAAR +ICIM+ IRCM NAAR + MoH NAAR + Local EPA's ICIM + Regional & Local EPA's	Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET) FEIACS & territorial bodies MoNR through FAWR & its territorial bodies	MoEF, MoH, MoA, GDSHW MoEF, MoH, GDSHW +Municipalities, MoH, WSSA MoEF, MoH, Municipalities	 SCWM,MoEP,SHMS,SEI MoH, SES SCWM,MoEP MoEP, SCWM,RDEP,SEI MoEP,SHMS
Control & enforcement in water management	RBMD, MoE, MoRD	MEPNR MoF	NAAR	MoNR - FAWR , FSNRM& territorial bodies, AoKK	MoEF, Municipalities + WSSA	MoEP/SES/RDEP/SEI/SEIBSA S

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Training & capacity building	MoE MoAF	MoEPNR, MoA	MoEWM MoAFRD	AoKK Kuban State Agricultural University	MoEF, MoA	MEP/MA/NGOs
Regime/Registration of Pesticides and Agrochemicals	MoAF, Regional MoAF Offices	MoA, MoEPNR	MoAFRD	MoA	MoA	MoA UP CMU

Table 6.2 Functions and roles of national institutions dealing with the transboundary problem of changes in commercial marine living resources

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
International Conventions/ agreements ratification/signature…	Council of Ministers MoFA, MoEW MoAF	Parliament, MoFA MoEPNR	Parliament, MoFA MoEWM, MoAFRD	State Duma Council of Federation MoFA, MoNR MoA	General Assembly Council of Ministers MoFA MoEF MoA	Parliament MoFA MoEP MoA
Formulation of agricultural policies, including fisheries	MoAF integrated with MoEW MoH, MRD	MoA, MEPNR	MoAFRD	MoA and its Agency on Fishery AoKK	MoA	MoA
Development of national program for developing fisheries and aquaculture	MoAF	MEPNR, MoA	MoAFRD	MoA through the Federal Agency on Fishery	MoA	MoA MoEP Cabinet of Ministers of Ukraine - CMU
Development of action plans for the protection of endangered fish species, including establishment of their catch prohibition	MoAF & Institute of Fisheries-Varna	MEPNR	MoAFRD	MoA through the Federal Agency on Fishery	MoA, MoEF	MoEP MoA
Maintenance of the Fisheries Database	MoAF & Institute of Fisheries-Varna		MoAFRD	MoA through the Federal Agency on Fishery	MoA	MoEP MoA
Maintenance of the Fishing Vessels Register	MAF, Executive Agency on Fischeries - EAF	Ministry of Economic Development	MoAFRD	MoA through the Federal Agency on Fishery	MoA	Ministry of Transport and Comunications - MoTC
Issuance of permission for merchant fishing	Same & Municipalities	Local Authorities	MoAFRD	MoA through the Federal Agency on Fishery MoNR	MoA	MoA

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Inspection and control of compliance with permissions for fishing	EAF	MEPNR	National agency for fishing and aquaculture	MoA through the Federal Agency on Fishery MoNR	MoA	MoA MoEP State Ecological Inspection for the Black Sea and Azov Sea - SEIBSAS

Table 6.3 Functions and roles of national institutions dealing with the transboundary problem of chemical pollution

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
International Conventions/ agreements ratification/signature…	Council of Ministers MoFA, MoEW	Parliament, MoFA MoEPNR	Parliament, MoFA MoEWM, MoAFRD	State Duma Council of Federation MoFA, MoNR	General Assembly Council of Ministers MoFA MoEF	Parliament MoFA MoEP
Chemical pollution – originating from land						
Formulating national laws, regulations and plans for limiting and eliminating pollution of water resources, including those for land use	MoEW MoAF MoRD, MUN	Parliament (Committee for Environmental Protection and Natural Resources). MoEPNR, MoA	MoEWM MoAFRD MoTCT Ministry of Administration and Interior – MoAI	*National level*: MoNR MoRD *Regional level*: Legislative Assembly of Krasnodar kray (AoKK)	SPO MoEF; MoA Ministry of Public Works and Settlements (MoPWS) Metropolitan Municipalities	MoEP Environmental Committee of Ukrainian Parliament State Committee on Water Saving – SCoWT MoA, SCLR
Management of Water resources, including water supply and sanitation	MoEW MoRD, River Basin Management Directorate – RBMD WSC	MEPNR, MoA, Local Governments	MoEWM, NAAR & its river basin directorates MoTCT & Municipalities	MoNR through FAWR & its territorial bodies National level - MoRD Regional level - AoKK	MoEF, General Directorate of State Hydraulic Works – GDSHW Municipalities, Water Supply and Sewerage Administrations	MoEP SCoWT Municipal water utilities
Monitoring of • surface waters including: o bathing waters • groundwaters • water bodies/ resources intended for human consumption • pollution discharge • air emmissions	REI, & MoH MoRD, WSC & Municipalities REI	MEPNR MoHSWL + Local Governments MEPNR MoHSWL	NAAR +ICIM+ IRCM NAAR + MoH NAAR + Local EPA's MoH NAAR + Local EPA's ICIM + Regional & Local EPA's	Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET) FEIACS & territorial bodies MoNR through FAWR & its territorial bodies MoH and its territorial bodies	MoEF, MoH, MoA, GDSHW MoEF, MoH, GDSHW +Municipalities, MoH, WSSA MoEF, MoH, Municipalities	SCWM,MoEP,SHMS,SEI MoH, SES SCWM,MoEP MoEP, SCWM,RDEP,SEI MoEP,SHMS

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Control and enforcement	RBMD, MoE, MoRD,MoEW	MEPNR MoF , MoED	NAAR MoTCT&Municipalities	MoNR - FAWR , FSNRM& territorial bodies, FEIACS & territorial bodies AoKK	MoEF, Municipalities + WSSA, GDoSHW	MoEP/SES/RDEP/SEI/SEIBSAS Municipalities
Regime/Registration of Pesticides and Agrochemicals	MAF, Regional MAF Offices	Ministry of Agriculture, MEPNR	Ministry of Agriculture, Forests and Rural Development	Ministry of Agriculture	Ministry of Agriculture	MA/UP/CMU
Identification of sensitive and less sensitive areas	MOEW integrated with all other cited institutions, depending on the specific case	Ministry of Agriculture, MEPNR	MEWM		Ministry of Environment and Forestry	MEP
Chemical pollution – originating from sea						
Formulation of laws/regulations for shipping activities, including contingency planning	MT, Executive Agency "Port Authorities" (EAPA) Executive Agency "Sea Administration" (EASA)	Ministry of Economic Development (MoED), Parliament	MoTCT	Ministry of Transport (MoT)	Undersecretariat for Maritime Affairs (UMA)	UP MoTC MoEP
Implementation of Contingency plans on pollution from tankers and/or accidents on sea	MT, EAPA, EASA	Port Administration, MoED	MoTCT, Romanian Naval Authority (RNA)	MoT	MoEF, UMA, General Directorate of Coastal Safety and Salvage Administration (GDoCSSA), Metropolitan Municipalities(depending on the scale)	Ministry for Emergency Situations (MoES)
Inspection and control on ships and compliance with IMO Regulations regarding ballast waters	MT, EAPA, EASA	Port Administration, MoEPNR	MoTCT, RNA	MoT	MoEF, UMA,	MoTC, SEI, SEIBSAS

Table 6.4 Functions and roles of national institutions dealing with the identified transboundary problem of biodiversity changes, including alien species introduction

Role	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
International Conventions/ agreements ratification/signature…	Council of Ministers Ministry of Foreign Affaires - MoFA, Ministry of Environment and Waters - MoEW	Parliament, MoFA Ministry of Environment Protection and Natural Resources - MoEPNR	Parliament, MoFA Ministry of Environment and Water Management - MoEWM, Ministry of Agriculture, Forests and Rural Development - MoAFRD	State Duma Council of Federation MoFA, Ministry of Natural Resources - MoNR	General Assembly Council of Ministers MoFA Ministry of Environment and Forestry - MoEF	Parliament MoFA Ministry of Environmental Protection - MoEP
Formulating national laws, regulations and plans	MoEW Ministry of Agriculture and Forests - MoAF Ministry of Regional Development -MoRD	Parliament (Committee for Environmental Protection and Natural Resources). MoEPNR	MoEWM	*National level*: MoNR *Regional level*: Legislative Assembly of Krasnodar kray	MoEF; State Planning Organization - SPO	MoEP Environmental Committee of Ukrainian Parliament
Development of regional plans and strategies	MoEW MoAF MoRD	Ministry of Economic Development - MoED MoEPNR	MoEWM MoAFRD Ministry of Transport, Constructions and Tourism - MoTCT	Administration of Krasnodar kray (AoKK)	SPO MoEF	MoEP & it's Regional Department of Environmental Protection Regional Administration
Management of Natural Parks/Reserves	MoEW Regional Environmental Inspectorate - REI	MoEPNR	MoEWM	MoNR	MoEF	State Service of Nature Reserves Management - SSNRM
Enforcement	MoEW REI	MoEPNR	MoEWM Environment Guard - EG	MoNR through Federal Agency for Water Resources (FAWR), Federal Service for Nature Resources Management (FSNRM) & its territorial bodies	MoEF	SSNRM

Table 6.5 Functions and roles of existing inter-ministerial coordination bodies

Role/function	Bulgaria	Georgia	Romania	Russian Federation
Consultative	Supreme Consultative Water Council	National Consultative Commission for Integrated Coastal Zone Management		
Consultative/decision – making in the field of water management at basin level	Basin Councils		Basin Committee	Basin Councils
Consultative/decisional (ICZM Plans&programmes, EIA, etc.)			National Committee for Coastal Zone	
WFD Implementation	MoEW, MAF, MRDPW, MEER and MH under Memorandum of Understanding		Interministerial Council of Waters	
Issuance of licenses/permits		Inter-agency Council for Water Use	Inter-ministerial Committee	
Enforcement of the National Action Plan for water protection against the pollution caused by nitrates from agricultural source			Commission (MoWEP, MoAF and MoH)	

6.3 Policy/legal analysis

6.3.1 International legislation and agreements

The Black Sea States' activities in the field of environmental protection take place under the 'umbrella' of the Convention on the Protection of the Black Sea against Pollution, adopted in 1992 at Bucharest (1992 Bucharest Convention), which together with the 1996 Black Sea Strategic Action Plan and additional protocols form the legal basis for regional cooperation.

The 1992 Bucharest Convention is a typical "framework" instrument modelled on similar regional seas agreements adopted in the late 1970s to the early 1990s. Although drafted and adopted approximately at the same time as some 'second generation' regional seas treaties, such as the 1992 Helsinki (Baltic Sea), the 1992 OSPAR (North Sea) and the 1995 Mediterranean conventions, the Black Sea framework in terms of its substance and conceptual approach is reminiscent of the much earlier 'first generation' regional seas regimes.

The 1993 Odessa Declaration was exactly the type of an action-orientated document which was necessary to supplement the general obligations of the 'framework' treaty and established specific and concrete targets and timetables for implementing the objectives of the 1992 Bucharest Convention. However, none of these targets appear to have been accomplished on time. In the same vein, the objectives of the Strategic Action Plan for the Black Sea (BS SAP) adopted in 1996 proved to be too ambitious and had to be amended in 2002. The 2002 Sofia Declaration is imprecise (as compared with the 1993 Odessa

Declaration), since concrete objectives were not developed/included. However, it is still not entirely clear whether the new timeframes have been complied with, as no implementation and compliance review or control system exist at present.

The Black Sea Countries are also bound by international environmental agreements and conventions. A large number of conventions and agreements have signed and ratified by all six countries (Annex 13), providing a good basis for improvement of transboundary cooperation. International/transboundary cooperation is also supported through bi/tri-lateral agreements (Annex 14)

In most of the Black Sea Countries the provisions of the above mentioned legal frameworks are transposed into national strategies/policies/regulations.

6.3.2 National legislation

National strategies/policies/regulations do not specifically address the four priority Black Sea transboundary issues. These are not formally looked upon as priority areas and are handled within broader programme areas, such as:

- Habitat changes and alien species introduction within broader biodiversity programmes.
- Changes in commercial marine living resource within broader biodiversity programmes.
- nutrient over-enrichement/eutrophication among other elements of water management plans/strategies.

As a consequence, there are no dedicated budgetary allocations specifically for the Black Sea transboundary problems and no statistic is available for the total (public, private, domestic and and foreign) capital investments channelled to address each of the problems.

Environmental policies in all six Black Sea Countries make use of the “polluters pays“ principle, based on laws, provisions, plans, procedures, standards to be met and prohibited activities. Also, enforcement powers are assigned to agencies, fines and other penalties are specified, and monitoring is promoted to ensure compliance.

Georgia, the Russian Federation and Ukraine, having once been part of the Soviet Union, have similar legislation. Similarities can be found in terms of environmental regulation which is organized as management of different natural resources such as land, water, forest, biotic and natural resources. Environmental protection has been treated as a separate issue. Since natural resources have not been privatized (initial steps have been made only for land privatization), the management structure has maintained its main features of the state owner control for the use of the resources. In the Russian Federation the special problem that occurred is that natural resources, differentiation of state property and nature management, environmental protection and environmental safety, etc are under the joint jurisdiction of the Russian Federation and the territorial subjects of the Russian Federation (art. 72 of the Constitution).

For Romania and Bulgaria the EU accession process represents the driving force for both adoption and implementation of environmental legislation ensuring/ being in favour to sustainable development. It can be stated that in terms of policy/legal status there is a need for improvement/harmonisation in four of the countries: Ukraine, Russian Federation, Georgia and Turkey. While in Turkey the Process of harmonization with EU policies is on-going and progress is evident under the EU accession process, in Ukraine and Georgia, even though the programmes have been approved and adopted, the socio–economic situation and political instability are slowing implementation down.

Despite the above comments on a lack of problem-specific legislation, an attempt has been made to divide existing national legislation into the four major transboundary problems (Annex 15), together with a table identifying key pieces of over-arching legislation. In addition, sectoral legislation relating to the following four sectoral categories is presented in the same Annex:

- Tourism
- Urban planning
- Agriculture
- Industry and transport

Since the legislation is not issue-specific, and the majority of the immediate and underlying causes of the four major transboundary problems are shared, inevitably many of the individual pieces of legislation overlap. In Annex 15, however, individual pieces of legislation have been assigned, where possible, to individual problems or sectors, to help identify where attention has been focused. Of course, a greater number of individual laws does not necessarily imply greater coverage or attention to a problem than a single, comprehensive piece of stand-alone legislation.

Nevertheless, it appears that reasonably robust legislation exists to cover the four major transboundary problems, albeit that standards/norms for industrial wastewater discharge to sewer require further clarification. The current lack of a basin-wide approach to pollution management in at least three of the countries [Georgia, Russia and Ukraine; Turkey's EU accession talks should shift the emphasis in this country] seriously weakens the ability of regulators to consider the downstream effect on the Black Sea of direct wastewater discharges to rivers.

In terms of sectoral legislation, ICZM-specific legislation appears to have been introduced only in Romania, with IPPC-type legislation only in Romania and Bulgaria. Environmental management in the remaining four countries, could be strengthened by the introduction of similar industry-related legislation, as would the introduction of over-arching Best Agricultural Practice legislation/guidance in Georgia, Russia and Ukraine to help tie-together existing nating national lrgislation and guidance.

6.4 Conclusions

The BSC achievements to date are limited. While both the 1993 Odessa Declaration and the 1996 Strategic Action Plan for the Black Sea (BS SAP) established specific and concrete targets and timetables for implementing the objectives of the 1992 Bucharest Convention, very few of these targets appear to have been accomplished on time. It is also symptomatic that the 2002 Sofia Declaration is devoid of precision (when compared with the 1993 Odessa Declaration) which may indicate the Contracting Parties' unwillingness to set up concrete objectives given their unfortunate previous experience.

The current organizational structure of the BSC is multi layered. There is little accountability within the existing organizational structure. For example, deadlines missed are often further extended and incomplete activities are rolled over to the next period. The resources, both human and financial, required maintaining such a complex organization is neither cost effective nor sustainable.

On the whole, there are two principle conclusions that stem from the legal analysis of the existing regulatory framework established under the 1992 Bucharest Convention and its subsidiary instruments. First, from the point of view of its general adequacy and consistency with current trends in international environmental law-making, the existing legal basis for regional environmental cooperation in the Black Sea is unsatisfactory; it is outdated. The second point, however, is that even in its current form this framework still provides the foundation for more effective regional efforts in combating marine pollution and improving the environmental status of the Sea. Consequently, some immediate improvements in the performance of the BSC could be achieved without radical changes in the existing legal framework.

7. STAKEHOLDER ANALYSIS

7.1 Introduction

A Stakeholder Analysis was conducted in order to determine the priority concerns of stakeholders in the region, and their perceptions and concerns regarding the management of the Black Sea ecosystem. It is important to gauge stakeholder concerns and priorities so that the project can take steps to address these, build on positive trends in opinions and work to introduce new ecologically oriented concepts where appropriate. By empirically measuring stakeholder concerns and perceptions, the project also has a tool for understanding where efforts should be focused to bring about optimal changes in ecosystem management. The Stakeholder Analysis also assists the project to identify potential areas of tension between stakeholder groups that may impact future resource management.

The methodology for this study is outlined in section 2.4 of the TDA. The specific stakeholders and their involvement in the Black Sea ecosystem are outlined in section 3.4.2 of the TDA. The stakeholder analysis is based on quantitative surveys administered throughout the Black Sea region. The findings here are weighted towards slightly the responses in Romania as 110 surveys were collected there where as there were 34 from Bulgaria, 63 from Georgia, 110 from Russia, 35 from Turkey, and 83 from Ukraine. The discrepancy in survey numbers from various countries will be addressed where it is pertinent to the findings.

The most notable findings of this study are that there is a large degree of cohesion among stakeholder groups across the region and across countries as well. The stakeholders appear to be open to increased information about environmental issues and feel that doing so would benefit the Black Sea health. Further, while there seems to be a perceived trade-off between environmental stewardship and economic development, the perceptions did not appear to be so entrenched that they could not be altered with targeted stakeholder education efforts. Stakeholder perceptions about cause and effect relationships, and level of concern for specific issues varied across groups and issues and as expected those issues which are better understood appear to take higher priority. The perceptions of stakeholders are outlined based on survey results, the specific transboundary issues are addressed (Sections 7.4-7.7) and recommendations are presented (Section 7.8).

7.2 Environmental perceptions of stakeholders

Stakeholders were asked about their overall perception of the health of the Black Sea, their economic and professional dependence upon it and their sense of responsibility for the health of the Black Sea. The general consensus among all stakeholders surveyed is that the Black Sea is not healthy. Alternatively, there was not clear agreement on either the dependence upon or responsibility for the Black Sea among all stakeholder groups. This lack of consensus is to be expected as a wide array of stakeholders reflected varying degrees of dependence and responsibility (Figs 7.2 and 7.3).

With regards to the perception about Black Sea health, of all individuals surveyed 33% felt that it was healthy, 61% felt that is was not healthy, and 6% did not know. On a group by group basis, the stakeholders tended to feel that the Black Sea was not healthy or there was division within the groups. Those who felt that it was healthy were Fisheries agencies, social welfare/public health ministry officials, labour ministry officials, the livestock industry, harbour and port administrators and nature preserve staff. In other cases, there was no clear agreement between members of the same stakeholder group (Table 7.1.)

Table 7.1 Stakeholder perceptions of the Black Sea

No / Divided / Yes	Do you think that the Black Sea is healthy?	Are you professionally or economically dependent upon the health of the Black Sea?	Do you consider the health of the Black Sea to be your responsibility?
All surveys combined	No	Divided	Divided
1. Water, Hydro-meteorological Department	Divided	Divided	Divided
2. Environmental Ministry[62]	Divided	Divided	Yes
3. Industry Ministry	No	Divided	Divided
4. Energy Ministry	Divided	No	Divided
5. Economic Ministry	No	Yes	Yes
6. Foreign Affairs Ministry	No	Divided	Yes
7. Defence Ministry	Divided	No	No
8. Internal Affairs Ministry	No	Yes	Divided
9. Agriculture Ministry	Divided	Divided	Yes
10. Fisheries Agencies	Yes	Yes	Yes
11. Social Welfare / Public Health Ministry	Yes	Divided	Divided
12. Labour Ministry	Yes	Divided	Divided
13. Public Administrator/ planning agency	Divided	Divided	Divided
14. Regulator agent official/ Enforcement agent	No	Divided	Yes
15. Shipping Agencies	No	Yes	Yes
16. Parliamentary committees[63]	No	Divided	Yes
17. Inter ministerial Committees/Basin Committees	No	No	Divided
18. Non Governmental Organization	No	Divided	Yes
19. Scientists	No	Yes	Yes
20. Manufacturing industry	No	No	No
21. Agro-industry	Divided	Divided	No
22. Live stock industry	Yes	No	No
23. Shipping industry	Divided	Divided	Divided
24. Fishing industry	No	Yes	Yes
25. Harbour/port administration	Yes	Yes	Yes
26. Regional government official	No	No	Yes
27. District water management official	No	Yes	Yes
28. Environmental Protection Agencies official	No	Divided	Yes
29. Municipal Government	Divided	Yes	Yes
30. Municipal waste manager	No	Yes	Yes
31. Nature reserve staff	Yes	Divided	Yes
32. Community based organization	No	No	No
33. Worker on a state owned farm	No	Divided	Divided
34. Worker on a privately owned farm	No	No	No
35. Fisherman small scale	Divided	Divided	Divided
36. Educator/teacher	No	No	Divided
37. Student	No	Divided	Divided
38. Public health care provider	No	No	Divided
39. Member of coastal community	No	Divided	Divided
40. Tourism/Recreation industry	No	Yes	Divided
41. Press and media	No	No	Yes
42. International Funding institutions.	No	No	Divided

[62] Natural Resources, Ecology, Water or Environmental Ministry
[63] Parliamentary committees for environmental protection

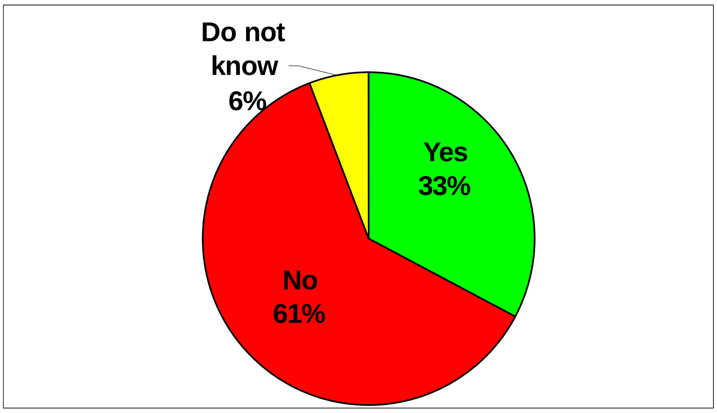


Figure 7.1 Stakeholders' responses to the queston: "is the Black Sea healthy?"

Almost equal portions of stakeholders identified themselves as dependent and not dependent on the health of the Black Sea (Fig. 7.2). Most individuals reported an indirect professional or economic dependence on the health of the Black Sea. Within groups this division was more varied within nearly half of the groups showing no clear agreement on this issue, as delineated in Table 7.1. These findings suggest that it may be advisable to raise the profile of the economic importance of the Black Sea health with regard to chemical pollution and possibly biodiversity. Though this link is often difficult to clearly delineate, attention to economic importance of the Black Sea may generate broader support for Black Sea Commission activities.

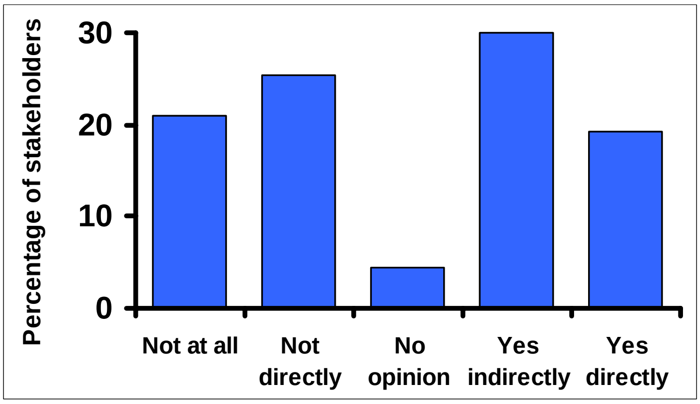


Figure 7.2 Stakeholders' assessment of their dependence on the health of the Black Sea

In comparison to the dependence results, a large portion of respondents reported that they feel either directly or indirectly responsible for the health of the Black Sea. (Fig. 7.3) This may be a result of the polling venue itself, or of those stakeholders selection process, however if verifiable this does bode well for the over all support for the project. In contrast though there was not clear agreement within 40% of stakeholder groups of their overall responsibility for the health of the Black Sea. It should be noted that most groups that feel they are dependent on the health of the Black Sea also feel that they are responsible for it. One very important exception is the tourism and recreation that strongly agreed that they are dependent on the Health of the Black Sea, however they were divided in terms of the responsibility for the health of it. This suggests that there may be a good point for a targeted intervention for the tourism and recreation industry, at least, to help it take steps to avoid negatively impacting the Sea.

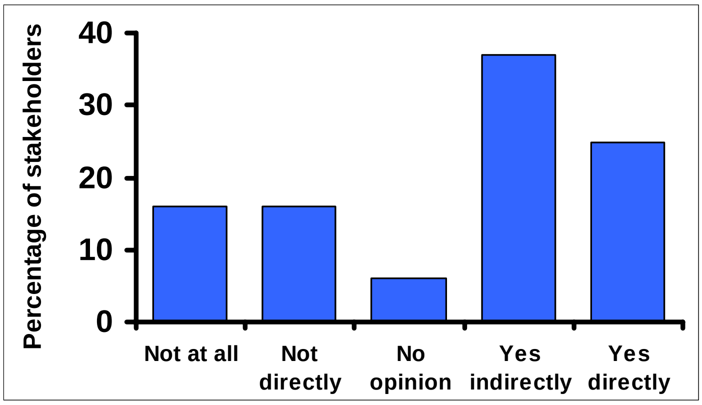


Figure 7.3 **Stakeholders assessment of their responsibility for the health of the Black Sea**

Stakeholders were given a set of statements within the survey and asked to select their level of agreement from: strongly disagree, disagree, neither agree nor disagree, agree, and agree strongly. The responses were examined both as stakeholder groups and individual respondents. They were asked questions pertaining to specific environmental issues, as well as broader concerns impacting environmental management strategies. Responses regarding the perceived trade-off between economic development and environmental health were illuminating, as were responses pertaining to the need for environmental education and support for regional cooperation.

In response to the question of the importance of economic development and environmental protection stakeholders individually indicated that environmental health of the Black Sea is important to them. A significant majority disagreed or disagreed strongly with the statement that economic development now is more important than the environmental health of the Black Sea region (Fig. 7.4). This bodes well for the future, but local opinion (at least) is likely to much more strongly in favour of agreement if economic development substantially increases employment or personal wealth.

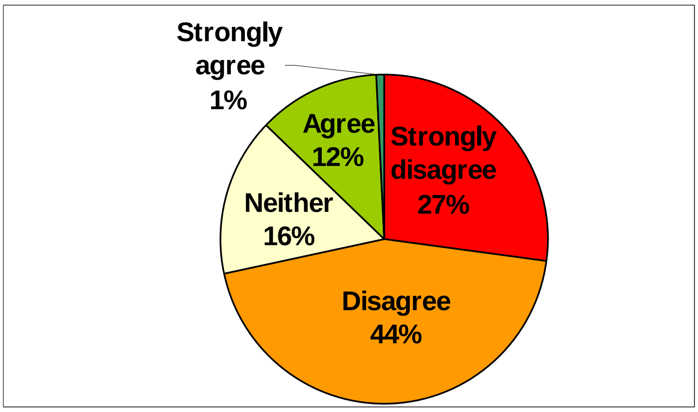


Figure 7.4 **Stakeholders' responses to the statement: "economic development now is more important than the environmental health of the Black Sea region"**

This paradox is refelected in responses to the statement: 'most other people believe that meeting short term economic needs is more important than long term environmental concerns', with 50% of individual respondents agreeing (Fig. 7.5). This suggests that stakeholders may be dubious of the ability to meet economic needs while protecting the ecology/state of health of the Black Sea. This may also suggest that people are more willing to say they believe that other people seem to value economic issues more than environmental issues, rather than admit to this themselves. It is interesting to note that of all stakeholders surveys less than a dozen agreed more strongly with the statement: 'economic development now is more important than environmental health of the Black Sea region', than the statement: 'most other people believe that meeting short term economic needs in more important than long term environmental concerns.' This suggests that people are concerned about the environment individually, but feel that overall there should be stronger levels of support for environmental issues across the region.

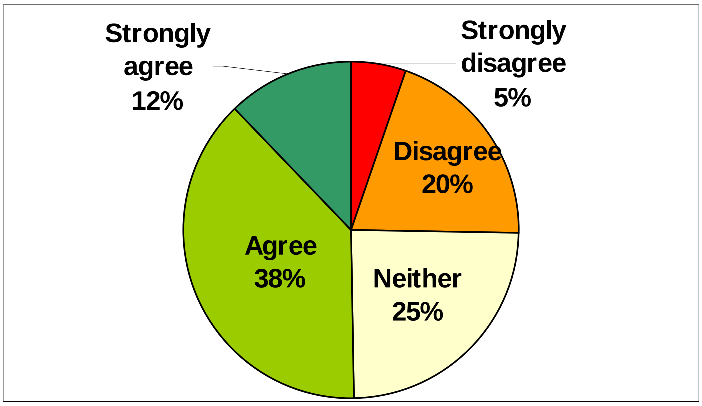


Figure 7.5 Stakeholders' responses to the statement: "most other people believe that meeting short term economic needs is more important than long term environmental concerns"

This supposition is supported by the responses to the statement: 'if people know more about the causes of environmental problems they would want to make changes to improve it'. Individually, 80% of stakeholders were in agreement, with 34% in strong agreement. In comparison, only 6% disagreed and 1% disagreed strongly (Fig. 7.6). This suggests that there is a strong need for environmental education that clearly links cause and effects of environmental problems, and details actions individuals can take to make improvements in conditions. The strong level of agreement spanned all countries throughout the region and all stakeholder groups.

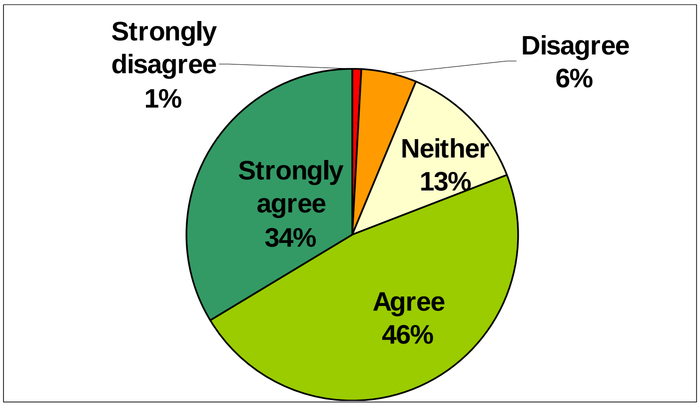


Figure 7.6 Stakeholders' responses to the statement: "if people knew more about the causes of environmental problems they would want to make changes to improve it"

There is strong support for regional cooperation in the Black Sea region. There was very strong agreement from stakeholders in response to the statement: 'regional cooperation of countries around the Black Sea can improve conditions in my community' (Fig. 7.7). While the statement does not refer specifically to environmental issues, the strong support from all stakeholder groups and all countries suggests that there is awareness among stakeholders of the importance of increased cooperation throughout the region, and the benefits it can bring to communities.

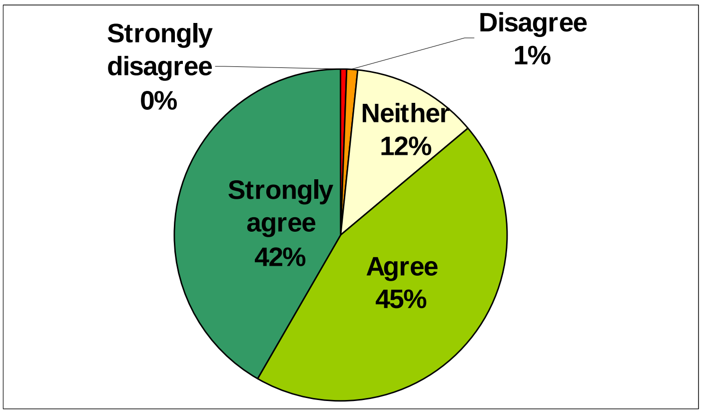


Figure 7.7 Stakeholders' responses to the statement: "regional cooperation of countries around the Black Sea can improve conditions in my community"

The findings suggest that there is a strong foundation for further investments to maintain/improve the status of the Black Sea, based the overall concern and willingness of stakeholders to support such activities. While these portend well for the future, the actual awareness and understanding of cause and effect relationships should be elucidated so that stakeholders have a clearer understanding of the role they play in specific issues. The sections below outline stakeholder priorities and perceptions of the major transboundary issues dealt with in Section 4.

7.3 Priority issues for stakeholder groups

Stakeholders were asked to list priorities as highest to lowest for the four major issues addressed in this TDA. The priorities are presented by all surveys combined, and then by specific groups. Overall the highest priority issue was chemical pollution by a significant margin. All groups listed this as a high to medium priority, with the exceptions of the Environment Ministry stakeholder group and the Agro-industry stakeholder group. Further, only minor difference are found amongst the ranking priorities of different Environmental Ministries respondents. Agro-industry repondents prioritized nutrient over-enrichment as the most important issue, again with limited variation between the rankings provided by individual respondents.

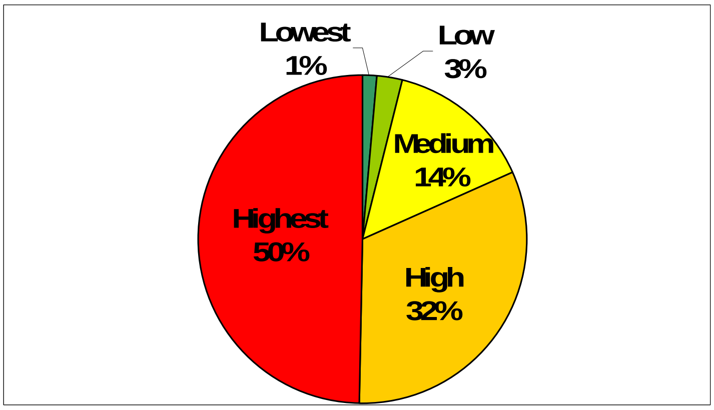


Figure 7.8 Stakeholders' prioritisation of 'pollution' as a transboundary issue

The second highest priority for all stakeholders was decline in fisheries (Figure 7.9). Though there was more variation in this among stakeholders than the concern about pollution, the average stakeholder ranked this as high level concern, though not the top priority. Many groups also listed this as a higher level priority, though Defence Ministry officials, planners, regulators, shipping industry, nature preserve staff, students, and public health care providers all ranked this as a low priority concern. Small scale fishermen rank this as their top priority by a significant margin.

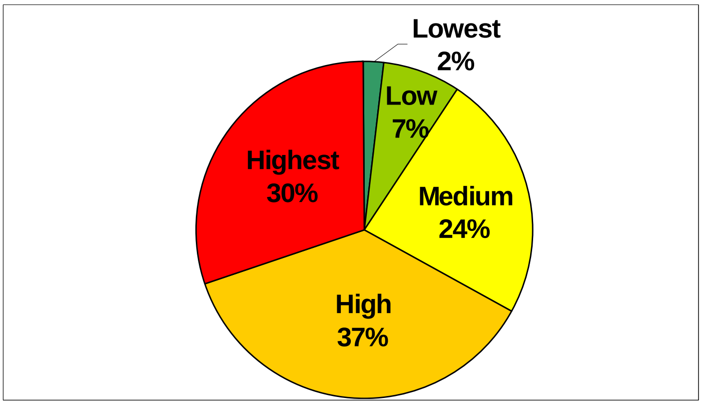


Figure 7.9 Stakeholders' prioritisation of 'decline in fisheries resources' as a transboundary issue

The third ranked priority of all stakeholder groups is the habitat and biodiversity changes (Fig. 7.10). This was ranked at the top priority concern by Defence Ministry officials, planners, regulators, parliamentary committees for environmental protection, and nature reserve staff. These results are as expected for these groups, and may indicate a positive trend for habitat conservation, especially as planners and regulators view this as a high-level concern. In turn, this may indicate a willingness towards tighter regulation of harmful activities in sensitive areas.

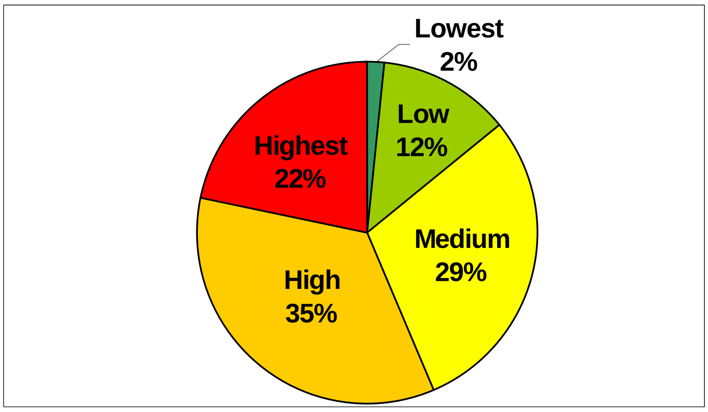


Figure 7.10 Stakeholders' prioritisation of 'changes in biodiversity' as a transboundary issue

The lowest priority concern among all combined stakeholders is nutrient over-enrichment/eutrophication (Fig.7.11). This may be as a result of lower levels of awareness of information or weaker understanding of the implications of this problem for the Black Sea ecosystem. Only the agro-industry and fishery industry ranked this as a top priority concern. The average agro-industry responses were driven by Romanian surveys where this issue may have greater traction than in other countries less immediately impacted by this issue. Agro-industry respondents may have been exposed to awareness raising issues arising from Romanian EU accession.

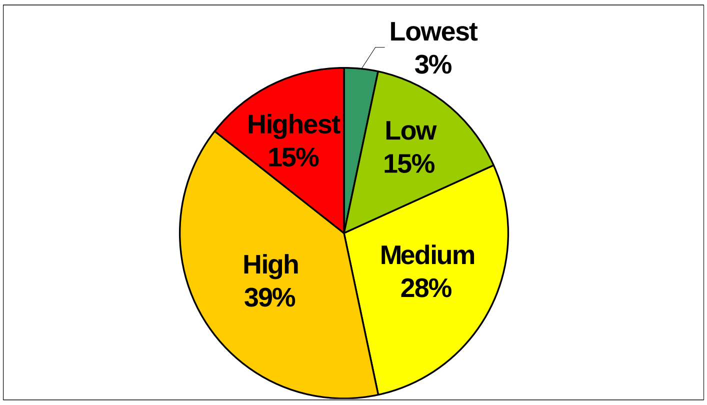


Figure 7.11 Stakeholders' prioritisation of 'eutrophication' as a transboundary issue

The full priority rankings for all surveys combined and by indvidual stakeholder group are presented in Table 7.2.

7.4 Nutrient over-enrichment/eutrophication

Though few stakeholders ranked nutrient over-enrichment as a priority concern, there is a considerable amount of awareness of this as an issue as it impacts the Black Sea, but probably less awareness of the implications. The perceptions of cause and effects of nutrient over-enrichment and eutrophication appear to be based in economic interests generally, with groups who benefit from current status quo advocating a continuation of practices, and those who are impacted by the problems it creates supporting a change. All stakeholder groups expressed an explicit concern about sewage and animal waste in the Black Sea.

Table 7.2 Stakeholder group priorities

1st priority / 2nd priority / 3rd priority / 4th priority	Nutrients	Fisheries	Pollution	Biodiversity
All surveys combined	4th priority	2nd priority	1st priority	3rd priority
1. Water, Hydro-meteorological Department	3rd priority	2nd priority	1st priority	4th priority
2. Environmental Ministry[64]	1st priority	4th priority	2nd priority	1st priority
3. Industry Ministry	3rd priority	4th priority	1st priority	2nd priority
4. Energy Ministry	4th priority	2nd priority	1st priority	3rd priority
5. Economic Ministry	4th priority	2nd priority	1st priority	3rd priority
6. Foreign Affairs Ministry	2nd priority	3rd priority	1st priority	4th priority
7. Defence Ministry	4th priority	2nd priority	1st priority	2nd priority
8. Internal Affairs Ministry	3rd priority	2nd priority	1st priority	4th priority
9. Agriculture Ministry	4th priority	2nd priority	1st priority	3rd priority
10. Fisheries Agencies	4th priority	1st priority	2nd priority	3rd priority
11. Social Welfare / Public Health Ministry	3rd priority	2nd priority	1st priority	4th priority
12. Labour Ministry	4th priority	3rd priority	1st priority	2nd priority
13. Public Administrator/ planning agency	3rd priority	4th priority	2nd priority	1st priority
14. Regulator agent official/ Enforcement agent	3rd priority	4th priority	2nd priority	1st priority
15. Shipping Agencies	4th priority	3rd priority	1st priority	2nd priority
16. Parliamentary committees[65]	4th priority	2nd priority	1st priority	3rd priority
17. Inter ministerial Committees/Basin Committees	4th priority	2nd priority	1st priority	3rd priority
18. Non Governmental Organization	4th priority	3rd priority	1st priority	2nd priority
19. Scientists	4th priority	2nd priority	1st priority	3rd priority
20. Manufacturing industry	2nd priority	3rd priority	1st priority	4th priority
21. Agro-industry	4th priority	1st priority	2nd priority	3rd priority
22. Live stock industry	3rd priority	2nd priority	1st priority	4th priority
23. Shipping industry	4th priority	3rd priority	1st priority	2nd priority
24. Fishing industry	2nd priority	4th priority	1st priority	3rd priority
25. Harbour/port administration	4th priority	3rd priority	1st priority	3rd priority
26. Regional government official	4th priority	2nd priority	1st priority	3rd priority
27. District water management official	1st priority	3rd priority	2nd priority	4th priority
28. Environmental Protection Agencies official	3rd priority	3rd priority	1st priority	2nd priority
29. Municipal Government	3rd priority	2nd priority	1st priority	4th priority
30. Municipal waste manager	4th priority	2nd priority	1st priority	3rd priority
31. Nature reserve staff	3rd priority	4th priority	2nd priority	1st priority
32. Community based organization	4th priority	3rd priority	2nd priority	4th priority
33. Worker on a state owned farm	4th priority	2nd priority	1st priority	3rd priority
34. Worker on a privately owned farm	4th priority	1st priority	3rd priority	3rd priority
35. Fisherman small scale	4th priority	1st priority	2nd priority	3rd priority
36. Educator/teacher	3rd priority	1st priority	2nd priority	4th priority
37. Student	3rd priority	4th priority	2nd priority	2nd priority
38. Public health care provider	2nd priority	4th priority	1st priority	3rd priority
39. Member of coastal community	4th priority	2nd priority	1st priority	3rd priority
40. Tourism/recreation industry	4th priority	2nd priority	1st priority	3rd priority
41. Press and media	3rd priority	2nd priority	1st priority	4th priority
42. International funding institutions	2nd priority	3rd priority	1st priority	4th priority

The perceptions of organic wastes from livestock sources impacting the Black Sea and contributing to eutrophication varied. NGOs and public health care providers strongly agreed that there is an impact. Economic ministry officials, parliamentary committee for environmental protection representatives, district water management, nature reserve staff,

[64] Natural Resources, Ecology, Water or Environmental Ministry
[65] Parliamentary committees for environmental protection

and tourism and recreation industry officials also agreed. There was, however, a division between agricultural ministries, with Romanian and Russian officials agreeing and Bulgarian and Georgian officials disagreeing about the impact of livestock waste on the Black Sea. In the livestock industry Romanian respondents tended to agree while Russians and Bulgarians disagreed. There was disagreement from regional government officials and international funding organizations with regards to pollution from animal farming having a significant impact on the Black Sea. This variation among groups may be a matter of outreach and national priorities, as well as economic interests. In comparison to livestock wastes having impacts, there was overall agreement from all stakeholder groups that municipal waste is a significant problem for the health of the Black Sea.

The perception of other nutrient sources, specifically from agriculture activities appears to be more based in economic issues. In response to the statement: 'it is difficult to enforce current regulations on agro-chemicals use,' all groups agreed with medium to low level agreement that enforcement is difficult.

In contrast, in response to the statement: 'fertilizer use on land causes problems the Black Sea,' there was division within agricultural ministries with Georgian and Bulgarian officials disagreeing, while others agreed strongly. There was also internal division within the agro industry, livestock industry and disagreement from farm worker stakeholder groups in response to this statement. This suggests that the perception of cause and effect relationships between fertilizers and eutrophication should be more clearly delineated for these groups.

When asked if current agricultural practices are sustainable for the environment (Fig. 7.12), most stakeholders did not feel that they were, with strongest dissention from economic ministry officials, environmental protection agents, public health care providers and international funding organizations. Agricultural ministry officials are extremely divided across all countries. However, labour ministry officials and farming industry representatives felt that current practices are not environmentally sustainable, and 30% neither agreed nor disagreed. Only 23% of all stakeholders surveyed agreed that current agricultural practices are sustainable. This suggests that while the groups listed above were more cohesive in their views, there is an overall awareness that agricultural practices are not beneficial to the environment.

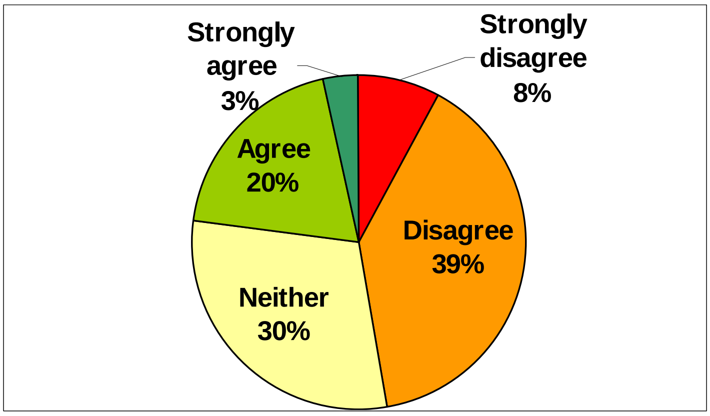


Figure 7.12 Stakeholders' responses to the statement: "current agricultural practices are sustainable for the environment"

This mirrors responses to the perceived need to use agro-chemicals to product needed food. The agricultural ministries, fisheries agencies, fishing industry, manufacturing industry, agro-industry, livestock industry, regional government officials, farm workers, and tourism industry agreed that agrochemicals were necessary, while there was division within the internal affairs ministries, social welfare/public health ministries and nature preserve staff. There was disagreement that agrochemicals are required from public administrators, and parliamentary committees for environmental protection, public health care providers and the press. This may be because these groups have access to different information about alternative farming practices.

Again, farm workers felt that environmentally safe farming practices would limit economic opportunities, while international funding organizations, nature preserve staff, NGOs, parliamentary committees, and labor ministry officials disagreed. There was wide variation among agricultural ministry officials in response to this, with no discernable trend from country to country. There was a trend towards disagreement among all other groups.

This suggests that stakeholders who are most responsible for activities leading to nutrient over-enrichment are either unaware of the impacts or do not feel that it is appropriate to admit being at fault for these problems. It may be advisable to develop strategies to reduce impacts while also increasing awareness and economic viability of alternative practices.

7.5 Decline in commercial fish species/stocks

The decline in commercial fisheries (including specific species and total stocks) is an important issue for many stakeholders. The survey revealed stakeholder group opinions about the abundance of fisheries, causes of overfishing and market demands, and perceptions about legal mechanisms for management. Overall, the divison among stakeholder groups regarding fisheries is largely due to either economic divisions – those who have economic interests in fisheries and those who do not - or information access issues between those who have access to information about fisheries and those who do not. Overcoming this divide may be a worthwhile target for the future.

When asked about the abundance of fish in the Black Sea, and whether there are enough fish for everyone who wants them, there was agreement from the national shipping companies (or administrative or executive agencies) and farm workers. In contrast there was disagreement from agricultural ministry officials, fisheries – national company/administration/executive agencies, social welfare/ public health ministries, labor ministry officials, regulatory agencies, parliamentary committees, NGOs, scientists, environmental protection agents, municipal waste managers, nature preserve staff, small scale fishermen, public health care providers, members of coastal communities, press and media, and international funding institutions. The shipping industry and fishing industry did not have strong views one way or the other. This suggests that those who are economically involved in harvesting Black Sea stocks are either unwilling or unable to suggest that there are not enough fish available, while those who are exposed to alternative information or the impacts of over-fishing have a view of declining fisheries. The exception to this is the small-scale fishermen who are likely to be most directly impacted by declining stocks and therefore they do not agree that there are enough fish available.

Similarly, stakeholders were asked about why over-fishing occurs, with the statement: ‘people take more fish because they need to, not because of greed.’ Those who agreed were from the economic ministry, foreign affairs ministry, agricultural ministry, fisheries - national company/administration/ executive agencies, shipping companies and the agro-industry. There was strong agreement particularly from fisheries industries, small-scale fishermen and residents of coastal communities. Alternatively, there was disagreement from the, internal affairs ministry, public administration planning agency, district water management officials, municipal waste managers, public health care providers, and international funding organizations. It is possible that those who disagreed have had more access to information on overfishing and are sensitive to the increased commercialization of fishing, as well as the challenges of regulating the fisheries, while those that disagree are more sensitive to the immediate demands for access to fish, especially small-scale fishermen and coastal community members.

Nonetheless there was a consensus among all stakeholder groups that steps should be taken to increase fish stocks in the Black Sea. However, in terms of preserving some species, national shipping companies and agencies, the shipping industry and fishing industry representative felt it was more important to meet market demand now, though there was division within each of these groups. All other groups including small scale-fishermen and those from national fishery organizations disagreed, and felt that preserving species was more important. While there was division within groups, overall there was disagreement from 73% the individual stakeholders surveyed that market demand is more important than preserving some species, while only 12% agreed (Fig. 7.13).

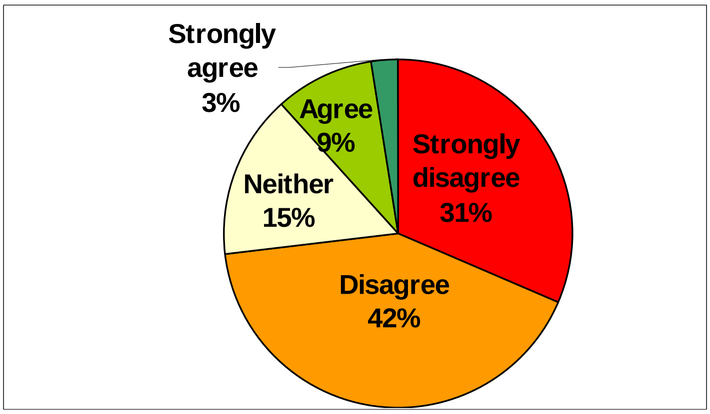


Figure 7.13 Stakeholders' responses to the statement "meeting market demand for fish now is more important than preserving some species"

In terms of regulatory mechanisms, there was agreement among all stakeholders with the statement: 'I support stronger enforcement of fisheries regulations than we currently have.' It should be noted that agreement with this statement by the fisheries industry was notably weaker than others, though was still supportive.

The statement: 'international agreements on fishing in the Black Sea could be unfair to some users' was supported by NGOs and small-scale fishermen, while foreign affairs ministry officials disagreed. This is probably because of a perception among NGOs and small-scale fishermen that their interests would not be addressed by such agreements, which would favour larger commercial interests instead. Alternatively, foreign affairs ministry officials who are often responsible for drafting such agreements, probably feel that it is their responsibility to ensure equitable use whenever possible.

The fisheries concerns were not especially divisive among stakeholder groups. Anticipated responses among various groups emerged, with the possible exception of more acute concern about preserving species and the need for insuring fair access among small scale fishermen. This suggests that it may be important to include small-scale fishmen as a key stakeholder group in the future, as well as to increase opportunities for dialogue among those with intrinsic interests in preserving species and those with economic interests in continuing current fishing practices.

7.6 Chemical pollution (including oil)

The threat of chemical pollution, including oil ranked as the highest priority concern for stakeholders as a whole (Fig. 7.14). The prioritization of this issue suggests that the awareness level of chemical pollution is quite high and the causes are more clearly understood than other issues addressed in Section 4.. Further, the image of oil spills spoiling shores and threatening wildlife has a much more visceral visual impact than declining biodiversity or nutrient enrichment. As a result, people may be inclined to associate environmental degradation with such events, and may believe that the over all condition in the Black Sea is because of pollution, whereas understanding the cause and effect relationships of other sources of environmental/economic degradation are less accessible to the general population. The over all perception of most stakeholder groups surveyed suggests that this perception is common across most stakeholder groups. The individual stakeholders surveyed shows that 81% ranked oil pollution as a high level concern.

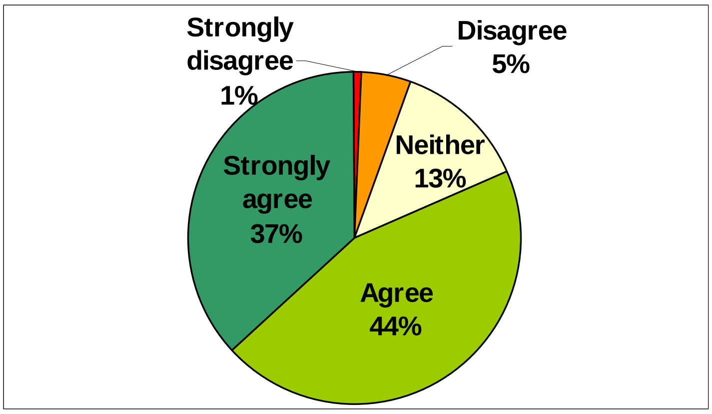


Figure 7.14 Stakeholders' responses to the statement:"oil pollution in the Black Sea is a high level of concern"

All groups agreed with the statement that 'oil pollution in the Black Sea is a high level concern.' This supports earlier findings of the high prioritization of pollution among stakeholder groups reflected in Table 7.2. In terms of oil pollution, it appears that this is the most prevalent perceived cause of pollution of the Black Sea. However, industrial waste is also a concern. All groups disagreed that industrial wastewater treatment facilities work well at the current time, and therefore these are perceived to be polluting the Black Sea waters.

There was a discrepancy between groups regarding the impacts of aging ships and poor maintenance having negative impacts on the Black Sea waters. All groups except those in the national shipping companies/agencies, shipping industry and the fishing industry felt that the perceived deteriorating condition of ships caused problems in the Black Sea. This again would be expected as they would be the two groups most likely to be contributing to these problems. It is likely that these groups would prefer not to perceive themselves as responsible for negative impacts on the ecology of the Black Sea.

In comparison, all stakeholder groups agreed that if new technologies were used there would be less pollution in the Black Sea. This suggests that people are aware that declining conditions and outdated technologies are responsible for the decline in Black Sea conditions (Section 4.4.4). This also reflects a common belief that there are technological fixes to environmental problems.

For methods to improve the conditions of the Black Sea, people consider that government should be the primary means to schieve this. All stakeholder groups agreed that there would be less pollution if enforcement was stronger and fines were higher for polluters, though the manufacturing industry was only in very weak agreement. However, it should be taken into account that individual groups generally are inclined to suggest that other groups are responsible for pollution, rather than themselves. For example all groups agreed that monitoring and enforcement of ship activities should be regulated more strongly, though the harbor and port administrators and national shipping companies/agencies did not support this as enthusiastically as other groups did. Similarly, all groups supported the statement that 'activities in harbors should be strictly regulated' but, again, shipping industry and port and harbor administers did not agree with the same level of support as other groups.

This trend is also reflected in the issues pertaining to nutrient loading. It suggests that it will be important not to assign blame to particular groups, but to target activities towards helping them to shift their current practices to more environmentally sustainable approaches.

7.7 Habitat and biodiversity changes (including alien species introduction)

The issue of habitat and biodiversity changes is the third priority concern of all combined stakeholders, after pollution and decline in fisheries. The issue draws more attention from groups who have a degree of expertise in ecological issues or are immediately impacted by the changes which have occurred in recent times. There was a high level agreement over the need to conserve natural conditions; however, there did not appear to be a high level of understanding of the mechanisms that may support this.

With regard to a significant threat to biodiversity changes in the Black Sea – invasive species, stakeholders with access to ecological information and impacted by these were much more familiar with the issue than the broader stakeholder population. In response to the statement: 'new or unfamiliar creatures are in the water of the Black Sea,' those in agreement were from: Natural Resources, Ecology , Water or Environmental Ministry; Fisheries National Company/ Administration/Executive Agencies; Shipping National Company/ Administration/Executive Agencies; Parliamentary committees for environmental protection; NGOs; Scientists; Shipping industry ; Fishing industry; Environmental Protection Agencies official; and Nature reserve staff groups; Fisherman small scale; and, Public health care providers. In contrast those who disagreed with this statement were from International Funding Institutions and the Tourism/Recreation industry. This disagreement may be because a lack of access to information, or the perception that their economic livelihood could be impacted, in the case of tourism/recreation industry representatives.

In contrast, all groups agreed with the statement: 'I no longer see some animals in and around the Black Sea which were there 20 years ago.' Yet again, those with access to more ecological information agreed more strongly.

Is terms of habitat conservation there was a discrepancy between stakeholder groups that again mirrored the trends noted above. In response to the statement: ‘oastal development is good for the Black Sea environment,’ there was strong agreement from the economic ministry, industry ministry stakeholder groups. In contrast, National fisheries companies/agencies, regulator agent official/ Enforcement agent, NGO, shipping industry, Environmental Protection Agencies official, Nature reserve staff, Fisherman small-scale, Public health care provider, Press and media, and International Funding Institution Stakeholder groups disagreed strongly. Yet, in response to the statement: ‘the tourism industry needs a clean environment to be profitable,’ all groups agreed strongly.

The protection of habitats and conservation of biodiversity appears to be an issue of importance to groups that are invested in ecosytemic approaches to environmental management, or who have access to scientific information, in comparison to those groups who are less informed and less likely to be directly impacted by these changes. It may be advantageous to increase information flow to these groups, increasing the relevance of habitat protection and biodiversity conservation to non-specialists groups. There are initial signs that groups are moving in this direction but educational efforts should be fostered where possible, especially to stakeholder groups mediating these changes.

7.8 Summary and preliminary recommendations

In summary, the stakeholder analysis demonstrates two very important issues: first, that overall stakeholders feel a level of connection to the health of the Black Sea that should be nurtured through increasing awareness of causes and effects of environmental issues; and second, that stakeholder groups tend to be divided along economic interests when it comes to a perceived tradeoff between economic and environmental priorities. These two major findings suggest that a strategy of stakeholder involvement that focuses on education and awareness specific to individual stakeholder groups, in combination with increasing the awareness the economic benefits of environmental stewardship should be considered for future activities in the Black Sea. Stakeholder appear to be ready and willing to accept the information, and over all they appear to willing to consider alternative practices, if these are presented in a clear and logic manner that will not significantly hamper their economic conditions. Specific actions may include the following recommendations:

- Develop focused stakeholder involvement strategies for livestock industry and port and harbor administrators to help them recognize and remedy actions that adversely impact the Black Sea ecosystem.
- Target activities towards helping groups to adjust their current practices to more environmentally sustainable approaches, in all areas and issues.
- Increase outreach efforts that emphasize the importance of biodiversity and habitat conservation.
- Target efforts to inform stakeholder groupss about nutrient loading and eutrophication, and provide alternative approaches to current waste water and nutrient management practices.
- Develop an outreach programme that includes stakeholders from all fisheries sectors to take steps towards addressing the causes of over-fishing.
- Develop targeted interventions for the tourism and recreation industry to help it to take steps to avoid negatively impacting the waters of the Black Sea.

- Develop an outreach component for the BS Commission that links the economic well-being of the region with the health of the Black Sea.

8. CONCLUSIONS AND NEXT STEPS

8.1 Conclusions

- The four transboundary problems of nutrient-enrichment, changes in marine living resources, chemical pollution and biodiversity/habitats change are all very closely linked by the immediate and underlying causes.
- The Danube is clearly the single largest source of entry of both freshwater and pollutants to the Black Sea. Close cooperation between the ICPDR and the BSC is central to tackling the transboundary problems of the Sea.
- River pollution loads far exceed those of direct municipal/industrial sources.
- Available data suggest that atmospheric deposition could be an entry pathway for a similar load of nitrogen to that transported by rivers. However, there is considerable uncertainty over this assessment.
- Considerable progress has been made since the 1996 TDA was produced (e.g. the reduction of river-borne nutrient loads by some 30%), but environmental improvements have primarily been brought about by a collapse in agricultural productivity and a decline in manufacturing industry, rather than direct government interventions.
- However, the Sea is slow to respond to changes in nutrient (and other pollutant) loads. It will be many years before the reduced river loads are likely to be reflected in the Sea itself.
- Indicators suggest that a regional decline in the agricultural sector appears to have 'bottomed-out'. The sector is in a weak state, but is still a major employer in all countries. Agricultural polices need to be strengthened (and legislation enforced) to ensure that as the sector recovers, pollutant emissions can be more effectively managed.
- In terms of nutrient pollution, livestock farming probably represents a higher priority to tackle than arable farming. Nutrients need to be applied to land when crops are able to utilise them, so over-winter storage facilities for livestock manure/slurry is essential if this source of nutrients is to be tackled. In effect, this requires farms to have storage facilities for atleast 6 months of manure/slurry production.
- The harvesting of commercial marine living resources appear to have increased, but whether the situation has improved or not since 1996 is really not known. Reported fish landings are now about half of what they were in the 1980s.
- Agreed regional stock assessment methodologies, improved collection of statistics on fish stocks/landings and a regional legally-binding document on fisheries should be viewed as priorities. At a regional level, values for sustainable catches/landings of commercial marine living resources remain unknown.
- Fisheries management presents serious challenges for all countries, but perhaps the greatest challenge will be for Turkey, which has (by far) the largest fishing fleet and greatest number of nationals employed in this industry.
- The emphasis of chemical pollution assessment should be on point source loads and sediment/body burden monitoring within the marine environment. Local investigations are key to understanding sources of pollution.
- It is difficult to assess the scale of chemical pollution within the Sea: extremely high values of some pollutants have been identified, but these tend to be localised. Levels of some pesticides in particular give cause for concern, but much greater attention needs to be paid to quality assurance of POP analyses. The development of

harmonised regional environmental quality standards, emission limit values and a regional priority pollutants list should help provide more focus for what is potentially a difficult and expensive problem to assess/manage.

- There is now an increased risk of pollution from shipping and offshore oil/gas installations. A single large-scale accident could have devastating consequenses for the whole region.
- Good habitat status is a critical to maintaining high levels of biodiversity within the Black Sea. All 5 habitats within the coastal margin ecotones category are considered to be in a critical status in at least one country; both types of benthic pelagic habitat (neritic and open sea) are considered critical in at least one country; and 13 of 37 types of benthic habitat are considered to be critical in at least one country. Those most at risk include neritic water column, coastal lagoon, estuaries/delta and coastal wetlands/saltmarsh habitats. The designation of additional Marine Protected Areas is required to protect these habitats.
- The number of alien species introductions has continued unabated since the original Black Sea TDA was written. Little has been done to tackle the two most important vectors of alien species introduction: shipping and aquaculture.
- Biodiversity, particularly in the NW shelf has improved greatly as the area affected by hypoxic conitions has dramatically reduced. Low dissolved oxygen conditions still remain a potential problem in parts of the NW shelf, but hypoxic events are now less severe and less frequent than they once were. However, the area in front of the Dniester River remains a cause for concern.
- Biodiversity in the Black Sea is often considered in terms of pre- and post-*Mnemiopsis* invasion time-scales.
- The impacts of the *Beroe ovata* insasion during the 1990s are unclear. Some authorities consider that the *Mnemiopsis* threat to fish catches is very much reduced as a consequence of this [it clearly is, but the extent of reduction is not clear], while others are more cautious. However, the 4-years (or thereabouts) cycle of *Mnemiopsis* biomass/abundance, compared with the strong seasonl growth dynamics of *Beroe* mean that *Mnemiopsis* is very unlikely to be eradicated from the Black Sea; only controlled to some level.
- The original Black Sea SAP was over-ambitious in its aims, due to its focus on point source emissions to the Sea. Of the 50 hot-spots identified for capital investment from the 1996 TDA, only 12 of these investments have been completed and there are either no, or only partial plans to tackle over half of the originally identified priority point sources of pollution.
- The emphasis of the next SAP should be broadened to include diffuse sources of chemical (including nutrient) pollution.
- The issue of cost-effectiveness in tackling transboundary issues needs to be tackled robustly. There are clear governmental costs associated with capital investments required to tackle point sources, but for diffuse source pollution the costs may be borne largely by farmers. For example, the costs for introducing/enforcing an agricultural soil nutrient testing programme could be recouped by farmers from savings made in reduced inorganic fertilser application rates.
- The establishment of the Black Sea Commission and its Permanent Secretariat should have been identified as a “call to arms” by coastal country governments to tackle the transboundary issues faced and caused by the Sea, but national support to the Commission (outside of the fees paid to support the Permanent Secretariat) has been weak in some cases, weakening its progress.

- The Commission is over-burdoned, having too many roles/tasks for the resources (financial and staffing) available to it. Either its priorities need to be re-defined (narrowed) or the resources available to it enhanced.
- One of the Commission's most important tasks should be the collation and analysis of data from the six coastal countries to support national and international investments to tackle the transboundary problems of the Sea.
- The BSIMAP remains underfunded or poorly coordinated at national level by Bulgaria, Georgia and Ukraine at least. The recent (2005) expansion of the Turkish BSIMAP programme represented a substantial step forward, but while the number of Turkish monitoring sites has increased dramatically, the chemical monitoring frequency at these sites remains only twice per year, compared to four times per year in other national BSIMAP programmes. A great deal of coastal water monitoring is clearly undertaken in Russian coastal waters, but relatively little of this national data is made available to the Commission.
- Biological monitoring of the Black Sea, particularly in terms of zoobenthic communities has taken a considerable step forwards with the production of regional methods manuals and pilot monitoring exercises, but a re-assessment of the existing BSIMAP monitoring sites in terms of the selection of appropriate monitoring and reference sites is required if this programme is to be considered truly "integrated".
- National cooperation between different institutes and ministries responsible for Black Sea regulation/monitoring requires improving in most countries, with issues of data ownership restricting access to government-funded data collection exercises.
- EU Accession has provided an enormous stimulus to Bulgarian and Romanian responses to Black Sea environmental issues, and is begining to have a similar effect on Turkish funding/willingness to more effectively tackle some of the Sea's transboundary problems.
- Examples are given throughout this document where reported data are either incompatible, missing or highly innaccurate. These issue need to be addressed as a matter of urgency. National reporting to the Black Sea Commission Permanent Secretariat has been of highly variable quality.
- There is an encouraging willingness amongst stakeholders to help address the problems faced by the Sea. However, information on the transboundary problems, causes and consequences is not being sufficiently well passed on to allow action to be undertaken.

8.2 Next steps

Issues to be considered in the follow-on SAP include:

- Identification/designation of further Black Sea MPAs.
- Agricultural pollution/management (focus initially on livestock farming, but development of a soil nutrient testing programme for arable farming should also be considered)
- Improving regional development of guidance/enforcement of BAT/GAP regulations.
- A re-assessment of pollution hot-spots.
- Further assessment of atmospheric nitrogen loads to the Sea
- A re-assessment of priorities for the BSC Permanent Secretariat.
- Development of a code of practice for data handling for use by the Permanent Secretary and national reporting bodies
- Comparison of natıonal standards for industrial discharges to sewer.

- Harmonısatıon of national emission standards and marine environmental quality standards.
- Development of a regional list of priority pollutants.
- Greater consideration of the Black Sea as a receiving waterbody when setting emission limit values for point source discharges to river.
- Improved actions to tackle the two primary vectors of alien species introduction: shipping and aquaculture.
- Stricter enforcement of existing national environmental legislation.
- Greater focus on outputs of the BSC Advisory Groups.
- Greater emphasis on the development of a regional legally-binding document on fisheries.
- Development of a regionally agreed system to match fishıng effort to stocks (prohibition periods, minimum admissible fish length, etc).
- Harmonisation of methodologies for the collection and collation of fisheries statistics at a regional level
- Establishment of regionally agreed national fishing zones in all Black Sea countries
- Prohibition of non-sustainable fishing technologies (notably dragging and bottom trawling).
- Improving steps to prevent illegal fishing practices.
- Regional harmonisation of ICZM policies and practices.
- Provision of assistance to industrial sectors (including mining enterprises) to develop Environmental Management Systems and practice cleaner production activities
- Regular re-evaluations of major marine systematic (biological) groups in each of the BS countries, using the latest IUCN criteria and guidelines.
- Development of a habitat- and ecosystem- oriented approach to biodiversity management.
- Creation of a Black Sea Red Book of Habitats, Flora and Fauna

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Annex 1: GLOSSARY OF TERMS

Best Available Technology/Technique	The most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and their impact on the environment as a whole.
Biochemical Oxygen Demand (5-day test)	The amount of oxygen used for biochemical oxidation by a unit volume of water at a given temperature over a 5-day period. BOD is an index of the degree of organic pollution in water.
Causal Chain Analysis	An analysis of the immediate, underlying and root causes leading to the generation of an environmental problem.
Commonwealth of Independent States	Countries arising from the break-up of the Soviet Union.
Chemical Oxygen Demand	The quantity of oxygen used in biological and non-biological oxidation of materials in water; a measure of water quality.
Catch Per Unit Effort	The catch in numbers or weight taken for a given amount of fishing effort over time using specific gear.
The Danube and Black Sea Task Force	The DABLAS Task Force comprises a number of representatives from the countries in the region, the International Commission for the Protection of the River Danube (ICPDR), the Black Sea Commission, International Financing Institutions (IFIs), the EC, interested EU Member States, other bilateral donors and other regional/ international organisations with relevant functions. The European Commission DG Environment holds the Secretariat of the Task Force.
Ecological Quality Objective	A desired level of ecological quality (EcoQ) relative to predetermined reference levels.
Ecotoxicological Assessment Criterion	The concentration level of a substance above which concern is indicated, and have been used by OSPAR to identify possible areas of concern and to indicate which substances might be a target for priority action.
Eutrophication	Excessive nutrient concentrations in a waterbody, usually caused by emissions of nutrients (animal waste, fertilizers, sewage) from land, which causes a dense growth of plant life (Phytoplankton and benthic macrophytes/macroalgae). The decomposition of the plants depletes the supply of oxygen, leading to the death of animal life;
Good Agricultural Practice	The way products should be used according to the statutory conditions of approval, which are stated on the label.
Gross Domestic Product	An estimate of the total money value of all the final goods and services produced in a given one-year period using the factors of production located within a particular country's border.

Goss Domestic Product, Value Added	Value added is defined as gross output minus intermediate consumption and equals the sum of employee compensation, net operating surplus and depreciation of capital assets. The shares of each sector are calculated by dividing the value added in each sector by total value added. Total value added is less than GDP because it excludes value-added tax (VAT) and similar product taxes.
Gross National Income *per capita*	GNI *per capita* (formerly GNP *per capita*) is the gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. GNI, calculated in national currency, is usually converted to U.S. dollars at official exchange rates for comparisons across economies, although an alternative rate is used when the official exchange rate is judged to diverge by an exceptionally large margin from the rate actually applied in international transactions. To smooth fluctuations in prices and exchange rates, a special Atlas method of conversion is used by the World Bank.
Integrated Coastal Zone Management	Integrated coastal zone management (ICZM) is a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. It covers the full cycle of information collection, planning (in its broadest sense), decision making, management and monitoring of implementation. ICZM uses the informed participation and cooperation of all stakeholders to assess the societal goals in a given coastal area, and to take actions towards meeting these objectives. ICZM seeks, over the long-term, to balance environmental, economic, social, cultural and recreational objectives, all within the limits set by natural dynamics. 'Integrated' in ICZM refers to the integration of objectives and also to the integration of the many instruments needed to meet these objectives. It means integration of all relevant policy areas, sectors, and levels of administration. It means integration of the terrestrial and marine components of the target territory, in both time and space.
Marine Protected Area	An area of sea (or coast) especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.
Neritic	Strictly: of or relating to the region of the sea over the continental shelf which is less than 200 meteres deep. However, in the Black Sea the depth limit refers only to oxygenated surface waters (typically 120-150 m deep)
Pelagic	The pelagic zone of the Sea begins at the low tide mark and includes the entire water column

Polycyclic Aromatic Hydrocarbon	Polycyclic aromatic hydrocarbons are a very large number of naturally occurring and man-made chemicals. The pure compounds are white or yellowish crystalline solids. They are insoluble in water but dissolve readily in fats and oils. Well-known PAHs include the compounds benzo[a]pyrene, fluoranthene, naphthaline and anthracene.
Poly-chlorinated biphenyl	PCBs are mixtures of 209 different chemicals (cogeners) that come in various forms including oily liquids, solids and hard resins. PCBs are organochlorines that were manufactured until the mid-1980s, after which they were banned due to their toxicity and persistence. PCBs have been widely used as insulators in electrical equipment. They have also been used in the production of hydraulic fluids, lubricants, inks, adhesives and insecticides. They are still found in old electrical equipment and releases into the environment continue from landfills. PCBs are very persistent in the environment, taking years to degrade. They are fat-soluble and bioaccumulate in the tissues of animals. PCBs have become worldwide pollutants due to long-distance transport on air currents. Exposure to PCBs can permanently damage the nervous, reproductive and immune systems of the human body. PCBs are known carcinogens and have been linked with the development of various forms of cancer including skin and liver. In mammals, PCBs are passed via the placenta to developing young in the womb and via breast milk to newborn babies. The disposal of wastes containing PCBs is regulated by the Basel Convention.
Persistent Organic Pollutant	Persistant Organic Pollutants (POPs) are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel. Such pollutants include toxic chemicals like DDT, Chlordane, and Endrin, Dioxins and Furans, among many others. The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). In implementing the Convention, governments agree to take measures to eliminate or reduce the release of POPs into the environment.
Strategic Action Programme	A regional strategic programme of measures designed to tackle the major environmental problems of a transboundary waterbody.

Sliding BOD	The measurement of BOD_5 relies upon biological (bacterial) uptake of oxygen. However, if toxicants are present at high levels in a water sample, they suppress the rate of growth of bacteria, so that over a 5-day period of time, oxygen consumption by the bacteria is reduced. If the original (contaminated) water sample is diluted with "pure" water, the concentrations of toxins is reduced, so the growth of bacteria is less inhibited. Thus, samples with a lower concentration of biodegradable organic matter, can demonstrate higher BOD5 levels if toxic substances are present. This phenomenon is known as sliding BOD.
Transboundary Diagnostic Analysis	A Transboundary Diagnostic Analysis (TDA) is a scientific and technical assessment, through which the water-related environmental issues and problems of a region are identified and quantified, their causes analysed and their impacts, both environmental and economic, assessed. The analysis involves an identification of causes and impacts at national, regional and (sometimes) global levels, and the socio-economic, political and institutional context within which they occur. The identification of causes can specify sources, locations, and sectors.
Total Organic Carbon	All of the organic (carbon-containing) substances in natural waters and sediments may be termed TOC. There are many natural and man-made substances that all contribute to TOC. TOC is partly broken down by micro-organisms, in the process consuming oxygen. At high TOC concentrations, so much oxygen in the water may be used up that there is not enough to support fish and other aquatic animals, which then die.

Annex 2: ABBREVIATIONS AND ACRONYMS

1,2-DCE	1,2-Dichloroethylene
ICZM	Integrated Coastal Zone Management
AoKK	Assembly of Krasnodar Kray
BAP	Best Agricultural Practice
BAT	Best Available Technology/Technique
BOD_5	Biochemical Oxygen Demand (5-day test)
BS	Black Sea
BSC	Black Sea Commission
BSERP	UNDP/GEF Black Sea ecosystem recovery project
BSIMAP	Black Sea İntegrated Monitoring and Assessment Programme
BWM Convention	International Convention for the Control and Management of Ships' Ballast Water
CCA	Causal Chain Analysis
CIL	Cold Intermediate Layer
CIS	Commonwealth of Independent States
CITES	Convention on İnternational Trade in Endangered Species of wild flora and fauna
CMU	Cabinet of Ministers of Ukraine
COD	Chemical Oxygen Demand
CP	Contracting Party
CPUE	Catch Per Unit Effort
DABLAS	The Danube and Black Sea Task Force
DDT	Dichloro-Diphenyl-Trichloroethane
DIN	Dissolved Inorganic Nitrogen
EAC	Ecotoxicological Assessment Criterion
EAF	Executive Agency on Fisheries
EAPA	Executive Agency "Port Authorities"
EC	European Commission
EcoQO	Ecological Quality Objective
EEA	European Environment Agency
EEZ	Economic Exclusive Zone
EPA	Environmental Protection Agency
EU	European Union
FAWR	Federal Agency for Water Resources
FEIACS	Federal Environmental, Industrial and Atomic Control Service
FSNRM	Federal Service for Natural Resources Management
GAP	Good Agricultural Practice
GDoSHW/GDSHW	General Directorate of State Hydraulic Works
GDP	Gross Domestic Product
GEF	Global Environment Facility
GNI *per capita*	Gross National Income *per capita*
HCB	Hexachlorobenzene
HCH	Hexachlorocyclohexane
HELCOM	Helsinki Commission (Baltic Sea)
ICIM	Environmental Engineering Research Institute
ICPDR	International Commission for the Protection of the Danube River
IFI	International Financial Institution
IPPC	Integrated Pollution Prevention and Control

IRCM	Institutul Roman de Cercetari Marine (National Institute for Marine Research and Development "Grigore Antipa" - IRCM)
IUCN	International Union for Conservation of nature and Natural Resources
IW	Inland Waters
MEP	Ministry of Environmental Protection
MLR	(Commercial) Marine Living Resources
MoA	Ministry of Agriculture
MoAF	Ministry of Agriculture and Forests
MoAFRD	Ministry of Agriculture, Forests and Rural Development
MoE	Ministry of the Environment
MoEF	Ministry of Environment and Forests
MoEP	Ministry of Environmental Protection
MoEPNR/MEPNR	Ministry of Environment Protection and Natural Resources
MoEW	Ministry of Environment and Water
MoEWM	Ministry of Environment and Water Management
MoFA	Ministry of Foreign Affairs
MoH	Ministry of Health
MoNR	Ministry of Natural Resources
MoRD/MRD	Ministry of Rural Development
MoT/MT	Ministry of Transport
MoTC	Ministry of Transport and Comunications
MoTCT	Ministry of Transport, Construction and Tourism
MUN	Municipalities
MPA	Marine Protected Area
NAAR	National Adninistration "Apele Romane"
NGO	Non-Governmental Organisation
NW	North-West
OSPAR	Oslo and Paris Commission (North-East Atlantic)
PAH	Poly-Aromatic Hydrocarbon
PCB	Poly-chlorinated biphenyl
PIU	Project Implementation Unit (of the BSERP)
PLC	Pollution Load Compilation
POP	Persistent Organic Pollutant
PS	Permanent Secretariat
QUASIMEME	Quality Assurance of Information for Marine Environmental Monitoring in Europe
RBMD	River Basin Management Directorate
RDEP	Regional Department for Environmental Protection
REI	Regional Environment Inspectorate
RID	Riverine Inputs and Direct Discharges
SAP	Strategic Action Programme
SAR images	Synthetic Aperture RADAR (RAdio Detection And Ranging) images
SCLR	State Committee for Land Resources
SCUBA	Self-Contained Underwater Breathing Apparatus
SCWM	State Control Water Management
SEI	State Ecological Inspection
SEIBSAS	State Ecological Inspection for the Black Sea and Azov Sea
SES	Sanitary and Epidemiology Service of Ministry of Health
SHMS	State Hydro-Meteorological Service
SPO	State Planning Organization

TDA	Transboundary Diagnostic Analysis
TNMN	Trans-national monitoring network
TOC	Total Organic Carbon
TTT	Technical Task Team
UMA	Undersecretariat of Maritime Affairs
UNDP	United Nations Development Programme
UP	Ukrainian Parliament
USD	United States Dollars
UWWT	Urban Waste Water Treatment
WFD	Water Framework Directive
WSC	Water & Sewerage Companies
WSSA	Water Supply and Sewerage Admisnistrations
WWTP	Waste Water Treatment Plant

Annex 3: LIST OF CONTRIBUTING SPECIALISTS

Name	Country/ affliation	E-mail address	Main area(s) of contribution
Abaza, Valeria	Romania	abaza@alpha.rmri.ro	Habitat loss/ biodiversity
Akkoyunlu, Atilla	Turkey	Akkoyun@boun.edu.tr	Pollution loads
Aydin, Ali	Turkey	afaydin@ins.itu.edu.tr afaydin@itu.edu.tr afaydin@ttnet.net.tr	Stakeholders, governance and socio–economic analysis
Bloxham, Martin	International Consultant	martin.bloxham@btconnect.com	TDA process, tutoring and editing
Buachidze, Nugzar	Georgia	emc.buachidze@yahoo.com	Pollution assessment
Citil, Ercan	BSERP	ecitil@superonline.com	Regional physical and geographical characteristics
David, Madalina	Romania	madalinadina@yahoo.com	Pollution loads
Duzgunes, Ertug	Turkey	ertug@ktu.edu.tr erduz@excite.com	Marine living resources
Galabov, Konstantin	Bulgaria	krgalabov@interbgc.com kgalabov@techno-link.com	Stakeholders, governance and socio–economic analysis
Garlitska, Lesya	Ukraine	garlitska@gmail.com garlitska@farlep.net	Habitat loss/ biodiversity
Gurel, Melike	Turkey	mgurel@ins.itu.edu.tr	Causal chain analysis
Iliev, Kiril	BSC Permanent Secretariat	kiliev@blacksea-commission.org	GIS presentation of results
Islam, Oana	Romania	otortolea@yahoo.com	Stakeholders, governance and socio–economic analysis
Komakhidze, Akaki	Georgia	wefri@gol.ge	Marine living resources
Komorin, Victor	Ukraine	vkomorin@mail.ru vnkomorin@yahoo.com	Pollution assessment
Korshenko, Alexander	Russian Federation	korshenko@mail.ru	Pollution assessment
Kresin, Vladimir	Ukraine	morlab@vk.kh.ua morlab@ukr.net	Pollution loads
Kudelya, Sergei	Russian Federation	skudelya@yamdex.ru	Web-based applications
Lagidze, Tengiz	Georgia	laghidzeana@hotmail.com	Causal chain analysis
Lipan, Iozefina	BSERP	jlipan@bserp.org	Contracting, governance, pollution and hot-spots analysis
Machavariani, Merab	Georgia	biodiv@caucasus.net	Habitat loss/ biodiversity
Makarova, Mariam	Georgia	waterdept_mm@yahoo.com	Pollution loads
Matthews, Mary	International Consultant	mary.matthews@tethysconsultants.com	Stakeholders and socio-economic analysis
Micu, Dragos	Romania	ddrraaggoossmm@yahoo.com	Habitat loss/

Name	Country/ affliation	E-mail address	Main area(s) of contribution
		dragos.micu@gmail.com	biodiversity
Mihail, Otilia	Romania	otilia.mihail@mmediu.ro	Pollution assessment
Mihneva, Vesselina	Bulgaria	vvmihneva@yahoo.com	Causal chain analysis
Mutlu, Erhan	Turkey	mutlu@ims.metu.edu.tr	Pollution assessment
Nenov, Valentin	Bulgaria	vnenov@btu.bg	Pollution loads
Nicolaev, Simion	Romania	nicolaev@alpha.rmri.ro	Marine living resources
Oros, Andra	Romania	andra@alpha.rmri.ro	Pollution loads
Panayotova, Marina	Bulgaria	mpanayotova@io-bas.bg	Habitat loss/ biodiversity
Parr, Bill	BSERP	bill@bserp.org	Eutrophication, marine living resources, chemical pollution and hot-spots analysis
Perelet, Renat	Russian Federation	renat@perelet.msk.ru	Stakeholders, governance and socio–economic analysis
Pisotsky, Victor	Ukraine	vpisotskiy@yahoo.com	Stakeholders, governance and socio–economic analysis
Radu, Gheorghe	Romania	gpr@alpha.rmri.ro	Marine living resources
Raykov, Violin	Bulgaria	vio_raykov@yahoo.com	Marine living resources
Sharabidze, Merab	Georgia	msharabidze@yahoo.com	Stakeholders, governance and socio–economic analysis
Shlyakhov, Vladislav	Ukraine	fish@kerch.com.ua	Marine living resources
Shtereva, Galina	Bulgaria	chem@io-bas.bg	Pollution assessment
Stanica, Adrian	Romania	adrian_stanica@yahoo.com	Causal chain analysis
Stolberg, Felix	Ukraine	stolberg@kharkov.ua	Causal chain analysis
Todorova, Valentina	Bulgaria	vtodorova@io-bas.bg	Habitat loss/ biodiversity
Uysal, Irfan	Turkey	iruysal@yahoo.com	Habitat loss/ biodiversity
Volovik, Stanislav	Russian Federation	stanıslavvolovık@maıl.ru	Marine living resources
Volovik, Yegor	BSERP	yevolovik@bserp.org	Web-based applications
Voronina, Lyudmila	Russian Federation	idpo@kubsu.ru	Socio–economic and stakeholders analysis
Yarmak, Leonid	Russia	iczm@mail.ru	Pollution loads and causal chain analysis
Zhuravleva, Elena	Russian Federation	idpo@kubsu.ru	Governance analysis

Annex 4: MAIN BLACK SEA HABITATS AND CRITICAL HABITATS AT NATIONAL LEVEL

Black Sea Habitats	National habitats: X – present, CR – critical					
	BU	GE	RO	RU	TU	UA
Coastal margin ecotones						
1. Sedimentary shores	X	CR	X	X	X	X
2. Rocky shores	X	CR	X	X	X	X
3. Coastal brackish/saline lagoons	CR	CR	CR		CR	X
4. Estuaries and deltas	X	CR	CR		CR	CR
5. Wetlands and saltmarshes	CR	CR	X		CR	CR
Pelagic habitats (water column)						
1. Neritic	CR	CR	CR	X	X	CR
2. Open sea	X	CR	X	X	CR	X
Benthic habitats						
1. Supralittoral rock						
1.1 Association of *Littorina neritoides*, *Lygia italica* and *Tylos laeillei* on exposed or moderately exposed supralittoral rock	X				X	X
1.2 *Chthamalus stellatus* on exposed supralittoral rock	X				X	X
2. Supralittoral sand						
2.1 Taliid amphipods in decomposing seaweed on the sand-line	X		X	X		X
3. Mediolittoral rock						
3.1 Mussels and/or barnacles on very/moderately exposed mediolittoral rock	X	CR	X		X	X
3.2 *Enteromorpha* spp. Minor development of *Ceramium*, *Cladophora*, *Coralina*, *Porphyra*	X		X	X	X	X
4. Mediolittoral sand and muddy sands						
4.1 Coarse sands with *Donacilla cornea* and facultative *Ophelia bicornis*	CR	CR	CR	CR	X	X
4.2 Fine sands with *Pontogammarus maeoticus*	X		X	X		X
5. Sublittoral rock/other hard subsata						

Black Sea Habitats	National habitats: X – present, CR – critical					
	BU	GE	RO	RU	TU	UA
Coastal margin ecotones						
5.1 Facies with *Mytilus galloprovincialis*, on exposed or moderately exposed infralittoral rock – vertical or bedrock	X	X	CR	X	X	X
5.2 Association with *Cystoseira* spp. on exposed or moderately exposed infralittoral bedrock and boulders	CR		CR	X	CR	CR
5.3 Association of green and red seaweeds on moderately exposed or sheltered infralittoral rock *Enteromorpha*, *Ulva* spp., *Porphyra* spp.	X		X	X	X	X
5.4 *Pholas dactylus* in infralittoral soft rock.	X		X			X
5.5 *Peicola litophaga* in infralittoral hard rock	X		X			
5.6 Spirorbid worms on infralittoral rock, *Vermiliopsis infundibulum* biogenic rocks	X	X				X
5.7 Sponge crusts, colonial ascidians and a bryozoan/hydroid turf on moderately exposed to sheltered infralittoral rock	X		X			X
5.8 *Polydora* sp. tubes on infralittoral soft rock	X	X	X			X
5.9 *Ficopomatus enigmaticus* biogenic reefs	X		X			
6. Sublittoral sediments						
6.1 *Donax unculus* in infralittoral coarse sands	X	X	X	CR	X	X
6.2 *Chamelea gallina*, *Lentidium mediterraneum* and *Lucinella divaricata* in shallow clean sands	X	X	X	CR	X	X
6.3 *Lentidium mediterraneum* in shallow fine sands			CR			CR
6.4 *Solen marginatus* in sheltered ifralittoral fine sands	X				X	X
6.5 *Branchiostoma lanceolatum*, *Protodorvillea kefersteini* and *Ophelia limacina* in circalittoral coarse sand with shell gravel	X			X		X

Black Sea Habitats	National habitats: X – present, CR – critical					
	BU	GE	RO	RU	TU	UA
Coastal margin ecotones						
6.6 *Mytilus galloprovincialis* beds on coarse sand with shell gravel	X		X	X	X	X
6.7 *Phyllophora nervosa* on shell gravel			X		X	CR
6.8 *Modiolus adriaticus*, *Aonides paucibranchiata* and *Gouldia minima* in coarse sands	X	X		CR	X	X
6.9 *Mya arenaria* in sands and muddy sands	X		X		X	X
6.10 *Anadara inequivalvis* on sands and muddy sands	X		X	X		X
6.11 *Zostera* beds in lower shore or infralittoral clean or muddy sand	CR		X	X	X	CR
6.12 *Melinna palmata* in infralittoral mud	X	X	X			CR
6.13 *Abra alba*, Cardiidae and *Mytilus* in infralittoral mud	X	X		CR	X	X
6.14 *Mya arenaria* and *Mytilus galloprovincialis* in infralittoral mud			X			X
6.15 *Nephthys* in infralittoral mud			X			X
6.16 *Mytilus galloprovincialis* beds in infralitoral and circalittoral mud	CR	X		X	X	X
6.17 *Spisula subuncata* and *Aricidea claudiae* in circalittoral mud	X			CR	X	X
6.18 *Modiolula phaseolina*, *Amphiura stepanovi* and *Notomastus profundus* in circalittoral mud	X		X	X	X	CR
6.19 *Pachycerianthus solitarius* in circalittoral mud	X		X	X		X
6.20 Periazoic zone	X		X	X		X
6.21 Anoxic H_2S zone with anaerobic sulphate reducing bacteria	X		X	X	X	X

Annex 5: INVENTORY OF AQUATIC AND SEMI-AQUATIC RED LIST SPECIES, ENDANGERED IN AT LEAST ONE COUNTRY AROUND THE BLACK SEA

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Cystoseira barbata (Stackhouse) C.Agardh, 1842		EN				
Cystoseira crinita Duby		RE				
Dictyota dichotoma (Huds.) Lamour			VU			
Sphacelaria saxatilis (Kuck.) Sauv.			VU			
Coccotylus truncatus (Pallas) Wynne & Heine (syn. *Phyllophora brodiaei*)		VU				
Phyllophora crispa (Hudson) P.S.Dixon (syn. *P.nervosa*)		VU				
Phyllophora pseudoceranoides (Gmel.) Newr. & R.Taylor, 1971		CR	EN			
Laurencia hybrida (DC.) Lenorm.			VU			
Nemalion helminthoides (Vell.) Batt.			VU			
Bulbochaete subquadrata Mrozinska - Webb			VU			
Stigeoclonium fasciculare Kutz.			VU			
Chara braunii Gmelin			VU			
Pteridium aquilinum Gled. ex Scop.		RE				
Salvinia natans (L.) All.		LC	VU			
Marsilea quadrifolia L.		EN				
Aldrovanda vesiculosa L.		EN				
Alisma lanceolatum With.		VU				
Apium nodiflorum (L.) Lag.		RE				
Blackstonia acuminata (Koch et Ziz) Domin.		RE				
Cakile maritima euxina Scop.		EN				
Calla palustris L.		RE				
Caltha palustris L.		RE				
Carex melanostachya Bieb. ex Willd.		VU				
Catabrosa aquatica Beauv.		RE				
Centaurea pontica Prodan et E.I.Nyarady		CR				
Cirsium alatum (S.G.Gmelin) Bobrov		VU				
Comarum palustre L.		RE				
Epipactis palustris (L.) Crantz		VU				

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Equisetum fluviatile L.		VU				
Equisetum hyemale L.		RE				
Equisetum palustre L.		VU				
Euphorbia paralias L.		EN				
Limosella aquatica L.		VU				
Peucedanum palustre (L.) Moench		EN				
Potamogeton compressus L.		VU				
Potamogeton pusillus L.		VU				
Potamogeton trichoides Cham. et Schlecht		VU				
Ruppia cirrhosa (Petagna) Grande		EN				
Ruppia maritima L.		EN				
Sagittaria trifolia Willd.		EN				
Trapa natans L.		LC	VU			
Zannichellia palustris L.		VU				
Zostera marina L.		CR				
Zostera noltii Hornem.		CR				
Halichondria panicea (Pallas, 1766)		VU				
Odessia maeotica (Ostroumoff, 1896)		VU	VU			
Gibbula divaricata (Linne, 1758)		CR				
Tricolia pullus (Linne, 1758)		CR				
Epitonium commune (Lamarck, 1822)		CR				
Valvata pulchella Studer, 1820		VU				
Micromelania lincta Milaschewitsch, 1908		VU	NT			
Calyptraea chinensis (Linne, 1758)		VU				
Chrysallida fenestrata (Jeffreys, 1848)		EN				
Ebala pointeli (de Folin, 1868)		CR				
Anisus rotundatus (Poiret, 1801)		VU				
Gyraulus acronicus (Ferrusac, 1807)		VU				
Chlajmaguire@e-solventa.commys glabra (Linne, 1758)		RE				
Ostrea edulis Linne, 1758		CR	VU			
Adacna fragilis Milaschewitsch, 1908		EN				
Hypanis plicata relicta Eichwald, 1829		EN				
Monodacna colorata Eichwald, 1829		EN				
Monodacna pontica Eichwald, 1838		EN				
Unio crassus Philipsson, 1788		VU				

Species	IUCN regional status					
	BG	**RO**	**UA**	**RU**	**GE**	**TR**
Donacilla cornea (Poli, 1795)		CR				
Solen marginatus Pulteney, 1799		CR				
Tellina donacina Linne, 1758		RE				
Tellina fabula Gmelin, 1791		RE				
Gastrana fragilis (Linne, 1758)		EN				
Donax trunculus Linne, 1758		VU				
Pitar rudis (Poli, 1795)		VU				
Irus irus (Linne, 1758)		CR				
Paphia aurea (Gmelin, 1791)		VU				
Petricola lithophaga (Philipsson, 1788)		CR				
Pholas dactylus Linne, 1758		CR				
Teredo navalis Linne, 1758		CR				
Ophelia bicornis Savigny, 1818		RE				
Fadejewobdella quinqueannulata Lukin, 1929			VU			
Hirudo medicinalis Linne, 1758		LC	VU			
Trocheta subviridis Dutrochet, 1817			EN			
Tanymastix stagnalis (Linne, 1758)			EN			
Branchinecta orientalis G. 0. Sars, 1901			EN			
Branchinectella media (Schmankewitsch, 1873)			EN			
Branchinella spinosa (Milne-Edwards, 1840)			EN			
Branchipus schaefferi Fischer, 1834			EN			
Centropages kroyeri pontica (Karawaev, 1895)	EN					
Oithona minuta (Kriczagin, 1873)	EN					
Hippolyte leptocerus (Heller, 1863)		CR				
Lysmata seticaudata (Risso, 1816)		RE				
Philocheras trispinosus (Hailstone, 1835)		RE				
Astacus astacus (Linne, 1758)		CR	NT			
Upogebia pusilla (Petagna, 1792)	LC	LC	EN		-	-
Clibanarius erythropus (Latreille, 1818)		CR				
Polybius navigator (Herbst, 1794)		EN				
Carcinus aestuarii (Nardo, 1847)		EN	EN			

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Xantho poressa (Olivi, 1792)		LC	EN			
Eriphia verrucosa (Forskal, 1785)		NT	EN			
Pilumnus hirtellus (Leach, 1815)		LC	EN			
Brachynotus sexdentatus (Risso, 1827)		CR				
Pachygrapsus marmoratus (Fabricius, 1787)		LC	EN			
Hemimysis anomala G. O. Sars, 1907		LC	EN			
Hemimysis serrata Bacescu, 1938		EN	EN			
Katamysis warpachowskyi G.O.Sars, 1893		LC	EN			
Iphigenella acanthopoda G. 0. Sars, 1896			VU	-	-	-
Iphigenella shablensis (Carausu, 1943)	VU	LC	NT	-	-	-
Chaetogammarus ischnus major (Stebling, 1898)	VU	LC				
Dikerogammarus villosus (Sovinskii, 1894)	VU	LC				
Amphitholina cuniculus (Stebbing, 1874)		EN				
Palingenia longicauda (Olivier, 1791)		RE				
Coenagrion lindeni (Selys, 1840)			EN			
Coenagrion mercuriale (Charpentier, 1840)			EN			
Squalus acanthias Linne, 1758		VU	-			VU
Huso huso (Linne, 1758)		EN	VU			EN
Acipenser gueldenstaedtii Brandt & Ratzenburg, 1833		EN				EN
Acipenser nudiventris Lovetsky,1828		RE	EN			EN
Acipenser ruthenus Linne, 175		CR	VU			
Acipenser stellatus Pallas, 1771		EN				EN
Acipenser sturio Linne, 1758		RE	EN		CR	CR
Salmo labrax Pallas, 1814		EN	EN			
Umbra krameri Walbaum, 1792		VU	VU			
Petroleuciscus borysthenicus (Kessler, 1859)		VU				
Leuciscus idus idus (Linne, 1758)		VU				
Rutilus frisii (Nordmann, 1840)			EN			
Tinca tinca (Linne, 1758)		EN				
Chalcalburnus chalcoides (Guldenstadt, 1772)		CR				
Vimba vimba (Linne, 1758)		VU	EN			

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Barbus barbus barbus (Linne, 1758)		VU	VU			
Carassius carassius (Linne, 1758)		EN				
Misgurnus fossilis (Linne, 1758)		VU				
Belone belone (Linne, 1761)		EN				
Lota lota (Linne, 1758)		VU				
Pungitius platygaster (Kessler, 1859)	CR	LC				
Syngnathus typhle Linne, 1758		VU				
Nerophis ophidion (Linne, 1758)	EN	EN				
Hippocampus guttulatus Cuvier, 1829		NT	EN			
Liza ramado (Risso, 1810)		VU				
Sander marinus (Cuvier, 1828)	EN		EN			
Gymnocephalus schraetser (Linne, 1758)		LC	VU			
Zingel zingel (Linne, 1766)		VU	NT			
Diplodus annularis Linne 1758		RE				
Spicara smaris (Linne, 1758)		EN				
Mullus barbatus ponticus Essipov, 1927		EN				
Pomatomus saltatrix (Linne, 1766)		VU				
Symphodus ocellatus (Forsskal, 1775)	VU	NT				
Symphodus tinca (Linne, 1758)	VU	NT				
Trachinus draco Linne, 1758	CR	VU				
Uranoscopus scaber Linne, 1758	CR	EN				
Aidablennius sphynx (Valenciennes, 1836)	VU	NT				
Coryphoblennius galerita (Linne, 1758)	VU	EN				
Parablennius zvonimiri (Kolombatovic, 1892)		VU				
Salaria pavo (Risso, 1810)	VU	EN				
Ophidion rochei Muller, 1845		VU				
Scomber scombrus Linne, 1758		EN				
Sarda sarda (Bloch, 1793)		CR				

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Thunnus thynnus (Linne, 1758)		EN				
Xiphias gladius Linne, 1758		CR				
Pomatoschistus minutus (Pallas, 1770)	CR	LC				
Knipowitschia cameliae Nalbant & Otel, 1995		CR				
Knipowitschia longecaudata (Kessler, 1877)	EN	NT				
Zosterisessor ophiocephalus (Pallas, 1814)	CR	CR				
Neogobius syrman (Nordmann, 1840)	CR	LC				
Neogobius rjmaguire@e-solventa.comatan (Nordmann, 1840)	VU	VU				
Chromogobius quadrivittatus (Steindachner, 1863)	CR					
Gobius bucchichi Steindachner, 1870	CR					
Gobius cobitis Pallas, 1814	EN					
Proterorhinus marmoratus (Pallas, 1814)	EN	LC				
Benthophiloides brauneri Beling &Iljin, 1927	VU	CR				
Scorpaena porcus Linne, 1758		VU				
Chelidonichthys lucernus (Linne, 1758)		VU	DD			
Platichthys flesus (Linne, 1758)		VU				
Pegusa lascaris (Risso, 1810)		VU				
Bufo calamita Laurenti, 1768			VU			
Emys orbicularis (Linne, 1758)		EN				
Gavia stellata (Pontopiddan, 1763)		EN				
Gavia arctica (Linne, 1758)		VU				
Gavia immer (Brunnich, 1764)		VU				
Tachybaptus ruficollis (Pallas, 1764)		EN				
Podiceps nigricollis Brehm, 1831		EN				
Podiceps auritus (Linne, 1758)		EN				
Podiceps cristatus (Linne, 1758)		EN				
Puffinus yelkouan (Acaerbi, 1827)		VU				
Phalacrocorax pygmaeus (Pallas, 1773)		EN	VU			

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Phalacrocorax aristotelis (Linnaeus, 1761)		DD	VU			
Pelecanus onocrotalus Linne, 1758		EN	VU			
Pelecanus crispus Bruch, 1832		CR	VU			
Ixobrychus minutus (Linne, 1758)		EN				
Nycticorax nycticorax (Linne, 1758)		EN				
Ardeola ralloides (Scopoli, 1769)		EN	VU			
Egretta garzetta (Linne, 1766)		EN				
Egretta alba Linne, 1758		EN				
Ardea cinerea Linne, 1758		EN				
Ardea purpurea Linne, 1766		EN				
Ciconia nigra Linne, 1758		VU	VU			
Plegadis falcinellus (Linne, 1766)		EN	VU			
Platalea leucorodia Linne, 1758		EN	VU			
Anser erythropus (Linne, 1758)		VU				
Branta ruficollis (Pallas, 1769)		EN	VU			
Tadorna ferruginea (Pallas, 1764)		VU	VU			
Tadorna tadorna (Linne, 1758)		EN				
Anas penelope Linne, 1758		EN				
Anas strepera Linne, 1758		EN				
Anas querquedula Linne, 1758		EN				
Netta rufina (Pallas, 1773)		EN				
Aythya nyroca (Guldenstadt, 1770)		EN	VU			
Mergus albellus Linne, 1758		EN				
Mergus serrator Linne, 1758		EN	VU			
Mergus merganser Linne, 1758		EN				
Oxyura leucocephala (Scopoli, 1769)		CR	DD			
Pandion haliaetus (Linne, 1758)		VU				
Rallus aquaticus Savigny, 1809		VU				
Grus grus Linne, 1758		EN	VU			
Anthropoides virgo Linne, 1758		RE	EN			
Haematopus ostralegus (Linne, 1758)		EN	NT			
Himantopus himantopus (Linne, 1758)		EN				
Recurvirostra avosetta (Linne, 1758)		EN				
Charadrius dubius (Scopoli, 1786)		EN				
Charadrius alexandrinus (Linne, 1758)		EN	NT			

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Charadrius hiaticula (Linne, 1758)		EN				
Pluvialis apricaria (Linne, 1758)		VU				
Pluvialis squatarola (Linne, 1758)		EN				
Arenaria interpres Brisson, 1760		VU				
Charadrius morinellus Linne, 1758		CR				
Vanellus vanellus (Linne, 1758)		EN				
Calidris alpina Linne, 1758		EN				
Limicola falcinellus (Pontoppidan, 1763)		EN				
Lymnocryptes minimus (Brunnich, 1764)		EN				
Gallinago media Latham, 1787		EN				
Limosa limosa (Linne, 1758)		EN				
Numenius arquata (Linne, 1758)		EN	VU			
Numenius phaeopus (Linne, 1758)		DD	VU			
Numenius tenuirostris Vieillot, 1817		DD	EN			
Tringa totanus (Linne, 1758)		EN				
Tringa glareola Linne, 1758		EN				
Tringa stagnatilis (Bechstein, 1803)		DD	VU			
Phalaropus lobatus (Linne, 1758)		VU				
Phalaropus fulicarius (Linne, 1758)		VU				
Stercorarius pomarinus (Temminck, 1815)		VU				
Stercorarius parasiticus (Linne, 1758)		VU				
Larus melanocephalus Temminck, 1820		EN				
Larus minutus Pallas, 1776		EN				
Larus genei Breme, 1839		EN				
Larus canus Linne, 1758		EN				
Larus ichthyaetus Pallas, 1773		DD	VU			
Sterna nilotica Gmelin, 1789		EN				
Sterna caspia Pallas, 1770		EN	NT			
Sterna sandvicensis Latham, 1787		EN				
Sterna albifrons Pallas, 1764		EN				
Chlidonias hybridus Pallas, 1811		EN				
Chlidonias niger (Linne, 1758)		EN				
Chlidonias leucopterus (Temminck, 1815)		EN				
Alcedo atthis (Linne, 1758)		EN				
Arvicola amphibius (Linne, 1758)		EN				

Species	IUCN regional status					
	BG	RO	UA	RU	GE	TR
Neomys fodiens (Pennant, 1771)		EN				
Desmana moschata (Linnaeus, 1758)		DD	EN			
Lutra lutra (Linne, 1758)		EN	VU			
Mustela lutreola (Linne, 1761)		EN	VU			
Phocoena phocoena (Linne, 1758)	VU	DD	EN		VU	VU
Delphinus delphis Linne, 1758	VU	EN	DD		LC	
Tursiops truncatus (Montagu, 1821)	VU	EN	NT		DD	
Monachus monachus (Hermann, 1779)	RE	RE	RE			CR

RE = regionally extinct
CR = critically endagered
EN = endangered
VU = vulnerable
NT = near threatened
LC = least concern
DD = data deficient

Annex 6: INVENTORY OF AQUATIC AND SEMI-AQUATIC ALIEN SPECIES INTRODUCED TO THE BLACK SEA AND COASTAL HABITATS

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
Phytoplankton	*Asterionellopsis glacialis* (Castracane) Round 1990	1967	Bacillariophyta	Alien	Unknown	TE	Unknown	Atlantic, Pacific	Zaitsev & Öztürk (2001)
	Chaetoceros diversum var. papilionis Senicheva, 2002	1999	Bacillariophyta	Alien	Unknown	TE	Unknown	Pacific	Aleksandrov et al. (2006)
	Chaetoceros tortissimum Gran, 1900	2001	Bacillariophyta	Alien	Unknown	TE	Unknown	N Europe	Aleksandrov et al. (2006)
	Detonula pumila (Castracane) Gran 1900	1999 (2001)	Bacillariophyta	Alien	Ships	RE	Moderately invasive	cosmopolitan	Prodanov et.al. (2001)
	Lioloma pacificum (Cupp) Hasle, 1996	1999	Bacillariophyta	Alien	Ships	TE	Unknown	Indian Ocean	Zaitsev et al. (2004)
	Pseudosolenia calcar-avis (Schultze) Sundström, 1986	1924	Bacillariophyta	Alien	Ships	PE	Highly invasive	Atlantic, Indo-Pacific	Zaitsev & Öztürk (2001)
	Rhizosolenia setigera Brightwell 1858	1987-1997 (1999)	Bacillariophyta	Alien	Ships	TE	Non-invasive	N Atlantic, Pacific, North Sea, Baltic Sea, Mediterranean	Velikova et al. (1999)
	Scrippsiella trochoidea (Stein) (Loeblich III, 1976)	1999	Bacillariophyta	Alien	Ships	RE	Non-invasive	Atlantic	Cınar et al. (2005)
	Skeletonema subsalsum (A. Cleve) Bethge, 1928	1993	Bacillariophyta	Alien	Unknown	PE	Unknown	European water bodies	Aleksandrov et al. (2006)
	Thalassiosira nordenskioeldii Cleve, 1873	1986	Bacillariophyta	Alien	Unknown	TE	Unknown	N Europe	Zaitsev & Öztürk (2001)
	Alexandrium acatenella (Whed. Et. Kof.), 1985	2001	Dinophyta	Alien	Ships	TE	Unknown	Pacific Ocean	Zaitsev & Öztürk (2001)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Alexandrium affine (Inue et Fukuyo) Balech, 1985	2001	Dinophyta	Alien	Ships	TE	Unknown	Asia SE	Zaitsev & Öztürk (2001)
	Alexandrium monilatum Howel, F.J. Taylor 1979	1991 (1995)	Dinophyta	Alien	Ships, diffusion	PE	Moderately invasive	Atlantic ocean, Gulf of Mexico	Moncheva et.al. (1995)
	Alexandrium pseudogonyaulax (Biecheler) Horiguchi ex Yuki et Fukuyo, 1992	2002	Dinophyta	Alien	Ships	TE	Unknown	Asia SE	Zaitsev et al. (2004)
	Alexandrium tamarense (Lebour) Balech, 1995	2001	Dinophyta	Alien	Ships	TE	Unknown	Cosmopolitan	Zaitsev et al. (2004)
	Petalodinium porcelio J.and M. Cachon 1968	1995-1996 (1999)	Dinophyta	Cryptogenic	Ships	TE	Non-invasive	Mediterranean, Atlantic N.E.	Stoyanova (1999)
	*Scaphodinium mirabile M*argalef	1995-1996 (1999)	Dinophyta	Cryptogenic	Ships	TE	Non-invasive	Mediterranean	Stoyanova (1999)
	Spatulodinium pseudonoctiluca (Pouchet) J.and M. Cachon 1968	1995-1996 (1999)	Dinophyta	Cryptogenic	Ships	TE	Non-invasive	Mediterranean, Atlantic N.E. and Japanese Sea	Stoyanova (1999)
	Oxyphysis oxytoxoides (Kofoid, 1926)	1991 (1995)	Dinophyta	Alien	Ships	PE	Moderately invasive	Alaska, California	Moncheva et.al. (1995)
	Gymnodinium aureolum (Hulburt) Hansen, 2000	2002	Dinophyta	Alien	Ships	TE	Unknown	N America	Zaitsev et al. (2004)
	Gymnodinium impudicum (S. Fraga & I. Bravo) Hansen & Moestrup	2001	Dinophyta	Alien	Unknown	TE	Unknown	Atlantic Ocean, Mediterranean, Pacific Ocean	Aleksandrov et al. (2006)
	Gymnodinium radiatum Kofoid et Swezy 1921	1998	Dinophyta	Alien	Unknown	TE	Unknown	Pacific Ocean	Aleksandrov et al. (2006)
	Gymnodinium uberrimum (Allman), Kofoid and Swezy, 1921	1994 (1995)	Dinophyta	Alien	Ships	PE	Moderately invasive	Europe inland	Moncheva et.al. (1995)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Cochlodinium polykrikoides Margelef, 1961	2001	Dinophyta	Alien	Ships	TE	Unknown	N America, Indian Ocean	Zaitsev et al. (2004)
	Pronoctiluca pelagica Fabre-Domerque, 1889	1983	Dinophyta	Alien	Unknown	TE	Unknown	Cosmopolitan	Aleksandrov et al. (2006)
	Prorocentrum minimum (Pavillard) Schiller, 1933	1948	Dinophyta	Alien	Unknown	PE	Unknown	Cosmopolitan	Aleksandrov et al. (2006)
	Mantoniella squamata (Manton et Parke, 1960)	198x (1997)	Chlorophyta	Cryptogenic	Diffusion/Ships	PE	Highly invasive	Atlantic Mediterranean	Mihnea & Dragos (1997)
	Pterosperma cristatum Schiller, 1925	1948	Chlorophyta	Alien	Unknown	PE	Unknown	Mediterranean, Pacific Ocean	Aleksandrov et al. (2006)
	Pterosperma joergenseni Schiller, 1925	1948	Chlorophyta	Alien	Unknown	PE	Unknown	Mediterranean	Aleksandrov et al. (2006)
	Pyramimonas longicauda Van Meel 1984	2001	Chlorophyta	Alien	Ships	TE	Unknown	Pacific Ocean	Zaitsev et al. (2004)
	Poropila dubia Schiller, 1925 (Vergr., 1911-1914)	1948	Chlorophyta	Alien	Unknown	PE	Unknown	Mediterranean	Aleksandrov et al. (2006)
	Apedinella spinifera Throndsen, 1971	1999	Chrysophyta	Alien	Unknown	RE	Unknown	Mediterranean, Atlantic Ocean, Pacific Ocean	Aleksandrov et al. (2006)
	Bacteriastrum hyalinum Lauder, 1864	1907	Chrysophyta	Alien	Unknown	NE	Unknown	Atlantic Ocean	Aleksandrov et al. (2006)
	Distephanus speculum f. *octonarius* (Ehrenberg) S. Locker & E. Martini	1979	Chrysophyta	Alien	Unknown	TE	Unknown	Atlantic Ocean	Aleksandrov et al. (2006)
	Octactis octonaria (Ehrenberg) Hovasse, 1946	1948	Chrysophyta	Alien	Unknown	PE	Unknown	Mediterranean	Aleksandrov et al. (2006)
	Hillea fusiformis (Schiller) Schiller, 1925	1948	Cryptophyta	Alien	Unknown	PE	Unknown	Mediterranean	Aleksandrov et al. (2006)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Phaeocystis pouchetii Hariot (Lagerheim, 1893)	1989 (1990)	Haptophyta	Alien	Ships	PE	Highly invasive	Atlantic, Pasific, North Sea, Arctic	Petrova-Karadjova (1990)
	Ectocarpus caspicus Henckel, 1909	1980	Phaeophyta	Alien	Unknown	TE	Unknown	Caspian Sea	Aleksandrov et al. (2006)
Micro-phytobenthos	*Cocconeis britannica* Naegeli, 1849	1902	Bacillariophyta	Cryptogenic	Unknown	NE	Unknown	N Europe	Aleksandrov et al. (2006)
	Navicula finmarchica (Cleve & Grunow) Cleve 1895	1970	Bacillariophyta	Alien	Unknown	TE	Unknown	N Europe, Pacific Ocean	Aleksandrov et al. (2006)
	Nitzschia sigmoidea (Nitzsch) W. Smith, 1853	1986	Bacillariophyta	Alien	Unknown	TE	Unknown	N Europe, Europe water bodies	Aleksandrov et al. (2006)
	Toxonidea insignis Donkin, 1858	1902	Bacillariophyta	Cryptogenic	Unknown	NE	Unknown	N Europe	Aleksandrov et al. (2006)
	Undatella quadrata (Brebisson) Paddock et Sims, 1980	1985	Bacillariophyta	Alien	Unknown	TE	Unknown	N Europe	Aleksandrov et al. (2006)
	Pinnularia trevelyana (Donkin) Rabenhenhorst, 1861	1902	Bacillariophyta	Cryptogenic	Unknown	NE	Unknown	N Europe	Aleksandrov et al. (2006)
Macroalgae (phytobenthos)	*Desmarestia viridis* (Müll). (Lamouroux, 1813)	1992 (1993)	Phaeophyceae	Alien	Ships, Natural expansion	PE	Moderately invasive	Atlantic, Meditteranean	Minicheva & Eryomenko (1993)
	Ectocarpus siliculosus (Dillwyn)(Lyngbye, 1819)	1973	Phaeophyceae	Alien	Ships	PE	Non-invasive	Atlantic	Cınar et al. (2005)
	Halothrix lumbricalis (Kützing)(Reinke, 1888)	2004	Phaeophyta	Alien	Ships	RE	Non-invasive	Atlantic	Cınar et al. (2005)
	Pilayella littoralis (Linnaeus, (Kjellman, 1872)	1998	Phaeophyta	Alien	Ships	RE	Non-invasive	Atlantic	Cınar et al. (2005)
	Acrochaetium codicolum (Borgesen, 1927)	1996	Rhodophyta	Alien	Ships	RE	Non-invasive	Atlantic	Cınar et al. (2005)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Asparagopsis armata (Harvey, 1855)	1973	Rhodophyta	Alien	Ships	PE	Non-invasive	Atlantic	Cınar et al. (2005)
	Chondrophycus papillosus (C. Agardh)(Garbary & Harper, 1998)	1973	Rhodophyta	Alien	Ships	PE	Non-invasive	Red Sea	Cınar et al. (2005)
	Laurencia intermedia (Yamada, 1931)	1986	Rhodophyta	Alien	Ships	PE	Non-invasive	Red Sea,	Cınar et al. (2005)
	Polysiphonia fucoides (Hudson) (Greville, 1824)	1973	Rhodophyta	Alien	Ships	PE	Non-invasive	Atlantic	Cınar et al. (2005)
	Polysiphonia paniculata (Montagne, 1842)	1986	Rhodophyta	Alien	Ships	PE	Non-invasive	Atlantic	Cınar et al. (2005)
	Ulva fasciata (Delile, 1813)	1990	Chlorophyta	Alien	Lessepsian	PE	Non-invasive	Red Sea	Cınar et al. (2005)
Vascular plant	*Acorus calamus* L.	18xx (2000)	Magnoliophyta	Alien	Unknown	PE	Moderately invasive	Asia SE	Ciocarlan (2000)
	Arundo donax L.	196x (2000)	Magnoliophyta	Alien	Agriculture	PE	Non-invasive	Asia inland	Ciocarlan (2000)
	Azolla caroliniana Wild.	196x-197x	Pterydophyta	Alien	Ships	PE	Unknown	MesoAmerica	Zaitsev & Öztürk (2001)
	Azolla filiculoides Lamarck	1916	Pterydophyta	Alien	Diffusion	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Azolla mexicana C.Presl. (auct non Willd.)	1916	Pterydophyta	Alien	Diffusion	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Bidens connata Willd.	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Bidens frondosa L.	18xx	Magnoliophyta	Alien	Unknown	PE	Moderately invasive	N Am. inland	Ciocarlan (2000)
	Bidens vulgata E.L.Greene	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Brachyactis ciliata Ledeb.	18xx	Magnoliophyta	Alien	Unknown	PE	Moderately invasive	Asia inland	Ciocarlan (2000)
	Cyperus difformis L.	19xx	Magnoliophyta	Alien	Agriculture	PE	Non-invasive	Azores	Ciocarlan (2000)
	Cyperus odoratus L.	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	N Am. inland	Ciocarlan (2000)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Elodea canadensis Michaux, 1791	189x	Magnoliophyta	Alien	Diffusion	PE	Moderately invasive	N Am. inland	Ciocarlan (2000)
	Elodea nuttallii (Planchon) St.John	19xx	Magnoliophyta	Alien	Diffusion	PE	Highly invasive	N Am. inland	Ciocarlan (2000)
	Heliotropium curassavicum L.	18xx	Magnoliophyta	Alien	Ships	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Hordeum jubatum L.	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	Asia Far East	Ciocarlan (2000)
	Juncus tenuis Willd.	18xx	Magnoliophyta	Alien	Unknown	PE	Highly invasive	N Am. inland	Ciocarlan (2000)
	Lemna minuta H.B.K.	18xx	Magnoliophyta	Alien	Unknown	PE	Highly invasive	N Am. inland	Ciocarlan (2000)
	Monochoria korsakowii Regel et Maack	19xx	Magnoliophyta	Alien	Agriculture	PE	Non-invasive	Asia inland	Ciocarlan (2000)
	Oryza sativa L.	19xx	Magnoliophyta	Alien	Agriculture	TE	Non-invasive	Asia SE	Ciocarlan (2000)
	Populus canadensis Moench.	18xx	Magnoliophyta	Alien	Agriculture	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Sagittaria latifolia Willd.	18xx	Magnoliophyta	Alien	Ornamental	PE	Moderately invasive	N Am. inland	Ciocarlan (2000)
	Sagittaria trifolia L.	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	Asia inland	Ciocarlan (2000)
	Salix babylonica L.	18xx	Magnoliophyta	Alien	Ornamental	PE	Non-invasive	Asia Far East	Ciocarlan (2000)
	Salix rigida Muhlenb.	18xx	Magnoliophyta	Alien	Agriculture	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
	Vallisneria spiralis L.	19xx	Magnoliophyta	Alien	Ornamental	PE	Moderately invasive	N Am. inland	Ciocarlan (2000)
	Veronica peregrina L.	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	S America	Ciocarlan (2000)
	Xanthium orientale L.	18xx	Magnoliophyta	Alien	Unknown	PE	Non-invasive	N Am. inland	Ciocarlan (2000)
Zooplank ton	*Eutintinnus lusus-undae* Entz, 1885	2001	Ciliophora	Alien	Unknown	TE	Non-invasive	Atlantic, Pacific, Indian Ocean Mediterranea,n	Aleksandrov et al. (2006)
	Salpingella aff. *rotundata* Kofoid & Campbell, 1929	2002	Ciliophora	Alien	Unknown	TE	Unknown	Pacific Ocean	Aleksandrov et al. (2006)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Eudoxoides spiralis (Bigelow, 1911)	1978 (1980)	Hydrozoa	Cryptogenic	Natural expansion	NE	Non-invasive	Atlantic Mediterranean	Porumb (1980)
	Rathkea octopunctata (Sars, 1835)	1957 (1959)	Hydrozoa	Alien	Diffusion	NE	Non-invasive	Atlantic Mediterranean	Porumb (1959b)
	Mnemiopsis leidyi Agassiz 1865	1982	Ctenophora	Alien	Ships	PE	Highly invasive	N America E coast, S America E coast	Zaitsev et al (1988)
	Beroe ovata Bruguiere 1789	1996 (1998)	Ctenophora	Alien	Natural expansion or Ships	PE	Highly invasive	Atlantic	Gomoiu & Skolka (1998); Konsulov & Kamburska (1998)
	Verruca spengleri Darwin, 1854	1959	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1959a)
	Acartia tonsa Dana, 1849	1976	Crustacea	Alien	Ships, Canals	PE	Non-invasive	Western Atlantic, Indian and Pacific Oceans	Zaitsev & Öztürk (2001)
	Calocalanus pavo (Dana, 1849)	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Clausocalanus arcuicornis (Dana, 1849)	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Ctenocalanus vanus Giesbrecht, 1888	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Cymbasoma rigidum Thompson, 1888	1975	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1975) (teza)
	Cymbasoma thompsoni (Giesbrecht, 1892)	1975	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1975) (teza)
	Ischnocalanus plumulosus (Claus, 1863)	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Labidocera brunescens (Czerniavski, 1868)	1978 (1980)	Crustacea	Cryptogenic	Natural expansion	TE	Non-invasive	Mediterranean	Porumb (1980)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Mecynocera clausi I.C. Thompson, 1888	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Mesocalanus tenuicornis (Dana, 1849)	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Monstrilla grandis Giesbrecht, 1891	(1975)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1975) (teza)
	Monstrilla helgolandica Claus, 1863	(1975)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1975) (teza)
	Monstrilla longicornis Thompson, 1890	(1975)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1975) (teza)
	Neocalanus gracilis (Dana, 1849)	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Oncaea mediterranea (Claus, 1863)	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Oncaea minuta Giesbrecht, 1892	1997	Crustacea	Alien	Unknown	RE	Non-invasive	Indo-West Pacific	Aleksandrov et al. (2006)
	Paracalanus aculeatus Giesbrecht, 1888	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Paracalanus nanus Sars, 1907	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Phaenna spinifera Claus, 1863	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
	Oithona brevicornis Giesbrecht, 1891	2001	Crustacea	Alien	Ships	TE	Unknown	Atlantic Ocean, Indo-Pacific	Aleksandrov et al. (2006)
	Oithona plumifera Baird, 1843	2001	Crustacea	Alien	Unknown	TE	Unknown	Cosmopolitan	Aleksandrov et al. (2006)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Oithona setigera Dana, 1852	2001	Crustacea	Alien	Unknown	TE	Unknown	Unknown	Aleksandrov et al. (2006)
	Rhincalanus sp.	1997	Crustacea	Alien	Unknown	TE	Unknown	Unknown	Aleksandrov et al. (2006)
	Scolecithrix sp.	2001	Crustacea	Alien	Unknown	TE	Unknown	Unknown	Aleksandrov et al. (2006)
	Callianassa truncata (Giard et Bonnier, 1890)	1948 (1967)	Crustacea	Cryptogenic	Natural expansion	NE	Non-invasive	Mediterranean	Bacescu (1967)
	Stylocheiron sp.	1978 (1980)	Crustacea	Alien	Natural expansion	NE	Non-invasive	Mediterranean	Porumb (1980)
Zoobenthos/ Zooplankton	*Blackfordia virginica Mayer 1910*	193x (1936)	Hydrozoa	Alien	Ships	PE	Non-invasive	N American E coast	Valkanov (1936)
Zoobenthos	*Bougainvillia megas (Kinne, 1956)*	19xx (1933)	Hydrozoa	Cryptogenic	Ships	PE	Non-invasive	Atlantic	Paspalev (1933)
	Bougainvillia muscus (Van Beneden, 1844)	1960	Hydrozoa	Alien	Ships	PE	Moderately invasive	Atlantic Ocean	Zaitsev & Öztürk (2001)
	Eudendrium capillare Allman, 1856	1990	Hydrozoa	Alien	Unknown	TE	Unknown	Cosmopolitan	Shadrin (1999)
	Eudendrium vaginatum Allman, 1863	1990	Hydrozoa	Alien	Unknown	TE	Unknown	N America, Atlantic Ocean	Shadrin (1999)
	Pachycordyle navis (Millard, 1959)	197x	Hydrozoa	Cryptogenic	Unknown	NE	Non-invasive	E North Atlantic, Southern Africa, Black Sea	Aleksandrov et al. (2006)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Tiaropsis multicirrata (M.Sars, 1835)	1990	Hydrozoa	Alien	Unknown	TE	Unknown	E North Atlantic, Arctic Ocean	Shadrin (1999)
	Haliplanella luciae (Verrill 1899)	196x (1971)	Anthozoa	Alien	Ships	PE	Moderately invasive	NW Pacific	Bacescu et al. (1971)
	Balanus amphitrite Darvin, 1854	1905	Crustacea	Alien	Ships	NE	Unknown	Mediterranean, Atlantic Ocean	Zaitsev et al. (2004)
	Balanus eburneus (Gould, 1841)	1892	Crustacea	Alien	Ships	PE	Non-invasive	N American E coast; S America E coast	Zaitsev & Öztürk (2001)
	Balanus improvisus Darwin, 1854	1844	Crustacea	Alien	Ships	PE	Highly invasive	N Atlantic, N Pacific, Mediterranean	Gomoiu & Skolka (1996); Zaitsev & Özturk (2001)
	Chthamalus stellatus (Poli 1795)	(1933)	Crustacea	Alien	Natural expansion	PE	Non-invasive	Mediterranean	Borcea (1933)
	Sphaeroma walkeri Stebbing, 1905	2002 (2004)	Crustacea	Alien	Ships	TE	Non-invasive	Indo-Pacific	Skolka & Gomoiu (2004)
	Nannastacus euxinicus Bacescu, 1951	1951	Crustacea	Cryptogenic	Natural expansion	NE	Non-invasive	Mediterranean, Black Sea	Bacescu (1951)
	Idyella pallidula Sars, 1905	1964	Crustacea	Alien	Unknown	TE	Non-invasive	Atlantic Ocean, Pacific Ocean	Aleksandrov et al. (2006)
	Paramphiascella vararensis (T Scott, 1903)	1964	Crustacea	Alien	Unknown	TE	Non-invasive	Atlantic Ocean, Pacific Ocean	Aleksandrov et al. (2006)
	Proameira simplex (Norman & T Scott, 1905)	1964	Crustacea	Alien	Unknown	TE	Non-invasive	Atlantic Ocean, Mediterranean, Pacific Ocean	Aleksandrov et al. (2006)
	Robertgurneya rostrata (Gurney, 1927)	1964	Crustacea	Alien	Unknown	TE	Non-invasive	Atlantic Ocean, Pacific Ocean	Aleksandrov et al. (2006)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Amphiascus tenuiremis (Brady & Robertson in Brady, 1880)	1996	Crustacea	Alien	Unknown	NE	Unknown	Atlantic Ocean, Pacific Ocean	Aleksandrov et al. (2006)
	Macrobrachium rosenbergii (De Man, 1879)	1990-1992	Crustacea	Alien	Aquaculture	TE	Non-invasive	Indo-Pacific	Aleksandrov et al. (2006)
	Alpheus dentipes Guerin-Meneville, 1832	1966 (1973)	Crustacea	Alien	Natural expansion	PE	Non-invasive	Europe W coast, Mediterranean	Bulgurkov (1973)
	Callinectes sapidus Rathbun, 1896	1967 (1968)	Crustacea	Alien	Ships	PE	Non-invasive	N American E coast	Bulgurkov (1968)
	Eriocheir sinensis H. Milne-Edwards, 1853	(1934)	Crustacea	Alien	Canals, Ships	PE	Moderately invasive	Asia Far East	Vasiliu (1934)
	Marsupenaeus japonicus (Bate 1888)	1977	Crustacea	Alien	Aquaculture	NE	Non-invasive	Asia SE	Zaitsev & Öztürk (2001)
	Rhithropanopeus harrisii (Gould, 1841)	1937	Crustacea	Alien	Ships	PE	Moderately invasive	N American E coast	Zaitsev & Öztürk (2001)
	Pandalus kessleri Czerniavsky, 1878	1959	Crustacea	Alien	Aquaculture	NE	Non-invasive	Asia Far East	Zaitsev & Öztürk (2001)
	Hemianax ephippiger (Burmeister, 1839)	(1898)	Insecta	Alien	Natural expansion	TE	Non-invasive	Africa Inland	McLachlan (1898)
	*Corambe obscura (*Verrill, 1870)	1980 (1994)	Gastropoda	Alien	Ships	PE	Non-invasive	W Atlantic	Sinegub (1994)
	Physella acuta (Draparnaud, 1805)	195x (1987)	Gastropoda	Alien	Unknown	PE	Moderately invasive	S Europe	Grossu (1987)
	Physella heterostropha (Say, 1817)	2004	Gastropoda	Alien	Unknown	TE	Unknown	N American inland	Aleksandrov et al. (2006)
	Potamopyrgus antipodarum (Gray, 1843)	194x (1951)	Gastropoda	Alien	Ships	PE	Moderately invasive	New Zealand	Grossu (1951)
	Rapana venosa (Valenciennes, 1846)	1954	Gastropoda	Alien	Ships	PE	Highly invasive	Asia SE	Kaneva-Abadjieva (1958); Zaitsev & Öztürk (2001)

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	Neptunea arthritica (Bernardi, 1857)	2000	Gastropoda	Alien	Unknown	TE	Unknown	Indo-Pacific	Aleksandrov et al. (2006)
	Ercolania viridis (A. Costa, 1866)	2001	Gastropoda	Alien	Ships	TE	Non-invasive	N America, Atlantic Ocean	Zaitsev et al. (2004)
	Anadara inaequivalvis (Bruguiere, 1789)	1982 (1983)	Bivalvia	Alien	Ships	PE	Moderately invasive	Asia SE	Marinov et al. (1983)
	Corbicula fluminea (O.F.Muller 1774)	2000	Bivalvia	Alien	Canals	RE	Moderately invasive	Asia Inland	Micu & Telembici (2004)
	Crassostrea gigas Thunberg, 1793	190x	Bivalvia	Alien	Ships, Aquaculture	PE	Non-invasive	Asia Far East	Zaitsev & Öztürk (2001)
	Crassostrea virginica (Gmelin 1791)	1973	Bivalvia	Alien	Aquaculture	PE	Non-invasive	N Am. E coast	NIMRD internal reports (Csernok E.)
	Dreissena bugensis (Andrussov 1897)	2004	Bivalvia	Alien	Ships	RE	Moderately invasive	Dniepr River basin	Micu & Telembici (2004)
	Hypanis vitrea glabra (Ostroumoff, 1905)	2004	Bivalvia	Alien	Unknown	TE	Unknown	Caspian Sea	Aleksandrov et al. (2006)
	Musculista senhousia (Benson in Cantor, 1842)	2002 (2004)	Bivalvia	Alien	Ships	TE	Non-invasive	NW Pacific	Micu (2004a,b)
	Mytilopsis leucophaeata (Conrad, 1831)	2000	Bivalvia	Alien	Ships	TE	Moderately invasive	N America	Aleksandrov et al. (2006)
	Mytilus edulis Linnaeus, 1758	2001	Bivalvia	Alien	Aquaculture	TE	Unknown	Atlantic	Zaitsev et al. (2004)
	Mytilus trossulus Gould, 1850	2001	Bivalvia	Alien	Ships	TE	Unknown	Pacific Ocean	Zaitsev et al. (2004)
	Mya arenaria Linnaeus, 1758	1966	Bivalvia	Alien	Ships	PE	Highly invasive	N American E coast	Zaitsev & Öztürk (2001)
	Pteria hirundo (Linne, 1758)	(2002)	Bivalvia	Alien	Ships	TE	Non-invasive	Mediterranean	D. Micu unpublished data

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	Ruditapes philippinarum (Adams and Reeve 1850)	(1985)	Bivalvia	Alien	Aquaculture	NE	Non-invasive	Asia SE	NIMRD internal reports (Telembici A.)
	Sinanodonta woodiana (Lea 1834)	1962 (1986)	Bivalvia	Alien	Aquaculture	PE	Moderately invasive	Asia Far East	Sarkany-Kiss (1986)
	Teredo navalis Linne 1758	700-500 B.C.	Bivalvia	Cryptogenic	Diffusion, Ships	PE	Non-invasive	N Atlantic	Gomoiu & Skolka (1996)
	*Ficopomatus enigmaticus (*Fauvel, 1923)	1935 (1957)	Polychaeta	Alien	Ships	PE	Moderately invasive	India	Marinov (1957)
	Dipolydora quadrilobata Jacobi, 1883	199x	Polychaeta	Alien	Ships	PE	Highly invasive	N Atlantic, N Pacific, Arctic, Mediterranean	Todorova & Panayotova (2006)
	Glycera capitata Oersted, 1843	197x	Polychaeta	Alien	Ships	TE	Non-invasive	Atlantic Ocean, Mediterranean, Pacific Ocean	Aleksandrov et al. (2006)
	Hesionides arenaria Friedrich, 1937	(1954)	Polychaeta	Cryptogenic	Unknown	PE	Non-invasive	Mediterranean-Atlantic	Valkanov (1954)
	Magelona mirabilis (Johnston, 1845)	1997	Polychaeta	Alien	Ships	TE	Non-invasive	N Europe	Aleksandrov et al. (2006)
	Nephtys ciliata (Muller, 1776)	(197x)	Polychaeta	Alien	Ships	TE	Non-invasive	Atlantic Ocean, N Europe, Pacific Ocean	Zaitsev & Öztürk (2001)
	Polydora cornuta Bosc, 1802	1962	Polychaeta	Alien	Ships	PE	Highly invasive	Cosmopolitan	Zaitsev et al. (2004)
	Polydora websteri Hartman in Loosanoff & Engle, 1943	19xx (2005)	Polychaeta	Cryptogenic	Ships	PE	Highly invasive	Pacific	Surugiu (2005)
	Sigambra tentaculata (Treadwell, 1941)	196x	Polychaeta	Alien	Ships	TE	Non-invasive	Atlantic Ocean	Zaitsev & Öztürk (2001)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Streblospio shrubsolii (Buchanan, 1890)	(1957)	Polychaeta	Cryptogenic	Unknown	PE	Non-invasive	N Atlantic, N Pacific, Mediterranean, North Sea, Baltic Sea	Marinov (1957)
	Streptosyllis varians Webster & Benedict, 1887	(1966)	Polychaeta	Cryptogenic	Unknown	PE	Non-invasive	N Atlantic	Kaneva-Abadjieva & Marinov (1966); Marinov (1966)
	Tubificoides benedii (Udekem, 1855)	1916	Oligochaeta	Alien	Ships	PE	Unknown	N America	Zaitsev et al. (2004)
	Molgula manhattensis (De Kay 1843)	(1971)	Tunicata	Alien	Ships	PE	Non-invasive	N Atlantic	Bacescu et al. (1971)
	Urnatella gracilis Leidy, 1851	(1954)	Entoprocta	Alien	Diffusion	PE	Non-invasive	N Am. inland	Bacescu (1954)
Necton	*Aristichthys nobilis (Richardson, 1845)*	1960 (1967, 1968)	Osteichthyes	Alien	Aquaculture	TE	Non-invasive	Asia Far East	Georgiev (1967) Banarescu (1968a)
	Heniochus acuminatus (Linnaeus, 1758)	2003	Osteichthyes	Alien	Unknown	TE	Non-invasive	Indo-Pacific	Aleksandrov et al. (2006)
	Oreochromis aureus (Steingachner, 1864)	197x	Osteichthyes	Alien	Unknown	TE	Moderately invasive	African water bodies	Aleksandrov et al. (2006)
	Plecoglossus altivelis altivelis (Temminck & Schlegel, 1846)	196x-197x	Osteichthyes	Alien	Aquaculture	NE	Non-invasive	Pacific Ocean, Asia SE	Zaitsev & Öztürk (2001)
	Hypophthalmichthys molitrix (Valenciennes, 1844)	1953	Osteichthyes	Alien	Aquaculture	PE	non-invasive	Asia Far East	Zaitsev & Öztürk (2001)
	Oreochromis niloticus niloticus (Linnaeus, 1758)	(197x)	Osteichthyes	Alien	Unknown	TE	Moderately invasive	African water bodies	Aleksandrov et al. (2006)
	Ctenopharyngodon idella (Valenciennes, 1844)	1959 (1968)	Osteichthyes	Alien	Aquaculture	PE	Moderately invasive	Asia Far East	Banarescu (1968)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Chelon labrosus (Risso, 1827)	1977 (1980)	Osteichthyes	Alien	Diffusion	PE	non-invasive	Europe W coast, Africa W coast, Mediterranea	Minev (1980)
	Gambusia affinis (Baird & Girard, 1853)	1921	Osteichthyes	Alien	Biocontrol	PE	Non-invasive	MesoAmerica	Manea (1985)
	Carassius auratus auratus (Linnaeus, 1758)	19xx (1938)	Osteichthyes	Alien	Ornamental	PE	Moderately invasive	Asia Far East	Busnita (1938)
	Carassius gibelio (Bloch, 1782)	19xx (1934)	Osteichthyes	Alien	Diffusion	PE	Highly invasive	Asia Far East	Antonescu (1934)
	Cyprinus carpio carpio Linnaeus, 1758	12xx	Osteichthyes	Cryptogenic	Aquaculture	PE	Non-invasive	Unknown	Manea (1985)
	Ictiobus bubalus (Rafinesque, 1818)	1978 (1980)	Osteichthyes	Alien	Aquaculture	TE	Non-invasive	N Am. inland	Angelescu & Macoveschi (1980); Angelescu et al. (1980)
	Ictiobus cyprinellus (Valenciennes, 1844)	1978 (1980)	Osteichthyes	Alien	Aquaculture	TE	Non-invasive	N Am. inland	Angelescu & Macoveschi (1980); Angelescu et al. (1981)
	Ictiobus niger (Rafinesque, 1819)	1978 (1980)	Osteichthyes	Alien	Aquaculture	TE	Non-invasive	N Am. inland	Angelescu & Macoveschi (1980); Angelescu et al. (1982)
	Lithognatus mormyrus (Linne, 1758)	(1980)	Osteichthyes	Alien	Natural expansion	NE	Non-invasive	Atlantic Mediterranean, Black Sea	Stanciu & Ilie (1980)
	Mugil soiuy Basilewski, 1855	1975 (1980)	Osteichthyes	Alien	Aquaculture	PE	Non-invasive	Asia Far East	Minev (1980); FAO (1997)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establish ment success	Invasiveness (at present)	Native range	Reference
	Mylopharyngodon piceus (Richardson, 1846)	1960	Osteichthyes	Alien	Aquaculture	PE	Moderately invasive	Asia Far East	Banarescu (1968)
	Pseudorasbora parva (Temminck & Schlegel, 1846)	1960 (1964)	Osteichthyes	Alien	Aquaculture	PE	Highly invasive	Asia Far East	Banarascu (1964)
	Oncorhynchus mykiss (Walbaum, 1792)	1971 (1974)	Osteichthyes	Alien	Aquaculture	PE	moderately invasive in rivers	N American E coast	Aleksandrova &. Manolov (1974)
	Tribolodon brandtii (Dybowski, 1872)	195x	Osteichthyes	Alien	Unknown	TE	Unknown	Pacific Ocean	Aleksandrov et al. (2006)
	Ameiurus melas (Rafinesque 1820)	1997 (1998)	Osteichthyes	Alien	Diffusion	RE	Non-invasive	N Am. inland	Wilhelm (1998)
	Ameiurus nebulosus (Lesueur, 1819)	1910 (1934)	Osteichthyes	Alien	Diffusion	PE	Non-invasive	N Am. inland	Antonescu (1934)
	*Gambusia holbrooki (*Girard, 1859)	1924 (1973)	Osteichthyes	Alien	biocontrol , Ships	PE	Moderately invasive	N American inland	Karapetkova & Peshev (1973)
	Lateolabrax japonicus (Cuvier,1828)	196x-197x	Osteichthyes	Alien	Aquaculture	NE	Non-invasive	Pacific Ocean, Asia SE	Zaitsev & Öztürk (2001)
	Lepomis gibbosus (Linne, 1758)	1918 (1929)	Osteichthyes	Alien	Diffusion	PE	Highly invasive	N Am. inland	Busnita (1929)
	Micromesistius poutassou (Risso, 1827)	1999	Osteichthyes	Alien	Diffusion, Ships	TE	Non-invasive	N Europe, Atlantic Ocean, Mediterranean	Zaitsev & Öztürk (2001)
	Morone saxatilis (Walbaum, 1792)	1965	Osteichthyes	Alien	Aquaculture	TE	Non-invasive	N American E coast	Aleksandrov et al. (2006)
	Oncorhynchus gorbuscha (Walbaum, 1792)	1961	Osteichthyes	Alien	Aquaculture	NE	Non-invasive	N American inland	Zaitsev & Öztürk (2001)

Ecofunctional group	Species	First occurence, when available (First published record)	Higher taxon	Status	Vector(s)	Establishment success	Invasiveness (at present)	Native range	Reference
	Percarina demidoffii Nordmann, 1840	1985 (1986)	Osteichthyes	Alien	Natural expansion	PE	Moderately invasive	Rivers Dniester, Dnieper, Bug, Don	Otel & Banarescu (1986)
	Perccottus glenii Dybowski, 1877	2001 (2004)	Osteichthyes	Alien	Diffusion	RE	Moderately invasive	Asia Far East	Nalbant et al. (2004)
	Salmo salar (L. 1758)	1992 (2000)	Osteichthyes	Alien	Aquaculture	PE	Non-invasive	Norway	Ustundag et al. (2000)
	Sphyraena obtusata Cuvier, 1829	1999	Osteichthyes	Alien	Unknown	TE	Unknown	Indo-Pacific	Aleksandrov et al. (2006)
Semi-aquatic	*Mus musculus Linne, 1758*	2000 B.C.	Mammalia	Cryptogenic	Diffusion	PE	Highly invasive	India	Pop & Homei (1973)
	Rattus norvegicus (Berkenhout, 1769)	173x	Mammalia	Alien	Diffusion	PE	Highly invasive	Asia Inland	Pop & Homei (1973)
	Ondatra zibethica (Linne, 1766)	193x (1973)	Mammalia	Alien	Diffusion, Escapes from fur farms	PE	Highly invasive	N Am. inland	Pop & Homei (1973)
	Myocastor coypus (Molina, 1782)	1967 (1988)	Mammalia	Alien	Illegal introduction, Escapes from fur farms	PE	Moderately invasive	S America	Markov (1988)
	Mustela vison (Schreber, 1777)	(2005)	Mammalia	Alien	Diffusion	RE	Moderately invasive	N Am. inland	Murariu & Munteanu (2005)
	Nyctereutes procyonoides (Gray, 1834)	193x (1973)	Mammalia	Alien	Diffusion	PE	Moderately invasive	Asia Far East	Pop & Homei (1973)

PE – permanently established   RE – recently established
TE – temporarily established   NE – not established

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Annex 7: GROUPS USED IN THE STAKEHOLDER ANALYSIS

1. **Water, Hydro-meteorological Department** (government level or below): These stakeholders are those responsible for water quality and quantity management, including enforcement of water policies and regulations at regional/local level. In most of countries they are within the Ministry of Environment. and/or Natural Resources[66]

2. **Natural Resources, Ecology, Water or Environmental Ministry**: In all six Black Sea Countries this Stakeholders Group belonging to the central/federal governmental are responsible for the development and implementation of the national policy in the environmental sector, including the ones for water resources management. International Cooperation and cooperation on transboundary water courses is also under their responsibility. In Bulgaria and Romania it is also under their responsibility to transpose and implement EU legislation.

For the Stakeholders groups 3,4,5,6 the central/federal government structures differ, so the industry, economic and energy sectors are combined in:

- Bulgaria – Ministry of Economy and Energy;
- Georgia – Ministry of Economy, Industry and Trade;
- Romania - Ministry of Economy and Commerce
- Russian Federation – Ministry of Industry and Energy, Ministry of Economy
- Turkey – Ministry of Industry and Trade, Ministry of Energy and Natural Resources
- Ukraine – Ministry Industry and Trade, Ministry of Fuel and Energy

3. **Industry Ministry**: This represents the Stakeholder group responsible for policy-making and regulatory functions in the fields of civil and defence industries and energy sector, technical standardization and metrology, and mineral exploration under production-sharing agreements. In all six countries most of the industrial sectors were privatised or this process is ongoing. The industrial activities often impacted the Black Sea Waters, though they may not be aware of it.

4. **Energy Ministry**: This Stakeholders are responsible for policy – making and regulatory functions in the energy sector and to promote its development and competitive capacity. Their activities often impact the waters of the Black Sea, though they may not be aware of it.

5. **Economic Ministry**: These Stakeholders are responsible for policy making and regulatory functions in the economic policy as well as for the implementation of the integration policy and effecting foreign economic cooperation.

6. **Foreign Affairs Ministry**: In general, this stakeholders group, is responsible with carrying out the foreign policy in compliance with the legal frameworks, as well as

[66]In the Russian Federation, the hydro-meteorological department is responsible for environmental monitoring only. Other Russian departments responsible for monitoring compliance with regulatory legislation are also included in this group.

approving and negotiating all regional and international treaties and agreement pertaining to the Black Sea.

7. **Defence Ministry**: These ministries oversee the protection of the territorial boundaries and political interests of the countries of the Black Sea region. Their presence as naval and land forces can have an impact on the Black Sea.

8. **Internal Affairs Ministries**: This stakeholder group represents the ministries or agencies who over see national level issues, which can include internal security, natural resource development over sight and demographic statistical oversight.

9. **Agriculture Ministries**: This Ministry provides key governmental coordination of the agricultural sectors, often at the national and district levels. They may also oversee fisheries in some countries. They are an important sector to the Black Sea, as their work involves supporting regulations, data collection and other key aspects of oversight.

10. **Fisheries national companies/Administration/Executive Agencies**: This stakeholder group is responsible for development of fisheries, either as a state owned company, an administrative unit within other ministries, or as an independent government agency. They are a key stakeholder in the region.

11. **Social Welfare/Public Health Ministries**: This key governmental sector oversees the conditions of the human population of the Black Sea region. Their responsibilities can include human development, over sight of human health and epidemiological trends. They are a key stakeholder in the region, as the health of the environment impacts the health of the human population.

12. **Labour Ministry**: This stakeholder group is involved in employment issues and is strongly involved in monitoring socio-economic trends of environmental issues within the Black Sea pertaining to employment levels, job rates and associated sectors.

13. **Public Administrators/planning agencies**: These organizations are those responsible for planning and implementation of public policies. They often are nested within other ministries, and are important to the Black Sea as the group responsible for the decisions as to where specific urban developments occur in various sectors.

14. **Regulatory agent officials/Enforcement agents**: This stakeholder group represents those individuals within government institutions tasked with oversight of enforcement and regulation of activities and policies related to the Black Sea, both directly and indirectly.

15. **Shipping National Companies/Administration/Executive Agencies**: This group represents the government organization that oversees the shipping industry, either as a state owned entity, or as privately owned firms which are then monitored by such a national administration or executive agency.

16. **Parliamentary committees for environmental protection**: This group, which is not active in each Black Sea country, is charged with addressing environmental or natural resource management at the parliamentary level. In some cases these bodies can influence the development and implementation of legislation pertaining to coordinated Black Sea management.

17. **Inter-ministerial committees/Basin committees**: These organizations are either those which are brought together to address water management issues at the basin level, or either at the civil and governmental level, or at the intersectoral ministerial level. Their decisions at the basin level can impact the conditions of waters flowing into the Black Sea.

18. **Non-governmental organizations (NGO)**: These stakeholders self identify themselves as belonging to organized, and often nationally or internationally registered and affiliated organizations dealing with development, environmental, social and education aspects of the Black Sea region.

19. **Scientists**: The stakeholder group includes trained technical and academic specialists who address the broad array of physical and social science impacts of issues in and upon the Black Sea.

20. **Manufacturing industries**: The manufacturing industry includes both large and small scale, light and heavy industry, and the supporting sectors. They impact the Black Sea through their waste disposal activities.

21. **Agro-industry**: This stakeholder group provides support to the agricultural sector by providing commercial fertilizers, chemicals, technical equipment and know how, transport and sales of crops and processing of agricultural goods. They impact the Black Sea through their waste disposal activities.

22. **Livestock industry**: The livestock industry is the stakeholder group involved in raising, managing, transporting and processing livestock in the Black Sea region.

23. **Shipping industry**: These stakeholders are involved in all aspects of shipping and marine transport. They deal with movement of goods and people upon the Black Sea. They also are responsible for transportation of energy resources.

24. **Fishing industry**: The fishing industry stakeholder group includes those involved with large scale fishing vessels, fishing byproduct manufacturing, the associated shipping industry specifically focused on fishing, fishery sales and distributors and other affiliated groups.

25. **Harbour/port administrations**: Members of this group are responsible for the management of harbours and ports in the Black Sea. They include harbour masters, and firms operating within the ports to support the shipping and fisheries industries.

26. **Regional government officials**: This stakeholder group consist of those individuals who are responsible for implementing government policies at the regional/district level, either as part of the national government, or as a member of the regional/district governance structure. Their input to the Black Sea can be based on their activities at the local level.

27. **District water management officials**: This group represents those who serve as a water management official at the district level. Their work may involve monitoring, regulation and/or enforcement of water related issues, which will impact the Black Sea conditions, either directly or indirectly.

28. **Environmental protection agency officials**: Members of this group are tasked with the protection of the environment on behalf of the government. Their work involves enforcement of policies, and may include monitoring, evaluation and enforcement. They are often working within other ministries, and their work is key to the protection of the Black Sea ecosystem.

29. **Municipal government officials**: The municipal government stakeholder group oversees municipal functions in urban cities and rural towns. Among other things, they generally supervise and fund the activities of the municipal waste manager.

30. **Municipal waste managers**: These stakeholders are those responsible for municipal waste management including processing and disposal. Their activities often impact the waters of the Black Sea, though they may not be aware of it.

31. **Nature reserve staff**: The staff at nature preserves oversees the preserve or park on behalf of the regional or national government, depending on the country. They often are responsible for protection of highly sensitive areas and habitats.

32. **Community based organizations**: This stakeholder group includes organizations established within communities to deal with common concern around specific community related issues, including issues pertaining to the Black Sea ecosystem.

33. **Workers on state owned farms**: These stakeholders are those who work on farms owned by the government. Their activities often impact the waters of the Black Sea, though they may not be aware of it.

34. **Workers on privately owned farms**: These stakeholders are those who work on farms owned individually or by private firms. Their activities often impact the waters of the Black Sea, though they may not be aware of it.

35. **Fisherman (small scale)**: Those who fish mainly for local markets or for themselves. They tend to fish closer to shore and be more directly impacted by shifts in environmental conditions. They are also often acutely aware of shifts in fish populations.

36. **Educators/teachers**: Educators and teachers as a stakeholder group assist students to understand cause and effect relationships, develop critical thinking skills, and communication, as well as specific subjects pertaining to the health of the Black Sea ecosystem.

37. **Students**: This category includes students at all levels from primary through university level. They are a critical group to assess, because their current perceptions will be those in the future of the region.

38. **Public health care providers**: The public health care providers are those professionals who watch over the health of the population around the Black Sea. They also are able to monitor trends in epidemiology impacting and due to local environmental conditions in the Black Sea.

39. **Members of coastal communities**: This category includes all stakeholders who live in the coastal zone within both urban and rural communities. These stakeholders are generally

most impacted by conditions, but tend to be less active in direct management, though their behaviours often impacts the conditions of the Black Sea.

40. **Tourism/recreation industry**: This industry includes those working with tour groups, restaurants and hotels, cruise ships, entertainment industry, specific sports, and others that directly or indirectly rely on the environmental conditions within the region.

41. **Press and media**: The press and media organizations include local, national and international press that provide information to the project and about the project to their audiences about the activities of the project.

42. **International funding institutions**: These institutions include multilateral and bilateral funding organizations that support efforts related to the Black Sea, and to issues that impact the Black Sea ecosystem.

Annex 8: MINIMUM FISH SIZES FOR LANDING IN BLACK SEA COUNTRIES

Latin name	English Name	Minimum admissible length (cm)					
		BG	GE	RO	RU	TR	UA
Abramis brama	Bream				30		
Acipenser gueldenstadti	Danube sturgeon	100		140	110		
Acipenser stellatus	Starry sturgeon	90		100	100		100
Alosa kessleri pontica	Pontic shad	22		22	17		17
Alosa caspia nordmani	Danube shad			15			11
Alosa caspia tanaica	Azov shad				11		
Alosa maeotica	Black Sea shad		25				
Atherina boyeri	Sand smelt			7			
Belone belone euxini	Garfish	35					
Callinectes sapidus	Blue crab					8	
Citharus sp.	Flounder					20	
Clupeonella cultriventris	Kilka			7			
Cyprinus carpio	European carp				32		
Engraulis encrasicolus maeoticus	Anchovy	8	7	7	6.5	9	6.5
Spicara maena / flexuosa / smaris?	Pickarel		10				
Glyptocephalus cynoglossus	Gray sole		45				
Gobiidae	Gobies						11
Huso huso	Beluga	140		170			
Liza aurata	Golden mullet	25			20		20
Miracorvina angolensis	Angola croacker		45				
Merlanginus merlanngus euxinus	Whiting	12	13				12
Mugillidae	Other mullets/	30	30	25		20	20
Mugil cephalus	Flathead grey mullet	25	20		20	30	20
Mugil soiuy	Haarder	30					38
Mullus barbatus ponticus	Striped mullet	12	25		8.5	13	8.5

Latin name	English Name	Minimum admissible length (cm)					
		BG	GE	R0	RU	TR	UA
Mullus surmuletus	Red mullet		12			11	
Neogobius melanostomus	Round goby				11		
Pomatomus saltatrix	Bluefish		22				
Psetta maeotica torosus / maxima	Turbot	45		40		40	35
Platichthys flessus luscus	European flounder	20		20			
Raja clavata	Thornback ray		60				
Rutilus rutilus heckeli	Roach				18		
Sarda sarda	Bonito	28				25	
Scomber scrombus	Atlantic mackerel						15
Sprattus sprattus phalericus	Sprat	7		7		-	6
Squalus acanthias	Spiny dogfish	90	35	100			85
Stizostedium lucioperca	Zander				38		
Trachurus mediterraneus ponticus	Horse mackerel	12	13	12		13	10
Vimba vimba	Vimba				22		

Annex 9: LANDFILL DATA

The tables below show data collated from the six Black Sea countries. Data only for landfills within 10 km of the coastline were requested, and it was hoped to gain some idea of the scale of unauthorised (illegal) dumping along the coastline – a major problem in all countries. The 10 km boundary was not based on an scientific argument but was a pragmatic, arbitrary value to limit the amount of data that couldbe collated given the time and resources available.

It is clear from the tables that information on relatively few anuthorised landfills has been provided. It is also apparent from Fig. 4.18 that some of the Bulgarian landfills are not located within 10 km of the coast but are further inland. From landfills named after the towns and cities close to where they are located, it appears that the grid refences for these sites have been incorrectly given. Data were provided on only two Turkish landfills.

In is also clear from the second table that incorrect units have been given on the size/capacity of some landfills. Where no units were provided, the units in which data were request have been used as the default.

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Is the landfill authorised?	Does the landfill accept hazardous waste?	Does the landfill have a liner?	Does the landfill have a leachate treatment system?	Does the landfill have a storm water diversion system?	Is the amount of waste monitored?
Bulgaria	**1**	Varna, village of Vaglen	43.120000	27.560000	Yes	No	Yes	Yes	No	Yes
Bulgaria	**2**	Bourgas Bratovo	42.483000	27.483000	Yes	No	Yes	No	No	Yes
Bulgaria	**3**	Marinka	42.478000	27.455000	Yes	No	No	No	No	No
Bulgaria	**4**	Varna Beloslav	43.110000	27.420000	Yes	No	No	No	No	Yes
Bulgaria	**5**	Varna Solvey Sodi	43.120000	27.420000	Yes	No	No	No	No	No
Bulgaria	**6**	Varna Polymeri	43.150000	27.450000	Yes	No	No	No	No	Yes
Bulgaria	**7**	Agrapolychim Devnjya	43.110000	27.420000	Yes	Yes	No	No	No	Yes
Bulgaria	**8**	Bourgas Luk Oil	42.483000	27.483000	Yes	Yes	No	No	No	Yes
Bulgaria	**9**	Bourgas Copper Mine	42.480000	27.491000	Yes	Yes	No	No	No	Yes
Georgia	**10**	Batumi	41.758333	41.741667	Yes	No	No	No	No	Not permanently monitored
Georgia	**11**	Poti	42.247222	41.811111	Yes	No	No	No	No	Not permanently monitored
Georgia	**12**	Kobuleti	41.944444	41.861111	No	No	No	No	No	No
Romania	**13**	Mangalia - Albesti	43.470000	28.260000	Yes	Stabilised hazardous wastes	Yes	Yes	Yes	Yes
Romania	**14**	Costinesti	43.570000	28.380000	Yes	No	Yes	Yes	Yes	Yes
Romania	**15**	Constanta port area	44.150000	28.340000	Yes	Special cell designed for hazardous wastes	Yes	Yes	Yes	Yes
Romania	**16**	Eforie South	44.100000	28.380000		No	No	No	No	Yes
Romania	**17**	Medgidia	44.010000	28.380000		No	No	No	No	Yes
Romania	**18**	Harsova	44.410000	27.570000		No	No	No	No	Yes
Romania	**19**	Cernavoda	44.200000	28.020000		No	No	No	No	Yes
Romania	**20**	Techirghiol	44.030000	28.350000		No	No	No	No	Yes
Romania	**21**	Basarabi	44.100000	28.240000		No	No	No	No	Yes

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Is the landfill authorised?	Does the landfill accept hazardous waste?	Does the landfill have a liner?	Does the landfill have a leachate treatment system?	Does the landfill have a storm water diversion system?	Is the amount of waste monitored?
Romania	**22**	Negru Voda	43.490000	28.120000		No	No	No	No	Yes
Romania	**23**	Luminita	44.530000	28.190000	Yes					Yes
Romania	**24**	SC Lafarge Romcim Medgidia	44.140000	28.160000	Yes					Yes
Romania	**25**	SC Etermed SA Medgidia	44.140000	28.160000	Yes					Yes
Romania	**26**	SC Argus SA	44.140000	28.160000	Yes					Yes
Romania	**27**	SC Rompetrol Refinery - Petromidia SA - Navodari	44.100000	28.380000	Yes					Yes
Romania	**28**	Marway Fertilchim SA - Navodari	44.190000	28.360000						Yes
Romania	**29**	Agighiol	45.020000	28.520000	No	No	No	No	No	Yes
Romania	**30**	Vararie	45.100000	28.480000	No	No	No	No	No	Yes
Romania	**31**	Macin	45.140000	28.080000	No	No	No	No	No	Yes
Romania	**32**	Babadag	44.530000	28.420000	No	No	No	No	No	Yes
Romania	**33**	Isaccea	45.160000	28.270000	No	No	No	No	No	Yes
Romania	**34**	Sulina	45.090000	29.380000	No	No	No	No	No	Yes
Romania	**35**	SC Alum SA	45.100000	28.430000	Yes				Yes	Yes
Romania	**36**	SC Feral SRL	45.100000	28.480000						
Romania	**37**	SC Feral SRL	45.100000	28.430000	No	Yes				
Russia	**38**	Loo village	45.100000	28.480000	No	No	No	No	No	Yes
Russia	**39**	Adler village	44.133333	39.100000	No	No	No	No	No	No
Russia	**40**	Landfill in Tuapse city	44.283333	38.833333	No	No	No	No	No	No
Russia	**41**	Lermontovo village	44.800000	37.950000	No	No	No	No	No	No
Russia	**42**	Kabardinka village	44.350000	38.533333	No	No	No	No	No	No
Russia	**43**	Tekos village	44.516667	38.216667	No	No	No	No	No	No
Russia	**44**	Dzhanhot village	45.066667	37.316667	No	No	No	No	No	No
Russia	**45**	Krasniy village	43.490000	28.120000	No	No	No	No	No	No
Russia	**46**	Kumatir village			No	No	No	No	No	No
Russia	**47**	Utash-4 village			No	No	No	No	No	No
Russia	**48**	Yurovka village	45.116667	37.416667	No	No	No	No	No	No

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Is the landfill authorised?	Does the landfill accept hazardous waste?	Does the landfill have a liner?	Does the landfill have a leachate treatment system?	Does the landfill have a storm water diversion system?	Is the amount of waste monitored?
Russia	**49**	Supseh village			No	No	No	No	No	No
Russia	**50**	Gay-Kodzor village			No	No	No	No	No	No
Russia	**51**	Glebovka village	44.733333	37.583333	No	No	No	No	No	Yes
Turkey	**52**	İstanbul, Kemerburgaz/Odayeri	41.000000	28.900000	Yes	No	Yes	Yes	Yes	No
Turkey	**53**	İstanbul, Şile/Kömürcüoda	41.016667	29.566667	Yes	No	Yes	Yes	Yes	No
Ukraine	**54**	Pervomaisk gully	44.600000	33.633333	Yes	No	Yes	No	Yes	Yes
Ukraine	**55**	Gaspra, Yalta	44.450000	34.116667	Yes	No		No	Yes	Yes
Ukraine	**56**	Alushta	44.733333	34.416667	Yes	No		No	Yes	Yes
Ukraine		Kerch, KATP-122804	45.250000	33.316667	Yes	No	No	No	No	Yes
Ukraine	**57**	Evpatoria	45.483333	32.716667	Yes	No	Yes	No	Yes	Yes
Ukraine	**58**	Chernomorskoe	44.883333	34.983333	Yes	No		No	No	Yes
Ukraine	**59**	Sudak	45.050000	35.300000	Yes	No	No	No	No	Yes
Ukraine	**60**	Feodosia	44.966667	35.216667	Yes	No	No	No	No	Yes
Ukraine	**61**	Koktebel	45.133333	33.616667	Yes	No	No	No	No	Yes
Ukraine	**62**	Saki	45.366667	33.150000	Yes	No	Yes	No	No	Yes
Ukraine	**63**	Novoozernoe, GKPSU Ekologia	45.983333	33.833333	Yes	No	Yes	No	Yes	Yes
Ukraine	**64**	Krasnoperekopsk, Crimea soda plant site, Krasnoe lake	45.966667	33.783333	Yes	Yes	No	No	No	Yes
Ukraine	**65**	Krasnoperekopsk, Brom plant, Staroe lake	44.733333	37.583333	Yes	Yes	No	No	Yes	Yes
Ukraine		Krasnoperekopsk, Brom plant			Yes	No			No	Yes
Ukraine		Krasnoperekopsk, Brom plant			Yes	No	No	No	No	Yes
Ukraine		Krasnoperekopsk			Yes	No	No	No	No	Yes
Ukraine	**66**	Armyansk, Titan plant	46.100000	33.690000	Yes	Yes	No	No	Yes	Yes
Ukraine	**67**	Armyansk, Titan plant	46.100000	33.690000	Yes	Yes	No	No	Yes	Yes

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Is the landfill authorised?	Does the landfill accept hazardous waste?	Does the landfill have a liner?	Does the landfill have a leachate treatment system?	Does the landfill have a storm water diversion system?	Is the amount of waste monitored?
Ukraine		Armyansk, Titan plant			Yes	Yes	No	No	No	Yes
Ukraine		Armyansk, Titan plant			Yes	Yes	Yes	No		Yes
Ukraine		Armyansk, Titan plant			Yes	Yes	No	No	No	Yes
Ukraine		Armyansk, Titan plant			Yes	No	No	No	Yes	Yes
Ukraine		Armyansk			Yes	No	No	Yes	Yes	Yes
Ukraine		Kirilovka			Yes	No	Yes	No	No	Yes
Ukraine		Primorsk			Yes	No	Yes	No	No	Yes
Ukraine		Berdyansk			Yes	No	Yes	No	No	Yes
Ukraine		Berdyansk, pond-evaporator, Azot plant			Yes	No	Yes	No	No	Yes
Ukraine		Berdyansk, pond-evaporator, Berdyansk state plant of glass fiber			Yes	No	Yes	No	No	Yes
Ukraine		Yakimovka			Yes	No	Yes	No	No	Yes
Ukraine		Radionovka			Yes	No	Yes	No	No	Yes
Ukraine		Priazovsk			Yes	No	Yes	No	No	Yes
Ukraine		Nova Dofinovka			Yes	No	No	No	No	Yes
Ukraine		Karolono-Bugaz			Yes	No	No	No	No	Yes
Ukraine		Sergeevka			Yes	No	No	No	No	Yes
Ukraine		Mikolaevka			Yes	No	No	No	No	Yes
Ukraine		Tuzly			Yes	No	No	No	No	Yes
Ukraine	**68**	Primorske	45.530000	29.610000	Yes	No	No	No	No	Yes
Ukraine	**69**	Primorske	45.700000	29.800000	Yes	No	No	No	No	Yes

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
Bulgaria	**1**	Varna, village of Vaglen	43.120000	27.560000	Municipal	24,000	1,773,875 m^3	1976		Yes
Bulgaria	**2**	Bourgas Bratovo	42.483000	27.483000	Municipal	13,269.9	923,000 m^3	1986		Yes
Bulgaria	**3**	Marinka	42.478000	27.455000	Industrial, non-hazardous	1,500	100,000 m^3	1969		Yes
Bulgaria	**4**	Varna Beloslav	43.110000	27.420000	Industrial, non-hazardous			1978		Yes
Bulgaria	**5**	Varna Solvey Sodi	43.120000	27.420000	Industrial, non-hazardous			1972		Yes
Bulgaria	**6**	Varna Polymeri	43.150000	27.450000	Industrial, non-hazardous			1972		Yes
Bulgaria	**7**	Agrapolychim Devnjya	43.110000	27.420000	Hazardous	10	750 m^3			Yes
Bulgaria	**8**	Bourgas Luk Oil	42.483000	27.483000	Hazardous	25	2200 m^3			Yes
Bulgaria	**9**	Bourgas Copper Mine	42.480000	27.491000	Hazardous	20	1,500 m^3			Yes
Georgia	**10**	Batumi	41.758333	41.741667	Municipal	18	7,600,000 m^3	1965		Yes
Georgia	**11**	Poti	42.247222	41.811111	Municipal	8	42,400 m^3/yr	1967		Yes
Georgia	**12**	Kobuleti	41.944444	41.861111	Municipal	1,6		1964		Yes
Romania	**13**	Mangalia - Albesti	43.470000	28.260000	Municipal and industrial, non-hazardous	22.4	3,200,000 m^3	1972	2006	Recently transformed into an ecological landfill: previous landfill is closed and ecologised. New expanded landfill consists of two cells: one for

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
										municipal wastes/ capacity 655,000 $m^{3;}$ and one for stabilised dangerous wastes / capacity 27300 m^3
Romania	**14**	Costinesti	43.570000	28.380000	Municipal and non-hazardous industrial	10	1,200,000 m^3	2004		Yes
Romania	**15**	Constanta port area	44.150000	28.340000	Harbour generated wastes	2.3	150,300 m^3			Previous landfill was closed, new ecological landfill is under construction. Started in 2004
Romania	**16**	Eforie South	44.100000	28.380000	Municipal	7	100,000 m^3	1960	2006	Yes, but being phased out
Romania	**17**	Medgidia	44.010000	28.380000	Municipal and sewage sludge	15	900,000 m^3	1984	2006	Yes, but being phased out. Plans for a new ecological landfill to replace it in the near future
Romania	**18**	Harsova	44.410000	27.570000	Municipal	5	150,000 m^3	1989	2010	Yes, but

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
										being phased out
Romania	**19**	Cernavoda	44.200000	28.020000	Municipal	3	565,000 m^3	1977	2012	Yes, but being phased out
Romania	**20**	Techirghiol	44.030000	28.350000	Municipal	3	150,000 m^3	1960	2012	Yes, but being phased out
Romania	**21**	Basarabi	44.100000	28.240000	Municipal	3	160,000 m^3	1976	2015	Yes, but being phased out
Romania	**22**	Negru Voda	43.490000	28.120000	Municipal	2.5	270,000 m^3	1970	2006	Yes, but being phased out
Romania	**23**	Luminita	44.530000	28.190000	Sewage sludge	5.8				
Romania	**24**	SC Lafarge Romcim Medgidia	44.140000	28.160000	Industrial, non-hazardous	4				Yes
Romania	**25**	SC Etermed SA Medgidia	44.140000	28.160000	Industrial, non-hazardous	1.2				Yes
Romania	**26**	SC Argus SA	44.140000	28.160000	Industrial, non-hazardous	0.32				Yes
Romania	**27**	SC Rompetrol Refinery - Petromidia SA - Navodari	44.100000	28.380000	Sludge from oil refining	2.47			2006	Yes
Romania	**28**	Marway Fertilchim SA - Navodari	44.190000	28.360000	Industrial	48		1954		
Romania	**29**	Agighiol	45.020000	28.520000	Municipal				2015	Yes, but being phased out
Romania	**30**	Vararie	45.100000	28.480000	Inert wastes				2007	Yes, but being phased out
Romania	**31**	Macin	45.140000	28.080000	Municipal				2016	Yes, but being phased out

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
Romania	**32**	Babadag	44.530000	28.420000	Municipal				2009	Yes, but being phased out
Romania	**33**	Isaccea	45.160000	28.270000	Municipal				2009	Yes, but being phased out
Romania	**34**	Sulina	45.090000	29.380000	Municipal				2017	Yes, but being phased out
Romania	**35**	SC Alum SA	45.100000	28.430000	Industrial, non-hazardous	79.4	5,400,000 m^3			Yes; must comply with EU norms by 2010
Romania	**36**	SC Feral SRL	45.100000	28.480000	Industrial, non-hazardous	4.73			2009	Yes, but will be closed in 2009
Romania	**37**	SC Feral SRL	45.100000	28.430000	Industrial, non-hazardous	4.73			2009	Yes, but will be closed in 2009
Russia	**38**	Loo village	45.100000	28.480000	Municipial	4.85	292,000 m^3			Yes
Russia	**39**	Adler village	44.133333	39.100000		7.85	800,000 m^3			Yes
Russia	**40**	Landfill in Tuapse city	44.283333	38.833333		4.2	140,000 m^3			Yes
Russia	**41**	Lermontovo village	44.800000	37.950000		8	112,000 m^3			Yes
Russia	**42**	Kabardinka village	44.350000	38.533333		22	179,000 m^3			Yes
Russia	**43**	Tekos village	44.516667	38.216667		1	17,000 m^3			Yes
Russia	**44**	Dzhanhot village	45.066667	37.316667		1	18,000 m^3			Yes
Russia	**45**	Krasniy village	45.116667	37.416667		6.7	280,000 m^3			Yes
Russia	**46**	Kumatir village	45.100000	28.480000		5.3	6,200 m^3			Yes
Russia	**47**	Utash-4 village	45.100000	28.430000		4	10,000 m^3			Yes
Russia	**48**	Yurovka village	45.100000	28.480000		1.5	700 m^3			Yes
Russia	**49**	Supseh village				1	100 m^3			Yes
Russia	**50**	Gay-Kodzor village				1.5	100 m^3			Yes
Russia	**51**	Glebovka village	44.733333	37.583333		28	420,000 m^3			Yes
Turkey	**52**	İstanbul,	41.000000	28.900000	Municipial	125		1995	2020	Yes

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
		Kemerburgaz/Odayeri								
Turkey	**53**	İstanbul, Şile/Kömürcüoda	41.016667	29.566667	Municipial	70		1995	2020	No
Ukraine	**54**	Pervomaisk gully	44.600000	33.633333	Municipial	4.98	1,950,464 m^3	2001		Yes
Ukraine	**55**	Gaspra, Yalta	44.450000	34.116667	Municipial	5.76		1971		Yes
Ukraine	**56**	Alushta	44.733333	34.416667	Municipial	6.87	4,500,000 m^3	1960		Yes
Ukraine		Kerch, KATP-122804	45.250000	33.316667	Municipial	21.9	7,000,000 m^3			Yes
Ukraine	**57**	Evpatoria	45.483333	32.716667	Municipial	28	4,979,400 m^3	1998		Yes
Ukraine	**58**	Chernomorskoe	44.883333	34.983333	Municipial	7.5	300,000 m^3	1970		Yes
Ukraine	**59**	Sudak	45.050000	35.300000	Municipial	4.5	300,000 m^3	1960		Yes
Ukraine	**60**	Feodosia	44.966667	35.216667	Municipial	7	1,100,000 m^3	1974		Yes
Ukraine	**61**	Koktebel	45.133333	33.616667	Municipial	3	333,000 m^3	1997		Yes
Ukraine	**62**	Saki	45.366667	33.150000	Municipial	5	300,000 m^3			Yes
Ukraine	**63**	Novoozernoe, GKPSU Ekologia	45.983333	33.833333	Municipial	4	286,800 m^3			Yes
Ukraine	**64**	Krasnoperekopsk, Crimea soda plant site, Krasnoe lake	45.966667	33.783333	Industrial	2207	100,055,000 tonnes			Yes
Ukraine	**65**	Krasnoperekopsk, Brom plant, Staroe lake	41.016667	29.566667	Industrial	5	609,000 tonnes			Yes
Ukraine		Krasnoperekopsk, Brom plant			Industrial	0.13	2,700 tonnes			Yes
Ukraine		Krasnoperekopsk, Brom plant			Industrial, limestone production	0.8	1,500,000 tonnes			Yes
Ukraine		Krasnoperekopsk			Municipial	10	641,000 m^3	2001		Yes
Ukraine		Armyansk, Titan plant			Industrial and municipal	4.3		1997		Yes
Ukraine		Armyansk, Titan plant			Industrial, phosphogypsum	1.5				Yes

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
Ukraine		Armyansk, Titan plant			Industrial, acid collector-evaporator	4132	51,450,000 tonnes			Yes
Ukraine		Armyansk, Titan plant			Industrial, phosphogypsum storage site	16				Yes
Ukraine		Armyansk, Titan plant			Industrial, phosphogypsum	56.1				Yes
Ukraine		Armyansk, Titan plant			Industrial	167				Yes
Ukraine		Armyansk			Municipial	6.92	132,000 tonnes	2004		Yes
Ukraine	**66**	Kirilovka	46.100000	33.690000	Municipial	3.1	466,377 tonnes	1972		Yes
Ukraine		Primorsk			Municipial	7	53,280 tonnes			Yes
Ukraine		Berdyansk			Municipial	19	3,516,150 tonnes			Yes
Ukraine	**67**	Berdyansk, pond-evaporator, Azot plant	46.100000	33.690000	Industrial and municipal	21.4	300,000 tonnes	1961		Yes
Ukraine		Berdyansk, pond-evaporator, Berdyansk state plant of glass fiber			Industrial	1.78	45,750 tonnes	1973		Yes
Ukraine		Yakimovka			Municipal	11.6	256,000 tonnes	n.a.		Yes
Ukraine		Radionovka			Municipal	3.9	9,682 tonnes			Yes
Ukraine		Priazovsk			Municipal	6.38	85,249 tonnes	1988		Yes
Ukraine		Nova Dofinovka			Municipal	11.3				Yes
Ukraine		Karolono-Bugaz			Municipal	1.5				Yes
Ukraine		Sergeevka			Municipal	4				Yes
Ukraine		Mikolaevka			Municipal	2				Yes
Ukraine		Tuzly			Municipal	2				Yes

Country	Reference to Fig, <>	Name of landfill	Longitude	Latitude	Type of waste handled	Surface area (ha)	Landfill capacity	First year of operation	Last year of operation	Is the landfill still operational
Ukraine	**68**	Primorske	45.530000	29.610000	Municipal	2				Yes
Ukraine	**69**	Primorske	45.700000	29.800000	Municipal	1.5				Yes

Annex 10:BOD_5 LOADS

Industrial BOD_5 loads to the Blkack Sea (tonne/yr)

Country	Industrial Pollution Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	Rosenets - oil terminal								1.3			
	Port Varna	668.2		114.3	402.9			2925.8	527.8	14.9	12.5	13.4
Bulgaria	Port Bourgas				367.7	267	184.7		481.5	558.2	412	344
	Solvey SODI AD											
	LUKOIL Neftochim	245.8	180.5	389	3500.9		541.6	193.9	473		312	256
Georgia	Batumi Oil Terminal										19,0	18,1
Romania	Rompetrol Refinemnet	786.17	634.67	518.7	421.63	317.6	211.61	176.39	242.07	231.55	196.35	165.623
	OIL Terminal						22.39	4.45	1.6	1.69	18.023	1.899
Russian Federation	Ballast water treatment plant, Tuapse	15.70	11.20	9.40	10.52	10.50	9.20	7.80	7.80	5.80	9.30	9.00
	Ballast water treatment plant, Novorossiysk											
	KBI Murgul, Copper									741	741	
Turkey	TUGSAS Samsun, Fertilizer											
	KBI Samsun Copper										1040	
	OJSC "BROM", Krasnoperekopsk											
	Illichivs'k sea trade port	15.8	18.1	21.5	22.2	32.4	25.5	29.9	27.8	36.7	43.8	48.4
	Saky's Chemical plant	105.8	90.1	53.1	45.3	37.7	44.2	65.9	34.8	91.6	96.2	84.4
	Sevastopol's Heat power station	5.1	4.8	3.9	5.1	5.8	9.1	8.1	3.1	4.6	3.7	3.2
Ukraine	OJSC "Ilıchevskıy sea fısh port"	3.5	2.6	3.4	3.4	2.7	1.9	1.0	0.9	2.0	1.9	1.8
	Odesa's port plant	0.6	15.5	18.3	18.5	16.3	15.4	9.9	3.8	8.6	8.2	7.5
	OJSC "Odesa's port refrıgerator"	4.2	4.2	3.9	3.5	3.7	3.3	3.4	3.0	3.2	3.4	3.0
	OJSC "Odesa's Heat power station"	11.7	10.8	9.8	9.7	7.0	8.2	9.9	8.6	6.2	3.5	3.3
	OJSC "Kamysh-Burunskıy ıron ore combıne"	12	10.2	8.3	7.4	7.1	10	7.4	3.033	8.4	6.6	5.6

Municipal BOD$_5$ loads to the Black Sea (tonne/yr)

Country	Municipal Pollution Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bulgaria	Balchik WWTP								4.9	6.1	12.2	6.2
	Asparuhovo WWTP	0.1			0.1				118.0	102.2	11.7	11.8
	Tsarevo WWTP				30.2		66.7	36.2	23.8	40.7	37.0	41.0
	Sozopol WWTP					6304.1	206.3	74.4	41.3	66.3	45.6	55.2
	Pomorie WWTP										32.5	36.1
	Ravda WWTP										43.1	45.6
	Obzor-Byala WWTP										16.3	16.5
	Meden Rudnik WWTP										88.2	89.4
	Bourgas WWTP										65.2	65.4
	Kiten WWTP										17.3	17.4
Georgia	Kobuleti Sewage System		192.0	200.0		200.0	128.0	128.0	130.0	82.0	79.0	79.0
Romania	Constanta Sud WWTP	1362.3	1644.1	1536.4	2956.2	2485.5	1792.4	1354.9	2131.1	965.7	802.3	557.6
	Constanta Nord WWTP	2163.8	2354.3	2275.3	1708.4	894.7	1254.0	1072.0	670.0	417.0		
	Eforie Sud WWTP	294.7	225.6	342.3	1150.8	618.1	612.1	399.0	237.1	115.3	296.0	160.4
	Mangalia WWTP	522.8	415.2	327.8	553.3	417.7	636.3	166.9	230.5	62.1	120.1	141.3
Russian Federation	Adler	149.0	146.0	124.5	111.0	107.0	105.0	106.0	103.0	106.0	137.0	167.0
	Kudepsta	127.0	118.5	110.0	108.0	108.0	105.0	102.0	102.0	98.6	96.0	97.9
	Bzugu	143.0	134.5	128.0	122.0	120.0	116.0	107.5	108.0	102.0	115.0	117.0
	Navaginskiye	634.0	621.0	591.0	566.0	604.0	508.0	419.0	402.0	452.0	541.0	554.0
	Dagomis	116.0	106.0	94.0	91.0	87.0	87.0	89.0	86.0	87.7	99.0	101.0
	Lazarevskiye	68.8	68.4	63.0	58.0	51.0	51.0	52.6	50.8	53.0	54.0	55.8
	Tuapse	116.0	83.3	80.0	84.0	100.0	101.4	103.1	114.8	95.3	55.6	41.8
	Gelendzhik	55.0	46.0	62.0	51.0	81.0	57.9	63.6	12.8	85.3	101.0	236.5
	Kabardinka										19.7	17.6
	Novorossiysk	316.6	355.2	329.0	344.8	324.2	333.3	315.4	401.7	342.1	358.8	315.9
	Anapa	103.6	96.8	72.4	85.7	58.7	79.0	68.3	79.0	74.6	76.4	71.7

Country	Municipal Pollution Source	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Turkey	Trabzon (Pretreatment)									2975.0	1430.0	1430.0
	Samsun WWTP									8044.0	780.0	3340.0
	Zonguldak WWTP									1194.0	120.0	120.0
	Giresun (Marine Disposal)									806.0	440.0	440.0
	Ordu (Marine Disposal)									1272.0	803.0	803.0
	Bafra WWTP									332.0	80.0	32.0
	Ereğli (Marine Disposal)									775.0	1310.0	1310.0
Ukraine	PMWSF, Yalta	307.9	387.2	381.3	347.9	392.7	383.8	304.4	244.8	276.2	297.9	326.7
	PMWSF, Simeiz	126.8	127.6	131.2	127.3	154.3	126.3	109.9	109.5	117.7	132.2	121.5
	PMWSF, Hurzuf	77.3	50.7	47.2	46.9	45.3	40.3	29.9	18.9	21.0	21.1	20.7
	SBP "North", Odesa	2146.6	2208.9	681.7	576.3	591.4	544.2	594.4	571.3	641.6	637.5	603.3
	SBP "South", Odesa	2146.6	2208.9	681.7	576.3	591.4	544.2	594.4	571.3	641.6	637.5	603.3
	PMWSF, Yevpatoriia	209.4	208.1	207.3	171.5	140.9	111.5	118.7	121.6	148.0	215.4	245.2
	Public enterprise "Sevtownwatersewerage"	3130.7	3252.7	2968.5	2675.8	2520.9	2205.8	2439.4	2739.0	3080.5	3271.4	3300.2
	PMWSF, Feodosiia	124.4	117.4	116.3	120.2	123.7	123.3	163.4	50.8	181.1	192.2	178.2
	PMWSF, Alushta	75.5	63.3	73.7	77.3	82.5	84.2	80.7	121.4	115.3	117.8	125.3
	PMWSF, Sudak	43.9	25.6	25.9	25.9	25.7	25.1	24.2	33.1	27.2	34.4	69.9
	TPE "Clearing building", Skadovs'k	5.5	5.1	4.8	4.6	4.2	3.9	3.3	3.3	3.5	3.6	3.7
	Ochakovwatersewerage	5.7	4.1	3.5	2.8	1.1	1.2	1.1	1.2	1.2	1.0	1.0
	PWP, Partenit	7.9	6.7	7.0	16.1	17.7	10.7	17.7	16.5	18.3	18.5	17.0
	SCB, Balaklawa	703.5	685.5	617.0	576.8	522.9	541.0	391.8	459.4	440.0	423.3	411.5
	Public combine, Chornomors'k	4.6	5.7	4.9	4.3	3.9	3.7	3.6	3.9	4.7	4.7	4.4

River BOD_5 loads to the Black Sea (ktonne/yr)

Country	River	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Bulgaria	Kamchiya				1.63	2.30	2.15	2.94	1.50	1.73	0.61	4.15
	Aheloy									0.01	0.01	0.03
	Veleka									0.24	0.13	1.04
	Ropotamo									0.01	0.01	0.04
	Batova									0.01	0.00	0.04
	Diavolska									0.00	0.00	0.01
	Dvoinitza									0.03	0.02	0.07
	Hadjiska									0.01	0.01	0.04
	Karaach									0.02	0.01	0.05
	Rezovska									0.10	0.07	0.42
Georgia	Rioni	0.44	1.88	1.31	1.29	1.48	0.94	0.62	0.51	0.51	0.78	0.81
	Supsa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Chorakhi	0.40	0.40	0.40	0.30	0.35	0.39	0.48	0.50	0.51	0.78	0.84
	Natanebi	0.02	0.02	0.02		0.03	0.03	0.03	0.03		0.08	0.07
	Khobi	0.01	0.10	0.10	0.30	0.18	0.10	0.10	0.13	0.12	0.12	0.11
	Kubastskali										0.04	0.04
Romania	Danube	616.30	621.30	758.90	776.40	710.70	456.60	303.00	343.00	256.83	383.39	341.61
Russian Federation	Sochi	1.21	1.24	0.99	0.70	0.92	1.36	2.59	1.24	1.08	1.59	1.80
	Khosta	0.28	0.19	0.12	0.17	0.25	0.23	0.34	0.31	0.31	0.50	0.66
	Mzimta	2.59	1.83	1.97		2.88	2.74	5.35	5.06	3.90	6.49	5.84
	Tuapse	0.95	1.79	0.78	1.85	1.72	1.76	1.71	2.37	2.17	2.34	4.32
Turkey	Sakarya	17.70	10.02	17.98	25.61	13.03	18.53	4.95	18.85	11.97	14.90	14.57
	Kızılırmak								0.99	0.03	0.18	0.55
	Filyos					8.42	13.81		19.49	4.61	2.01	10.71
	Yeşilırmak	7.31	6.03	5.48	6.33	3.46	8.08	7.82	10.54	20.47	9.89	14.21
Ukraine	Dniepro	95.07	84.10	99.19	162.92	174.20	111.98	132.75	94.54	95.87	133.64	130.24
	Southern Bug	5.44	8.91	7.40	8.63	7.10	6.31	7.09	5.97	9.19	6.16	7.80
	Dniester	22.58	34.42	52.14	19.89	41.42	26.42	34.71	38.34	21.51	15.79	33.59

River BOD_5 loads to the Sea of Azov (ktonne/yr)

Country	River	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Russian Federation	**Kuban**	18.1	19.6	28.0	19.1	15.2	16.4	14.0	25.2	13.7		
	Don	54.7	78.2	77.8	64.3	78.9	58.3	64.4	48.0	82.1		

Annex 11: IMPLEMENTATION OF HOT-SPOTS CAPITAL INVESTMENTS IDENTIFIED IN THE 1996 TDA

(green)	Identified capital investments made
(orange)	Some progress in implementing capital investments
(red)	Further work required

Country	Pollution source name	Pollution source type	Nature of investment identified under 1996 TDA	Estimated Financial Requirement (1996 TDA, USD)	Implemented measures 1995-2005	Capital investment costs 1995 - 2005 (USD)	Planned measures for 2005 - 2015	Estimated costs for 2005-2015 plan implementation (USD)
Bulgaria	Rosenets	Oil Terminal	WWTP Construction	8,00,000	WWTP Construction	800,000	Construction planned for completion by end 2006	
Bulgaria	Varna	Port	WWTP Extension	700,000	WWTP Extension	700,000		
Bulgaria	Burgas	Port	WWTP Extension	2,200,000	WWTP Extension	2,000,000		
Bulgaria	Asparouhovo	Domestic	WWTP Extension	7,000,000	WWTP Extension	7,000,000	Plant closed	
Bulgaria	Balchik	Domestic	WWTP Extension	8,000,000	WWTP Extension		Construction started in 2006	8,000,000
Bulgaria	Sodi	Soda Ash	WWTP Construction	1,250,000	WWTP Construction	1,250,000	Under construction	
Bulgaria	Tsarevo	Domestic	WWTP Extension	8,000,000	WWTP Extension	8,000,000	Under construction	
Bulgaria	Neftochim	Refinery	WWTP Construction	2,500,000	WWTP extension	2,500,000	Construction planned for completion by end 2006	
Bulgaria	Sozopol	Domestic	WWTP Extension	6,000,000	WWTP Extension		Construction starts 2006	6,000,000
Georgia	Kutaisi	Domestic	WWTP Reconstruction	6,000,000				

Country	Pollution source name	Pollution source type	Nature of investment identified under 1996 TDA	Estimated Financial Requirement (1996 TDA, USD)	Implemented measures 1995-2005	Capital investment costs 1995 - 2005 (USD)	Planned measures for 2005 - 2015	Estimated costs for 2005-2015 plan implementation (USD)
Georgia	Batumi	Domestic	WWTP Reconstruction	13,000,000			Water supply and sanitation for the town of Batumi	97,099,000
Georgia	Chiatura	Manganese	WWTP Construction	10,500,000				
Georgia	Poti	Domestic	WWTP Reconstruction	2,000,000			Water supply and sanitation for the town of Poti	16,359,000
Georgia	Zestaponi	Metallurgy	WWTP Construction	1,500,000				
Georgia	Tskhaltubo	Domestic	WWTP Reconstruction	1,000,000				
Georgia	Zugdidi	Domestic	WWTP Reconstruction	1,500,000				
Romania	Fertilchim	Fertilizer	WWTP Rehabilitation	16,750,000	Fertiliser plant was closed after 1996. Phosphates installation was re-opened in 2003/2004, but only as a storage facility			
Romania	Petromidia	Petrochemical	WWTP Rehabilitation	9,324,000	Rehabilitation of the Navodari wastewater treatment plant, which serves both Petromidia Complex, and the neighboring city (2001-2002)	5,000,000	WWTP improvement and modernization	20,000,000
Romania	Constanta North	Domestic	WWTP Extension	8,000,000	Extension and modernization :	16,527,209+ 2,558,717+ 5,687,457	Continuing - extension and modernization	21,491,692+ 11,805,282+ 19,395,606
Romania	Eforie South	Domestic	WWTP Extension	1,800,000	Extension and modernization:		Continuing - extension and modernization .	
Romania	Mangalia	Domestic	WWTP Rehabilitation	4,000,000	Extension and modernization	18,663,334		

Country	Pollution source name	Pollution source type	Nature of investment identified under 1996 TDA	Estimated Financial Requirement (1996 TDA, USD)	Implemented measures 1995-2005	Capital investment costs 1995 - 2005 (USD)	Planned measures for 2005 - 2015	Estimated costs for 2005-2015 plan implementation (USD)
Romania	Constanta South	Domestic / Industrial	WWTP Rehabilitation	42,420,000	Extension and modernization:	30,590,000+ 17,571,657	Finalisation of pumping stations, sewage system and reservoires	5,654,188
Russia	Rostov-on-Don	Domestic	WWTP Extension	21,000,000				
Russia	Taganrog	Domestic	WWTP Extension	13,000,000				
Russia	Sheskhoris	Oil	WWTP Rehabilitation	6,500,000	Reconstruction	Included in 172,000,000 USD investment		
Russia	Azov	Domestic	WWTP Extension	10,500,000				
Russia	Tuapse	Port	WWTP Construction	1,400,000	Under reconstruction	200,000	Finalise reconstruction	1,000,000
Russia	Anapa	Domestic	WWTP Extension	4,000,000	Under reconstruction	3,400,000	Finalise reconstruction	8,300,000
Russia	Gelendzhik	Domestic	WWTP Extension	4,000,000	Reconstruction	4,000,000		
Russia	Dzhoubga	Domestic	WWTP Extension	3,100,000	Not needed[67]			
Turkey	KBI Samsun	Copper	WWTP Rehabilitation	7,500,000				
Turkey	TUGSAS Samsun	Fertilizer	WWTP Rehabilitation	9,600,000				
Turkey	Trabzon	Domestic	WWTP Construction	14,000,000				
Turkey	Trabzon (Center)	Domestic	WWTP Construction		Marine disposal	10,670,000		

[67] Population of Dzoubga is 5,200 people. WWTP exists and complies with Existing standards

Country	Pollution source name	Pollution source type	Nature of investment identified under 1996 TDA	Estimated Financial Requirement (1996 TDA, USD)	Implemented measures 1995-2005	Capital investment costs 1995 - 2005 (USD)	Planned measures for 2005 - 2015	Estimated costs for 2005-2015 plan implementation (USD)
Turkey	Trabzon (Sürmene)	Domestic	WWTP Construction				Marine Disposal	2,666,667
Turkey	Trabzon (Of)	Domestic	WWTP Construction				Marine disposal	2,666,667
Turkey	Trabzon (Vakfikebir)	Domestic	WWTP Construction				Marine disposal	3,000,000
Turkey	Trabzon (Arsin)	Domestic	WWTP Construction				Marine disposal	2,000,000
Turkey	Trabzon (Çarşıbaşı)	Domestic	WWTP Construction				Marine disposal	2,000,000
Turkey	KBI Murgul	Copper	WWTP Rehabilitation	2,500,000				
Turkey	Samsun	Domestic	WWTP Construction	13,216,000				
Turkey	Samsun (Terme)	Domestic	WWTP Construction		Biological treatment	1,730,000		
Turkey	Görele	Domestic	WWTP Construction				Marine disposal	3,000,000
Turkey	Bulancak	Domestic	WWTP Construction				Marine disposal	3,333,333
Turkey	Zonguldak	Domestic	WWTP and sewerage	27,000,000				
Turkey	Zonguldak (Ereğli)	Domestic	WWTP and sewerage	3,920,000	Marine disposal	1,660,000		
Turkey	Zonguldak (Gülüçlü)	Domestic	WWTP and sewerage		Marine Disposal			
Turkey	Giresun	Domestic	WWTP Construction	7,840,000				
Turkey	Giresun (Bulancak)	Domestic	WWTP Construction		Marine disposal	68,666		
Turkey	Giresun (Centre)	Domestic	WWTP Construction				Marine Disposal	4,000,000

Country	Pollution source name	Pollution source type	Nature of investment identified under 1996 TDA	Estimated Financial Requirement (1996 TDA, USD)	Implemented measures 1995-2005	Capital investment costs 1995 - 2005 (USD)	Planned measures for 2005 - 2015	Estimated costs for 2005-2015 plan implementation (USD)
Turkey	Ordu	Domestic	WWTP Construction	7,616,000				
Turkey	Ordu (Center)	Domestic	WWTP Construction		Marine disposal			
Turkey	Ordu (Fatsa)	Domestic	WWTP Construction		Marine disposal	2,130,000		
Turkey	Ordu (Ünye)	Domestic	WWTP Construction		Marine disposal	1,730,000		
Turkey	Bafra	Domestic	WWTP Construction	3,808,000				
Ukraine	Pivdenni	Domestic	WWTP Construction	1,200,000	General reconstruction	3,900,000	General reconstruction	37,000,000
Ukraine	Pivnichni	Domestic	WWTP Construction	39,600,000	General reconstruction		General reconstruction	61,000,000
Ukraine	Balaklava	Domestic	WWTP Construction	7,800,000				
Ukraine	Yevpatoria	Domestic	WWTP Construction	9,500,000	Reconstruction and updating	5,170,000	Reconstruction of sewage pipeworks, etc.	4,200,000
Ukraine	Sevastopol	Domestic	WWTP Construction	13,300,000				
Ukraine	Yalta	Domestic	WWTP Construction	3,100,000	General reconstruction	460,000		
Ukraine	Gurzuf	Domestic	WWTP Construction	4,200,000	General reconstruction	1,100,000		
Ukraine	Kamish Burunski	Iron ore	WWTP Construction	1,200,000				
Ukraine	Illichevsk	Port	WWTP Construction	1,978,000				
Ukraine	Krasnoperekopsk	Brom	WWTP Construction	600,000	General repair works	4,800	Routine reparis	

Annex 12:EXISTING PROTOCOLS TO THE BUCHAREST CONVENTION

The 1992 Protocol on protection of the Black Sea Marine Environment against pollution from land based sources requires the BSC to:

- Define pollution prevention criteria as well as recommend appropriate measures to reduce, control and eliminate pollution of the marine environment of the Black Sea from land-based sources (Article 6);
- Assist the Contracting Parties in informing one another of measures taken, results achieved or difficulties encountered in the application of this Protocol; and
- Determine procedures for the collection and transmission of such information (Article 7).

The 1992 Dumping Protocol provides, among other things, that the BSC shall be entrusted with receiving records of permits on dumping in the Black Sea of wastes or other matter issued by competent national authorities.

The 1992 Emergency Protocol requires that the BSC shall be informed and provide this information to other interested states in cases where the marine environment of the Black Sea is in imminent danger of being damaged or has been significantly damaged by pollution.

The 2003 Black Sea Biodiversity and Landscape Conservation Protocol added an entirely new aspect to the mandate of the BSC, having extended it to cover issues of species and landscape protection and conservation. Under the Biodiversity Protocol the BSC must:

- Promote the implementation of the Protocol, inform the Contracting Parties of its work and make recommendations on measures necessary for achieving the aims of the Protocol (Article 13).
- Report on the state of the biological and landscape diversity and efficacy of undertaken measures to preserve and manage it to the Meeting of the Contracting Parties on a five year basis in a jointly agreed reporting format.
- Be responsible (through its subsidiary bodies - the Advisory Group on the Conservation of Biological Diversity and the *ad hoc* Advisory Group on the Development of Common Methodology for Integrated Coastal Zone Management) for scientific activities and monitoring and assessment in the field of biological and landscape diversity, delegating the co-ordination of this work to the appropriate activity centres (Batumi, Georgia, and Krasnodar, the Russian Federation) (Article 10).

Annex 13:INTERNATIONAL CONVENTIONS AND THEIR RATIFICATION STAGE

No.	Name	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
CONVENTIONS RELATED TO ENVIRONMENTAL PROTECTION							
1	United Nations Convention on the Law of the Sea	+	a	d	d	-	d
2	Agreement relating to the implementation of Part XI of the Convention	a	p	a	a	-	+
3	Agreement for the implementation of the provisions of the Convention relating to the conservation and management of straddling fish stocks and highly migratory fish stocks	d	-	-	d	-	+
4	Convention on the Protection of the Black Sea Against Pollution, (Bucharest, 1992)	+	+	+	+	+	+
5	UN Convention on Combat Desertification (1994)	acc	+	acc	acc	+	acc
CONVENTIONS RELATED TO PROTECTION AGAINST POLLUTION							
6	International Convention for the Prevention of Pollution from Ships (London, 1973) MARPOL	+ annex I-VI	+ annex I-V	+ annex I&V	+ annex I-V	+ annex I&V	+ annex I-V
7	Convention for Civil Liability for Oil Pollution Damage (London, 1972)	-	-	-	+	-	+
8	London Convention Protocol (1996)	-	+	-	-	-	-
9	UN Convention on Long-range Trans-boundary Air Pollution (Geneva, 1979)	+	acc	+	+	+	+
10	1984 Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)	+ap	-	a	+acc	+	+acc
11	1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes	+ap	-	-	+acc	-	+acc
12	1988 Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes	+	-	-	+acc	-	+acc
13	1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes	+	-	-	-	-	+-
14	1994 Oslo Protocol on Further Reduction of Sulphur Emissions	+	-	-	+-	-	+-
15	1998 Aarhus Protocol on Heavy Metals	+	-	+	-	-	+-
16	1998 Aarhus Protocol on persistent organic pollutants	+	-	+	-	-	+-

No.	Name	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
17	1999 Gothenburg Protocol on Abate Acidification, Eutrophication and ground-level Ozone Formation	+	-	+	-	-	-
18	Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985)	a	a	a	+acc	a	+acc
19	Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, 1987)	a	a	a	+acc	a	+acc
20	London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (London, 1990)	+	a	a	+acc	+	+
21	Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (Copenhagen, 1992)	+	a	acc	-	+	+
22	Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, 1997)	+	a	+	-	+	-
23	Beijing Ammendment	+	-	acc	-	+	-
24	Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel, 1989)	a	a	a	+	+	a
25	United Nations Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992)	+	-	+	+	-	+
26	Protocol on Water and Health (London 1999)	+-	+-	+	+	-	+
27	Protocol on Civil Liability (Kiev, 2003)	+-	+-	+-	-	-	+-
28	Convention on the Trans-boundary Effects of Industrial Accidents (Geneva,2001)	+	_	a	+a	-	-
29	Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemical and Pesticides in International Trade (Rotterdam, 1998)	a	_	a	-	+-	a
30	Convention on Persistent Organic Pollutants (Stockholm) 2001[68]	+	+-	+	+-	+-	+-
	CONVENTIONS RELATED TO NATURE PROTECTION						
31	Ramsar Convention on Wetlands of International Importance Especially Waterfowl Habitat (Ramsar,1971)	+	+	+	+	+	+
32	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Washington, D.C., 1973)	a	a	a	c	a	a

68 Signed by all countries, ratified by Bulgaria and Romania only

No.	Name	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
33	European Convention on Wildlife and Environment protection (Berne 1979)	a with reservation	-	a	-	+ with reservation & objection	+ with reservation
34	Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979)	+	+	+	-[769]	-	+
35	Agreement on the Conservation of African-Asian Migratory Water birds (The Hague, 1995)	+	+	+	-	-	+
36	Agreement on the Conservation of Cetaceans of the Mediterranean and Black Sea (Bonn, 1996)	+	+	+	-	-	+
37	Convention on Biological Diversity (Rio de Janeiro, 1992)	+	a	+	+	+	+
38	Cartagena Protocol on Biosafety	+	a	+	-	+	a
39	Convention on plant protection (Roma , 1951)[70]	ad	_	ad	ad	ad	-
CONVENTIONS RELARED TO ENVIRONMENTAL IMPACT ASSESSMENT							
40	Convention on Environmental Impact Assessment in a Trans-boundary Context (Espoo, 1991)[71]	+	_	+	+-	-	+
41	Protocol on Strategic Environmental Assessment (Kiev, 2003)	+-	+-	+-	-	-	+-
CONVENTIONS RELATED TO CLIMATE CHANGE							
42	UN Framework Convention on Climate Change (New York, 1992)	+	a	+	+	+	+
43	Kyoto Protocol to Amend the UN Framework Convention on Climate Change (Kyoto, 1997)	+	a	+	+	-	+
CONVENTIONS RELATED TO PUBLIC INFORMATION & PARTICIPATION							
44	Convention on Access to Public Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus, 1998)	+	+	+	-	-	+
45	Protocol on Pollutant Release and Transfer Registers (Kiev,2003)	+-	+-	+-	-	-	+-

Note: "+" – signed and ratified, "+-" – signed, but not ratified, "+a" – signed and under accession, "a"-accession, "ac"- acceptance, "+acc"-signed and accepted, "+ap"- signed and approved, "ad"- adherence, "p" – consent to be bound [1], "d" – declaration, "c"- continuation , "-"- is not signed

` States bound by the Agreement by having ratified, acceded or succeeded to the Convention under article 4, paragraph 1, of the Agreement.

[32] Signed by all countries, ratified by Bulgaria and Romania only

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[69] Russian Federation, is not party - has signed the MoU for Siberian Crane

[70] In force since 2 october 2005

[71] Russian Federation signed but not ratified the Convention

Annex 14: INTERNATIONAL COOPERATION THROUGH BI/TRI-LATERAL AGREEMENTS

- Convention between the Government of the Republic of Bulgaria and the Government of Romania in the field of Environmental Protection, signed on signed on 09.12.1991, unlimited.

- Agreement between the People's Republic of Bulgaria and the Republic of Turkey for cooperation in the use of water of transboundary rivers – signed on 23.10.1968 in Istanbul; in force since 26.10.1970; ratified Decree 958/28.11.1968., SG 94/1968; text – UN Treaties, volume 807, p. 117, № 11513.

- Agreement between the Republic of Bulgaria and the Republic of Turkey for establishing the border in the area of Resovska/Mutludere river mouth and delineation of the sea area between the two countries in the Black Sea – signed on 04.12.1997 in Sofia; in force since 04.11.1998; ratified with a law passed by the National Assembly on 24.06.1998, SG 79/1998.

- Agreement between the Government of the Republic of Bulgaria and the Government of the Republic of Turkey on Cooperation in the Field of Environmental Protection, 19.04.2004 (* The Agreement has not entered into force yet).

- Agreement between the Ministry of Environment and Water of the Republic of Bulgaria and the Ministry of Environment and Natural Resources of Ukraine on Cooperation in the field of Preservation of the Environment and Rational Use of Natural Resources, signed on 30.01.2003, unlimited.

- Agreement between the Ministry of Environment and Water of the Republic of Bulgaria and the Ministry of Environment and Water Management of Romania on Cooperation in the Field of Water Management, signed on 12.11.2004, in force since 15.03.2005, unlimited.

This is the first specific agreement signed with the competent authorities for WFD in a neighboring country specifically aimed at WFD implementation including transitional and coastal waters.

- Agreement between the Romanian Government and the Ukrainian Government regarding the cooperation in the Field of Border Waters Management, signed on 30.09.1997

- Agreement between the Ministry of the Environment and Urbanism of the Republic of Moldova, the Ministry of Waters, Forests and Environmental Protection of Romania and Ministry of Environment and Natural Resources of Ukraine regarding the cooperation in the area formed by the Danube Delta and Inferior Prut river's protected areas, adopted on 05.06.2000

- Agreement between the Government of Romania and Government of the Republic of Turkey regarding the cooperation in the Field of Environmental Protection, adopted on 10.09.2001

Annex 15:RELEVANT NATIONAL LEGISLATION

Cross-sectoral legislation

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Water Act (State Gazette, issue 67/1999, enforced on 28 January 2000, amended in State Gazette, issue 87/2000). Draft Water Management Act – December 31,2005, to enter into force[1]	Law on Water (1997) amended in 2000	Water Law no. 107/1996 modified and supplemented by the Law no 310/ 28.06.2004	Water Code (1995)	Water Law no. 831	Water Code (1995)
Environmental Protection Act (EPA), State Gazette No 91/25.09.2002	Law on Environmental Protection(1996)	Law on Environmental Protection	Federal Law "On Environmental Protection" No. 7-ФЗ/2002	Environmental Protection Law (9/8/1983)	Environmental Protection Law (1991)
Regulation no.12/ 2002 concerning the quality required of surface water intended for the abstraction of drinking water	Law on Mineral Resources (1996)	Law 458/2002 concerning the quality of drinking water		Coastal Law (1990/92-3621)	Law on the State Program of Protection and Rehabilitation of the Environment of the Black and Azov Seas (2201)
Regulation no. 9/2001 on the Quality of Water Intended for Human Consumption	Law on Management and Protection of the Sea Coast and River Banks/2000	Emergency Ordinance 202/2002 approved by Law 280/2003 on Integrated Coastal Zone Management		Water Pollution Control Regulations (2004)	Law on Drinking Water and Drinking Water Supply (2003)
				Regulation concerning water for human consumption/Official Gazette No. 25730 - 17 February 2005.	
				Regulation on Environmental Impact Assessment /Official Gazette No 25318/16 December 2003	

Chemical pollution

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation no.12/ 2002 concerning the quality required of surface water intended for the abstraction of drinking water	Law on Pesticides and Agrochemicals (1998)	GD No 100/2002 concerning the quality required of surface water intended for the abstraction of drinking water	Resolution No. 561 of the Head of Krasnodar Kray Administration of 10.06.2004 ”On the Introduction of Amendments to the Resolution No. 579 of the Head of Krasnodar Kray Administration of 28.05.2002 “On Collecting Payments for the Discharge of Wastewater and Pollutants into Sewerage Systems of Krasnodar Kray Settlements”	Water Pollution Control Regulations (2004)	Law of Ukraine On Wastes (1998)
Regulation no.11/ 2002 on the quality of bathing water	Law on Hazardous Chemicals (1998)	GD No 202/2002 for the approval of the Technical Norms on the quality of fresh waters needing protection or improvement in order to support fish life	Resolution No. 162 of the Head of Krasnodar Kray Administration of 10.03.1999 “On Determining Minimal Sizes of Water Protection Zones of Water Objects of Krasnodar Kray and Their Coastal Protective Strips”	Regulation on Soil Pollution Control / 31 May 2005	Law on Environmental Audit (2004)
Regulation No. 8 /2001 on the quality of coastal marine waters	Law on State Ecological Expertise	OMAPAM No 44/09.01.2004 (OJ No 154/23.02.2004) for approving the Regulation for the water quality monitoring for priority/dangerous priority substances	Administrative Transgressions Code of the Russian Federation No.195-ФЗ/2001		

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation no.4/ 2002 on the quality of fish and shellfish water	Law on Construction, Function, Service, Maintenance and Operation of some Oil Transportation Facilities and Legislative Principles of Import, Transportation, Storage and Export of Oil Carried out by these Facilities on the Territory of Georgia.	GD No 201/2002 on the Quality required of shellfish waters establishes norms concerning the quality required for shellfish waters	Federal Law "On Environmental Assessment " No. 174-ФЗ		
	Regulation on Protection of Surface Water of Georgia from Pollution/Order No.130/1996 of MoEWP	GD 188/2002 updated through the GD 352/2005on the approval NTPA 011, 001 and 002 regarding the discharging conditions of urban wastewater into the aquatic environment	GOST 17.1.3.11-84 Nature protection. hydrosphere. Common requirements on protection of surface (except for marine waters)and underground water against pollution by mineral fertilizers		
	Procedures for Estimation of Feasible Constrains on Collection of Polluted And Discharged Water, Flowing into Water /Order 105/1996	Order No 125/1996 of the Minister of Waters, Forests and Environmental Protection for the approval of the regulation procedure for social and economic activities with environmental impact details the permitting procedures for new investments and existing activities, as well as for the methodology of elaboration of the impact assessment studies.	GOST 17.1.3.04-82 Nature protection. hydrosphere. Common requirements on protection of surface (except for marine waters) and underground water against pollution by pesticides.		

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Instruction no.1/2004	Approval of Regulations on "Environmental Impact Assessment" And Instructions of Trunk Pipelines/Order 59/2002	Ministerial Order No 1141/06.12.2002 (OJ No 21/16.01.2003) approving the Procedure and the competencies for issuing the water management permits and licences			Resolution of the Cabinet of Ministers of 20.07.1996 # 815 on the Regulation of the State Water Monitoring
Regulations no. 6/2000 on the Limit Values for Admissible Contents of Dangerous and Harmful Substances in the Waste Water Discharged in the Water Bodies	Law on Hazardous Chemicals (1998)	MO No 1241/16.01.2003 (OJ No 104/19.02.2003) approving the Procedure for modification or withdrawal of water management permits or licences.			Resolution of the Cabinet of Ministers of 08.05.1996 p. On approval of procedures of determination of the size and borders of water protection zones and regime of economic activities within these zones
Ordinance on amending and supplementing Regulation No. 6/9.11.2000 on the limit values for admissible contents of dangerous and harmful substances in the waste water discharged in the water bodies (State Gazette No. 24/23.03.2004), implementing the requirements of Directive 91/271/EEC concerning urban waste water treatment		Ministerial Order No. 1144/2002 transposing the EU requirements related to EPER			Resolution of the Cabinet of Ministers of 11.09.1996 N1100 On the procedure of development and approval of norms maximum allowable discharge of polluting substances and list of substances to be regulated during discharge
Regulation no.7/2000 on on the Terms and Procedure for Discharge of Industrial Waste Waters into Settlement Sewer Systems		Ministerial Order No. 1140/2002 on The National Guidance on the Register of Emitted Pollutants (EPER Guidance)			Resolution of the Cabinet of Ministers of 25.03.1999 On approval of the Rules of the protection of surface waters against pollution by return waters
Regulation no. 10/2001 on issuing of permits for the discharge of waste waters		MO No 1241/2003			Law on Ecological Expertise (1995)

Nutrient over-enrichment/eutrophication

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
MOEW Order № RD – 970/28.07.2003 on identifying the sensitive areas in the Republic of Bulgaria according to the requirements of Directive 91/271/EEC concerning urban wastewater treatment.	Law on Pesticides and Agrochemicals (1998)	OMAPAM No 1072/19.12.2003 (OJ No 71/28.01.2004) for approving the organization of the National Integrated Monitoring, Supervision and Decision Support System against nitrate pollution from agricultural sources in surface waters and ground waters and the Surveillance and Appropriate Control Programme, as surface waters and groundwater	Federal Law "On Environmental Assessment " No. 174-ФЗ	Regulation on the protection of waters against pollution caused by nitrates from agricultural sources" /18. 02. 2004	Law on the State Program of Protection and Rehabilitation of the Environment of the Black and Azov Seas (2201)
Regulation no.1/2000 on the research, use and protection of groundwater	Law on Hazardous Chemicals (1998)	Governmental Decision 964/2000 concerning the approval of the Action Plan for the protection of waters against pollution with nitrates coming from agricultural sources	Norms SP 2.1.5.1059-01	Regulation on Environmental Impact Assessment /Official Gazette No 25318/16 December 2003	Resolution of the Cabinet of Ministers of 08.02.1999, No 166.On the approval of the Rules for Wetlands of National Significance
Regulation no.2/2000 on the Protection of Waters against Pollution Caused by Nitrates from Agricultural Sources	Law on Soil Protection (1994)	Law 458/2002 amended by the Law no 311/2004	Federal Law "On Atmospheric Air Protection" No. 96-ФЗ/1999		
Regulation no. 10/2001 on issuing of permits for the discharge of waste waters			GOST R 50611-93 Organic-mineral fertilizer		

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation No. 10 of 06.10.2003 on the Emission Limit Values (Concentrations in waste gasses) of sulphur dioxide, nitrogen oxides and total dust, discharged to the atmosphere from large combustion plants, SG No 93 of 21.10.2003					

Fisheries

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Fisheries and Aquacultures Act		Law on Fishing Fund, Fishery and Aquaculture No. 192/2001	Resolution No. 124 of the Head of Krasnodar Kray Administration of 05.02.2004 "On Interdepartmental Commission of Determining Catch Quotas of Water Biological Resources for Coastal Fisheries between Krasnodar Kray Applicants"	Fischeries Law (1971) ammended in 1983	Law on Fish, other Alive Water Resources and Food Products from Them (2003)
Ordinance Nerd 09-25,Sofia/13.01.2006 of the Minister of Agriculture and Forestry regarding the total allowable catch		Order No. 277/ 4 July 2002 regarding approval of the Regulations for organizing and functioning of the National Company for Management of Fishery Resources	Resolution No. 113 of the Head of Krasnodar Kray Administration of 16.02.1999 "On Measures for the Protection of Marine Biological Resources in Coastal Areas Adjacent to the Territory of Krasnodar Kray"		
		Order No. 262/16 July 2001 regarding the Preparation of the Directory of Vessels and Fishing boats			

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
		Order No. 422/30 October 2001 for approval of the Regulation on the conditions for development of the commercial fishing activities in the Black Sea waters			
		Annual Order on the Fishing Prohibition (140/247/2002)			
		Order No. 179/1 June 2001 regarding the Registering and transmission of the data related with the marine fishing activity			

Biodiveristy and habitat changes

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Biodiversity Conservation Act/2002	National Biodiversity Strategy and Action Plan/2005	Law 462/2001 concerning for the approval of Governmental Emergency Ordinance no. 236/2000 concerning the regime of natural protected areas and conservation of natural habitats	Law No. 656-КЗ of Krasnodar Kray of 31.12.2003 “On Specially Protected Natural Territories of Krasnodar Kray”	Law for Protection of Cultural and Natural Amenities(1983-2863)	Forestry Code of Ukraine (1994)
Medicinal Plants Act	Law on Plant Protection (1994)	Decree No 187/30.03.1990 (OJ No 46/31.03.1990) - ratifying the Paris Convention on Protection of World Cultural and Natural Heritage	Resolution No. 850 of the Head of Krasnodar Kray Administration of 29.07.2002 “On the Protection of Water Biological Resources in the Black and Azov Sea Basin on the Territory of Krasnodar Kray”	National Parks Law (1983)	

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Protected Territories Acts	Law on Protected Area System (1996)	Law No 26/24.04.1996 (OJ No 93/08.05.1996) -Forestry code	Resolution No. 113 of the Head of Krasnodar Kray Administration of 16.02.1999 “On Measure for the Protection of Marine Biological Resources in Coastal Areas Adjacent to the Territory of Krasnodar Kray”	Forestry Law	Law on Fauna
Protection of Agricultural Lands Act	Law on State Ecological Expertise (1996)	Law No 103/23.09.1996 (OJ No 328/17.05.2002) on hunting fund	Federal Law “On Specially Protected Natural Territories” No. 33-ФЗ/1995	Council of Ministers Decree for Agency for Specially Protected Areas (19.10.1989)	Law on conservation of the Environment
Forests Act	Law on Environmental Permits (1996)	GD No 230/04.03.2003 (OJ No 190/26.03.2003) on the delimitation of the biosphere reserves, national parks and natural parks and the setting up of their administrations	Federal Law “On Fauna” No. 52-ФЗ/1995	Regulation on CITES /Official Gazette No 25545 dated 6 August 2004	
Protection of New Animal and Vegetable Species Act	Law on Wildlife (1996)	MO No 374/03.09.2004 (OJ No 849/16.09.2004) on the approval of the Action Plan regarding Cetaceans Conservation from Black Sea, Romania waters	Federal Law “On Natural Medicinal Resources, Medicinal Spa Localities and Resorts” No. 26-ФЗ		
Hunting and Game Protection Act/2000	Law on Creation and Management of Kolkheti Protected Area (1998)	MO No 850/27.10.2003 (OJ No 793/11.11.2003) on procedure of entrustment of administration and custody of the protected natural areas			
Genetically Modified Organisms Act/2005	Forest Code (1999);	MO No 552/26.08.2003 (OJ No 648/11.09.2003) on approval of the internal zoning of natural and national park from biological diversity conservation point of view			

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation on the conditions and order for issuance of permits for introduction of non-native or reintroduction of native animal and plant species into the nature/2003	Presidential Decree No. 280/2001 on Coordinated Planning and Implementation of Ongoing and Prospective Programmes Related to Bojomi-Kharagauli National Park and its Supporting Zone	MO No 246/22.07.2004 (OJ No 732/13.08.2004) on cave classification-natural protected areas			
	Administrative Violation Code (1984)	GD No 2151/30.11.2004 (OJ No 38/12.01.2005) on setting up the protected natural area regime for new zones			
	Law on Fauna	Law No 462/18.07.2001 regarding the protected natural area regime, conservation of natural habitats, wild flora and fauna approval			
		MO No 647/06.07.2001 (OJ No 416/26.07.2001) for the approval of the authorization procedures for the harvesting, seizing, acquisition activities and trading on the external or internal market and import of plants and animals from wild fauna and flora			

Sectoral policies
Tourism

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
	Law on Sanitary Protection of Health Resorts	Governance Ordinance No.. 58/1998 regarding the touristic activities in Romania	Resolution No. 1665-П of Krasnodar Kray Legislative Assembly of 18.09.2002 (edition of 24.04.2003) "On Temporary Order of Organization, Equipment and Exploitation of Beaches of Krasnodar Kray Water Bodies"	Tourism Incentives Law: (12.03.1993)	Law on resorts (2000)
		GD No 459/2002 on the quality of bathing water	Federal Law "On Natural Medicinal Resources, Medicinal Spa Localities and Resorts" No. 26-ФЗ/1995	No.2634, 4957 Law on Changes for Tourism Incentives Law	Resolution of the Cabinet of Ministers "On the legal regime of sanitary protection zones of water bodies" (18.12.1998 N 2004)
				General Sanitary Law no.1593	Law on the assurance of sanitary-epidemiological wellbeing of population
					Resolution of the Cabinet of Ministers of 18.12.1998 # 2004 On the legal regime of sanitary protection zones of water bodies

Urban planning

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation No. 7 of 2003 for the rules and standards for management of different territories and management zones types	Law on Land Registration	Law No 5/06.03.2000 (OJ No 152/12.04.2000) on the territorial planning use	Land Code of the Russian Federation No. 136-ФЗ/2001	Settlements law (3.5.1985)	Land Code (2001

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation for amendments and complements to Regulation No. 7 of 2003 for the rules and standards for management of different territories and management zones types (State Gazette 51/21.06.2005)	Regulations of Sea and River Shores of Georgia and Regulations for Engineering Protection/Order 4/2002	Law 247/2005 on land use planning system	Urban Planning Code of the Russian Federation No. 73-ФЗ/1998	Land Use and Development Law (1985-3194)	
Regulation No. 8 of 2001 for the scope and the content of territorial plans rules and standards for management of different territories and management zones types			Federal Law "On Land Planning" No. 78-ФЗ/2001	Bosphorus Law: (18.11.1983)	
Regulation for amendments and complements to Regulation No. 8 of 2001 for the scope and the content of territorial plans rules and standards for management of different territories and management zones types (State Gazette 51/21.06.2005)					

Agriculture

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Ordinance No 22 of 4 July 2001on organic production of plants, plant products and foodstuffs of plant origin and indications referring thereto on them	Law on Pesticides and Agrochemicals (1998)	Order No. 918/2002 of the Minister of Waters and Environmental Protection for the approval of the Code for Best Agricultural Practices	GOST R 50611-93 Organic-mineral fertilizer	Regulation on the Principles and Implementation of Organic Farming/10 June 2005	Law on pesticides and agrochemicals (06.05.1995 N 86)

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Ordinance No 35 of 30 August 2001on organic production of livestock, livestock products and foodstuffs of animal origin and indications referring thereto on them	Law on Soil Protection (1994)	Governmental Decision 964/2000 for the approval of the National Action Plan for water protection against the pollution caused by nitrates from agricultural sources	GOST 17.1.3.11-84 Nature protection. hydrosphere. Common requirements on protection of surface (except for marine waters)and underground water against pollution by mineral fertilizers	Regulation on the Production, Import, Export, Marketing and Inspection of Organic, Organomineral, Soil Conditioner and Microbial Fertilizer used in Agriculture, 22 April 2003	Law on resorts (2000)
Law for the approval of the Code for best Agricultural Practices	1997 Presidential Decree for the adoption of the Concept of Agrarian Policy of Georgia		GOST 17.1.3.04-82 Nature protection. hydrosphere. Common requirements on protection of surface(except for marine waters) and underground water against pollution by pesticides.	The Code on Good Agricultural Practices- 08/09/2004 (Official Journal no. 25577)	Resolution of the Cabinet of Ministers “On the legal regime of sanitary protection zones of water bodies” (18.12.1998 N 2004)
			GOST 12.3.041-86. Application of pesticides for the protection of vegetation. Requirements of safety.	The Regulation no.25377/18.02.2004 on the protection of waters against pollution caused by nitrates from agricultural sources	Resolution of the Cabinet of Ministers “On approval of the Procedure of usage of the lands of water fund”(13.05.1996 N 502)
			SanPiN 1.2.1077-01. Hygienic requirements to storage, application and transportation pesticides and agrochemicals. Sanitary regulations and normatives	Law on Grazeland: (28.02.1998)	Resolution of the Cabinet of Ministers “On the approval of the Rules for Compiling River Passports and Rules for the Determination of Bank Areas of the Waterways and Their Use” (14.04.1997 No 347)
			GOST 26074-84 - Liquid manure. Veterinary and sanitary requirements for treatment, storage, transportation and utilization	No.3083 Law of Agricultural Reform on Arrangement of Fields in Irrigated Area	

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
			GOST 17.1.2.03-90 Nature protection. Hydrosphere. The criteria and quality characteristics of water for irrigation		

Industry & Transport

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
Regulation no.7/2000 on on the Terms and Procedure for Discharge of Industrial Waste Waters into Settlement Sewer Systems	Law on Security of Hazardous Industrial Objects/1997(2000)	Governmental Decision No 625/2001 for the approval of the authorisation procedure of traders	Federal Law "On Environmental Assessment " No. 174-ФЗ	Harbors Law: (14.04.1923)	Law on the State Program of the Development of Water Industry (2002)
Regulation on the Terms and Procedures for Issuing of Integrated Permits for Construction and Operation of New and Operation of Existing Industrial Establishments and Installations/Decree No 62 of the Council of Ministers of 12.03.2003, SG No 26 of 21.03.2003	Law on Construction, Function, Service, Maintenance and Operation of some Oil Transportation Facilities and Legislative Principles of Import, Transportation, Storage and Export of Oil Carried out by these Facilities on the Territory of Georgia/1996	Ministerial Order No 169/02.03.2004 (OJ No 206/09.03.2004) for the approval of the direct confirmation method for the reference documents regarding the Best Available Techniques (BREF) approved by European Union	Federal Law “On Power Industry” No. 35-ФЗ/2003	No.4737 Law on Industrial Zone	
		Governmental Emergency Ordinance (GEO) No 34/2002 on integrated pollution prevention, reduction and control, subsequently modified and approved by the Parliament through the Law 645/2002			
		Order 566/2003 (M.Of. No. 689/01.01.2003)of the MoEWP on the approval of the guide for BAT for cement industry.		No. 4691 Law on Development of the Technology	

Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
		Order 37/2003 of the MoEWP (M.Of. No. 247/10.04.2003) on the approval of the guide for BAT for pulp and paper industry			