Commission on the Protection of the Black Sea Against Pollution

Permanent Secretariat

Final

'Diagnostic Report' to guide improvements to the regular reporting process on the state of the Black Sea environment

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Abbreviations used:

AG – Advisory Group of the Black Sea Commission (subsidiary body)
AC – Activity Center of the Black Sea Commission (subsidiary body)
ACCOBAMS – Regional Agreement on the Conservation of Cetaceans
AZNIIRKH – Azov Scientific Research Institute of Fisheries
BSC – Commission for the Protection of the Black Sea Against Pollution (Black Sea Commission, (www.blacksea-commission.org)
BAT – Best Available Techniques
BAP - Best Available Practices
BSC PS – Black Sea Commission Permanent Secretariat
BSERP – Black Sea Environment Recovery Project
BSIS – Black Sea Information System
BSIMAP – Black Sea Integrated Monitoring System
CBD AG – Conservation of Biodiversity Advisory Group of the BSC
EC – European Commission
EEA - European Environment Agency
EMSA – European Maritime Security Agency
ESAS AG – Environmental Safety Aspects of Shipping Advisory Group of the BSC
FOMLR AG – Fisheries and Other Marine Living Resources Advisory Group of the BSC

GEF – Global Environment Facilities
GES - good environmental status
HELCOM – Helsinki Commission (Regional Agreement in the Baltic Sea)
IAEA _ International Atomic Energy Agency, Monaco
IBSS – Institute of Biology of Southern Seas (Odessa and Sevastopol Branches), Ukraine
IO-BAS – Institute of Oceanology, Varna, Bulgaria
IFR-Varna – Institute of Fishery, Varna, Bulgaria
ISKI - Istanbul Water and Sewerage Administration of Greater Municipality of Istanbul
LBS – Land Based Sources of Pollution
MB UHMI–Sevastopol -Marine Branch of the Ukrainian Hydro-Meteorological Institute
ML – Marine Litter
MHI – Marine Hydrophysical Institute-Sevastopol
MoU – Memorandum of Understanding
MoE – Ministry of Environment (in BG – Ministry of Env. and Waters; GE- Ministry of Environmental Protection and Natural Resources; RO – Ministry of Environment and Sustainable Development; In RU – Ministry of Natural Resources; TU – Ministry of Environment and Forestry; UA – Ministry of Environment Protection)
MSFD – EU Marine Strategy Framework Directive
NODC – National Oceanography Data Center
OSPAR – Commission. Regional Agreement in the North Sea
PMA AG – Pollution Monitoring and Assessment Advisory Group of the BSC
R/V – Research Vessel
SoE – State of the Environment (Report)
SAP – Strategic Action Plan
SAP IR – Implementation Report on the Strategic Action Plan
QUASIMEME – Inter-comparison exercises
TDA – Transboundary Diagnostic Report
TUBITAK - Turkish Scientific and Technological Research Council
UNDP – United Nation Development Program
UNEP – United nation Environment Program
WFD – Water Framework Directive

BS states: BG- Bulgaria; GE – Georgia; RO – Romania; RU – Russian Federation; TU – Turkey; UA – Ukraine

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Executive Summary

The 'Diagnostic Report' project aims to identify the achievements and gaps in the existing BSIMAP and BSIS, to assess the suitability of data for calculation of BSC and EEA indicators, and the relevance of the monitoring system in the BS region to meet the requirements of regional commitments, stipulated in BS legal/policy documents and of the MSFD. Hence, the gap analyses allows identifying areas where further efforts are needed to improve the monitoring and reporting systems in the Black Sea region so that the assessments of pressures, state and impacts could serve in decision-making in the region and fit into Pan-European assessments based on EEA agreed set of indicators, taking into consideration ('forward looking') also the wider approach envisaged in the Annexes I and III of the MSFD.

The examination of BSIMAP, overview of data compiled in the BSIS and outside, and possibilities for indicator-based reporting analyses were undertaken by the BSC PS in a consultation with BS experts. Many scientific institutions in the region contributed to the checks of availability of data outside of the official reporting flow, submitting often full inventories of cruises and meta data on parameters of interest. Generalized requirements (benchmarks for the analyses) to the data and monitoring system have been formulated on the base of EEA methodologies for indicators calculation and on specific needs to meet the obligations of the MSFD in EU-member states.

In total, information about 20 major data-holders, 30 important projects which carried out cruises and/or produced data outside of BSIS and 30 observation systems operating in the Black Sea area has been compiled. Meta data (outside of BSIS) were reported by 15 Institutes, some of them provided full inventories for nutrients, Chl, macroalgae and contamination of biota. The information provided by BS Institutes was further supplemented with the help of extensive Internet search (publications, on-line data sets, GIS, etc.). All collected data/information (BSIS, BSIMAP and outside of them reported by Institutions) were analysed and cross-tables were produced showing availability of datasets in question and their suitability to calculate indicators. A summary of suitability of Black Sea data (of BSIS and external data sources) for calculation of BSC and EEA indicators and MSFD descriptors was prepared in a special table and conclusions were drawn (see below).

Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	Suitability of BS data according to:	
				BSIS	Other data sources
NO3+NO2 (S)	Y	Y	Y (D.5)	Y	Y
PO4 (S)	Y	Y	Y (D.5)	Y	Y
N/P (S)		Y		Y	Y
Chlorophyll-a (S)	Y	Y	Y (D.5)	Not enough data, limited only reporting to 1-2 States	Y Need to be tested

Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	Suitability of BS data according to:	
				BSIS	Other data sources
Ocean color in support of Chl-a (S)	N	N	N	N	Y Analyses needed, effort to further develop algorithms, verification by ground-trith data To be further discussed and tested
Hypoxic situations, expansion of zones of hypoxia (I)	Y	N	Y (D.5,D.6,D.7)	Limited data available Could be tested	Y Data available Could be tested
Harmful algal blooms (I)	N	N	Y (D.5)	Considered. Needs further expert work on phytoplankton	Y
Primary Production	N	N	Y (D.5)	N	Considered. Limited information Needs further expert work
HSs in biota (S)	Y	Y	Y (D.8,D.9)	N Considered. Very lmited data.	Considered. Limited data.
HSs in sediments (S)	Y	Y?	Y (D.8)	N Still can be tested with few data sets already available for more than 5 yrs.	Limited data.
Biological effects of HS (I)	N	N	Y (D.8)	Not yet considered	Not yet considered
Discharge of oil from refineries and offshore installations (P)	N	Y	N	N	N
Illegal discharges of oil at sea (P)	Y	Y	N	N Poor reporting. Considered by contract with EMSA for provision of satellite images.	N Poor reporting
Accidental oil spills from shipping (P)	Y	Y	N	Y	Y

Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	Suitability of BS data according to:	
				BSIS	Other data sources
Shipping density (P)	Y	N	N	Y	Y
Loads: Inputs of nutrients and HSs from direct (point) sources (P)	Y	N	Y (D.5)	Considered for Hot Spots and Rivers	Y
Marine Litter: Amount/composition/ sources	N	N	Y (D.10)	N	Considered. Not as regular monitoring. An assessment was made.
Biomass of macroalgae	Y	N	Y (D.1,D.5,D.6)	Y Limited data.	Y
Biodiversity: species composition / number of species / species richness	Y	N (species diversity only)	Y (D.1,D.5,D.6)	Y Limited data	Y
Macroalgae Distribution	Y	N	Y (D.1,D.5,D.6)	Y Limited data	Y
Seagrasses	N	Y?		N	Y
NIS/IAS	Y	N	Y (D.2)	Y	Y
Designated Protected Areas	Y	Y		Y	Y
Threatened and protected species	Y	Y		Y	Y
Fishing fleet capacity / fishing effort (P)	Y	Y	N	Y	Y
Fish stock biomass (S) and its sub-indicators	Y	Y	Y (D.3)	Y	Y
Fish catches / biomass	Y	Y	Y (D.3)	Y	Y
Total landings	Y			Y	Y
Fishing mortality	Y	N	Y (D.3)	Y (see Annex IV)	Y
Spawning Stock Biomass	Y	N	Y (D.3)	Y	Y
Aqua. Production	Y	N	N	Y	Y
SST (surface water temperature)	N	N	N	Y	Y
SLR (sea level rise)	Y*	N	N	* as ICZM indicator, limited data	Y
Northward movement of species	N	Y	N	N	Y
Total number of Med sps /expansion area	N	N	N	N	Y (see Annex v)
Invasive Species diversity and abundance	Y	N	Y (D.1,D.5,D.6)	Limited data	Y

Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	Suitability of BS data according to:	
				BSIS	Other data sources
Bathing water: Chemical and microbiological parameters	Y	Y	N	Very limited data.	Y

On the basis of the numbers of BS indicator that exist in relation to the EEA and MSFD 'needs' the following concusions were drawn. Among the eutrophication indicators (inorganic nutrients, chlorophyll and N/P ratio), N/P is not specifically reported to the BSC but as a generic indicator it can be easily derived from BSIS. Chlorophyll is poorly reported to the BSC and the data cannot be used for a regional assessment. However, outside of BSIS Chlorophyll data are available and suitable to build trends and maps of spatial distributon. Nutrients data in BSIS is suitable to trace trends and spatial distribution in coastal waters, but not in the open-sea.

Expansion of hypoxia zones (BSC and MSFD indicator) can not be traced based on BSIS data, however, data are available in the region.

Harmful algal blooms (MSFD indicator) are regularly studied in the Black Sea, the BSIS data are not enough to support this indicator, however, external data are sufficient for regional assessments. Primary production (MSFD indicator) is not regularly studied in the Black Sea to build statistically significant trends or spatial distributions. There are no data in BSIS, and outside of BSIMAP different methods are used to measure primary production, therefore the data are not suitable for comparisons. IBSS-Sevastopol developed equations to calculate primary production from Chlorophyll, specifically for the Black Sea. The method should be verified by other Institutes.

Hazardous substances in biota, sediments (BSC, EEA, MSFD indicators) and their effects (MSFD indicator) are studied in the Black Sea sporadically, the data are not sufficient for regional assessments yet.

Discharge of oil from refineries and offshore installations (EEA indicator) is not reported to the BSC, there is no information on the availability of data in the region. Illegal discharges of oil from ships (BSC, EEA indicator) are considered, EMSA provides satellite images in case of suspected oil spill, however, verification of spills (aerial surveillance, for instance) is still poorly provided by states.

Loads (BSC, MSFD) are well reported to the BSC, data are sufficient for hot spots and rivers. Marine Litter (MSFD) is not a component of the BSIMAP, data outside of BSIS are available, however, assessments are possible for ML on the coast, but not in the Sea and on its bottom.

Most of the BSC Biodiversity indicators are also EEA and MSFD indicators, however, the data supporting those indicators for macroalgal communities in the BSIS are limited, for seagrassess – not reported, outside of BSIS – available and suitable for building indicators. MPAs are well reported to the BSC, together with threatened and protected species.

Those BSC Fishery indicators which appear also as EEA and MSFD indicators are well reported to the BSC, however, stock assessments for most of the fish species are in need for harmonization.

The EEA indicator 'North-ward movement of species' is not reported to the BSC, however, scientific studies in the region are available. Invasive species diversity and abundance (BSC, MSFD) are poorly reported to the BSC. Data outside of BSIS are suitable for the indicators calculation.

Bathing waters data are regularly collected in all Black Sea states, data outside of BSIS are sufficient for tracing compliance with established standards (not yet harmonized in the region).

The report describes the structure of BSIMAP, which was conceptually developed in 2001 and the modifications introduced through the years. National monitoring activities in the Black Sea states are supported by Ministries of Environment. Other Ministries, such as Ministry of Education, Agriculture, Transport and Academies of Science support problem-oriented monitoring in the frames of different projects. Ministries of Agriculture are responsible for fisheries investigations (stock assessments, catches, fishing fleets, etc.) and Ministries of Transport support/supervise most of the investigations related to environment safety aspects of shipping.

The status of national monitoring systems was thoroughly analysed and existing problems were identified against the requirements of the BSIMAP and MSFD. The analysis of identified datasets and BS monitoring/observation systems revealed gaps in regularity and data coverage, gaps in the national monitoring systems in terms of organization/strategy and compliance with commitments, problems with data accessibility, compatibility and suitability to produce indicators.

The major gaps were listed as follow:

1. the monitoring is often not integrated (carried out by different Institutes, which do not synchronize their field work);
2. recommended frequency of observations (identified in BSIMAP in line with WFD) is not always observed;
3. mandatory parameters are often not covered;
4. open-sea stations are missing – no agreed stations for a regular monitoring;
5. reference stations – mainly missing or not specified as such, except Romania;
6. long-term time series data stations lack special attention and permanent financial support;
7. poor coordination between responsible authorities;
8. poor financial assistance, in general;
9. regional dimension absent;
10. BSIMAP stations are mainly coastal, very few marine stations are monitored;

11. monitoring does not use much automated systems and other modern tools for observations;
12. lack of harmonization (especially in fisheries).

What are the reasons for those gaps in BSIMAP? The main reasons can be listed, as follow:

- Poor financial assistance;
- National strategy does not foresee the monitoring as integrated;
- Lack of expertise, lack of equipment, old research vessels;

Recommendations to filling the identified gaps in monitoring and reporting have been elaborated, including proposals on development of new indicators, how to improve the existing EEA indicator specifications to make them more suitable for Black Sea assessments, on harmonization of GES identification and wider assessments in EU and non-EU member states, and others.

The main recommendations given for the monitoring and reporting improvement are:

1. Creation of network of reference sites
2. Expanding the BSIMAP toward open sea
3. Revision of the existing BSIMAP to exclude parameters considered as non-relaible in routine monitoring and inclusion of new parameters (for instance, for tracing of climate change)
4. Further harmonization of methodologies
5. Introduction of new observation techniques and modern equipment
6. Initiation of regional cruises for transboundary environment problems assessments
7. Actions to be undertaken to attend the insufficiently studied domains such as:

- Fish and other marine living resources stock assessments in a harmonized way
- Cetaceans surveys
- Marine Litter in the sea
- Contamination of sediments and biota, effects of HS
- Habitats mapping, biodiversity assessments, etc.

Therefore, major targets in further development of the Black Sea monitoring to fit into Pan-EU assessments should forsee improvements in:

- **Frequency of observations** – in line with WFD and MSFD (so far not always sustained properly, as mentioned above).

- **Proper geographical coverage** – include open sea.

- **Sustain stations and transects with long-terms observations**

- **Networks development, mandatory parameters covered.**

- **Harmonization** – inter-comparison exercises, further development of guidelines, common understanding of GES, indicators, etc.

- **Quality control and assurance** – sustainable mode of implementation.

The supporting activities recommended should focus on:

- Utilization of the **capacities of all Institutes** dealing with monitoring in the region (not only those, which are officially nominated by the Ministries so far). Bi-lateral and multi-lateral agreements to be developed.

- **Avoiding overlapping of activities and efforts** – as, mentioned, often two or more Institutes undertake observations in the same area without proper coordination (best example is the Kerch accident 11 November 2007[1]).

- **Partnership** with international organizations – EEA, IMO, ESA, EMSA, HELCOM, utilizing their experience.

- **Capacity building** – regular trainings, bringing best available practices to the region, strengthening the collaboration between different authorities engaged in monitoring, further development of inter-ministerial mechanism, etc.

- **Sharing -** The data flow and dissemination of information (prepared reports based on data collected) within BSC as well as from BSC should be transparent, two-way and easily accessible by everybody. It is particularly important to develop further the Black Sea Information System and make its data and metadata services accessible online on the BSC website (which is in line with INSPIRE directive), and to make sure that the special information needs of stakeholders are met by providing different products. The work carried out within the BS monitoring (at least meta data) should be transparent, interact with and enjoy the confidence of all the stakeholders, including local authorities, industry, nongovernmental organizations, expert institutions, public and other bodies.

Crucial issues in the improvement of BSIMAP and BSIS in the Black Sea region are the better coordination between authorities involved, less complicated organization and a **strategy for integrated monitoring** developed at the national level, using best available examples (e.g. the system in Romania) and assuring sustainable financial assistance for better planning of activities.

[1] A full report on the investigations undertaken in 2007-2009 to trace the impact of the Kerch accident is available.

Introduction

The collection of data/information under the umbrella of the Bucharest Convention started in 2001. Special reporting templates (Excel Format) were initially developed and later several times amended to improve collection of data/information in response to the needs of decision making in the Black Sea region and for calculation of indicators necessary for assessments of the Black Sea ecosystem state and efficiency of implemented policies. Presently, the Black Sea Information System (BSIS, http://www.blacksea-commission.org/_bsis-description.asp) consists of nationally reported data in the fields of land based sources of pollution, conservation of biodiversity, fisheries and other marine living resources, environmental safety aspects of shipping, integrated coastal zone management and pollution monitoring and assessment.

The Black Sea Integrated Monitoring and Assessment Programme (BSIMAP: 2001 first mentioned, final version adopted in 2006, 13th Meeting of the Commission, see http://www.blacksea-commission.org/_bsimap.asp, Information & Resources, with outlined optional and mandatory parameters, planned to act in the period 2006-2011) seeks to maximize the use of historical data from previously established monitoring sites for trend analysis, supported by new additional sites to improve the assessment of the current chemical/ecological status of the Black Sea.

In 2007-2009 the BSC produced three important reports: Black Sea Transboundary Diagnostic Analysis 2007 (http://www.blacksea-commission.org/_tda2008.asp), State of the Environment of the Black Sea in 2001-2006/7 (http://www.blacksea-commission.org/_publ-SOE2009.asp) and Implementation of the Black Sea Strategic Action Plan in 2002-2007 (http://ps-blacksea-commission.ath.cx/ministerialmeeting2009/documents/implementation%20of%20SAP%202002-2006/SAP_IR_.pdf). While working on these reports, the BSC PS faced certain problems, which implied the necessity of self-evaluation in relation to national data reporting (official flow) to BSIS and performance of states in the frames of the BSIMAP. In relation to indicator-based reporting the BSC PS found needed to seek for additional time-series data outside of BSIS, which meant that a good evaluation is also required for the availability of such data in the Black Sea region to assure possibly access and consequently higher quality assessments in future. Later a solution should be sought how these data can become a part of BSIS in a sustainable manner.

The process of development of indicators in the Black Sea region is a part of the cooperation existing between BSC and EEA. Going back to 2006, in line with the MoU between the Black Sea Commission and EEA, the BSC PS processed and provided to EEA monitoring data for review and recommendations on development of indicators:

- Fisheries data
- Shipping data (oil pollution)
- Oxygen, BOD_5 (Biological Oxygen Demand for 5 days), species of nutrients, hydrocarbons.

The following comments were obtained from EEA:

'There are no consistent data sets in the Black Sea Commission data base, the time series are with large differences in the determinands measured by the countries, the number of stations and years covered. Therefore, the data sets are not suitable for indicator-based reporting.'

In 2007-2008 the BSC PS communicated with EEA on the topic of sufficiency/availability of data in the Black Sea region, recognizing the importance of indicator-based reporting and being aware that the Black Sea region could provide better data sets than those available in the BSIS. In parallel, the BSC PS worked hard in further development of the BSIS (with reporting templates close to EEA formats) and improving of the official flow of data. In response EEA agreed on the need for a new evaluation of BSIS to be undertaken and insisted also on a thorough check of the sustainability of the Black Sea data, no matter in or outside of BSIS, including expected data from 2009 onwards.

The present report presents a diagnosis of BSIS and BSIMAP in answering the following questions:

1. What are the achievements and gaps (and their causes) in the BS data reporting and regional monitoring system (BSIS and BSIMAP)?
2. Can we use the Black Sea data for the purposes of indicator-based reporting?

a. EEA indicators
b. BSC indicators
c. MSFD descriptors[2] (Annex I of the Directive)
d. Wider assessments (*sensu* Annex III MSFD), including the initial assessment 2012 and the following 6-years reports (to be repeated every 6 years).

The report contains recommendations how to improve the regional monitoring programme, data collection, indicator-based analyses and evaluation/assessment of the state of the Black Sea environment to facilitate BSC marine assessments in the context of national obligations under regional frameworks as well as EEA reporting and MSFD implementation[3].

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The Report focuses on:

What are the achievements/successes and 'bottlenecks'/obstacles in the:

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[2] In this Report, in particular in Annex VII, we have used the DRAFT criteria for the GES descriptors in the MSFD's Annex I derived by the MSFD CIS' WG GES (as included in the Draft EC Decision, cf. http://www.endseurope.com/docs/100608a.doc). The final date for the production of this Report was earlier than the adoption of the Criteria in Council.

[3] A 'forward-looking' component with regards to the additional monitoring and assessments required – in general terms – for the implementation of the MSFD.

- Annual data collection by the Black Sea Commission (BSC, Commission for the Protection of the Black Sea Against Pollution) from the 6 coastal states;
- Development of regionally-adopted and annually updated indicators for the preparation of systematic/sustained and periodic (5-yearly) Black Sea 'State of the Environment' (SoE) assessments based on formally agreed data flows from the Black Sea coastal states into BSIS;
- Status of BSIMAP.

The 'bottlenecks'/obstacles are outlined in terms of:

- Why these exist;
- Who is responsible (has a role) for them; and
- How they could be overcome and by whom.

The report overviews:

- Availability and sustainability of data outside of the official data flow to BSIS. Suitability of all available BS data for indicator-based reporting (BSC and EEA indicators, where possible MSFD)
- National and Projects-related monitoring systems.

Regarding the EEA requirements, the report considers not only *the suitability of BS data for calculating EEA indicators, but also the usefulness of EEA indicators/methodologies for the Black Sea and recommends* on how to improve existing EEA indicator specifications/methodologies to make them more suitable for Black Sea assessments.

In relation to the MSFD implementation and on the basis of the assessments above, the Report includes a 'forward looking component' answering the following questions:

- What is the general situation in the Black Sea with the wider-marine assessments at the regional level (MSFD Annex III)? What would be needed to improve on the current situation?
- For the 'GES'–related assessments (MSFD Annex I): is there anything that could already be stated regarding the feasibility of fulfilling this type of assessments in the Black Sea?

Section I: BSIMAP and BSIS

The main purpose of the BSIS (Black Sea Information System) and BSIMAP (Black Sea Integrated Monitoring and Assessment Program) is to provide reliable and consolidated data for 'state of the environment' reporting, 'impact assessments' of major pollutant sources, 'transboundary diagnostic analysis' and SAP implementation reports (BSSAP process) in view of decision-making needs in the Black Sea region. The sites, parameters

and monitoring frequencies also reflect data requirements for compliance with relevant national and international legislation and agreements.

The most relevant international policies and agreements in terms of monitoring the Black Sea and reporting are considered to be not only the SAP for the Rehabilitation and Protection of the Black Sea 2009 (adopted in April 2009), but attempts have also being made to harmonize approaches and principles with the Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD) which are obligatory for Romania and Bulgaria, and seriously taken into consideration by Turkey in the accession process.

The regional monitoring program BSIMAP is based on National monitoring programs, financed by the Black Sea states. Outside of National Programs, pilot monitoring field trips related to various environmental problems have been and are carried out in the frames of different projects, financed by donors, such as EU DG Research and DG Environment, NATO Science for Peace Program, UNDP/GEF and UNEP and others (see Annex I – Listing the Projects, cruises undertaken, data bases compiled).

BSIMAP follows the DPSIR (Drivers, Pressures, State, Impact, Response) Model and allows detecting negative impacts as well as the effects of measures taken in a timely manner, thereby enabling the necessary corrective actions to be further taken. The choice of parameters to monitor is related to the main environmental problems considered in the Black Sea region and re-evaluated every 10 years based on BSC reports – TDA and SoE (e.g., TDA 2007, SoE Report 2002 and 2008, www.blacksea-commission.org).

The main environmental problems in the region are*:* Eutrophication, Chemical pollution (including oil), Biodiversity decline, Habitats destruction and Overfishing.

Main policy questions which BSIMAP answers are:

1. What is the level of eutrophication? Are the regional efforts to combat eutrophication effective and do we see them reflected in the concentrations of **nutrients** in the Sea?
2. What are the **priority pollutants** in the Black Sea and their impact on ecosystem and human health? Does pollution reduction occur?
3. Is the **bathing water quality** safe for human health?
4. What is the **response of biodiversity** to main pollution and what is the level of habitats destruction/revitalization?
5. Does **pollution of biota** exceed the human consumption safety limits?
6. How does overfishing, pollution and eutrophication affect the **major stocks** of marine living resources?
7. What is the impact of **increasing oil/gas exploration** activities in the Sea?
8. Effects of sea-level changes and other **climate change** parameters?

The priority parameters in BSIMAP envisaged, providing knowledge-based answers to the main policy questions, the recommended BSIMAP initial actions and the status of their implementation with improvements needed are listed below:

Table 1. BSIMAP priority parameters, actions, implementation.

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implementation	Improvements needed
Trace metals: **Cd, Hg, Pb, Cu, others** (mandatory in BSIMAP)	What are the loads of trace metals from land-based sources of pollution? Are agreed measures effective in reducing pollution?	monitor discharges and estimate riverine, direct industrial and municipal loads	1. compile national meta data on all riverine, industrial and municipal sources of pollution in the coastal zone 2. develop set of indicators to be reported 3. harmonize monitoring strategies and networks	Monitored, reported for rivers and 50 Hot Spots, most of them WWTP. Specific indicators are not developed, LBS Reports contain Figures showing trends. Data of states can be compared. Methods to measure trace metals harmonized.	Hg rarely measured. Indicators need to be developed. River monitoring strategies are not harmonized.
	What are the concentrations in water, sediments and biota?	monitor concentrations	2. develop background values and assessment criteria for environmental quality 3. sustain the regional quality assurance and quality control system 4. develop set of indicators for reporting on the state of the Sea environment	Monitored with gaps, basically in water, rarely in sediments and biota. QA/QC sustained. Trends outlined. Methods harmonized.	Background values absent in TU and GE. Assessment criteria for water quality need to be harmonized. Set of indicators to be developed.

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implement ation	Improvements needed
			5. outline trends in historical data harmonize the methods used and national monitoring strategies and networks		
Pesticides (mandatory in BSIMAP for sediments, optional for water)	What are the levels of pesticides in the water, sediments and biota?	monitor concentrations	assess the scope of the problem for the Sea by random sampling or based on available data in the vicinity of major sources of organotin pollution (say major ship routes, nearby river mouths, etc.)	Monitored with gaps. Data available. Last assessment – SoE, 2008.	Not monitored on a regular basis in BG and GE. Rarely measured in sediments and, especially, in biota. Better monitoring and assessments needed.
PCBs (optional in BSIMAP for water, mandatory for sediments and biota)	What are the loads of PCBs into the Sea?	monitor loads	compile national data if available: inventory of PCBs sources and preliminary assessment of loads, including riverine inputs	Not monitored, not reported to BSIS. Inventory of sources and assessment of loads missing.	Pilot monitoring to identify the sources, assess the problem with consequent decision on PCBs loads relevance for the regional monitoring program
	What are the concentrations of PCBs in marine biota (including mammals) and bottom sediments?	monitor concentrations	pilot monitoring of PCBs levels in bottom sediments and biota (or analyses of available data) and decision on their relevance for regional monitoring program	Not monitored. Not reported to BSIS. Data available outside of BSIMAP and BSIS, but scarce (UA, RO, for instance).	Pilot monitoring to assess the problem with consequent decision on PCBs relevance for the regional monitoring program
	Which are the		1. quality check	Not monitored,	Pilot monitoring:

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implement ation	Improvements needed
PAHs (not included in BSIMAP for land-based sources)	major sources and how large are the inputs?	monitor loads	the existing information on PAHs concentrations in water and 2. further compile and quality check data on PAHs loads where available 3. list of pollution sources	not reported to BSIS, no list of pollution sources.	Sources to be identified, loads assessed, decision on their relevance for the regional monitoring program to be taken
	What are the concentrations in water and sediments (optional)	measure concentrations of PAHs in water and sediments	include PAHs measurements in programs of cruises (projects) to check if the problem exists	Monitored with gaps, mainly in water. No harmonization of methods.	Pilot monitoring: screening of the levels of PAHs in bottom sediments, with consequent decision on PAHs relevance for the regional monitoring program. Harmonization needed.
	Do PAHs affect fish and shellfish (optional)	measure concentrations of PAHs in fish and shellfish	Incorporate random sampling where possible to address the problem (feasibility study)	Monitored randomly in UA	Better screening needed, pilot monitoring recommended.
Noxious and Harmful Substances	What chemicals are transported via the Sea?	collect data on transportation	1. compile meta data on regular transportations 2. illegal discharges, accidents occurrence	Not collected	Pilot project/feasibility study recommended
Phenols (not included for LBS loads, optional for	What are the loads of phenols coming from land-based sources of	monitor loads and concentrations	1. assess levels of phenol pollution in	Not monitored, not reported	Pilot project: Inventory of sources, assessment of loads and concentrations in

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implementation	Improvements needed
water and mandatory for sediments in the Sea)	pollution? What are their concentrations in water? Do phenols pose risk to human health and Sea environment?		the marine environment 2. assess impact of phenol pollution on coastal waters 3. outline trends in historical data 4. inventory of pollution sources of phenols		water and sediments, decision on Phenols relevance for the regional monitoring program.
Detergents (mandatory for loads, optional for sea water)	What are the concentrations in Sea waters? What are the loads from rivers and other land-based sources of pollution?	monitor loads and concentrations	1. assess the level of detergents in coastal waters 2. outline trends in historical data	Concentrations in the Sea monitored with gaps, reported basically by RU, TU and UA	Better assessment of the problem needed (loads). For water concentrations – improvement of the monitoring in coastal waters.
Oil pollution, petroleum hydrocarbons (TPHs, mandatory)	What are the pollution sources of oil	monitor loads and concentrations	1. assess pollution loads of oil from land based sources and offshore installations, illegal discharges and accidents 2. outline trends	LBS monitored	Offshore installations and illegal discharges. Updated assessment of trends for LBS needed.
	What are the values of total petroleum hydrocarbons in water, sediments and biota?	monitor concentrations	identify background values, assess trends	Monitored with gaps, especially in BG, GE. Mainly concentrations in water and loads are measured. No harmonization of methods.	Better monitoring of TPH in sediments and biota needed. Harmonization of methods needed.

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implement ation	Improvements needed
Radionuclides (optional)	What are the trends of radionuclides in the Sea? Do they pose risk to human health and Black Sea biota?	1. monitor concentrations of radionulides in water, sediments and biota 2. assess risk to human health and biota	assess trends	Not reported to BSIS, classified information. Available scientific assessment in the SoE, 2008.	The data to be reported to BSIS
Nutrients (mandatory)	Are agreed measures effective in reducing eutrophication? What are the levels of nutrients in water and sediments, what are the loads from rivers and other land-based sources of pollution?	monitor concentrations and discharges, assess loads of nutrients	outline indicators and trends for loads and concentrations, introduce monitoring of nutrients in sediments (where possible) to assess the level of secondary eutrophication TRIX index for estimation of eutrophication processes.	Monitored – loads and water concentrations. Data available for sediments. Indicators developed.	Monitoring of sediments and open sea waters
Phytoplankton (mandatory)	How often phytoplankton blooms occur? What are the areas of most frequent phytoplankton blooms? What are the consequences for the Black Sea flora and fauna?	monitor chlorophyll, phytoplankton abundance, biomass and species composition	outline indicators, background values, trends	Monitored, reported with gaps. Indicators, background values, trends known.	Open-sea monitoring
Zoobenthos (mandatory)	What are zoobenthos communities structure and abundance?	monitor abundance, species composition	habitats classification and mapping, outline of trends	Monitored. Habitats classification available.	Mapping pending.

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implement ation	Improvements needed
	Is their state improving in comparison to previous periods?				
State of other communities, endangered species (mandatory)	What is the state of macrophytes? Do numbers of endangered species increase?	monitor abundance	Red data book update, Assess natural habitats state, trends	Monitored, Red Data Book available	Habitats state needs to be better reported to BSIS
Sources and occurrence of Marine Litter (ML) on beaches and in the sea (floating, on the bottom)	What are the sources of litter, its amount/type, and areas of its occurrence? Marine litter in the Sea – amount/type, areas of accumulation.	UNEP guidelines	assess the scope of the problem in the Sea – bottom, coast, on the surface, major sources	Not attended in BSIMAP. Randomly monitored by NGOs, not reported to BSIS. Last assessment – 2007	To incorporate this kind of monitoring into BSIMAP with relevant reporting formats prepared
Effects of ML on birds and marine organisms	What are the effects of ML on birds and marine organisms		Compile information	Scarce data – not reported to BSIS, not attended in BSIMAP	Search for available information, involve NGOs
Impact of fisheries on ecosystem (mandatory)	What are the trends in fish catches? Which species are overfished? By catches and discards levels? Strandings? Bioaccumulation of toxic substances? Increase in fishing fleet?	monitor ichthyoparameters, assess stocks, catches, by-catches, etc.	1. harmonization of methodologies 2. trends	Monitored, harmonization in progress	By-catch, illegal fishery poorly monitored, needs improvement. Stock assessments further harmonized, relevant surveys organized.
Genetic disturbance	What are the trends in aquaculture development? What species are cultivated?	Compile data, monitor nutrients in aquaculture farms	track the eutrophication effect of mariculture	Trends in aquaculture development and species cultivated are reported	Eutrophication effect of aquaculture not known, feasibility study needed. Genetic effects

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implement ation	Improvements needed
	Are their escapes from farms?			to BSIS.	not known.
Transfer of diseases	What diseases are reported?			Not reported to BSIS	Compile information
Chemicals used in aquaculture	What chemicals are used for treatment?		Assess possible negative effects	Not reported to BSIS	Compile information, assess possible effects
Habitats destruction (mandatory)	Are destructive techniques used in the Black Sea region? What are the reasons for habitats destruction in the Black Sea?	Benthos investigations, monitor via sonars and underwater video as well, etc.	assess most threatened habitats at present, identify habitats of Sea importance to designate them as protected areas, identify threatened species and species which should be regulated	Monitored with gaps	Improve this kind of monitoring
Non-native species composition, abundance (mandatory)	What exotic species are intentionally and non-intentionally introduced	monitor exotic species	list of exotic species, vectors of introduction, impacts	Monitored, Lists available	Assessments of risk, Ballast water monitoring
	What are risks and vectors of introduction of new exotic species				
Microbiological indicators (mandatory)	What is the quality of bathing waters in terms of bacteriological pollution	monitor bacteriological parameters	list of beaches to be reported	Monitored, list of beaches available	Better reporting to BSIS needed
Atmosphere: Green house gases,	What is the level of atmospheric pollution?	monitoring of gases , deposition and	Improve reporting format, become	Monitored, poorly reported to BSIS	Contract with EMEP, end-users of Promote and similar

Priority parameters to be monitored	Issue to be addressed (Policy questions)	Monitoring	Initial Actions	Status of implement ation	Improvements needed
particulate matter, chemical pollution (optional)	Which areas are mostly polluted?	precipitation	end-user of PROMOTE project		projects. Development of stations for measurements of deposition.
Nutrients and pollutants from diffuse sources	What is the level of nutrients and pollutants entering the Sea from diffuse sources of pollution, including atmosphere?	Collection of data to be used in relevant models (MONERIS, SWAT, others)	Develop guideline for inventory, classification and assessment of diffuse sources of pollution, starting with nutrients. Development of models or adoption of available ones.	Not attended in BSIMAP	Priority issue, needs to be attended

Some of the **parameters in BSIMAP** are optional, others – compulsory, depending on the priorities. Compulsory parameters in BSIMAP are: nutrients, TPHs and PAHs, trace metals, PCBs, pesticides, detergents, biology (phytoplankton, zooplankton, benthos, fish, mammals, invasive species). Pollution and eutrophication parameters are studied in water, sediments, and biota.

In Annex II a full list of optional and mandatory parameters of BSIMAP is presented.

BSIMAP and BSIS are also about implementation of legal/policy documents in the field of environmental protection.

For instance, the implementation of the Land Based Sources and Activities of Pollution Protocol (LBSA) is monitored through collection of data on:

1. Institutions responsible for the LBSA Protocol Implementation (here the information can be provided according to the Articles of the revised LBSA Protocol, including monitoring Agencies for rivers, atm. pollution, municipal and industrial discharges, etc.)

2. LBS Projects, Programs, Plans, Strategies, Measures if any in River Basin Management, Nutrients and other Pollution Reduction, including POPs, Reduction of Air Pollution, Hot Spots, etc. Format:

2.1. Name of the Program/Project/Plan/Strategy/Measure

2.2. Duration (start-end)

2.3. Donor (Funding organization), amount of funding

2.4. Objective - the ultimate aim, what you are going to achieve by this program/project/plan/strategy/measure – for instance, referring to legally binding document, such as Urban Waste Water Directive, and formulate a relevant objective – build a tertiary treatment and reduce nutrients by 50%)

3. New agreements, national legislation and policy developments, changes in procedures, licensing if any.

4. BAT and BAP introduced (if any).

5. Air Quality - general information on number of stations measuring air quality, which are the organizations reporting to EMEP, which are the organizations responsible for the Kyoto Protocol, does your state produce inventories of Green House Gases for the Kyoto Protocol, who is responsible for the National Communications under the Kyoto Protocol (see http://unfccc.int/national_reports/annex_i_natcom_/items/1095.php)?

6. Publications.

In a similar way the implementation of other legal/policy documents is traced and reported. These documents are the Emergency Protocol (Protocol on Cooperation in Combating Pollution of the Black Sea Marine Environment by Oil and Other Harmful Substances in Emergency Situations), Dumping Protocol (Protocol on Protection of the Black Sea Marine Environment against Pollution by Dumping), Biodiversity Protocol (Protocol on Black Sea Biodiversity and Landscape Conservation) and the Strategic Action Plan (for the latter see the SAP Implementation report: http://www.blacksea-commission.org/_publ-BSSAPIMPL2009.asp). More details can be provided upon request.

Main pressures monitored in the Black Sea region are Land Based Sources of pollution and eutrophication, Shipping, Fishery and activities on the coast (Coastal Zone Management- available observation systems outside BSIMAP are listed in Annex I).

1. Land Based Sources of Pollution

Nutrients and pollutants stemming to the sea from rivers, municipal and industrial sources. Initially list of BS Hot Spots was agreed and decided to update it every 5 years. A Black Sea Methodology for identification of Hot Spots (and later deletion from the List) is developed for the purpose of update (pending for official adoption).

2. Shipping

- Ballast waters transportation
- Port Reception facilities
- Dispersants
- Ships calling at ports
- Quantities of cargoes
- Oil spills
- Dumping
- Pollution fines

3. Fishery[4]

- Stocks
- Landings
- Bycatch
- Strandings
- Illegal Fishery
- Economic indicators
- Gears
- Fleet
- Protection measures – fishing seasons, bans, fishing free zones, etc.

4. ICZM[5]

- Population and geography
- Energy
- Water and wastewater
- Biodiversity
- Coastal erosion
- Economy
- Tourism
- Health
- Solid waste management
- Agriculture
- Industry
- Transport
- Climate

Section II: Monitoring, data flows to the BSC and indicators: Achievements and the bottlenecks

II.1. Monitoring

II.1.1. Regional monitoring

As mentioned above, the regional monitoring program BSIMAP (Fig. 1) is based on National monitoring programs, financed by the Black Sea states.

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[4] Sources used outside of BSIMAP: http://www.fao.org/; www.fishbase.org; http://www.seaaroundus.org/lme/62.aspx

[5] Sources used outside of BSIMAP are listed in Annex I. Important: http://web.worldbank.org; http://www.imf.org/external/pubs/ft/weo/2007/02/weodata/ weoselgr.aspx; http://www.unwto.org/facts/menu.html;

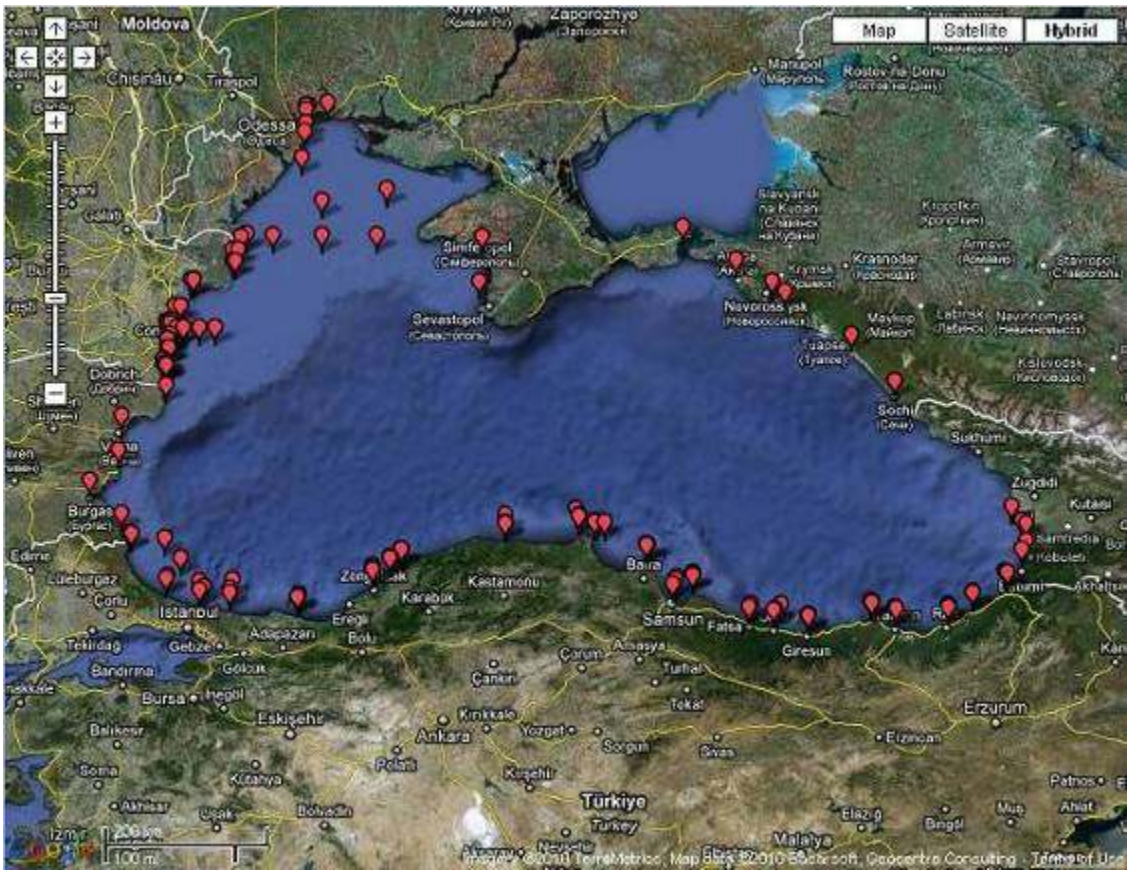


Figure 1. BSIMAP monitoring stations

Table 2. Number of national monitoring sites included in the BSIMAP, with an indication of spatial coverage

Territorial waters	Pollution Hot Spots	Sampling Sites reported	Length of coast, km	Average distance (km) represented per sampling site
Bulgaria	9	5	300	60
Georgia	6	5	310	62
Romania	5	21 (34 in the National Monitoring System)	225	17
Russian Federation	4	5	475	95
Turkey	10	3 (69 since 2007)	1400	466 (20 since 2005)
Ukraine	9	14	1628	116

Note: In 2009 Turkey reported 69 stations, Romania – 34.

There is no financial assistance for the monitoring in the Black Sea foreseen in the budget of the BSC. The BSC supports inter-comparison exercises (QUASIMEME), elaboration of guidelines to assure compatibility of data - harmonization of sampling techniques, methods of processing of samples and calculation of indicators.

II.1.2. National monitoring systems – status quo, gaps in data collected

Each state decides **how many and which stations** annually can be observed in the frames of the National Monitoring Program, what should be the frequency of sampling and which of the stations will be reported at the regional level. BSIMAP provides recommendations on parameters, frequency and methodologies. For measurements in water - at least 4 times per year is recommended in BSIMAP. For sediments and benthic communities – once or twice per year at least. Contamination in biota – once per year at least. Oceanographic parameters, nutrients, plankton and *Mnemiopsis* (or other exotic species) – monthly sampling recommended. It is also advised to have stations in impacted and undisturbed areas (reference stations) for the purpose of comparison, in transitional, coastal and marine waters. The monitoring is expected to be **integrated, regular and sustained at the same stations in time and space.**

Table 3. Compliance with BSIMAP recommendations in 2000-2010 in Black Sea SoE monitoring

Item/State	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
National Monitoring System Available	Yes	Yes	Yes	Yes	Yes	Yes
Responsible Institutions[6]	Ministry of Environment and Water	Ministry of Environmental Protection and Natural Resources	Ministry of Environment and Sustainable Development	Ministry of Natural Resources	Ministry of Environment and Forestry	Ministry of Environment al Protection
Reporting Institutions (agreed and regular reporting)	Basin Directorate - Varna, Environment Agency - Sofia, Institute of Oceanology-	National Environmental Agency of the Ministry of Environmental Protection and Natural Resources of	National Institute for Marine Research and Development	Roshydromet, (GOIN-Moscow, Azov Sea Institute of the Fishery Problems-Rostov;	Istanbul University (Institute of Maritime Sciences and Management), Ministry of Agriculture –	Ukrainian Ecological center, Institute of Southern Seas-Odessa, Kerch

[6] Bathing Waters are under the responsibility of Ministries of Health and reported accordingly. Fishery is under responsibilities of Ministries of Agriculture/relevant Agencies. In Russian Federation the monitoring system is very complicated (details are provided further).

Item/State	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
	Varna, Institute of Fishery – Varna	Georgia together with its branch in Ajara (Black Sea Monitoring Center).		and Shirshov Institute-Moscow)	Fishery Agency	Fishery Institute (YugNIRO Institute) , Ecological Inspection-Odessa
Recommended frequency of observations observed	No	No	Yes	Not for all parameters	No	Not always
Integrated national monitoring assured	No	No	Yes	No	Recently assured	No
Mandatory parameters observed	No	No	Yes	No	Yes	Yes
Transitional, Coastal, Marine stations observed	No	No	Yes	No	Yes	Not always
Reference stations available	No	No	Yes	No	Yes	Not mentioned
Financial assistance provided – sufficiently and timely	No	No	Problems appeared in 2009	Unknown size and time of funding (-State budget of Roshydromet, budget of local authorities of the towns of Sochi and Tuapse, business)	Yes	Not always
Is R/V available for the national monitoring	No	Yes, but small and old	Yes, small and old	Hydromet uses boats, as all stations are coastal	Very old vessel of the Istanbul University	Yes, but not in a good state
Bathing waters monitoring properly organized	Yes	Yes (partly)	Yes	Yes	Yes	Yes

II.1.2.1. Bulgaria

National Institutions involved: Basin Directorate, Environmental Agency (MoEW), Institute of Oceanology (Varna), Institute of Fisheries (Varna), Maritime Administration.

The National monitoring system is in a poor state during the last years – since 2006 sampling campaigns are carried out twice per year (in Spring and Summer). Samples are collected at 5 stations only (maximum), 1-mile zone offshore – in front of Shabla, in Varna Bay, Obzor, Bourgas and Achtopol (Fig. 2). Biological monitoring is carried out by the Institute of Oceanology – Varna, in no parallel with the hydrochemical monitoring of the Environmental Agency.

The Ministry of Environment and Water does not possess an appropriate sea vessel so currently the monitoring is carried out on contract based cooperation with other institutions.

Figure 2. Map of sampling stations in Bulgarian Black Sea waters.

II.1.2.2. Georgia

National institutions involved: National Environmental Agency of the Ministry of Environmental Protection and Natural Resources of Georgia together with its branch in

Ajara (Black Sea Monitoring Center-Batumi). LBS – Ministry of Environment; ESAS – Ministry of Transport.

Financial assistance is not provided by the government, but in the frames of different projects. In 2001-2006 - limited studies in terms of spatial and temporal coverage. In 2007 and 2008 monitoring and reporting were organized in a more efficient way. However, water column parameters were monitored whereas there was no monitoring of sediments and biota contamination.

Biology is reported by the Monitoring Center in Batumi.

II.1.2.3. Romania

National institutions (laboratories) involved: National Institute for Marine Research and Development (NIMRD-Constanta) under the supervision of the Ministry of Environment and Sustainable Development. ESAS – Ministry of Transport.

The National Programme has a good spatial and temporal coverage with 34 sampling stations, at standard depths and being performed 4 times per year.

List of monitored parameters and matrices is almost complete being;
Water - temperature, Secchi depth, salinity, dissolved oxygen, saturation %, BOD_5 , nutrients: NO_2, NO_3, NH_4, TON, PO_4, SiO_4, TOC, total hydrocarbons, trace metals, pesticides, PAH, phytoplankton, total coliforms, fecal coliforms, Streptococcus fecalis.
Sediments – total hydrocarbons, trace metals, pesticides, PAH, macrozoobenthos.
Biota - total hydrocarbons, trace metals, pesticides, PAH

Figure 3. Map of monitoring stations in Romanian Black Sea waters.

II.1.2.4. Russian Federation

National monitoring is sustained by the Ministry of Natural Resources. Biological investigations, contamination of biota and sediments are not part of the routine monitoring. ESAS – Ministry of Transport, Fishery - AzNIIRKH. Organizations of ROSHYDROMET performing the national monitoring under the supervision of the Ministry of Natural Resources are:

Table 4. ROSHYDROMET organizations and their responsibilities in the national monitoring system of the Russian Federation

№	Organization	City	Function
1	Special Center on Hydrometeorology and Monitoring of Environment of the Black and Azov Seas (SCHME BAS) of North-Caucasus Regional Division of Roshydromet.	Sochi	Sampling, processing, initial analyses, data stored in the Russian State Data Fond
2	TYPHOON	Obninsk	Processing of water and sediment samples (hazardous substances)
3	North-Caucasus Regional Center of Hydrometeorology	Rostov	Management of monitoring
4	All Russian Institute of Hydrometeorology-World Data Center	Obninsk	Data holder
5	State Oceanographic Institute	Moscow	Preparation of analytical materials, Management, Data holder, Analyses of data, Publication of Annual report
6	Institute of Global Climate and Ecology	Moscow	Operational information in cases of extreme

Standard hydrological, hydrochemical (incl. nutrients) parameters and contaminants are monitored in sea water in 6 areas between Tuapse and Sochi since 1992.

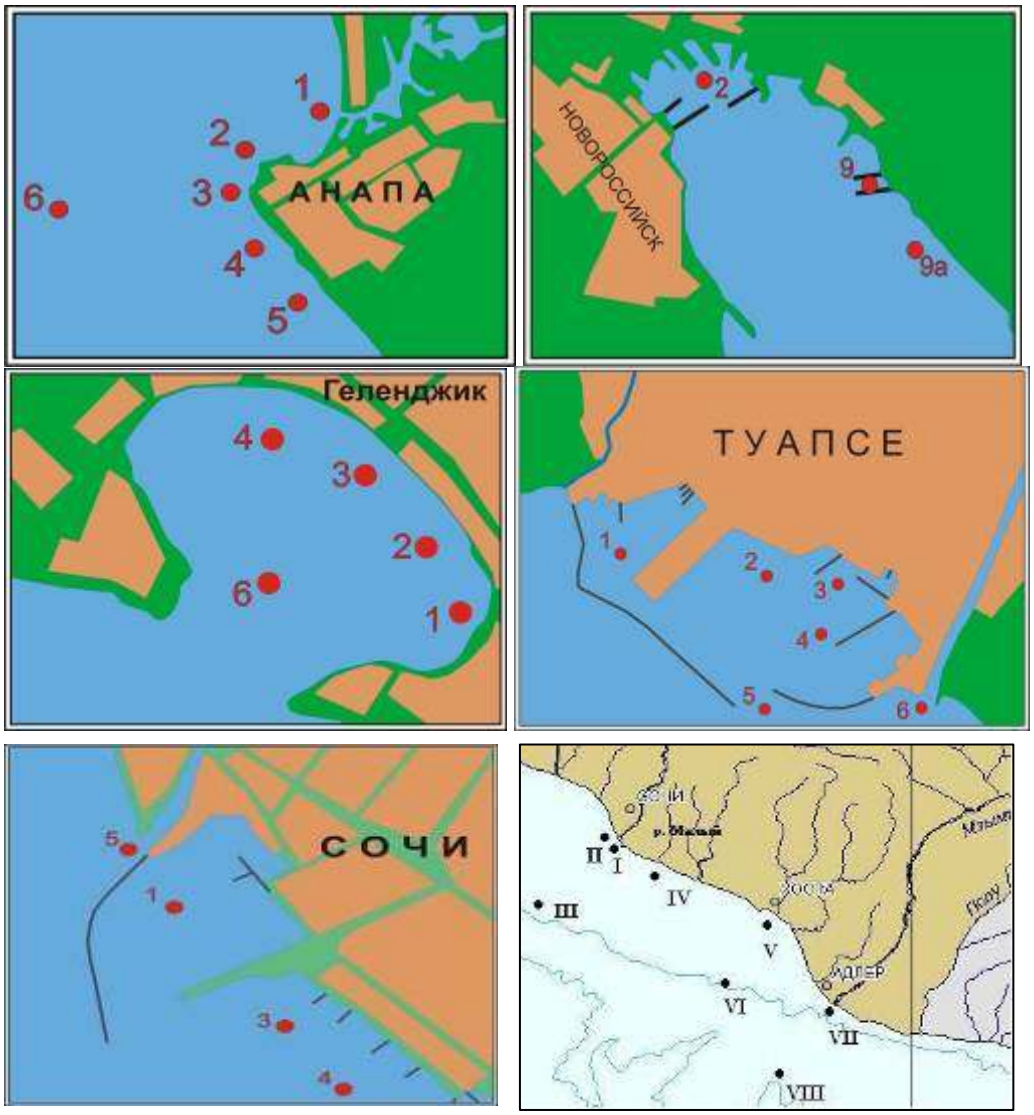


Figure 4. Maps of stations monitored by the Centers in Tuapse (1-5) and Sochi (last scheme) in Russian Black Sea waters.

II.1.2.5. Turkey

Institute of Marine Sciences and Management of Istanbul University carries out the national monitoring under the supervision of the Ministry of Environment and Forestry. 69 stations are monitored two times per year since 2005. LBS – Ministry of Environment and Forestry (MoEF); ESAS – MoEF and Ministry of Transport; Fishery – Ministry of Agriculture.

List of monitored parameters and matrices are almost complete being:
water- temperature, Secchi depth, salinity, dissolved oxygen, oxygen saturation %, BOD5, nutrients NO2, NO3, NH4, TON, PO4, SiO4, TOC, TSS, total petroleum hydrocarbons,

trace metals, pesticides, Chlorophyll-a, PAH, detergents, phytoplankton, total coliforms, fecal coliforms, Streptococcus fecalis
sediments – total hydrocarbons, trace metals, PAH, macrozoobenthos,
biota - trace metals

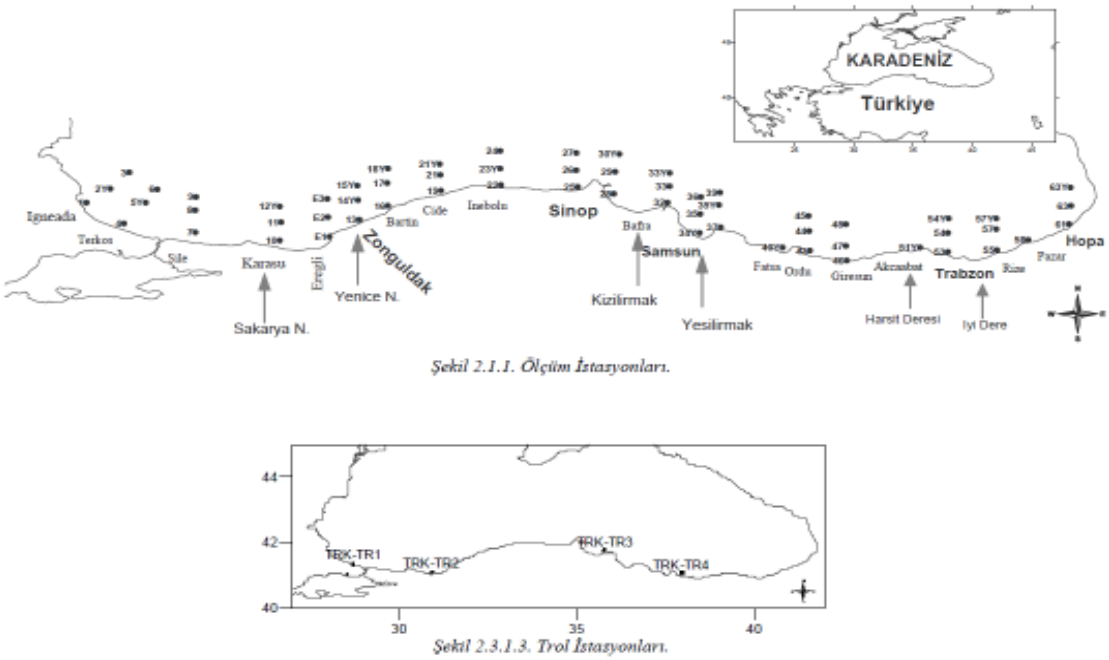


Figure 5. Map of sampling stations in Turkish Black Sea waters.

II.1.2.6. Ukraine

National Institutions involved in national monitoring:

- UkrSCES - the Ukrainian Scientific Center of Ecology of the Sea, MoEP
- SABSI – State Ecological Inspection of Azov and Black Seas, MoEP
- SEINWRBS - State Ecological Inspection of Environmental Protection of the Black Sea's North-West region, MoEP

Fishery - YugNIRO, Kerch, Crimea (Southern Scientific Research. Institute of Marine Fisheries and Oceanography).

The Programme is annually supported and biological investigations are included. The biological monitoring is carried out by the Institute of Southern Seas – Odessa which is not organized in parallel with the hydrochemical investigations. Biological data concerning for the N-W part is reported, data from Crimea and other UA waters are not made available.

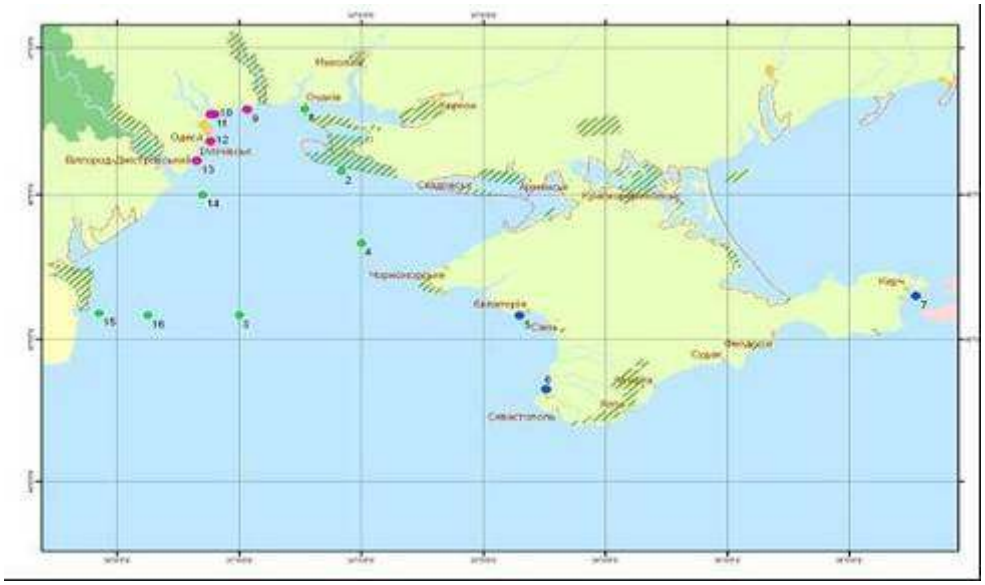


Figure 6. Map of sampling stations in Ukrainian Black Sea waters.

The stations given on the map are not regularly supported during each year. For instance, the map for 2008 looks in a different way and only the stations of the Odessa Ecological Inspection (they cover the region of the city of Odessa, nearby hot spots situated) are sustained on an annual basis and reported. Other UA waters are not reported. This kind of data is compiled in the Marine Branch of the Ukrainian Hydro-Meteorological Institute (MB UHMI) –Sevastopol.

Monitoring at defined stations network is carried out by the UA ecological inspections on a monthly basis (or as otherwise stated below) since 2003 and less frequently before that. A full set of hydrochemical parameters, including contaminants in water are monitored. Contaminants in biota and sediments are not included in the Programme.

In addition, MB UHMI – Sevastopol is in position to compile data from all ecological inspection stations in Ukraine – these stations (of SABSI and SEINWRBS) are annually reported in the Marine Water Pollution Annual Report of the State Oceanographic Institute (SOI) – Moscow. The stations monitored are in most affected by human activities areas (hot spots):

- In front of the rivers Danube, Suhoi Liman (nearby Ilichevsk), river South Bug and Bugskii Liman, Odessa port, Yalta – monthly observations;
- Ilichevsk town – once per two months;
- In the branches of the Danube river – April-September;
- Dniepr Liman – April-November.

Summary: National monitoring activities in the Black Sea states are supported by Ministries of Environment. Other Ministries, such as Ministry of Education, Agriculture, Transport and Academies of Science support problem-oriented monitoring in the frames of different projects. Ministries of Agriculture are responsible for fisheries investigations (stock assessments, catches, fishing fleets, etc.) and Ministries of Transport support/supervise most of the investigations related to environment safety aspects of shipping.

Reasons for gaps in BSIMAP: The main reasons can be listed, as follows:

- Poor financial assistance;
- National strategy does not foresee the monitoring as integrated;
- Lack of expertise, lack of equipment, old research vessels;

The monitoring/observation activities of most important Black Sea scientific Institutions – data holders which do not report or report not in full to BSIS are listed further. Thus, almost all data described in Section II.3 stay outside of the official reporting to the BSC. The latter is presented in II.2.

II.2. Data flow to the BSC

Regularity and quality of data collected in BSIS since 2001 are presented in detail in Section II.6 in terms of suitability of data for calculating indicators.

Overall, the reporting of BS states improved considerably during the last years, the quality of submitted data became higher and the gaps in data flow less significant. The table below gives a very general overview of the BS states official reporting:

Table 5. Official data reporting to BSIS

Item/State	BG	RO	GE	RU	TU	UA
How many Institutions are responsible for reporting?	7	3	6	7	3	5
Major gaps in reporting	Pollution data – water, sediments, biota	No gaps	Pollution data – water, sediments, biota; Biodiversity and Fishery data	Biodiversity and Fishery data; Pollution in sediments and biota	Biodiversity data	Pollution in sediments and biota
Major reason for gaps in reporting	Poor coordination	N/A	Financial	Poor coordination	Poor coordination	Financial
Quality of	good	excellent	good	good	excellent	excellent

Item/State	BG	RO	GE	RU	TU	UA
data					since 2005	
How can be the reporting improved?	By improved coordination between Ministries and by stable financial assistance for monitoring	N/A	By stable financial assistance for monitoring	By improved coordination between Ministries, Agencies and simplified organization of monitoring	By improved coordination between MoEF and scientific institutions	By stable financial assistance for monitoring
Can the data be used for scientific ecosystem analyses in TDA and SoE reports?	Only for independent analyses of water quality, biodiversity, etc., with no ecosystem approach	Yes	Only for independent analyses of water quality, biodiversity, etc., with no ecosystem approach	Only for independent analyses of water quality, fishery, etc. with no ecosystem approach	Only for independent analyses of water quality, fishery, etc. with no ecosystem approach	Only for independent analyses of water quality, biodiversity, fishery, etc., with no ecosystem approach
Can the data be used for SAP IR?	Yes	Yes	Yes	Yes	Yes	Yes

Reasons for gaps in BSIS: In general, there are two major reasons for poor reporting to BSIS– data are not available at all (they have not been collected due to one or another reason, basically the reason is financial, next and related to the previous – poor state of the Research Vessels, lack of equipment and lack of trained personal) or data are available, but due to poor inter-ministerial mechanism they cannot be obtained by the Focal Points. Besides, the Focal Points have no dedicated time in their ToRs officially to work for the Black Sea Commission. For them it is always an extra and completely voluntary work without many incentives.

II.3. Data outside of the official reporting

(for more details see Annex I and III)

The Black Sea directory of Marine Organisations is based on EDMO - European Directory of Marine Organisations (www.seadatenet.org). EDMO contains up-to-date addresses and activity profiles of research institutes, data holding centres, monitoring agencies, governmental and private organisations, that are in one way or another engaged in oceanographic and marine research activities, data & information management and/or data acquisition activities. Currently, full Black Sea EDMO list contains around 170 organisations, the important data-holders are listed further.

Availability of data in major data-holders (listed further by country) and outside of the official reporting is overviewed to the best of the BSC and experts from the BSC AGs

knowledge. Special attention is given to chlorophyll_a, nutrients, fishery, climate change, hazardous substances in biota and biodiversity data. The meta data provided for this report by the listed data owners is summarised in Section II. 6 of this Report.

The BSC web site shows links to the following important data bases in the BS region, existing outside of BSIS (see http://www.blacksea-commission.org/_datalinks.asp). Their data sets have not been evaluated for suitability to calculate indicators. Other important links are given in Annex I.

Physical Oceanography

1. NATO SfP Black Sea Database. Database includes all main physical, chemical and biological variables for the entire Black Sea basin for the period 1954 - 1996 and serves as a base line for contemporary and future research activities and management purposes in the region.
2. National Oceanographic Data Centre of Ukraine (NODC). The Oceanographic Data Base of Marine Hydrophysical Institute includes more than 114 thousand hydrological for period 1890-2007. It contains all the data for the Black Sea which were obtained by MHI and other Ukrainian organizations. Open this link for data access and choose "Select Data" menu.
3. World Ocean Database 2009. WOD-2009 is the largest, most comprehensive collection of scientific information about the oceans with records dating as far back as 1800. Black Sea data can be retrieved using WOD Select and Search tool or downloaded from section Geographically sorted data (for Black Sea region select data from WMO squares 1402-1404).
4. Common Data Index (CDI) data access service at the SeaDataNet portal. CDI provides access to individual datasets (such as samples, timeseries, profiles, trajectories, etc) of members of the SeaDataNet infrastructure, which combines informational resources of 40 national oceanographic data centres and marine data centres from 35 countries riparian to all European seas. The process of data retrieval is organized in search&shop way and is explained in details at the CDI webpage. User registration is mandatory, and user access to data depends on obtained user license.
5. Oceanographic Database of the Hellenic National Oceanographic Data Centre.

Black Sea Observations at the MyOcean Project website.

Modeling and Forecast

1. European Costal Sea Operational observing and Forecasting System (ECOOP). The Project products are:
   - Basin-scale analysis and forecast of the Black Sea circulation and stratification.
   - Regional forecast for South coast of Crimea and North East Black Sea.
     Dataset.
   - Regional forecast for the North-West of the Black Sea.
     Dataset.
   - Regional forecast for the South West of the Black Sea.
     Dataset.

2. Salto / Duacs Black Sea Near-Real-Time Sea Level Anomalies.

3. Sea Temperature and Current velocity. The project FP7-SPACE-2007-1: My Ocean-WP10-BS.
4. 3-day weather forecast over the Black Sea. MM5 v.3.7 mesoscale model.
5. Black Sea Physics Analysis and Forecast at the MyOcean Project website

Climatology
1. SeaDataNet climatologies:
   - 4D analysis of temperature and salinity with DIVA software(Choose Black Sea from menu)
   - Black Sea Climatic maps and fields prepared for in-situ physical parameters and characteristics of O2-H2S interaction zone.
   - Averaged maps and fields of sea surface parameters obtained from satellite data.
   - Altimetry (Geostrophic Velocity Anomalies and Sea Level Anomalies)
2. Climatic atlas for the Black Sea at the website of National Oceanographic Data Centre of Ukraine.
3. Black Sea product SeaDataNet. Black Sea Climatic maps and fields prepared for in-situ physical parameters and characteristics of O2-H2S interaction zone. Averaged maps and fields of sea surface parameters obtained from satellite data.
4. Climatic Atlas of the Black Sea produced at the National Oceanographic Data Center of Russian Federation (in Russian).
5. Oceanographic Atlas of the Black Sea: http://www.hydro-international.com/news/id3511-Oceanographic_Atlas_of_the_Black_Sea.html

Satellite data and images
1. GIOVANNI - Ocean Color Radiometry Online Visualization and Analysis. Global Monthly Products (Chlorophyll, water-leaving radiance, SST, etc).
2. OceanColor web (Chlorophyll, water-leaving radiance, SST, etc).
3. Marine portal National Space Agency of Ukraine (NSAU). SST from NOAA satellites, Chlorophyll. Note: data are accessible upon registration.

Biology & Ecosystem
1. Black Sea Zooplankton Checklist
2. Black Sea Phytoplankton Checklist
3. Black Sea species in the FishBase
4. Rapana venosa in the Black Sea at the Global invasive spesies database
5. Mnemiopsis leidyi database
6. Black Sea Ecosystem information at the Sea Around Us Project website.

Major Data-holders in the Black Sea region:

II.3.1. Bulgaria

1. Institute of Oceanology –Bulgarian Academy of Sciences, Varna (IO-BAS)

The data base of the Institute contains data from regular hydrological/hydrochemical (since 1975) and biological investigations (since 1991) carried out in Bulgarian Black Sea waters

on a regular basis. Chlorophyll_a and macroalgal communities meta data (full inventories) were delivered for the period 2000-2009 and examples are presented in Annex III. The Institute is the National Oceanography Data Center.

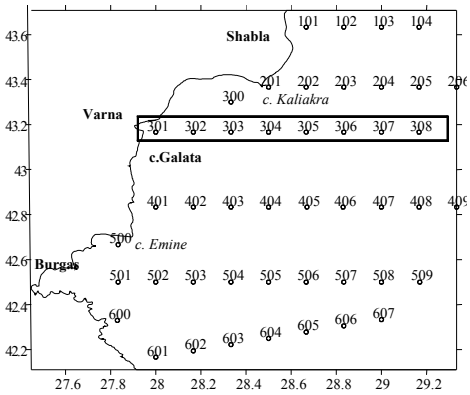


Figure 7. Map of sampling stations observed by IO-BAS in Bulgarian Black Sea waters

In 2001-2009 nutrients were monitored by IO-BAS at 3 transects: in front of Cape Kaliakra, Cape Galata and Burgas Bay and occasionally – in front of Shabla and Maslen Cape. The most regular observations are available at Cape Galata. Inventory of cruises is presented in Annex III.

2. Institute of Fishing Resources, Varna (IFR-Varna)

The data base of the Institute contains long-term data on nutrients, biota (all trophic levels, except macroalgae) and fishery. Along the Bulgarian coast (up to 30 miles offshore), Capes Kaliakra, Galata and Emine, Burgas Bay, Varna Bay and Varna lakes have been regularly monitored since 1953 up to now. Monitoring was held seasonally in 1953-2005 and since 2005 randomly. Most regular monitoring was held in Varna Bay and in front of Cape Galata.

The Institute of Fishery, within the Project daNUbs (see Annex II), collected full set of organic and inorganic nutrients, chlorophyll was regularly measured by CTD in 2001-2004.

Maps of sampling stations are presented below:

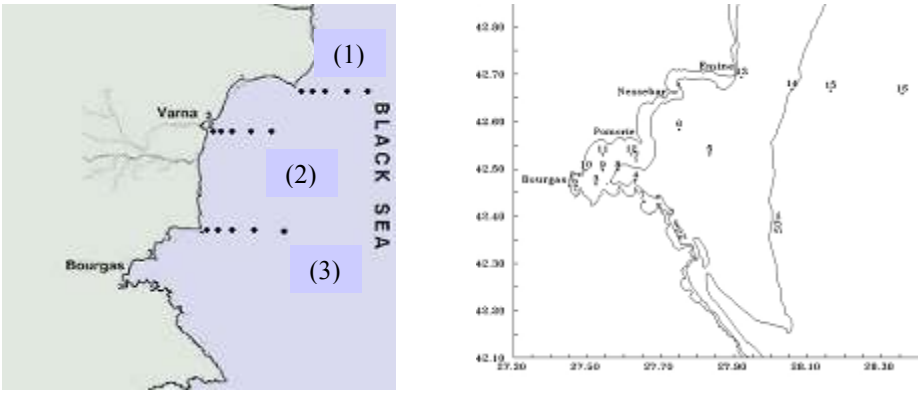


Figure 8. Map of sampling stations monitored by IFR-Varna in Bulgarian Black Sea waters: (1) transects Kaliakra (1), Galata (2), Emine (3); Bourgas Bay (second figure).

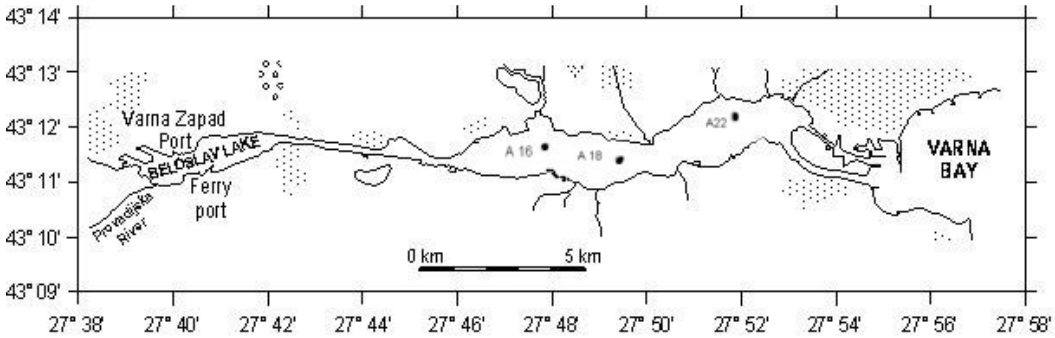


Figure 9. Map of Varna/Beloslav Lakes and Varna Bay

3. Central Laboratory of Ecology, Sofia (CLOE)

Regular investigations were held in Sozopol Bay (not far from the city of Bourgas) seasonally in1993-2009. Nutrients and chlorophyll were measured.

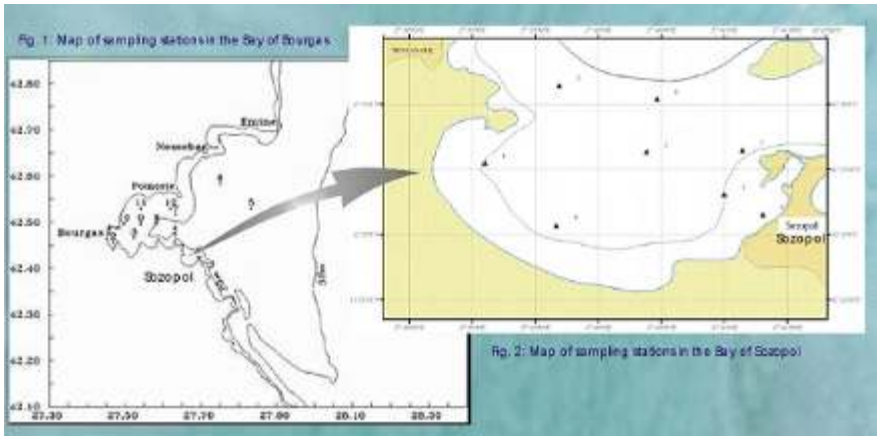


Figure 10. Map of sampling stations observed by CLOE in Bulgarian Black Sea waters

II.3.2. Georgia: There is no data source different from BSIS.

II.3.3. Romania

In the BSC BSIS the Romanian data as frequency of observations and stations (agreed for reporting) is fully presented, in general. They have additionally **daily stations at Sulina and Constanta** monitored monitored by NIMRD-Constanta as follows:

- Sulina station

since 1980 - phosphates, silicates, oxygen
since 1981 - ammonium
since 1988 - nitrates, nitrites

- Constanta station

since 1959 - temperature, salinity, oxygen
since 1960 - phosphates, silicates
since 1976 - NO3, NO2
since 1980 - NH4

- East Constanta transect

between 1963 - 1980 - (5 station per transect monthly) - temperature, salinity, oxygen, PO4, SiO4, NO3, NO2, NH4. The sampling on this transect was seasonal in 1980 – 1985. Since 1986 the transect has depended on different projects, therefore it is not always regularly observed.

Measurements of organic nitrogen started in 2006, available data in BSIS for 2006-2008.

Chlorophyll a:

- **Nato Database** - January 1976 – August 1979 – transect Sulina, Sf. Gheorghe, Portita, Constanta from surface and 10m layer, discontinuous data;
- **COMS Black project:** - March 1995 – Mila 9, Constanta; April 1995 – Sulina, Mila 9, Zaton, Chituc, Constanta;
- **DANUBS project** – 2001 – 2003 – from north to south in the shelf waters. Since 2004 – till present – Chl is measured at all coastal and transitional stations of the Romanian national monitoring system, from March to October.

2. GeoEcoMar

The Institute performs investigations in Romanian waters, marine geology and sedimentology, geo-ecology, bio-chemistry, physics, and others. Detail information can be provided upon request.

II.3.4. Russian Federation

1. Southern Branch of Shirshov Institute of oceanology RAS- Gelendzhik

The data base of the institute contains data on hydrological and hydrochemical observations.

Permanent station (in the vicinity of the city of Gelendzhik) - regular observations of all organic and inorganic nutrients, 2-4 times per month in 2001 – 2009. In 2003-2005, standard hydrological/hydrochemical monitoring was held on a weekly basis at other selected points around Gelendzhik as well (two times per year (winter and summer) surveys were carried out in the whole Gelendjik Bay). List of parameters (standard hydrology/hydrochemistry) includes: temperature, dissolved oxygen, BOD5, alkalinity, pH, phosphorus phosphate, and total P, silicon, nitrogen, nitrates, nitrites, ammonia, urea, organic nitrogen. In 2005-2009, the frequency of sampling was 2 times per month.

Additionally, there is a large array of data in the north-eastern part of the Black Sea and a more or less regularly observed transect – up to 100-mile off Gelendzhik to the center of the Sea, under the implementation of a program with standard hydrochemistry (regular), and organics measured rarely. Total in Gelendzhik the hydrochemical data base includes 1210 stations (Fig. 11) observed in the period 1984 - 2008.

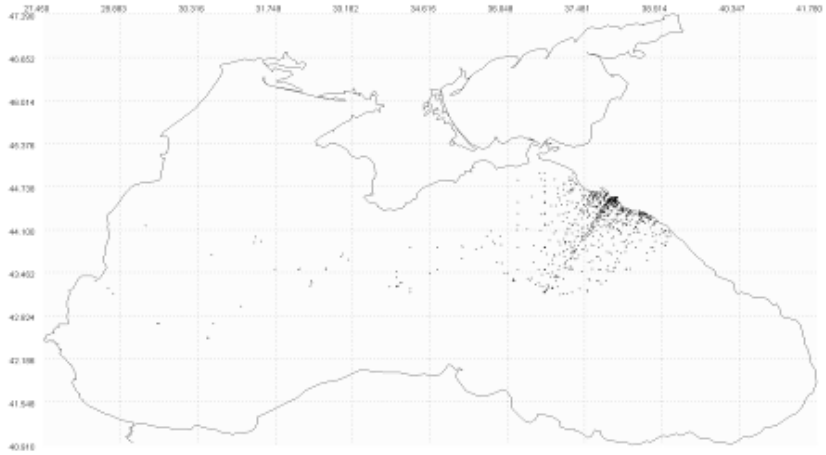


Figure 11. Map of sampling stations in the Eastern, Central and Western Black Sea, observed by the P.P.Shirshov Institute of oceanology RAS (Gelendzhik)

2. Shirshov Institute, Moscow

The Shirshov Integrated monitoring has the main aim to study:

- Meso-scale hydro-physical processes in near shore area
- Fine structure of hydrochemistry of oxygen depletion zone
- Phytoplankton variations in time and space
- Zooplankton studies with special references to invasive ctenophores *Beroe* and *Mnemiopsis* abundance and distribution
- Investigations on long-term changes in benthic communities

Cruises, including open sea areas have been performed on a relatively regular basis in the period 2001-2009 and before (Annex I).

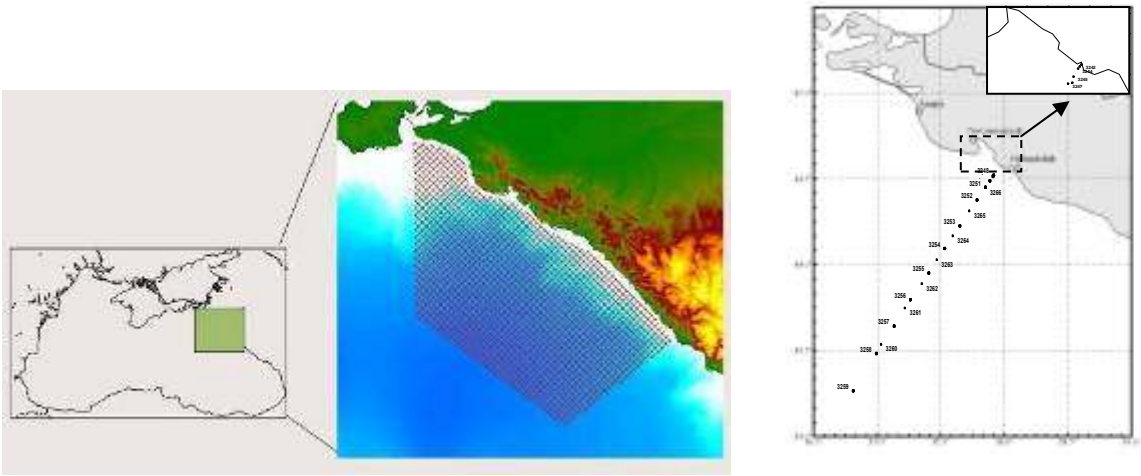


Figure 12. Map of sampling area covered by the Shirshov Institute of oceanology and the "standard" monitoring transect in front of Gelendzhik (second figure)

The “standard” transect is situated offshore from the city of Gelendzhik toward the center of the north-eastern part of the Black Sea. The distance from shore varies in different cruises from 5 to 100 miles depending on the weather conditions and vessel capacity.

Regular monthly observations on phytoplankton communities (and chlorophyll) are carried out in the Russian shelf area since 2005. The sampling site is at 2 miles offshore (50 m depth) in front of Gelendzhik. R/V “Ashamba” is used for collecting of phytoplankton samples. Hydrohysical and standard hydrochemical parameters (+ all nutrients) are also included in the monitoring. Normally, sampling is carried out on a monthly basis, from March to December.

Regular two times a year observations on zooplankton communities have been performed in the Russian shelf area since 1993 at the R/V Akvanavt and R/V “Ashamba”in front of Gelendzhik and in entire northeastern Black Sea. Hydrohysical and in some cruises standard hydrochemical obresvation have been carried out.

3. Novorossiysk educational and research marine biological center

Traditional water quality parameters are measured, including pH, dissolved O_2, H_2S, methane, BOD_5, suspended solids, detergents, trace metals (Al, Cd, Cu, Cr, Fe, Hg, Mn, Ni, Pb, Zn), Arsenic, TPH, pesticides, phenols. Macroalgae and seagrasses are also investigated. Chlorophyll-a is not measured.

Figure 13. Map of sampling points in the Novorossiysk Bay and along the Russian coast

4. AzNIIRKH-Rostov

Parameters observed during all cruises are nutrients, contamination of biota (TPH, PAHs), macroalgae, seagrasses, etc. This is a comprehensive monitoring activity held in the period

of 1999-2009 3 times per year; spring, summer and autumn at more than 250 transects and about 1300 stations in all four areas seen on the map below (See also Annex III).

Figure 14. Map of sampling stations in the Black and Azov Seas**.**

In Russian Federation there are also other organizations/Agencies involved in a routine monitoring outside of Roshydromet or Ministry of Natural Resources (MNR) system. Some of them are:

1. Yujmorgeologia / Rosnedra, MNR. Gelendjik, sediments pollution.
2. Black-Azov Seas Directorate – inspection of seas/ Rosprirodnadzor, MNR. Novorosiysk, water pollution.
3. AzNIIRKH / Rosribolovstvo, MNR. Rostov, biological resources.
4. Lukoil / Private company. Water pollution, incl. standard hydrochemistry

II.3.5. Turkey

1. Institute of Marine Sciences / Middle East Technical University, Erdemli-Mersin (IMS/METU)

IMS/METU meta data information is extractable from
http://www.ims.metu.edu.tr/ims_inventory/invsrv.dll/queryds.

Relevant large integrated projects of IMS/METU (cruises carried out/data compiled) were: of ISKI (1986-1994; regular), TUBITAK (1990-2000, less regular) and SESAME Project (2007-2008).

Full set of stations are presented for 1986-2008 as:

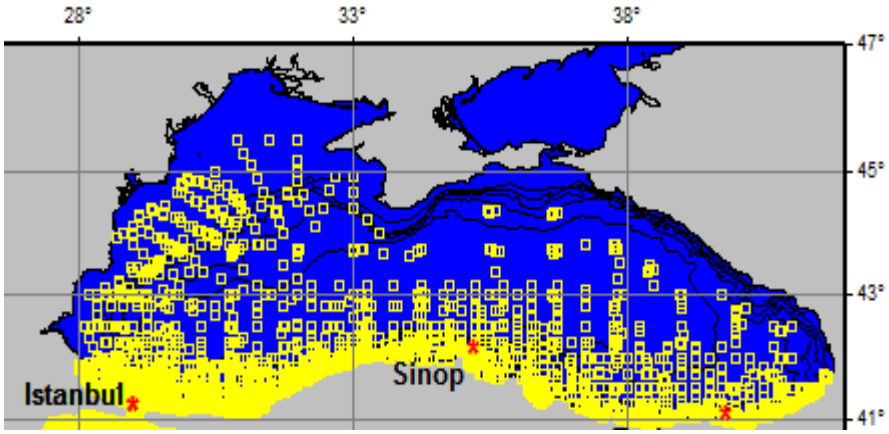


Figure 15. Map of sampling stations observed by IMS/METU in Turkish Black Sea waters.

2. Institute of Marine Sciences and Management / İstanbul University, İstanbul

Ongoing water quality monitoring in the Strait of Istanbul (Bosphorus) area since 1996 is carried out in the context of long-term project of ISKI (1996-2009). Cruises have been performed regularly once per month in the vicinity of the Strait of Istanbul. There is one station at the Black Sea-Bosphorus junction which is a time series station covered also by previous studies of IMS/METU.

3. Sinop University, Department of Hydrobiology

Meta data from Sinop Bay and coastal area are provided to the BSC (see Annex III).
Complex monitoring was designed as a time-series study, however, sustained only by short-term TUBITAK projects, therefore, needs special attention to operate it in the long-term. Monitoring has been held almost monthly since 1998 collecting hydrochemical and chlorophyll data sets, also phytoplankton, zooplankton and macrozoobenthic data sets.

At present, this data set is part of the National Data Inventory (http://www.ims.metu.edu.tr/inventory/) and BS SCENE UP-GRADE (FP7) and SeaDataNet (FP6) Projects.

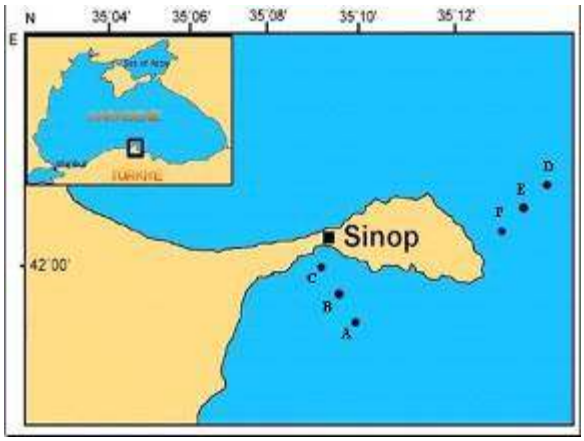


Figure 16. Map of sampling stations in the vicinity of Sinop

II.3.6. Ukrainian data

1. Institute of Biology of Southern Seas, Sevastopol

The data base of the Institute contains a huge stock of various oceanographic data collected in the Black Sea for the last 135 years. These datasets are exceptionally valuable as, in addition to biological data on the species level, they include hydrophysical, hydrochemical, and other environmental variables including unique parameters (in situ bioluminescence, e.g.).

IBSS Databases online (http://www.ibss.org.ua/Default.aspx?tabid=325):

- Multidiscipline historical data base of the Black Sea (NATO ODBMS online version, released in 2003);
- A Global Plankton Database: An Inventory and Data From the Former Soviet Union Expeditions (online version, released in 2005);
- NMFS-COPEPOD: the global plankton database
- IBSS data in MedOBIS;
- IBSS data in World Ocean Database

IBSS regular monitoring in Crimea coastal waters for nutrients and Chlorophyll is carried out at stations presented in Fig. 17.

Figure 17. Map of regular (●) and episodical (▲) studies of parameters of the environment in the coastal zone of Crimea performed by the Department of Applied Oceanology and Aquaculture, IBSS NASU (Ukrainian National Academy of Science).

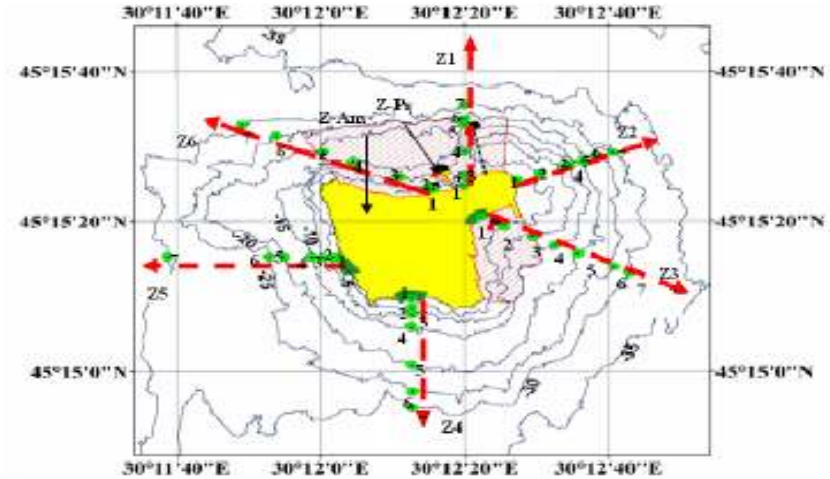
Details about frequency and areas of observations during the last 10 years are provided in Annex III. Meta data (full inventories of nutrients, chlorophyll, macroalagae and seagrasses) are available, can be provided upon request.

2. Odessa University

The Island of Zmeiniy (North-Western Part of the Black Sea, Ukraine) area has been studied by the Odessa University for temperature, salinity, oxygen and sea level on a daily basis in 2004-2009. Chlorophyll a,b,c, phytoplankton, zooplankton, bacteria and nutrients (P and N compounds) have been measured every 5 days in 2004-2008 and every 10 days in 2008-2009 (March-December) - at two depths: 0 m and 8 m. Recently fish investigations have been started.

Meta data is available through http://www.seadatanet.org/metadata/edmed and https://www.bodc.ac.uk/data/information_and_inventories/edmed/results/ .

Coordinates of the investigated area:
45,25753N=45º15'26,9"N
30,20499E=30º12'17,9"E



-5- - -35- - isobaths, m

ZPr – station of regular (routine) monitoring of coastal water,

Z at – atmospheric monitoring site

Figure 18. Sampling locations around the Island of Zmeiniy in 2004-2009: UA, external data.

Additionally, 40 stations around the Island (distance from 50 to 300 m off the Island), approximately once per season with the same list of parameters (as mentioned above) are monitored: at surface and bottom (the depths vary from 5 to 30 m at different stations).

3. **Sevastopol Marine Hydrophysical Institute (MHI, Sevastopol) –** National Oceanography Data Center.

The Institute performs investigations on climate change indicators, nutrients, satellite observations and others. The Oceanographic Data Base of the Marine Hydrophysical Institute includes more than 114 thousand hydrological records for the period 1890-2007.

The cruises of the Institute in the Black Sea, covering coastal and marine waters, are listed in Annex III.

In 2006-2008 the Institute carried out 6 cruises in Sevastopol Bay, 36 stations in each cruise and collected hydrological, hydrophysical and nutrients data.

4. YugNIRO Institute, Kerch, Crimea, Ukraine (Southern Scientific Research Institute of Marine Fisheries and Oceanography)

Regular observations in Ukrainian waters, including fisheries (the Institute reports all UA fishery data to BSIS) are held. Detail information could be provided upon request.

II. 4. Project related monitoring and data bases created in the Black Sea region since 2001

In the European Directory of Marine Environmental Research Projects (http://seadatanet.maris2.nl/v_edmerp/browse.asp) 292 projects are listed for the last 10 years to have taken place in the Black Sea, though a few projects are double-reported (such as SESAME, ARENA, e.g.). Other inventory can be found at: ftp://ftp.cordis.europa.eu/pub/fp7/environment/docs/catalogue-projects-fp7envnmp_en.pdf.

There is **no full inventory** of all projects (EC, NATO, UN, private) which have taken place in the Black Sea during the last 20 years, since the Bucharest Convention was signed and the cooperation in the region was progressively increasing. This is one of the important gaps in the region – not knowing the exact number of projects, their funding, what they produced and where the products are kept. Undoubtedly, all of the projects collected data (historical or during cruises, bibliography, etc.).

Some of the most important projects of the Black Sea Commission are presented in **Annex I** with a concise overview of their activities, cruises (if any) and data collected (if any).

The cruise summary reports in SeaDataNet (http://seadata.bsh.de/csr/retrieve/V1_index.html) list 179 cruises in the period 2000-2010 in the Black Sea, carried out on board of different vessels (Akvanavt – Russian Federation, Shirshov Institute; Prof. Valkanov – Bulgaria, IFR-Varna; Academic – Bulgaria, IO-BAS-Varna; and many others). Each cruise is described in detail in SeaDataNet: area of observation, parameters observed, etc.

II.5. Quality control/assurance

Explored regional options – QUASIMEME, IAEA exercises, or regionally organized inter-comparisons. The latter are carried out in support to the sampling and processing methodologies harmonization in the Black Sea region (e.g. nutrients, phytoplankton, zooplankton, TPH, etc.). In BSIS the data quality checks are under the responsibility of the reporting Institutions[7]. Some projects, such as SESAME (see Annex I) include in their work programs inter-calibration and inter-comparison exercises.

The project UPGRADE Black Sea SCENE (http://www.blackseascene.net/, see Annex I) deals with elaboration of Black Sea Guidelines for QC/QA in biology and hydrochemistry.

[7] The BSC PS checks the data submitted to BSIS and requires additional quality checks where necessary.

II.6. Suitability of data for calculating indicators

In order to review the suitability of BSIS and other (external) data for calculating EEA indicators, BSC indicators as agreed today and MSFD GES Descriptors and wider assessments (Annex I and III) a common table of indicators is established - Table 13 (See section III).

II.6.1 Nutrients

Long-term winter upper 10 m nutrient (NO3+NO2-N, PO4-P) data has been accepted as major eutrophication EEA CSI. Winter has been accepted as the most enriched period of surface waters with nutrients as a consequence of seasonal mixing. In the Black Sea, besides seasonal mixing effect, large river inputs in spring also enrich the surface waters with nutrients (SoE, 2008). Therefore, the available data in BSIS have been examined for both seasons in the transitional, coastal and marine waters and see if they are suitable for aggregation and temporal trends (Table 6). Winter months are considered as December-February and spring as March-May. Worth to add that, it is almost always the case to find data for other seasons if there is data in winter and spring in a year.

External data sources were also searched for since nutrients are widely measured in different monitoring systems in the Black Sea basin. Meta data reports obtained from country experts presented in Section II.2 and in Annex III are summarized as external data (Table 6).

Table 6. Availability of nutrient data in BSIS and external data sources**.**

	Indicator name	Years	No of sts in Transitional waters (winter / spring)	No of sts in Coastal waters (winter / spring)	No of sts in Marine waters (winter / spring)	Time series
RO BSIS	NO3+NO2 PO4	2001	10 / 18			1996-2007 Available from graphical presentation in 2007 RO National report
		2002	n.a/ 20			
		2003	n.a/ 16	n.a/ 9		
		2004	n.a/ 19	n.a/ 9		
		2005	n.a/ 19	n.a/ 9		
		2006	n.a/ 16	n.a/ 9		
		2007	n.a/ 23	n.a/ 3		
		2008	n.a./ 29			
External						
Sulina- daily	PO4	1980- onwards	1/1			
	NO3+NO2	1988- onwards	1/1			

Constanta daily	PO4	1960- onwards		1/1	
	NO3+NO2	1976- onwards		1/1	
East Constanta transect-monthly	NO3+NO2 PO4	1963-1980		5/5	
East Constanta transect-seasonal	NO3+NO2 PO4	1980-1985		5/5	
Not regular	NO3+NO2 PO4	After 1985		5/5	

	Indicator name	Years	No of sts in transitional waters (winter / spring)	No of sts in Coastal waters (winter / spring)	No of sts in Marine waters (winter / spring)	Time series
GE	NO3+NO2 PO4	2007	n.a/ 5			x
		2008	n.a/ 7			

	Indicator name	Years	No of sts in transitional waters (winter / spring)	No of sts in Coastal waters (winter / spring)	No of sts in Marine waters (winter / spring)	Time series
UA	NO3+NO2 PO4	2001		n.a/ 3	n.a / 2	2003-2008
		2002		n.a/ 3	n.a / 3	
		2003	1 /n.a	3 / 3	2 / 3	
		2004		3 / 3	2 / 3	
		2005	2 /n.a	2 / 4	2 / 2	
		2006		3 / 3	3 / 3	
		2007		9 / 9	2 / 2	
		2008		4 / 4	2 / 2	
External Sevastopol coast-monthly	NO3+NO2 PO4	1999-2005		15 / 15		
		2000-2009		2 / 2		
		2002-2009		1 / 1		
		2004-2009		1 / 1		
Balaklava Bay and nearby		2000-2009		4 / 4		
		2004-2009		5 / 5		
Laspi Bay (historical)		1983-1986		8 (not regular)		
Laspi Bay-monthly		2007-2009		3 / 3		
Karadag, Koktebel Bay (seasonal?)		2004-2009		7 / 7		
		2004-2006		3 / 3		
		2007-2009		5 / 5		
Sevastopol Bay		1998-2008		33		
Island of Zmeiniy		2004 - 2009		6 / 6		

(every 5-10 days)					

	Indicator name	Years	No of sts in transitional waters (winter / spring)	No of sts in Coastal waters (winter / spring)	No of sts in Marine waters (winter / spring)	Time series
BG BSIS	NO3+NO2 PO4	2001		5 / 5		2001-2007
		2002		5 / 4		
		2003		5 / 5		
		2004		n.a/n.a		
		2005		5 / 3		
		2006		5 / 5		
		2007		1 / 4		
		2008		n.a/ 1		
External IO-BAS (Varna Bay, Capes Galata and Emine) .		2001		5/n.a	8/n.a.	
		2002		6/6	9/9	
		2003		n.a/6	n.a./9	
		2004		n.a/n.a	n.a/n.a	
		2005		6/8	9/9	
		2006		5/n.a	8/n.a.	
		2007		6/n.a	9/n.a.	
		2008		n.a/4	n.a./8	
		2009		6/n.a	9/n.a.	
BG National monitoring system was established in 1953, sustained till 2000 by IFR-Varna and IO-BAS, supported mainly by the Ministry of Agriculture, Academy of Science and by different projects. Since 2000 this monitoring is not part of the National System.						
Capes Kaliakra, Galata, Emine transects		2000		- /2	10/10	
		2001		- /2	9/1	
		2002		-/2	10/1	
		2003		-/3	-/10	
		2005		-/1	-/5	
		2006		-/1	3/4	
		2008		-/?	?	
		2009		-/?	?	
Bourgas Bay		1993-1999		12/12		
Varna Bay-Lake		2000-2009	3/3	10/10		
Sozopol Bay (CLOE)		1993 - 2009		8/8		

	Indicator name	Years	No of sts in transitional waters (winter / spring)	No of sts in Coastal waters (winter / spring)	No of sts in Marine waters (winter / spring)	Time series
TR	NO3+NO2 PO4	2005	n.a/ 5	n.a/ 49	n.a/ 9	2005-2009
		2006	n.a/ 5	n.a/51	n.a/ 10	
		2007	5 /n.a	51 /n.a	10 /n.a	
		2008	n.a/ 5	n.a/ 35	n.a/ 18	
		2009	Programme implemented, data will be submitted			
External Sinop monthly	NO3+NO2 PO4	1998 – 2000 2002- present		1-3 / 1-3	limited	
Bosphorus-BS junction monthly	NO3+NO2 PO4	1996- present		1 / 1		
Bosphorus-BS junction historical	NO3+NO2 PO4	1986		n.a / 3		
		1987		n.a / 3		
		1989		3 / 3		
		1990		n.a / 3		
		1991		1 / 3		
		1992		n.a / 3		
		1993		1 / 3		
		1994		n.a / 3		
		1995		n.a / 3		
		1996		n.a / 3		
TR Black Sea		1986-1997		> 30 sts Not regular	> 30 sts Not regular	
		2000-2001		“	“	
		2005-2008		Not regular	Not regular	

	Indicator name	Years	No of sts in transitional waters (winter / spring)	No of sts in Coastal waters (winter / spring)	No of sts in Marine waters (winter / spring)	Time series
RU	NO3+NO2 PO4	2002		5 / 5		2002-2008
		2003		6 / 2		
		2004		8 / 8		
		2005		8 / 8		
		2006		8 / 8		
		2007		8 / 8		
		2008		8 / 8		
External Gelendijk Bay and the Standard **Gelendzhik** transect	NO3+NO2 PO4	2001-2009		19 periods?		

Gelendzhik larger area	1984-2009		?/?	?/?
Black and Azov seas	1999-2009		Large number of stations , Annex	
Novo. Bay	2000		13/13	
	2001		13/13	
	2002		13/13	
	2003		-/13	
Port Novo.	2000-2006		10/10	
S.Oil Harbour	2000-2006		3/3	
Russian Coast	2000-2001		10/10	
	2004		-/15	
	2005		15/15	
	2006		15/-	
	2007		21/6	
	2008		6/-	
	2009		6/-	

It is almost clear that nutrient data suit for indicator tests. Evaluation of long term nutrient data (from available sources) by Yakushev et al. (in press) shows that for both, nutrient levels and N/P ratios, there is a clear indication of temporal variability, which can be assessed in terms of trends.

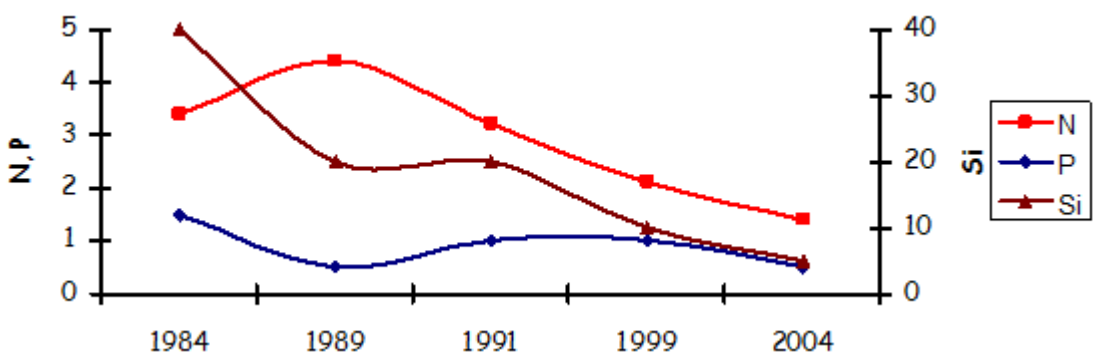


Figure 19. Interannual changes of upper layer concentrations of inorganic species of N, P, Si in the North-Eastern Black Sea averaged for the 5-years intervals.

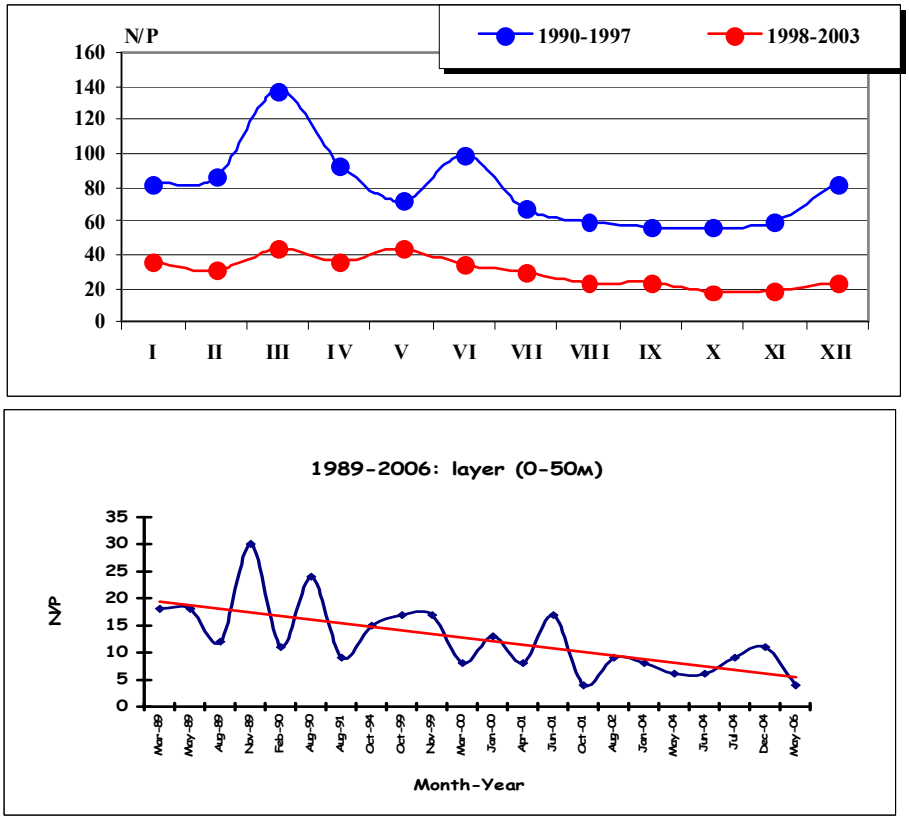


Figure 20. N/P ratio seasonal dynamics at Sulina in 1990-1997 compared to 1998-2003 (NW Black Sea), data A. Cociasu, NIMRD, Constanta, Romania.(A); N/P ratio dynamics in 0-5 m layer in the NE Black Sea in 1989-2006 (B).

A different presentation of long-term nutrient distribution at Sulina is showing the same temporal change from 1988 to 2002.

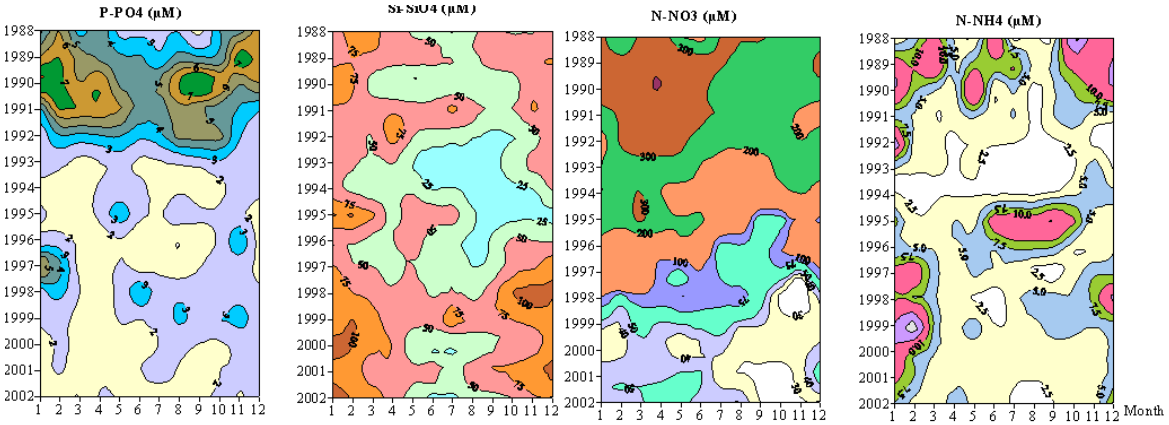


Figure 21. Long-term variability of phosphorus, silica and nitrogen species in Romanian waters.

II.6.2 Dissolved oxygen - hypoxia

Hypoxic situations (<2mg/l) and the expansion of zones of hypoxia is considered to be the coastal impact indicator of eutrophication (BSC set of indicators, MSFD Annex I and III) . The occasions of hypoxic conditions since 1970s in the NWS was evaluated in BS SoE (2008), the most sever one being occurred in 1983 (52% coverage of bottom layers). After 2000 no hypoxia has been observed in Black Sea coastal waters.

However, it should still be considered as a good 'impact indicator' for near-bottom waters especially during stratified seasons (summer and autumn) when the minimum oxygen levels are observed in the coastal waters.

When the BSIS data sets are examined between 2001-2008, obviously there are data in almost all countries/stations where oxygen is measured. In general, data in transitional and coastal waters is not showing hypoxia after 2001 (therefore, no contradiction with data outside of BSIS).

Relevant figures presented below (being extracted from SoE 2008) show that DO content at different depths may be useful to indicate the health of the coastal and marine waters.

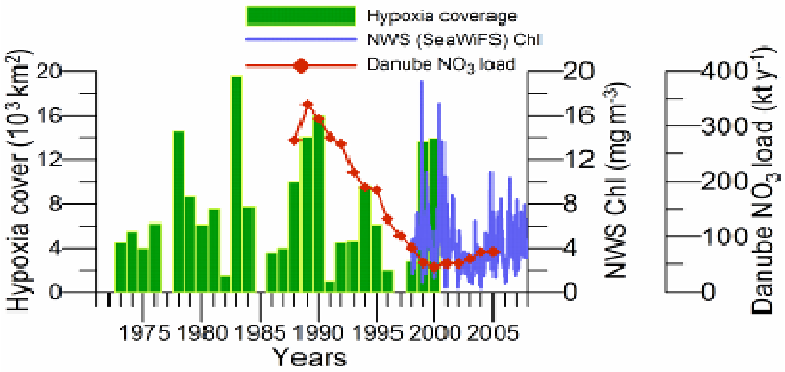


Figure 22. Long-term variations of spatial coverage of hypoxia in the northwestern shelf (SoE 2008: redrawn from Loyeva et al., 2006), average chlorophyll concentration (mg m^{-3}) for the northern part of the NWS provided by daily-8 km SeaWiFS ocean color sensor and the River Danube N-NO_3 discharge.

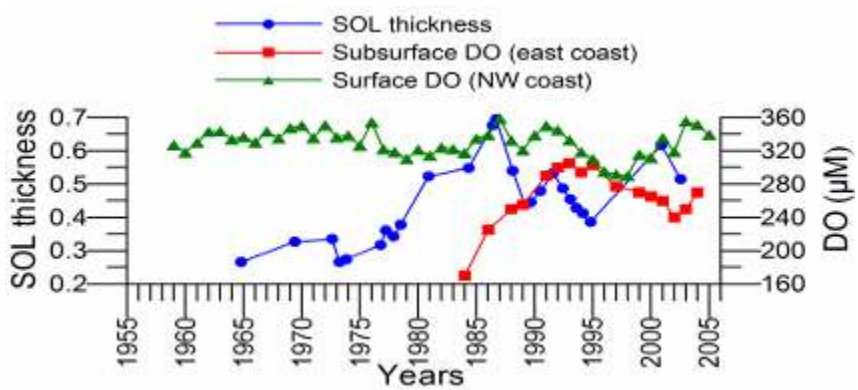


Figure 23. SOL (Surface Oxygen Layer) thickness measured as the difference between the sigma-t surfaces of 20 µM dissolved oxygen and 5 µM hydrogen sulphide concentrations deduced by all available data from the deep interior basin (SoE 2008: after Konovalov et al., 2005), average dissolved oxygen concentration within the layer of σ_t ~14.45 and 14.6 kg m^{-3} surfaces in the region off the eastern coast (SoE 2008: after Yakushev et al., 2005), and annual-mean surface dissolved oxygen concentration in northwestern coastal waters

II.6.3 Chlorophyll – *in situ* & observed

Temporal trends of *in situ* chlorophyll data is considered as a state indicator both in EEA CSI and BSC indicator list. However, EEA methodology requires summer surface concentrations. This is unrealistic for BS where chlorophyll concentrations show peak values in late winter, late spring and strong peaks in autumn not only in the surface but also in subsurface layer (SoE, 2008). Therefore, Table 7 is aimed to organize the available information in such a format without making differentiation on station types, assuming most of the stations at the coastal area. At a later stage, when all the external data sources are evaluated and all the stations are plotted on a common map, one can differentiate transitional, coastal and marine stations and aggregate the data accordingly.

Most data being obtained from external data sources are presented in Table 7 which also includes BSIS data where available. External data presented in the Table contains also the sampling period and stations mentioned in external nutrient data.

Table 7. Chlorophyll data information obtained from BSIS and external data sources

	Indicator name	Years	Seasons	Sampling (Surface/profile)	number of stations
RO - BSIS	Chlorophyll	2001	March-October	surface	11
		2002	March-October	surface	11
		2003	March-October	surface	11

	2004	March-October	surface	11
	2005	March-October	surface	11
	2006	March-October	Surface	11
	2007	March-October		
Chl	For all external nutrient data presented in Table 6, Chl measurements are almost available. At Constanza there is regular data since 2001 in parallel to nutrient measurements.			

RO - Ext

For Romanian BSIS data, information was available from 2007 National Report not from the data files.

BG - Ext

Indicator name	Years	Seasons	Sampling (Surface/profile)	number of stations
Chlorophyll (FIR, R/V Akademik)	2000	Spring/Autumn	?	7/29
	2001	Autumn	?	17
	2002	Summer/Spring/ Autumn	?	22/8/23
	2003	Summer/Spring/ Autumn	?	33/22/14
	2007	Winter/Spring/ Summer/Autumn		23/51/63/9
	2008	Summer/Spring/ Autumn	P (coastal)	4
	2008	Summer/Spring/ Autumn	P (offshore)	13
	2009	Summer/Spring/ Autumn	P	49/10/21
(CLOE)	1993-2009	Winter/Spring/ Summer/Autumn	?	8

UA- Ext

Indicator name	Years	Seasons	Sampling (Surface/profile)	number of stations
Chl (Sevastopol Bay)	1998-2008	Monthly?	Surface?	33
Chl (Island of Zmeiniy)	2004-2009	Full seasons	0-8 m	6

TR-BSIS

Indicator name	Years	Seasons	Sampling (Surface/profile)	number of stations
Chlorophyll (Black Sea coast)	2001			
	2002			
	2004	Autumn	P	63
	2005	Spring	P	63
	2006	Spring/Autumn	P	66
	2007	winter	P	66
	2008	Spring/Autumn	P	58/60

TR- Ext	Chlorophyll (Sinop area)	1999	Spring/summer /autumn/winter	P	2/2/2/2
		2000	Spring/summer /autumn	P	2/2/2
		2002	Spring/summer /autumn/winter	P	1/1/2/1
		2003	Spring/summer /autumn/winter	P	2/2/2/2
		2004	Spring/summer /autumn/winter	P	2/2/1/1
		2005	Spring/summer /autumn/winter	P	1/1/1/1
		2006	Spring/summer /autumn/winter	P	2/1/1/1
		2007	Spring/summer /autumn/winter	P	1/1/1/1
		2008	Spring/summer /autumn/winter	P	1/1/1/1
		2009	Spring/summer /autumn/winter	P	1/1/1/1
	Bosphorus-BS Junction	1986-1996 historical: Where nutrient data is available. See Table 6. 1996-2009 present: See Table 6.			
	BS-TR waters	1986-1997, 2000-2001, 2005-2008: where nutrient data is available.			

It is obviously clear that Chlorophyll measurements are made at regular basis at certain locations of the Black Sea and there is a better data spatial coverage for the region in the last decade.

The long-term data of the last two decades show a decrease in chlorophyll levels and one example area is from the Island of Zmeiniy (Ukraine) given below. An other example of such a decreasing trend is from the Bourgas Bay and the Black Sea Entrance of the Strait of Istanbul (Bosphorus) where both data sets are evaluated together (SoE, 2008). Both cases indicate that trends in chlorophyll levels at certain locations (with data) can be used as indicators.

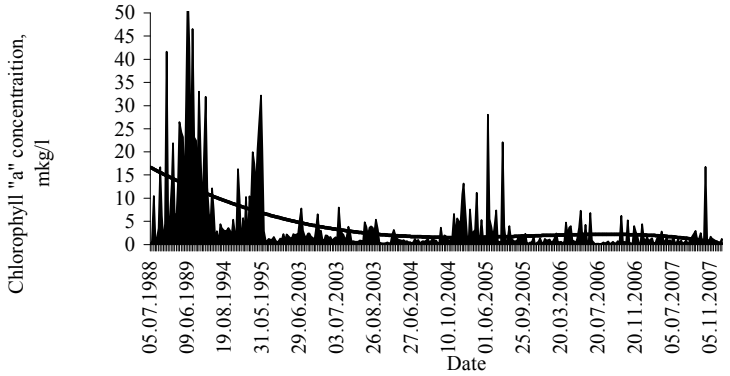


Figure 24. Multi-annual dynamics of Chl_a at the Island of Zmeiniy (Odessa National I.I. Mechnikov University)

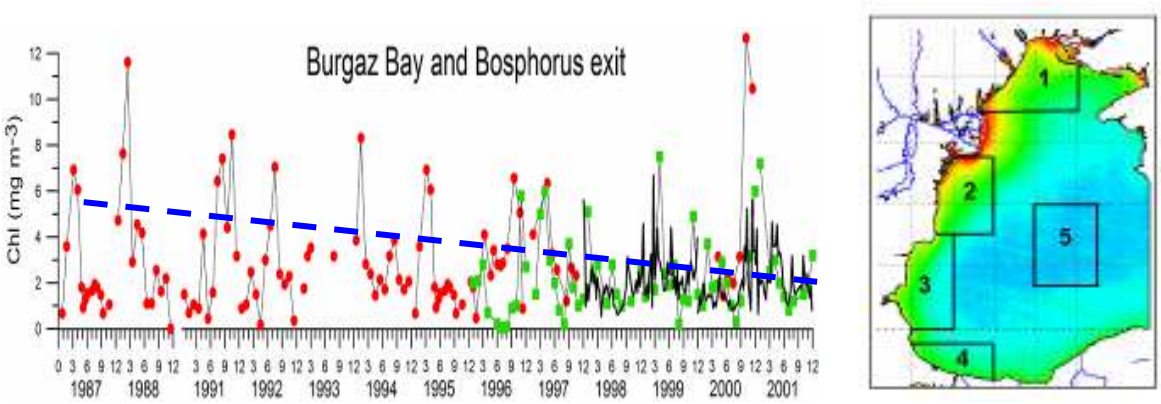


Figure 25. Monthly surface chlorophyll concentration during 1987-2001 measured in the Bourgas Bay (red dots) and the Bosphorus northern exit (green squares), and the SeaWiFS ocean color data for the region 4 (bold lines, region 4 - map on the left). The dashed line shows decreasing trend of peak Chl concentration since the 1980s. The field data are provided by G. Hibaum (CLOE), Moncheva (IO-BAS) and E.Okus (Istanbul University) and satellite data by daily-8, 9 km resolution SeaWiFS ocean colour product.

Ocean color in support of Chl-a : SeaWiFS (and MODIS data) 1998-2007 was used in the SoE, 2008 and compared with in situ data where available. It is recommended in SoE (2008) to be used widely in the basin as indicator of chlorophyll.

When the data obtained from MODIS and SeaWifs are examined they are found suitable for trend analysis, however absolute values can not be used as they are showing integral concentrations at the surface waters (not exactly at the sea surface, but in the surface layer).

SST
http://www.ims.metu.edu.tr/SeaDataNet/indexsat.asp?doc=pageSSTday.htm

Chl
http://www.ims.metu.edu.tr/SeaDataNet/indexsat.asp?doc=pageChl-A.htm

SEAWIFS	Obtained from IMS/METU experts																
Year	Months												Seasons				Annual
1997									9	10	11	12				aut	
1998	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
1999	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an

2000	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2001	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2002	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2003	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2004	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an

MODIS																	
Year	Months												Seasons				Annual
2002							7	8	9	10	11	12			sum	aut	an
2003	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2004	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2005	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2006	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2007	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an
2008	1	2	3	4	5	6	7	8	9	10	11	12	Win	spr	sum	aut	an

II.6.4 Biodiversity

Biodiversity indicators for the Black Sea were first required to be examined for marine angiosperms (seaweeds, sea grasses, macro algae) in coastal waters. EEA CSI does not include them at the moment. MSFD (Annex I, III) makes clear reference to them as biological descriptors of GES.

This is the less concerned ecosystem component in terms of regular monitoring and data reporting to the BSC compared to phytoplankton, zooplankton, macrozoo benthos.

To the corresponding MSFD (Annex III) the biological features for macroalgae and angiosperms identified as: species composition, biomass and annual/seasonal variability. These classical indices also being used in the BSIS for benthic vegetation of marine ecosystems reflect the dynamics of community structure parameters.

The analysis of data gathered in BSIS btw 2001-2008 is shown in Table 8a. BG, RO and UA seemingly considering the importance of macro algae as an environmental and ecosystem quality indicator and controlling the distribution of main groups and recording the species diversity, biomass and areal coverage.

Two external data sources were provided by Ukraine for North Western BS and Crimea regions (Table 8b,c). Both data sets are comprehensive in terms of temporal and spatial coverage. Similarly, external data made available for Bulgarian coastal waters is summarized in Table 8d.

Table 8a. Available data for macroalgae in BSIS (B: Biomass, L: Location, M: Months, Y: Yes).

	Indicator name	Years	Rodophyta	Chlorophyta	Phaeophyta
BG	Abundance and Biomass /space and time variations	2001	B / 1L , 3M	B / 1L , 3M	B / 1L , 3M
		2004	B / 1L, 1M	B / 1L, 1M	B / 1L, 1M
	species composition/ number of species	2001	Y	Y	Y
		2004	Y	Y	Y

	Indicator name	Years	Rodophyta	Chlorophyta	Phaeophyta
RO	Abundance and Biomass /space and time variations	2004	B / 5L , 1M	B / 5L , 1M	B / 5L , 1M
		2005	B / 5L , 1M	B / 5L , 1M	B / 5L , 1M
		2006	B / 6L, 1M	B / 6L, 1M	B / 6L, 1M
	species composition/ number of species	2004	Y	Y	Y
		2005	Y	Y	Y
		2006	Y	Y	Y

	Indicator name	Years	Rodophyta	Chlorophyta	Phaeophyta
RU	Abundance and Biomass /space and time variations	2001	B / 1L , 1M	B / 1L , 1M	B / 1L , 1M
	species composition/ number of species	2001	Y	Y	Y

	Indicator name	Years	Rodophyta	Chlorophyta	Phaeophyta
UA BSIS	Abundance and Biomass /space and time variations	2005	B / 4L , 1-3M	B / 4L , 1-3M	B / 4L , 1-3M
		2006	B / 3L, 1-3M	B / 3L, 1-3M	B / 3L, 1-3M
		2008	B / 5L, 1M	B / 5L, 1M	B / 5L, 1M
	species composition/ number of species	2005	Y	Y	Y
		2006	Y	Y	Y
		2008	Y	Y	Y

Table 8.b External macroalgae structural and functional data from NWBS between 2000 and 2009 by Ukraine.

	Years	Biomass /space and time variations	species composition/ number of species	S/W Community	S/W population, dominant sp
UA Ext NWBS region	2000	5 L , 1-6 M	Y	Y	Y
	2001	4 L, 1-7 M	Y	Y	Y
	2002	6 L, 1-4 M	Y	Y	Y
	2003	5 L, 1-5 M	Y	Y	Y
	2004	5 L, 1-2 M	Y	Y	Y
	2005	8 L, 1-3 M	Y	Y	Y
	2006	5 L, 1-7 M	Y	Y	Y
	2007	5 L, 1-9 M	Y	Y	Y
	2008	5 L, 1-9 M	Y	Y	Y
	2009	4 L, 1-10 M	Y	Y	Y

All groups of macroalgae: Rodophyta, Chlorophyta, Phaeophyta (Provided by Prof. Minicheva for the Diagnostic Report).

Table 8c. External macroalgae data (structural parameters) for Sevastopol between 2003 and 2009 in Crimea region (L: Location, D: Depth, M: Months, Y: Yes).

	Years	Biomass /space and time variations	species composition/ number of species
UA Ext Crimea region	2003	3 L, 7 D, 1 M	Y
	2004	4 L, 7 D, 1 M	Y
	2005	2 L, 6 D, 1 M	Y
	2005	2 L, 4-5 D, 12 M	Y
	2006	4 L, 4-5 D, 1 M	Y
	2007	5 L, 5-6 D, 1 M	Y
	2008	15 L, 5-6 D, 1 M	Y
	2009	1 L, 6 D, 1 M	Y

Table 8d. External macroalgae data (structural parameters) for Bulgarian coastal area between 2001 and 2009 (L: Location, M: Months, Y: Yes).

	Years	Biomass /space and time variations	species composition/ number of species
BG Ext	2001	4 L, 3 M	Y
	2002	4 L, 3 M	Y
	2006	6 L, 1 M	Y
	2007	18 L, 1 M	Y
	2008	19 L, 1M	Y

2009	4 L, 1 M	Y

In relation to the structural parameters selected as descriptors or indicators, quality of marine environment is indirectly related with them whereas directly related with the functioning of biological communities and, it is preferable for monitoring biological indicators to use also the functional parameters (Table 8b, Minicheva communication for the Diagnostic report). They are the morphofunctional indices, simply the S/W ratio of population and community and easy to obtain (Minicheva, Zotov et al. 2003, See Annex VI). Therefore, it is suggested to use them in parallel to the MSFD descriptors (Minicheva communication, Annex VI).

In CBD AG report (2008/09), it was reported by Ukraine that in the northwestern part of the Black Sea shelf there are two types of macrophyte communities as recorded in 2008 and compared with 2006/07 data: (1) off-shore community, which spreads to the 10 m depths, and (2) shelf deep-water community, which is located on the depth 25–50 m. Off-shore macrophytes are sensitive to local anthropogenic actions and climatic features of a year. Deep-water macrophytes show the long-term dynamics of regional processes, and can be the indicators of global climatic changes and general ecological situation in a shelf area.

II.6.5. Fisheries and aquaculture

Three core indicators considered by both EEA and BSC and also considered in MSFD (Annex I, III) are fishing fleet capacity, status of fish stocks/stocks outside safe biological limits and catches by major species/areas and aquaculture production.

Related data sets of BSIS were evaluated by experts from FOMLR AG and no other data sources were referenced for this work. According to this study the following findings are summarized:

Table 9. Fishing fleet in the Black Sea region by number of vessels (Y: there is data, N: no data)

Year/State	BG	RO	GE	RU	TR	UA
2002	**Y**	**Y**	**Y**	**Y**	N	**Y**
2003	**Y**	**Y**	**Y**	N	**Y**	**Y**
2004	**Y**	**Y**	**Y**	N	**Y**	**Y**
2005	**Y**	N	N	N	**Y**	N
2006	**Y**	N	N	N	N	**Y**
2007	**Y**	**Y**	N	N	**Y**	**Y**
2008	**Y**	**Y**	N	N	**Y**	**Y**

One of the main problems in the Black Sea region is the lack of comprehensive information on fishing activity, catch quantities and composition and how they affect the

current state of fish stocks. Consequently, reports on the annual catch quantities and composition are produced with serious gaps and the analysis of fish stocks current state are far from high level of accuracy.

As an obligation to the EC, there exits Member State fleet register where power and gross tonnage of vessels are also registered besides numbers and that are good indicators for fishing effort.

Total landings (fish catch) and total catch by major fish type can be evaluated by region and country in 2001-2008 period with BSIS data.

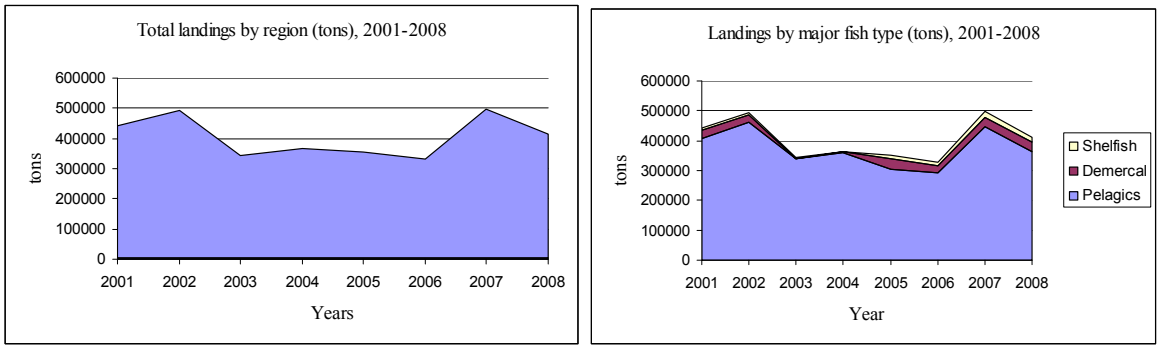


Figure 26. Total landings by region and landings by major fish type

Catches of major commercial species by countries can also be evaluated as indicator for 2001-2008.

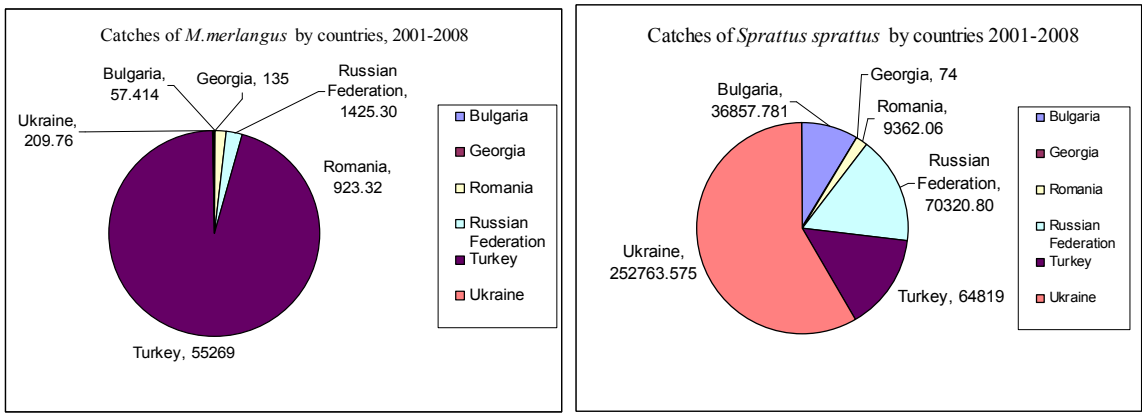


Figure 27. Catches by counrties and catches of Merlangus merlangus and Sprattus sprattus by countries

Total Allowable Catch (TAC) and quotas is an other indicator that can be used with additional conditions, related to the strengthening of the control, reporting and fishing

prohibition extension. However, TAC data is available mostly in only Romania and Bulgaria.

Bottlenecks/Gaps/misreporting: For the above mentioned indicators, there is no data reported by Russian Federation and very scarce data from Georgia. No data on IUU (Illegal, Unregulated and Unreported) catches and landings.

Commercial fish stocks is considered as an other common indicator for fishery where there are various sub indicators:

- Number of commercial stocks;
- Number of assessed stocks; (The assessed stocks are 2 – sprat and turbot)
- Number of non-assessed stocks; (the rest of the stocks are not assessed)
- Percentage of non assessed / stocks of economic importance
- Percentage of overfished / stocks of economic importance
- Percentage of safe / stocks of economic importance

All these sub-indicators of stock biomass are derived form the analysis (ICA, XSA, Darby and Flatman, 1994; Patterson and Melvin, 1996. Analyses were performed by SGMED plus Black Sea and SGMED -09-01 in 2008 and 2009).
(http://fishnet.jrc.it/c/document_library/get_file?p_l_id=1807&folderId=129105&name=DLFE-23810.pdf)

Fishing mortality – sub indicator derived from the analytical methods applied.
Spawning Stock Biomass– sub indicator derived from the analytical methods applied.
Recruits– sub indicator derived from the analytical methods applied
Landings - indicator used in the analysis in order to derive sub-indicators.

Aquaculture production by countries is also a good and widely accepted indicator, however, the reported data in the region is limited.

Marine Trophic Index is not included among BSC indicators. Data are available in the region to calculate this indicator (see http://www.seaaroundus.org/lme/62/200.aspx).

A detail expert report on all these fishery indicators with recommendations on improvement of monitoring and data flows is presented in Annex IV.

II.6.6 Hazardous Substances in biota (and sediments)

The concentrations and trends of cadmium, mercury, lead, DDT, lindane and PCBs in biota are commonly assessed by regional conventions and EEA and decreasing trends of them indicate the effectiveness of pollution reduction measures. The metals and lindane are on the Dangerous Substances Directive list of 33 priority substances for their ecosystem and human health impacts.

It has been noted that the lack of consistent or reliable data from the marine conventions or EEA countries inhibits adequate assessment of concentrations and trends of hazardous substances in European marine water. Aggregated data do not necessarily convey the uncertainty these problems cause. The trend analysis should be based on a consistent and reliable sampling strategy to achieve a powerful statistical analysis.

Black Sea data on above mentioned HSs in biota are quite limited in obtaining temporal trends. Table 10 summarizes the data available from BSIS. It seems that it is possible to look at the trends of selected contaminants (e.g. DDT, Cd, Pb, Lindane, HCB) in mussels in Romanian waters. However, examining the data it was observed that not the same stations were sampled at the same time of the year which creates a big uncertainty for trend analysis. There are 4 locations where the sampling time is close at each year and there is 4-5 years of data. These data show, in general, no statistically significant trends of metals in biota. A slightly decreasing trend for Cd and Pb still could be mentioned, however, longer-term data are needed for the same species and same location to draw conclusions.

Other countries did not submit contaminants in biota data apart from Turkey who has submitted data on Cd, Pb and PAHs since 2004. Unfortunately, this data set is not suitable yet for trend analysis and the monitoring programme need to be reviewed in terms of sampling period, number of samples and parameters measured.

PMA AG Report (2008/09) does not include any assessment of the contaminants in biota and also it has not been tackled in SoE, 2008. Romania should be encouraged in applying statistical tests to look for trends for these contaminants.

Table 10. BSIS Data on contamination of biota

	Indicator name	Years	Seasons	organism	number of stations
RO	DDT, DDD, DDE	2001	may	mussel	1
		2002	may, july	mussel	4
		2004	june, april	mussel	4
		2005	april	mussel	5
		2006	april	mussel	6
		2007	august	mussel	6
		2008	may,june,sept.	mussel	5
	Cd,Pb	2001	may, sept	mussel	3
		2002	may, july	mussel	4
		2003	may, july	mussel	4
		2004	june, april	mussel	4
		2005	april	mussel	5
		2006	april	mussel	6
		2007	august	mussel	6
		2008	may,june,sept.	mussel	5
	Lindane	2001	may	mussel	1
		2002	may, july	mussel	4

		2004	june, april	mussel	4
		2005	april	mussel	5
		2006	april	mussel	6
		2007	august	mussel	6
		2008	may,june,sept.	mussel	5
	HCB	2004-09	apr-oct.	mussel	4-8
GE	DDT, DDD, DDE	2001-2008	X	X	X
	Hg,Cd,Pb	2001-2008	X	X	X
	Lindane	2001-2008	X	X	X
	PAHs	2001-2008	X	X	X
BG	DDT, DDD, DDE	2001-2008	X	X	X
	Hg,Cd,Pb	2001-2008	X	X	X
	Lindane	2001-2008	X	X	X
	PAHs	2001-2008	X	X	X
UA	DDT, DDD, DDE	2001-2008	X	X	X
	Hg,Cd,Pb	2001-2008	X	X	X
	Lindane	2001-2008	X	X	X
	PAHs	2001-2008	X	X	X
TR	DDT, DDD, DDE	2001-2008	X	X	X
	Cd, Pb	2001-2003	X	X	X
		2004	sept.	mussel	7
	Lindane PAHs	2005	april	mussel	4
		2006	april & sept.	mussel	10 & 8
		2007	X	X	X
		2008	sept.	mussel	1
		2001-2008	X	X	X
		2001-2004	X	X	X
		2005	april	mussel	2
	DDT, DDD, DDE	2006	april	mussel	9
		2007	X	X	X
		2008	sept.	mussel	1
RU		2001-2008	X	X	X

Hg, Cd, Pb	2001-2008	X	X	X
Lindane	2001-2008	X	X	X
PAHs	2001-2008	X	X	X

An other indicator to assess the trends in contamination levels in coastal waters can be proposed as the HSs in sediments. However, considering the difficulties in evaluating the sediment data, BSIS data where available should be evaluated by experts for trends first. In terms of sampling periods from 2001 to 2008, Romanian data in BSIS is showing a regular annual sampling for some selected contaminants (e.g. Cd, Pb, PAHs). Annual Turkish sediment data has also a continuous manner since 2004 at least for few contaminants of concern. Ukrainian data are available for 2005, 2007 and 2008. A small group of regional experts could cooperate with OSPAR or HELCOM sediment group experts to evaluate the suitability of these data sets to obtain any trends at contamination levels.

IAEA investigations/cooperation with Institutions in the Black Sea region were overviewed, however, they covered basically periods before 2000, and investigations, such as:

1998 - 11 stations in UA waters with mussels samples (PHs-total, 9 organochlorine pesticides, PCBs-total, 21 ind. PCBs) - 1999 - fish - turbot 20 ind. - average sample (7 PAHs, 7 Me, DDT, DDD, DDE, Lindane, HCB, PCBs-total);
2000 - 9 stations with mussels samples (PHs-total, 9 organochlorine pesticides, PCBs-total, 21 ind. PAHs, sum C14-C34 (aliphatic hedrocarbons);
2000 – Phylophora – field of Zernov (10 Me, 18 ind. PAHs, 11 organochlorine pesticides, PCBs-total.

IAEA cooperated in studies under the umbrella of the BSERP Project in September-October 2003 and June 2006, however, only contamination of biota was studied in different Black Sea coastal waters.

II.6.7 LBS inputs from direct and riverine sources

The Pressure indicators for eutrophication and contamination with hazardous substances (HSs) are accepted as inputs from point (direct) and riverine sources. Therefore, inputs of nitrogen and phosphorus as well as of selected contaminants (Cd, Hg, Pb, PCBs, DDT etc.) from these sources and also from atmospheric deposition at the regional scale are of interest.

In view of above, when BSIS data sets are examined (Table 11), some valuable data sets could be highlighted that are regularly collected in longer terms; like municipal, industrial and riverine nitrogen and phosphorus data from Bulgaria, Romania, Ukraine, Russian Federation and riverine inputs from Turkey.

Regarding the HS inputs, trace metal (Cd, Hg, Pb) loads are available in longer term from industrial and riverine sources only from Bulgaria and riverine sources from Turkey. Atmospheric deposition of these substances at the regional scale was also estimated from EMEP model results (ref: SAP IR (2002-2007))

The data on inputs are aggregated on a yearly basis. Method of aggregation of data is not clearly stated in BSIS and country annual reports on pressures. However, all states reported on their river monitoring strategies with specifications of frequency of observations: priority parameters are observed on a monthly basis in BG, RO, GE, RU, TU and weekly in UA.

Table 11. BSIS data on Land Based Sources of pollution

			Years	Number of point sources and rivers
RO	Municipal	BOD	1995-2005; 2004-2008	4; 3
		TSS	1995-2005; 2004-2008	4; 3
		TIN	1998-2005	4
		TN, TP	2003-2005; 2004-2008	4; 3
		PAHs	X	X
		TPH	2001-2008	3
		Cd, Pb	2001-2002; 2004-2008	4
	Industrial	BOD	1995-2008	1; 2
		TSS	1995-2008	2
		TN	2001; 2005	2; 1
		PAHs	X	X
		TPH	2001-2008	1
		Cd, Pb	2001-2002; 2004-2008	2
	Riverine	BOD	2001-2002, 2004-2008; 2001-2006	4; 1
		TSS	2001-2002, 2004-2008; 2001-2006	4; 1
		DIN, PO4	1990-2004; 2001-2006	1; 1
		TP, TN	2006-2008; 2001-2006	4; 1
		Trace Metals	2001-2002, 2004-2008	4
		TPH	2008	1
GE	Municipal	BOD	1996-2008	4
		TSS	1996-2008	4

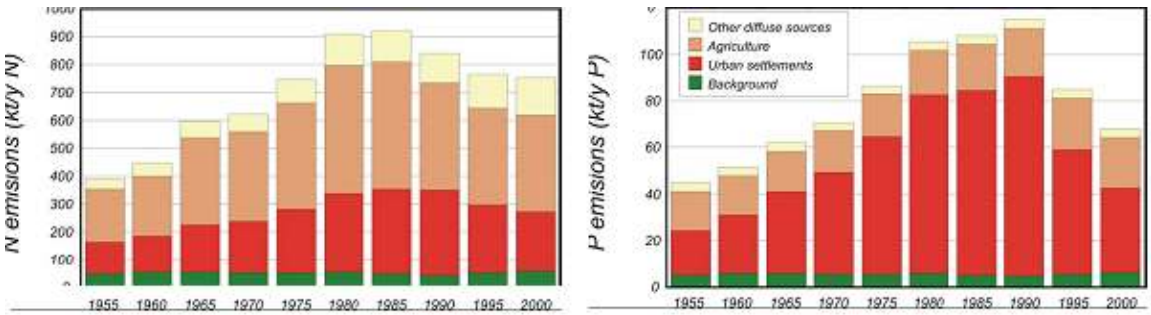
		TN, TP	X	X
		PAHs	X	X
		TPHs	1996-2008	1
		T.Metals	X	X
		BOD	2003-2008	2
	Industrial	TSS	2003-2008	2
		TN, TP	X	X
		PAHs	X	X
		TPHs	2004-2008	2
		T.Metals	X	X
		BOD	2003-2008	4
	Riverine	TSS	2003-2008	4
		TN, TP	2003-2008	2
		PAHs	X	x
		TPHs	2003-2008	2
		T.Metals	2003-2008	2

		BOD	1995; 1998; 1999; 2000;2001; 2002;2003-2006;2007;2008	1; 2; 1; 2;3; 3;16;17;18
BG	**Municipal**	TSS	1995; 1998; 1999; 2000;2001; 2002;2003; 2004;2005;2006;2007;2008	1, 2, 1, 2,3, 4,14, 12,16,13,14,15
		TP	1999-2001; 2002;2003; 2004;2005; 2006;2007-2008	1; 4; 16; 15;17;16;17
		DIN	1995;1998-1999;2000-2003;2004;2005;2006; 2008	1;1;2;4;2;1;7
		TPHs	2005;2006-2007;2008	2;10;4
		T.Metals	X	X
		BOD	1995-2008	1-5
	Industrial	TSS	1995-2008	1-5
		TN, TP	2001-2008	1-3
		PAHs	x	X
		TPHs	2005-2008	1-2
		Cd; Pb; Hg	2002-2008	1-2
		BOD	1990-2008	1

	Riverine	TSS	1990-2008	1
		TN, TP	1990-2008	1
		PAHs	x	X
		TPHs	1990-2008	1
		T.Metals	1990-2008	1
		BOD	1995-2005 ; 2006-2008	15;9
UA	Municipal	TSS	1995-2005 ; 2006-2008	14;9
		TIN; PO4	1995-2005 ; 2006-2008	15;9
		PAHs	x	x
		TPHs	1995-2005 ; 2006-2008	14;9
		T.Metals	x	x
		BOD	1995-2005 ; 2007-2008	8;1
	Industrial	TSS	1995-2005 ; 2006-2008	9;1
		TIN;PO4	1995-2005 ; 2006-2008	8/6;1
		PAHs	x	x
		TPHs	1995-2005 ; 2006-2008	8;1
		T.Metals	1995-2005	2
		BOD	1991-2001 ; 2006-2008	4;4
	Riverine	TSS	1991-2001 ; 2006-2008	4;0
		TN, TP	1991-2008 ; 2006-2008	4;4
		PAHs	x	X
		TPHs	1991-2001 ; 2006-2008	4;4
		T.Metals	1991-2008 ; 2006-2008	4;3
		BOD	2002-2007 ; 2008	7;5
TR	Municipal	TSS	2002-2003 ; 2004,2005,2008	7;6
		TN, TP	2002-2007 ; 2008	7;5
		PAHs	x	X
		TPHs	2007-2008	2;4
		T.Metals	2005-2006 ; 2007 ; 2008	2;4;6
		BOD	2002-2003 ; 2004 ; 2007-2008	1;2;3
	Industrial	TSS	2002-2003 ; 2004-2006 ; 2007-2008	3;2;3

		TN, TP	2002-2006 ; 2007-2008	1;3
		PAHs	x	X
		TPHs	2007-2008	2
		T.Metals	2002-2006 ; 2007-2008	2;3
		BOD	1992-2002 ; 2002-2006 ; 2007-2008	3;4;5
	Riverine	TSS	1992-2002 ; 2002-2008	3;4
		TIN, PO4	1992-2002 ; 2002-2008	3;5
		PAHs	x	X
		TPHs	x	X
		T.Metals	1992-2002 ; 2002-2005 ; 2006-2008	3;4;1
		BOD	1995-2008	11
RU	**Municipal**	TSS	1995-2008	11
		DIN; PO4	2000-2008	11
		PAHs	x	X
		TPHs	1995-2008	11
		T.Metals	x	X
		BOD	1995-2008	2
	Industrial	TSS	1995-2008	2
		TN, TP	x	X
		PAHs	x	X
		TPHs	1995-2008	2
		T.Metals	x	X
		BOD	1990-2008; 1995-2005	3; 4
	Riverine	TSS	1990-2008; 1995-2005	3; 4
		DIN; PO4; TP	1990-2008; 1995-2005	3; 4
		TN	2005-2008	3
		PAHs	X	X
		TPHs	1990-2008; 1995-2005	3; 4
		T.Metals	1995-2005	3 ?

Long term evaluation of emissions and inputs (Yakushev et.al., in press, will be published by CIESM in 2010) show the reliability of data (all sources) proving the data suitability to indicators:



Fgure 28. Relative contributions of different point and diffuse sources to the emissions of (a) total nitrogen (N) and (b) total phosphorus averaged over 5 year bins (from daNUbs project Final Report, 2005).

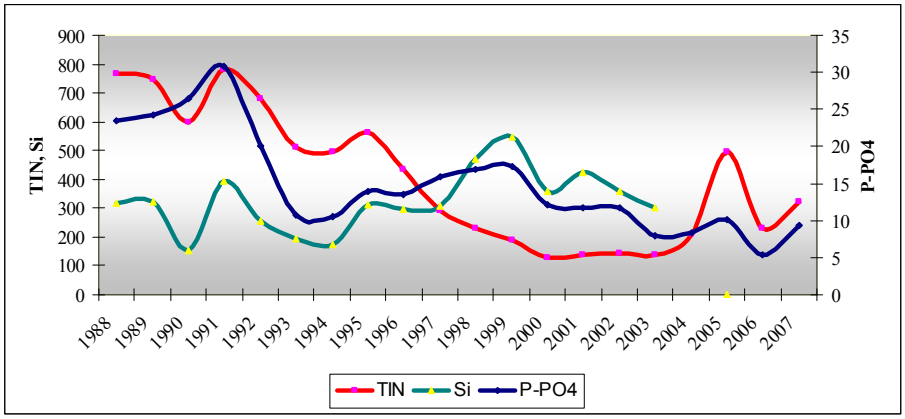


Figure 29. Long-term dynamics of Danube nutrient loads (in Kilotonnes) measured at Sulina, data A. Cociasu, NIMRD, Constanta, Romania.

II.6.8. Inputs from shipping

Discharge of oil from refineries and offshore installations is not reported by the Black Sea countries. The only available information is the number of off-shore installations.

Number of oil spills have been reported by all the countries usually both in numbers and volume. However, spills from illegal discharges have not been differentiated from the total number of spills and the reported numbers are most related to accidental oil spills (ESAS AG reports based on BSIS data). Table 12 shows the oil spill data where source identified or not. Shipping intensity has also been considered in BS reporting to BSIS where this can only be referred as an indirect pressure on the environment.

Concerning the illegal discharges from shipping, aerial surveillance in maritime areas in the EU is the chosen indicator. JRC (Joint Research Center of EC, IPSC) has also produced spill maps using satellite images. This study of JRC is also including the Black Sea and

being efficiently used in TDA, 2007 and SoE, 2008 reports as well as the ESAS AG Reports.

Table 12. Data on illegal discharges of oil, accidents and shipping density

	BG	GE	RO	RU	TU	UA
Illegal discharges of oil at sea	2002:N 2008: Y		2002:N 2008: Y	2002:N 2008: N	2002:N 2008: N	2002:N
Accidental oil spills from shipping	2002: N 2003:Y** 2004:Y** 2005:Y** 2006:Y** 2007:Y** 2008: Y**	2001:N 2002: N 2003:Y** 2004: N 2005:Y 2006:Y 2007:Y 2008:	2001:N 2002: N 2003:Y** 2004: Y** 2005: Y** 2006:Y** 2007: Y** 2008: Y**	2001:Y** 2002: Y** 2003:Y** 2004: Y** 2005:Y** 2006: Y** 2007: Y** 2008: Y**	2001:N 2002: N 2003: Y** 2004: N 2008: N	2002:N 2005: Y** 2006:Y** 2007: Y** 2008: Y**
Shipping density	2004: 1502 2005: 1578 2006: 1955 2007: 3586	2002: 2152 2005: 2675 2006: 2615	2003: 5023 2008: 5950	2001: 3598 2002: 3764 2003: 4256 2004: 8275 2005: 7064 2008: 6552	2001 :1598 2002 :2136 2003 :2784 2004 :5211 2005 :5915 2006 :6173 2007 :9612 2008 :9989	2005: 9408 2006:10489 2007:10336

** source of spill not identified

II.6.9 Climate change impact indicators

Sea Surface Temperature: The winter-mean (December-March) sea surface temperature (SST) variations shown in Fig. 34 were described by different monthly-mean data sets. The first one was complied by Hadley Centre, UK Meteorological Office from all available in situ measurements within the interior part of the basin with depths greater than 1500 m and Advanced Very High Resolution Radiation (AVHRR) satellite observations (Rayner et al., 2003). The second data set was provided by the Global Ice-Sea Surface Temperature, version 2.2 data set (GISST2.2) for the region confined by 42°–44°N latitude range and 29°–39°E longitude range during 1950–1994 (Kazmin and Zatsepin, 2007). Other data sets include the NCEP-Reynolds 1° resolution monthly AVHRR night-time measurements for 1983–2006 and 4 km resolution weekly Pathfinder5 AVHRR night-time measurements for 1987–2005. Fig. 1 also shows the minimum Cold Intermediate Layer temperature variation (characterized by temperatures less than 8°C below the seasonal thermocline) as the mean of all available data from the interior basin for May-November period of 1950-1995 (Belokopytov, 1998) and from the regular measurements along several cross-sections within the eastern Black Sea during July-September period of 1990-2004 (Krivosheya et al., 2005).

The winter GISST data reveal an approximately 1.0 ^{o}C cooling trend from 9.0 ^{o}C in 1970 to 8.0 ^{o}C in 1985. The Hadley SST data instead remain uniform at 8.7±0.1^{o}C during the 1960s and 1970s and then decreased abruptly from about 8.5 ^{o}C at 1981 to 7.7 ^{o}C at 1984. The cooling phase persists up to 1994 and switches abruptly to the warming mode until 2002 that was then replaced by a cooling mode up to the present. The NCEP-Reynolds data that form a part of the Hadley data set are similar to the Hadley one after 1993. The more recent and refined Pathfinder data set was also similar to the NCEP-Reynolds data after the beginning of the 1990s. The accompanying CIL data support reliability of the Hadley winter SST data because the minimum CIL temperature in summer months reflects signature of the winter SST. Approximately 0.7^{o}C difference between the subsurface summer CIL temperature and the winter Hadley SST should probably arise from different spatial averaging of the available data sets.

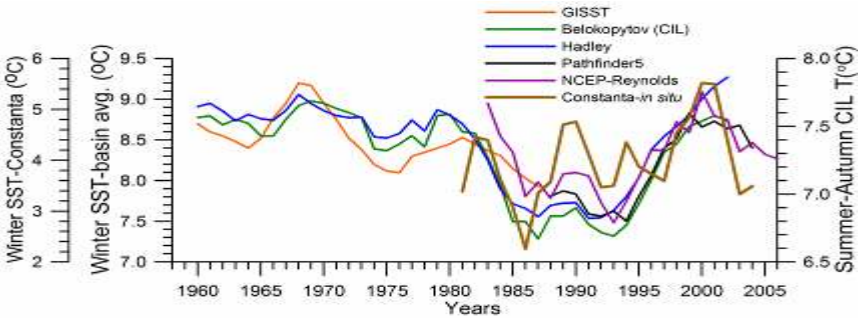


Figure 30. Long-term variations of the basin-averaged winter-mean (December-March) Sea Surface Temperature (SST) during 1960-2005 using the monthly data sets of Hadley Centre-UK Meteorological Office (blue), GISST (Kasmin and Zatsepin, 2007; red), NCEP-Reynolds 1° resolution AVHRR (violet), Pathfinder5 4 km resolution AVHRR (black), minimum temperature of the Cold Intermediate Layer for the mean of May - November period (green), and the winter-mean (December-March) SST measured near Constanta (Romanian coast). All these data were plotted after smoothed by the three point moving average.

The summer SST variations differ from the winter ones to a considerable extent (Fig. 30; blue). For example, cold winters of 1991-1992 are followed by relatively warm summers with SST ≥ 25 ^{o}C in August. Contrary to a steady rise of the winter SST after 1994, summer SSTs remain relatively low (below 24.5 ^{o}C) until 1998, and fluctuates between 25 ^{o}C and 26 ^{o}C afterwards. In-situ measurements along the northeastern coast (Shiganova, 2005) generally support these features (Fig. 30; blue). On the other hand, the annual-mean basin-averaged SST reveals a warming trend from ~14.8 ^{o}C in 1989 to 15.6 ^{o}C in 2005 with some oscillations along the trend (Fig. 30; green). In particular, 1992, 1993, 1997, 2003 and 2004 emerge as cold years.

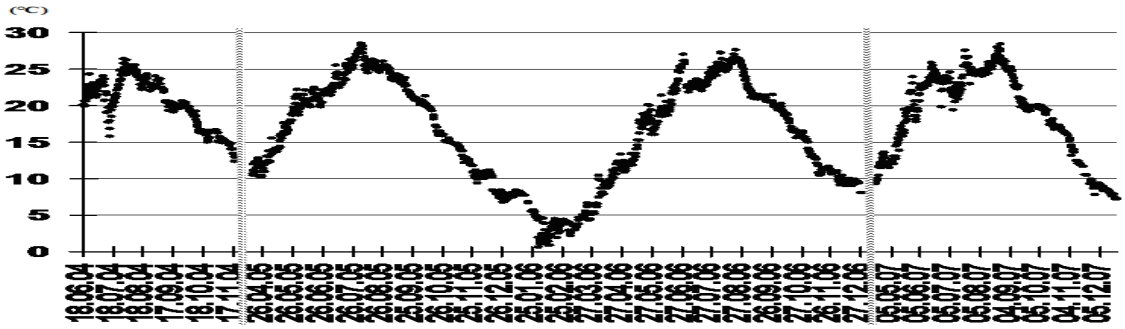


Figure 31. Results of daily measurements of surface water temperature (°C) during 2004-2007 at the Island of Zmiiniy (Ukraine)

Long term trends in the sea surface temperature of the Black Sea and available data for assessments are comprehensively reported in a relevant paper of G. I. Shapiro, D. L. Aleynik, and L. D. Mee (can be provided upon request or visit: Ocean Sci. Discuss., 7, 91–119, 2010; www.ocean-sci-discuss.net/7/91/2010/© Author(s) 2010. This work is distributed under the Creative Commons Attribution 3.0 License).

Sea level: It is a prominent feature of global warming as well as large scale atmospheric systems in regional seas. Sea level change provide best response of the physical climate to atmospheric forcing, because the link includes an overall response of the changes in the surface atmospheric pressure through the inverse barometer effect, water density changes in response to temperature and salinity variations (steric effects), precipitation, evaporation and river runoff. The detrended sea level anomaly (SLA) time series (Reva 1997, Tsimplis and Josey 2001, Stanev and Peneva 2002), as an average of the measurements at 12 coastal stations around the Black Sea, oscillate within the range of 10 cm (Fig. 32). Its higher (lower) values coincide with the warm (cold) cycles of the water temperature indicating that a part of the observed sea level change has a thermal origin due to the thermo-steric effect. The annual-mean tide-gauge data show a high degree of consistency with the altimeter SLA data as well (Fig. 34). They both exhibit a rising trend of 3 cm y^{-1} from 1993 to the mid-1999 followed by -3.0 cm y^{-1} declining trend for 07/1999–12/2003 in consistent with the cooling phase indicated by the winter SST data. Good agreement between the monthly SLA changes and the Danube discharge rates suggest its predominant role on the basin-scale sea level oscillations.

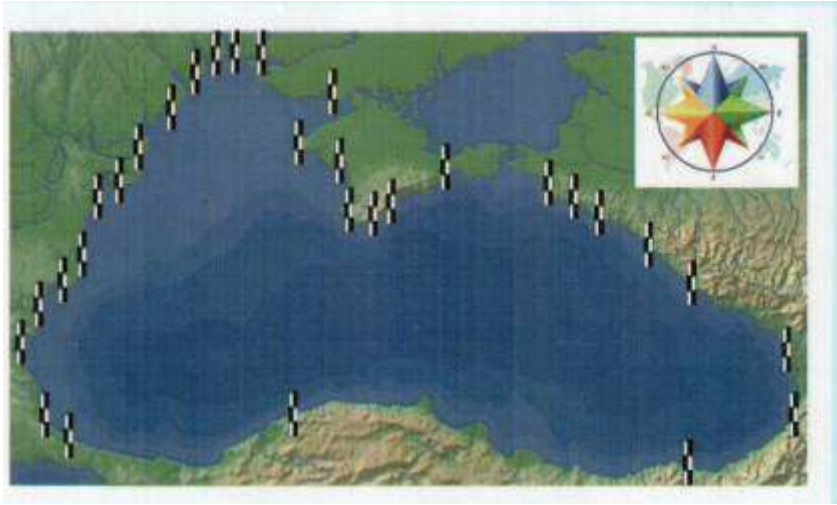


Figure 32. Sea level rise stations around the Black Sea

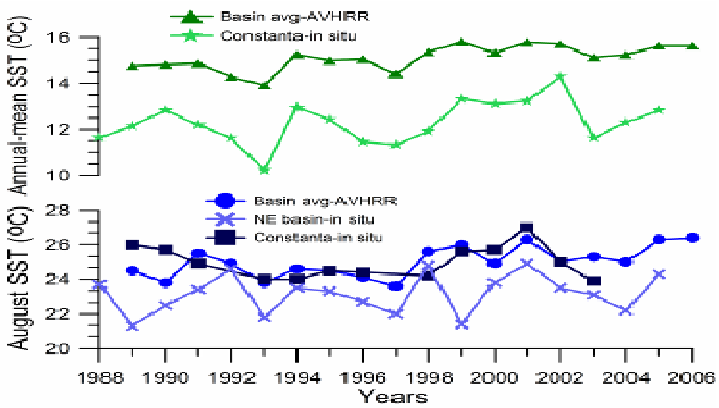


Figure 33. Annual-mean (triangles) and August (dots) SST variations obtained by the basin-averaging of 9 km monthly-mean, gridded NOASS/NASA AVHRR Oceans Pathfinder data, and annual-mean (stars) and August (crosses) SST variations measured at Constanta (Romanian coast) and along the northeastern coastal waters (squares; Shiganova, 2005).

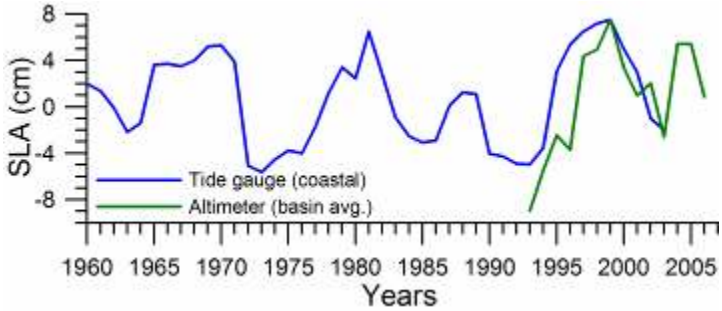


Figure 34. Long-term variations of the detrended sea level anomaly (blue) after high frequency oscillations have been filtered by the three point moving average and its

comparison with annual mean sea level anomaly retrieved from satellite altimeter measurements (after Oguz et al., 2006).

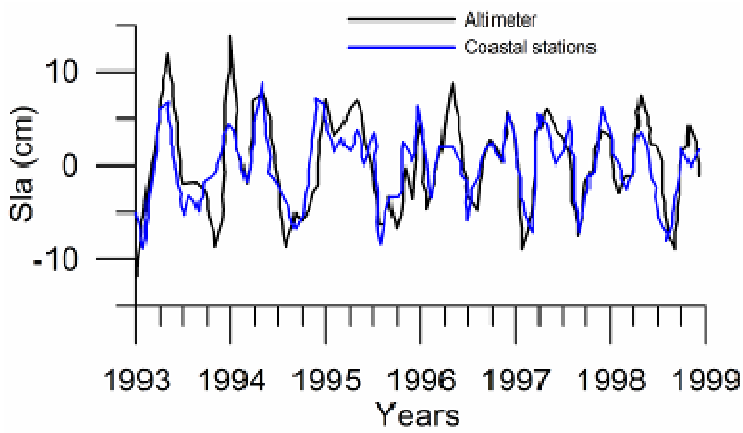


Figure 35. Comparison of the detrended monthly-mean sea level anomaly obtained from the basin-averaged altimeter data (black) and the mean of 12 coastal sea level stations around the basin (blue) (after Goryachkin et al., 2003).

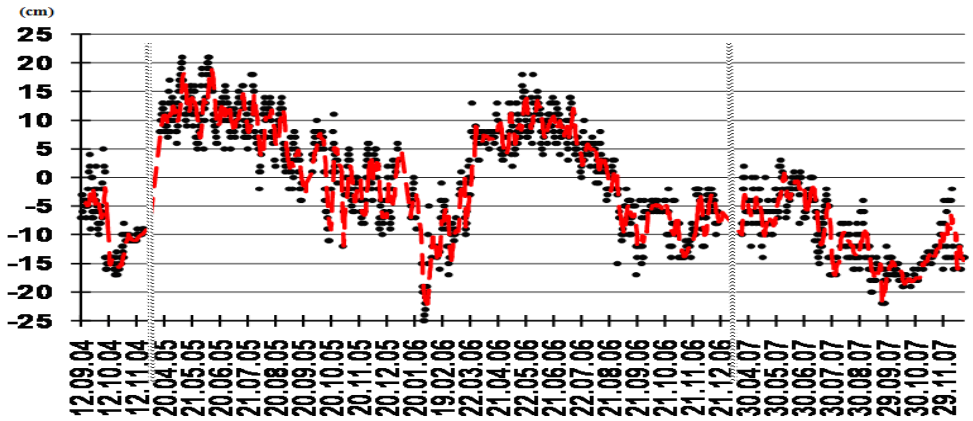


Figure 36. Results of decadal averages (from daily measurements) of sea level data (cm) during 2004-2007 on Island of Zmeiniy (Ukraine, North-Western part of the Black Sea).

Northward movement of species

Full expert report is presented in Annex V and below there is a summary of the Report.

The Black Sea biota contains of 80% of Atlantic-Mediterranean origin, 10.4% and 9.6% of species of freshwater and Ponto-Caspian origin, respectively. At present, the total number of species in the *Black* Sea is relatively small (about 3,774 spp.) and of these 1,619 are fungi, algae, and higher plants; 1,983 are invertebrates, 180 are fish, and 4 are sea mammals- dolphins (Zaitzev, Alexandrov, 1998; see Ref. in Annex V).

In the 20th century, especially in its second half, under the influence of climatic and anthropogenic factors, significant changes have occurred in the diversity of the flora and fauna of the Black Sea.

As a result of the man-induced changes that occurred in the Black Sea ecosystem by the end of the 1980s, it represented a mesotrophic or eutrophic (in its northwestern and the western parts) basin with disturbed functioning, which was favorable for the development of gelatinous plankton. Besides, the occasional and sometimes intentional introduction of non-native species of animals and plants is a global phenomenon that has not avoided the Black Sea as well. As a result, the Black Sea became a basin—recipient for many non-native species of different origins both marine and brackish water species.

In addition in the Black Sea during last decades temperature increased both in the surface mixed and the cold intermediate layers (Fig.37), which facilitates the increase of population of thermophilic species and their northward expansion from the Mediterranean. Until recently new Mediterranean species have been recorded temporally or permanently mainly in the near-Bosporus region. Therefore, they are usually not regarded as established non-native species. But if we take into account only established species, their share in total numbers of non-native species consist of 36%. Since 1960s and certainly earlier with the Bosporus Strait with Low-Bosporus current delivered many Mediterranean species different taxonomic groups. But selected Mediterranean species of phyto- , zooplankton, benthic and fish species more and more often are recorded also off northwestern and northeastern coastal areas. At present, this process is facilitating by rising temperature. As a result of that numbers of penetrated and even established species far from Bosporus are increasing during last years. Species that penetrated beyond the Bosporus reach the centre, southwest, southeast and northeast, moving with the currents or lenses of the Mediterranean water or are releasing with ballast water. Number of species brought with ballast waters increased especially around harbor areas. Some species were represented by a few specimens; others are increasing their density.

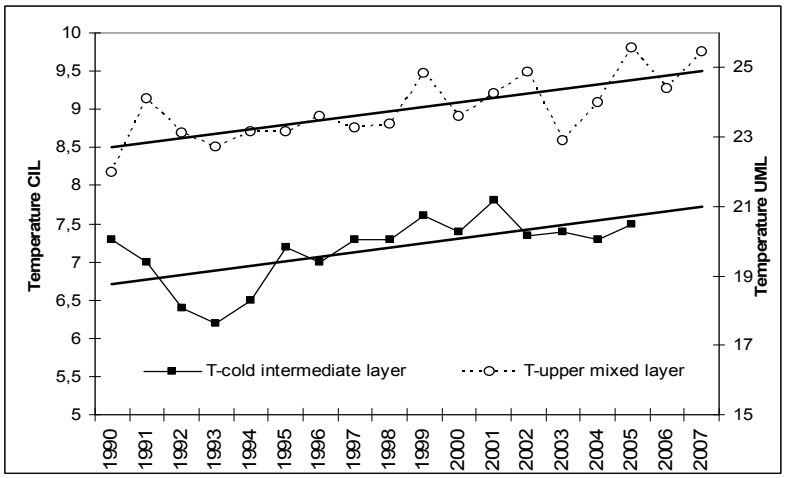


Figure 37. Rise of water temperature during the last decades (Data of lab. Hydrophysics of Southern branch of SIO RAS)

Phytoplankton: Mediterranean phytoplankton species new for the Black Sea are recorded year after year, and their numbers keep increasing. A significant number of species native to the Mediterranean colonize the Bosporus region. However, some other newcomers of the 1960s and early 1970s were found not only near the Bosporus but also near the Crimea. *Zooplankton:* high numbers of holozooplankton species dispersed with Low-Bosporus current into the Black Sea and occur temporally off the Bosporus. Among them, 59 species are Copepoda. All of them were recorded along the southern Black Sea but none of them became abundant. Recently also 46 species of Mediterranean and Marmara Sea Copepoda were found in the southern Black Sea (Zagorognya et al, 1999, Tarkan et al., 2005, see Ref. in Annex V). But all of these species may be considered as regular migrants arrived with Mediterranean water mass. In the northeastern Black Sea off Gelendzhik three species of Mediterranean Copepoda were recorded. In the coastal waters off the Crimea, the numbers of the non-native planktonic species observed keep increasing, all of Mediterranean origin. To date, it is not clear whether all will be capable to establish.

Benthos: Area of distribution twenty two species of Mediterranean Bivalvia is limited off Bosporus. Thirty Mediterranean species of Polychaeta were recorded off Bosporus area. The numbers of Mediterranean species off Bosporus area keep increasing.
During last decades some species, which occurred earlier only off Bosporus area began penetrate in other areas of the Black Sea.

Macrophytes: The list of macrophytes of the Black Sea published in 1975, and the list after 1975, shows 38 additions. The most significant change is the almost twofold increase in the number of *Cladophora*, *Ulva*, *Ceramium*, *Polysiphonia*, *Cystoseira* and *Sargassum*; many of them play a key role in the bottom communities of the Mediterranean (26 species). Most are thermophilic and indicators of the transition zone between the boreal and tropical domains (Milchakova, 2002, see Ref. in Annex V).The greatest number of species has probably penetrated with currents, and became established in near-shore water of the Anatolian coast. Their proportion reaches 26% of the total number of macrophytes.

Fish: Significant range of northward extensions has been recorded for the Mediterranean fish species in the Black Sea. Most of them had been recorded earlier in the Black Sea as seasonal migrants but now they have an extended area of distribution in the Black Sea. Some of them have changed phenology: they used to spend short period of warm seasons in the Black Sea for spawning/ and feeding but now some of them stay longer in the Black Sea, intensively reproduce and even most probably stay for over-wintering, which were not observed earlier (the dorado *Sparus aurata*, the salema *Sarpa salpa*).

Thus there is a progressing trend of arrival of Mediterranean species into the Black Sea both with the currents as natural expansion and with ballast waters. Most of these species arrived in previous years as well but relatively low temperature and low salinity prevented their establishment. Now with rising temperature some species could establish. First of all benthic species that inhabit at the depths where salinity is higher, especially in the southern part of the Black Sea. Some of these species began to establish in the near ports areas.

II.6.10 Bathing waters

Competent authorities concerning bathing water are the Ministry of Health at the national level and Regional Inspectorates on Public Health Protection and Control that carry out sampling and monitoring of bathing waters.

All states have bathing water monitoring. **The bathing waters are classified in BG, RO and TU in the following categories:**

- Compliant with mandatory values of the 76/160/EEC Directive for the 5 parameters (class CI)
- Compliant with mandatory and more stringent guide values of the Directive for the 5 parameters (class CG)
- Not compliant with mandatory values of the Directive for the 5 parameters (class NC)
- Banned (temporarily closed) or closed throughout the season (class B)

Examples:

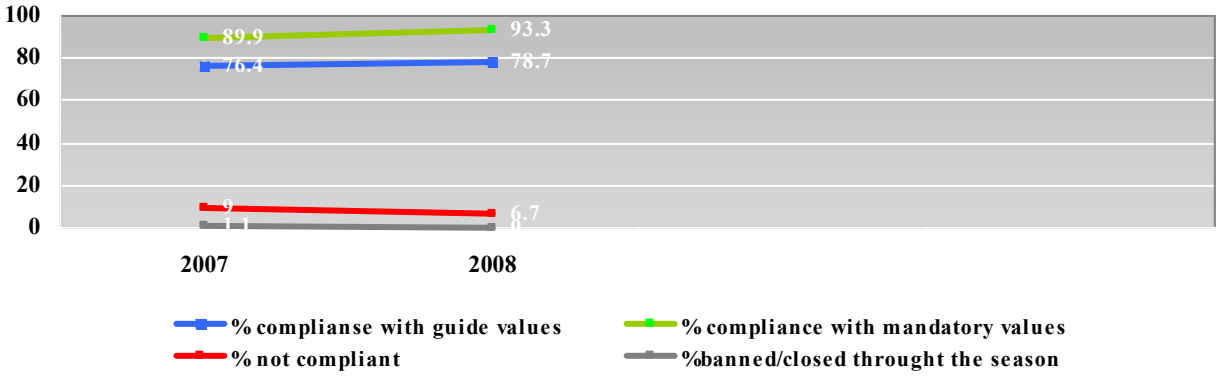


Figure 38. Results of bathing water monitoring in Bulgaria.

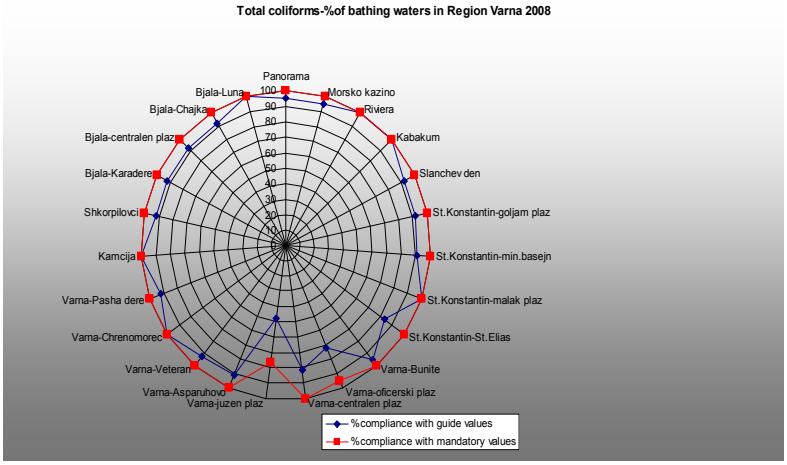


Figure 39. Results of bathing water monitoring in Bulgaria.

Figure 40. Results of bathing water monitoring in Ukraine.

All states have data that allow calculation of the EEA indicator. The BSC receives incomplete reporting of data, however annually a bathing water workshop is carried out, where all states report in tables and figures. The reporting of data is poorly arranged due to insufficient communication between Ministries of Environment and Ministries of Health.

Section III: Conclusions and recommendations

A summary of suitability of Black Sea data collections (in BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies is presented below (Table 13).

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Indicator group	Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	EEA- method requirements	Other Proposed Reliable methodology	Suitability of BS data according to BSIS	Suitability of BS data according to other data sources
Eutrophication	NO3+NO2 (S)	Y	Y	Y (D.5)	winter, 0-10 m, coastal (<20 km) and offshore (>20 km)data, time-series of at least 3-5 yrs at selected stations to be aggregated by selected month and depth and run for trend analysis	Not only winter but also spring concentrations to be considered b/c of increased river inputs to the coastal surface waters	Y	Y
	PO4 (S)	Y	Y	Y (D.5)	"		Y	Y
	N/P (S)		Y		"		Y	Y
	Chlorophyll-a (S)	Y*	Y	Y (D.5)	summer, surface chl, min 3 yrs of data in the last 10 years and min 5 yrs of data in 15-20 yrs.	* EEA methodology requires summer surface concentrations. This is not satisfactory for BS where chl conc show peaks in late winter, late spring and strong autumn peaks not only in the surface but also in subsurface layer (BS SoE, 2008)	Not enough data, limited only reporting to 1-2 States	Y Need to be tested

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Indicator group	Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	EEA- method requirements	Other Proposed Reliable methodology	Suitability of BS data according to BSIS	Suitability of BS data according to other data sources
	* Ocean color in support of Chl-a (S)	N	N	N		* SeaWiFS data 1998-2007 was used in the SoE Report (2008) and compared with in situ data where available. It is recommended to be used widely in the basin as indicator of chl.	N	Y Analyses needed, effort to further develop algorithms, verification by ground-trith data To be further discussed and tested
	Hypoxic situations , expansion of zones of hypoxia (I)	Y*	N	Y (D.5,D.6,D.7)		* Hypoxia (<2 mg/l) in the NWS is not only related to eutrophication but also circulation, meteorological and strafication conditions. SoE (2008 Fig.2.5.1) Bottom water oxy values in summer and autumn is a good indicator in coastal waters.	Y Limited Data available Could be tested	Y Data available Could be tested
	Harmful algal blooms (I)	N	N	Y (D.5)		Species dominance/frequency of occurrence etc.	Considered. Needs further expert work on	Y

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Indicator group	Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	EEA- method requirements	Other Proposed Reliable methodology	Suitability of BS data according to BSIS	Suitability of BS data according to other data sources
							phytoplankton	
	Primary Production	N	N	Y (D.5)			N	Considered. Limited information Needs further expert work
Hazardous substances and oil (contamination	HSs in biota (S)	Y	Y	Y (D.8,D.9)	temporal trends for each station at the same time of the year. Hg, Cd, Pb and the POPs (HCB, Lindane, PCBs,DDT) in mussels and fish.	Reminder: In addition to EEA methodology: 1) statistically sound sampling strategy 2) EOM data for normalization	N Considered. Very limited data available.	Considered. Limited data.
	HSs in sediments (S)	Y	Y?	Y (D.8)	Same above : in sediments	Reminder: In addition to EEA methodology: 1) statistically sound sampling strategy 2) Normalization and enrichment values to be considered	N Still can be tested with few data sets already available for more than 5 yrs.	Considered. Limited data.
	Biological effects (I)	N	N	Y (D.8)			Not yet considered	Not yet considered ?

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Indicator group	Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	EEA- method requirements	Other Proposed Reliable methodology	Suitability of BS data according to BSIS	Suitability of BS data according to other data sources
Shipping	Discharge of oil from refineries and offshore installations (P)	N	Y	N	1) Discharges from refineries based on measurements of oil in refineries effluents 2) Discharges from offshore installations including from production water, drill cuttings, spills and flaring operations.		N	N
	Illegal discharges of oil at sea (P)	Y	Y	N	1) actual number of slicks observed per hour of surveillance flying ; slicks <1m3 not to be considered 2) JRC 2001- compilation of satellite images		N Poor reporting. Considered by contract with EMSA for provision of satellite images	N Poor reporting
	Accidental oil spills from shipping (P)	Y	Y	N	In numbers		Y	Y
	Shipping density (P)	Y	N	N		?	Y	Y

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Indicator group	Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	EEA- method requirements	Other Proposed Reliable methodology	Suitability of BS data according to BSIS	Suitability of BS data according to other data sources
Loads	Inputs of nutrients and HSs from direct (point) sources (P)	Y	N	Y (D.5)		1)Monthly monitoring of river water discharges and contaminant levels 2) Trend analysis when data sets are suitable	Considered fpr municipal, industrial Hot spots and rivers.	Y, Considered
Litter	Amount/composition/ sources	N	N	Y (D.10)			N	Considered. Not as regular monitoring. An assessment was made.
Biodiversity	biomass of macroalgae	Y	N	Y (D.1,D.5,D.6)	Annual and seasonal variability /trends		Y, limited data	Y
	Species composition / number of species / species richness	Y	N (species diversity only)	Y (D.1,D.5,D.6)	"		Y	Y
	Macroalgae Distribution	Y	N	Y (D.1,D.5,D.6)	Area coverage		Y	Y
	Seagrasses						N	Y
	NIS/IAS	Y	N	Y (D.2)			Y	Y
	Designated Areas	Y	Y				Y	Y
	Threatened and protected species	Y	Y				Y	Y
Fisheries and aquaculture	Fishing fleet capacity / fishing effort (P)	Y	Y	N			Y	Y
	Stock biomass (S) and its	Y	Y	Y (D.3)			Y	Y

Table 13. Summary of suitability of Black Sea data collection (of BSIS and external data sources) to the BSC and EEA indicators and MSFD descriptors together with proposed methodologies.

Indicator group	Indicator name / type	BSC indicators	EEA-CSI	MSFD-GES descriptors	EEA- method requirements	Other Proposed Reliable methodology	Suitability of BS data according to BSIS	Suitability of BS data according to other data sources
	sub-indicators							
	Catches / biomass		Y	Y (D.3)		Trends	Y	Y
	Total landings							Y
	Fishing mortality	Y*	N	Y (D.3)		* derived with analytical methods	Y (see Annex ıv)	Y
	Spawning Stock Biomass	Y*	N	Y (D.3)		"	Y	Y
	Aqua. Production	Y	N	N			Y	Y
Climate change	SST	N	N	N		See II.4.8	Y	Y
	SLR	Y*	N	N		See II.4.8	* as ICZM indicator	Y
	Northward movement of species	N	Y	N			N	Y
	Total number of Med sps /expansion area	N	N	N		Temporal variation in numbers of Med sps and spatial coverage	N	Y (see Annex v)
	Invasive species diversity and abundance	Y	N	Y (D.1,D.5,D.6)			Limited data	Y
Bathing waters	Chemical and microbiological parameters	Y	Y	N			N	Y

On the basis of the numbers of BS indicator that exist in relation to the EEA and MSFD 'needs' the following concusions were drawn. Among the eutrophication indicators (inorganic nutrients, chlorophyll and N/P ratio), N/P is not specifically reported to the BSC but as a generic indicator it can be easily derived from BSIS. Chlorophyll is poorly reported to the BSC and the data cannot be used for a regional assessment. However, outside of BSIS Chlorophyll data are available and suitable to build trends and maps of spatial distributon. Nutrients data in BSIS is suitable to trace trends and spatial distribution in coastal waters, but not in the open-sea.

Expansion of hypoxia zones (BSC and MSFD indicator) can not be traced based on BSIS data, however, data are available in the region.

Harmful algal blooms (MSFD indicator) are regularly studied in the Black Sea, the BSIS data are not enough to support this indicator, however, external data are sufficient for regional assessments. Primary production (MSFD indicator) is not regularly studied in the Black Sea to build statistically significant trends or spatial distributions. There are no data in BSIS, and outside of BSIMAP different methods are used to measure primary production, therefore the data are not suitable for comparisons. IBSS-Sevastopol developed equations to calculate primary production from Chlorophyll, specifically for the Black Sea. The method should be verified by other Institutes.

Hazardous substances in biota, sediments (BSC, EEA, MSFD indicators) and their effects (MSFD indicator) are studied in the Black Sea sporadically, the data are not sufficient for regional assessments yet.

Discharge of oil from refineries and offshore installations (EEA indicator) is not reported to the BSC, there is no information on the availability of data in the region. Illegal discharges of oil from ships (BSC, EEA indicator) are considered, EMSA provides satellite images in case of suspected oil spill, however, verification of spills (aerial surveillance, for instance) is still poorly provided by states.

Loads (BSC, MSFD) are well reported to the BSC, data are sufficient for hot spots and rivers. Marine Litter (MSFD) is not a component of the BSIMAP, data outside of BSIS are available, however, assessments are possible for ML on the coast, but not in the Sea and on its bottom.

Most of the BSC Biodiversity indicators are also EEA and MSFD indicators, however, the data supporting those indicators for macroalgal communities in the BSIS are limited, for seagrassess – not reported, outside of BSIS – available and suitable for building indicators. MPAs are well reported to the BSC, together with threatened and protected species.

Those BSC Fishery indicators which appear also as EEA and MSFD indicators are well reported to the BSC, however, stock assessments for most of the fish species are in need for harmonization.

The EEA indicator 'North-ward movement of species' is not reported to the BSC, however, scientific studies in the region are available. Invasive species diversity and abundance (BSC, MSFD) are poorly reported to the BSC. Data outside of BSIS are suitable for the indicators calculation.

Bathing waters data are regularly collected in all Black Sea states, data outside of BSIS are sufficient for tracing compliance with established standards (not yet harmonized in the region).

Summary of Gaps in monitoring and in the reported data, reasons for these gaps (including capacity and related issues) and who is responsible for or has a role in relation to them.

Major gap in BSIMAP: the monitoring is mainly not integrated.

BS states Ministries of Environment nominate Institutions which monitor pressures, state and impacts in the Black Sea in the frames of the National Monitoring Systems and report data to BSIS. In most of the states the monitoring is spread in between different Institutions, frequently with overlapping of efforts/observations. Often the reporting comes to the BSC in the following way: hydrochemistry/hydrophysics/hydrology is reported by one Institute and hydrobiology by another one (from the same state). The checks show that the reported hydrobiological and hydrochemical/hydrophysical/hydrological observations do not take place at the same stations and at the same time. Therefore, the data collected in this manner are not a product of an integrated monitoring program/strategy and cannot be used for ecosystem-based approach to assessments of Black Sea environment status. The latter does not mean that integrated monitoring in the Black Sea does not completely exist. There are many Institutes in the region performing observations in an integrated manner. However, the National Monitoring Systems are not properly designed/organized to utilize the integrated monitoring available and correspondingly the reporting to the BSC reflects this non-holistic approach. The only exception is the reporting of Romania, where the SoE monitoring is integrated (carried out by a single Institute) and all observations on the state of the Black Sea environment take place in the long-term run at the same stations, with the same frequency and covering the full set of parameters agreed under BSIMAP.

Other BSIMAP major gaps in 2001-2010 (taking into consideration the requirements of BSIMAP and MSFD) can be listed as follows:

13. recommended frequency of observations (identified in BSIMAP in line with WFD) is not always observed;
14. mandatory parameters are often not covered;
15. open-sea stations are missing – no agreed stations for a regular monitoring;
16. reference stations – mainly missing or not specified as such, except Romania;
17. long-term time series data stations lack special attention and permanent financial support;
18. poor coordination between responsible authorities;
19. poor financial assistance, in general;
20. regional dimension absent;
21. BSIMAP stations are mainly coastal, very few marine stations;
22. monitoring does not use much automated systems and other modern tools of observations;
23. lack of harmonization (especially in fisheries).

The gaps in the reporting are directly related to the gaps in the monitoring and the reasons are different in the different Black Sea states. However, the main problems by state are as follows:

Bulgaria – national monitoring program not well established, lack of integration, poor coordination in between responsible organizations, lack of financial assistance, overlapping of activities.
Georgia – national monitoring program not well established, lack of integration, poor coordination in between responsible organizations, lack of financial assistance.

Romania – no gaps in national monitoring, needed more stable financial assistance.
Russian Federation – too many organizations involved in the monitoring, lack of integration, complicated structure of national monitoring program, poor coordination in between responsible organizations, overlapping of activities.
Turkey – no gaps in national monitoring, however the frequency of observations (twice a year) is insufficient. Biology component needs better integration.
Ukraine – lack of integration, insufficient coordination in between responsible organizations, lack of stable financial assistance.

Recommendations for improving of monitoring activities

The need for further development/reconstruction of BSIMAP relates to regional priorities recently identified (climate change, for instance) or reconfirmed major environment concerns (eutrophication, pollution, biodiversity change, habitats destruction, overfishing) which are calling for broadening of scope of investigations and expertise, utilization of new approaches and techniques.

Thus, the BS Monitoring Strategy for 2011–2020 should further develop the existing practices (filling the gaps in agreed already observations, improve geographical coverage, etc.) and encompass **new issues** as well as the development of new methodologies and tools. Issues of particular importance include: (a) the relation to climate change and climate change policies; (b) the development of tools for **integrated regional** assessment of BS state (simultaneous observations in all countries, including cruises for Marine Living Resources (MLR) stock assessments, etc.); (c) regular open sea observations; (d) development of networks (reference stations, trends stations/transects in transitional, coastal and marine waters, marine mammals strandings and by-catch, etc.); (e) cumulative effects and transboundary environment problems; (f) screening for new pollutants; (g) pollution incidents; (h) habitat mapping; (j) air pollution (or contract with EMEP); (i) ballast water monitoring; (k) marine litter; (l) hazardous substances transportation and others.

Creation of network of reference sites and stations is proposed to have 3 levels of organization:

Level 1 – All existing national monitoring sites in Black Sea countries will continue with national funding. Station network may comprise 5-20 coastal (including marine and transitional waters) stations per country with different levels of anthropogenic impact and pollution. Different monitoring components should be designed to be integrated as much as possible.
Level 2 – National integrated sites in which programmes with a suite of hydrological, hydrochemical and hydrobiological observations (including measurements of most of the pollutants) are to be implemented with national funding. A minimum 3 sites per country (1 with high anthropogenic impact, 1 with moderate level and 1 with low level of anthropogenic impact) is recommended.
Level 3 – An international reference sites network (1 – 2 sites per country) with full programme of observations (hydrology, hydromorphology, hydrochemistry, hydrobiology, atmospheric and marine environment pollution, etc.) is needed. This can be funded by national sources, EU, UNEP and other donors.

For all proposed levels, it will be necessary to combine the efforts of different institutions at the national level to fulfill the requirements of an integrated monitoring system and as well to establish a national system for marine data collection and management or to strengthen the functioning of existing national data depository system (example of NODCs). They should

also be able to communicate with international reporting systems (e.g. of BSIS of BSC, EEA and others).

Specific revisions for the present BSIMAP monitoring strategy are also recommended like the exclusion of contaminants monitoring in water since they are around the detection limits of the methods applied and usually not considered as reliable for routine monitoring. Instead, contaminants monitoring in biota and sediments to detect temporal trends could be strongly recommended.

Answers to all policy questions of BSIMAP as well as the indicator based assessments as an integral part of the pan-European marine assessments carried out by EEA require improvement and harmonization of methodologies used in the BS region to assure compatibility of data collected. For instance, data sets of TPH of different states can hardly be compared due to different methodologies used in samples processing. The same stands for phytoplankton, zooplankton, fish stocks, etc. The BSC has checked and assured the compatibility of data for nutrients, trace metals and pesticides. Stock assessments are harmonized for sprat and turbot only. River monitoring strategies are not fully harmonized. Further harmonization activities are envisaged in the Work Plan of the BSC for 2010 and will continue after.

New observation techniques need to be developed: near –real time observations (multi sensor buoys and marine stations/platforms), GEOSS and GMES capacities used in the region; satellite and aerial surveillance.

National research and monitoring activities constitute an indispensable part of a well functioning present BSIMAP. However, regional component is absent in the Program and it should build on international agreements under the umbrella of the BSC for joint ventures based on common (and transboundary) environmental problems seeking for a regional solution.

Initial step for a regional dimension could be: BS pilot programmes in all states waters undertaken in a harmonized way and transboundary problem-driven, such as:

1. Fish and other marine living resources stock assessments
2. Cetaceans surveys
3. Marine Litter in the sea
4. Contamination of sediments and biota
5. Habitats mapping, biodiversity assessments, etc.

(The proposed investigations above can be listed as insufficiently studied domains in the existing monitoring system at present).

Supporting activities:

- Utilization of the **capacities of all Institutes** dealing with monitoring in the region (not only those, which are officially nominated by the Ministries so far). Bi-lateral and multi-lateral agreements to be developed.

- **Avoiding overlapping of activities and efforts** – often two or more Institutes undertake observations in the same area without proper coordination (best example is the Kerch accident).

- **Partnership** with international organizations – EEA, IMO, ESA, EMSA, HELCOM, utilizing their experience.

- **Capacity building** – regular trainings, bringing best available practices to the region, strengthening the collaboration between different authorities engaged in monitoring, further development of inter-ministerial mechanism, etc.

- **Sharing -** The data flow and dissemination of information (prepared reports based on data collected) within BSC as well as from BSC should be transparent, two-way and easily accessible by everybody. It is particularly important to develop further the Black Sea Information System and make its data and metadata services accessible online on the BSC website (which is in line with INSPIRE directive), and to make sure that the special information needs of stakeholders are met. The work carried out within the BS monitoring (at least meta data) should be transparent, interact with and enjoy the confidence of all the stakeholders, including local authorities, industry, nongovernmental organizations, expert institutions, public and other bodies.

Major targets in improvement of monitoring to fit into Pan-EU assessments:

- **Frequency of observations** – in line with WFD and MSFD (so far not always sustained properly, as mentioned above).

- **Proper geographical coverage** – include open sea.

- **Sustain stations and transects with long-terms observations**

Note: The main gap is that most of these stations with historical data are in coastal waters. In the open sea (in the gyres) the observations are not regular, mainly carried out in the frames of projects. Open sea regular observations should be nationally supported (by the budgets of Ministries of Environment) as projects data reporting is not part of the national data reporting to BSIS obligations.

- **Networks development, mandatory parameters covered.**

- **Harmonization** – inter-comparison exercises, further development of guidelines, common understanding of GES, indicators, etc.

- **Quality control and assurance** – sustainable mode of implementation.

Crucial: Better coordination between authorities involved, less complicated organization and a strategy for integrated monitoring are the main challenges at the national level. Financial assistance provided in a sustainable way is viatal to better coordinate and plan activities in monitoring and reporting.

Recommendations for improving of reporting process

The network of reporting institutions in the Black Sea should be further developed. The responsibilities in reporting to the BSC should be fully reorganized to encompass as much as possible the data collected in an integrated manner. Network of Monitoring stations and sites must be improved on the basis of above approach with established 3 level sites. Level 3 sites – nominated and partly funded by National Authorities – will report regularly directly to Secretariat and in parallel to national Authorities. All data from existing Level 2 and Level 1 sites and stations – one time per year will be sent to the Secretariat by each National Authority as national reports.

Usually the projects (NATO, EC, UNDP/GEF, others) carry out different cruises, produce and store data. The regional data base (BSIS) should be proposed as the permanent domain for any data in the region produced by projects. Ownership and data exchange policy should be developed and sustained by the BSC in relation to major data-holders in the Black Sea region.

For the BSIS (when fully operational on-line) a link to WISE-marine could be considered. The BSIS reporting templates for eutrophication/pollution data are similar to EIONET templates.

For assessments sensu MSFD, Annex I descriptors, the BSIS is missing basically biological data (see Annex VII). In general, the marine biology, incl. biodiversity conservation and habitats data reporting, needs serious improvement and further development to meet the requirements of the evaluations, envisaged in the MSFD.

For wider assessments (sensu MSFD, Annex III) the major gaps in the BSIS itself (not in reporting) are:

- marine meteorology;
- physical oceanography;
- sedimentology;
- marine geology and geophysics, etc.
- habitats destruction;
- erosion;
- GIS development.

Oceanographic data are reported to the National Oceanographic Data Centers in the BS region (not to BSIS), e.g. IO-BAS-Varna in Bulgaria, MHI-Sevastopol in Ukraine, etc. Meta data submission is harmonized through the project BlackSeaSCENE and available data sets can be found through SeaDataNet (http://www.seadatanet.org/). National Oceanographic Data Centres and Satellite Data Centres should be wider involved in the BSC network and linked to BSIS.

In relation to the EMODNET process (BSC is an observer): as known, the Ur-EMODnet preparatory actions have been handled by four consortia as for hydrography, geology, chemistry, biology and broad scale habitats. Black Sea is included within the EMODNET Chemical Pilot Project (Chemistry Lot). Within the Chemistry Lot, Black Sea data have been evaluated for a period of 1960-2009 basically with the participation of 6 collating regional institutes and the BSC. More than 21,000 stations were recorded and evaluated with respect to matrix, parameter and institutes. The project is ongoing and the next evaluation of results will take place in May 2010. Seemingly, the involved institutes and meta data contributions to the project is limited.

Unfortunately, the Black Sea has not been foreseen as an area of interest in the other Lots.

In line with the EC Maritime Spatial Planning (EC Integrated Maritime Policy) the BSC aims to recommend and motivate the creation of maritime technologies that will aid the development of maritime activities in a way compatible with the good environmental status of the seas. In preparation for such recommendations the BSIS needs to be enlarged, incorporating new components related to navigation and marine infrustructures, shipping density, seefloor data, energy projects, accidents, socio-economy, etc. All these new

reporting and relevant data base (parts of BSIS) will be developed in the farmes of the MONINFO project (see Annex III).

Recommendations on how to improve the existing EEA indicator specifications, proposals for new indicators

The EEA CSI of indicators can be accepted as suitable for the Black Sea since almost all of them are already accepted indicators by the BSC (Table 13). The EEA methodologies for calculation of indicators are used in the Black Sea region and no recommendations for improvement arrive from BS experts.

However, like for nutrients and chlorophyll, different seasons for data collection is recommended for the Black Sea. In winter and spring, surface waters of the Black Sea is enriched with nutrients, therefore, spring data should also be considered for aggregation and indicator evaluation. Surface values of chlorophyll might not be enough because of occurrence of deep chlorophyll maximum, seasonal surface maximums are different, vice versa. When BSIS and external data sources are considered together, nutrient and chlorophyll data can be tested as indicators suitable for the Black Sea.

The quality of marine environment is directly related with the functioning of biological communities and indirectly with their structure. However classically, in BSC, in the Annexes of MSFD and practices of EEA, structural parameters are selected to build indicators. Within the scope of this work, regional experts have proposed a few more indicators to be considered (used in the Black Sea) which are based on functional parameters of biological communities. They are:
G. Minicheva (author) – S/W (methodology/examples in Annex IV).
G. Shulman (author) – fatness of sprat (methodology/examples in Annex IV).

For climate change:
E. Yakushev – positioning of the CIL (cold intermediate layer) in the Black Sea.

and additionally organic nitrogen could be tested as indicator, where long term data is available (Sulina-Romania data set, Gelendizck-Russian data set), especially for coastal areas under the pressure of river inputs. Nutrients in sediments could be a valuable indicator of secondary eutrophication.

Other recommendations for indicator-based reporting

There are many Black Sea stations with long term regular observations. A full list of these stations and data collected at them will help to better test for BSC, EEA and MSFD indicators.

Also a common understanding in the region is needed for the definition of transitional, coastal and marine waters for indicator based analysis and assessments.

In relation to Fishery – recommendations on monitoring and reporting are given in detail in Annex IV.

MSFD 'forward-looking component'

There are some standardised methods (agreed methodologies) for monitoring and assessment in the Black Sea which ensure comparability of data/results as required by regional commitments and the MSFD, as mentioned above. Further work is needed for TPH, biota and

fish stock assessments. Harmonization of river monitoring strategies, habitat mapping (using the same classification and methods), hot spots update.

'GES' identification in a harmonised way is in progress (a regional methodology in line with MSFD is drafted, pending for discussions and adoption). Reference conditions are identified in Bulgaria and Romania, in a similar way they will be proposed for development in non-EU states. Background values and water quality classes are known for Bulgaria, Romania, Russian Federation and Ukraine.

In general, for a wider regional assessment based on MSFD Annex III / Table 1 and Table II, the Black Sea basin monitoring activities (either covered by BSIMAP or other national programmes and projects) may provide useful volumes of data for certain characteristics of the sea, pressures and impacts. In the Black Sea, biology (biodiversity and fisheries) is regularly monitored besides chemistry and hydrophysical variables which are a great advantage. However, all these efforts are not well integrated and coordinated at the national and regional scales, as mentioned above. Therefore, accessibility to all available data and information is a major gap. Another one is the spatial and temporal coverage of especially the biological variables. Besides, when the data compiled/overviewed for the present Report is considered, the major data gaps for the assessment of sea characteristics (Annex III/Table 1) are the data relevant to marine acidification and habitat types in some states. And for the pressures and impacts (Annex III/Table 2), data on physical loss, damage and other physical disturbances are the major missing parts in terms of data availability or accessibility. In terms of GES descriptors, data and information on D.4 (food webs) and D.11 (energy, under water noise) were not available and not evaluated within this report. Other descriptors are partially covered by Black Sea monitoring/reporting activities, as summarised in Table 13 (see also Annex VII).

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Annex I: Projects in the Black Sea region[8]

I. Data Collection + Field observations +Remote sensing Projects

1. **EC 4th FP daNUbs** (finalized), **Years: 2001-2004**, **Full name:** Nutrients management in the Danube Basin and its impact on the Black Sea, **http://danubs.tuwien.ac.at/**

The project, through literature and data review in combination with field work, addressed:

- the nutrient balance in the Black Sea catchment with main emphasis on diffuse pollution (e.g. agriculture, air pollution) and the transport, retention and losses of nutrients in the catchment (nutrient balances in case study regions),
- the transport, retention and losses of nutrients and silica along the Danube River and
- the effect of riverine nutrient and silica discharges on the parts of Western Black Sea directly influenced by the Danube River plume

· Mathematical models: Based on an improved process understanding, mathematical models were further developed, combined, and applied to quantitatively assess nutrient fluxes from the Danube Basin along the Danube and the Delta to the mixing zone of the Western Black Sea and to quantify the impact of these fluxes on the Western Black Sea. This part used:

- the MONERIS-emission model based on a GIS data base,
- the Danube Water Quality Model (DWQM) for the description of the transport and transformation processes in the river system,
- the Danube Delta Model (DDM) for the quantification of nutrient transport in the Danube Delta and (iv) the Shelf Model for modelling the direct impact of the Danube load on the Western Black Sea. Based on these models the whole system was considered as a complex unit and scenarios were developed as a basis for scenario evaluation.

· Strategic planning: the project was oriented towards elaboration of advise for future strategic planning on the catchment scale. This part included:

- a method to establish comparable, basin-wide, periodic nutrient balances considering the national data availability and
- the evaluation of different solutions for future nutrient management strategies considering socio-economic developments in the Danube Basin.

1.1. Field cruises carried out by NIMRD-Constanta and IFR-Varna in the Western Part of the Black Sea:

[8] Among all the numerous projects carried out in the Black Sea region in 2000-2010 we chose those which had cruises or created data bases (to the best of our knowledge)

Bulgarian waters: major cruises in Varna Bay (10 stations); transects at Capes Kaliakra (5 stations), Galata (5 stations) and Emine (5 stations) – 1-to 30 miles offshore.

- 3-8 June 2001
- 13-15 November 2001
- 23-25 August 2002
- 18-20 November 2002
- 12-15 August 2003

Romanian waters: all stations from the RO national monitoring system observed on a seasonal basis.

1.2. Archives of data (hydrology, chemistry, biology) – not anymore accessible through the WEB page of the project.

The project compiled historical data collected in the Western Part of the Black Sea for the period 1990-2000, Excel files.

2. EC 5th FP EUROGEL(finalized), Years: 2002-2005**, Full name:** EUROpean GELatinous zooplankton:mechanisms behind jellyfish blooms and their ecological and socio-economic effects**, http://www.bio.uib.no/eurogel/**

The project defined the basic biological and ecological factors that govern reproduction, growth, and survival for a number of different gelatinous species, commonly occurring in high abundance. Five different habitats were appointed as model environments, all characterised by their seasonal or permanent mass occurrence of jellyplankton, but otherwise quite divergent. These study sites were investigated with the aim of defining and quantifying the importance of each target species, and especially its ability to affect fish production, and are backed up by other field- and experimental studies. The results were put into a historical perspective by reviewing previous documentation of fisheries and jellyplankton biomass. Literature and new data were used in a mathematical model, to define the competitive ability between the targeted jellyplankton species and visual predators like fish, and this helped in understanding in which biological and environmental conditions one or the other of the two types of competitors will dominate. A particle-tracking model was used to give prognoses for mass-occurrence of jellies due to advective transport. As a more specific approach towards the aquaculture industry acute and chronic effects on fish of jellyfish stings were studied. Socio-economic effects of jellies outbreaks in EU waters were investigated as well.

2.1. **Cruises**

Year	Date	Station	Note
2004	4.06.	K1, K3, K10, K20, K30	Cape Kaliakra – 1-30 miles offshore
	5.06.	B5, G1, G3, G10, G20, G30	Varna Bay (B5) and Cape Galata – 1-30 miles offshore
	28.08.	K1, K3, K10, K20, K30	Cape Kaliakra – 1-30 miles offshore
	29.08.	G1, G3, G10, G20, G30	Cape Galata – 1-30 miles offshore
	30.08.	24-hours station	Varna Bay
	4.10.	B5, G1, G3, G5, G10, G15, G20	Varna Bay (B5) and Cape Galata – 1-20 miles offshore
2005	15.03.	B5, G1, G3, G5, G10, G15,	Varna Bay (B5) and Cape Galata – 1-15 miles offshore
	26.04.	B5, G1, G3, G5, G10, G15	Varna Bay (B5) and Cape Galata – 1-15 miles offshore

	14.06.	B5, G1, G3, G5, G10, G20	Varna Bay (B5) and Cape Galata – 1-20 miles offshore
	22.08.	B5,G1, G3, G5, G10, G15	Varna Bay (B5) and Cape Galata – 1-15 miles offshore

a. **Historical data** – 1965-2001 – jellies, mesozooplankton, fish. Not accessible through the WEB page of the project.

3. UNDP/GEF BSERP , I and II phase (finalized**), Years:** 2001-2008**, Full name:** Black Sea Environment Recovery Project**, http://ps-blacksea-commission.ath.cx/bserp/**

Black Sea Environment recovery Project – in support of the Bucharest Convention implementation.

The BSERP contributed to sustainable human development in the Black Sea area through reinforcing the cooperation and the capacities of the Black Sea countries to take effective measures in reducing nutrients and other hazardous substances to such levels necessary to permit Black Sea ecosystems to recover to similar conditions as those observed in the 1960s. The overall objective of the project was to ensure (i) that all of the Black Sea countries take concrete measures (including investment activities) in the eutrophication causing sectors to reduce load of nutrients and hazardous substances on the Black Sea ecosystem and, (ii) that major findings and recommendations of the project are incorporated in national policies, strategies and, where possible, in national legislation.

Cruises in 2003 -2006, carried out by international scientific teams at Bulgarian R/V Akademik (3 cruises) and Ukrainian R/V Vladimir Parshin (1 cruise) – Western Part of the Black Sea. Datasets are multidisciplinary, containing data in areas of physical and chemical oceanography, marine biology, meteorology, sediment quality etc.

- **Format:** ASCII (reports, data files)
- **Data source link**: mailto:secretariat@blacksea-commission.org

4. UNEP/ACCOBAMS (finalized), **Years**: 2008-2009, **Full name:** in the text, **www.blacksea-commission.org**

The UNEP/ACCOBAMS/BSC project consisted of two main sub-activities, undertaken in Ukraine and Turkey:

In Ukraine:
'Involvement of Black Sea artisanal fisheries in anti-bycatch and anti-marine litter activities

Objectives of the project

- To study numbers and composition of cetacean by-catches, record birds mortality and ML taken from the sea during normal fishing operations on the seabed in the northwestern Black Sea off the coast of Ukraine.
- To prepare, publish and disseminate in Ukraine among fishing crews the responsible professional guidelines and propagandistic leaflets regarding ML issues and ghost fishing.

In Turkey:

'Cetacean bycatch and stranding related to turbot fishery and marine litter pollution in the Western Black Sea Turkish coast'

Components of the project are: research of incidental catches of Black Sea cetaceans and other species in turbot bottom gillnets, research of marine litter (ML) taken by bottom-set gillnets during turbot fishing operations, research of stranding cetaceans on Turkish coast of the western Black Sea, seasonally, and of its possible relation with the turbot fishing operations, research of coastal ML in the Western Black Sea, public awareness, education and information exchange regarding ML and cetaceans

Project implemented. Final report available.

5. **EC FP7 SESAME, Years:** 2007-2010**, Full name:** "Southern European Seas: Assessing and Modelling Ecosystem changes", **(http://www.sesame-ip.eu/)**

SESAME aims to assess and predict changes in the Southern European Seas (Mediterranean and Black Sea) ecosystems and in their ability to provide key goods and services with high societal importance, such as tourism, fisheries, ecosystem biodiversity and mitigation of climate change through carbon sequestration in water and sediments. The Mediterranean and Black Sea, are unique and evolve rapidly with large interannual to decadal variability and abrupt fluctuations. For this reason, SESAME will merge economic and natural science in order to study the changes in the Western and Eastern Mediterranean and Black Sea. To this end, it will bridge the gap between natural and socio-economic sciences in order to assess the ability of the ecosystems to sustain these essential functions.

The project provides an integrated, ecosystem-based approach, considering Mediterranean and Black Sea as a coupled climatic/ecosystem entity, with links and feedbacks to the World Ocean. The assessment of these changes is based on the identification of the major regime shifts in ecosystems that have taken place in the last 50 years.

SESAME provides a platform for training, education and outreach in an integrated manner, which will ensure that the scientific results are translated and disseminated to all levels of society. Existing information, models, simulations and scenarios are combined under several Work Packages (WPs).

6.1. Cruises: April 2008, October 2008: details at http://seadata.bsh.de/csr/retrieve/V1_index.html

6.2. Archives – data compilation since 1950s, Data holder: **Israel Oceanographic & Limnological Research Limited**, IOLR, (http://isramar.ocean.org.il/sesamemeta/)

6. EC FP7 HYPOX, Years: 2009-2012, **Full name**: In situ monitoring of oxygen depletion, (www.hypox.net)

HYPOX is a EU funded project involving 16 partner institutions located in 11 countries in and around Europe. HYPOX is focusing on a better understanding of the occurrence of hypoxia (low oxygen conditions) in aquatic systems and the influence of anthropogenic impacts on the responsible processes. the scientific work focuses on capacity building for improved oxygen monitoring (continuously at high temporal resolution) at a number of target sites as well as on modeling and prediction of hypoxia and ecosystem consequences.

Black Sea related work is focusing on three sites:

1. Istanbul Strait

   (Istanbul Technical University, Eastern Mediterranean Centre for Oceanography and Limnology; Ifremer, France; Max Planck Institute for Marine Microbiology, Bremen, Germany). Main topic: Occurrence and effect of lateral intrusions of oxic Mediterranean waters on anoxic Black Sea waters. A first cruise was conducted in November 2008 (http://hypoxnews.blogspot.com/2009/11/black-sea-cruise-in-istanbul-strait.html). Work will continue in April 2010 on board FS Maria S. Merian.

2. Romanian Shelf

   (Alfred Wegener Institute for Polar and Marine Research, Germany; National Institute of Marine Geology and Geo-ecology of Romania). Main topic: shelf ecosystem recovery under decreasing anthropogenic nutrient supply and the effect of climate patterns on shelf hypoxia dynamics status: The Geoecomar already conducted surveys in the area (the first HYPOX cruise in april 2008; http://hypoxnews.blogspot.com/2009/11/surveys-of-hypox-partner-geoecomar-at.html). an oceanographic mooring will be deployed in 2009.

3. Crimean Shelf

   (A.O.Kovalevsky Institute of Biology of the Southern Seas, Ukrainian National Academy of Science, Ukraine; Max Planck Institute for Marine Microbiology, Bremen, Germany). Main topic: benthic processes under changing oxygen concentrations due to chemocline oscillations. The first main cruise to the area will happen in April 2010 and include deployment of oceanographic moorings and various other instruments.

   In September and November 2009 – IBSS, Tarkhankut gas seeps region – a shallow area near the Crimea Peninsula. The observations conducted include physico-chemical as well as biological parameters.

   Cruises also at : http://hypoxnews.blogspot.com/search?updated-min=2009-01-01T00%3A00%3A00-08%3A00&updated-max=2010-01-01T00%3A00%3A00-08%3A00&max-results=15

7. EC FP7 MEECE, Years: 2010-2013, Full name: Marine Ecosystem Evolution in a Changing Environment, http://www.meece.eu/

MEECE is an European FP7 Integrated Project with 22 partners from across Europe. The project is coordinated by the Plymouth Marine Laboratory in the UK.

MEECE will use predictive models that consider the full range of drivers to explore the responses of the marine ecosystem in a holistic manner, rather than driver by driver as has been done in the past. MEECE will explore the impacts of both **climate drivers** (acidification, light, circulation and temperature) and **anthropogenic drivers** (fishing, pollution, invasive species and eutrophication).

This innovative approach will help scientists and decision makers to respond to multiple driver impacts with appropriate, knowledge-based, management applications. MEECE will also go a step further and provide methodologies to evaluate new decision making and management tools.

What will MEECE do?

- Review the impacts of the drivers on the marine ecosystem.

- Scenario test the impacts of drivers on the structure and functioning of marine ecosystems.
- Develop indicators of ecosystem status.
- Develop a coupled model system to predict ecosystem response from plankton to fish.
- Create a model library of ecosystem modules couplers and decision support tools for management concerning the EC Marine Strategy, EC Maritime Policy and the EC Common Fisheries.

8. **EC EuroARGO (GMES services), Years:** 2008 on**, Full name:** Global Ocean Observing Infrastructure (about the Black Sea program: http://www.euro-argo.eu/news_and_events/euro_argo_black_sea_meeting)

The Euro-Argo array is the European component of a world wide in situ global ocean observing system, based on autonomous profiling floats. The Argo objective is to develop a global array of floats (spaced 300 km apart, on average) throughout the ice-free areas of the deep ocean. It is estimated that some 3,000 floats are required to reach this objective. The floats are battery powered, with a design life of between 3/4 to 5 years, i.e. about 800 floats must be deployed per year to maintain the target array. The data are transmitted in real time by satellite to data centres for processing, management, and distribution. The Euro-Argo objective is to provide a sustained European contribution to the international Argo programme.

The first autonomous profiling float was deployed in the Black Sea on 8th of Dec. 2009.

9. **EC FP6 MONRUK, Years:** 2007-2009**, Full name:** Aeronautics and Space project developing marine monitoring services for Russia, Ukraine and Kazakhstan**,** **http://monruk.nersc.no/**

The overall objective was to develop and implement satellite Synthetic Aperture Radar (SAR) monitoring of the marine environment in Russia, Ukraine and Kazakhstan (the RUK area) as a component of GMES. Satellite SAR images for the three study areas were collected in order to develop and validate retrieval algorithms for ocean and sea ice parameters. The SAR data collection was done by: (a) using existing ERS and ENVISAT SAR data retrieved from ESA archives; (b) new acquisition of ENVISAT ASAR data, including alternating polarization images, and (c) RADARSAT SAR images.

Results:

- Established procedure to facilitate access to SAR data from ENVISAT and RADARSAT in near real time for the RUK area.
- Improved algorithms and analysis tools for SAR ocean and sea ice products.
- Demonstration of SAR monitoring and service chain to key users in the RUK area .
- Installed and tested an information system with web map servers and regional data nodes.
- Results of user requirements analysis, users surveys and feedback from users to service chain testing, which will be useful to all potential data provideres and service providers who plan to offer new and improved information products to users.
- Recommendations for development of future monitoring services for the marine environment in the RUK area

10. EC PROMOTE (finalized), Years: 2006-2009**, Full name:** PROtocol MOniToring for the GMES Service Element:Atmosphere**, http://www.gse-promote.org/, continued through: MACC (http://www.gmes-atmosphere.eu/services/raq/raq_nrt/)**

Mission: To deliver the Atmosphere GMES Service Element a sustainable and reliable operational service to support informed decisions on the atmospheric policy issues of stratospheric ozone depletion, surface UV exposure, air quality and climate change.

PROMOTE project created a dedicated web page for the Black Sea region in the field of atmospheric pollution (http://db.eurad.uni-koeln.de/promote/RLAQS/riu_rlaqs.php?force=BSC).

11. EC EuropeAID (finalized), **Years 2007-2009**, **Full name**: Environmental Collaboration for the Black Sea**, http://www.ecbsea.org/en/**

The Project aimed to improve:

- regional cooperation for protection of the Black Sea;
- national capacities to implement and enforce existing environmental legislation, secondary laws and regulations to implement the Bucharest Convention;
- national legislations, secondary laws and regulations to implement the Bucharest Convention at national level, taking into account convergence to EU water related legislation, in particular the Water Framework Directive (WFD) and the forthcoming EU Marine Strategy (see also the page on International and EU legislation);
- biological water quality monitoring of pollution;
- integrated coastal zone management;
- protection of marine biodiversity through the establishment of Marine Reserves;
- public participation and awareness raising.

As a result of the two years of intensive work of ECBSea Project offices in Georgia, Moldova and Ukraine, international and national experts in cooperation and consultation with the Environmental Ministries as well as stakeholders in the beneficiary countries, the Project came up with the following outputs for the Black Sea:

1. Text of Amendments to the Bucharest Convention
2. Guidelines for the Establishment of Marine Protected Areas in the Black Sea (in English and Russian)
3. Background paper for the regional NGO workshop: "The Bucharest Convention: How to improve transparency and accountability?"
4. Draft Law of Ukraine on Coastal Zone
5. Guidelines on Territorial Planning in Coastal Zone of Ukraine (in English and Ukrainian)
6. Current State and Perspectives of Legal Regulation for Wetlands of National and Local Importance in Ukraine
7. Designation Dossier for the Establishment of the Marine Protected Area in the Black Sea Ukraine:
10. Desk Study of Small Phyllophora Field MPA in Karkinitsky Bay
    - Field Survey of Karkinitsky Bay MPA
    - GIS maps of Karkinitsky Bay
8. Preliminary Management Plan for the Small Phylophora Field Marine Protected Area Karkinitsky Bay (Ukraine)

9. Proposal for the Declaration of a Marine Protected Area: "Botanical Reserve of National Importance, Small Phyllophora Field of Karkinitsky Bay" (Ukraine)
10. Water Sector Convergence Plan (Road Map) for the four EU Directives (Georgia)
11. Concept for the New Framework Water Law of Georgia
12. Integrated Coastal Zone Management Strategy for Georgia
13. Integrated Plan for Sustainable Development of Tskhaltsminda Coastal Community in Georgia
14. Report on Results of Coastal Community Survey on Sustainable Development in Tskhaltsminda (Georgia)

12. HERMES (finalized), **Years: 2005-2009, Full name:** Hotspot ecosystem research on the margins of European seas**,** http://www.eu-hermes.net

Biological oceanography, Chemical oceanography, Cross-discipline, Fisheries and aquaculture, Marine geology.

HERMES was designed to gain new insights into the biodiversity, structure, function and dynamics of ecosystems along Europe's deep ocean margin. It represented the first major attempt to understand Europe's deep-water ecosystems and their environment in an integrated way by bringing together expertise in biodiversity, geology, sedimentology, physical oceanography, microbiology and biogeochemistry, so that the generic relationship between biodiversity and ecosystem functioning can be understood. Studies will extend from the Arctic to the Black Sea and include open slopes, where landslides and deep-ocean circulation affect ecosystem development, and biodiversity hotspots, such as cold seeps, cold-water coral moulds, canyons and anoxic environments, where the geosphere and hydrosphere influence the biosphere through escape of fluids, presence of gas hydrates and deep-water currents.

Cruises: February-March 2007 (seep systems of the NW and NE Crimean margin); R/V Meteor.

II. Projects collecting data, creating data bases (no field observations)

1. **EC FP5 ARENA** (finalized), **Years:** 2003-2006**, Full name:** A Regional Capacity Building and Networking Programme to Upgrade Monitoring and Forecasting Activity in the Black Sea**, www**

Biological oceanography, Environment, Physical oceanography

ARENA initiated a co-operative ocean programme to assess and identify the Black Sea resources, the needs for operational oceanography, to formulate a Data-Base Management System and to build capacity through training and improving the communication and other essential facilities, for the monitoring, understanding, modelling/prediction and forecasting for the entire basin.

2. **EC FP6 ASCOBOS** (finalized), **Years**: 2005-2008, Full name: A Supporting Programme for Capacity Building in the Black Sea Region Towards Operational Status of Oceanographic Service**,** http://www.ascabos.io-bas.bg

ASCABOS increased public awareness and stimulated and motivated the utilization of operational oceanographic information in management and decision-making practices. Considerable work has been performed on compiling meta-databases on the Black Sea environmental data, information and research within previous international initiatives and projects. To support and to strengthen the exchange between scientists, governmental managers and other users ASCABOS developed a Black Sea information system, containing all available metadata, validated and efficiently updated through the Internet. ASCABOS organized a cost-effective VOS pilot programme, applying modern technologies and developments for data collection, transmission, storage, use and dissemination. The VOS programme responded to the GOOS demand for long-term monitoring of the marine ecosystems.

3. EC DG Env. MONINFO, Years: 2009-2010, Full name: "Environmental Monitoring of the Black Sea Basin: Monitoring and Information Systems for Reducing Oil Pollution", http://www.blacksea-commission.org/_projects_observers_partners.asp#MONINFO.

Main objectives:

- Improved information system for combating oil pollution
- Enhanced monitoring system of operational and accidental pollution
- Enhanced response capabilities, including risk management and emergency preparedness planning

BSC PS is implementing the project, project-specific staff is hired. Detailed information on the progress of implementation can be found in the 6th and 12th months reports on the MONINFO part of the BSC webpage,

4. EC FP7 UBSS, Years: 2009-2012, continuation of the BS SCENE project (2006-2008), **Full name:** "UP-GRADE Black Sea Scientific Network", **(http://www.blackseascene.net/). Working under the standards of SeaDataNet: -** http://www.seadatanet.org/

1) To extend and strengthen significantly the existing Black Sea Scientific Network, including previous (under Black Sea SCENE) and new environmental and socio-economic research institutes and universities from the countries around the Black Sea and 2 EU member states and 2 International bodies. They will meet in regular workshops, together with partners from EU member states:

- To discuss and to prepare long term arrangements for sustaining the Black Sea SCENE network and the Black Sea virtual data and information infrastructure
- To strengthen and further improve exchange of knowledge, communication and discussions on environmental problems.
- To join, coordinate and tune scientific input for the protection, rehabilitation and sustainable development of the Black Sea Ecosystem.

For new Institutions, including BSC PS"

- To assess the present quality of Black Sea datasets, managed by the regional partners, through inventory of Data Quality Control methods and comparison with EU standards and practices.
- To harmonize the future quality of datasets by exploring and harmonizing common DQC and DQA methods.
- To adopt and implement internationally agreed protocols for cataloguing and exchanging Black Sea datasets: collecting meta data and using XML formats for populating standardized meta-directories and preparing exchange formats for the data sets.

- To promote, to disseminate, to maintain and to plan further future exploitation of the Black Sea SCENE virtual data and information infrastructure, inter alia by further increasing the public understanding, awareness and knowledge about the Black Sea environment. To illustrate the important role and impact of the Black Sea SCENE infrastructure.

2) To ensure Black Sea datacenters interoperability and to improve the exchange, availability and accessibility of scientific environmental data & information, through implementing common communication standards and adapted SeaDataNet technologies in the Black Sea virtual data & information infrastructure.

3) To improve exchange of quality comparable data & information and to ensure the quality, compatibility and coherence of the data issuing from so many sources through adoption and execution of standardized methodologies for data quality checking on partner's data (data quality assessment on Black Sea partner's data).

The meta data collected is stored in SeaDataNet, http://www.seadatanet.org/

SEADATANET has developed an efficient distributed Marine Data Management Infrastructure for the management of large and diverse sets of data deriving from in situ and remote observation of the seas and oceans.

Professional data centres, active in data collection, are constituting a Pan-European network providing on-line integrated databases of standardized quality.

The on-line access to in-situ and remote sensing data, meta-data and products is provided through a unique portal interconnecting the interoperable node platforms constituted by the SeaDataNet data centres.

The development and adoption of common communication standards and adapted technology ensure the platforms interoperability. The quality, compatibility and coherence of the data issuing from so many sources, is assured by the adoption of standardized methodologies for data checking, by dedicating part of the activities to training and preparation of synthesised regional and global statistical products from the most comprehensive in-situ and remote sensing data sets made available by the SeaDataNet partners.

Data, value added products and dictionaries serve wide uses: e.g. research, model initialisation, industrial projects, teaching, marine environmental assessment.

5. EC FP7 EnviroGRIDS, Years : 2009-2013**, Full name :** "Building Capacity for a Black Sea Catchment Observation and Assessment System supporting Sustainable Development" Project", **(http://www.envirogrids.net/)**

General objectives: The scientific aim of the EnviroGRIDS project is to assemble an observation system of the Black Sea catchment that will address several GEO Societal Benefit Areas within a changing climate framework. This system will incorporate a shared information system that operates on the boundary of scientific/technical partners, stakeholders and the public. It will contain an early warning system able to inform in advance decision-makers and the public about risks to human health, biodiversity and ecosystems integrity, agriculture production or energy supply caused by climatic, demographic and land cover changes on a 50-year time horizon.

Technical objectives: The generic technical objectives of the EnviroGRIDS project are to:

- run a gap analysis of existing regional observation systems to prepare recommendations for improvement of networks of data acquisition in each region/country,
- build capacity on observation systems in the Black Sea catchment,
- improve regional network to coordinate the efforts of partners active in observation systems
- link, gather, store, manage and distribute key environmental data,
- develop the access to real time data from sensors and satellites,
- create spatially explicit scenarios of key changes in land cover, climate and demography,
- distribute large calculations and datasets on large computer clusters,
- streamline the production of indicators on sustainability and vulnerability of societal benefits,
- provide a standard for integrating data, models and information and communication tools,
- provide policy-makers and citizens with early warning and decision support tools at regional, national and local levels.
- produce innovative tools to visualize and interpret data and results of integrated models,
- alert citizens concerning exposure to environmental risks,
- build capacities in the implementation of many new standards and frameworks (INSPIRE, GEOSS, OGC).

Report on the gaps in the Black Sea catchment area observation systems and data available (contact point: V. Myroshnichenko: volodymyr.myroshnychenko@blacksea-commission.org .

11. EC FP7 MyOCEAN (GMES Marine Core Services), Years: 2009-2011, Full name: Ocean Monitoring and Forecasting**, http://www.myocean.eu.org/**

MyOcean is the implementation project of the GMES (Global Monitoring for Environment and Security) Marine Core Service, aiming at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting.

During years 2009-2011, thanks to FP7 co-fundings, MyOcean will lead the setting up of this new European service, grown on past investments in research & development, system development and international collaborations.

MyOcean Service provides the best information available on the Ocean for the large scale (worldwide coverage) and regional scales (European seas), based on the combination of space and in situ observations, and their assimilation into 3D simulation models: temperature, salinity, currents, ice extent, sea level, primary ecosystems, etc.

MyOcean service is available:

- anywhere (the service covers the whole globe)
- at any depth (models give access to a 3D depiction)
- at anytime (in real time, with short term forecast, and also past situations for at least the last 25 years)

- to anyone (access to products is open and free).

Maritime security, oil spill prevention, marine resources management, climate change, seasonal forecasting, coastal activities, ice sheet surveys, water quality and pollution … are some of the targeted applications.

12. EC EMODNET, maritime Policy Actions, DG Mare, **Years:** 2009- , **Full name:** European Marine Observation and Data Network, (http://ec.europa.eu/maritimeaffairs/emodnet_en.html)

The European Marine Observation and Data Network (EMODNET) is a new initiative of the EC to assemble fragmented and inaccessible marine data into interoperable, contiguous and publicly available data streams for complete maritime basins. These data will be made available to public and private operators, allowing for the growth of commercial and non-commercial services based on the EMODNET data. EMODNET will provide data on scales defined by the regions and subregions of the EU Marine Strategy Framework Directive (MSFD), which aim is to achieve good environmental status in marine waters by 2020. One of the MSFD regions is the Black Sea. EMODNET data should be directly available through the Water Information System for Europe dealing with marine information (WISE-Marine) and supporting the data and indicator needs for the initial assessments of marine waters required by member States in 2012 by the MSFD.

The preparatory actions for EMODNET include four projects (lots) - on hydrography, geology, chemistry and biology, which will set up the preliminary version of EMODNET - ur-EMODNET. The last two projects are directly related to the Black Sea. Particularly, the chemical project, which is based on the SeaDataNet network of National Oceanographic Data Centers, has among participants six leading marine institutes from the Black Sea region. The projects will identify the main challenges in moving from an ur-EMODNET to an operational EMODNET. Some of the on-line map layers of the European Atlas of the Seas, which is being developed by EC, will be sourced from the ur-EMODNET. The ur-EMODNET will be operational throughout 2010 and 2011, collecting feedback from users on fitness for purpose and indicating how the definitive EMODNET might be set up. Based on the knowledge gathered during this exploratory ur-EMODNET a strategy will be developed for moving ahead.

13. EC FP7 KnowSeas, Years: 2009-2012. **Full name**: Knowledge-based Sustainable Management for Europe's Seas, http://www.knowseas.com/

Knowledge-based Sustainable Management for Europe's Seas (KnowSeas) is a Collaborative Project funded by the European Community under 7th Framework Programme. It has 30 partners from 15 countries and is coordinated by the Scottish Association for Marine Science.

The overall objective of the project is a comprehensive scientific knowledge base and practical guidance for the application of the Ecosystem Approach to the sustainable development of Europe's regional seas. This will increase the evidence base available for decision makers and facilitate the practical implementation of the Ecosystem Approach, currently seen by some stakeholders as confusing and nebulous. It will be delivered through a series of specific sub-objectives that lead to a scientifically based suite of tools to assist policy makers and regulators with the practical application of the Ecosystem Approach. It is also

expected to deliver high quality scientific outputs that advance our understanding of coupled social and ecological systems.

Data Base: Rapana venosa under discussion:

1. History of invasion - donor area, when, where, how; Black Sea & worldwide
2. Ecological effects of *Rapana venosa* introduction in the Black Sea (and a few notes regarding elsewhere) - biological characteristics of an invasive species and receptor basin, nature and magnitude of invasive impact, scientific evidence and speculation. Ongoing ecological dynamic change in *Rapana* population (e.g. what is reason for recent decrease in average *Rapana* size along the eastern Turkish Black Sea coast?).
3. How does climate change modify the invasive impact of *Rapana* - observations and hypotheses?
4. Destructive fisheries impact - impacts of fishing methods on demersal ecology, experiments with alternative fisheries methods.
5. Identification of gaps in knowledge and scientific uncertainties.
6. Socio-economic importance of *Rapana* as a valuable fisheries resource,
7. Rapana fisheries, stock and population dynamics.
8. What fisheries regulations and environmental policy relative to *Rapana venosa* do exist in Black Sea countries? If there are regulations, are they adequate? Management dilemma - population control and/or resource protection.

14. EC DABLAS, Years: 2001-2009**,** to be continued**, Full name:** Danube Black Sea Task Force **, http://ec.europa.eu/environment/enlarg/dablas/index_en.htm**

The DABLAS Task Force was set up in November 2001 with the aim to provide a platform for co-operation for the protection of water and water-related ecosystems in the Danube and Black Sea Region.

15. EC Mnemiopsis leidyi Database, Years: 2008 continuous**, (http://ps-blacksea-commission.ath.cx/MLDB/)**

The prototype of the Black Sea Mnemiopsis leidyi Database has been developed in a framework of the EC Black Sea SCENE Project by the IMS METU (Turkey) and IBSS NASU (Ukraine). Considering the importance of such database for understanding changes in the Black Sea Environment, leading data holders from the Black Sea countries under the umbrella of the Permanent Secretariat of the Black Sea Commission (BSC/PS) on voluntarily basis agreed to create and maintain joint Black Sea Mnemiopsis leidyi and Beroe ovata Data Base (ML-BO-DB) based on this prototype.

The Mnemiopsis leidyi Database contains data on observations of invasive species ctenophore *Mnemiopsis leidyi* obtained in the Black Sea since 1991. Database is continuously updated, while more data holders are joining the activity. By the end of 2009 database contained 51 datasets (1721 stations, about 3000 samples).

- **Link**: http://ps-blacksea-commission.ath.cx/MLDB/
- **Brief description:** The Mnemiopsis leidyi Database (MLDB) contains data on abundance and biomass of ctenophore Mnemiopsis leidyi collected in the Black Sea. The invasive ctenophore Mnemiopsis leidyi (Agassiz, 1865) was first found in the Black Sea in early 1980-s. This species created the tremendous ecosystem damage and big economic losses in the region in the late 1980-s, 1990-s. It was recognized as one of the main ecological problems for the Black Sea ecosystem.

- **Released:** 2008, updated regularly
- **Time period:** 1991 - 2009
- **Resolution:** stations
- **Coverage:** Black Sea
- **Areas of application:** ecosystem studies and assessment, biodiversity
- **Accessibility:** free for data older 5 years, conditional for recent data
- **Format:** MS SQL database, ASCII
- **Reported by:** BSC PS

16. EC FP7 PEGASO, Years: 2010-2014, **Full name:** People for Ecosystem-based Governance in Assessing Sustainable Development of Ocean and coast, **www**

Main objectives:

1. To construct an ICZM governance platform, to support the development of integrated policies for the coastal, marine and maritime realms of the Mediterranean and Black sea basins.
2. To make an integrated regional assessment for the Mediterranean and Black Sea coastal and maritime areas.
3. To refine and further develop efficient and easy to use tools for making sustainability assessments in the coastal zone
4. To test and validate the assessment tools at regional and local scales to understand both global and cumulative local trends and how they interact in specific coastal and marine regions.
5. To establish and strengthen mechanisms for networking and capacity development so as to promote knowledge transfer and the long-term use of the project outputs

17. EC DG Env. MONINFO Phase II, Years: 2010-2011, www.blacksea-commission.org

The project enables the coastal states to better prevent and respond to operational/accidental/illegal oil pollution. Within this long term policy approach, and in support of decision making toward reduction/elimination of oil pollution **in the Black Sea, the project** will pursue the following objectives:

- Establishment of operational Regional Database and Information Platform (RDIP), as a component of BSIS, including expert system for oil pollution mitigation and counteraction activities,
- Update of Environmental Sensitive Indices for the BS region,
- Training experts and other users to work with the RDIP,
- Populating of the RDIP with reliable data and information,
- Implementing a satellite monitoring pilot study in detecting oil pollution (illegal, operational, accidental)
- Development of a mechanism for aerial surveillance for confirmation of reported oil spills,
- Internet based oil spill transport model,
- Automatic Identification System (AIS) and backtracking,
- Visualization of all geo-spatial information through GIS mapping,
- Supporting oil pollution related activities of the SAP 2009,
- Sustaining and further building of capacity in the region.

The second phase is oriented to practical aspects in facilitating and support of monitoring and information management of oil pollution in the Black Sea region. MONINFO 2 consists of the following work-packages:

- WP 1. RDIP and Expert System on oil pollution mitigation and counteraction activities,
- WP 2. Application of a Web based model for oil pollution forecasting for the Black Sea,
- WP 3. Regional Black Sea AIS data server,
- WP 4. Remote sensing monitoring of oil pollution,
- WP 5. Capacity building and sustainability.

III. Data bases with long-term time series data in the region

1. NATO TU-Black Sea database

- **Link:** http://sfp1.ims.metu.edu.tr/
- **Brief description:** Black Sea inter-disciplinary multivariable historical database was created in framework of the NATO TU-Black Sea project in 1994-1997 and is maintained in framework of the NATO SfP ODBMS Black Sea Projects. It includes all main physical, chemical and biological variables for the entire Black Sea basin. Database covers the most crucial period in the history of the Black Sea ecosystem starting from the "background" situation in 1960 till the drastic changes occurred in 90s. All data included into the database were quality checked by qualified groups of regional experts, well acquainted with the Black Sea data. Each value of physical, chemical and bio-optical data is accompanied with the quality flag.
- **Released:** 2002
- **Time period:** 1956-2001
- **Resolution:** stations
- **Coverage:** Black Sea
- **Areas of application:** ecosystem studies and assessment
- **Accessibility:** free
- **Format:** ASCII (csv)
- **Data source link:** http://sfp1.ims.metu.edu.tr/ODBMSDB/
- **Reported by:** BSC PS

2. Black Sea Oceanographic Database (BSOD)

- **Brief description:** The Black Sea Oceanographic Database (BSOD) was compiled on the base of the NATO TU-Black Sea database and MEDAR-MEDATLAS. The BSOD includes main physical, chemical and biological variables for the entire Black Sea basin (148 variables). The database includes data obtained at 74,532 oceanographic stations.
  For more information contact: Sukru Besiktepe, Director of IMS METU, sukru@ims.metu.edu.tr.
- **Released:** 2005
- **Time period:** 1890 - 2003
- **Resolution:** stations
- **Coverage:** Black Sea
- **Areas of application:** ecosystem studies and assessment
- **Accessibility:** free, provided by request by Institute of Marine Sciences, Middle East Technical University (www.ims.metu.edu.tr)
- Format: Paradox Database distributed on CD

- **Reported by:** BSC PS

3. Hydro-meteorological database of DHMO

- **Brief description:** water levels, water temperature, measured water discharge, H/Q water discharge, water turbidity, suspended sediments, air temperature, precipitation, evaporation, wind velocity and direction, soil temperature, water quality, air quality, radioactivity
- **Released:** updated daily
- **Time period:** mainly since 1960-present (water levels and temperature – since 1921, water quality – monthly since 1970, air quality – since 1990, radioactivity – since 1980)
- **Resolution**: actual measurements
- **Coverage:** Black Sea Basin - Lower Danube Region
- **Areas of application:**
- **Accessibility:** restricted
- **Format:** ASCII
- **Data source link:** mailto:dhmo@izm.odessa.ukrtel.net
- **Reported by:** DHMO

Additional information:

1. Medar/medatlas II (http://www.ifremer.fr/medar/) – finished in 2002

2. NATO SfP ODBMS Black Sea Project (http://sfp1.ims.metu.edu.tr/) – finished in 2002, Relevant NATO Linkage Grant "**Updated interdisciplinary Black Sea database on a basis of recent international projects/cruises."** (IMS METU/ MHI/ SIO RAS) 2004-2005, which created CD with joint ODBMS-MEDAR database – the "Black Sea Oceanographic Database" (available on request from IMS METU)

3. ECOOP: European Coasta Seas Operational Observing and Forecasting System: http://www.ecoop.eu/

IV. Availability of data/GIS in the Black Sea catchment area assessed through Internet search and in the frames of the EnviroGRIDS project, relevance to the needs in assessments per priority transboundary problems in the Black Sea: for more details contact: V. Myroshnichenko: <volodymyr.myroshnychenko@blacksea-commission.org>

Ref. Report: Myroshnychenko V. et al. 2010. EnviroGRIDS Gap Analysis Report (Phase I). Deliverable D2.2-1 (Black Sea Commission archive).

The legend for cells in the cross-tables presented further in this chapter is as follows:

A: Accessible – data from this dataset can be accessed and used for non-commercial purposes;
E: Exist –data exist but access to data is restricted or charged;
U: Useful – data from the dataset are useful for cross-linked category, however to learn on data accessibility it is necessary to look at other cells in the same row whether they contain **A** or **E.**
NA: Not Applicable – the cross-linked dataset is not applicable to current end-user needs category, for example, Georgians national datasets are not applicable to end-user needs of ICPDR
Empty cell: it means that linkage between dataset and end-user needs category does not exist or not identified.

Global scale

Dataset name	*Category*	**BSC priority transboundary problems**					*Resolution*	*Web link*
		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*		
ESRI maps	GIS	A	A		U	A	various	http://www.esri.com/
UNIGE GIS datasets	GIS	E	E		E	E	various	
VMap0	GIS	A	A		U	A	1:1000000	http://www.mapability.com/info/vmap0_index.html
VMap1	GIS	E	E		U	A	1:250000	http://www.mapability.com/info/vmap1_index.html

Dataset name	Category	BSC priority transboundary problems					Resolution	Web link
		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*		
GRUMP	Population	A	U		U	U	30"	http://sedac.ciesin.columbia.edu/gpw/
GPW	Population	A	U		U	U		http://sedac.ciesin.columbia.edu/gpw/
LandScan	Population	A	U		U	U	30"	http://www.ornl.gov/sci/landscan/index.html
ASTER GDEM	DEM	A	A				30m	http://www.ersdac.or.jp/GDEM/E/2.html
SRTM DEM	DEM	A	A				90m	http://www2.jpl.nasa.gov/srtm/
Globcover	Land cover	A	A		A	A	300m	http://ionia1.esrin.esa.int/index.asp
MODIS Land Cover Type product	Land cover	A	A		A	A	500m	https://lpdaac.usgs.gov/lpdaac/products/modis_products_table
DSMW v. 3.5	Soil	E	E		U	U	1:5000000	http://www.fao.org/ag/agl/lwdms.stm
HWSD v 1.1	Soil	A	A		U	U	1km	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/index.html?sb=1
ERS/MetOp Soil Moisture	Soil	A	A		U	U	50km	http://www.ipf.tuwien.ac.at/radar/index.php?go=ascat
Global Runoff Database	Hydrology	A	A			A	at stations	http://www.bafg.de/cln_016/nn_294146/GRDC/EN/Home/homepage__node.html?__nnn=true
Hydroweb	Hydrology	A	A			A	major water bodies and wetlands	http://www.legos.obs-mip.fr/en/soa/hydrologie/hydroweb/
GPCP Precipitation	Meteorology	A	A			A	1°	http://precip.gsfc.nasa.gov/
TMPA (precipitation)	Meteorology	A	A			A	0.25°	
TRMM (rainfall)	Meteorology	A	A			A	0.25°	http://trmm.gsfc.nasa.gov/data_dir/data.html
Global Rainfall Map	Meteorology	A	A			A	0.1°	http://sharaku.eorc.jaxa.jp/GSMaP/
WorldClim	Climate	A	A			A	1km	http://www.worldclim.org/

Dataset name	Category	BSC priority transboundary problems					Resolution	Web link
		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*		
(precipitation, T°)								
CRU TS 2.1 (precipitation, T°, vapor pressure, cloud cover)	Climate time series	A	A			A	1km	http://www.cru.uea.ac.uk/cru/data/hrg/timm/grid/CRU_TS_2_1.html
Climate of the World (T°, wind, pressure, precipitation etc)	Climate stations data	A	A			A	stations	http://www.ncdc.noaa.gov/oa/wdc/index.php
SST	Ocean	A	U	U	U	A	1km+	numerous web sites
Ocean color data (Chl)	Ocean	A	U	A	A	A	1km+	http://oceancolor.gsfc.nasa.gov/
Ocean surface wind	Ocean	A	A			A	25km	http://manati.orbit.nesdis.noaa.gov/ascat/
Sea Level anomalies	Ocean	U	U	A	A	A		http://www.aviso.oceanobs.com/en/data/products/sea-surface-height-products/global/index.html
UNEP Geo Data Portal	various themes	U	U	U	U	U	1km+ / Country	http://geodata.grid.unep.ch/webservices/
International Energy Agency (IEA) energy statistics	Energy						Country	http://data.iea.org/ieastore/statslisting.asp
PREVIEW Global Risk Data Platform	Disasters	A	A	A	A	A	events	http://preview.grid.unep.ch/

EU/European scale

Dataset name	*Category*	BSC priority transboundary problems					*Resolution*		
		Eutrophication	*Chemical pollution*		*Changes in marine living resources*	*Biodiversity changes*	*Climate change*		
EuroGlobalMap	GIS	E	E			U	E	1:1000000	http://www.eurogeographics.org/content/products-services-eurodem
EuroRegionalMap	GIS	E	E			U	E	1:250000	http://www.eurogeographics.org/products-and-services/euroregionalmap
EuroBoundaryMap v4.0	GIS	E	E			U	E	1:100000	http://www.eurogeographics.org/products-and-services/euroboundarymap
EuroDEM	DEM	A	A					60m	http://www.eurogeographics.org/content/products-services-eurodem
CLC1990 raster	Land cover	U	U			U	A	100m	http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-clc1990-100-m-version-12-2009
CLC2000 vector	Land cover	U	U			U	A	100m	http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-seamless-vector-database-1
CLC2000 raster	Land cover	U	U			U	A	100m	http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-100-m-version-12-2009
CLC2006 raster	Land cover	U	U			U	A	100m	http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-clc2006-100-m-version-12-2009
Population density disaggregated with Corine land cover 2000	Population	A	U			U	U	100m	http://www.eea.europa.eu/data-and-maps/data/population-density-disaggregated-with-corine-land-cover-2000-2
ESBD V.2	Soil	A	A			U	U	1:1000000	http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDBv2/index.htm
ESBD V.2 raster	Soil	A	A			U	U	1km	http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB_data_1k_raster_intro/ESDB_1k_raster_data_intro.html
Degree of soil sealing	Soil	A	A			U	U	100m	http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing-100m
EEA Waterbase	Water quality	A	A		U	U	U	rivers, water bodies, coastal waters	several datasets at http://www.eea.europa.eu/data-and-maps/data/

Dataset name	*Category*	BSC priority transboundary problems					*Resolution*		
		Eutrophication	*Chemical pollution*		*Changes in marine living resources*	*Biodiversity changes*	*Climate change*		
Sediment discharges	Water quality	A	A		U	U	U	at stations	http://www.eea.europa.eu/data-and-maps/data/sediment-discharges
Airbase	Air quality	A	A			U	U	at stations	http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-1
EMEP grids reprojected by EEA (emissions)	Air quality	A	A			U	U	50km	http://www.eea.europa.eu/data-and-maps/data/emep-grids-reprojected-by-eea
Air pollutants (emissions)	Air quality	A	A			U	U	country	numerous data sources at http://www.eea.europa.eu/
Greenhouse gases emissions	Air quality, climate	A	A			U	A	country	numerous data sources at http://www.eea.europa.eu/
Eurostat Statistics Database	Socio-economic	A	A		A	U	U	country/ major provinces	http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database
Nature 2000	Protected areas				A	A	U		http://www.eea.europa.eu/data-and-maps/data/natura-2000
Nationally designated areas	Protected areas				A	A	U	100m	http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-4
REABIC database	Ecosystem, invasive species				A	A	U		http://www.reabic.net/map_europe.html
GRID-Europa Datasets -GNV	Climate, soils, vegetation, water, socio-economic, population, GIS	A	A		A	A	A	various	http://www.grid.unep.ch/data/data.php

Dataset name	*Category*	**BSC priority transboundary problems**					***Resolution***		
		Eutrophication	***Chemical pollution***		***Changes in marine living resources***	***Biodiversity changes***	***Climate change***		
E-PRTR	pollutant emissions to air, water and land	A	A		U	U	A	country	http://prtr.ec.europa.eu/

Dataset name	Category	BSC priority transboundary problems					Resolution	Web link
		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*		
Black Sea Information System (BSIS)	Water quality, ecosystem, ICZM	A	A	A	A	U	stations / country	mailto:secretariat@blacksea-commission.org
Black Sea Surveys data	Sea water quality	A	A	A	A	U	stations	mailto:secretariat@blacksea-commission.org
Black Sea TDA GIS	GIS	U	U	A	A	U	1:100000, 1:200000	mailto:secretariat@blacksea-commission.org
NATO TU-Black Sea database	Ecosystem	A	A	A	A	U	stations	http://sfp1.ims.metu.edu.tr/ODBMSDB/
Black Sea Oceanographic Database	Ecosystem	E	E	A	A	U	stations	For CD apply to IMS METU http://www.ims.metu.edu.tr/
Mnemiopsis leidyi Database	Ecosystem, biodiversity			A	A	U	stations	http://ps-blacksea-commission.ath.cx/MLDB/
Black Sea SLA	Sea level anomalies	U	U	U	A	A	1/8°	http://www.aviso.oceanobs.com/en/data/products/sea-surface-height-products/regional/m-sla-black-sea/index.html
Climatic Maps (T°, Salinity, Density, O2, H2S)	Climate	A	A	U	U	A		http://www.ims.metu.edu.tr/SeaDataNet/indexclimat.asp?doc=inSituProductDescription.htm
Satellite Averaged Maps (SST, Chl)	Climate	A	A	U	U	A		http://www.ims.metu.edu.tr/SeaDataNet/indexsat.asp?doc=satelliteProductDescription.htm

Regional scale: Black Sea

V. Available observation systems, networks and services in the Black Sea, including its catchment area

Most of the existing observation systems are multipurpose, i.e. one observation system can produce different data types. Vice versa, data of the same type can be produced by different observation systems.

The European Directory of the Ocean-observing Systems **(the EDIOS Directory)** is at http://www.edios.org/, a unique searchable metadatabase. The EDIOS directory provides information on observing systems operating repeatedly, regularly and routinely in European waters, contains metadata on platforms, repeated ship-borne measurements, buoys, remote imagery, etc. EDIOS is an initiative of the European Global Ocean Observing System (EuroGOOS, http://www.eurogoos.org/). The EDIOS directory currently holds well over 12,000 data entries, which are regularly updated.

Global observation systems

		SC priority transboundary problems				
Category	***Observation system (instrument) / network***	***Eutrophication***	***Chemical pollution***	***Changes in marine living resources***	***Biodiversity changes***	***Climate change***
Land cover, vegetation	Landsat, Terra, Aqua, SPOT	U	U		A	U
Soil moisture	METOP	A	A			
Surface temperature	NOAA	A	U	A	U	A
Atmosphere	Terra, Aqua	U	U			A
Elevations	Terra (ASTER)	A	A			
Sea color, Chl, algal blooms	Aqua (MODIS, EOS (MERIS)	A	A	U	U	A
Weather	Meteo satellites, Terra, Aqua, TRMM	A	A			A
Oil spills	RADARSAT, ERS (SAR)	E	E	U	U	
Hi-resolution imagery	SPOT, IKONOS, IRS etc	U	U	U	E	
Sea Level Heights	Jason, Envisat	U	U			A
Sea wind	METOP (ASCAT)	U	U			A
Disasters (flood, forest fire)	ERS, Terra, Aqua	U	U	U	U	E
Rainfall	TRMM	U	U			A
Weather, climate, hydrology	WMO Global Observing System (GOS) comprises observing facilities on land, at sea, in the air and in outer space, owned and operated by the Member countries of WMO.	U	U	U	U	E
State of the oceans	Global Ocean Observing System (GOOS) comprising of satellites, ARGO floats, autonomous data buoys, Voluntary Observing Ships (VOS), Global Sea-Level Observing System (GLOSS) to observe	U	U			A

Category	Observation system (instrument) / network	SC priority transboundary problems				
		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*
	atmospheric and oceanographic conditions.					
Weather, climate, hydrology	WMO GTS (Global Telecommunication System)	E	E			E
Oceanography	International Oceanographic Data Exchange (IODE) of IOC UNESCO	A	A	A	A	A

Observation Systems of European scale

Category	Observation system (instrument)	BSC priority transboundary problems				
		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*
Satellite based data products	Satellites of European Space Agency (ESA)	E	E	U	U	E
	GENESI-DR project data repositories	A	U	U	U	A
Various data products	Joint Reseash Centre (JRC)	E	E	E	E	E
Weather, meteorology	European Centre for Medium-Range Weather Forecasts (ECMWF)	U	U			A
Flooding	European Floods Alert System (EFAS)	U	U			U
Water	Water Information System for Europe (WISE)	U	U	U	U	U
River discharges	European Terrestrial Network for River Discharge (ETN-R)	E	E			E
Invasive species	European Research Network on Aquatic Invasive Species (ERNAIS)			A	A	
Protected areas	NATURE 2000			A	A	
Environment	European Environmental Information and Observation Network (Eionet)	E	E	E	E	E
	European Environmental Agency	A	A		A	
Climate	European Network of greenhouse gases					A
Pollution	POPs European Monet network		E			

Black Sea Observation Systems / networks / programs

Category	Observation system / network / program	BSC priority transboundary problems

		Eutrophication	*Chemical pollution*	*Changes in marine living resources*	*Biodiversity changes*	*Climate change*
State of the sea	Black Sea Global Ocean Observing System (Black Sea GOOS); MyOcean and ECOOP projects	A	A			A
Sea level anomalies	AVISO Black Sea	A	A			A
SST, Chl	NOAA and Aqua satellites data processed at local data center (Marine Hidrophysical Institute, Ukraine)	A	A	U	U	A
Weather	Marine Hidrophysical Institute, Ukraine	A	A			A
Oceanography	Black Sea Oceanographic Data and Information Network (ODIN Black Sea)	A	A	A	A	A
State of environment and ecosystem	Black Sea Integrated Monitoring and Assessment Programme (BSIMAP) implemented by Black Sea countries	A	A	A	A	A
	Black Sea Scientific Network (Black Sea Scene project)	A	A	A	A	A

Details of datasets quoted in the Tables above

UNIGE GIS datasets
Brief description: various GIS datasets containing information on boundaries, population, watersheds, DEM (SRTM), etc. Released: update frequency varies depending on data type
Period: various
Resolution: various
Areas of application: environment management
Accessibility: depends on data type
Format: shape files
Reported by: UNIGE

VMap0
Link: http://www.mapability.com/info/vmap0_index.html
Brief description: Vector Map (VMap) Level 0 is an updated and improved version of the National Imagery and Mapping Agency's (NIMA) Digital Chart of the World (DCW®). The VMap Level 0 database provides worldwide coverage of vector-based geospatial data. It consists of geographic, attribute, and textual data stored on CD-ROM or as downloaded files. VMap Level 0 includes major road and rail networks, hydrologic drainage systems, utility networks (cross-country pipelines and communication lines), major airports, elevation contours, coastlines, international boundaries and populated places.
Released: ? (based on 1993 DCW data)
Resolution: 1:1,000,000
Areas of application:
Accessibility: free
Format: vector (shape files)
Download link: http://www.mapability.com/info/vmap0_download.html

VMap1
Link: http://www.mapability.com/info/vmap1_index.html
Brief description: Vector Map (VMap) Level 1 provides medium resolution worldwide coverage of vector-based geospatial data. Data content includes 10 thematic layers: boundaries and coastlines; elevation and contour lines; road and rail networks; hydrography; utility networks; vegetation cover; and so on. These themes are arranged in over 100 vector layers of information, with mass numbers of features, attributes, and geographic names appropriate to their respective scales. The VMAP1 data is divided into a rather complex global mosaic of 234 geographic zones, however at the present time only 57 of them are released to public. The Black Sea Catchment area is not released yet.
Released: 2004

Resolution: 1:250,000
Areas of application:
Accessibility: free
Format: vector (shape files)
Download link: http://www.mapability.com/info/vmap1_download.html

GRUMP
Link: http://sedac.ciesin.columbia.edu/gpw/
Brief description: Global Rural-Urban Mapping Project (GRUMP) builds on GPWv3 by incorporating urban and rural information, allowing new insights into urban population distribution and the global extents of human settlements.
Released in 2005
Period: 1990 – 2000 (estimate) with 5 years step
Resolution: 30”
Areas of application: research, policy making, and communications…
Accessibility: free.
Format: .bil, grid, ascii
Download link: http://sedac.ciesin.columbia.edu/gpw/global.jsp

GPW
Link: http://sedac.ciesin.columbia.edu/gpw/
Brief description: Gridded Population of the World, version 3 (GPWv3) depicts the distribution of human population across the globe and includes population estimates to 2015.
Released in 2003
Period: 1990 – 2015 (estimate) with 5 years step
Resolution: 2.5’ (in reality 4-100km depending on administrative units)
Areas of application: research, policy making, and communications…
Accessibility: free.
Format: .bil, grid, ascii
Download link: http://sedac.ciesin.columbia.edu/gpw/global.jsp

LandScan
Link: http://www.ornl.gov/sci/landscan/index.html
Brief description: The LandScanTM Dataset comprises a worldwide population database compiled on a 30" X 30" latitude/longitude grid. Census counts (at sub-national level) were apportioned to each grid cell based on likelihood coefficients, which are based on proximity to roads, slope, land cover, nighttime lights, and other information. LandScan has been developed as part of the Oak Ridge National Laboratory (ORNL) Global Population Project for estimating ambient populations at risk.
Release: 2008
Period: annually, with each new release superseding the previous
Resolution: 30”
Areas of application: research, policy making, communications.
Accessibility: free for research and education (registration is required).
Format: .ESRI grid

ASTER G-DEM
Link: http://www.ersdac.or.jp/GDEM/E/2.html
Brief description: Global DEM for all the land area covered by ASTER.
Released in 2009
Resolution: 1” = ~30m
Areas of application:
Automated calculation of slope direction and angle, catchment area, faults, etc.
Flood risk areas can be estimated
Hydrology (water resource management)
Energy (oil resource exploration)
Accessibility: GDEM data will be provided free of charge to the users who utilize in 9 GEOSS societal benefit areas.
Format: GeoTIFF
Download link: http://www.gdem.aster.ersdac.or.jp/
Reported by: UAB

SRTM3 V2.1
Link: http://www2.jpl.nasa.gov/srtm/

Brief description: Shuttle Radar Topography Mission (SRTM) 2000 obtained elevation data on a near-global scale to generate the most complete high-resolution digital topographic database of Earth.
Released in 2009
Resolution: 3" = ~90m
Automated calculation of slope direction and angle, catchment area, faults, etc.
Flood risk areas can be estimated
Hydrology (water resource management)
Energy (oil resource exploration)
Accessibility: free.
Format: SRTM
Download link: http://dds.cr.usgs.gov/srtm/version2_1/

GLOBCOVER
Link: http://ionia1.esrin.esa.int/index.asp
Brief description: global land cover maps on base of observations from the 300m MERIS sensor on board the ENVISAT satellite mission, including 10 bi-monthly reflectances composites for period December 2004 - June 2006
1 annual reflectance composite for year 2005
22 land cover classes are defined with the UN Land Cover Classification System (LCCS).
Released in 2009 (Version 2.2)
Period: see above
Resolution: 300m
Areas of application: Deforestation/decertification monitoring, Habitats monitoring, etc
Accessibility: free for scientific purposes.
Format: HDF
Download link: ftp://us-ext-nas.eo.esa.int/regional

MODIS Land Cover Type
Link: https://lpdaac.usgs.gov/lpdaac/products/modis_products_table
Brief description: The MODIS Land Cover Type product contains multiple classification schemes, which describe land cover properties derived from observations spanning a year's input of Terra and Aqua data. The primary land cover scheme identifies 17 land cover classes defined by the International Geosphere Biosphere Programme (IGBP), which includes 11 natural vegetation classes, 3 developed and mosiacked land classes, and three non-vegetated land classes.
Released: updated yearly
Period: 2001-2007
Resolution: 500m
Areas of application: Lande cover change monitoring, Deforestation/decertification monitoring, Habitats monitoring. etc
Accessibility: free for scientific purposes, (acknowledgement of source is required)
Format: HDF-EOS
Download link: https://wist.echo.nasa.gov/api/

DSMW v. 3.6
Link: http://www.fao.org/ag/agl/lwdms.stm
Brief description: the Digitized Soil Map of the World Including Derived Soil Properties (version 3.6) is based on the FAO/UNESCO Soil map of the world. The CD-ROM contains two types of files, DSMW map sheets and derived soil properties files with images derived from the Soil map of the World. DMSW consists of the data from 10 map sheets: Africa, North America, Central America, South America, Europe, Central and Northeast Asia, Near East, Far East, Southeast Asia, and Australiasia. The maps are available in four formats: two vector formats (ARC/INFO Native and Export) and two raster formats (ERDAS and IDRISI). The derived soil properties files include programs that interpret the maps in terms of parameters such as pH, organic carbon content, C/N ratio, clay mineralogy, soil depth, soil and terrain stability for specific crop production, soil moisture storage capacity and soil drainage class
Released: 2003
Resolution: 1:5,000,000
Accessibility: on request (for low cost)
Format: raster, ArcInfo

HWSD v. 1.1
Link: http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/index.html?sb=1
Brief description: the Harmonized World Soil Database (HSWD) v. 1.0 was compiled on the base of four source databases:the European Soil Database (ESDB), the 1:1 million soil map of China, various regional SOTER

databases (SOTWIS Database), and the Soil Map of the World. The HWSD is composed of a GIS raster image file linked to an attribute database in Microsoft Access format. While these two components are separate data files, they can be linked through a commercial GIS system. The HWSD attribute database provides information on the soil unit composition for each of the 15773 soil mapping units. The database shows the composition of each soil mapping unit, and standardized soil parameters for top- and subsoil.
Released: 2009
Resolution: 1km raster. The spatial resolution of the SMUs varies by region depending on the source data. The best resolution represents approximately a 1:1 million map scale and can be found in China, the territory covered by ESDB (Europe and Russia), and Eastern and Southern Africa, which is included in the SOTWIS database. The DSMW (FAO-74) represents a 1:5 million map scale.
Accessibility: free
Format: raster

ERS/MetOp Soil Moisture
Link: http://www.ipf.tuwien.ac.at/radar/index.php?go=ascat
Brief description: Global, coarse-resolution soil moisture data (25-50 km) are derived from backscatter measurements acquired with scatterometers onboard the satellites ERS-1 and ERS-2 (1991 to present) and the three MetOp satellites (2006-2020). Two different product types are derived:
Level 2 products representing the soil moisture content within a thin soil surface layer (< 2 cm) during the time of overflight of the satellite (SSM),
Level 3 products representing the water content in the soil profile, regularly sampled in space and time (SWI).
Released:
Period: 1991-2007
Resolution: 50km
Accessibility: on request
Format: binary
Reported by: UNIGE

Global Runoff Database
Link: http://www.bafg.de/cln_016/nn_294146/GRDC/EN/Home/homepage__node.html?__nnn=true
Brief description: Global Runoff Database contains time series of daily and/or monthly river discharge data of more than 7300 stations from 156 countries, comprising around 280,000 station-years with an average time series length of about 38 years. The earliest data are from the year 1807, the most recent from the year 2008. The database is updated as soon as data are supplied by the national hydrological services, our primary data providers.
Released: updated yearly.
Period: 1807 – 2008 (estimate)
Resolution: hydrological stations
Areas of application: research
Accessibility: free for non-commercial uses under the conditions of GRDC's data policy.
Format: ASCII
Data link:
http://www.bafg.de/cln_016/nn_294146/GRDC/EN/02__Services/01__RiverDischarge/riverdischarge__node.html?__nnn=true
Note: in GEOSS
Reported by: UNIGE

Hydroweb
Link: http://www.legos.obs-mip.fr/en/soa/hydrologie/hydroweb/
Brief description: Lakes, rivers and wetlands water levels from satellite altimetry
Period: since 1992 -
Resolution: major lakes, reservoirs and rivers
Areas of application: research
Accessibility: free
Format: . ascii

GPCP One -Degree Daily Precipitation Data Set
Link: http://precip.gsfc.nasa.gov/
Brief description: The Global Precipitation Climatology Project One-Degree Daily Precipitation Data Set (1DD Data Set) provides daily, global 1x1-deg gridded fields of precipitation totals for October 1996 through the delayed present. The 1DD draws upon several different data sources covering different areas of the globe. Every attempt has been made to make the complete record homogeneous, given the different available input sources.
Released: 2009.

Period: since 1996 - present
Resolution: 1°x1°
Areas of application: weather, climate change
Accessibility: free
Format: . binary grid
Data link: http://www1.ncdc.noaa.gov/pub/data/gpcp/1dd-v1.1

TMPA
Link: http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=TRMM_3B42RT
Brief description: The Tropical Rainfall Measuring Mission (TRMM) Multi-Satellite Precipitation Analysis (TMPA) provides a calibration-based sequential scheme for combining precipitation estimates from multiple satellites. TMPA is available both after and in real time.
Released:
Period: since 1998
Coverage: latitude band 50°N–S
Resolution: 0.25°?
Areas of application: weather, climate change
Accessibility: free
Format:
Data link: http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=TRMM_3B42RT

Global Rainfall Map
Link: http://sharaku.eorc.jaxa.jp/GSMaP/
Brief description: Global Rainfall Map by JAXA/EORC GSMaP Near Realtime System provides hourly global rainfall maps in near real time (about four hours after late from observation) as well as corresponding NRT rainfall data and Daily Accumulated Rainfall.
Released: 2008.
Period: since 2008 - present
Resolution: 0.1° (0.25 for Daily Accumulated Rainfall)
Areas of application: weather, climate change
Accessibility: free
Format: binary grid/ ASCII
Data link: GSMaP_NRT data are freely available from password protected ftp server. Please contact trmm_real@jaxa.jp to get data.

WorldClim
Link: http://www.worldclim.org/
Brief description: WorldClim is a set of global climate layers (climate grids) with a spatial resolution of a square kilometer. They can be used for mapping and spatial modeling in a GIS or other computer programs. The climate elements considered were monthly precipitation and mean,
minimum, and maximum temperature.
Released: 2005
Period: since 1950 – 2000
Resolution: 1km
Areas of application: weather, climate change
Accessibility: free
Format: ESRI grids
Data link: http://www.worldclim.org/download
Reported by: UNIGE

CRU TS 2.1
Link: http://www.cru.uea.ac.uk/cru/data/hrg/timm/grid/CRU_TS_2_1.html
Brief description: The CRU TS 2.1 dataset comprises 1224 monthly grids of observed climate, for the period 1901-2002, and covering the global land surface at 0.5 degree resolution. There are nine climate variables available: daily mean, minimum and maximum temperature, diurnal temperature range, precipitation, wet day frequency, frost day frequency, vapour pressure and cloud cover.
Released: 2004
Period: since 1901 – 2002
Resolution: 0.5°
Areas of application: weather, climate change
Accessibility: free for scientific purposes
Format: ASCII
Data link: http://www.cru.uea.ac.uk/cru/data/hrg/cru_ts_2.10/data_all/

Reported by: UNIGE

Climate of the World
Link: http://www.ncdc.noaa.gov/oa/wdc/index.php
Brief description:
The global surface summary of day product is produced by the National Climatic Data Center (NCDC) in Asheville, NC. The input data used in building these daily summaries are the Integrated Surface Data (ISD), which includes global data obtained from the USAF Climatology Center, located in the Federal Climate Complex with NCDC. The latest daily summary data are normally available 1-2 days after the date-time of the observations used in the daily summaries. The online data files begin with 1929, and are now at the Version 7 software level. Over 9000 stations' data are typically available.
The daily elements included in the dataset (as available from each station) are:
Mean temperature (.1 Fahrenheit)
Mean dew point (.1 Fahrenheit)
Mean sea level pressure (.1 mb)
Mean station pressure (.1 mb)
Mean visibility (.1 miles)
Mean wind speed (.1 knots)
Maximum sustained wind speed (.1 knots)
Maximum wind gust (.1 knots)
Maximum temperature (.1 Fahrenheit)
Minimum temperature (.1 Fahrenheit)
Precipitation amount (.01 inches)
Snow depth (.1 inches)
Indicator for occurrence of:
Fog
Rain or Drizzle
Snow or Ice Pellets
Hail
Thunder
Tornado/Funnel Cloud
Number of stations per country in 2010:
Bulgaria - 37
Georgia - 12
Romania - 14
Russia - ~15 in BSC
Turkey - ~30 in BSC
Ukraine - 21
Monthly issues contains monthly mean temperature, pressure, precipitation, vapor pressure, and sunshine for approximately 2,000 surface data collection stations worldwide and monthly mean upper air temperatures, dew point depressions, and wind Velocities for approximately 500 observing sites. This is the final quality controlled copy and generally has a 4 - 6 month time lag.
Released: 2006
Period: since 1929 – present (surface summary of day product)
Resolution: Stations
Areas of application: weather, climate change
Accessibility: free/conditional (see website)
Format: ASCII
Data link: ftp://ftp.ncdc.noaa.gov/pub/data/gsod/ (or use web interface to select data).

SST
Link: numerous web sites, e.g. http://oceancolor.gsfc.nasa.gov/; http://www.ghrsst.org/index.htm.
Released: updated daily

OceanColor
Link: http://oceancolor.gsfc.nasa.gov/

Ocean Surface Vector Winds
Link: http://manati.orbit.nesdis.noaa.gov/ascat/

Sea Level Anomalies
Link: http://www.aviso.oceanobs.com/en/data/products/sea-surface-height-products/global/index.html
Period: 1992 -

Resolution: 20' gridded from along track data
Accessibility: free

UNEP Geo Data Portal
Link: http://geodata.grid.unep.ch/
Brief description: The GEO Data Portal is the authoritative source for data sets used by UNEP and its partners in the Global Environment Outlook (GEO) report and other integrated environment assessments. Its online database holds more than 500 different variables, as national, subregional, regional and global statistics or as geospatial data sets (maps), covering themes like Freshwater, Population, Forests, Emissions, Climate, Disasters, Health and GDP.
Released: updated yearly
Period: 1950 -2050
Resolution: 1km+, per country / per region (depending on data type)
Areas of application: weather, climate change
Accessibility: free/conditional (see website)
Format: ASCII
Data link: http://geodata.grid.unep.ch/webservices/
Reported by: UNIGE

PREVIEW Global Risk Data Platform
Link: http://preview.grid.unep.ch/
Brief description: The PREVIEW Global Risk Data Platform is a multiple agencies effort to share spatial data information on global risk from natural hazards. Users can visualise, download or extract data on past hazardous events, human & economical hazard exposure and risk from natural hazards. It covers tropical cyclones and related storm surges, drought, earthquakes, biomass fires, floods, landslides, tsunamis and volcanic eruptions.
Released: updated yearly
Period: 1975-2008
Resolution: events
Areas of application: disasters management
Accessibility: free
Format: shape files, ASCII
Data link: http://preview.grid.unep.ch/index.php?preview=data&lang=eng
Reported by: UNIGE

EuroGlobalMap
Link: http://www.eurogeographics.org/content/products-services-eurodem
Brief description: EuroGlobalMap is a topographic dataset at the scale 1:1 Million and it covers 32 countries. It contains 6 themes (including a total of 23 feature classes):
Administrative boundaries
Hydrography
Transport
Settlements
Elevation
Geographical names Product Formats
Released: 2010
Resolution: 1:1,000,000.
Coverage: Austria, Belgium, Luxembourg, Croatia, Czech Republic, Cyprus, Denmark incl Greenland, Faroe Islands, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Moldova, Northern Ireland, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Andorra, Sweden, Switzerland, The Netherlands, Ukraine.
Areas of application: geo-market analysis, socio-economic analysis, demographic analysis, asset management, geo-referencing cross-border data.
Accessibility: licensed (license costs from € 150 per country)
Format: Shape files (ETRS 89)

EuroRegionalMap
Link: http://www.eurogeographics.org/products-and-services/euroregionalmap
Brief description: EuroRegionalMap contains following themes: administrative boundaries, hydrography, transport, settlements, vegetation, named locations, miscellaneous(monuments, power lines, towers etc).
Released: 2009
Resolution: 1:250,000
Coverage: EU 27 (besides Bulgaria), plus Iceland, Norway, Switzerland, Lichtenstein, Faeroe Islands and the Republic of Moldova.

Areas of application: marketing planning, service provision and retail site location, environmental analysis, vehicle routing, map backdrop against which to display specific information.
Accessibility: licensed (license cost vary from € 25,000 to € 137,000)
Format: raster or triangular irregular network (ERTS 89)

EuroBoundaryMap v4.0
Link: http://www.eurogeographics.org/products-and-services/euroboundarymap
Brief description: EuroBoundaryMap v4.0 is a seamless geo database at the scale 1:100 000. It contains geometry, names and codes of administrative and statistical units.
Released: 2009
Resolution: 1:100,000
Coverage: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark (incl. Faroe Islands and Greenland), Estonia, Finland, France (incl. French Guiana, Guadeloupe, Martinique, Reunion and Monaco), Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy (incl. San Marino and Vatican City), Kosovo, Latvia, Lithuania, Luxembourg, Malta, Moldova, Northern Ireland, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain (incl. Andorra and Gibraltar), Sweden, Switzerland (incl. Liechtenstein), The Netherlands, Ukraine.
Areas of application: geo-market analysis, socio-economic analysis, demographic analysis, asset management, geo-referencing cross-border data.
Accessibility: licensed (license cost from € 200 per country)
Format: Shape files (ETRS 89)

EuroDEM
Link: http://www.eurogeographics.org/content/products-services-eurodem
Brief description: EuroDEM v1.0 is a digital representation of the ground surface topography of Europe. It describes the distribution of terrain or 'bare earth' heights. This does not include 'first surface' elevations such as vegetation and manmade structures.
Released: 2010
Resolution: ~60m. Vertical accuracy of 8 to 10 metres.
Coverage: EU 27, the four EFTA countries (Iceland, Leichtenstein, Norway and Switzerland) as well as Croatia, Kosovo, Bosnia & Herzegovina, Serbia, Montenegro, Macedonia, Moldova and the Kaliningrad area.
Accessibility: licensed (license cost vary from € 30,000 to € 750,000)
Format: raster or triangular irregular network (ETRS 89)

Corine land cover (CLC1990) 100 m - version 12/2009 (EU without Scandinavia and Britain)
Link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-clc1990-100-m-version-12-2009
Brief description: Raster data on land cover for the CLC1990 inventory
Released in 2009
Resolution: 100m
Areas of application:
Accessibility: free of charge provided the source is acknowledged
Format: GeoTiff
Download link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-clc1990-100-m-version-12-2009
Reported by: UAB

Corine Land Cover 2000 seamless vector database (EU)
Link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-seamless-vector-database-1
Brief description: Corine land cover 2000 is the year 2000 update of the first CLC database which was finalised in the early 1990s as part of the European Commission programme to COoRdinate INformation on the Environment (Corine)
Released in Oct 2009
Resolution: ~100m
Areas of application:
Accessibility: free of charge provided the source is acknowledged
Format: shape files
Download link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-seamless-vector-database-1
Reported by: UAB

Corine land cover 2000 (CLC2000) 100 m - version 12/2009 (EU)
Link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-100-m-version-12-2009

Brief description: Raster data on land cover for the CLC2000 inventory
Released in 2009
Resolution: 100m
Accessibility: free of charge provided the source is acknowledged
Format: GeoTiff
Download link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-clc2000-100-m-version-12-2009
Reported by: UAB

Corine land cover 2006 (CLC2006) 100 m - version 12/2009
Link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-clc2006-100-m-version-12-2009
Brief description: Raster data on land cover for the CLC2006 inventory. Coverage: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, France, Hungary, Iceland, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, the former Yugoslavian Republic of, Montenegro, Netherlands, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia.
Released in 2009
Resolution: 100m
Areas of application:
Accessibility: free of charge provided the source is acknowledged
Format: GeoTiff
Download link: http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-clc2006-100-m-version-12-2009
Reported by: UAB

Population density disaggregated with Corine land cover 2000
Link: http://www.eea.europa.eu/data-and-maps/data/population-density-disaggregated-with-corine-land-cover-2000-2
Brief description: Raster data on land cover for the CLC2006 inventory. Coverage: EU27 + Croatia + Liechtenstein.
Released in 2009
Resolution: 100m
Areas of application:
Accessibility: free of charge provided the source is acknowledged
Format: GeoTiff
Download link: http://www.eea.europa.eu/data-and-maps/data/population-density-disaggregated-with-corine-land-cover-2000-2

ESDB v2.0
Link: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDBv2/index.htm
Brief description: European Soil Database v2.0, consisting of four components: the Soil Geographical Database of Eurasia at scale 1:1,000,000 (SGDBE), a PedoTransfer Rules Database (PTRDB), the Soil Profile Analytical Database of Europa (SPADBE) and documentation of the Database of Hydraulic Properties of European Soils (HYPRES). The database contains a list of Soil Typological Units (STU). Besides the soil names they represent, these units are described by variables (attributes) specifying the nature and properties of the soils: for example the texture, the water regime, the stoniness, etc.
Coverage: Europe except Georgia and Turkey
Released: 2006
Resolution: 1:1,000,000
Accessibility: free of charge upon registration
Format: shape files
Download link: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB_Data_Distribution/ESDB_data.html

ESDB v2.0 Raster version
Link:
http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB_data_1k_raster_intro/ESDB_1k_raster_data_intro.html
Brief description: derived from ESDB v. 2.0
Coverage: EU27
Released: 2006
Resolution: 1x1km
Accessibility: free of charge upon registration
Format: shape files
Download link: http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB_Data_Distribution/ESDB_data.html

EEA Fast Track Service Precursor on Land Monitoring - Degree of soil sealing 100m
Link: http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing-100m
Brief description: Raster data set of built-up and non built-up areas including continuous degree of soil sealing ranging from 0 - 100% in aggregated spatial resolution (100 x 100 m). Coverage: EU27, Albania, Bosnia and Herzegovina, Croatia, Macedonia, the former Yugoslavian Republic of, Montenegro, Serbia, Turkey.
Released: 2009
Resolution: 100m
Accessibility: free of charge provided the source is acknowledged
Format: geotiff?
Download link: http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing-100m

Waterbase – Rivers
Link: http://www.eea.europa.eu/data-and-maps/data/waterbase-rivers-5
Brief description: Waterbase contains timely, reliable and policy-relevant data collected from EEA member countries through the WISE-SoE data collection (formerly known as Eurowaternet and Eionet-Water) process. This dataset contains annual data on hazardous substances in rivers.
Coverage: EU15, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, the former Yugoslavian Republic of, Poland, Romania, Serbia, Slovakia, Slovenia, Turkey.
Released: 2009 (1962-2007)
Resolution: by station/WaterbaseID
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Download link: http://www.eea.europa.eu/data-and-maps/data/waterbase-rivers-5
Reported by: UAB

Waterbase – Lakes
Link: http://www.eea.europa.eu/data-and-maps/data/waterbase-rivers-5
Brief description: Waterbase contains timely, reliable and policy-relevant data collected from EEA member countries through the WISE-SoE data collection (formerly known as Eurowaternet and Eionet-Water) process. This dataset contains seasonal and annual data on water quality and raw data of hazardous substances in lakes.
Coverage: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Macedonia, the former Yugoslavian Republic of, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Serbia and Montenegro, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom.
Released: 2009 (1931-1939, 1949-2007)
Resolution: by station/WaterbaseID
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Reported by: UAB

Waterbase - Transitional, coastal and marine waters
Link: http://www.eea.europa.eu/data-and-maps/data/waterbase-transitional-coastal-and-marine-waters-5
Brief description: Waterbase contains timely, reliable and policy-relevant data collected from EEA member countries through the WISE-SoE data collection (formerly known as Eurowaternet and Eionet-Water) process. This dataset contains annual data on discharges to Transitional, coastal and marine waters, inputs (loads) and hazardous substances in water, biota and sediments.
Coverage: Albania, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Turkey, United Kingdom.
Released: 2009 (1978-2007)
Resolution: by country
Areas of application:
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Reported by: UAB

Waterbase - Groundwater
Link: http://www.eea.europa.eu/data-and-maps/data/waterbase-groundwater-5

Brief description: Waterbase contains timely, reliable and policy-relevant data collected from EEA member countries through the WISE-SoE data collection (formerly known as Eurowaternet and Eionet-Water) process. This dataset contains annual data on bodies and quality.
Coverage: EU27, Albania, Bosnia and Herzegovina, Macedonia, the former Yugoslavian Republic of, Montenegro, Serbia, Serbia and Montenegro, Turkey.
Released: 2009 (1960-2007)
Resolution: by country
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Reported by: UAB

Sediment discharges from European rivers
Link: http://www.eea.europa.eu/data-and-maps/data/sediment-discharges
Brief description: This dataset is composed of 3 layers: 1) GISCO watersheds, 2) Total Suspended Solid (TSS) delivery downstream within the sea and 3) Sediment flow from quality stations.
Coverage: EU15, Bosnia and Herzegovina, Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Liechtenstein, Lithuania, Malta, Norway, Poland, Romania, Slovakia.
Released: 2005
Resolution: at stations
Areas of application:
Accessibility: free of charge provided the source is acknowledged
Format: shape files

AirBase - The European air quality database
Link: http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-1
Brief description: AirBase is the air quality information system maintained by the EEA through the European topic centre on Air and Climate Change. It contains air quality data delivered annually under 97/101/EC Council Decision establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution within the Member States (EoI Decision).
Coverage: EU27, Andorra, Bosnia and Herzegovina, Croatia, Macedonia, the former Yugoslavian Republic of, Montenegro, Serbia, Turkey.
Released: 2009 (1969-2007)
Resolution: by station
Accessibility: free of charge provided the source is acknowledged
Format: .mdb

Interpolated air quality data
Link: http://www.eea.europa.eu/data-and-maps/data/interpolated-air-quality-data-1
Brief description: The maps are derived from the measurement data at the stations in AirBase in combination with modelled output from EMEP and with other parameters. These maps are assessment tools for use at the European scale. They may show results which differ from assessments made at national scale.
Coverage: EU27, Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia, yu.
Released: 2008 (2004-2005)
Resolution: ~50km
Accessibility: free of charge provided the source is acknowledged
Format: .shp
Reported by: UAB

EEA aggregated and gap filled air pollutant data
Link: http://www.eea.europa.eu/data-and-maps/data/eea-aggregated-and-gap-filled-air-emission-data-3
Coverage: EU27, Croatia, Macedonia, the former Yugoslavian Republic of, Serbia, Turkey.
Released: 2009 (period 1990-2007)
Resolution: per country
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Download link: http://www.eea.europa.eu/data-and-maps/data/eea-aggregated-and-gap-filled-air-emission-data-3

EMEP grids reprojected by EEA
Link: http://www.eea.europa.eu/data-and-maps/data/emep-grids-reprojected-by-eea
Brief description: EEA has reprojected the grid used by EMEP for analyses on air emissions (150*150 km2 and 50*50 km2 grids covering Europe).

Coverage: EU27, Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Croatia, Georgia, Kazakhstan, Moldova, Republic of, Monaco, Montenegro, Russian Federation, San Marino, Serbia, Turkey, Ukraine, yu.
Released: 2005
Resolution: 150km, 50km
Accessibility: free of charge provided the source is acknowledged
Format: .shp

National Emission Ceilings (NEC) Directive Inventory
Link: http://www.eea.europa.eu/data-and-maps/data/national-emission-ceilings-nec-directive-inventory-4
Brief description: Data on emissions of air pollutants (NH3, NMVOC, NOX, SO2) reported annually by MSs to the EC (with copies to EEA) under Directive 2001/81/EC.
Coverage: EU27.
Released: 2009 (period 1990-2007)
Resolution: per country
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Reported by: UAB

National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention)
Link: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-3
Brief description: Data on emissions of air pollutants submitted to the LRTAP Convention and copied to EEA and ETC/ACC. Coverage: EU27, Croatia, Macedonia, the former Yugoslavian Republic of, Montenegro, Norway, Serbia, Switzerland.
Released: 2009 (period 1980-2007)
Resolution: per country
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Download link: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-3

National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism
Link: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-3
Brief description: Data on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States). Coverage: EU27, Croatia, Turkey.
Released: 2009 (1985-2007)
Resolution: by country
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Download link: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-3

National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism
Link: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-3
Brief description: Data on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States). Coverage: EU27, Croatia, Turkey.
Released: 2009 (1985-2007)
Resolution: by country
Accessibility: free of charge provided the source is acknowledged
Format: .mdb
Download link: http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-3

Eurostat Statistics Database
Link: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database
Brief description: Detailed statistics on the EU and candidate countries on following themes:
General and regional statistics
Economy and finance
Population and social conditions

Industry, trade and services
Agriculture, forestry and fisheries
External Trade
Transport
Environment and energy
Science and technology
Coverage: EU and candidate countries.
Resolution: country/major country regions
Areas of application: comprehensive analysis of countries development, trends, etc.
Accessibility: aggregated data freely accessible while microdata (data, which contain information about individual statistical units) are confidential. Access to anonymised microdata available at Eurostat only for scientific purposes.
Format: ASCII

Nature 2000
Link: http://www.eea.europa.eu/data-and-maps/data/natura-2000
Brief description: Natura 2000 is the key instrument to protect biodiversity in the European Union. It is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats. Natura 2000 is based on the 1979 Birds Directive and the 1992 Habitats Directive. The spatial data (borders of sites) submitted by each Member State is integrated into a spatial database and, after validation with a specifically developed GIS tool, linked to the descriptive data.
Coverage: Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden.
Resolution:
Areas of application:
Accessibility: free
Format: GIS, mdb

Nationally designated areas (National - CDDA)
Link: http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-4
Brief description: The European inventory of nationally designated areas holds information about protected sites and about the national legislative instruments, which directly or indirectly create protected areas. Coverage: EU27, Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, the former Yugoslavian Republic of, Moldova, Republic of, Monaco, Montenegro, Russian Federation, Serbia, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan (BSC is totally covered).
Released: 2009 (previous versions 2002-2008)
Resolution: ~100m
Accessibility: free of charge provided the source is acknowledged
Format: .shp
Download link: http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-4

REABIC database
Link: http://www.reabic.net/map_europe.html
Brief description: The Regional Euro-Asian Biological Invasions Centre (REABIC) database provides on-line information on biological invasions.
Released: 2001
Resolution: actual observations
Areas of application: ecosystem, biodiversity
Accessibility: free (detailed information on request)

GRID-Europa Datasets -GNV
Link: http://www.grid.unep.ch/data/data.php
Brief description: Historical GRID data collection on climate, soils, vegetation, water, socio-economic, human population, boundaries, etc
Released: update frequency varies depending on data type
Period: various
Resolution: various
Areas of application: environment management
Accessibility: 80 % free
Format: shape files, ASCII
Data link: http://www.grid.unep.ch/data/data.php
Reported by: UNIGE

Annex II. BSIMAP mandatory and optional parameters

Table 1. BSC data requirements

Data Name	Requirements
Eutrophication/Nutrient Enrichment	
Nutrients loads from point and diffuse sources	River discharges Municipal discharges (coastal zone) Industrial sources (coastal zone) Atmospheric deposition to the Black Sea
Nutrients, oxygen in sea water	
Data on algal blooms	
Chemical Pollution	
Pollution loads from point and diffuse sources	River discharges Municipal discharges (coastal zone) Industrial sources (coastal zone) Atmospheric deposition to the Black Sea
Concentration of pollutants in sea water, sediments, and biota	Parameters defined in BSIMAP (see Tables further)
Oil spills	Data of satellite and aerial surveillance, accidents
Data for modeling of oil spill propagation	Meteorological data, SST, altimetry, wind, currents with best available resolution
Changes in Marine Living Resources	
Stocks of commercially important fish species	
Catches and by-catches	
Aquaculture production	
Fishing fleet capacity	
Biodiversity Changes/Habitats Loss	
Phytoplankton, zooplankton, benthos	
Indicator species	
Invasive alien species	
Habitats population dynamics data	
Habitats mapping	
Land cover change	Black Sea coastal zone
Coastline change	
Climate Change	
SST	
Chlorophyll	
Data of oceanographic observations in open sea	

Data from automatic buoys (e.g. Argo)	

1. PMA - Eutrophication

Media: **Water**

General	English	Mandatory	Optional
Country	Reporting	+	
	UA – Ukraine		
	RO – Romania		
	BG – Bulgaria		
	TU – Turkey		
	GE - Georgia		
	RU - Russian Federation		
Region	large region	+	
Sampling location	local site name	+	
N	coordinate North, 45º 07,998'		+
E	coordinate East, 29º 41,317'		+
Ndec	coordinate North, decimal, 43,5678	+	
Edec	coordinate East, decimal, 39,7306	+	
year	year of sampling	+	
month	month of sampling	+	
day	day of sampling	+	
depth of station	depth, m	+	
depth of sampling	depth of sampling, m	+	
layer	layer:	+	
	1 – surface		
	2 - intermediate		
	3- near bottom		
Hydrology			
Temp	water temperature, (deg. C)	+	
salinity	salinity, (‰)	+	
pH	Hydrogen ion concentration (pH)	+	
O2 %	Dissolved oxygen, percentage of saturation, (%)	+	
O2	Dissolved oxygen, (µmol/l O2)	+	
TSS	Total Suspended Solids, (mg/l)		+
Secci disk	Transparency according Secci disk, (m)		+
BOD_5	Biological Oxygen Demand, 5 days, (µmol/l O2)		+
TOC	Total Organic Carbon, (mg/l)		+
H_2S	Hydrogen sulphates, (mg/l)	+	
P (PO_4)	Phosphates P (PO4), (µmol/l P)	+	
P total	Phosphorus total, (µmol/l P)	+	
N (NH_4)	Ammonia N (NH4), (µmol/l N)	+	
N (NO_2)	Nitrite N (NO2), (µmol/l N)	+	
N (NO_3)	Nitrate N (NO3), (µmol/l N)	+	
N total	Nitrogen total, (µmol/l N)	+	
Si (SiO_4)	Silicates Si (SiO4), (µmol/l Si)	+	

2. PMA - Pollution

Media **Water**

General	English	Mandatory	Optional
Heavy Metals			
Fe	Iron Fe, (µg/l)		+
Mn	Manganese Mn, (µg/l)		+
Zn	Zinc Zn, (µg/l)		+
Co	Cobalt Co, (µg/l)		+
As	Arsenic As, (µg/l)		+
Hg	Mercury Hg, (µg/l)	+	
Cu	Copper Cu, (µg/l)	+	
Cd	Cadmium Cd, (µg/l)	+	
Pb	Lead Pb, (µg/l)	+	
Ni	Nickel Ni, (µg/l)		+
Cr	Chromium Cr, (µg/l)		+
Pesticides			
DDT	DDT (ng/l)		+
DDD	DDD (ng/l)		+
DDE	DDE (ng/l)		+
DDT total	DDT total, (ng/l)		+
α-HCH	α-HCH, alpha-hexachlorocyclohexane, (ng/l)		+
β-HCH	β-HCH, (ng/l)		+
γ-HCH (Lindane)	γ-HCH, lindane, γ-hexachlorocyclohexane, (ng/l)		+
HCH total	HCH total, (ng/l)		+
metaphos	metaphos, (ng/l)		+
chlorophos	chlorophos, (ng/l)		+
phosalone	phosalone, (ng/l)		+
hexachlorobenzene	hexachlorobenzene, (ng/l)		+
heptachlor	heptachlor, (ng/l)		+
aldrin	aldrin, (ng/l)		+
octachlorstyrene	octachlorstyrene, (ng/l)		+
heptachlorepoxide	heptachlorepoxide, (ng/l)		+
trans-chlordane	trans-chlordane, (ng/l)		+
cis-chlordane	cis-chlordane, (ng/l)		+
transnonachlor	transnonachlor, (ng/l)		+
trifluralin	trifluralin, (ng/l)		+
mirex	mirex, (ng/l)		+
photo-mirex	photo-mirex, (ng/l)		+
cis-nonachlor	cis-nonachlor, (ng/l)		+
PCB			
CB 18	CB 18, (ng/l)		+
CB 28	CB 28, (ng/l)		+
CB 31	CB 31, (ng/l)		+
CB 52	CB 52, (ng/l)		+
CB 99	CB 99, (ng/l)		+
CB 101	CB 101, (ng/l)		+
CB 105	CB 105, (ng/l)		+
CB 118	CB 118, (ng/l)		+
CB 128	CB 128, (ng/l)		+
CB 138	CB 138, (ng/l)		+
CB 153	CB 153, (ng/l)		+
CB 156	CB 156, (ng/l)		+
CB 170	CB 170, (ng/l)		+

CB 180	CB 180, (ng/l)		+
CB 183	CB 183, (ng/l)		+
CB 187	CB 187, (ng/l)		+
CB 195	CB 195, (ng/l)		+
CB 209	CB 209, (ng/l)		+
PCBs total	PCBs total, (ng/l)		+
TPHs+PAH			
TPHs	Total Petroleum Hydrocarbons, (µg/l)	+	
phenols	Phenols, (µg/l)		+
detergents	Detergents, (µg/l)		+
naphtalene	Naphtalene, (ng/l)		+
acenaphthylene	Acenaphthylene, (ng/l)		+
fluorene	Fluorene, (ng/l)		+
acenaphthene	Acenaphthene, (ng/l)		+
phenanthrene	Phenanthrene, (ng/l)		+
anthracene	Anthracene, (ng/l)		+
fluoranthene	Fluoranthene, (ng/l)		+
pyrene	Pyrene, (ng/l)		+
benzo(a)anthracene	Benzo(a)anthracene, (ng/l)		+
chrysene	Chrysene, (ng/l)		+
benzo(b)fluoranthrene	Benzo(b)fluoranthrene, (ng/l)		+
benzo(k)fluoranthrene	Benzo(k)fluoranthrene, (ng/l)		+
benzo(a)pyrene	Benzo(a)pyrene, (ng/l)		+
dibenzo(a,h)anthracene	Dibenzo(a,h)anthracene, (ng/l)		+
indeno(1,2,3cd)pyrene	Indeno(1,2,3cd)pyrene, (ng/l)		+
benzo(g,h,i)perylene	Benzo(g,h,i)perylene, (ng/l)		+
PAHs total	Total polyaromatic hydrocarbons, PAHs total, (ng/l)		+
Radioactivity			
Cs	Cesium, (bekkerels/l)		+
Tr	Torium, (bekkerels/l)		+
Sr	Strontium, (bekkerels/l)		+

3. PMA - Pollution

Media **Bottom Sediments**

General	English	Mandatory	Optional
BS description	description of bottom sediments (EEA classification)	+	
	M - Mud		
	FS - Fine Sand		
	MS - Middle Sand		
	CS - Coarse Sand		
	G - Gravel		
granulometry	the role of different size classes in total weight of BS		+
Chemistry			
TOC	Total Organic Carbon (dry weight, %)		+
TOC-CL	Total Organic Carbon (calcination losses, µg/g)		+
P total	Phosphorus total, (µg/g)		+

Heavy Metals			
Fe	Iron Fe, (µg/g)		+
Al	Aluminium Al, (µg/g)		+
Mn	Manganese Mn, (µg/g)		+
Zn	Zinc Zn, (µg/g)		+
Co	Cobalt Co, (µg/g)		+
V	Vanadium V, (µg/g)		
As	Arsenic As, (µg/g)		+
Ba	Barium Ba, (µg/g)		+
Cu	Copper Cu, (µg/g)	+	
Cd	Cadmium Cd, (µg/g)	+	
Pb	Lead Pb, (µg/g)	+	
Ni	Nickel Ni, (µg/g)		+
Cr	Chromium Cr, (µg/g)		+
Li	Litium Li, (µg/g)		+
Hg	Mercury Hg, (µg/g)	+	
Pesticides			
DDT	DDT (ng/g)	+	
DDD	DDD (ng/g)	+	
DDE	DDE (ng/g)	+	
DDT total	DDT total, (ng/g)	+	
α-HCH	α-HCH, alpha-hexachlorocyclohexane, (ng/g)	+	
β-HCH	β-HCH, (ng/g)	+	
γ-HCH (Lindane)	γ-HCH, lindane, γ-hexachlorocyclohexane, (ng/g)	+	
HCH total	HCH total, (ng/g)	+	
metaphos	metaphos, (ng/g)		+
chlorophos	chlorophos, (ng/g)		+
phosalone	phosalone, (ng/g)		+
hexachlorobenzene	hexachlorobenzene, (ng/g)		+
heptachlor	heptachlor, (ng/g)		+
aldrin	aldrin, (ng/g)		+
octachlorstyrene	octachlorstyrene, (ng/g)		+
heptachlorepoxide	heptachlorepoxide, (ng/g)		+
trans-chlordane	trans-chlordane, (ng/g)		+
cis-chlordane	cis-chlordane, (ng/g)		+
transnonachlor	transnonachlor, (ng/g)		+
trifluralin	trifluralin, (ng/g)		+
mirex	mirex, (ng/g)		+
photo-mirex	photo-mirex, (ng/g)		+
cis-nonachlor	cis-nonachlor, (ng/g)		+
CB 18	CB 18, (ng/g)		+
CB 28	CB 28, (ng/g)		+
CB 31	CB 31, (ng/g)		+
CB 52	CB 52, (ng/g)		+
CB 99	CB 99, (ng/g)		+
CB 101	CB 101, (ng/g)		+
CB 105	CB 105, (ng/g)		+
CB 118	CB 118, (ng/g)		+
CB 128	CB 128, (ng/g)		+
CB 138	CB 138, (ng/g)		+
CB 153	CB 153, (ng/g)		+
CB 156	CB 156, (ng/g)		+
CB 170	CB 170, (ng/g)		+
CB 180	CB 180, (ng/g)		+
CB 183	CB 183, (ng/g)		+
CB 187	CB 187, (ng/g)		+

CB 195	CB 195, (ng/g)		+
CB 209	CB 209, (ng/g)		+
PCBs total	PCBs total, (ng/g)	+	
TPHs			
TPHs	Total Petroleum Hydrocarbons, (µg/g)	+	
phenols	Phenols, (mg/g)	+	
detergents	Detergents, (mg/g)		
PAH			
naphtalene	Naphtalene, (ng/g)		+
acenaphthylene	Acenaphthylene, (ng/g)		+
fluorene	Fluorene, (ng/g)		+
acenaphthene	Acenaphthene, (ng/g)		+
phenanthrene	Phenanthrene, (ng/g)		+
anthracene	Anthracene, (ng/g)		+
fluoranthene	Fluoranthene, (ng/g)		+
pyrene	Pyrene, (ng/g)		+
benzo(a)anthracene	Benzo(a)anthracene, (ng/g)		+
chrysene	Chrysene, (ng/g)		+
benzo(b)fluoranthrene	Benzo(b)fluoranthrene, (ng/g)		+
benzo(k)fluoranthrene	Benzo(k)fluoranthrene, (ng/g)		+
benzo(a)pyrene	Benzo(a)pyrene, (ng/g)		+
dibenzo(a,h)anthracene	Dibenzo(a,h)anthracene, (ng/g)		+
indeno(1,2,3cd)pyrene	Indeno(1,2,3cd)pyrene, (ng/g)		+
benzo(g,h,i)perylene	Benzo(g,h,i)perylene, (ng/g)		+
PAHs total	Total polyaromatic hydrocarbons, PAHs total, (ng/g)		+
Radioactivity			
Cs	Cesium, (bekkerels/l)		+
Tr	Torium, (bekkerels/l)		+
Sr	Strontium, (bekkerels/l)		+

4. PMA - Bathing Water Quality

Media **Water**

Total Coliforms	Op
Fecal Coliforms	Op
Fecal Streptococci	Op
Visual Observations	Op

EEA Indicator adopted.

5. CBD - Biodiversity change and decline, habitats destruction

Media **Water and Sediments**

BIOTA	
Chl a	m
Phytoplankton	m
Zooplankton	m
Indicator species (such as Noctiluca, etc.)	m
Invasive species	m

Macrophytobenthos	m
Macrozoobenthos	m
Habitats	m
Fish (see FOMLR)	m

5. PMA - Contamination of Biota

Media Bivalves, meat
Anchovies, meat
Sprat, meat
Turbot, meat
Horse mackerel, meat

Contaminant	
Cd	m
Cu	m
Hg	m
Pb	m
DDT	m
DDD	m
DDE	m
Lindane	m
PCBs	m
Phenols Chlorinated	op
Co	op
Zn	op
Fe	op
Ni	op
Cr	op
PAHs	op
Cs	op
Tr	op
Sr	op
Total radioactivity	op

6. LBS - Land Based Sources of Pollution

Mandotory: Pressures from Hot Spots (rivers, municipal and industrial sources) (all parameters in the Table below)

Estimated loads per year	UNIT	Frequency of observations per year
Dissolved oxygen		
Nitrate (N-NO3)	kilotonnes	
Nitrite (N-NO2)	kilotonnes	
Orthophosphate	kilotonnes	
Total Nitrogen	kilotonnes	
Total Phosphorus	kilotonnes	
Ammonia	kilotonnes	
Zinc (Zn) - Dissolved	tonnes	
Copper (Cu) - Dissolved	tonnes	
Chromium (Cr) - Dissolved	tonnes	
Lead (Pb) - Dissolved	tonnes	
Cadmium (Cd) - Dissolved	tonnes	
Mercury (Hg) - Dissolved	tonnes	
Nickel (Ni) - Dissolved	tonnes	
Total Zinc	tonnes	
Total Copper	tonnes	
Total Chromium	tonnes	
Total Lead	tonnes	
Total Cadmium	tonnes	
Total Mercury	tonnes	
Total Nickel	tonnes	
Lindane (instead of Gamma-HCH)	tonnes	
TSS (instead of Suspended Particulate Matter)	kilotonnes	
Total Hydrocarbons	kilotonnes	
Anionic active surfactants (instead of detergents)	kilotonnes	
Phenols	kilotonnes	
PCB-28	tonnes	
PCB-52	tonnes	
PCB-101	tonnes	
PCB-118	tonnes	
PCB-153	tonnes	
PCB-138	tonnes	
PCB-180	tonnes	
Total PCBs	tonnes	
BOD-5	kilotonnes	
COD-Cr	kilotonnes	
TOC	kilotonnes	
AOX	kilotonnes	
Tritium	Bq	
Other Radionuclides *(please name)*	Bq	
Average Riverine Flow for the Year (or volume for discharges)	m^3/sec	
Long Term Annual Average Riverine Flow (or volume for discharges)	m^3/sec	

7. ESAS – Environmental Safety Aspects of Shipping

Mandatory:

- Ballast waters transportation
- Port Reception facilities
- Dispersants use
- Ships calling at ports
- Quantities and types of cargoes
- Oil spills (volumes, numbers, areas)
- Dumping
- Pollution fines

8. FOMLR – Fishery and Other Living Resources

I. Fishery parameters/indicators

The following commercial species were agreed as indicator species:

➢ **Pelagic species:**
- **sprat**
- **anchovy**
- **horse mackerel**
- **bonito**

➢ **Demersal species:**
- **turbot**
- **whiting**
- **dogfish**

Rapana venosa

1. Catches
2. Effort – table and figure also
3. CPUE
4. Stock biomass
5. Population parameters: age/size – size structure (% per class – small species 0.5 cm, for larger – 1cm), growth parameters per year – spawning intensity (egg concentration), total mortality, natural mortality, etc.). In table min/max/av size per species per month. Age of anchovy, turbot… (where data are available) – min/max/av.

6. Changing of fish behaviour (for five years-reports) – migration routes
7. Other exotic fish species recorded and which of them became resource
8. List of species under extinction and recovering (for 5-years reports)
9. Gears: mesh size and minimal admissible length of fish
10. By catch of fish (incl sea horse, sturgeon) and mammals, strandings
11. AQUACULTURE DEVELOPMENT - PRODUCTION, NUMBER OF FARMS. RESTOCKING ACTIVITIES
12. Illegal fishery - IUU fishing, number of penalties

II. Economic indicators: fuel consumption, average age of the fleet, seafood consumption, employment, subsidy programs and type.

Annex III : Meta data submitted to the BSC

In the frames of this project the BSC PS developed special formats for submission of meta data on macroalgae, seagrasses, chlorophyll_a and contamination of biota, parameters which usually remain poorly reported to BSIS.

Full inventories of data availability were provided as follow:

1. Macroalgae meta data were reported by IO-BAS-Varna, IBSS – Odessa and Sevastopol branches, Biological station in Novorosiysk and AZNIIRKH for the period 2000-2009.

Example: IBSS-Sevastopol, Ukraine in July 2003

Country	Region	Geographical region	Sampling location	Year	Month	Horizon (limits), m
UA	Crimea	Sevastopol	Fiolent Cape	2003	7	0.5
	Crimea	Sevastopol	Fiolent Cape	2003	7	1
	Crimea	Sevastopol	Fiolent Cape	2003	7	1.5
	Crimea	Sevastopol	Fiolent Cape	2003	7	3
	Crimea	Sevastopol	Fiolent Cape	2003	7	5
	Crimea	Sevastopol	Fiolent Cape	2003	7	10
	Crimea	Sevastopol	Fiolent Cape	2003	7	15
UA	Crimea	Sevastopol	Blue Bay	2003	7	0.5
	Crimea	Sevastopol	Blue Bay	2003	7	1
	Crimea	Sevastopol	Blue Bay	2003	7	1.5
	Crimea	Sevastopol	Blue Bay	2003	7	3
	Crimea	Sevastopol	Blue Bay	2003	7	5
	Crimea	Sevastopol	Blue Bay	2003	7	10
	Crimea	Sevastopol	Blue Bay	2003	7	15
UA	Crimea	Sevastopol	Hersones Cape	2003	7	0.5
	Crimea	Sevastopol	Hersones Cape	2003	7	1
	Crimea	Sevastopol	Hersones Cape	2003	7	3
	Crimea	Sevastopol	Hersones Cape	2003	7	5
	Crimea	Sevastopol	Hersones Cape	2003	7	10
	Crimea	Sevastopol	Hersones Cape	2003	7	15

2. Seagrasses meta data were reported by IO-BAS-Varna, IBSS – Odessa and Sevastopol branches, Biological station in Novorosiysk and AZNIIRKH for the period 2000-2009.

Example: IBSS-Odessa, Ukraine in 2002-2003

Country	Region	Sampling location	Year	Month	Day	Horizon (limits), m	Type of substrate	Seagrasses community 1					
								Name of dominante (Latin)	Coverege,%	Value average			Number of companion species, n
										Biomass, $kg.m^{-2}$	Abundance, $n.m^{-2}$	Height of plant, cm	
Ukraine	NWBS	Suchoi liman	2002	April	22-23	0-3 m	nature	Y	Y	Y	N	N	Y
Ukraine	NWBS	Tiligulskiy liman	2002	June	4-5	0-3 m	nature	Y	Y	Y	N	N	Y
Ukraine	NWBS	Chadgibeiskiy liman	2002	June	19	0-3 m	nature	Y	Y	N	N	N	N
Ukraine	NWBS	Dofinovskiy liman	2002	July	17	0-3 m	nature	Y	N	N	N	N	N
Ukraine	NWBS	Tiligulskiy liman	2002	August	13-14	0-3 m	nature	Y	Y	Y	N	N	Y
Ukraine	NWBS	Suchoi liman	2002	September	4	0-3 m	nature	Y	Y	Y	N	N	Y
Ukraine	NWBS	Tiligulskiy liman	2003	April	22	0-3 m	nature	Y	N	N	N	N	Y
Ukraine	NWBS	Suchoi liman	2003	June	18	0-3 m	nature	Y	Y	Y	N	N	Y
Ukraine	NWBS	Dofinovskiy liman	2003	June	26	0-3 m	nature	Y	N	Y	N	N	N
Ukraine	NWBS	Tiligulskiy liman	2003	July	22	0-3 m	nature	Y	Y	Y	N	N	Y
Ukraine	NWBS	Tiligulskiy liman	2003	September	17	0-3 m	nature	Y	N	Y	N	N	Y

In Romania seagrasses recently reappeared, during the last 3-4 years, and the surface covered by them is still very small. If the populations of seagrasses will continue to increase, certainly more detail investigations will be undertaken.

3. Chlorophyll_a meta data were reported by IO-BAS-Varna (Bulgarian waters: 2000-2009) and IBSS-Sevastopol (Ukrainian waters 2000-2009)

Example: IO-BAS-Varna, Bulgaria in 2006

2 - 16.06.2006 R/V Akademik

Station	Date	Depth(m)	Chl-No samples
AD(501)	6/2/2006	0,9,35	3
AE(502)	6/2/2006	0,11,25,45	4
AF(503)	6/2/2006	0,10,25,50	4
AG(504)	6/2/2006	0,16,25,50,95	5
AH(505)	6/2/2006	0	1
Z(407)	6/3/2006	0	1
Y(406)	6/3/2006	0	1
X(405)	6/3/2006	0	1
W(404)	6/3/2006	0	1
V(403)	6/3/2006	0	1
U(402)	6/3/2006	0	1
T(401)	6/3/2006	0,9,30	3
L(301)	6/4/2006	0,9,21	3
M(302)	6/4/2006	0,10,21	3
N(303)	6/4/2006	0,10,25,38	4
O(304)	6/4/2006	0,12,25,50	4
P(305)	6/4/2006	0,12,25	3
R(306)	6/4/2006	0	1
J(206)	6/5/2006	0,11,25,50,90	5
I(205)	6/5/2006	0,10,50,75	4
H(204)	6/5/2006	0,14,25	3
G(203)	6/5/2006	0,10,25,50	4
F(202)	6/5/2006	0,11,25	3
A(101)	6/6/2006	0, 6	2
B(102)	6/6/2006	0,13,25,55	4
C(103)	6/6/2006	0	1
D(104)	6/6/2006	0	1
600	6/15/2006	0,18,40	3
601	6/15/2006	0,15,25,65	4
602	6/15/2006	0	1
603	6/16/2006	0,10,20,50,75	5
604	6/16/2006	0,10,23	3
605	6/16/2006	0	1
606	6/16/2006	0	1
Total			**89**

4. Contamination of biota meta data were reported for 2000-2009 by NIMRD-Constanta, UkrNCEM-Odessa and IBSS-Sevastopol.

Example: NIMRD-Constanta, Romania, in 2002.

Station	Depth (m)	N dec	E dec	Species	Year	Month	U.M.	Cu	Cd	Pb	Ni
Portita	0-5	44.6767	29.0067	Mytilus galloprovincialis	2002	July	µg/g f.w.	x	x	x	
Portita	0-5	44.6767	29.0067	Mya arenaria	2002	July	µg/g f.w.	x	x	x	
Portita	0-5	44.6767	29.0067	Rapana venosa	2002	July	µg/g f.w.	x	x	x	
Constanta Nord	0-5	44.2167	28.6583	Mytilus galloprovincialis	2002	May	µg/g f.w.	x	x	x	
Constanta Sud	0-5	44.0833	28.6467	Mytilus galloprovincialis	2002	July	µg/g f.w.	x	x	x	
Eforie Sud	0-5	44.0433	28.6600	Mytilus galloprovincialis	2002	July	µg/g f.w.	x	x	x	
Costinesti	0-5	43.9450	28.6444	Mytilus galloprovincialis	2002	July	µg/g f.w.	x	x	x	
Mangalia	0-5	43.8003	28.5850	Mytilus galloprovincialis	2002	July	µg/g f.w.	x	x	x	
Gura Buhaz	20	44.4000	28.8433	Merlangius merlangus euxinus (Nordmann, 1840)	2002	May	µg/g f.w.	x	x	x	
Gura Buhaz	20	44.4000	28.8433	Engraulis encrasicolus (Lineaus, 1750)	2002	July	µg/g f.w.	x	x	x	
Gura Buhaz	20	44.4000	28.8433	Trachurus mediterraneus ponticus Allev, 1956	2002	July	µg/g f.w.	x	x	x	
Gura Buhaz	20	44.4000	28.8433	Pomatomus saltatrix (Lineaus, 1758)	2002	July	µg/g f.w.	x	x	x	
Cazino Mamaia	20	44.2417	28.7083	Sprattus sprattus (Lineaus, 1758)	2002	May	µg/g f.w.	x	x	x	
Constanta Nord	20	44.2167	28.7000	Neogobius melanostomus (Pallas, 1811)	2002	May	µg/g f.w.	x	x	x	
Eforie Sud	20	44.0433	28.6700	Psetta maeotica (Pallas, 1758)	2002	May	µg/g f.w.	x	x	x	
Mangalia	20	43.7858	28.6183	Sprattus sprattus (Lineaus, 1758)	2002	May	µg/g f.w.	x	x	x	

More details on reported meta data and terms of access to the data can be provided upon request.

Other investigations (nutrients, phytoplankton, zooplankton, benthic communities, etc.) in the Black Sea were reported by different scientific institutions as follow:

Bulgaria

1. Institute of Oceanology, Varna

Table xxx. Observations of IO-BAS-Varna in 2001-2009, Bulgarian Black Sea waters

	Stations	Parameters
11.2001	13	NO2, NO3, PO4
05.2002	15	NO2, NO3, PO4, Si
08.2002	15	NO2, NO3, PO4, Si
11.2002	15	NO2, NO3, PO4, Si
03.2003	15	NO2, NO3, NH4,PO4
06.2003	17	NO2, NO3, NH4,PO4, Si
09.2003	15	NO2, NO3, NH4,PO4, Si
06.2004	16	NO2, NO3, NH4,PO4, Si
09.2004	16	NO2, NO3, NH4,PO4, Si
03.2005	15	NO2, NO3, NH4,PO4, Si
06.2005	16	NO2, NO3, NH4,PO4, TP, Si
09.2005	15	NO2, NO3, NH4,PO4, TP, Si
11.2005	17	NO2, NO3, NH4,PO4, Si
06.2006	15	NO2, NO3, PO4, Si
11.2006	13	NO2, NO3, NH4,PO4, Si
02.2007	17	NO2, NO3, NH4,PO4, Si
06.2007	15	NO2, NO3, NH4,PO4, Si
09.2007	8	NO2, NO3, NH4,PO4, TP
04.2008	12	NO2, NO3, NH4,PO4,TP, TN
06.2008	12	NO2, NO3, NH4,PO4,TP, TN
10.2008	12	NO2, NO3, NH4,PO4,TP, TN
02.2009	15	NO2, NO3, NH4,PO4, Si

2. Institute of Fishery, Varna, Bulgaria

Available long-term data sets since 1953. The Table below summarises cruises in 2000-2009.

Cape Kaliakra – K1 (1 mile offshore), K3 (3 miles offshore), K10 (10 miles offshore), K15 (15 milies offshore), K20 (20 miles offshore); K30 (30 miles offshore).

Cape Galata – G1 (1 mile offshore), G3 (3 miles offshore), G10 (10 miles offshore), G15 (15 milies offshore), G20 (20 miles offshore); G30 (30 miles offshore).

Cape Emine – E1 (1 mile offshore), E3 (3 miles offshore), E10 (10 miles offshore), E15 (15 milies offshore), E20 (20 miles offshore); E30 (30 miles offshore).

A4 – Beloslav Lake
A22 – Varna Lake
B5 – Varna Bay

Monthly observations available for the 1990s at B5, G1, G3, G10.

Table xxx. Observations of IFR-Varna in 2000-2009, Bulgarian Black Sea waters

Year	Date	Stations	Number of stations	Depths	Parameters
2000	9.02.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m	Water temperature, salinity, nutrients (including organic N and P in 2001-2004), oxygen, phytoplankton, zooplankton, benthos (without seagrasses and macroalgae), fish
	11.02.	Varna Bay&Varna Lake	12	0-bottom	
	10.02.	E1, E3, E10, E20, E30	5	0-150	
	14.03.	A22, B5, G3	3	0-bottom	
	25.04.	A22, B5, G3	3	0-bottom	
	18.05.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m	
	19.05.	Varna Bay	8	0-bottom	
	20.05.	Varna lake	4	0-bottom	
	19.05.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m	
	15.06.	A22, B5, G3	3	0-bottom	
	17.07.	A22, B5, G3	3	0-bottom	
	15.08.	Varna Bay&Varna Lake	12	0-bottom	
	14.08.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m	
	15.08.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m	
	14.09.	A22, B5, G3	3	0-bottom	
	18.10.	A22, B5, G3	3	0-bottom	
	13.11.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m	
	15.11.	Varna Bay &Varna Lake	12	0-bottom	
	14.11.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m	
2001	13.02.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m	
	20.02.	Varna Bay	8	0-bottom	
	28.02.	Varna Lake	4	0-bottom	

	14.02.	E1, E10, E20, E30	4	0, 10, 25, 50, 75, 100, 150m
	17.04.	A22, B5, G3	3	0-bottom
	3.06.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100, 150m
	4.06.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	5.06.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
	8.06.	Varna Lake& Varna Bay	12	0-bottom
	11.06.	Koket rais-4 stations	4	0-bottom
	16.07.	A22, B5, G3	3	0-bottom
	8.08.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	15.08.	Varna Bay &Varna Lake	12	0-bottom
	9.08.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
	14.09.	A22, B5, G3	3	0-bottom
	13.11.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100, 150m
	5.11.	Varna Bay&Varna Lake	12	0-bottom
	14.11.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	15.11.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
2002	13.02.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	15.02.	Varna Bay &Varna Lake	12	0-bottom
	14.02.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
	14.03.	A22, B5, G3	3	0-bottom
	5.06.	Varna Lake	4	0-bottom
	7.06.	Varna Bay	8	0-bottom
	15.07.	B-5, G1, G3, G10	4	0-bottom
	25.08.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100, 150m
	26.08.	Varna Lake	4	0-bottom
	24.08.	Varna Bay	8	0-bottom
	24.08.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	23.08.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
	10.09.	B5, G1, G3, G10	4	0-bottom
	20.11.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100, 150m
	21.11.	Varna Bay&Varna Lake	12	0-bottom
	19.11.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	18.11.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
2003	10.03.	B5, G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	11.03.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
	12.04.	A4, B5, G1, G3, G10	5	0-bottom
	7.05.	A22, B5, G1, G3, G10	5	0, 10, 25, 50, 75, 100, 150m
	15.08.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100,

				150m
	12.08.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	13.08.	E1, E3, E10, E20, E30	5	0, 10, 25, 50, 75, 100, 150m
	14.08.	24-hour station	1	0-bottom
2004	4.06.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100, 150m
	5.06.	B5, G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	28.08.	K1, K3, K10, K20, K30	5	0, 10, 25, 50, 75, 100, 150m
	29.08.	G1, G3, G10, G20, G30	5	0, 10, 25, 50, 75, 100, 150m
	30.08.	24-hours station	1	0-bottom
	4.10.	B5, G1, G3, G5, G10, G15, G20	7	0, 10, 25, 50, 75, 100, 150m
2005	15.03.	B5, G1, G3, G5, G10, G15,	6	0-bottom
	26.04.	B5, G1, G3, G5, G10, G15	6	0-bottom
	14.06.	B5, G1, G3, G5, G10, G20	6	0-bottom
	22.08.	B5,G1, G3, G5, G10, G15	6	0-bottom
2006	23.02.	G1, G3, G10	3	0-bottom
	18.04.	B5, G1, G3, G10, G15	5	0-bottom
	22.05.	B5, G1, G3, G5, G10	5	0-bottom
	7-15.12.	27 stations Trawl survey	27	
2007	06-14.04	6 stations Trawl survey	6	
	02-15.06	14 stations Trawl survey	14	
	20-23.06	G1, G3, G5, G10, K1, K3, K5, K10	8	0-bottom
		Varna Bay, Varna +Beloslav lake	14	0-bottom
	13.07.	Varna Bay, Varna +Beloslav lake	14	0-bottom
		G1, G3	2	0-bottom
	29-31.08	G1, G3, G5, G10, K1, K3, K5, K10	8	0-bottom
		Varna Bay, Varna +Beloslav lake	14	0-bottom
	12-27.10	Varna Bay, Varna +Beloslav lake	14	0-bottom
		G1, G3	2	0-bottom
2008	10.03.	Varna + Beloslav Lakes	6	0-bottom
	18-27.05.	open sea	15 stations Trawl survey	
	06.	Varna Bay	8	0-bottom
	29-30.09.	K1, K3, K10, K20	4	0, 10, 25, 50, 75, 100, 150m
	04.10.	G1, G3, G10, G20	4	0, 10, 25, 50, 75, 100, 150m
	16.10.	Varna Bay, G1, G3	10	0-bottom
	12.12.	Varna + Beloslav Lakes, Varna Bay	14	0-bottom
2009	15 .03.	Varna + Beloslav lakes, Varna Bay	14	0-bottom
	04.-	open sea	10	0, 10, 25, 50, 75, 100,

	27.05.			150m	
	01-04.06.	open sea, Varna Lake	14	0, 10, 25, 50, 75, 100, 150m	
	09.	Varna Lake, Varna Bay,	12	0-bottom	
	24-25.09.	open sea	10	0, 10, 25, 50, 75, 100, 150m	
	25.11	Varna Bay	8	0-bottom	

Russian Federation

1. Shirshov Institute, Moscow

Table xxx. Cruises in 2001-2009. The "standard" transect in front of Gelendjik (RU-I2)

Year	Season	Vessel	Distance off shore, miles
2001	April	R/V "Akvanavt"	65
2002	March	R/V "Akvanavt"	100
2002	May	R/V "Akvanavt"	90
2002	August	R/V "Akvanavt"	100
2002	September	R/V "Akvanavt"	30
2003	August	R/V "Ashamba"	7
2004	June	R/V "Akvanavt"	75
2005	June	R/V "Akvanavt"	65
2005	September	R/V "Ashamba"	5
2006	May	R/V "Akvanavt"	85
2007	June	R/V "Akvanavt"	100
2007	September	R/V "Akvanavt"	90
2008	April	R/V "Shtokmann"	100
2008	June	R/V "Ashamba"	7
2009	June	R/V "Ashamba"	10

2. Novorossiysk educational and research marine biological center

RF- I3- external data

Table xxx. Observations in Russian Black Sea waters

Region	Year	Season	Number of stations	Parameters observed
Novorossiysk Bay	2000-2002 2003 2005 2009	seasonal spring, summer summer summer	13	pH, dissolved O_2, NO_3^-, NO_2^-, NH_4^+, Si, Cl^-, PO_4^{3-}, Cu, Zn, Pb, TPHs
Port Novorossiysk	2000-2006	monthly	10	pH, dissolved O_2, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, TPH
Shesharis Oil Harbour	2000-2006	monthly	3	dissolved O_2, NO_3^-, NO_2^-, NH_4^+, $PO4^{3-}$, detergent, TPHs
Taman	2004 2005 2006 2007 2008 2009	summer, winter spring, summer, winter summer, winter summer, winter winter winter	15 15 15 15 6 6	NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, detergent, TPHs, phenols, suspended solids, Fe, Zn, Cu, Pb, Cd
Yuzhnaya Ozereyevka	2008	summer	18	pH, dissolved O_2, BOD5, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, Si, Alk, SO_4^{2-}, Cl^-, Mg^{2+}, Ca^{2+}, detergent, TPHs, phenols, suspended solids, Fe, Zn, Cu, Pb, Cd, Hg, Ni, Cr, Na, K, pesticides
Dzhubga	2005-2009	summer	2	pH, dissolved O_2, BOD5, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, Si, detergent, TPHs, phenols, suspended solids, Fe, Zn, Cu, Pb, Cd, Hg, As, Mn, methane
Tuapse (port)	2000-2001 2008	seasonal summer	10 3	NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, TPH, suspended solids, Fe, Al, Zn, Cu, Pb, BOD5 BOD5, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, TPHs, Fe, Cu, Pb, suspended solids
Tuapse (beach)	2007	seasonal	6	pH, dissolved O_2, BOD5, NO_3^-, NO_2^-, NH_4^+, $PO4^{3-}$, TPHs, phenols, Fe, Zn, Cu, Pb, Cd, Hg, suspended solids
Novomikhaylovskiy Tuapse Yakornaya shcel	2005	summer	2 2 2	pH, dissolved O_2, BOD5, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, detergent, TPHs, phenols, suspended solids, Fe, Zn, Cu, Pb, Cd, Hg
Sochi	2009	autumn	112	pH, dissolved O_2, BOD5, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, Si, Alk,

				SO_4^{2-}, Cl^-, detergent, TPHs, phenols, suspended solids, Fe, Zn, Cu, Pb, Cd, Hg, Mn

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3. AZNIIRKH, Rostov on Don

By RF- I4

Table xxx. Number of transects and stations observed in Russian waters in 1999-2009 seasonally – spring, summer and autumn.

Area (see the map above)	Number of transects	Number of stations
I	15	47
II	165	1050
III	45	135
IV	47	142

Turkey

Sinop Institute

Table xxx. Monitoring stations and sampling periods around Sinop by TR-I3.

Station	Site	year	month (s)
A	Inshore- 2 mile from shore	1998	5-7-8-9
A	Inshore- 2 mile from shore	2000	3-4-5-6-8-10
A	Inshore- 2 mile from shore	2002	1-2-5-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2003	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2004	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2005	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2006	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2007	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2008	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2009	1-2-3-4-5-6-7-8-9-10-11-12
A	Inshore- 2 mile from shore	2010	1-2--
B	Inshore- 3 mile from shore	1998	5-7-8-9-11
B	Inshore- 3 mile from shore	1999	1-2-3-4-5-6-7-8-9-11
B	Inshore- 3 mile from shore	2000	3-4-5-6-8-10-11
B	Inshore- 3 mile from shore	2002	11-
B	Inshore- 3 mile from shore	2003	1-2-3-4-5-6-7-9-10-11
B	Inshore- 3 mile from shore	2004	1-2-3-4-6-7-10
B	Inshore- 3 mile from shore	2005	7---8

B	Inshore- 3 mile from shore	2007	10--11-12
B	Inshore- 3 mile from shore	2008	1-2-3-4-5-6-7-9-10-11-12
B	Inshore- 3 mile from shore	2009	1-2-3-4-5-6-8-9-10-11-12
B	Inshore- 3 mile from shore	2010	1--2
C	Inshore- 1 mile from shore	1998	7-8-9-10
C	Inshore- 1 mile from shore	2002	11-
C	Inshore- 1 mile from shore	2003	10--11
C	Inshore- 1 mile from shore	2004	1-2-3-4-5-6-7-8-10
C	Inshore- 1 mile from shore	2005	7--8
C	Inshore- 1 mile from shore	2006	2--3
C	Inshore- 1 mile from shore	2007	10--11-12
C	Inshore- 1 mile from shore	2008	1-2-3-4-5-6-7-9-10-11-12
C	Inshore- 1 mile from shore	2009	2-3-4-5-6-8-9-10-11-12
C	Inshore- 1 mile from shore	2010	1--2
D	Offshore- 2 mile from shore	1998	6-7-8-9
D	Offshore- 2 mile from shore	1999	1-2-3-4-5-6-7-8-9-11
D	Offshore- 2 mile from shore	2002	9--10-11
D	Offshore- 2 mile from shore	2003	1-4-5-6-10-12
D	Offshore- 2 mile from shore	2004	3--4-7
D	Offshore- 2 mile from shore	2006	3-
E	Offshore- 1 mile from shore	2002	11-
E	Offshore- 1 mile from shore	2003	1-4-6-10
E	Offshore- 1 mile from shore	2004	7-
F	Offshore- 3 mile from shore	2002	11-
F	Offshore- 3 mile from shore	2003	1-4-6-10
F	Offshore- 3 mile from shore	2004	7-

Ukraine

MHI-Sevastopol

Table xxx. List of cruises carried out by MHI, Sevastopol in the Black Sea in 2000-2009

Vessel	Cruise	Number of stations	Date: start	Date: end	Parameters
PV	55	92	11.07.2000	10.10.2000	T, S,O2
PV	59	35	11.07.2003	22.07.2003	T, S,O2
PV	61	14	01.07.2004	10.07.2004	T, S
PV	62	12	20.07.2005	28.07.2005	T, S
EKSP	1206	33	14.12.2006	15.12.2006	T,S
EKSP	107	33	09.01.2007	10.01.2007	T,S
EKSP	507	44	16.05.2007	19.06.2007	T,S,O2
EKSP	707	54	18.07.2007	22.07.2007	T,S,O2, h2s
EKSP	1207	75	07.12.2007	12.12.2007	T,S
EKSP	308	42	24.03.2008	25.03.2008	T, S
PathF	908	13	06.09.2008	10.09.2008	T,S(CTD)
PathF	908	135	06.09.2008	12.09.2008	T(XBT)
EKSP	908	45	18.09.2008	22.09.2008	T,S
SAPFIR	1008	31	12.10.2008	13.10.2008	T, S
SAPFIR	409	35	29.04.2009	03.05.2009	T,S,O2
SAPFIR	809	54	14.08.2009	18.08.2009	T,S,O2
SAPFIR	1109-1	5	04.11.2009	04.11.2009	T,S
SAPFIR	1109-2	7	24.11.2009	24.11.2009	T,S,O2,H2S

IBSS-Sevastopol

The Institute performs monitoring at the Sevastopol coast since 1999 for a full set of hydrochemical parameters, including total nitrogen and total phosphorus. The same set of parameters have been monitored for Balaklava Bay and nearby coastal waters since 2000.

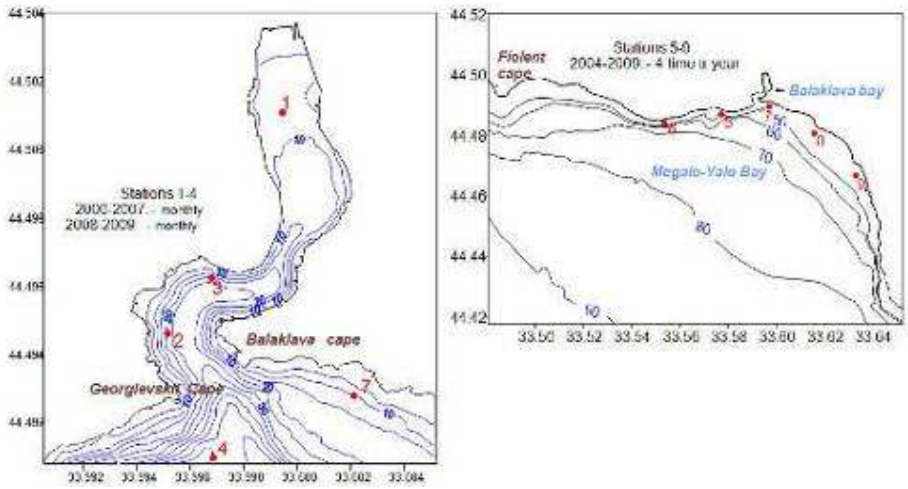


Figure xxx. Sampling stations in the Balaklava Bay and nearby coastal waters, UA-external data

Laspi Bay - historical data in 1983-1986 is displayed in Fig. 19 –left and the scheme of present sampling stations (monthly in 2007-2009) in the Laspi Bay is displayed in Fig. 19– right. The same set of parameters mentioned for other regions (Fig. 17 and 18) above is monitored in Laspi Bay too.

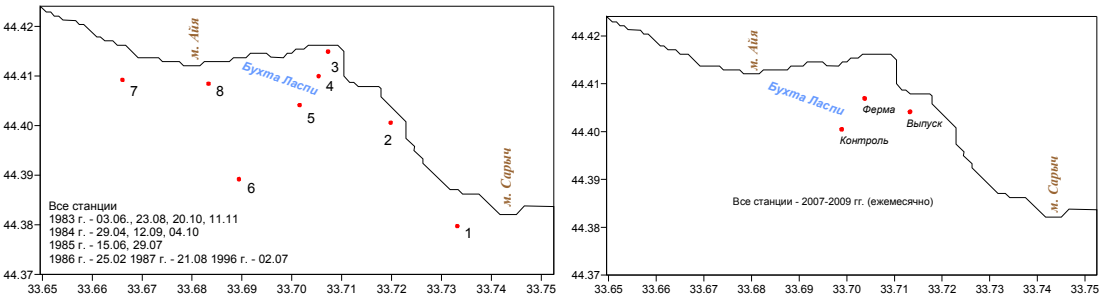


Figure xxx. Sampling stations in Lapsi Bay in the past (left) and at present (right): UA-external data.

Karadag and Koktebel Bay is monitored by the Institute at 15 stations in 2004-2009 with 3 times per year frequency. Hydrochemistry is covered including total phosphorus and total nitrogen.

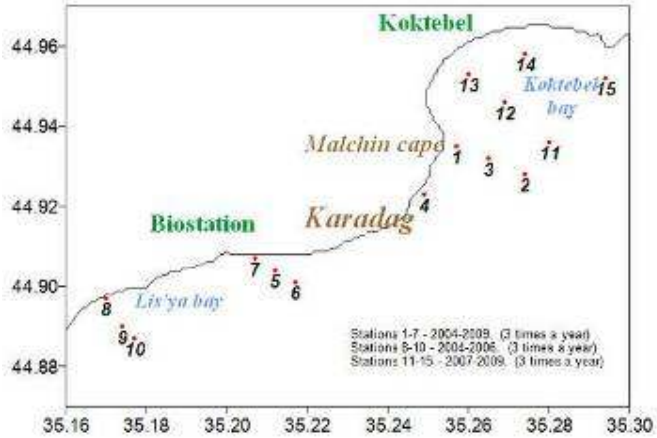


Figure xxx. Sampling stations in Karadag and Koktabel.

Additionally, at all stations listed above (from Sevastopol coast to Koktebel and Karadag), concentrations of chlorophyll-a and pheophytin-a, suspended matter and components of man-made pollution, such as trace metals (Pb, Cd, Cu, Zn, Ni , Hg, Cr), petroleum and chlorinated hydrocarbons in water and sediments were episodically measured.

In the Bay of Sevastopol, a station network seen in the map (Fig.21) below was monitored regularly during 1998-2008. Nutrients and chlorophyll-a were measured.

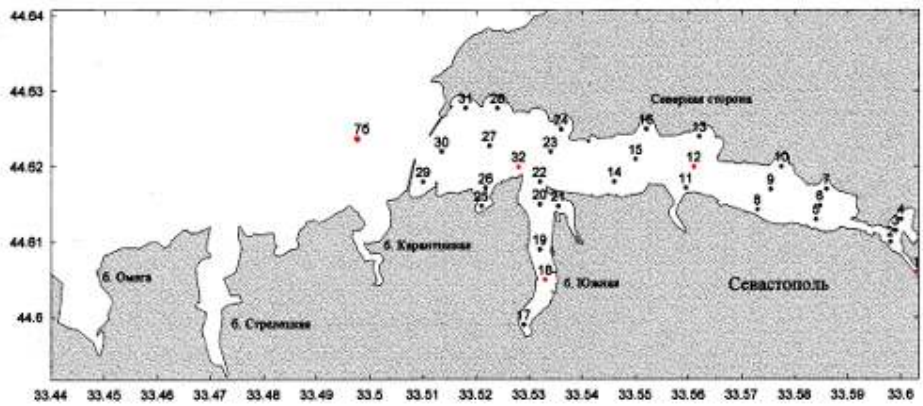


Figure xxx. Sampling stations in the Bay of Sevastopol visited regularly in 1998-2008: UA, external data

Primary Production in Sevastopol Bay was studied in 1960–1980 using radiocarbon method and in 2006–2007 using phytoplankton growth rates coupled with C:Chl *a* ratio and chlorophyll concentrations in the plankton.

Full inventory of macroalgae and seagrasses investigations (meta data) along the Ukrainian coast is provided. The studies were carried out by the Odessa and Sevastopol Branches of the Institute of Southern Seas (examples are given in Annex III, the inventory can be provided upon request).

Examples of presentation of data:

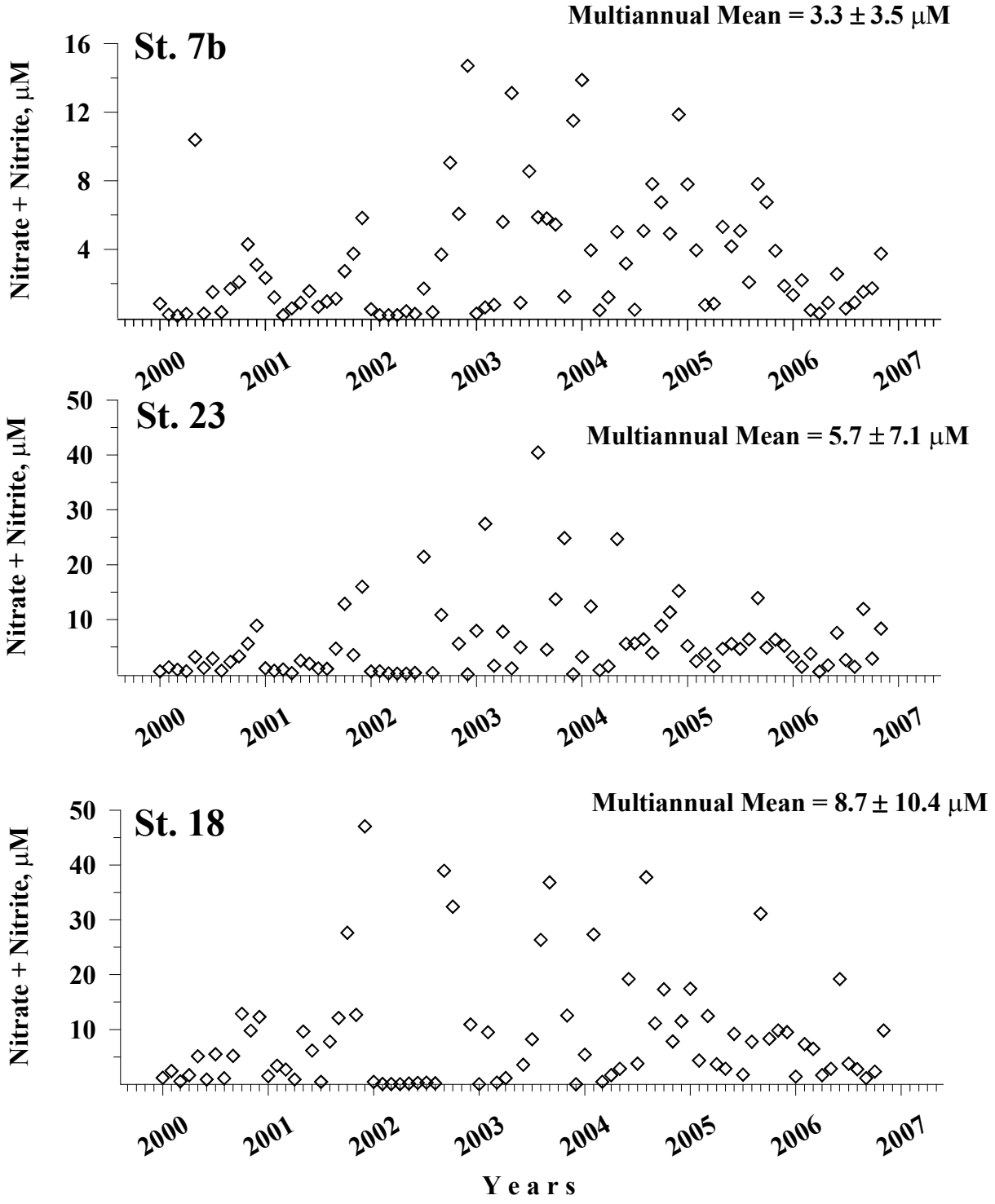


Fig. xxx. Long-term dynamics of nutrients species in UA waters.

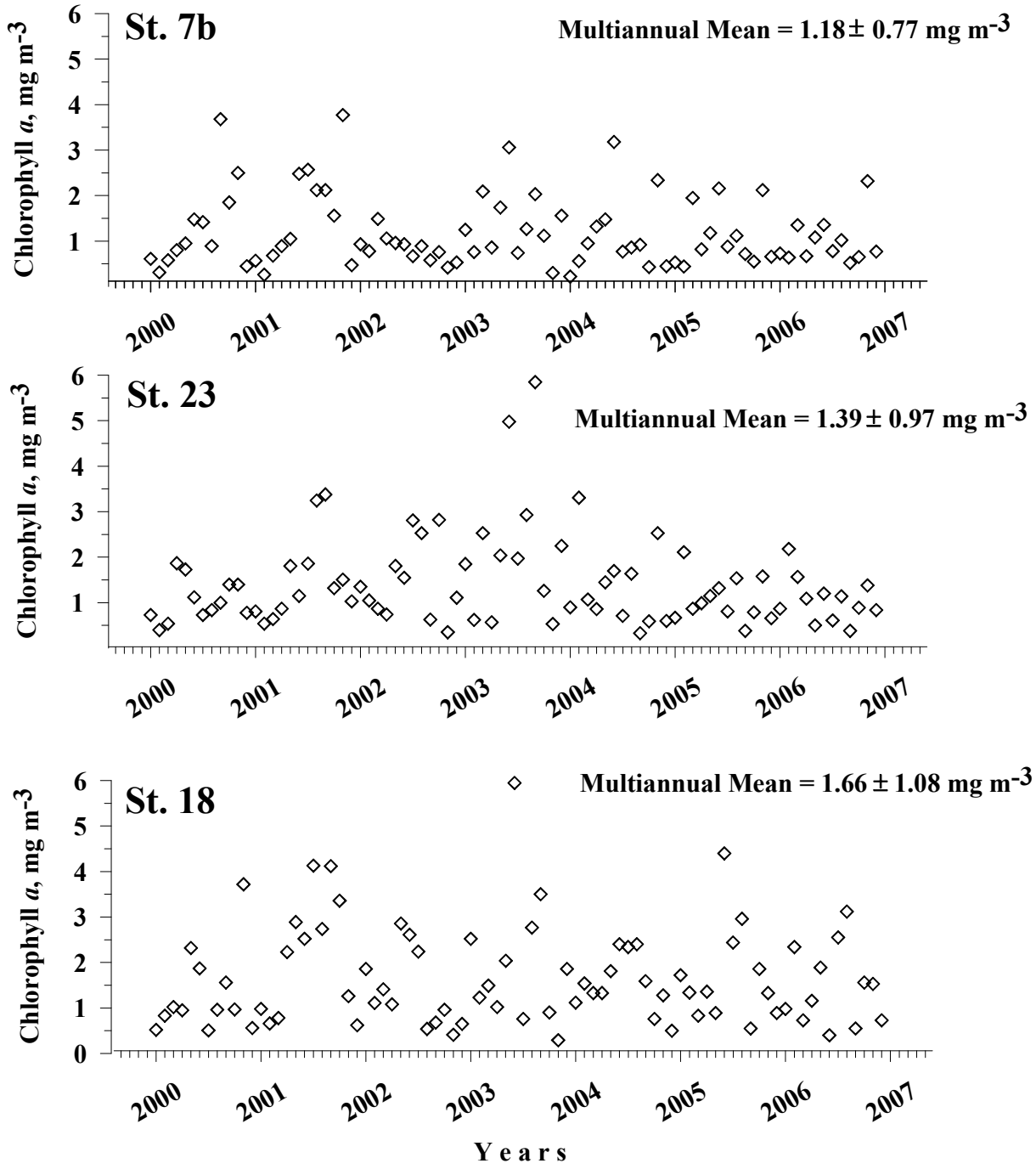


Fig. xxx. Long-term dynamics of Chlorophyll_a in UA waters.

Annex IV. Fishery Report on suitability of BSIS data for calculation of indicators

Violin Raykov, Institute of Fisheries, Varna, Bulgaria; FOMLR AG

Indicator: Fishing fleet –trends

The trend of fishing fleet in the Black Sea region in terms of number of fishing vessels is presented in Fig. 1. The majority of fishing vessels (6587 in 2008) has been registered and operated in Turkish Black Sea waters, especially in 2007 and 2008. The reporting of Russian Federation and Georgia in 2002-2008 is very poor and with many gaps (seeTable 1). Fishing capacity is missing in the reporting of all states for 2001. Significant reduction of the capacity has been registered in Ukraine and Romania. In 2008 total number of fishing vessels was 9694, respectively in Bulgaria the fishing vessel register reported 2545 vessels, in Romania - 439 and in Ukraine - 123.

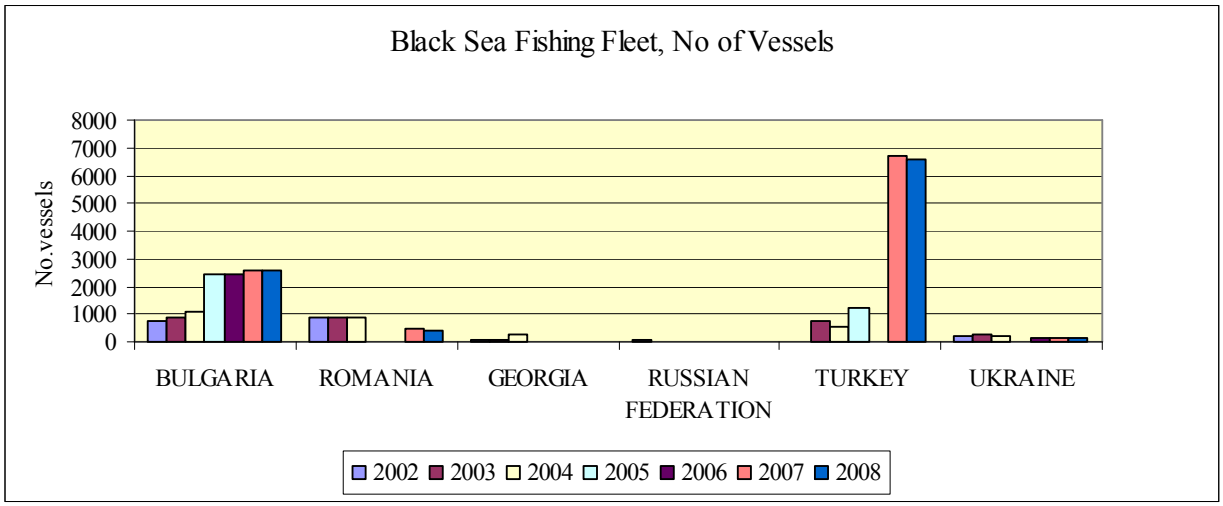


Figure 1. Fishing fleet by Number of vessels per state - trends for the Black Sea region

Table 1. Fishing fleet in the Black Sea region by number of vessels

Year/State	BULGARIA	ROMANIA	GEORGIA	RUSSIAN FEDERATION	TURKEY	UKRAINE
2002	719	898	66	61		199
2003	889	898	68		719	294
2004	1082	897	300		529	199
2005	2438				1198	
2006	2440					142
2007	2557	441			6700	135
2008	2545	439			6587	123

For proper fisheries management it is important to know the fishing effort. One of the main problems in the Black Sea region is the lack of comprehensive information on fishing activity, catch quantities and composition and how they affect the current state of fish stocks. Consequently, reports on the annual catch quantities and composition are produced with

serious gaps and the analysis of fish stocks current state are far from high level of accuracy. The communication between responsible authorities needs improvement. The data exchange at the regional level is not yet systematic and regular.

According to the EU regulations in Bulgaria and Romania (EU waters) Fishing Vessel Register have been created. The data about fishing fleet hence is a property of EC and countries national responsible bodies. Such bodies are National Agency for Fisheries and Aquaculture in Bulgaria (Ministry of Agriculture and Food supply, Bulgaria) in Romania is the same body called ANPA. In Turkey the responsible body is MARA. In Russian Federation – Ministry of Natural Resources (to be confirmed). In Georgia responsible body for fishing fleet data is Ministry of Environment. In Ukraine Fishing fleet Register exists (www.shipregister.kiev.ua)

The Bulgarian and Romanian Annual Reports on the Efforts to Achieve a Sustainable Balance Between Fishing Capacity and Fishing Opportunity during 2008 are prepared in accordance with the rules laid down in the Council Regulation (EC) No 2371/2002, Commission Regulation (EC) No 1438/2002 and Guidelines for an improved analysis of the balance between fishing capacity and fishing opportunities, version 1, March 2008, NAFA (2008). The fishing vessels of Bulgaria and Romania are registered in the Fishing Vessel Register of the National Executive Agency of Fisheries and Aquaculture.The rest of the Black Sea countries have no obligations under these regulations, and their reports to the Black Sea Commission do not contain data on Gross Tonnage (GT[9]) and power of the fishing vessels.
Marine fishery fleet of both member states can be assessed as multi-component. The most numerous group of vessels are small vessels (under 12m LOA[10]) which are tackled with several of nets and angling gears. Even they are equipped with engine, they move from the 3 miles zone away very rarely. Most of them are part-time used at sea, during the fishing seasons, peak moments mainly. Besides, the small vessel owners are fishing at sea in their free time, as supplementary activity. Even substantial catches of bonito and bluefish are caught by these vessels, only small part of the catch is declared and cannot serve for the purposes of the statistics. The small fishing vessels can be divided into 3 different groups and they are adjusted for net and trawl fishery. Most important are the vessels of type “Baltica” (>25m LOA) – they are the largest units of the Bulgarian fishing fleet. In Romanian waters, together with “Baltica”, TCMN and B-140 vessel types are included in the Fishing Register. The maximum working depths of these vessels are 90-95 m in Bulgarian and 60m depth in Romanian Black Sea waters and they are 28-32 years old.
According to tables 2 and 3, in Bulgaria there were 2438 fishing boats with a length overall less (LOA) than 12 m, representing approximately 96 % of all Bulgarian vessels and producing 57.28 % of all Bulgarian catches in the Black Sea. In Romania there were 423 fishing boats with a length overall less than 12m representing about 95 % of all Romanian vessels.

Table 2. Black Sea fishing fleet of Bulgaria and Romania in 2007

	Number		Power, kW		Gross tonnage, GT	
LOA	Bulgaria	Romania	Bulgaria	Romania	Bulgaria	Romania
under 12 m	2 438	423	47 347	2 711	4 286	547

[9] GT is a unitless index related to a ship's overall internal volume.

[10] Length overall

12 m – 15 m	38	5	3 856	447	601	66
15 m – 24 m	50	7	9 296	2 254	1 707	376
over 24 m	12	6	3 305	1 841	1 583	942
Total	2 538	441	63 062	6 053	8 334	1 931

Table 3. Black Sea fishing fleet of Bulgaria and Romania in 2008-2009

LOA	Number		Power, kW		Gross tonnage, GT	
	Bulgaria	Romania	Bulgaria	Romania	Bulgaria	Romania
under 12 m	2 438	423	47 347	2 711	4 286	547
12 m – 15 m	38	5	3 856	447	601	66
15 m – 24 m	57	5	9 296	1 654	1 903	376
over 24 m	12	6	3 305	1 841	1 583	746
Total	2 545	439	63 804	6 653	8 372	1 735

Note:
Source of information – Member state fleet register
Check up is valid up to 22.05.2009.

The fishing fleet of Ukraine operating in the Black and Azov Seas in 2008 incorporated 123 units of vessels more than 18 m long (Table 4).

Table 4. Black Sea fishing fleet of Ukraine by length (LOA)[2]

2006	**LOA**	**2007**	**LOA**	**2008**	**LOA**
142	>12m	135	>12m	123	>12m
56	20-40m	52	20-40m	48	20-40m
52	18-24m	50	18-24m	43	18-24m
34	>12m	33	>12m	32	>12m

In Ukraine, the majority of vessels (74%) were from 20 to 40 meters long (48 units) or from 18 to 24 m (43 units). Among them multi-purpose vessels capable to fish with trawls, purse seines, nets or long-lines were predominant. Only 8 vessels of them were designed to fish with trawls exclusively and 4 of them – to fish only with nets.

In 2002 most of the fishing vessels in Ukraine were at the age of 11 to 30 years old (70%), 23% were even older and only 7% were relatively new - not older than 10 years. Consequently, the reduction in number of fishing vessels in 2006-2008 made up 19 units or 13%.

In Turkey, 6 587 fishing vessels were registered in Black Sea ports. The total number of trawlers was 543, while purse seiners were 526 multi purpose (trawler, purse seine vessels) - 469, carrier vessels - 269 and small boats - 15 460. Most of the trawler and purse seiners operated in the Black Sea during the fishing season.

Proposed methods for fisheries fleet monitoring and control improvement

The most important role here belongs to the control bodies, and the control on IUU (Illegal, Unregulated and Unreported catches) is of major significance.

Survey of the presently used methods for fisheries monitoring, control and surveillance in the Black Sea countries needs to be undertaken.

Analysis of these methods compared to what should be needed for optimal / sufficient input to fisheries management. Identify gaps and propose solutions in the form of deployment of surveillance tools.

Assess the feasibility of regional data access and exchange system for fishing vessel positions and efforts, from technical, administrative, legal and political points of view. Issues include data exchange formats, confidentiality, commercial sensitivity, aggregation level, and more.

Conclusions, recommendations:

One of the most important issues in the proper fishing management is the fishing effort estimation. Difficulties come from:

- some of the vessels operate seasonally (part of the time they are used only for tourism) and as a result there are significant differences between fishing days of the vessels from one segment;
- Some fishermen use the vessels for fishing when possible – outside of their main job/occupation.

VMS is a cost-effective technology, but needs to be backed up by other surveillance means to detect purposeful IUU (Illegal, Unreported and Unregulated) fishing effort. On the regional level several control, surveillance and monitoring tools can be used together with the VMS: patrols and inspection vessels or aircraft, satellite imaging etc. VMS also extends only to the large fishing vessels, in many cases covering a major part of the catch but disregarding the majority of the fleet. Fishing vessel surveillance is in most cases implemented based on national law and carried out country-wise by national authorities – needs harmonization at the regional level.

Catches

Indicator: Catches by major species and areas:

Recent regional assessments were performed excluding Russian Federation and Georgia, whose reporting on catches was not comprehensive enough in the period 2001-2008. For instance Georgia reported catches for about 20 species for 2001-2002. In 2003 Georgia reported only Anchovy (*Engraulis encrasicolus* L.) landings, in 2004 -2006 no reported catch at all, as in 2007 reported catch compounded only by Anchovy (*E.encrasicolus* L.), whiting (*Merlangius merlangus*) and Picked dogfish (*Squalus acanthias*). For 2008 no landings data have been reported. Russian Federation reports on catches, data are missing since 2005.

We may conclude that due to described misreporting the total catch amount in the Black Sea is highly underestimated. For instance, the total landings in 2008 decreased up to 390 thousand tones (without RU and GE) compared to 482 thousand tons reported in 2007.

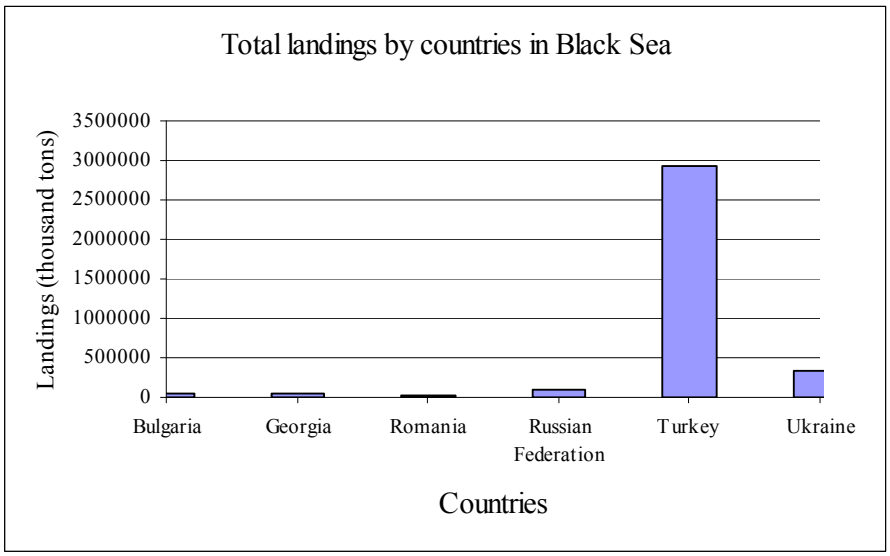


Figure 2. Total landings by countries in the Black Sea – sum for 2001-2008

The highest landings in the Black Sea (2001-2008) were reported by Turkey (2 929 936t).

Table 5 Total catch by countries in Black Sea for 2001 -2008

Bulgaria	Ukraine	Romania	Turkey	Russia	Georgia
51171.9	330299.8	12596.54	2929936	93874.74	45506.6

The overall catches for the BS coastal states without Turkey in 2001-2008 were 533 449.3t.

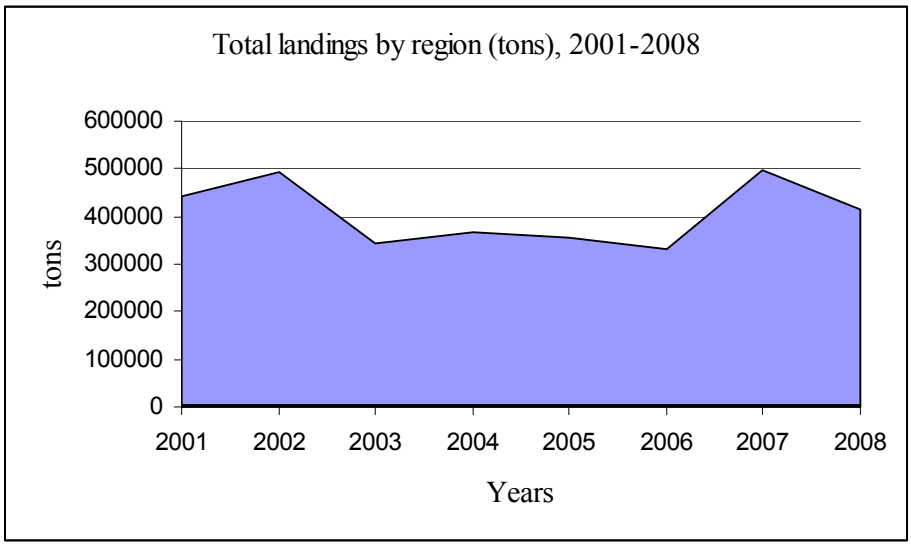


Figure 3. Total landings in the Black Sea region, 2001-2008

Turkey caught 90% of the total landings in the Black Sea in 2008 and 87% in 2007 as Anchovy represented 60% of Turkey's total catch in the Black Sea Total Turkey's catch of anchovy decreased significantly from 360 000 t in 2007 to 230 000 t in 2008.

Sub indicator: Fish landings by major fish type:

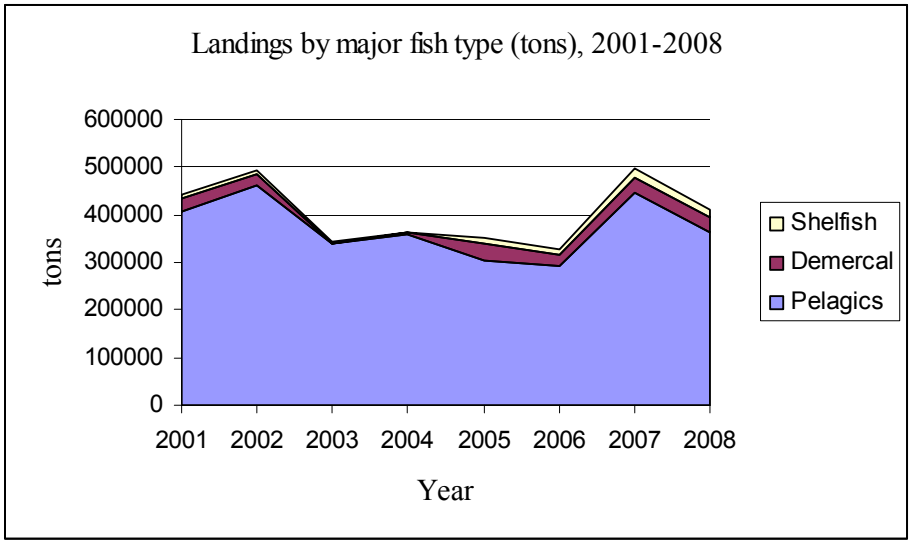


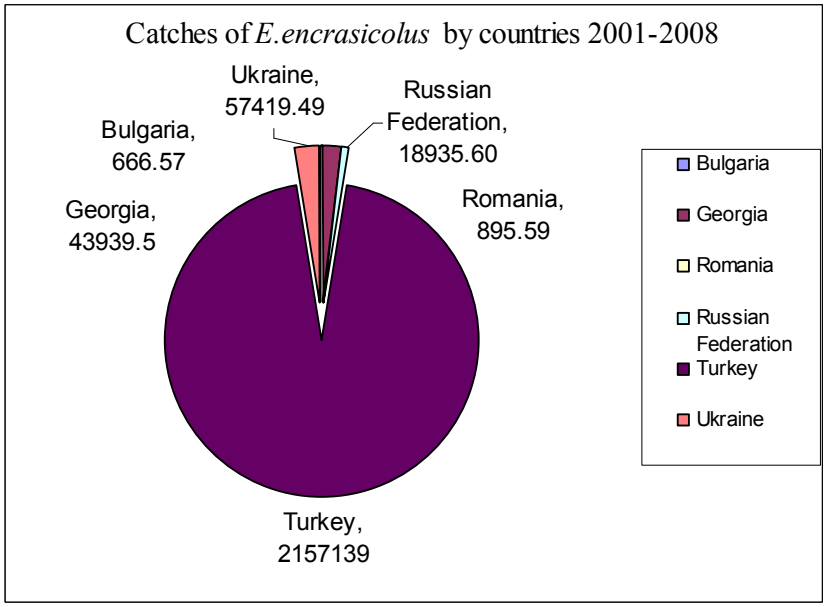
Figure 4. Landings by major fish type (tons), 2001-2008. (adjust the figures to Times font as the others above).

The greatest percent of catches belonged to the pelagic species (*E.encrasicolus, Sprattus sprattus* and *Trachurus mediterraneus*). The peak of the catches was in 2007.

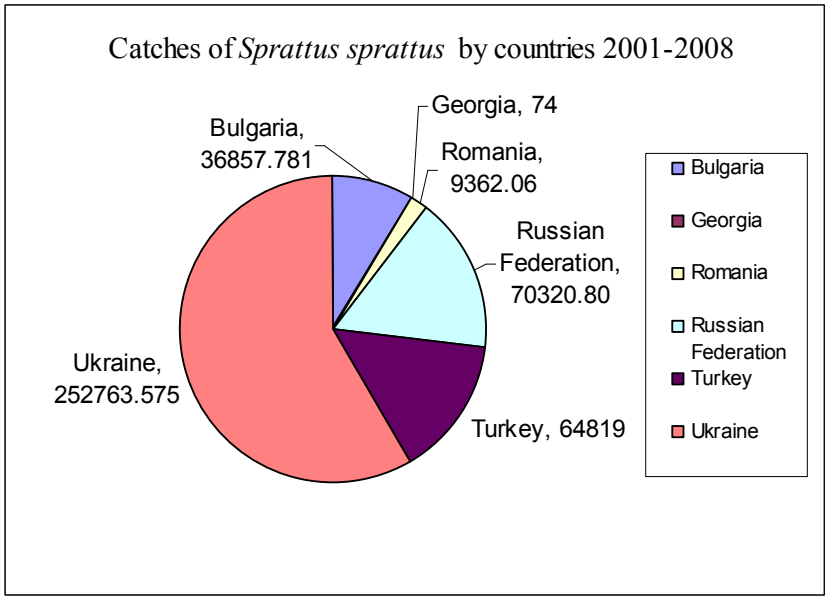
Among demercals species, turbot has the highest economical value. In 2005 the landings were 20 530.81 t., they decreased in 2006 up to 9 286.07 t, and again increased in 2007 and 2008 respectively to 16 672.12 t and 17 407.32 t.

Rapa whelk (*R.venosa*) landings are prevailing among shelfish species, as Turkey and Bulgaria catches are exported to Asian markets mostly.

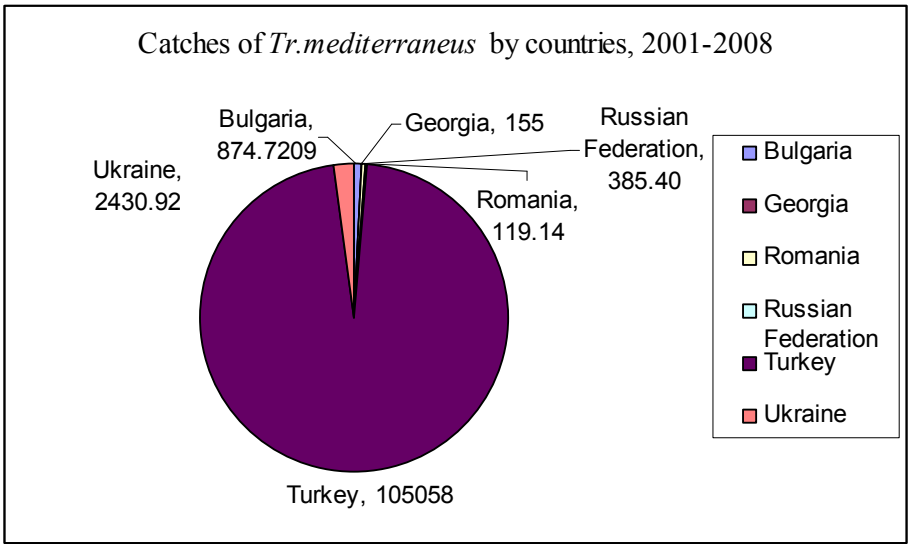
Indicator: Catches of major commercial species by countries, tones 2001-2008



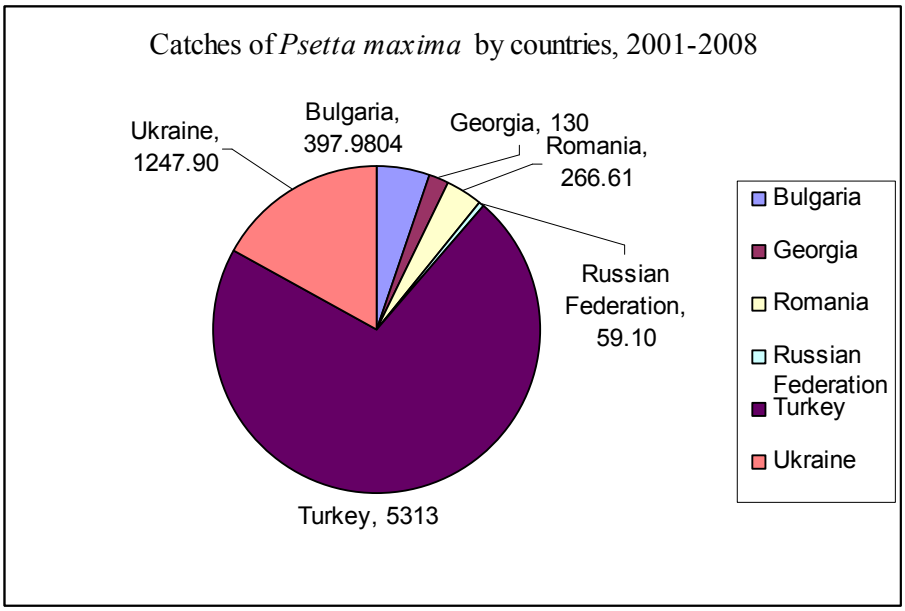
A.


Catches of *Sprattus sprattus* by countries 2001-2008
Bulgaria, 36857.781
Georgia, 74
Romania, 9362.06
Russian Federation, 70320.80
Turkey, 64819
Ukraine, 252763.575
Bulgaria
Georgia
Romania
Russian Federation
Turkey
Ukraine

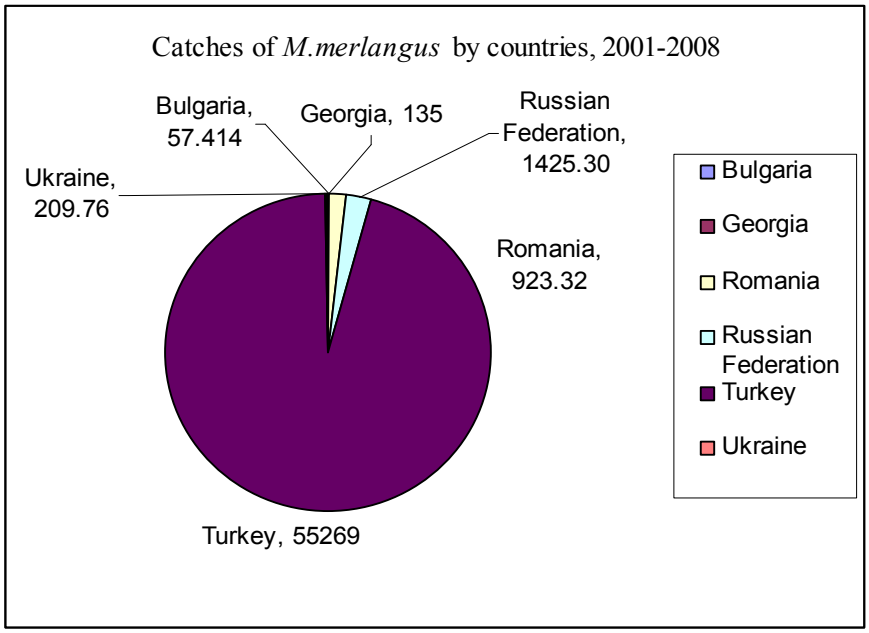
B.


Catches of *Tr.mediterraneus* by countries, 2001-2008
Bulgaria, 874.7209
Georgia, 155
Russian Federation, 385.40
Romania, 119.14
Ukraine, 2430.92
Turkey, 105058
Bulgaria
Georgia
Romania
Russian Federation
Turkey
Ukraine

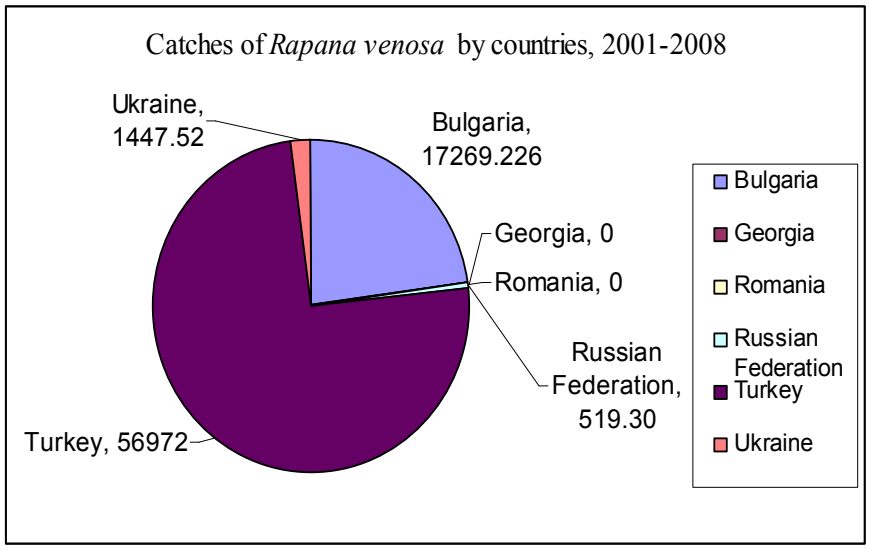
C.


Catches of *Psetta maxima* by countries, 2001-2008
Ukraine, 1247.90
Bulgaria, 397.9804
Georgia, 130
Romania, 266.61
Russian Federation, 59.10
Turkey, 5313
Bulgaria
Georgia
Romania
Russian Federation
Turkey
Ukraine

D.


Catches of *M.merlangus* by countries, 2001-2008
Bulgaria, 57.414
Georgia, 135
Russian Federation, 1425.30
Ukraine, 209.76
Romania, 923.32
Turkey, 55269
Bulgaria
Georgia
Romania
Russian Federation
Turkey
Ukraine

E.



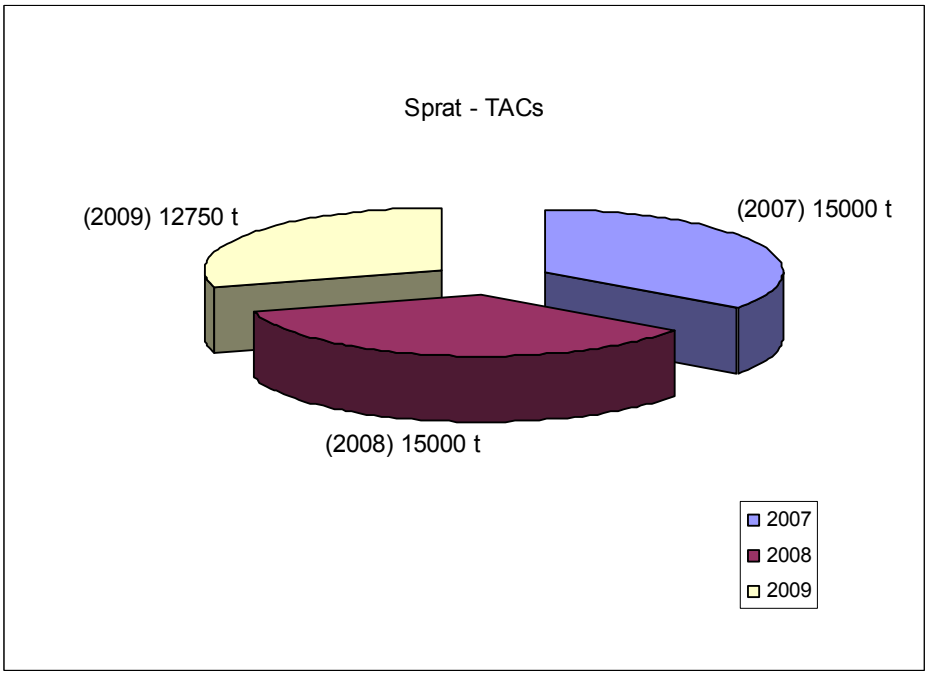
F.

Figure 5. Catches of major commercial species by countries, 2001-2008

In 2001-2008 the greatest percent of anchovy and scad landings belong to Turkey (Fig 5); 65% of the sprat landings belong to Ukraine; the major catches of demercal species (Whiting (90%), Turbot (70%) and Rapa whelk (80%) belong to Turkey.

Indicator: Total Allowable Catch (TAC) and quotas.

In the Black Sea region only Bulgaria and Romania established TAC's and quotas for two regulated species: sprat (*Sprattus sprattus*) and turbot (*Psetta maxima*) (Fig 6).



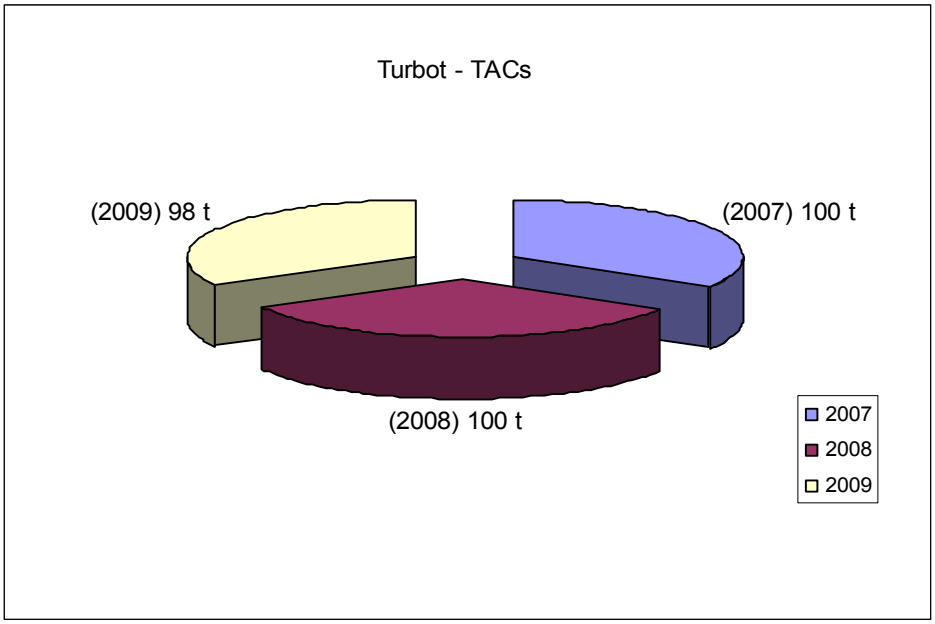


Figure 6. Total Allowable Catch and quotas in Bulgaria and Romania.

For 2007 and 2008 the quota was 15 000 t for sprat. In 2009 the quota was decreased to 12 750 t. For turbot the quota is shared between Bulgaria and Romania as follows: In 2007 – 100 t (50:50), in 2008 -100 t (50:50) and in 2009 – 98 t, with additional conditions, related to the strengthening of the control, reporting and fishing prohibition extension to 15 February 2010.

Bottlenecks/Gaps/misreporting: No data from Russian Federation and very scarce data from Georgia. No data on IUU catch and landings. Due to poor reporting the catches in the Black Sea might be well underestimated.

Recommendations: Reporting on catches needs improvement**.** Illegal fishery should be assessed as well.

Fish stocks

Indicator: Commercial Fish Stocks

Sub-indicators here are:
Number of commercial stocks;
Number of assessed stocks: The assessed stocks in the BS are only 2 – sprat and turbot;
Number of non-assessed stocks;(all the other stocks are not assessed based on harmonised methodologies);
Percentage of non assessed / stocks of economic importance;
Percentage of overfished / stocks of economic importance;
Percentage of safe / stocks of economic importance;

All these sub-indicators of stock biomass are derived form the analysis (ICA, XSA, Darby and Flatman,1994; Patterson and Melvin, 1996. Analyses were performed by SGMED plus Black Sea and SGMED -09-01 in 2008 and 2009):
(http://fishnet.jrc.it/c/document_library/get_file?p_l_id=1807&folderId=129105&name=DLFE-23810.pdf)

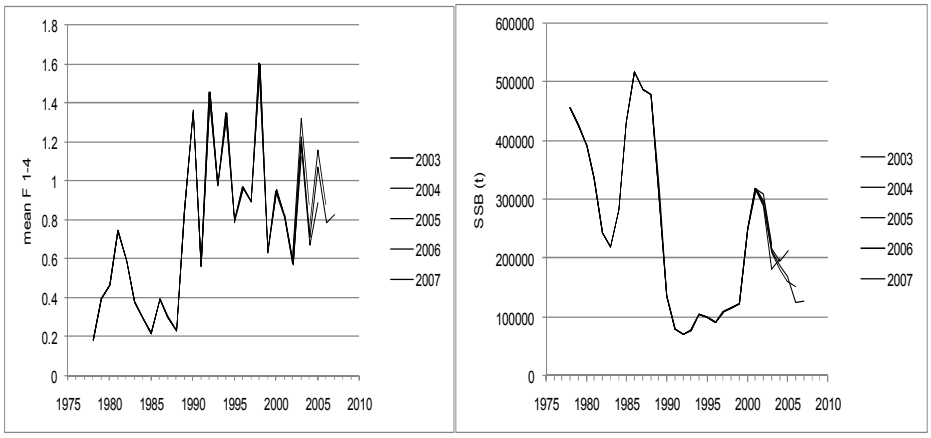
Fishing mortality – sub indicator derived from the analytical methods applied;
Spawning Stock Biomass– sub indicator derived from the analytical methods applied;
Recruits– sub indicator derived from the analytical methods applied;
Landings indicator used in the analysis in order to derive sub-indicators.

Examples of Sub-Indicators in the Black Sea:
№ of commercial stocks: 26
№ of assessed stocks: 2
№ of non-assessed stocks: 24
Percentage of non assessed / stocks of economic importance = 24*100/26 = 92.31%
Percentage of overfished / stocks of economic importance = 1*100/26 = 3.85%
Percentage of safe / stocks of economic importance = 1*100/9 = 3.85%

Harmonised (Black Sea) stock assessments by analytical methods have been carried out for sprat (*Sprattus sprattus*) and turbot (*Psetta maxima*) only.

Examples for sprat
Since 2000, the estimated fishing mortality is quite variable and ranged without a trend at a level of 0.8. The constant exploitation goes along with a recent declining trend in landings and spawning stock biomass. The stock size in 2006 and 2007 was low compared to 1980s and slightly exceeds the lowest level estimated for the 1990s.

The selection patterns estimated by the XSA (Extended survivor analysis, Pilling et al., 2008; Daskalov et al., 2009) indeed indicate some lower selection of the age groups 4 and 5 since 1990 by about 30%, but not to the extent assumed by most of the experts, who argued for a much higher reduction from the estimated level (see ICA, (Integrated catch analysis,Pilling et al., 2008; Daskalov et al., 2009) (http://fishnet.jrc.it/web/stecf).The following Figure 7 shows the average selection patterns for certain periods as estimated by the XSA.



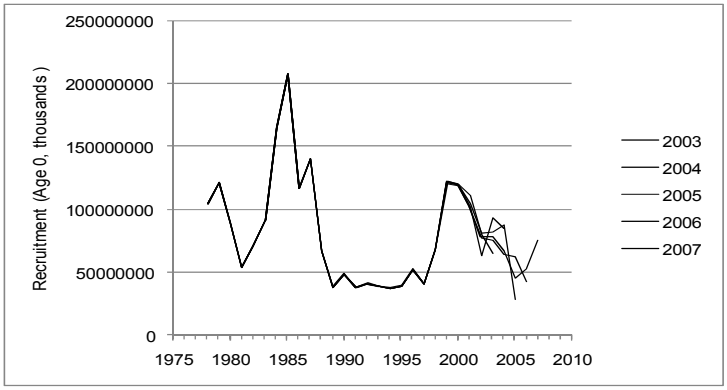


Figure. 7 Sprat in the Black Sea All coastal states catch data are included into the analysis.. Retrospective trends of the assessment parameters fishing mortality (average over ages 1-4), SSB (spawning stock biomass) and recruitment.

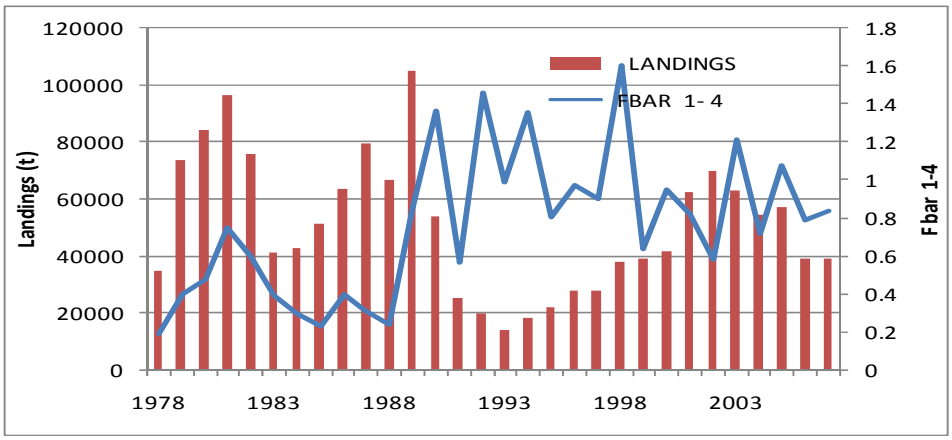


Figure 8. Sprat in the Black Sea (data of all BS states). Trends in official landings and mean fishing mortality.

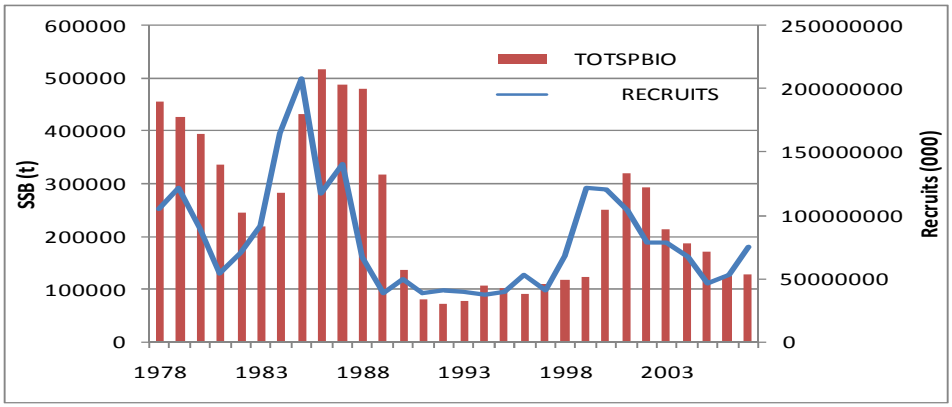


Figure 9. Sprat in the Black Sea.(all Black Sea states data). Trends in SSB and recruits at age 0.

To perform the analysis further (using specialised software) data on landings (reported by all coastal states) and some other indexes from Bulgaria, Romania and Ukraine were used.

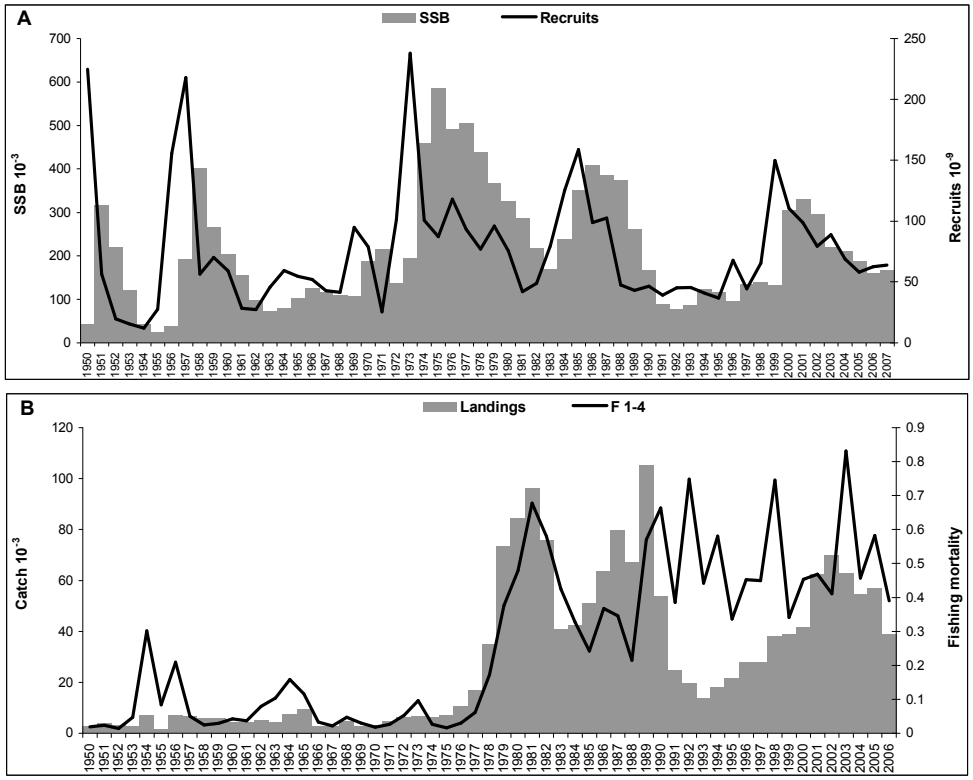


Figure 10. Time-series of sprat population estimates –A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).F1-4 means fishing mortality at ages 1 to 4.

Analysis of main population parameters (abundance, catch, fishing mortality) are carried out. The indexes reveal that the sprat stock has recovered from the depression in the early 1990s due to good recruitment in 1996-2001 and the biomass and catches have gradually increased over the early 1990s and early 2000s. The stock estimates, however, confirm the cyclic nature of the sprat population dynamics. The years with relatively strong recruitment were followed by years of low to medium recruitment which leads to a relative decrease of the Spawning Stock Biomass (SSB). High fishing mortalities (F_{2-4}) were observed in 1998, 2003 and 2005

Forecast: The status quo fishing in 2009 will result in increased landings around 57 500t, as compared to the 51 000 t landed in 2008. The SSB will increase to around 173 000 t in 2009 and drop to 150 000 in 2010 and 144 000 in 2011. The short-term forecast indicates that present level of fishing is probably too high and will affect negatively the SSB at the present level of recruitment.

Examples for Turbot:

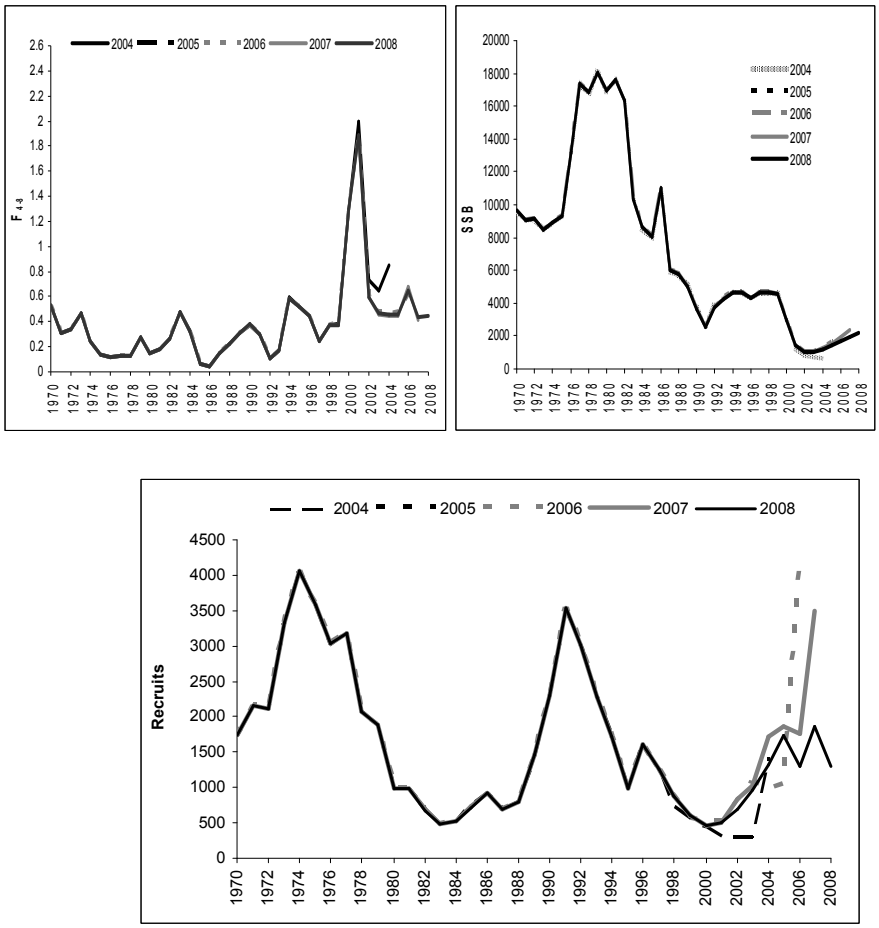


Figure 11. Turbot in the Black Sea (the catch data used for the analysis are from all Black Sea). Retrospective trends of the assessment parameters fishing mortality (average over ages 4-8), SSB and recruitment.

According to the analysis the recruitment has two peaks in 1971 – 1978 and 1988 – 1994 and increase of recruitment after 2001. Correspondingly, SSB attained higher values up to 18,000 t during the period 1976 – 1983 and very low values after 2000. Since 2004 slight increase in SSB was observed. Fishing mortality F_{4-8} (fishing mortality for age 4 to age 8) has a peak in 2000-2001 (Fig. 12).

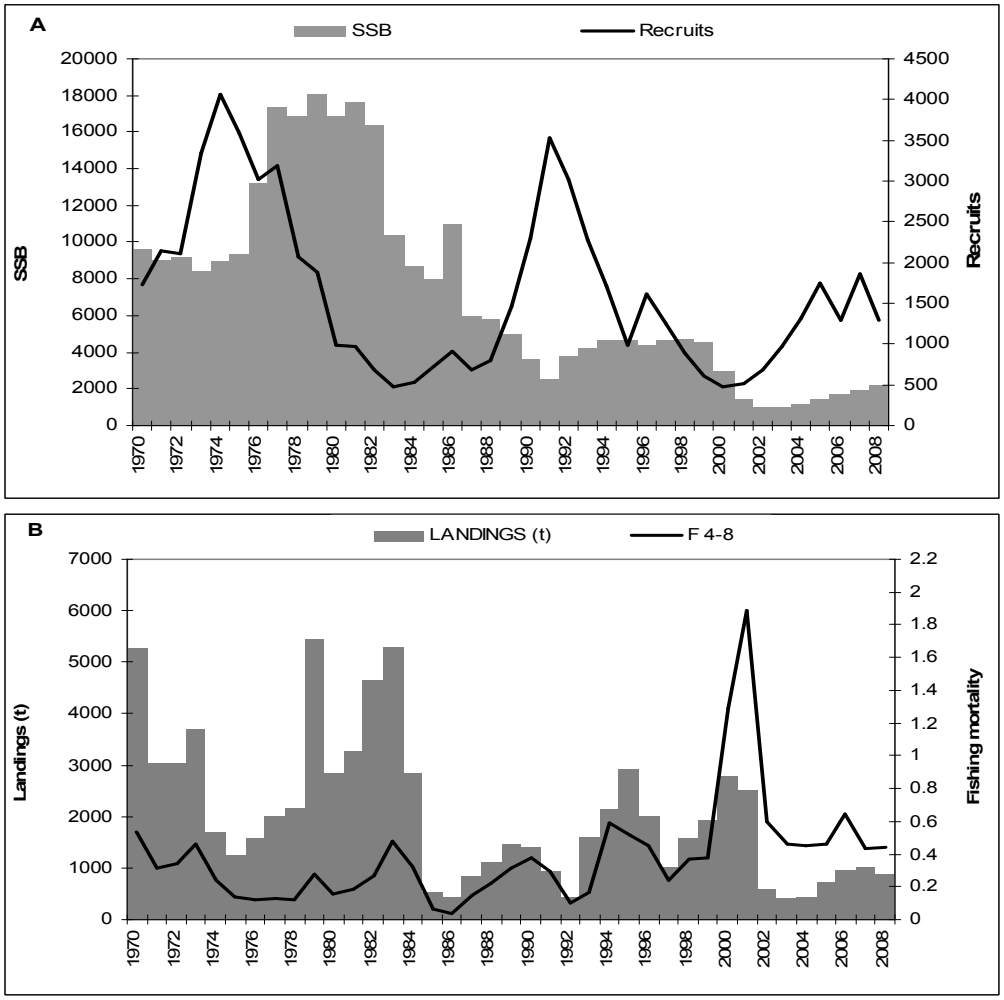


Figure 12. Time-series of turbot population estimates of total stock in the Black Sea (XSA, (Extended survivor analysis,Pilling et al., 2008; Daskalov et al., 2009) A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 4–8, line).

The results above presented a useful and indicative of trends in turbot abundance in the Black Sea. Gradual increase of SSB is observed after the historic low in 2002 but biomass still remains quite low compared to the stock size in the 1970 and 1980s. The present results cannot be used for the aims of the management advice and prediction of stock size.

Sub-indicator: State of the spawning stock size

Spawning stock biomass is a sub indicator, derived by analytical method. In the Black Sea data availability for this sub-indicator: only for sprat and turbot.

Example for turbot: The turbot SSB during recent years is at a low level compared to historical abundance. In 2002 and 2003 the SSB has been at the absolute minimum since 1970. Relative abundance estimates are confirmed by CPUE (abundance) data. Catches have also dropped since 2002. A gradual recovery in the SSB and catches is observed since 2004.

Sub-indicator: State of recruitment.

State of recruitment is a sub indicator, derived by analytical method. In the Black Sea data availability for this sub-indicator: only for sprat and turbot.

Example for turbot: Recruitment of turbot was at minimum in 2000-2001 and started to increase since 2002. The increase in recruitment since 2002 has positively influenced the SSB but given that many small and immature turbots are caught by fishermen such a positive influence may not propagate in the next years.

Sub-indicator: State of exploitation

State of exploitation is a sub indicator, derived by analytical method. In the Black Sea data availability for this sub-indicator: only for sprat and turbot.

Example for turbot: Fishing mortality has peeked in 2000-2001 due to relatively high catches provided the low biomass of the stock. The catches decreased since 2002 but fishing mortality remains quite high because of the low exploitable biomass.

Bottlenecks/Gaps/misreporting: There is no Legally Binding Document on fisheries/management in force for the Black Sea. Most of the stocks are not assessed (only for sprat and turbot assessments are available for the whole Black Sea), or just separate assessments (not in a harmonised manner) exist in some countries. No common fishery regulation (base for fisheries management) exists in the Black Sea region.

Recommendations: Dedicated surveys for stock assessments need to be carried out. Harmonization of methodologies (stock assessments and sub-indicators derived) is crucial.

Indicator: Trophic level

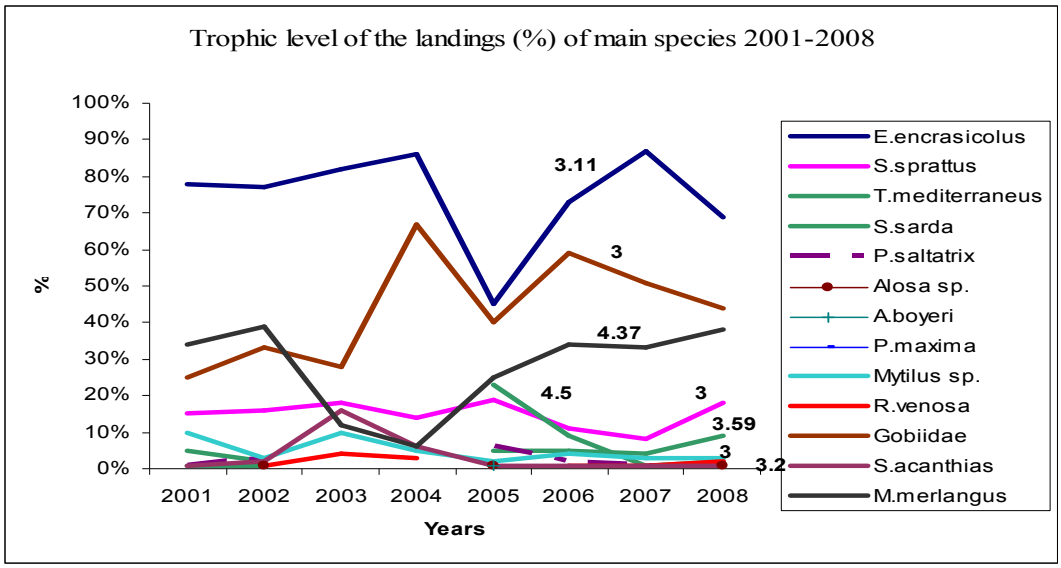


Figure 13. Trophic level (www.fishbase.org) of the pelagic, demercal and shellfish species landings, 2001-2008.

Table 6. Percent share of the species composition of the landings, trophic level (www.fishbase.org) with SE, 2001-2008.

	2001	2002	2003	2004	2005	2006	2007	2008	Trophic level	S.E.
Main pelagic species										
E.encrasicolus	78%	77%	82%	86%	45%	73%	87%	69%	3.11	±0,45
S.sprattus	15%	16%	18%	14%	19%	11%	8%	18%	3	±0,4
T.mediterraneus	5%	2%			5%	5%	4%	9%	3.59	±0,41
S.sarda	1%	1%			23%	9%	1%	2%	4.5	±0,74
P.saltatrix	1%	3%			6%	2%	1%	1%	4.5	±0,55
Alosa sp.		1%			1%			1%	3.93	±0,63
A.boyeri					1%				2.32	±0,26
Main demercal species										
P.maxima	10%	3%	10%	5%	2%	4%	3%	3%	3.96	±0,63
Mytilus sp.		1%	4%	3%		1%	1%	2%	3	
R.venosa	25%	33%	28%	67%	40%	59%	51%	44%	3.2	
Gobiidae	1%	2%	16%	6%	1%	1%	1%	1%	4.3	
S.acanthias	1%	1%	13%	4%					4.3	±0,67
M.merlangus	34%	39%	12%	6%	25%	34%	33%	38%	4.37	±0,66
Mugilidae	29%	21%	17%	9%	32%	1%	11%	12%	2.543333333	±0,16

Indicator: Aquaculture production

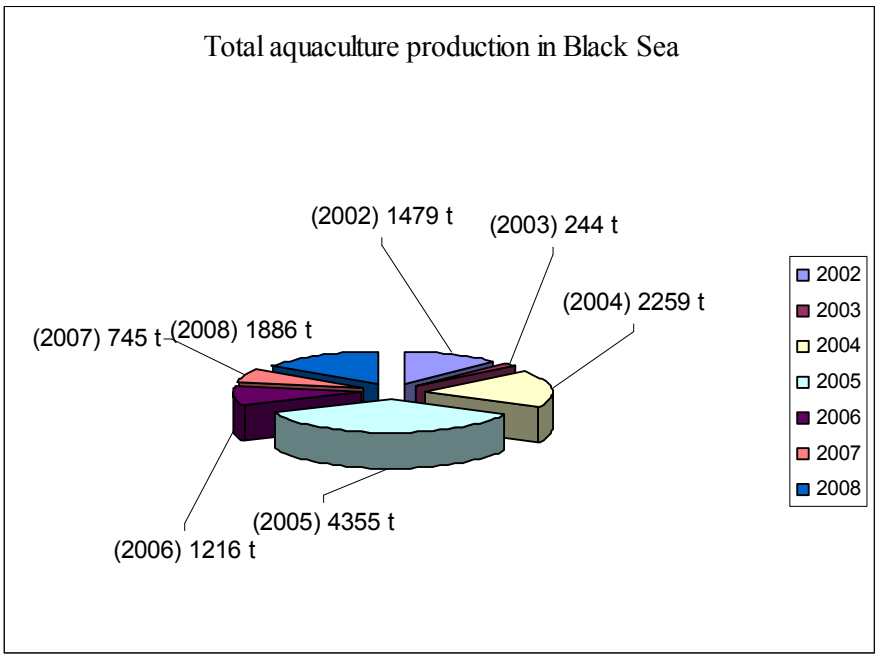


Figure 14. Total aquaculture production in the Black Sea

The aquaculture production increased in 2004 (2259 t) and in 2005 (4355 t). The reported data are from Turkey, Ukraine and Bulgaria, mostly. Romania has no developed marine aquaculture sector; some experimental investigations on *M.galloprovincialis* exist. Georgia

reported only for 2004, 400 t aquaculture production. No data from Russian Federation for the In 2008 only Bulgaria, Turkey and Ukraine reported for aquaculture production in Black Sea.(Table 7).

Table 7. Reported aquaculture production in the Black Sea for 2001-2008.

	BULGARIA	GEORGIA	ROMANIA	RUSSIA	TURKEY	UKRAINE
2002					1404	75
2003			3			241
2004	45	400			1414	400
2005	70				3410	845
2006	205				598	413
2007	240					505
2008	305				1173	408
Total	865	400	3		7999	2887

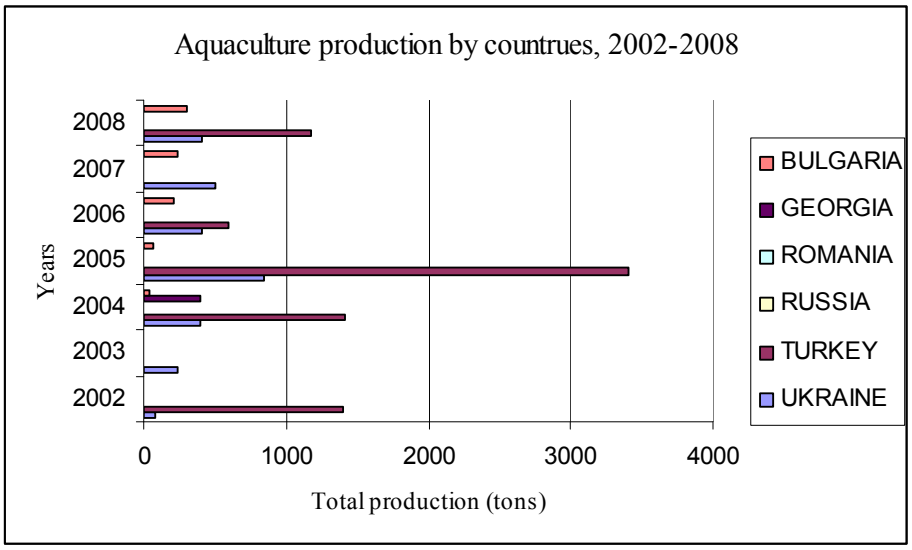


Figure 15. Annual aquaculture production by country.

As it shown on Fig.15, Turkey holds the first place in aquaculture production in the region. In 2005, a peak of around 3 500 t has been recorded.

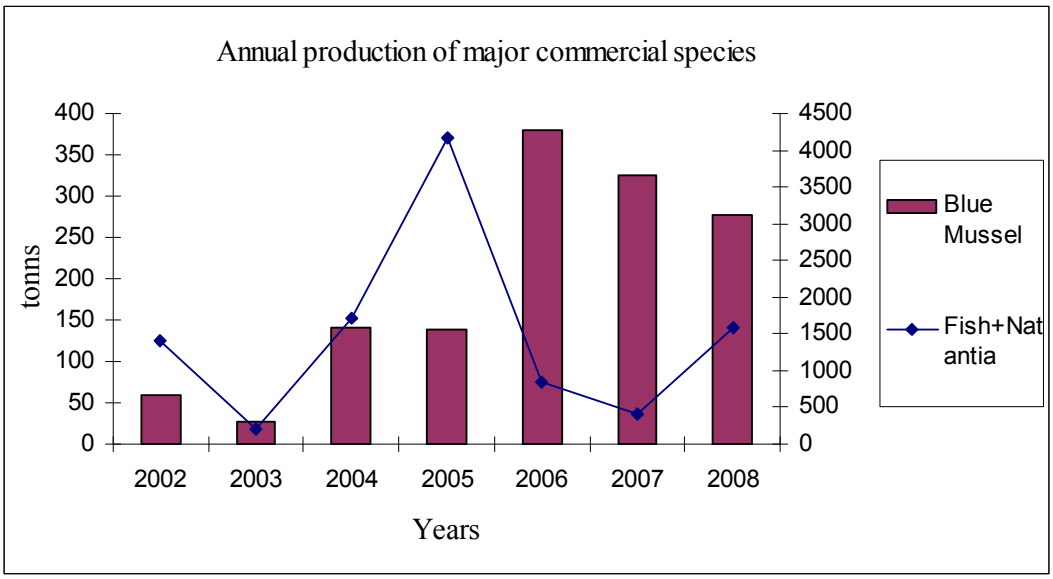


Figure 16. Annual production of major commercial species. What is Fish+Suborder Natantia (shrimps and prawns).

As it is shown on the Fig.16 the Blue mussel (*Mytilus galloprovincialis*) is the most popular species for artificial cultivation. In 2006 total blue mussel production increased, then decreased toward 2007-2008. Major fish species, object for cultivation in Turkey were Sea Bream (*Sparus aurata*), Sea Bass (*Morone morone*), trout (*Oncorhinchus mykiss*), as the majority of production came from the Aegean Sea and small quantities from the Black Sea (Fig /????).No Blue mussel production in the Turkish part of the Black Sea has been reported for 2008.

In Ukraine, the list with cultivated species in the Black Sea is large: *E.encrasicolus*, *Mugil soiuy*, *Atherina boyeri,* fam.Gobiidae, *Platichtys flesus*, *Mytilus galloprovincialis*, . Suborder Natantia (shrimps and prawns) Bulagarian marine fish cultivation includes *Mytilus galloprovincialis* and Baramundi (*Lates calcarifer*) cultivation.

Bottlenecks/gaps/misreporting:

No comprehensive data on environmental impact of aquaculture production exist in the region (lack of data on N and P discharges). No data reported on rates of nutrient and chemical discharges, number of escapes, and incidence of disease per unit production, (food given/fish production).

No data are available on contribution of nutrients from aquaculture to total coastal nutrient loads.

Recommendations: Better reporting on aquaculture is needed. Relevant monitoring to investigate on impacts of aquaculture would be beneficial.

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Annex V: Northward movement of species

Trend on increasing Mediterranean species arrival into the Black Sea.

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The flora and fauna of the present-day meromictic Black Sea, which was formed under the conditions of relatively low salinity and the existence of an anoxic zone beneath the upper oxygen-containing layer, is distinguished by a low species diversity characteristic of most of the taxonomic groups represented in it and by an absolute absence of many of them. Meanwhile, it features a rather high productivity, first of all, in near-shore regions, associated with a high abundance of key species, and by a richness of fish resources.

The Black Sea biota contains of 80% of Atlantic-Mediterranean origin species, 10.4% and 9.6% of species of freshwater and Ponto-Caspian origin, respectively. One more component of biota is an arctic assemblage, which is extremely poor and contains mainly flora (Mordukhai-Boltovskoi, 1969). Biota represented by the species originated from the Atlantic-Mediterranean Sea makes up species of Lusitanian province, and of the boreal zone of the Atlantic Ocean. Species, which have Lusitanian origin, belong to warm water species. They inhabit upper layer of the Black Sea. Species, which have Atlantic boreal origin, belong to moderately cold water species. They have clear features of cold-water relicts. Among them are mainly benthic, demersal and pelagic species, which live in the cold intermediate layer and below up to the boundary of anoxic layer. Only the most eurythermal of them may rise to the surface layers. In addition to salinity, qualitative impoverishment of the Black Sea biota is due to the absence of deep-water species at depths greater than 125-200 m.

At present, the total number of species in the Black Sea is relatively small and stands at 3,774 spp. Of these 1,619 are fungi, algae, and higher plants; 1,983 are invertebrates, 180 are fish, and 4 are sea mammals- dolphins (Zaitzev, Alexandrov, 1998). In the 20th century, especially in its second half, under the influence of climatic and anthropogenic factors, significant changes have occurred in the diversity of the flora and fauna of the Black Sea. Among the most pronounced anthropogenic factors, which affected biota and have to be mentioned:
—regulation of the runoff of major rivers;
—increase in the supply of dissolved mineral forms of phosphates and nitrates from large rivers accompanied by reduced silicate supply. This resulted in a decrease in the Si : P and Si : N ratios, which are important for the functioning of phytoplankton;
—increase in the supply of organic matter from the Danube River, which caused mass development of mixotrophic algae;
—changes in the composition of phytoplankton species and their proportions, domination of dinoflagellates instead of domination of diatoms, significant growth in the phytoplankton biomass and outburst in the development of harmful algae;
– subsequent eutrophication;
–corresponding increase in the primary production: twofold on the average over the entire sea and tenfold in its northwestern part ;
– subsequent outbursts of native gelatinous species such as *Aurelia aurita* and *Noctiluca scintillans*;
–deterioration in the condition of spawning and feeding areas of fishes;

–high pressure of fishery resulted in decreasing stocks of large pelagic fishes – migrants from the Aegean and Marmara seas and dolphins;
–invasion of non-native species, some of which negatively affected the communities in which they introduced or replaced native species.

The classical scheme of the functioning of a balanced ecosystem in an inland basin is based on a "top-down control" against predators that descends from large pelagic fishes and mammals to small pelagic fishes and lower to zooplankton (when large edible zooplankton dominates) and algae (when diatom algae dominate). As a result of the man-induced changes that occurred in the Black Sea ecosystem by the end of the 1980s, it became a mesotrophic or eutrophic (in its northwestern and the western parts) basin with disturbed functioning, which was favorable for the development of gelatinous plankton.

Among the factors mentioned, the occasional and sometimes intentional introduction of non-native species of animals and plants is a global phenomenon that has not avoided the Black Sea as well. As a result, the Black Sea became a basin—recipient for many non-native species of different origins both marine and brackish water species and affected all other seas of Ponto-Caspian basin and in a less degree the Sea of Marmara and the eastern Mediterranean as a donor area for many of these established species. All together 156 (or 171 according to other sources) species were established, which belong to different taxonomical groups (Fig.1).

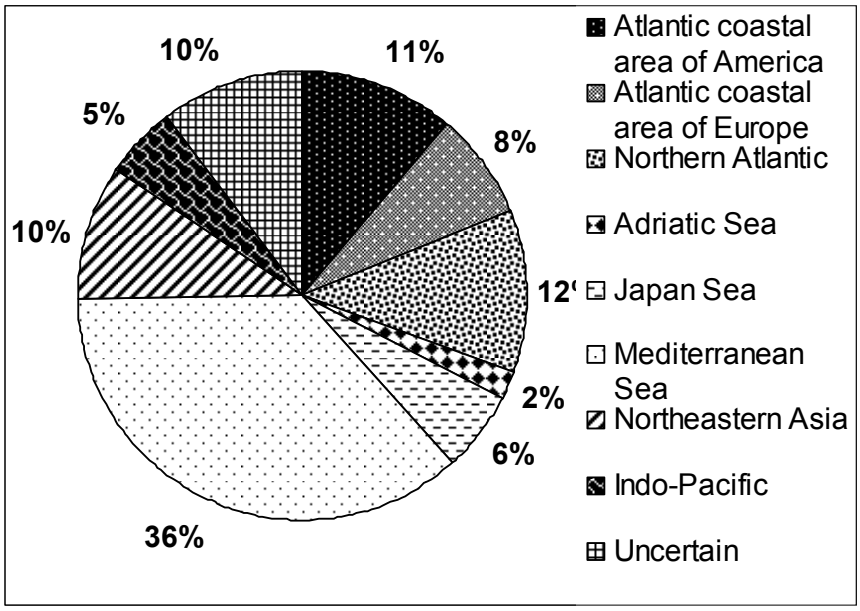

Fig.1 Donor areas of the non-native species and their share (%) in the Black Sea.

The disturbance of the Black Sea has favored the establishment of the new gelatinous representative of macroplankton such as the predatory warm-water ctenophore *M. leidyi*. Within the heated zone of the surface layer of the Black Sea it found conditions optimal with respect to the temperature, salinity, and productivity. Precisely under these conditions, it became capable of developing a high activity (intensity of the metabolism and, hence, the feeding and growth rates) and reached extremely high abundances. After *M. leidyi* invasion cascading effect occurred at the higher trophic levels, from a decreasing zooplankton stock to collapsing planktivorous fish to dolphins (bottom-up). Similar effects occurred at lower trophic levels: from a decrease in zooplankton stock to an increase in phytoplankton, relaxed from zooplankton grazing pressure (top-down) and from increasing bacterioplankton to increasing zooflagellata and ciliates (Shiganova et al, 2004).

Ten years later another warm water ctenophore *Beroe ovata* – predator on *M.leidyi* was introduced with ballast waters from the same area (coastal area of the north America) and established. Its invasion favored "invasion meltdown", when invasion one species stimulate invasion its predator after its appearance in the same recipient area. Resulted in *M.leidyi* population decreased and ecosystem began to recover trophic web at all levels (Shiganova et al.2000; 2003).

In addition in the Black Sea during last decades temperature increased both in the surface mixed and the cold intermediate layers (Fig.2), which facilitates the increase population of thermophilic species and their northward expansion from the Mediterranean. Until recently new Mediterranean species have been recorded temporally or permanently mainly in the near-Bosporus region. Therefore, they are usually not regarded as established non-native species. But if we take into account only established species, their share in total numbers of non-native species consist of 36%. Since 1960s and certainly earlier with the Bosporus Strait with Low-Bosporus current delivered many Mediterranean species different taxonomic groups. But selected Mediterranean species of phyto- , zooplankton, benthic and fish species more and more often are recorded also off northwestern and northeastern coastal areas. At present, this process is facilitating by rising temperature. As a result of that numbers of penetrated and even established species far from Bosporus are increasing during last years. Species that penetrated beyond the Bosporus reach the centre, southwest, southeast and northeast, moving with the currents or lenses of the Mediterranean water or are releasing with ballast water. Number of species brought with ballast waters increased especially around harbor areas. Some species were represented by a few specimens; others are increasing their density.

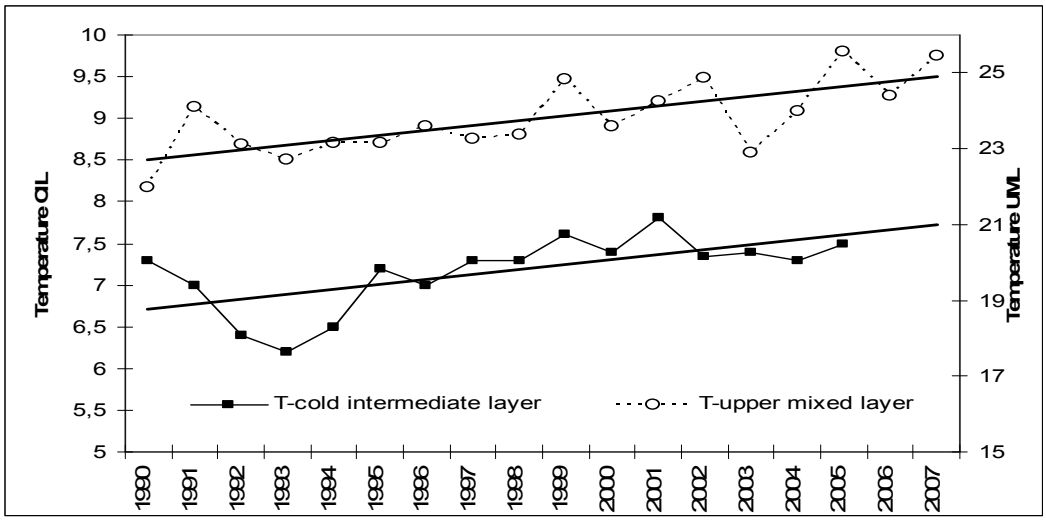

Fig. 2. Rising of water temperature during last decades (Data of lab. Hydrophysics of Southern branch of SIO RAS).

The process of establishment of the species that have already invaded the sea lasts in time. Selected species of this kind may temporarily become subdominant species, but, as a rule, they remain rare or are abundant only in definite years, which suggest a high stability of the communities of the Black Sea with respect to establishment of non-native species or conditions of the Black Sea with low salinity and low winter temperature do not favor them to keep self- reproducing population of the most of these species particularly representative of Copepoda .

Microplankton

Microplankton elements are Mediterranean tintinnids, first found in the northwestern Black Sea in 2002 (Table 1, upon request) (Polikarpov et al., 2003).

Phytoplankton

Mediterranean phytoplankton species new for the Black Sea are recorded year after year, and their numbers keep increasing. A significant number of species native to the Mediterranean colonize the Bosporus region (Table 2). Some of them might survive only in this area where salinity is higher than in other regions of the Black Sea. Examples include the diatoms *Fragillaria striatula* and *Thalassiothrix frauenfeldii*, the coccolithophorid *Calyptrosphaera incriase* and the peridinean *Ceratium macroceros*, registered since the beginning of the 1960s at a salinity of 34‰ and a temperature of 14 ◦ C. These conditions significantly differ from the Black Sea (Georgieva, 1993). However, some other newcomers of the 1960s and early 1970s were found not only near the Bosporus but also near the Crimea (Table 3, upon request) (Kuzmenko, 1966; Senichkina, 1973, Kovalev et al., 1998).

Table 2. Mediterranean phytoplankton species found near the Bosporus in the Black Sea (Georgieva, 1993).

	T °C	S‰
Biddulphia alternans (Bail.)V. H.	7.70	19.34
Eucampia cornuta (Cl) Grun	8.40	19.78
Rhizosolenia styliformis Brightw	17.13	17.59
Thalassiothrix mediterranus Pavill	7.89	19.13
Amphidinium conradi (Conrad) Schill.	7.44	18.38
A. vigrense Wolosz	10.79	18.18
A. mannanini Herd.	10.79	18.18
Ceratium hexacanthum f.contortum (Lemm.)Jorg.	7.80	18.39
C .massiliense (Gourret) Jorg	7.81	18.39
C. furca var.eugrammum (Eht.) Jorg.	18.67-24.97	16.44-18.39
C. fusus var.seta (Eht.) Jorg.	7.80	18.39
C .teres Kof.	-	-
C. trichoceros (Eht.) Kof.	10.79	18.18
C.tripos var. atlanticum Ostf.	7.81	18.39
C.hexacantum f. aestuarium (Schrod.) Schill.	7.81	18.39
Cochlodinium citron Kof.et Sw.	7.39	18.50
Gymnodinium paradoxum Schill.	-	-
G.pygmaeum Leb.	10.79	18.18
Oxytoxum parvum Schill.	7.41	18.33
O.variabile Schill	23.98	15.73
O. viride Schill.	8.88	20.32
Peridinium sinaicum Matz	18.82	18.36
Pronoctiluca acuta (Lohm.) Schill.	9.14-9.85	18.57-18.96
P. pelagica Pavill	7.64	-
Pyrocystis hamulus Cl.	13.20	17.20
P. fusiformis (W.Th.)Mur.	9.51	21.42
P. pseudonoctiluca (W.Th.) Schill.	6.52	18.40
Coccolithus pelagicus (Walich.) Schill.	7.55	18.20
Rhabdosphaera stylifera Lohm.	8.74	20.14
Syracosphaera coronata Lohm.	7.44	17.98
S. cornifera Schill. (Helladosphaera)	16.10	17.98
S. quadricornu (Anthosphaera) Schill.	8.74	29.14

S. spinosa Lohm.	7.31	18.52
Total: 33 species		

Kuz'menko (1966) listed *Dynophysis schuttii* Murr. et Whitt. and *Podolampas spinifer* Okatumura, previously unknown in the Black Sea but typical of the Mediterranean off the southern coast of the Crimea at a salinity of 18–18.5‰. In the early 1990s, *Katodinium rotundatum* (Lohm) Fott, *Achradina sulcata* Lohm., and *Pronoctiluca* sp., appeared in shallow water off Yalta. *Distephanus octonarius* var. *Polyactis* (Jorg) Gleser and *D. speculum* var. *Septenarius* Jorg, previously unknown in the Black Sea were also discovered off Crimea area (Senichkina, 1993). In all, 37 representatives of Mediterranean phytoplankton were registered in subsurface waters of the Bosporus region (Table 2) (Georgieva, 1993). Many of these species were recorded not only in the waters originated from the Sea of Marmara and Mediterranean but also in the typical Black Sea waters. It could be explained mixing of the Mediterranean and the Black Sea waters and driving waters with species in the upper layers. Resulted on these processes in the upper layers of the southern Black Sea such representatives of the Mediterranean phytoplankton as к *Syracosphaera cornifera, Ceratium furca* var. *eugrammum, Pyrocystis hamulus*, *Pronoctiluca acuta* etc. were recorded (Табл. 2) (Georgieva, 1993).

Not all species found recently may be considered as newcomers some of them were discovered after more detailed examinations of the Black Sea samples. Thus in coastal northwestern Crimea, long-term observations (1968–2002) brought to light new species for the Black Sea, such as the diatoms *Asterionellapsis glacilis*, *Chaetoceros tortissimus*, *Thallassiosira nordenskioeldii*, *Lioloma pacificus*, *Pseudonitzschi inflatula*, two subspecies of *Chaetoceros*, and the dinophyte *Dinophysis odiosa,* as author assumed they arrived from the Mediterranean (Senicheva, 2002).

During last years a considerable number of new Mediterranean species were found around the ports (Table 3) (Alexandrov, 2004; Moncheva, 1995; Terenko & Terenko, 2000; Terenko, 2003;Senicheva, 2001).

In early August 2001 the Mediterranean *Chaetocerus tortissimus*, *Cochlodinium polykrikoides*, and *Alexandrum sp*. were recorded in the coastal area of northeastern Black Sea (coastal Bolshoi Utrish). *Cochlodinium polykrikoides* reached a biomass of ca 500 $\mu g.l^{-1}$ (Vershinin et al., 2004). It was observed also in Odessa Bay in 2002 (Terenko, 2003).
Altogether 11 Mediterranean species of phytoplankton were found recently in the areas far from Bosporus, 10 species more were found in the Black Sea and considered as species probably Mediterranean origin (Table 3, upon request).

Zooplankton
As mentioned above, high numbers of holozooplankton species dispersed with Low-Bosporus current into the Black Sea and occur temporally off the Bosporus. Among them, 59 species are Copepoda. All of them were recorded along the southern Black Sea but none of them became abundant (Table 4).

Table 4. List of Mediterranean Copepoda found in the Black Sea (with additions after Kovalev et al., 1998). References : 1-Pavlova, 1964, 1965; Pavlova & Baldina, 1969; 2-Kovalev et al., 1976; 3-Kovalev, 1971; 4-Kovalev et al., 1987; 5-Porumb, 1980; 6-Kovalev et al., 1998; N- recent finding

Reference	1	2	3	4	5	6

Species						
Calanus tenuicornis Dana					+	
Calanus gracilis Dana		+				
Calanus minor Claus				+		
Eucalanus sp.					+	
Mecynocera clausi Thompson				+	+	
Paracalanus nanus Sars				+	+	
Paracalanus aculiatus Giebr.					+	
Clausocalanus arcuicornis (Dana)	+	+	+			
Clausocalanus paululus Farr.		+	+	+		
Clausocalanus (Brady)		+		+		+
Clausocalanus pergens Farr.		+		+		+
Clausocalanus parapergens Frost, Flem		+				
Clausocalanus mastigophorus (Claus)				+		
Calocalanus pavo Dana	+	+	+	+	+	
Calocalanus plumulosus Claus					+	
Calocalanus pavoninus Farr.	+		+			
Calocalanus plumatus Shmel.		+		+		
Calocalanus(tenuis?) Farr.			+			
Microcalanus pusillus Sars						N
Ctenocalanus vanus Giesbr					+	+
Aetideus armatus Boeck						N
Euchaeta marina Prestandrea						N
Phaenna spinifera Claus					+	
Scolecithrix danae Lubb		+				
Temora stylifera Dana				+		
Metridia lucens Boeck						N
Pleuromamma abdominalis Lubb				+		
Pleuromamma gracilis Claus				+		+
Pleuromamma sp.		+				
Centropages typicus Kroyri				+		+
Lucicutia flavicornis Claus			+			
Lucicutia gemina Farr				+		
Euterpina acutifrons Claus	+	+	+	+		
Candacia athiopica Dana		+				
Micsetelia gracilis Dana	+	+	+	+		+
Macrocetelia gracilis Dana		+				
Paroithona parvula Farr.					+	
Oithona sp.		+	+			+
Oncaea obscura Farr.						N
Oncaea minuta Gieshr.	+	+	+	+		+
Oncaea dentipes Giesbr.	+	+	+	+		+
Oncaea similis Sars		+	+	+		
Oncaea media Giesbr.		+				
Oncaea subtilis Giesbr.		+				
Oncaea curva Sars		+				
Oncaea conifera Giesbr.	+		+	+	+	
Oncaea mediterranea Claus	+		+	+	+	
Oncaea subtilis Giesbr.					+	

Oncaea venusta Philippi					+	
Corycaeus furcifer Claus	+	+	+		+	
Corycaeus latus Dana		+		+		
Corycaeus typicus Kroger	+		+	+		
Corycaeus flaccus Giesbr.	+		+			
Corycaeus clausi F. Dahl	+		+			
Corycaeus limbatus Brady				+		
Corycaeus sp.	+		+	+		
Corycella gracilis Dana		+				
Corycella rostrata Claus				+		
Corycella sp.	+		+			
59 species						

Recently also 46 species of Mediterranean and Marmara Sea Copepoda were found in the southern Black Sea (Zagorognya et al, 1999, Tarkan et al., 2005). But all of these species may be considered as regular migrants arrived with Mediterranean water mass.

In July 2009 the compass jellyfish *Chrysaora hysoscella* was first recorded in pre-Bosporus area (Öztürk,Topaloglu, 2009). In 2000 it was recorded in the Sea of Marmara (Inanmaz et al., 2003) and now this stinging species penetrated also into the Black Sea (Table 5, 6, upon request). This species has not been threatened until recently. But since the beginning of 2000 it began to increase area of distribution. This species is planktophagous, consume a range of planktonic animals (http://www.nhm.ac.uk/nbn).

In the northeastern Black Sea off Gelendzhik three species of Mediterranean Copepoda were recorded: *Euchaeta marina, Rhyncalanus nasutus, Pleuromamma gracilis* and one species Ostracoda: *Philomedos globosa* (pers. com. Musaeva E.I.). *Euchaeta marina* and *Pleuromamma gracilis* have already been found off Bosporus (Kovalev et al.,1998), two others were recorded for the first time. The most probably they were brought with ballast waters and did not established because they were not found in following years.
In the coastal waters off the Crimea, the numbers of the non-native planktonic species observed keep increasing, all of Mediterranean origin. To date, it is not clear whether all will be capable of establishment. Among them, one finds the harpacticoids *Amphiascus tenuiremis*, *A. parvus*, *Leptomesochra tenuicornis*, *Idyella palliduta*, *Ameiropsis reducta*, and *Proameira simplex*, the planktonic copepods *Oithona brevicornis, O. plumifera*, *O. setigera*, *Clausocalanus arcuicornis*, and *Scolecetrix* sp., species of the fam. Clausidiidae were found off Crimea, *Rhincalanus* sp. and *Oncaea minuta* – in the area of Smeinyi Island. Some species were represented by few specimens or single individuals (Zagorodnya & Kolesnikova, 2003). But we can not yet consider them as established species, although some of them were rather abundant.

But the species of Copepoda *Oithona brevicornis,* in 2005- 2006 developed in a very high abundance (in autumn 42667 ind.m^{-3} in central part of Sevastopol Bay. Since the middle of September until the end of 2006 O. *brevicornis* comprised from 70% to 96-97% of total mesozooplankton. Most probable this species is establishing now in the Black Sea (Altukhov, Gubanova, 2006; Gubanova, Altukhov, 2007). *O. brevicornis* was recorded also off Novorossiisk, Tuapse (Seliphonova, 2009). *O. brevicornis* might be brought from the Mediterranean or the Adriatic Sea or from the north Atlantic Ocean.

In May-June 2001 during cruise R/V Knorr 33 Mediterranean species of Copepoda were recorded in the western Black Sea. All of them were found in the Black Sea water with low salinity, but they were in good conditions (Seliphonova et al., 2008).

Thus now there are more and more Mediterranean subtropical species of mesozooplankton recorded in the Black Sea outside the Bosporus area which most probably were brought with ballast waters, but now we may consider only *Oithona brevicornis* as established species (Table 5).

Benthos.
Via Bosporus penetrate many larvae of benthic animals. Some of them may find substratum and settle. If density of individuals is high they may create self-reproducing population.

Among representative of benthic species, which penetrated from the Mediterranean and now live in the near Bosporus area there are representatives Gastropoda. According to their origin they may be subdivided: five Mediterranean (*Scissurella laevigata, Proneritula westerlundi, Alvania cimex, Doto paulinae, Calmella cavolinii*), eleven – Mediterranean-boreal (*Diodora graeca, Calliostoma granulatum, Aporrhais parpelicani, Turritella communis, Lunatia fusca, Trophonopsis muricata, Tritonalia erinacea, Tritia incrassata, Cylichnina cilindracea, Philine quadripartita, Leiostraca glabra*), two - Mediterranean - Lusitanian (*Payraudeutia intricata, Mitrella scripta*) (Chukhchin, 1984).

Area of distribution twenty two species of Mediterranean Bivalvia is limited off Bosporus. Among Anisopoda also two species *Leptochelia mergellinae* Smith and *Pontotanais borceai* Bacescu occur off Bosporus (Makkaveeva, 1979)

Thirty Mediterranean species of Polychaeta were recorded off Bosporus area. Among them even in 1960s two species Polychaeta *Sternaspis scutata* , *Ophiothrix tragilis* were found. In addition among Mediterranean species, which occur in near Bosporus area of the Black Sea: three species Ophiuroidea, one species Echinoidea, one species Asteroidea, one species Scaphopoda, eleven species Ostracoda, eight species Echinodermata (Kiseleva, 1979).
The numbers of Mediterranean species off Bosporus area keep increasing.

During the last decades some species, which occurred earlier only off Bosporus area began penetrating into other areas of the Black Sea. Three species of Amphipoda (*Synchelidium maculatum, Megamphopus cornutus, Monoculodes gibbisus)* were uncounted, which occurred only in near Bosporus area than were found off western shores of Crimea and western shores of Caucuses. Cirripedia *Verruca spengleri* occurred previously also only off Bosporus was found in high abundance in the coastal area of Crimea even in 1950s (Aykubova, 1948).

Among similar species uncounted far from southern part of the Black Sea we may mention Amphipoda *Colomastix pusilla* recently found in the northwestern area of Crimea and near Kerch strait (Revkov et al., 2003). Representative of Izopoda *Gnathia bacescoi* also occurred only near Bosporus but since 1969 was recorded in the coastal area of Crimea (Zaitsev, Alexandrov, 1998). Representative Pantopoda *Anoplodactylus petiolatus*, recorded earlier off Bosporus in 1986 was uncounted in the coastal area of Crimea near Yalta at the depths 10-20 m in community *Chamelea gallina* (Sergeeva, 1992). Three species Bivalvia, found earlier only off Bosporus were recorded in a few numbers in the coastal areas Crimea. Among them *Clausinella fasciata* , *Hiatella rugosa* (Revkov et al., 2003) and *Acanthocardia tuberculata* were found in near Kerch straight (Terent'ev,1998).

In 2001 alive individuals of juveniles of one more gatropod *Neptunea arthritica* (Bernardi,1857) (Gastropoda, Buccinidae) were recorded in the Kamyshevaya Bay (Sevastopol, Crimea). Probably they were brought in an ova laying. *Neptunea arthritica* is a

Far East species, predator which can live in the brackish waters. Establishment of this species may create deteriorations in the benthic communities of the Black Sea (Shadrin et al., 2002).
In 2001 two new non-native Bivalvia species were found in the Odessa Bay: edible *Mytilus edulis* and *Mytilus trossulus* (Alexandrov, 2004). *Mytilus edulis* probably was brought with ballast waters from the Mediterranean, where it use as aquaculture off the Spain and Italy shores or from the European shores where it cultivated as well. Probably Pacific species *Mytilus trossulus* was brought with ships from the Far East Russian areas, where it is a main cultivated species (Table 5) (Suprunov, Makarov,1990).

Thus numbers of Mediterranean benthic species in the near Bosporus area are increasing more than other groups and some of these species appeared also in the north-western Black Sea. Such systemic groups as Echenodermata are represented now more and more species (Table. 5).

Especially should be mentioned species, which arrived from the Adriatic Sea (Table 7), because conditions of the north Adriatic are more close to the Black Sea. There are only few of them: *Anadara inaequivalvis* and *Crassostrea gigas.* Both of them are not native for the Adriatic Sea. *Anadara inaequivalvis* was brought to the Adriatic Sea from the coastal area of Philippine Islands. After arrival into the Black Sea *Anadara inaequivalvis* has become a natural wide spread component of the coastal biocoenoses of the Black Sea. *Crassostrea gigas* entered the Black Sea from the Adriatic, but it was brought there from the Japan Sea (Skarlato & Starobogatov, 1972) (Table 7). It is occur in a few numbers. In addition *Crassostrea gigas* has been tried to cultivate in oyster farms in the northeastern Black Sea with usage special methodology (Zolotarev, 1996).

Macrophytes
The list of macrophytes of the Black Sea published in 1975, and the list after 1975, shows 38 additions. The most significant change is the almost twofold increase in the number of *Cladophora*, *Ulva*, *Ceramium*, *Polysiphonia*, *Cystoseira* and *Sargassum*; many of them play a key role in the bottom communities of the Mediterranean (26 species) (Table 3). Most are thermophilic and indicators of the transition zone between the boreal and tropical domains (Milchakova, 2002).

The greatest number of species has probably penetrated with currents, and became established in near-shore water of the Anatolian coast. Their proportion reaches 26% of the total number of macrophytes. Among them, green Chlorophyceae, brown Fucophyceae, and red Rhodophyceae are represented by ten, five, and 12 species, respectively (Aysel, Erdugan, 1995).

Off the coasts of Rumania and Bulgaria, six new Cladophora, among other green algae were brought with ballast water but origin of them are uncertain (Bavaru et al.,1991; Milchakova, 2002).

In 1990, in Odessa Bay, the near-shore euryhaline brown *Desmarestia viridis* was found for the first time in the Black Sea. By winter 1994/1995, *D. viridis* had already become a mass species of the near-shore zone of the bay. In recent years, *D. viridis* has spread over the northwestern Black Sea (Minicheva, 2007). This species most probably was brought with shipping from north Atlantic, but it is also species which was introduced into the Mediterranean in the coastal zone of France (Minicheva & Eremenko, 1993).

Fishes

Some Mediterranean fishes perform regular feeding and/or spawning migrations to the Black Sea. This refers, first of all, to valuable large predator species: the Mediterranean–Atlantic horse mackerel *Trachurus trachurus trachurus* (Linnaeus), the Atlantic bonito *Sarda sarda* (Bloch), bluefish *Pomatomus saltatrix* (Linnaeus), the Atlantic mackerel *Scomber scombrus* (Linnaeus), and the Mediterranean mackerel *S. japonicus colias* Gmelin.

The swordfish *Xiphias gladius* Linnaeus, the blue-finned tuna *Thunnus thynnus thynnus* (Linnaeus), the Mediterranean picarel *Spicara moena*, and the European pilchard *Sardina pilchardus* used to visit and even spawn in the western and northwestern parts of the sea (Svetovidov, 1964, Gordina & Bagnyukova, 1992). In the 1970s–1980s, the abundance of migrating species significantly decreased and most of the species virtually stopped entering the Black Sea. Meanwhile, during the recent years, the conditions for fattening have enhanced owing to increase in the stock of small pelagic fishes after the *Beroe ovata* invasion and decreasing of *M.leidyi* abundance. As a result, some Mediterranean species again appeared both in the western part of the sea (the mackerels, the bonito, and the bluefish) (Abaza et al., 2006) and in its northwestern part (the horse mackerel, the bonito, the bluefish, the Mediterranean picarel *Spicara moena* (L), the European pilchard *Sardina pilchardus* (Walbaum), the green wrasse *Labrus viridis* (Linnaeus), and triplefin *Tripterygion tripteronotus* (Risso) (Boltachev, 2006). In addition, starting from 1999, their feeding area is expanded and new Mediterranean fish species appear; for example, in the near-shore waters off the Crimea, the dorado *Sparus aurata* Linnaeus, the salema *Sarpa salpa* (Linnaeus), and the thick-lipped gray mullet *Chelon (=Mugil) labrosus* (Risso) appeared and intensely reproduced (Table 8, upon request) (Boltachev, 2006).

Previously, in contrast to the gilthead bream, the thick-lipped gray mullet has never been recorded in the northwestern part of the Black Sea. For the first time, a juvenile of *Chelon labrosus* was caught in October 1981 in Donzulav Bay. In October 1983, shoals of the thick-lipped gray mullet consisting of 10–15 fishes were observed in the waters off Sevastopol (Salekhova, 1987). Starting from 1999, the thick-lipped gray mullet has been repeatedly found in the areas off Sevastopol. A specimen of the salema off the Crimea was first noted in 1999 (Boltachev, 2006). At present, its abundance in this region is rapidly increasing.
The dorado can be often recorded as single specimens or minor shoals in Balaklava Bay and adjacent near-shore waters. Probably, the dorado and the salema may stay for overwintering now in the coastal waters off the Crimea (Boltachev, 2006).

The Mediterranean umbrine *Umbrina cirrosa* was once found in the Black Sea biospheric reserve in 1962 (Tkachenko, 1994). In summer 1999, one female with eggs was caught again in Pshada Bay (Pashkov, 2005).

All the above-listed species are not more than seasonal Mediterranean migrants rather than invaders into the Black Sea. Among the non-native species, three species of fishes previously not encountered in the Black Sea were found in the coastal waters of the Crimea. They include two specimens of the barracuda *Sphyraena pinguis* were caught with a bottom trawl in Balaklava Bay in August 1999. This is an Indian–Pacific species, which penetrated as a Lessepsian migrant via the Suez Canal to the eastern Mediterranean including the Aegean Sea in 1931 and ultimately reaching the Black Sea. This species is increasing area of distribution in the Mediterranean and became commercial species (Boltachev, 2009). According to first observation of Boltachev two caught individuals were identified as *Sphyraena obtusata* as well, but after very detailed analyses they were determined as *S. pinguis* (Boltachev, 2009). Another Indian–Pacific species *Sphyraena obtusata* is also Lessepsian migrant, penetrated into the Mediterranean recently only in 1992 (Table 9, upon request). This species is not

abundant, occurs rare in the Mediterranean. A few individuals were found off Bosporus area (Ozturk, 2006).

A specimen of the northern blue whiting *Micromecisthis poutassou* 15.7 cm long was caught in January 1999 over a sea depth of 60 m off Balaklava (Crimea). It is a typical Atlantic–boreal species widely spread in the Mediterranean basin including the Aegean Sea and the Sea of Marmara; most probably, it penetrated from the Mediterranean Sea. Blue whiting performs long-lasting migrations; it is known as a stenohaline eurythermal species dwelling at salinities no less than 33‰, but was first encountered at a salinity of 18‰. There are two ways of explanation of the appearance of the above two species in the Black Sea: fishes might migrate from the Sea of Marmara or the Mediterranean Sea or, which seems more probable, might be brought with ballast waters.

The third species is the coral-dwelling butterfly fish *Heniochus acuminatus*. A specimen 76 mm long was caught by a net in Balaklava Bay in October 2003. It is a typical tropical Indian–Pacific species and the conditions of Balaklava Bay are hardly favorable for it. This fish was most probably delivered with ballast waters (Boltachev, 2006).

During the recent years, in the waters off Rumania, centracant *Centracanthus cirrus,* which probably also penetrated from the Mediterranean Sea, was observed. To date, it has significantly increased its abundance and now represents a commercial fish in the littoral zone of Rumania (Abaza et al., 2006) and off Turkish coast (Ozturk, 2006). In the central part of the sea, its developing eggs were first found in June 1982 (Tzokur, 1988).

The golden goby *Gobius auratus* Risso, which was first found in the communities of near-shore macrophytes off the Crimea and in the 2000-s was found in the northeastern part of the sea may also be referred to Mediterranean invaders (Nadolinsky, 2004). Two more Mediterranean species of Gobiidae *G.cruentatus* and G. xanthocephalus were recorded recently off Crimea and Turkish area (Boltachev,2006; Ozturk,2006).

Another indo-Pacific Gobiidae *Tridentiger irigonocephalus* was recorded off the Crimea and Turkish areas (Boltachev, 2009). Representative of Gobiidae are small near bottom species therefore they could be brought most probably with ballast waters, particularly in the case of *Tridentiger irigonocephalus.*

One more indo-Pacific species was recorded in the Turkish area of the Black Sea: half-smooth golden pufferfish *Lagocephalus spadiceus* in 2008 (Tuncer et al, 2008).

In addition during last yeas Mediterranean species *Parablennius incognitus* became common in Turkish area and appeared off Crimea (Ozturk, 2006; Boltachev, 2009, this volume). Among other species *Syngnathus acus L.* was recently found off Crimea (Boltachev, 2009, this volume). Its origin is not clear. Probably it was brought from the northern Atlantic Ocean with ballast waters.

Discussion.

Thus during second part of XX century the Black Sea became the main recipient area for non-native temperate and warm water marine and brackish water species, which arrived from different donor areas. Most of euryhaline and euryterm species of Atlantic origin became abundant, often created large populations. In their turn most of these established species affected all other seas of the Mediterranean basin and the Caspian Sea as a donor area (Shiganova and Dumont, 2009).

Since the end of 1980 with the beginning of warm period more and more warm water species of different origin have established in the Black Sea.

During last decades a new trend has appeared. The Mediterranean species which have always penetrated into the Black Sea with Low Bosporus current and could live only off Bosporus area began to disperse with the currents and released with ballast waters in other areas of the Black Sea. Earlier they could not establish due to low temperature, particularly in winter but now with increasing temperature the share of these non-native species of a Mediterranean origin is gradually increasing over the recent years meanwhile and some of these species have already established.

These organisms driven with currents and ballast waters represent phyto- and zooplankton, macrophytes, benthic or demersal organisms, and fishes. These species as a rule have subtropical and in some cases even tropical origin (Tables 1-9). None of them became a mass species; their greater number still occur only in the near-Bosporus and southern parts of the Black Sea where salinity is higher. Selected species penetrated to the near-shore regions off Bulgaria, Rumania, and the Crimea also with currents, in the course of their migration, or with ship ballast waters (Tables 10, 11, 12, upon request).

New event for the Black Sea became appearance of species of Indo-Pacific origin (Table 10). Some of them are Lessepsian migrants, which arrived to the Mediterranean than expanded from the Mediterranean Sea to the Black Sea; others were brought with ballast waters.

Shift from fish to gelatinous plankton.

The most pronounced events were arrival of two warm water ctenophores: *Mnemiopsis leidyi* and *Beroe ovata* into the Black Sea. First one affected all trophic web of ecosystem and became the main drivers of the Black Sea ecosystem functioning. The stocks of most of commercial fish greatly dropped (Shiganova et al., 2003; 2004). While the other one considerably recovered ecosystem for rather short period. *Mnemiopsis leidyi* spread from the Black Sea to the Sea of Marmara, the Aegean Sea with the Black Sea currents and in some areas of Mediterranean with ballast waters (Shiganova et al., 2001, Shiganova, Maley, 2009, Galil et al., 2009; Boero et al. 2009; Fuentes et al. 2009).

During last years new tendency appeared – arrival gelatinous species from Mediterranean. Recently several Mediterranean jellyfishes penetrated first to the Sea of Marmara. Among them jellyfishes *Chrysaora hysoscella*, *Cassiopea andromeda*, Trachimedusa *Liriope tetraphylla.* In 2009 *Chrysaora hysoscella* was recorded for the first time in the Istanbul Strait and Turkish part of the Black Sea (Öztürk and Topaloglu, 2009). This is temperate planktivorous species and therefore we can not exclude that a new species *Chrysaora hysoscella* will establish in the Black Sea in favorable prey conditions of crustacean zooplankton if salinity will be tolerant for it. In 2007, the ctenophore *Bolinopsis vitrea* (L. Agassiz 1860) was also recorded in the Turkish part of the Black Sea (Ozturk & Shiganova in press).

Northward extension, increase abundance and change phenology.

First of all significant range northward extensions have been recorded for the Mediterranean fishes, seasonal migrants in the Black Sea. Most of them were recorded earlier in the Black Sea as seasonal migrants but now they extended area of distribution in the Black Sea. Some of them have changed phenology: they used to spend short period of warm seasons in the Black Sea for spawning/ and feeding but now some of them stay longer in the Black Sea, intensively

reproduce and even most probably stay for overwintering, what were not observed earlier (the dorado *Sparus aurata*, the salema *Sarpa salpa*).
Arrival and establish of the Mediterranean species.

We may consider that nine Mediterranean species of fish were most probably established during last years in the Black Sea (Table 8). But we still can not consider most of phytoplankton and zooplankton species as established, which were recorded both in the southern and northwestern areas of the Black Sea. The main reasons are low salinity and cold winters. Among Copepoda only temperate *Oithona brevicornis* could established. Among phytoplankton 11 species have established. There were mainly representative of Dinophyceae, which develop in spring and summer and most of them capable to produce cysts in unfavorable conditions. *Gymnodinium sanguineum* belongs to the species, which lives also in upwelling therefore tolerant to low temperatures (Table 3).

The most of benthic species and macrophytes may be considered as established species as in the southern Black Sea so in the other parts.

Thus there is a progressing trend of arrival of Mediterranean species into the Black Sea both with the currents as natural expansion and with ballast waters. Most of these species arrived in previous years as well but relatively low temperature and low salinity prevented their establishment. Now with rising temperature some species could establish. First of all benthic species that inhabit at the depths where salinity is higher, especially in the southern part of the Black Sea. Due to intensification of shipping, particularly between Mediterranean and Black sea countries (62% of vessels arrived in Novorossiysk harbor from the Mediterranean countries (Matishev et al., 2005) numbers of species released with ballast waters also increased. Some of these species began to establish in the near ports areas.

Total numbers of Mediterranean species found only in the southern Black Sea comprised 240 species (Table 10). At present time it is difficult to determine exactly how many of them might be included in the list of establish species. We can consider as established among them 23 species of macrophytes. Zoobenthic species, which are most probably, would be established as well in future, we have not included in the list of established species. Numbers of species found in the northwestern and western Black Sea comprised 84 species. Among them we have included 33 species as established: 10 species of zoobenthos, 11 species of phytoplankton, 3 species of microplankton (fam. Tintinnidae) and 9 fish (Table 10-12). This process ongoing and probably we have not taken into account some species which were recorded recently and locally.

In the Black Sea total established non-native species (without all near Bosporus Mediterranean species) from all areas comprised of 4, 1% of native biota (Fig.1). Established Mediterranean species with near Bosporus benthic species comprise 3, 1% of total biota.

In the Mediterranean Sea, numbers of established non-native species (745 valid species or 963 in total) (Zenetos et al., 2005) comprise 6,2%, of native biota (about 12,000 species) , the numbers of Lessepsian migrants comprise 3,2%. Therefore process expansion of tropical species into Mediterranean Sea almost equal to process of expansion of Mediterranean species into the Black Sea.

If we compare the Black Sea biodiversity with Mediterranean one, it decreases in about 3, 5 times. The numbers of establishes non-native species decrease in the same proportion in about 3,5 times for these seas. So, the basin is capable to accept the numbers of non-native species in proportion equal natural biodiversity (Shiganova and Dumont, 2010).

The most eurihaline and euryterm non-native species from other areas spread or were brought with ballast waters from the Black Sea into the Sea of Azov and the Caspian Sea where they could established. None of the Mediterranean species spread from the Black Sea farther to these seas. The only exception is 3 species of fam. Tintinnidae, which were found in the Sea of Azov. The reason is a low salinity of these seas (low than 15‰, the boundary of mesohaline water, which is important for biota).

Not all non-native Mediterranean species are harmful for the Black Sea ecosystem with exception gelatinous species. The rising of the numbers of species, abundances and areas of distribution of gelatinous plankton both native and invaders are the most dramatic events for Mediterranean, Sea of Marmara and the Black Sea. Expansion of gelatinous species from the Mediterranean to the Sea of Marmara and after that farther to the Black Sea is particular threat for their ecosystems. Continuation of expansion of aggressive the Black Sea invader *Mnemiopsis leidyi* in different areas of the Mediterranean Sea is also give particular concern.

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Annex VI: Proposed new indicators from the Black Sea

In MSFD (ANNEX III) the important biological features of different communities are identified as follow: species composition, biomass and annual/seasonal variability. These classical indices, used in the BSIS as well, reflect the dynamics of community structure parameters. However, the main role of indicators of the marine environment is to reflect the quality of the environment based on the state of the object monitored. Besides, the quality of marine environment is directly related with the functioning of biological communities and indirectly with their structure. Therefore, it is recommendable to pay attention at functional parameters of biological communities as well, not only structural.

1. Macroalgae communities

Under the Water Framework Directive 2000/60 EU implementation in Greece, the monitoring of macroalgae is based on the concept of morphological and functional algal groups available in the sea. The species are divided into two Ecological State Groups (ESG). In the ESG I the thick leathery, the articulate upright calcareous and the crustose calcareous species are grouped. Most of them are k-selected species. In the ESG II the foliose, the filamentous and the coarsely branched upright species are grouped. Most of them are r-selected species (Orfanidis & al., 2001). This is an interesting and sensible approach as in this case, during monitoring of benthic macroalgae and angiosperms, it is easy to consider the algal morphological parameters which are related to the functioning of aquatic vegetation and correspondingly with water quality.

Black Sea S/Wp and S/Wcom indicators (Minicheva, Zotov et al. 2003) – methodology of calculation can be provided upon request.
In the Black Sea specific morpho-functional indicators are used to identify the status of benthic communities and correspondingly water quality.

Macrophytobenthos morpho-functional indexes

Organization levels	Specific surface indexes	Surface indexes
Structure elements	*Specific surface of the structure elements* $(S/W)_{se}$	-
Thallus (single plant)	Specific surface of the thallus $(S/W)_{t}$	-
Population	Specific surface of the population $(S/W)_{p}$	Population surface index SI_{p}
Community	Specific surface of the community $(S/W)_{cm}$	Community surface index SI_{cm}
Floristic grouping of the region	Specific surface of the floristic grouping $(S/W)_{fg}$	Phytobentos surface index SI_{phb}

Taxonomic section	Specific surface of the taxonomic section $(S/W)_{ts}$	Taxonomic section surface index SI_{ts}

They are based on the parameters of the aquatic vegetation surface, elaborated within the morpho-functional ecology (Minicheva, 1998), and have greater advantage in monitoring of water quality in cmparison with the approach used in Greece (functional groups, k-selected and r-selected species). The coefficients of specific surface for certain populations (S/Wp) and communities (S/Wcom) of macroalgae which reflect their ecological activity are easy to estimate using the methods developed (Minicheva, Zotov et al. 2003, Guideline available in the archive of the BSC). In clean oligotrophic ecosystems large perennial macroalgal forms with a small specific surface of thallus develop. Dominating communities in these conditions are species with S/Wp not exceeding 10-15 m^2 kg^{-1}. During intensive production processes in the ecosystem and a rise in the eutrophic level, a change in the vegetative structure occurs. Small, short-cycle, rarely branched species with high S/Wp coefficients exceeding 50-100 m^2 kg^{-1} begin to prevail in the phytocoenoses. Correspondingly, the ecological activity of aquatic communities S/Wcom increases. The use of these indices in monitoring together with classical indices forseen in MSFD gives unbiased information on the state of marine coastal ecosystems and water quality (Fig.).

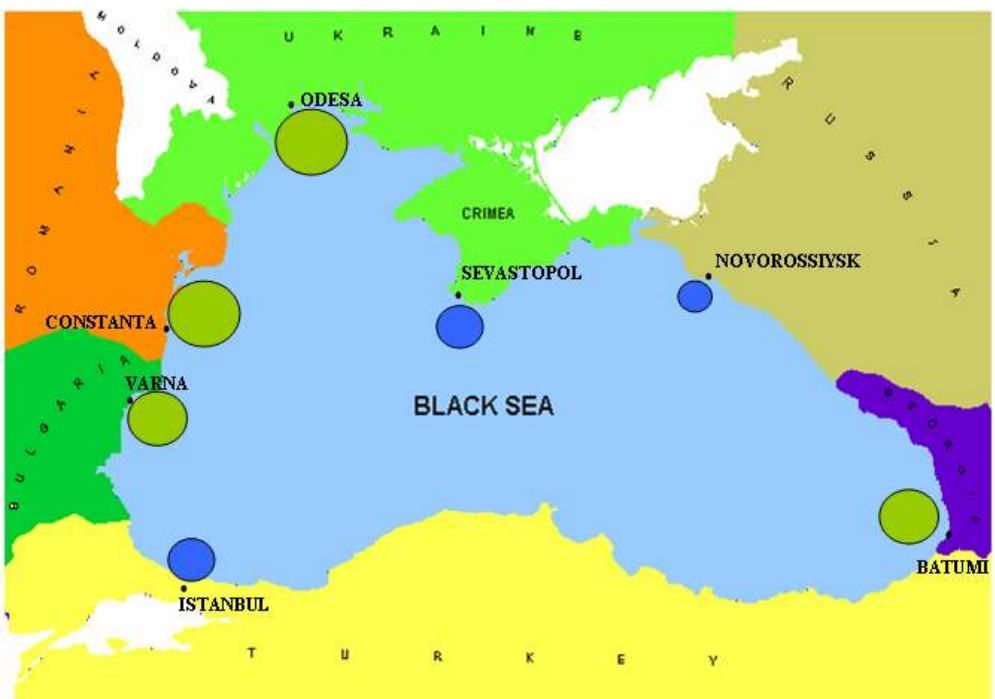

Fig.xxx. Trophic status of Black Sea coastal waters assessed on the basis of morphofunctional parameters of macroalgae (green – eutrophic; blue-mesotrophic).

Recommendations:

- The indices of specific surfaces of algal populations (S/Wp) and communities (S/Wcom) should be included in assessments of GES.
- Data reporting Format and a relevant regional monitoring system for primary production communities (macroalgae, microalgae, angiosperms) should be accordingly developed and agreed.

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2. Fishery – Indicator 'Fatness of sprat" (G. Shulman, 2009)

The level of fat reserves that fish accumulate to the end of their feeding period is an integrated indicator of their food supply (Shulman, 1974). The degree of fat content in mass fish species (as sprat *Sprattus sprattus phalericus* is in the Black Sea) can serve also as an indicator of ecosystem condition (Shulman, Love, 1999). Therefore, estimating the quantity of the fat accumulated by sprat during its feeding period, it is possible to characterize not only the present state of this species but also the condition of the Black Sea pelagic ecosystem as a whole. Moreover, the results of monitoring of the fat contents in Black Sea sprat that is carried out more than 40 years, allow to interpret the long-term dynamics of this indicator in connection to environmental changes (Shulman et al., 1994, 2005). The indicator of fat content (FCI) in sprat can be used also to the forecasting its stock conditions and school formations (Minyuk et al., 1997).

Method – calculation methodology avialble, can be provided upon request

Example:

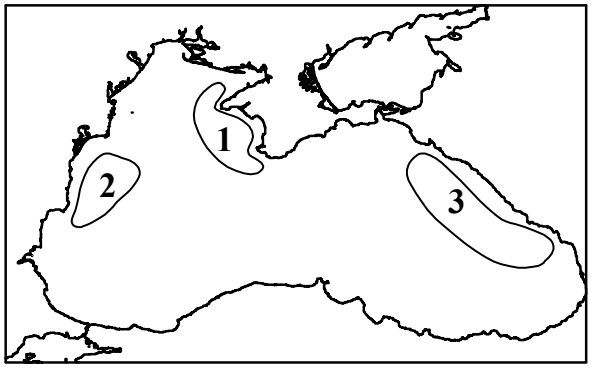

Fig. xxx. Main areas of sprat sampling locations in the Black Sea (Shulman et al., 2005). 1: North-Western part of the Black Sea (off the eastern Crimea); 2: Western part of the Sea (off Romania and Bulgaria); 3: Eastern part of the Sea (off Caucasus)

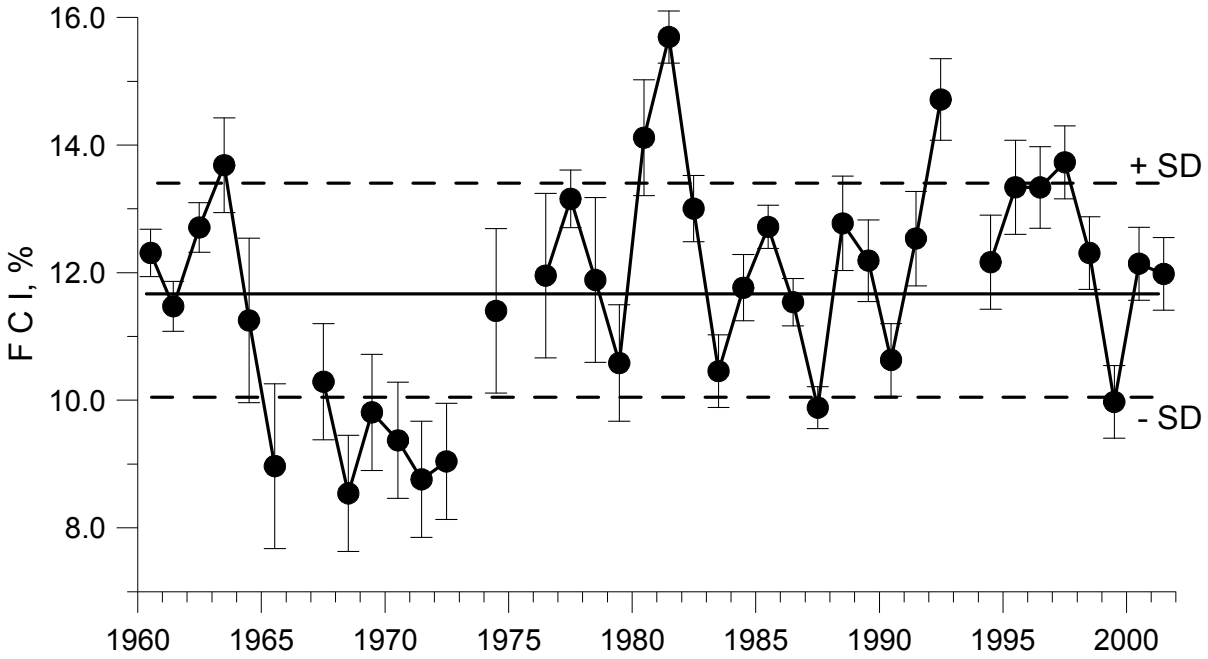

Fig. xxx. Long-term dynamics of the sprat fat content indicator (FCI) from 1960 to 2001 (after Shulman et al., 2005). Here, each data point represents average value of several observations from various locations, mainly from the area 1 (since 1994 the data only from the area 1 were accessible). Solid line shows mean long-term value of the FCI, dashed lines indicate standard deviations (± SD) of the FCI.

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Annex VII: 'Forward' Looking at MSFD (Annex I)

The Annex provides information on the availability of BS data for assessments envisaged in the MSFD, complimenting Table 13.

Descriptor 1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

Progress towards GES for this descriptor must address four ecological levels: ecosystem, landscape, habitat/community and species. For assessment at the levels of habitat/community and species, it is not required to use all criteria for each species and habitat/community type to be assessed. To support a holistic and adaptive management of human activities based on the ecosystem approach, a risk-based selection is to be applied, to ensure that the assessment and monitoring required is effective and efficient.

At species level

Taking into account Annex III, a set of relevant species types are to be drawn up for each region/sub-region. Sub-species and populations are to be assessed separately where the initial assessment identifies them as being at risk of not meeting targets for GES.

MSFD	**Black Sea region**
Species distribution: *Distributional range (1.1), distributional pattern (1.2) and area covered by the species (for sessile/attached species) (1.3)*	Data available, mostly outside of BSIS. Maps of selected commercial species distribution are available in BSIS.
Population size: *Population biomass (1.4) and Population abundance (1.5)*	Data available, mostly outside of BSIS
Population condition: *Population demography (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates) (1.6), population genetic structure (1.7), population health (1.8.), inter and intra-specific relationships (1.9)*	Data available, not reported to BSIS
Habitat distribution, extent and condition: *Habitat distributional range (1.10), Habitat distributional pattern (1.11), Habitat extent (1.12). The habitat condition relates to the*	Data available, not reported to BSIS

physical, hydrological and chemical conditions (1.13).	

At habitats/communities level

This level ensures the organisation of complex associations of species (in benthic and plankton communities) into more manageable units. As a general rule, the habitat and its associated community are to be treated together. Taking into account Annex III, a set of relevant habitat types are to be drawn up for each region/sub-region.

MSFD	**Black Sea region**
Habitat distribution: *Distributional range (1.14) and distributional pattern (1.15)*	Data available, not reported to BSIS. Mapping of habitats needs advancement.
Habitat extent: *Areal extent of habitat (area covered) (1.16) and habitat volume (1.17)*	Data available, not reported to BSIS.
Habitat condition: The habitat condition relates to the *physical (structure and associated physical characteristics, including structuring species), hydrological and chemical conditions (1.18)*	Data available, not reported to BSIS
Community condition: *species composition (1.19), relative abundance (1.20) and community biomass (1.21) functional traits (1.22)*	Data avialble, mostly outside of BSIS

Landscape level

Certain criteria are also relevant for assessment at landscape level wherever this is required, taken into account that a number of marine landscape features are listed for protection as 'habitats' in the Habitats Directive and certain Conventions. The condition of the habitats and species in the landscape may change. For species, especially those which are mobile (associated with multiple habitats) and of functional importance (e.g. pelagic-benthic coupling, structuring) are to be considered in particular.

MSFD	**Black Sea region**
Landscape distribution and extent: *Distributional range and areal extent (1.23)*	Data available, not reported to BSIS
Landscape structure: *Habitat composition,*	Data available, not reported to BSIS

cover and relative proportions (1.24)	
Landscape condition: As for habitat condition and community condition, as appropriate (1.25)	Data available, not reported to BSIS

Ecosystem level

Assessment at the level of species, habitat/community and landscape state provide the basis for assessment at the level of the ecosystem, in particular the ecosystem structure and ecosystem processes and functions. The regions and sub-regions, or appropriate subdivisions, provide suitable scales for this assessment. Certain aspects of ecosystem functioning and processes are provided by other descriptors (such as 4 and 6).

MSFD	**Black Sea region**
Ecosystem structure: *Composition and relative proportions of ecosystem components (habitats and species) (1.26)*	Data available, mostly outside of BSIS
Ecosystem processes and functions: *Interactions between the structural components of the ecosystem (1.27).*	Assessments can be provided (derived from data mostly outside of BSIS)

Descriptor 2: Non-indigenous species introduced by human activities are at levels that not adversely alter the ecosystem.

The identification of pathways and vectors is a prerequisite to effectively avoid that non indigenous species introduced as a result of human activities reach levels that adversely affect the ecosystems and to mitigate the impacts. This needs to be done in the initial assessment (Annex II, Table 2), bearing in mind that the presence of some non indigenous species may be the result of the introduction through human activities which are subject to regulation to assess and minimise their possible impact on aquatic ecosystems. This identification has also to be addressed in the establishment of environmental targets (Article 10), as the basis for management action in the programme of measures (Article 13). The appraisal of existing vectors also contributes to identifying important areas for prioritised monitoring.

Abundance and spreading of non-indigenous species, in particular invasive species

MSFD	**Black Sea region**
Abundance and distribution in the wild of non-indigenous species and, in particular, invasive non indigenous species (2.1).	Data avialble, mostly outside of BSIS
Spreading of non- indigenous species including, where appropriate and feasible, maps of colonies distinguishing as a result of primary introduction and secondary spread (2.2).	Data available, not reported to BSIS

Environmental impact of non-indigenous species

MSFD	**Black Sea region**
Ratio between non-indigenous species and native species in some well studied taxonomic groups, e.g. fish, macroalgae, molluscs (2.3)	Not considered.
Magnitude of the impacts of non-indigenous species, in particular invasive species, on native communities, habitats and ecosystem (2.4). If sufficient information is available, where appropriately developed, *the Biopollution Level (BPL) index (2.5)* can be used to assess the environmental impact.	Data available, not reported to BSIS. BPL index not considered.

Descriptor 3
Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

Level of pressure of the fishing activity
The primary indicator for this criterion is *Fishing mortality (F)(3.1).* Achieving good environmental status requires that F values are equal to or lower than the level capable of producing Maximum Sustainable Yield (MSY) over the long term (F_{MSY}).

F is estimated from appropriate analytical assessments based on the analysis of catch (to be taken as all removals from the stock, including discards and unaccounted catch) at age or at length and ancillary information. As regards the estimation of F_{MSY}, simulation models should ideally be used to give the values of F that, with a high probability, would maximize the yield over a long period of time without undermining the stock structure and hence future yields under similar exploitation strategies. Where the knowledge of the population dynamics of the stock do not allow to carry out simulations, scientific judgement of F values associated to the yield-per-recruit curve (Y/R), combined with other information on the historical performance of the fishery or on the population dynamics of similar stocks, may indicate which values satisfy the MSY criterion.

MSFD	**Black Sea region**
Fishing mortality (F)(3.1).	Data avialble, see Annex IV of this report

Secondary indicators: If analytical assessments yielding values for F are not available, then a possible secondary indicator is the *ratio between catch and a biomass index (hereinafter catch/biomass ratio) (3.2),* where the biomass index is ideally taken from sources independent from the commercial fishing activity (e.g. catch rates from bottom trawl surveys, biomass estimates from acoustic surveys, biomass estimates from egg-surveys).

The value for the indicator that reflects MSY (Maximum Sustainable Yield) is to be determined by scientific judgement following analysis of the observed historical trends of the indicator combined with other information on the historical performance of the fishery. Where stock production-based assessments are available, the catch/biomass ratio yielding Maximum Sustainable Yield (F_{MSY}) can be taken as indicative reference. Any observed value for catch/biomass ratio equal to or lower than the level reflecting MSY is considered to meet this criterion.

Alternatively to the catch/biomass ratio, secondary indicators may be developed on the basis of any other appropriate proxy for fishing mortality, adequately justified.

MSFD	**Black Sea region**
Ratio between catch and a biomass index	Data avialble, see Annex IV of this report

Reproductive capacity of the stock

The primary indicator is the *Spawning Stock Biomass (SSB)(3.3)*. SSB is estimated from appropriate analytical assessments based on the analysis of catch at age or at length and ancillary information.

Where an analytical assessment allows the estimation of SSB, the reference value reflecting full reproductive capacity is SSB_{MSY}, i.e., the spawning stock biomass that would achieve MSY under a fishing mortality equal to F_{MSY}. Any observed SSB values equal to or greater than SSB_{MSY} is considered to meet this criterion.

Where simulation models do not allow the estimation of a reliable value for SSB_{MSY}, then the reference to be used for the purpose of this criterion is SSB_{pa}, which is the minimum SSB value for which there is a high probability that the stock is able to replenish itself under the prevailing exploitation conditions. Any observed SSB values are to be equal to or greater than $SSB_{pa.}$

MSFD	**Black Sea region**
Spawning Stock Biomass	Data avialble, see Annex IV of this report

Secondary indicators: If analytical assessments yielding values for SSB are not available, then the *biomass indices taken from independent sources (see above)(3.4)* can be used if these indices can be obtained for the fraction of the population that is sexually mature. Where, in absence of analytical assessments, abundance indices are chosen as indicator, then the abundance indices observed must be used when scientific judgement is able to determine, through detailed analysis of the historical trends of the indicator combined with other information on the historical performance of the fishery, that there is a high probability that the stock will be able to replenish itself under the prevailing exploitation conditions.

Population age and size distribution.
The main attribute is the relative abundance of older fish, expressed by indicators such as:

MSFD	**Black Sea region**
The proportion of fish larger than a given length, e.g. the length at which 100% of the females are mature (3.5)	Not reported to BSIS, needs further investigation. Most probably available for commercial species.
The mean maximum length across all species found in research vessel surveys (3.6)	Not reported to BSIS, needs further investigation. Most probably available for commercial species.
The 95% percentile of the fish length distribution observed in research vessel surveys (3.7)	Not reported to BSIS, needs further investigation. Most probably available for commercial species.
Any other indicator reflecting numerically the relative abundance of old, large fish (3.8)	Not reported to BSIS, needs further investigation. Most probably available for commercial species.

Secondary indicator: *Size at full sexual maturation (3.9),* which may reflect the extent of undesirable genetic effects of exploitation.

For the two sets of indicators (proportion of old fish and size at first sexual maturity), expert judgement is required for determining whether there is a high probability that the intrinsic genetic diversity of the stock will not be undermined. The expert judgement is to be made following an analysis of the time series available for the indicator, together with any other information on the biology of the species at stake.

Given that the indicator "mean maximum length across all species" already incorporates information of a large set of fish and shellfish stocks, this criterion applies to the fish community rather than to individual stocks.

MSFD	**Black Sea region**
Size at full sexual maturation (3.9)	Not reported to BSIS, needs further investigation. Most probably available for commercial species.

***Descriptor 4* - All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.**

The species composition of food webs varies according to habitat and region, but the principles of energy transfer from sunlight and plants through successive trophic levels are the same. The criteria integrate across a range of ecosystem properties and address the functional aspects of marine food webs, and need to be applied and developed further at appropriate region-specific scale. Criteria are proposed in relation to two major attributes.

Energy flows in food webs

Ratio of production or biomass between different trophic levels

Indicators aim at measuring the degree of energy flow between different trophic levels. Ratios between primary production and top level predators are to be analyzed and controlled in order to test the efficiency of energy transfer through the food-web and whether the long term viability of all components is secured.

Depending on data availability, appropriate specific ratios are to be further developed, relating primary production to demersal exploited fish biomass and to macrobenthos invertebrate biomass.

MSFD	**Black Sea region**
Ratio of pelagic to demersal fish biomass and/or production(4.1)	Data available
Ratio of macrobenthos invertebrate to demersal fish production or biomass (4.2)	Not considered

Productivity (production per unit biomass) of key species or groups

Predator performance reflects long-term viability of components. Adequate indicators are to be developed further to assess the *performance of key predator species using their production per unit biomass (productivity),* to summarise the main predator-prey processes in the part of the food web that they inhabit, using the experience in some sub-regions (e.g. North Sea) in selecting appropriate species (e.g. mammals, seabirds) *(4.3).*

If sufficient information is available, where appropriately developed, indicators such as the Marine Trophic Index can address the *trophic relationships within the food web (4.4)*. The diet composition of a species or group of species describes the relative abundance of prey in a food web and can be diagnostic of food web changes.

MSFD	Black Sea region
Production per unit biomass	Data available, not reported to BSIS
Marine Trophic Index	Can be derived

Structure of food webs (size and abundance)

Proportion of selected species at the top of food webs

The rate of change in abundance of functionally important species will highlight important changes in food web structure. Indicators are to be developed for *large fish (by weight) (4.5),* using the experience in some sub-regions (e.g. North Sea). For large fish, data can be used from fish monitoring surveys, on an annual basis, at the scale of a regional or subregional sea.

MSFD	**Black Sea region**
L*arge fish (by weight) (4.5)*	Not considered

Abundance/distribution of key groups/species

Indicators describe *abundance trends (4.6)* to identify changes in population status potentially affecting food web status. Assessments are required at regular intervals, taking account of seasonal changes. Indicators are to be further developed at an appropriate scale, taking account of their importance to local and regional food webs. Particularly suitable groups/species in a region or sub-region include:

(i) biological groups with fast turnover rates (e.g. phytoplankton, zooplankton, jellyfish, short-living pelagic fish, bacteria) that will respond quickly to ecosystem change and are useful as early warning indicators;
(ii) groups/species that are targeted by human activities;
(iii) habitat-defining groups/species (e.g. benthic fauna);
(iv) groups/species at the top of the food web (which may accumulate harmful substances or respond to cascading effects from ecosystem changes);
(v) groups/species that are tightly linked to other groups/species at another trophic level.

MSFD	**Black Sea region**
Abundance trends (4.6)	Data available for all gropus/species listed in (i) to (v), mostly outside of BSIS

Descriptor 5: Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters

Based on the Initial Assessment, a risk-based approach, incorporating the assessment for coastal and transitional waters under the Water Framework Directive (2000/60, annex V, 1.2.3 and 1.2.4), is to be followed to assess if eutrophication may hinder the achievement of GES. The first step is to analyse primary symptoms (5.1-5.5) and, if they indicate effects of nutrient enrichment, to add appropriate analyses of secondary symptoms (5.6-5.8). The final analysis to be made combines information on nutrient loads, analyses of a range of primary symptoms and, where ecologically relevant, of secondary symptoms.

MSFD	**Black Sea region**
Nutrient loads	Data available

Primary symptoms or directs effects of eutrophication

MSFD	**Black Sea region**
Nutrients concentration in the water column (5.1)	Data available
Deviate from normal proportion of nutrient ratios (Si:N:P) (e.g. Si is reduced in relation to other nutrients) (5.2)	Can be derived
Water transparency due to increase in suspended algae (5.3)	Data available, mostly outside of BSIS
Chlorophyll (concentration, spatial areas of high concentrations) (5.4)	Data available, mostly outside of BSIS
Increase of opportunistic macroalgae (e.g. can form blankets over the natural flora and suffocate benthic animals	Data available, mostly outside of BSIS

Secondary symptoms or indirect effects of eutrophication

MSFD	**Black Sea region**
Dissolved oxygen (5.6)	Data available
Species shift in floristic composition (e.g.	Data available, mostly outside of BSIS

diatom:flagellate ratio, benthic to pelagic shifts, indicator species, harmful algae blooms). Annual bloom events of nuisance/toxic algal blooms. Annual to multi-year changes in frequency and/or duration of blooms. Changes in balance of diatoms/flagellates/cyanobacteria (5.7)	
Decrease in perennial seaweeds and seagrasses (5.8)	Data available, mostly outside of BSIS

Descriptor 6 - Sea-floor integrity is at a level that ensures that the structure and function of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

The scale for assessing GES by this descriptor can be particular challenging because of the patchy features of some benthic ecosystems, both for natural and pressure aspects. Assessment of GES will have to integrate results from local scale, to much larger regional and sub-regional scales. Consideration is to be given also to the many differences between coastal and deeper-water benthic communities, where relevant space and time scales are greater. To deal with these, a risk-based approach to monitoring and assessment is to be followed, as mentioned in the general section.

MSFD	**Black Sea region**
Differences between coastal and deeper-water benthic communities	No deep water benthic communities

Substrate characteristics

Together with hydrodynamics, substrate is a main factor structuring benthic habitats, being a driver of patterns in diversity, function and integrity of benthic communities. Indirect indicators of functions (i.e. the benthic communities associated with the substrate) can be more practical to use in assessing GES than indicators of the substrate itself. The magnitude of impacts of human activities differs greatly between substrate types.

The complexity and properties of the physical structure of biogenic substrates, which tend to be the substrate most sensitive to physical disturbance, largely influence the associated flora and fauna. They provide three-dimensional habitat for a large variety of species. Ecological status of biogenic substrates is related to the preservation of their functions (i.e. shelter from predators, contribution to the material exchange at the sediment-water interface, energy input via photosynthesis by submerged vegetation in the photic zone). Modelling using a GIS platform can be used for mapping sea-floor integrity features, as long as the errors involved are properly assessed and acknowledged when applying the results.

MSFD	**Black Sea region**
Type, abundance, biomass and areal extent of relevant biogenic substrate (6.1)	Not reported to BSIS, availability of data needs further investigation
Extent of the seabed affected by human activities (such as dredging, trawling or other alterations which may influence the substrate) for the different substrate types (6.2)	Not reported to BSIS, availability of data needs further investigation

Benthic community composition and functional traits
Methods already in use such as measures of species diversity, productivity (abundance, biomass), tolerance or sensitive taxa and taxocene dominance measures are to be applied.

When applying any index special attention is to be given to: i) distinct biogeographic regions, ii) different water depth habitat types, iii) different substrate type.

MSFD	**Black Sea region**
Diversity and richness indices, based on species number and relative abundance in the benthic community (6.3)	Data available, mostly outside of BSIS
Presence of particularly sensitive or tolerant species (6.4)	Data available, mostly outside of BSIS
Use of indexes assessing functionality of the benthic system, such as the proportion of opportunistic to sensitive species (6.5)	Data available, mostly outside of BSIS

Size-composition of benthic community
The size composition of a community, reflected by the proportion of the community comprised of small and large individuals, integrates information about processes underlying community dynamics such as productivity, mortality rate, and life history strategies of the benthic species in the area, viewed in aggregate.

MSFD	**Black Sea region**
Proportion of number or biomass of individuals above some specified length/size (6.6).	Data available, mostly outside of BSIS
Parameters (slope and intercept) of the size spectrum of the aggregate size composition data (6.7).	No information

Oxygen concentrations in bottom water and/or upper sediment layer
Where ecologically relevant, assessments of oxygen concentration need to be conducted in critical areas and in critical seasons.

MSFD	**Black Sea region**

Extent of area with spatial or temporal hypoxia (6.8)	Data available, not reported to BSIS
Ratio of oxygen/hydrogen sulphide concentration (6.9)	Data available, not reported to BSIS
Presence of benthic communities associated with low oxygen conditions (6.10)	Data available. Note: the Black Sea has naturally low oxygen conditions.

Descriptor 7 - Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems

Permanent alteration of hydrographical conditions can derive from activities such as constructions at sea, landfills and land claim, barrages, windmill farms and other renewable energy constructions, oil and gas platforms and bridges, dredging and deposition in the sea, but also from constructions on land with outlets into the sea e.g. power plants outfalls (Annex III, Table 2). Permanent alterations of the hydrographical conditions can consist in changes in the tidal (emergence) regime, current or wave action, salinity and temperature characteristics, water clarity, which can affect marine ecosystems.

A risk-based approach is to be used to assess the impact of activities which might permanently change the hydrographical conditions. Estimation of the expected hydrographical changes e.g. by modelling is the first step. At the large scale, tools such as strategic environmental assessment and maritime spatial planning can contribute to evaluate and assess the extent and cumulative impacts of such proposed activities. A more detailed assessment must be carried out in the environmental impact assessment (EIA) that precedes permission for a specific activity. An appropriate suite of indicators is to be selected which responds to the local pressures affecting the structure and function of the ecosystems. Already on that basis, measures are to be taken to minimize the effects on the ecosystem. If the activity is implemented, the monitoring programme to be carried out must keep track of changes in the ecosystems that may be affected by the hydrographical changes, through an appropriate set of indicators. If adversely affected, measures are to be taken and monitoring continued.

MSFD pressures	**Black Sea region**
Constructions at sea, landfills and land claim, barrages, windmill farms and other renewable energy constructions, oil and gas platforms and bridges, dredging and deposition in the sea, constructions on land with outlets into the sea e.g. power plants outfalls (Annex III, Table 2).	Permanent alterations of the hydrographical conditions, such as changes in the tidal (emergence) regime, current or wave action, salinity and temperature characteristics, water clarity, etc. can hardly be reported. Land-based or sea-based sources of permanent hydrographical alterations are not reported to the BSC, EIA are not available in BSIS. Further investigation for availability of data is needed.

Respectively:

MSFD	**Black Sea region**
Extent of area affected by the alteration (7.1)	No information, not reported to BSIS. Further investigation for availability of data is needed.
Spatial extent of benthic habitat affected permanent alteration (7.2)	

Changes in benthic communities and or production (7.3)	
Extent of area with spatial or temporal hypoxia	
Presence of benthic communities associated v oxygen conditions (7.5)	
Diversity and richness indices, based on species number and relative abundance in the benthic community (7.6)	
Presence of particularly sensitive or tolerant (7.7)	
Changes in habitat functions due to altered hydrographical conditions (e.g. spawning areas, breeding and feeding areas and migration routes of fish, birds and mammals) (7.8).	

Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects.

The concentration of contaminants in the marine environment and their effects have to be considered to assess the status of the marine environment, taking to account the requirements and the results of the implementation of the Water Framework Directive (WFD) in coastal waters and applying a risk-based approach, driven by an assessment of threats to the ecosystem.

The Member States will consider the substances or group of substances that:

(i) have been identified as exceeding the relevant Ecological Quality Standards set for coastal or transitional water bodies adjacent to the marine region or subregion, be it in water, sediment or biota and/or

(ii) are included in the list of priority pollutants in Annex X of EC Directive 2000/60 and are discharged into the concerned marine region or subregion and/or

(iii) are pollutants under the terms of the Directive and their discharges, releases, losses or emissions are significant in the marine region or subregion, including acute pollution events following accidents.

Progress towards good environmental status will depend on whether their presence in the marine environment is consistently decreasing for synthetic or priority substances, or is progressively stabilised at background values for natural ones, as well as on whether their biological effect are kept within acceptable limits.

MSFD	Black Sea region
Concentration of contaminants in the marine environment (measured, where relevant, in the same matrix used for the assessment in coastal or transitional waters) (8.1)	Data available
Biological effects on the elements of concerned ecosystems, after having established at national, regional or subregional level (i) the appropriate taxonomic groups where the effects must be identified, taking into account their sensitivity towards the pollutant concerned and within them (ii) the nature of the effect to be assessed (8.2)	Not reported to BSIS, further investigation of availability of data needed
Occurrence and extent of acute pollution events (e.g. slicks from oil and oil products) and impact on biota physically affected by this pollution (8.3)	Data on pollution events available, mostly outdise of BSIS. Impacts on biota – data available, not reported to BSIS

Descriptor 9 - Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards

Member States are to monitor the presence in wild caught fish, crustaceans, molluscs, echinoderms, roe and seaweed harvested in the different (sub) regions destined for human consumption for substances:

- for which maximum levels contained within products destined to human consumption are established at EU, regional, or national level, and/or
- referred to in descriptor 8, for which the predicted or measured environmental concentration is above the level where no biological effects appear.

The presence of the contaminants above is to be assessed against regulatory levels set for human consumption. This includes the performance of a trend analysis when either environmental concentration levels or biological effect levels are still in the process of being set.

Progress towards good environmental status will depend on whether the contaminants subject to surveillance are at levels below the levels established for human consumptions or showing a downward trend (for the contaminants for which regulatory levels are in the process of being set).

Levels, number and frequency of substances:

MSFD	**Black Sea region**
Actual levels that have been detected (9.1)	Scarce data available, mostly outside of BSIS
Number of contaminants for which exceeding levels have been detected (9.2)	Scarce data available, mostly outside of BSIS
Frequency where the regulatory levels are exceeded (9.3).	Scarce data available, mostly outside of BSIS

Descriptor 10: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

The distribution of litter is highly variable due to short time variations caused by meteorological and hydrodynamic events, including seasonal fluctuations. Such variability is to be taken into considerations when planning monitoring schemes.

MSFD	**Black Sea region**
Amount of visible litter in the marine and coastal environment	Not included in national monitoring systems. Data available from projects: see http://www.blacksea-commission.org/_publ-ML.asp
Degradation of litter at sea	No information
Impacts of litter on marine life.	Scarce data available, not reported to BSIS

Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

As well as underwater noise, other forms of energy inputs can be distinguished such as electromagnetic fields from electricity cables and light at the surface. At this stage, and subject to further development, only the aspect of underwater noise has been developed further as a fist priority.

Noise input can occur at many scales of both space and time. Anthropogenic sounds may be of short duration (e.g. impulsive) or be long lasting (e.g. continuous). Higher frequency sounds transmit less well in the marine environment whereas lower frequency sounds can travel far.

Organisms that are exposed to sounds can be adversely affected over a short time-scale (acute effect) or a long time-scale (permanent or chronic effects). Adverse effects can be subtle (e.g. temporary harm to hearing, behavioural effects) or obvious (e.g. death in the worst case). With sufficient resources and research, it might be possible to develop indicators for these many facets of harm from energy input; however the initial indicators described below (pressure indicators) focus on sounds that affect relatively broad areas rather than sounds that affect only local parts of the marine environment.

MSFD	**Black Sea region**
Distribution in time and place of loud, low and mid frequency impulsive sounds	No information, needs further investigation
Continuous low frequency sound	No information, needs further investigation