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REVIEW AND ANALYSIS OF MED POL PHASE III MONITORING ACTIVITIES

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1. Introduction

The present document, prepared for the third review meeting of MED POL Phase III Monitoring Activities, aims to review and evaluate the overall monitoring activities organized for Phase III and to identify the gaps occurred in the achievement of the overall goals and objectives of the Programme.

The previous work was presented at the second review meeting of the monitoring activities in 2003 (UNEP(DEC)/MED WG.243/3) which served to introduce and analyze the achievements and bottlenecks of the implementation of the different components of the Programme.

In addition to the content of this document, the Meeting is also invited to consider and refer to the Evaluation of MED POL PHASE III Programme (1996-2005) which was prepared by three independent consultants and presented to the last meeting of MED POL National Coordinators (Barcelona, 24 - 27 May 2005). In reading this reference document (UNEP(DEC)MED WG.264/3), special attention should be made to the realization of the monitoring activities.

2. Review and Analysis of Monitoring Activities

The monitoring activities are mandatory for all the Parties in reference to Art. 12 of the Barcelona Convention and Art. 8 of the Land–Based Sources Protocol, aiming to:

a. systematically assess, as far as possible, the levels of pollution along their coasts, in particular with regard to the sectors of activity and categories of substances listed in LBS protocol, and periodically to provide information in this respect; and
b. evaluate the effectiveness of action plans, programmes and measures implemented under this Protocol to eliminate to the fullest possible extent pollution of the marine environment.

The monitoring activities in MED POL Phase III Programme (1996-2005) were designed to consider the above and having the specific objectives of

- the determination of temporal trends of some selected contaminants in the coastal waters and specifically at the hot spots in order to assess the effectiveness of actions and policy measures;
- the presentation of periodical assessments of the state of the environment in hot spots and coastal areas (needed to provide information for decision makers on the basic environmental status of the areas which are under anthropogenic pressures), and
- the control of pollution by means of compliance to national/ international regulatory limits.

Concerning the trend-monitoring component, its specific aim is to detect site-specific temporal trends of selected contaminants basically at the designated hot spot sites in the coastal marine environment. The aim is eventually to monitor the effectiveness of control measures taken at pollution hot spots with long term data of several decades or more. Trends in pollutant or contaminant levels, in general, are also considered as “state” indicators of pollution and are included in most of the regional monitoring programmes to provide inputs to the assessments of the state of the marine environment.

Monitoring of loads aims to provide estimates of inputs of some major groups of pollutants (all listed in the Land Based-Sources Protocol) to the coastal marine environment via point (rivers, municipal and industrial effluents) and non-point (atmospheric) land-based sources.

Compliance monitoring, covering health-related conditions in bathing and shellfish/aquaculture waters as well as effluents, represents the pollution control component of MED POL Phase III. In order to fully achieve the objectives of this component, countries are encouraged to prepare compliance reports by comparing the results of the monitoring with the existing limit values of their national and/or the international and regional legislations.

Biological effects monitoring (monitoring with biomarkers) was also included in the monitoring programmes as a pilot activity to test the methodology and its use as an early-warning tool to detect any destructive effects of pollutants on marine organisms at the initial stage of exposures. Biomarkers, in general, are considered as “impact” indicators used for the evaluation of toxic effects of pollutants on coastal marine life. They can in fact be considered as the most direct method to assess exposure to, and effects of, chemical contaminants at very early stages (at cellular or organism level).

Another component of the MED POL Phase III Programme is the monitoring of eutrophication. The monitoring sites are those where eutrophication phenomena are common and, in addition, potentially risk areas under the direct impact of anthropogenic nutrient and organic material inputs.

2.1 Participation to the MED POL Phase III (1996-2005) Monitoring Activities

National monitoring agreements

In MED POL Phase III, national monitoring programmes (NMPs) were signed between the countries and UNEP/MAP – MED POL as adapted to respond to the common criteria developed by MED POL (MTS no.120, UNEP(DEC)MED WG.243/3, UNEP(DEC)MED WG231/14). The various components of the monitoring programmes are covered by the NMPs and integrated in the framework of MED POL Phase III to achieve the overall objectives mentioned in the LBS protocol. The status of the monitoring activities as well as their coverage by the end of MED POL Phase III are presented in Table 2.1.

Eleven national programmes were finalized during the 1999-2004 period (Table 2.1). Unfortunately, the status of implementation of the monitoring programmes during MED POL Phase III showed an inadequate geographical coverage of the coastal waters and hot spots of the region. In order to fill in this gap, countries are now asked either to provide comparable data sets for the entire period of Phase III or to complete some missing mandatory information and data. This was also one of the approved recommendations of the last CPs Meeting held in Portoroz, 8-11 November 2005. The same meeting also recommended to its Parties to formulate and implement marine pollution monitoring programmes pursuant to Article 12 of the Barcelona Convention and Art. 8 of the amended LBS Protocol.

Status of provision of data

Albania provided data on trend monitoring of two groups of contaminants (TMs and OCs) in the biomonitoring organism (MG). The contaminant data was also supported by the biological effects data (only with one biomarker of the proposed battery). Data is available for the 2001-2004 period with some discontinuity in TM data in 2002 due to some operational problems occurred in the laboratory. All data were loaded to the MED POL database without any major problem.

Croatia provided data on trend monitoring for two groups of contaminants (TMs and Ocs) in the biomonitoring organism (MG) and also for surface sediments. Biological effects data is also available. Monitoring of inputs covered effluents and rivers. Data for biota is

Table 2.1 2.1 Participation to the MED POL Phase III (1996-2005) Monitoring Activities

COUNTRY	Status of Monitoring Programmes (Agreements)		Participation to the components of Compliance and Trend (State) monitoring									
			Health-related		Coastal areas and hot spots			Point and non-point sources				
	Drafted	Agreement (revised)	Bathing waters	Shellfish growing waters	Trends monitoring in Biota	Trends monitoring in Sediment	Biological effects monitoring	Compliance in effluents Trend monitor. Of Loads				Eutrophication - pilot
								IND	MUN	RIV	ATM	
Albania	1998	1999 (2003)	C		√		√					
Algeria	2001, 2004	2004	C	C	√	√	√*	C	C	L		
Bosnia & H.												
Croatia	1998	2000 (2002)	C	C	√	√	√	C	C	L		
Cyprus	1998	1999 (2002,2005)	C	C	√			C,L				√
Egypt												
France												
Greece	1999	2000 (2003)	C	C	√	√	√	C,L	C,L	L	L	
Israel	2002	2002	C		√	√	√*			L	L	
Italy												
Lebanon	2000											
Libya												
Malta	2001											
Monaco												
Morocco	1999, 2003	2004	C	C	√	√	√	C,L	C,L	L		√
Ser.& Mon.												
Spain												
Slovenia	1998	1999 (2002,2004)	C	C	√	√	√		L	L		√
Syria	2000, 2003	2003	C		√		√*	C	C	L		
Tunisia	2001	2001 (2005)	C	C	√	√	√	C,L	C,L	C[#]L		√
Turkey	1999	2000 (2003)			√	√			C	L		√

* Refer to section 2.6
# Refer to section 2.2

available for 2000-2004 whereas sediments data is available since 2002. Data was loaded to the database and verified by the data originators afterwards.

Cyprus provided data on trend monitoring of TMs and OCs in the biomonitoring organism (MB) for 1999-2002. Unfortunately, there was a change of the programme implementing laboratories in 2003 and data for contaminants could not be provided after 2002. Monitoring of inputs covered effluents. Besides, coastal waters including the designated hot spots are monitored for nutrients and data was provided for 1999-2003 period. All available data was loaded to the database. Data for 2004 was very recently submitted to the Secretariat and will be loaded to the Database soon.

France has recently submitted to the Secretariat contaminant data on biota for 1996-2003 period. The data covers trace metals and organic contaminants in two groups (PAHs and organochlorine pesticides). Most of the data was recently loaded to the MED POL Database, however, some artificial information was created for a successful loading since the standard MED POL data reporting formats were not used. Complementary data and information could be asked during verification of data that will be held in consultation with the data originators.

Greece provided limited data for the year 1999 for contaminants in biota (MG) and sediment. Data on river inputs and coastal water nutrient levels were also provided for the same year. However, a big gap occurred after that date in data provision, probably due to the problems encountered in the coordination of the programme at the national level. The programme was re-initiated in 2004 and the related data sets corresponding to the NMP requirements for this period have been recently submitted to the Secretariat.

Israel provided TMs data on biota and sediments for 1999-2003 period. The biota data was available for fish (MB) and for alternative mussels (not MG) such as MC. For coastal water monitoring, data for nutrients and chlorophyll was also made available for the 2001-2003 period. Regarding the data for atmospheric loads, both dry (TMs and nutrients) and wet (only nutrients) deposition data was provided to the Secretariat for the 2000-2004 period. This database on atmospheric inputs could be considered as representing the inputs to the south-east Mediterranean. All data was loaded to the database and verified.

Morocco has recently provided data for biota, sediment and inputs for the period 1997-2004. There are discontinuities in data for different matrices with time. The most comprehensive data set is for monitoring of TMs in surface sediments. The monitoring strategy was agreed to be modified according to the agreement signed in 2004, therefore data is expected with agreed sampling strategy starting from 2005.

Slovenia provided data annually since the inception of its programme for the period of 1999-2004 as agreed in the monitoring programme. Data was made available on two groups of contaminants (TMs, PAH) for biota (MG) integrated with biological effects monitoring and only for PAH for surface sediments. River inputs as well as coastal water monitoring data was also provided. All data is loaded to the database and verified by the data originators.

Tunisia submitted data for 2001-2003 period after the monitoring programme was officially agreed. The data sets were complete for TMs in biota however have shown some discontinuities in OCs -total hydrocarbons- data both in biota and sediment. Biological effects data was also provided in parallel. Data on inputs are available. All data was loaded to the database.

Turkey provided data for 1998-2004 for almost all components included in the MED POL Phase III programme. TMs data for biota has a good time series whereas some discontinuities have occurred for PAHs and organochlorine pesticides. Contaminant data on sediment was also regularly provided. Data on river inputs as well as municipal and limited number of industrial discharges was provided with certain gaps in sampling frequencies. All data was loaded to the database and partially verified by the data originators.

Setting up of the Database

Reference could be made to the previous major documents (UNEP(DEC)/MED WG.202/2, rev.9/4/2002 and UNEP(DEC)MED WG.243/3, 2003) for the set up of the MED POL Phase III Monitoring Database (MEDPOL.mdb) and the inter-linked web version (http://195.97.36.231/medpol/).

The Database can be installed to any national institute requiring similar functionality for pollution monitoring systems supported with a Users' Manual and a detailed report on the modifications made after its first structuring. Technical assistance could be provided by the Secretariat to any interested party.

The MED POL monitoring database is at the moment hosting monitoring data of 10 Mediterranean countries. Data content is highly variable and the portion of data for each component and country is uneven. However, data storage is totally safe and a data verification/validation procedure is in place. It also allows to export data in different formats to other organizations such as to EEA /EIONET.

The present content of the Database based on the yearly and country statistics is provided in Annex I. The recently submitted data by Cyprus, Greece and Morocco have still to be loaded to the database.

2.2 Evaluation of compliance monitoring activities

The compliance monitoring activities of MED POL Phase III were planned as part of the pollution prevention and control strategies, to be applied for the implementation of the LBS Protocol and the Strategic Action Programme (SAP) to address pollution from land-based activities. As a result, compliance monitoring basically aims (MTS no.120) to complete the baseline studies for the types and amounts of pollutants discharged/dumped in the marine environment, to compile and update an inventory of land-based sources of marine pollution, to carry out effluent quality control where criteria and standards already exist, to assess the control measures being implemented and to monitor health-related conditions including bathing waters and shellfish-growing waters.

Concerning the assessment of the types and amount of pollutants released to the sea as well as the inventory of all pollution sources, the Secretariat did not include these activities in the regular national monitoring programmes but obtained the necessary data and information through an activity directly related to the implementation of the Strategic Action Programme (SAP) to address pollution from land-based activities, i.e. the preparation of national baseline budgets (NBBs) of emissions and releases from all pollution point sources. The data, which was mostly obtained through the use of widely recognized and tested emission factors, refer to the year 2003, was included in a database and is expected to provide a basis for the formulation of future monitoring programmes and for the launch of specific pollution reduction initiatives.

Monitoring of effluents is included within the monitoring activities of MED POL Phase III in order to carry out effluent quality control. This component aims at determining if the adopted common measures (MTS no. 95) related to the concentration of contaminants in effluents are complied with or not. When national measures related to the selected contaminants exist, they should be taken as a reference for compliance control. This component of the compliance monitoring activity should also be used to provide actual data at sources, to compare with and possibly substitute the estimated values of the NBBs for which a common regional methodology was applied (UNEP(DEC)/MED WG.231/Inf.3).

Concerning the assessment of the control measures achieved, a Reporting System to track the pollution reductions expected as part of the implementation of the SAP was prepared, tested and is now being finalized.

Monitoring at “hot spots” is also included in the compliance monitoring activities to verify whether the Environmental Quality Objectives (EQO) or limit values set out in the relevant regulations are complied with (e.g. DDT in water). As widely known, EQOs define some desired state of the environment that can be met through the attainment of specific measures. Although common EQOs do not exist in the Mediterranean, any national quality objectives available could be used for compliance monitoring at hot spots (basically in sea water and sediments). Collection and compilation of such data might also facilitate the development of EQOs.

Regarding the monitoring of health-related conditions (e.g. sanitary quality of bathing waters, waters used for shellfish culture and aquaculture, quality of sea food), both the adopted common measures at the regional level and the national limits provided in national regulations are expected to be verified. This type of monitoring has high significance at the national level.

Since the control of pollution is one of the basic goals of MED POL Phase III, compliance monitoring activities were considered as of vital importance at both national and regional levels. Table 2.2 summarizes the status of participation by the countries in the different components of the compliance monitoring activities and further details of programme implementation are presented underneath.

Table 2.2 Compliance monitoring activities participated in by the Countries in MED POL Phase III

COUNTRY	**Participation in the components of compliance monitoring**				
	Bathing waters	Shellfish/ aquaculture waters	Effluents	Hot spots	Number of participating institutes
Albania	√				1
Algeria	√	√	√		10
Bosnia & H.	No programme				
Croatia	√	√	√		8
Cyprus	√	√	√		3
Egypt	No programme				
France	No programme				
Greece	√	√	√	√	9
Israel	√			√	2*
Italy	No programme				
Lebanon	No programme				
Libya	No programme				

Malta	No programme				
Monaco	No programme				
Morocco	√	√	√		5
Serbia & M.	No programme				
Spain	No programme				
Slovenia	√	√			2
Syria	√		√		4
Tunisia	√	√	√		5
Turkey			√	√	1

*all the public health institutes considered as one group

Albania has submitted two compliance reports on bathing water quality for the years 2003 and 2004. The Programme objectives and the implementation of the programme are in line with the WHO/MED POL criteria. In 2003, monitoring was carried out at 9 beaches in five coastal areas. 6 beaches were found with %100 compliance while 3 beaches exhibited low compliance levels. The following year, only those beaches with critical compliance levels were monitored and it has been found out that the conditions in one of them has improved from 50 to 88% compliance level where the other two beaches still had poor sanitary conditions. In the national reports of the two consecutive years, it was stated that this is an influence of untreated sewage discharges.

Algeria will submit the first compliance reports at the end of 2005 based on the interim criteria of WHO/UNEP. In the official NMP, fourteen zones with about 200 stations covered monitoring of sanitary quality of bathing waters; among them, two zones with two representative stations for shellfish/aquaculture waters and seven zones with fourteen point stations for urban and industrial discharges.

Croatia has submitted compliance reports for the quality of bathing waters and shellfish waters as well as quality of shellfish produced –based on both WHO/UNEP and national criteria for the 2000-2004 period. Considering the compliance level of sanitary conditions of beaches, eight sites were monitored with about 700 stations and the range of compliance was found between 75-100% with stricter criteria for the whole period. The compliance level according to WHO/UNEP criteria was 93-100%. In the national reports, it was stated that the low compliance cases for bathing waters was due to the influence of inappropriate sewage effluent management. The compliance monitoring activities held at shellfish growing waters (and the flesh) have also provided valuable information for public health, and the waters were generally in full compliance with both criteria. Only in 2004, there were indications of microbiological contamination of waters at certain sites. Data on effluents was provided for the period of 2001-2003 without any compliance reports.

C*yprus* has provided compliance reports for bathing waters for the 1999-2003 period. The activity was performed with an intensive sampling strategy in about 100-150 stations usually having more than 1000 samples for each year. It was found out that all the stations comply with both WHO/UNEP criteria and the EU Directive. Data for shellfish waters including nutrients was made available but not compliance reports. Limited data for industrial effluents was submitted for the 2000-2003 period as well as the corresponding compliance reports.

Greece has included all the components of compliance monitoring activities to their MED POL-III Monitoring Programme and only submitted a report on bathing water quality covering the period 1999-2000. The compliance with Directive 76/160/EEC for the respective years was also presented in the report. Compliance monitoring of shellfish growing waters was foreseen to be implemented with EC/national regulation at 5 stations. No report was submitted until now. Compliance monitoring at industrial and sewage effluents was part of the NMP, however, no data and compliance information has yet been provided. Another component of the programme, compliance at hot spots, was considered for the seawater stations in which seven river estuaries are included. Limited data was also submitted without any compliance information. It was mentioned that two measures available for the control of pollution by Cd/Cd compounds and organohalogen compounds would be used to provide the compliance reports.

*Israe*l has implemented the activity for microbiological quality of bathing waters according to the national regulations, and has checked the compliance at six levels with respect to the *fecal coliform* counts. The sampling frequencies are stricter than those proposed by MED POL and 85 beaches at the Mediterranean coast were covered with more than 4,000 samples in a year. Based on the 2003 report submitted to MED POL, and interpreting the results with WHO/UNEP criteria (FC_{50}<100 FC/100mL), the compliance level of all samples was at an average value of 92% where there were only few beaches presenting certain problems. There is no compliance monitoring activity in effluents. The compliance monitoring activity at two stations of a sewage treatment plant area was included in the programme, relevant data was submitted which did not include all compliance information.

Morocco has provided the first compliance report on the bathing water quality in 2005 for the bathing season of 2004-2005. The compliance criteria was based on the national regulation which classify the bathing waters in four categories. In this period the compliance level of 69 stations was 85.5%. The compliance of shellfish growing waters was included in the NMP both for microbiological indicators and toxic phytoplankton, there is no submitted report on that yet. The compliance monitoring activity for effluents was also included in the NMP and the compliance report is expected to be submitted soon.

Slovenia has provided reports on the sanitary quality of bathing waters for the period of 2001-2004 based on both WHO/UNEP criteria and national legislation. It is possible to conclude with an overall evaluation for the whole period that the compliance level is 90-100% with respect to both standards. Regarding the study performed for the sanitary quality of shellfish waters, neither the water nor the meat quality was reported with respect to the WHO/UNEP criteria, which is based on microbiological indicators. Instead, the study was based on physical and biological conditions of the shellfish waters including the presence of toxic phytoplankton species which is an indicator chosen at national level. There is no compliance monitoring activity on effluents.

Syria has not yet provided information on any compliance monitoring.

Tunisia has submitted compliance reports for bathing waters for the year 2001 and 2002 based on the national regulation. According to the definitions cited in the regulation, in 2001, 65% of all the stations were in class A, 23% in class B and 12% in class C and the respective values in 2002 were 55%, 29%, 16%. The monitoring of sanitary quality shellfish waters and products were not included in the programme. Compliance monitoring of effluents with respect to national regulations was included in the programme where only raw data (once per month) was submitted until now. In the 2005 revision of the NMP, compliance monitoring of surface waters - rivers and lagoons- were also included in the programme which is the first practice for MED POL on the surface water quality. National criteria will be used to check compliance.

Turkey is the only country which did not succeed to include compliance monitoring of bathing waters in its NMP. The Ministry of Environment and Forestry is trying to establish a permanent cooperation with the Ministry of Health to fill in this gap. Compliance monitoring of aquaculture waters is not included in the NMP either. However, compliance monitoring in effluents was included in the programme and limited data and compliance reports was provided. Compliance monitoring activity at hot spot sediments of one estuary and two bays was part of the programme, where relevant data was submitted without any compliance information.

Conclusions :

In general, it can be concluded that compliance monitoring for the sanitary quality of bathing waters was implemented efficiently by nearly all participating countries in MED POL Phase III monitoring activities. The compliance reports provided to MED POL confirm that the information produced is very useful for the identification of emerging or chronic problems at some bathing areas, and warns national or local authorities to take action on the pollution source in the vicinity of these beaches.

The other component of health-related compliance activity, monitoring of shellfish/aquaculture waters and the quality of the consumed sea food, has not been part of most of the programmes and there are only 1-2 cases where useful compliance reports are produced for microbiological indicators. On the other hand, some countries have included toxic phytoplankton abundance –not biotoxins itself- in their programmes which does not take into account the WHO/UNEP criteria.

Regarding compliance monitoring of effluents, most of the countries are committed to provide data and compliance information for their municipal and industrial inputs to the sea. In all such cases data was provided, however it is very limited especially for industrial inputs. Compliance reports are very few. Besides, some countries never included the activity in their NMPs. Considering the results of the NBBs studies of all the Mediterranean countries for year 2003 and the relevant database established by MED POL, it is now considered necessary to review and possibly revise the ongoing monitoring of effluents plan and discuss the opportunity or not to gradually substitute the data of the NBBs (obtained by the use of emission factors) with data obtained through actual monitoring.

Compliance monitoring at hot spots (river estuaries, discharge areas etc) was included in three NMPs, and data was provided without any compliance information.

In conclusion, the Secretariat believes that the whole activity has to be revised considering 1) the use and importance of its individual components at the national and regional scales and 2) the need to make this type of monitoring an even better tool for the long-term implementation of the SAP.

2.3 Evaluation of site-specific temporal trend monitoring activities

One of the major component of the MED POL Phase III monitoring activities is the monitoring of contaminants at Mediterranean hot spots and coastal waters to attain site-specific temporal trends through an appropriate and consistent monitoring strategy. The first evaluation of the data collected in the MED POL Database was made in 2003 to identify the sampling and analytical variances for each monitoring practise. The aim of the present work is to perform a detailed analysis of variances and trends – where possible - for each monitoring site. Merging of MED POL Database with some national data sources was required to perform the trend tests with long-term time series of data. The use of QA data is also evaluated in this section.

An attempt was made to evaluate inorganic and organic contaminants data collected for biota at each sampling site included in the MED POL Phase III. The data sets were huge thus encompassing time consuming steps of data preparation and analysis. Therefore, the evaluation was initially concentrated on inorganic contaminants (TMs) data and a complete analysis was performed. Only some of the results are presented in this report. All analysis were recorded separately on CDs to be provided to the respective countries and laboratories during the Meeting. The CDs also include reference material and the software suite used for the analysis. The evaluation of organic contaminants data will continue and the results will be provided to the data originators and the national authorities at a later stage.

Data quality and statistical analysis of the available data

In temporal trend monitoring programmes of contaminants in biota, the emphasis is given on controlling sampling, analytical and seasonal variations to provide information on temporal patterns of changes. There are various ways of controlling the unwanted variations. For example, sampling variations can be reduced by taking more animals, analytical variations by doing replicate analyses, or by improving analytical procedures, and seasonal variation by taking samples at the same time each year. The first evaluation of the measured data performed after three years of ongoing programmes, presented at the second review meeting of monitoring activities (UNEP(DEC)MED WG.243/3, 2003), was meant to point out the weakness of the defined strategies as to address the main problems in the fulfillment of the defined goals. The present evaluation is mainly intended to go a step further and to identify the main problems in trend detection.

Requirements and criteria

After five to six year of ongoing programmes some countries still have only two or three years of useful data and also show problems with data quality. In order to understand if such programmes- where number of sampling years of for trend analysis is not enough- fulfill the designed objectives, only the compliance of within year variance with threshold values could be checked.

However, the first trend evaluation can be performed of countries with more than five years ongoing programmes and an attempt will be performed only for data series that fulfill this requirement. Some countries also provided additional data to extend the time duration of their data series. For the trend detection, the software suite "Trend-Y-tector" is used. The software was developed by the Netherlands National Institute for Coastal and Marine Management (RIKZ) in order to achieve the requirements of the OSPAR countries for a harmonized, uniform and objective method or suite of methods to analyse the yearly collected data.

Investigation of within year variances

In general, the statistical objective for the MED POL trend monitoring programme was set to detect a minimum linear trend of 10 % per year in 10 years with a power of 90%. The power of the programme is the probability that the F-test rejects the null hypothesis. For the considered linear trend, the F-test power depends on both *T* (number of years) and the signal-to-noise ratio $|b|/\psi$. Nicholson *et al.* (1997)[1] calculated a very useful table for $|b|/\psi$ corresponding to different powers as T varies from 5 to 25. For a 90% power and 10 years the signal-to-noise ratio is $|b|/\psi$=0,409. If it is supposed that b=0.1 (10% linear trend) then the acceptable variance to fulfil the objectives is ψ=(0,1/0,409), so that ψ=0,244 and the acceptable programme variance is ψ^2=0,060. Even if the underlying trend for a data set is not always linear, the programme objective is fulfilled if the within year variance is below the

[1] Nicholson M., R. Fryer, C.A. Ross (1997). Designing monitoring programmes for detecting temporal trends in contaminants in fish and shellfish. *Marine Pollution Bulletin*, 34, 10: 821-826.

threshold of 0,060. This limit is correct if we consider that in general the between year variance is always significantly lower than the within year variance (Nicholson et al, 1997).

Temporal trend detection

Nowadays, a variety of tests are available to analyze data record. Each one has its own capabilities and underlying assumptions and therefore considerable judgment is needed to select the appropriate one. The OSPAR Convention proposed three trend detection methods in a suite. The idea is to take the benefits of all methods, because there is not only one method which always offers the best analysis.

The three methods (Mann-Kendall, linear regression, lowess smoother) are amongst the most commonly used in this field. The order is from the simplest to the more complex method. Mann-Kendall is the most robust to outliers, but in case of a linear trend, the linear regression has more power and therefore is selected first. Since nature is not always linear, the smoother is taken to detect a non-linear trend.

Based on above, the trend analysis was performed at a 5 % significance and 90 % power and the log-normal distribution was used, because log-concentration has often been found to be approximately normally distributed with constant variance.

At the first step, after data was treated with the Mann-Kendall test and if the trend is detected, the tail slope is calculated. When the Mann-Kendall test is negative (no monotonic trend was detected), the smoother method is used to test for a nonlinear trend. When the number of years N<7 case a 3-point running mean and when N>6 the lowess smoother is used in the trend evaluation. All the trend estimates are expressed in percentages.

Weighted trend assessments

Until now, during trend assessment when data was screened for analytical quality, it was a practice to classify it as "acceptable" or "unacceptable". Only the data with "acceptable" QA was used for assessing trends using smoothers giving to each observation equal statistical weight. However, many data was rejected as "unacceptable" and this led to the shortening or loss of many time-series. Nicholson *et al*. (2001)[2] suggested that the QA could be used in future assessments if an appropriate weight is given to data with questionable QA in the statistical analysis.

In the OSPAR framework, Nicholson and Fryer (2002)[3] suggested to use the available QA information to categorize the analytical quality of data as Good, Poor, Unknown, and Unacceptable and allocate statistical weights $1 > W_{poor} > W_{unknown} > 0$ accordingly. This approach is simple and intuitive. However, the choice of statistical weights is arbitrary and takes no account of the relative importance of the analytical variance to the total environmental and analytical variance. For example, all data with "poor" analytical quality will have the same statistical weight, even though such data should be down-weighted less when the environmental variance dominates the analytical variance (when poor analytical quality does not matter so much). An iterative procedure is then used to convert these analytical

[2] Nicholson, M.D., Fryer, R.J. (2001). ANNEX 5: Weighting procedures for assessing trend data of variable quality, ICES Working Group on Statistical Aspects of Environmental Monitoring 2001 Report., pp 38-45.

[3] Nicholson, M.D., Fryer, R.J. (2002). ANNEX 5: Weighted smoothers for assessing trend data of variable analytical quality. ICES Working Group on Statistical Aspects of Environmental Monitoring 2002 Report., pp 35-40.

weights into statistical weights that accounts for the relative magnitudes of the environmental and analytical variances. The approach should be easy to apply routinely to data in the data bank.

For the sake of this evaluation, only QA data was presented and commented for each country and included in the CDs prepared for countries. In future, this information can be used in the weighted trend assessment. In general, the laboratory performance is acceptable for those which |z|<2 (Pedersen et al, 1997).[4]

Country based evaluation of data

Albania

In 2004, the sampling strategy was changed from mussel watch strategy (one sample with 50-120 specimens) to 5 samples with 15-20 specimens in order to understand the underlying sampling variance and to better address the statistical issues related to the trend evaluation.

No trend can for now be estimated due to the insufficient number of sampling years and data discontinuity in 2002. The data descriptive statistics are presented in Table 2.3.1. The within year sampling variance can be estimated only for 2004 data and is very low and far below the threshold of 0,060. Besides, the analytical variance (Table 2.3.2) is even lower than the sampling variance and thus it can be expected that the programme objectives will be fulfilled. The intercalibration z-scores obtained by the laboratory for trace metals in biota (Table 2.3.3) indicate only few problems during the 2003 exercise and are very high for lead (Pb). When this data will be used in future trend evaluations, the QA information can also be used to categorize the analytical quality of the data.

From exploratory statistics (Fig. 2.3.1) in the data, some questionable patterns were identified. Some changes in the levels can be observed between years. One of the possible explanations is the sampling in different seasons (Month 7 in 2001 for both stations, month 10 in 2003 and month 10 and 8 for stations C1.2 and C2.2 in 2004 where September-October period was identified as the pre-spawning period). The size fraction was also not so uniform between the different years. The values for mussel weight in 2003 (Fig. 2.3.1) was not in the same ranges of the other years. Probably wrong values were submitted to the database. It is clear that a more concise sampling strategy for the sampling period (pre-spawning period) and size fraction (the central on a log scale) has to be adopted and maintained in future.

[4] Pedersen, B., Cofino, W., Davies, I. (1997). The 1993-1995 QUASIMEME Laboratory Performance Study: Trace Metals in Sediment and Biota. *Marine Pollution Bulletin*, 35, Nos 1-6: 42-51.

Table 2.3.2. Analysis of analytical variance in SRM2976 CRM (*Mytilus galloprovincialis* tissue) for 2003 on data submitted by Albania.

Parameter	ω(Cd)·10^9		ω(HgT)·10^9	
Ex. value	61	Log(ω)	820	Log(ω)
	63	1,799	830	2,919
	63	1,799	837	2,922
	59	1,771	820	2,914
	61	1,778		
Variance		0,0002		0,00002

Table 2.3.3 Z-scores for trace metals in biota.

Year	Intercal. Code	CD_z	CR_z	CU_z	FE_z	HGT_z	MN_z	NI_z	PB_z	ZN_z
2002	MA-Medpol-6	0,1	0,4	-0,4	-0,2	-0,6	0,4		1,0	0,4
2003	IAEA-407	-0,5	4,0	3,0	-0,5	1,5	-4,1		30,0	0,0

Table 2.3.1 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mytillus galloprovincialis* at stations along the Albanian coast in the period 2001-2004(concentrations are in μg/kg DW)

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	C1.2	2001	1			721			
CD	C1.2	2003	1			269			
CD	C1.2	2004	5	330	405	366	350	34,2	0,002
CD	C2.2	2001	1			288			
CD	C2.2	2003	1			771			
CD	C2.2	2004	5	270	320	285	280	20,6	0,001
CR	C1.2	2001	1			3970			
CR	C1.2	2003	1			3930			
CR	C1.2	2004	5	3970	4800	4332	4160	361,3	0,001
CR	C2.2	2001	1			12487			
CR	C2.2	2003	1			1630			
CR	C2.2	2004	5	1250	1600	1438	1450	148,6	0,002
CU	C1.2	2001	1			11515			
CU	C1.2	2003	1			8360			
CU	C1.2	2004	5	9780	10500	10044	9950	279,9	0,000
CU	C2.2	2001	1			10366			
CU	C2.2	2003	1			6740			
CU	C2.2	2004	5	4480	4780	4612	4600	128,5	0,000
FE	C1.2	2001	1			808667			
FE	C1.2	2003	1			309200			
FE	C1.2	2004	5	424000	458000	438800	434000	13065,2	0,000
FE	C2.2	2001	1			1214188			
FE	C2.2	2003	1			293900			
FE	C2.2	2004	5	188000	198000	191400	190000	3974,9	0,000
HGT	C1.2	2001	1			152			
HGT	C1.2	2003	1			219			
HGT	C1.2	2004	5	180	210	195	190	12,5	0,001
HGT	C2.2	2001	1			242			
HGT	C2.2	2003	1			421			
HGT	C2.2	2004	5	405	440	418	415	13,5	0,000
MN	C1.2	2003	1			181300			
MN	C1.2	2004	5	21800	24630	22890	22550	1120,0	0,000
MN	C2.2	2003	1			139300			
MN	C2.2	2004	5	11180	13380	12338	12450	789,1	0,001
NI	C1.2	2003	1			4480			
NI	C1.2	2004	5	2150	2240	2194	2200	32,9	0,000
NI	C2.2	2003	1			3940			
NI	C2.2	2004	5	6100	6270	6180	6180	62,8	0,000
PB	C1.2	2001	1			1388			
PB	C1.2	2003	1			1640			
PB	C1.2	2004	5	3790	3960	3856	3850	68,8	0,000
PB	C2.2	2001	1			4031			
PB	C2.2	2003	1			2380			
PB	C2.2	2004	5	2550	2700	2618	2600	61,0	0,000
ZN	C1.2	2001	1			177515			
ZN	C1.2	2003	1			80500			
ZN	C1.2	2004	5	58400	61300	59800	59600	1270,8	0,000
ZN	C2.2	2001	1			121675			
ZN	C2.2	2003	1			244600			
ZN	C2.2	2004	5	63900	65900	64500	64200	803,1	0,000

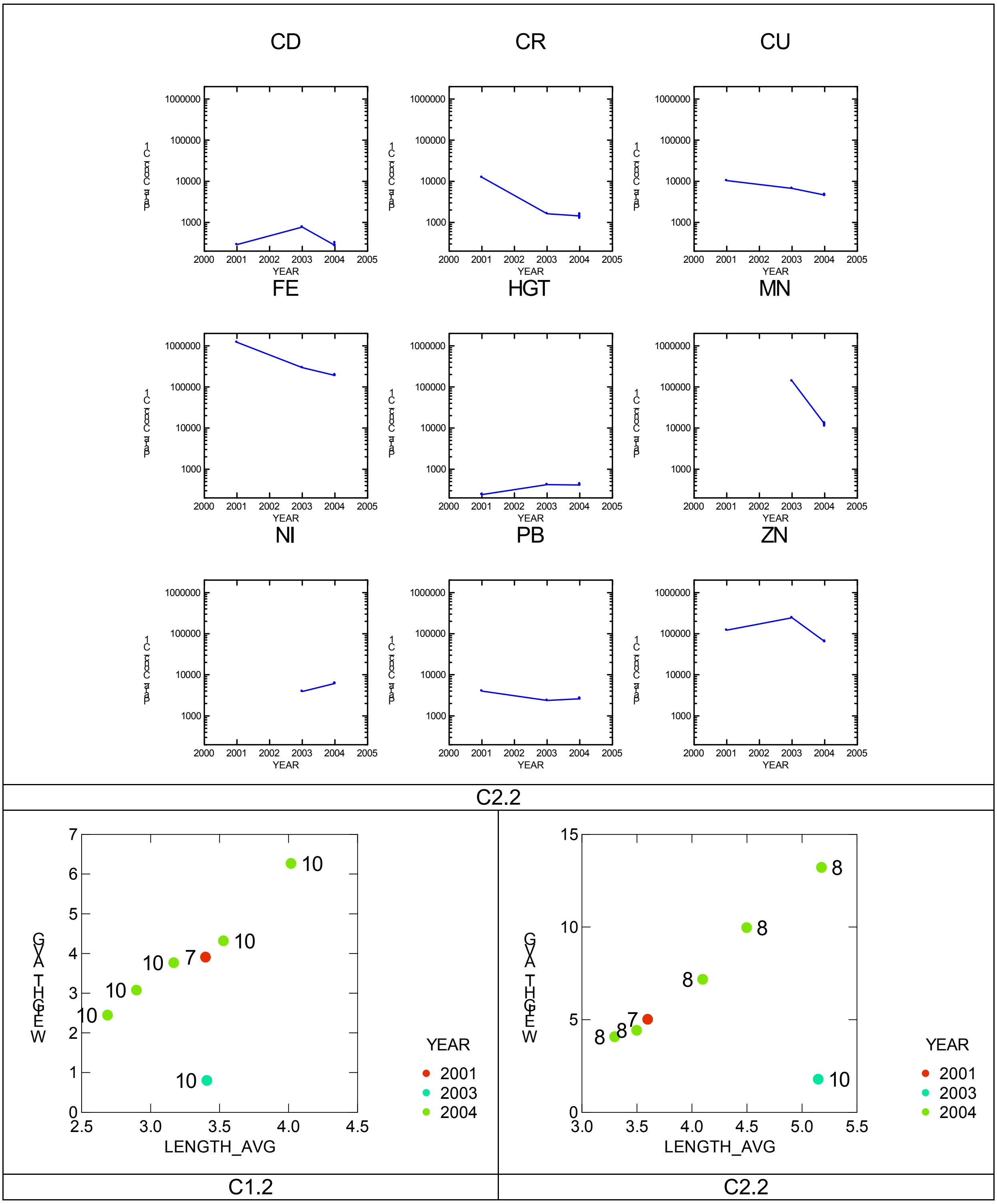


Figure 2.3.1 Values (Log scale) of trace metals mass fraction in *Mytilus galloprovincialis* (MG) by year at station C2.2 in Albanian coastal waters. Length to weight relationship by year at station C1.2 and C2.2 with superimposed month of sampling.

Croatia

Croatia adopted the suggested sampling strategy (5 samples – 15 specimens) in 2002 and started to sample in March instead of June. The descriptive statistics for Croatia are partially presented in Table 2.3.4, only for CD and HGT at selected stations. The complete statistics can be found on the CD provided to the Secretariat. From those statistics it is evident that starting from 2002 the within year variance is stable and low thus indicating an optimal sampling strategy. Only few cases of variance higher than the threshold of 0,060 were observed. They belong to low number of samples where 0.060 can not be used as a reliable threshold. The analytical within year variance (Table 2.3.5) is also very low and indicates good laboratory practice. The intercalibration z-scores (Table 2.3.6) are not acceptable only for CD and PB in 2003.

At this stage, only three successive years (2002-2004) of data is available and no trend evaluation can be performed. The previous years were sampled in different season and a clear seasonal signal can be detected (Fig. 2.3.2) when both seasons were sampled in a year.

An interesting change in value can be observed at station IN (Inavinil – Kaštela Bay) where higher total mercury levels were measured and problems related to mercury contamination reported. In 2004 an order of magnitude higher levels than already high values were measured (Table 2.3.4 and Fig. 2.3.2). The length vs weight relationship for the MG samples (Fig. 2.3.3) does not show any irregularity in sampling.

Table 2.3.5. Analysis of analytical variance in SRM2976 CRM (*Mytilus galloprovincialis* tissue) for data submitted by Croatia.

	2001		2002		2003		2004	
		Log(ω)		Log(ω)		Log(ω)		Log(ω)
Ω(HgT)·10^9	62,0	1,792	59,0	1,771	64,9	1,812	54,3	1,735
57,4-64,6	60,0	1,778	58,0	1,763	64,7	1,811	62,1	1,793
			66,0	1,820	59,9	1,777	59,9	1,777
							61,4	1,788
							58,2	1,765
Variance		0,0001		0,0009		0,0004		0,0005
Ω(Cd)·10^9	680	2,833	818	2,913	887	2,948	1009	3,004
660-980	800	2,903	837	2,922	761	2,881	991	2,996
	750	2,875	847	2,928	768	2,885	994	2,997
			859	2,934	777	2,890	887	2,948
			975	2,989	811	2,909	984	2,993
			987	2,994				
Variance		0,0013		0,0013		0,0007		0,0005

Table 2.3.6 Z-scores for trace metals in biota.

Year	Intercal. Code	CD_z	CR_z	CU_z	FE_z	HGT_z	MN_z	NI_z	PB_z	ZN_z
2003	IAEA-407	-5,29	1,05	-0,43			1,39		30,53	1,35

Table 2.3.4 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for cadmium – CD and total mercury mass fraction in *Mytillus galloprovincialis* at selected stations along the Croatian coast in the period 2000-2004 (concentrations are in µg/kg DW)

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	LOG_C1
CD	GR	2000	1			805,0			
CD	GR	2001	1			480,0			
CD	GR	2002	5	690,9	952,4	812,7	808,8	99,0	0,003
CD	GR	2003	5	991,1	1842,9	1422,8	1562,0	345,6	0,012
CD	GR	2004	5	1802,2	1957,7	1862,7	1842,3	59,9	0,000
CD	IN	2000	2	429,0	1011,0	720,0	720,0	411,5	0,069
CD	IN	2001	1			190,0			
CD	IN	2002	6	791,3	1107,8	952,0	953,4	126,8	0,003
CD	IN	2003	5	966,2	1122,4	1040,8	1049,4	71,2	0,001
CD	IN	2004	5	1089,8	1383,1	1230,1	1236,1	111,6	0,002
CD	LV	2000	1			1155,0			
CD	LV	2002	5	911,8	1086,5	995,7	970,6	76,8	0,001
CD	LV	2003	5	708,8	926,1	777,5	761,6	86,3	0,002
CD	LV	2004	5	1260,2	1568,6	1419,6	1409,8	118,4	0,001
CD	MA	2000	2	571,0	788,0	679,5	679,5	153,4	0,010
CD	MA	2001	1			500,0			
CD	MA	2002	6	570,8	947,1	694,6	644,1	140,0	0,007
CD	MA	2003	5	784,9	1033,6	922,0	935,6	90,3	0,002
CD	MA	2004	5	1108,3	1307,2	1175,4	1160,9	78,6	0,001
CD	SI	2000	1			505,0			
CD	SI	2001	1			340,0			
CD	SI	2002	6	537,4	726,4	626,2	623,2	72,5	0,003
CD	SI	2003	5	458,3	745,7	652,5	672,0	114,9	0,007
CD	SI	2004	5	605,8	814,3	694,9	674,1	79,5	0,002
CD	VR	2000	2	271,0	1002,0	636,5	636,5	516,9	0,161
CD	VR	2001	1			360,0			
CD	VR	2002	6	290,5	689,8	472,0	461,0	160,5	0,023
CD	VR	2003	5	439,2	625,5	509,4	472,7	74,3	0,004
CD	VR	2004	5	542,6	732,4	614,0	600,8	70,5	0,002
HGT	GR	2001	1			99,0			
HGT	GR	2002	5	253,0	284,0	267,8	263,0	12,5	0,000
HGT	GR	2003	5	183,4	218,8	202,0	201,6	14,8	0,001
HGT	GR	2004	5	195,0	245,8	221,6	226,8	23,6	0,002
HGT	IN	2001	1			663,0			
HGT	IN	2002	6	509,0	638,0	573,0	565,0	54,5	0,002
HGT	IN	2003	5	693,5	819,5	754,5	739,9	59,5	0,001
HGT	IN	2004	5	6654,7	10186,7	8578,1	8729,0	1381,9	0,005
HGT	LV	2002	5	116,0	131,0	121,4	120,0	5,7	0,000
HGT	LV	2003	5	130,0	157,5	143,2	141,9	10,2	0,001
HGT	LV	2004	5	129,7	163,8	145,6	144,1	12,3	0,001
HGT	MA	2001	1			82,0			
HGT	MA	2002	6	71,0	79,0	75,0	74,5	3,0	0,000
HGT	MA	2003	5	59,5	87,1	75,1	78,5	11,7	0,005
HGT	MA	2004	5	69,0	90,8	80,5	82,2	8,1	0,002
HGT	SI	2001	1			90,0			
HGT	SI	2002	6	85,0	96,0	89,2	88,0	4,3	0,000
HGT	SI	2003	5	65,2	78,8	70,5	70,2	5,6	0,001
HGT	SI	2004	5	70,7	87,3	78,7	79,6	6,2	0,001
HGT	VR	2001	1			812,0			
HGT	VR	2002	6	90,0	110,0	98,0	96,5	7,2	0,001
HGT	VR	2003	5	96,3	104,8	99,6	98,8	3,4	0,000
HGT	VR	2004	5	61,0	97,4	80,7	82,0	14,1	0,006

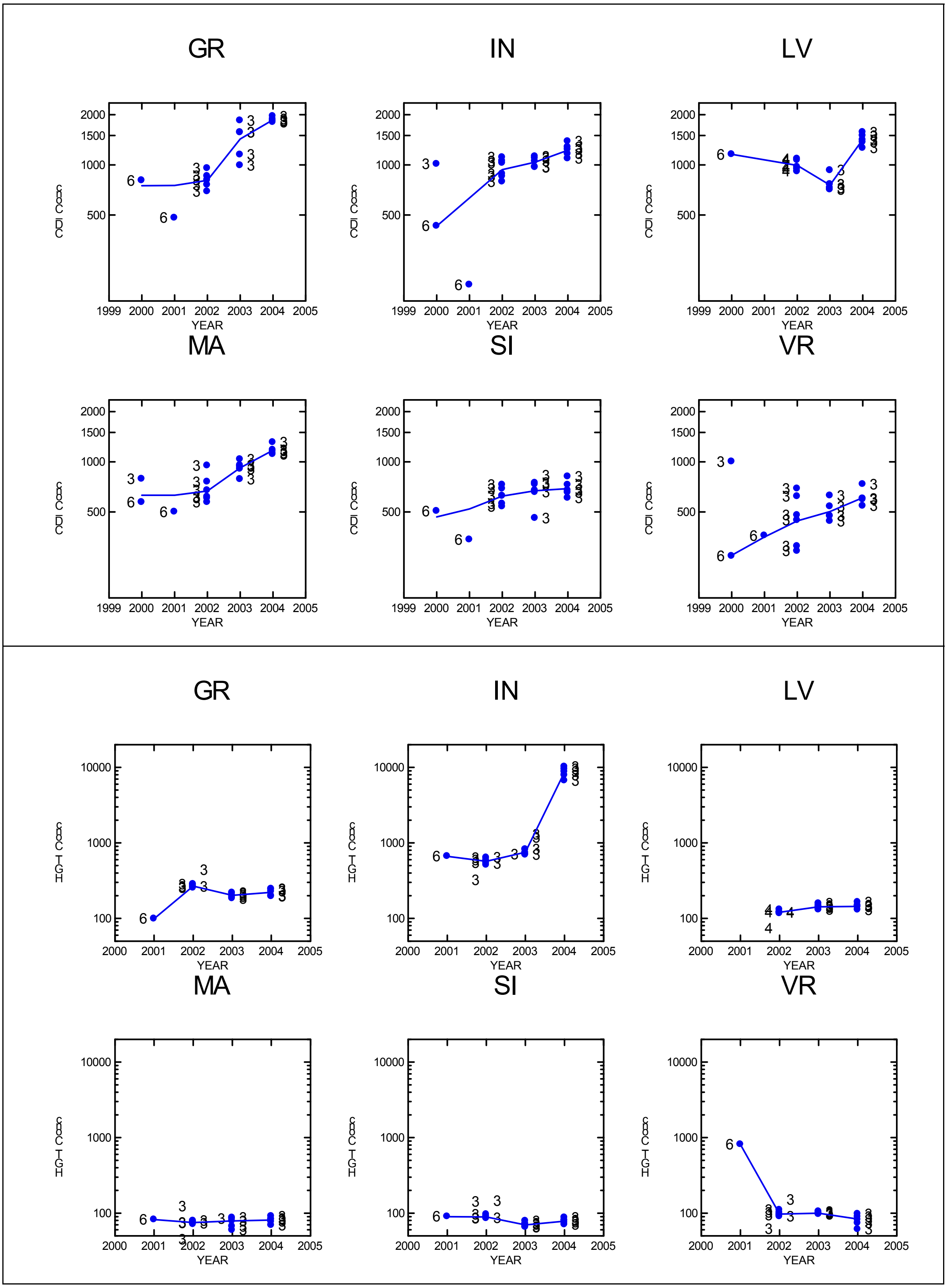


Figure 2.3.2 Values (Log scale) of cadmium (CD) and total mercury (HGT) mass fraction in *Mytilus galloprovincialis* (MG) by year at selected station in Croatian coastal waters.

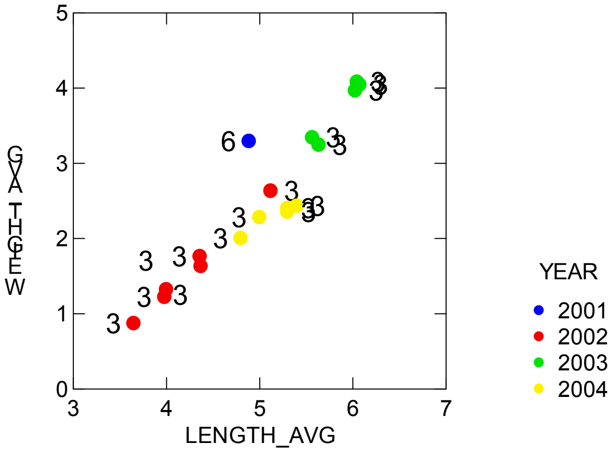


Figure 2.3.3 Length vs. weight for *Mytilus galloprovincialis* samples collected at IN station.

Cyprus

No new data were submitted to the Secretariat since the last evaluation made in 2003 (UNEP(DEC)MED WG.243/3, 2003). The data descriptive statistics are presented in Table 2.3.7. The within year sampling variance can be estimated only for 1999 and 2001 data and is very low and far below the threshold of 0,060 and well on track for the programme objectives fulfilment. For the period no QA data is available.

In 2003, Cyprus changed the laboratory in charge of the TM analysis and no data was submitted for the time of performance of this analysis.

Table 2.3.7 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mullus barbatus* at stations along the coast of Cyprus in the period 1999-2001(concentrations are in µg/kg DW)

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	FISH1	1999	6	190	210	203	205	8,2	0,000
CD	FISH2	1999	6	10	20	15	15	5,5	0,027
CD	FISH2	2001	5	30	40	34	30	5,5	0,005
CR	FISH1	1999	6	6590	7410	7123	7250	302,4	0,000
CR	FISH2	1999	6	340	830	563	555	164,2	0,017
CR	FISH2	2001	5	290	450	362	350	58,9	0,005
CU	FISH1	1999	6	1870	2250	2053	2055	161,8	0,001
CU	FISH2	1999	6	990	1470	1293	1320	164,5	0,004
CU	FISH2	2001	5	1460	2480	1900	1800	382,7	0,007
FE	FISH1	1999	6	25160	26740	26150	26505	696,3	0,000
FE	FISH2	1999	6	34650	49130	40363	38610	5505,1	0,003
HGT	FISH1	1999	6	460	530	497	500	28,0	0,001
HGT	FISH2	1999	6	310	410	362	365	41,7	0,003
HGT	FISH2	2001	3	450	880	710	800	228,7	0,025
NI	FISH1	1999	6	1380	2140	1730	1715	244,9	0,004
NI	FISH2	1999	6	800	1110	1005	1035	116,7	0,003
PB	FISH1	1999	6	1170	1250	1198	1190	31,9	0,000
PB	FISH2	1999	6	520	860	727	790	137,4	0,008
ZN	FISH1	1999	6	31250	38230	35607	35995	2365,8	0,001
ZN	FISH2	1999	6	21100	38260	28262	26210	7210,6	0,012
ZN	FISH2	2001	5	30900	51400	39620	37300	7932,0	0,007

France

France submitted data from 1996 to 2003 (covering the period of MED POL Phase III with available data) for mass fraction of trace metals, organochlorine pesticides and polyaromatic hydrocarbons in *Mytilus galloprovincialis*. The data is part of the ongoing NMP initiated in 1979. The trend monitoring sampling strategy adopted by France is different from the one adopted by the countries that participate in MED POL Phase III. One pooled sample with 50-60 specimens was used for the analysis and sampling frequency was seasonal. With every set of samples, CRM was also analysed with a variable number of replicates (2-6). QA exercises were performed regularly.

The data as well as trend analysis were regularly published in RNO Bulletins of IFREMER and made available on the internet (http://www.ifremer.fr/envlit/documentation/documents.htm#2). The trend evaluation was related to a seasonal sampling strategy and was based on a statistical model with a linear multiple regression. An example (RNO Bulletin, 2000) of the trend evaluation is presented in the next frame.

Example:

Trend evaluation for cadmium in *Mytilus galloprovincialis* (MG) at Locmariaquer

A statistical model of Cd mass fraction in MG from 1979 -1999 at Locmariaquer (Fig . A) was estimated with the next equation:

$$[\,\mathrm{Cd}\,]_{ij}^{\text{estimée}} = 1.60 - 0.11 t_i + 0.14 \sin\left(\frac{2\pi}{12} j\right) + 0.26 \cos\left(\frac{2\pi}{12} j\right)$$

The explained seasonal variance was 65 % for 81 samples. The statistical model result are presented in Fig. B and are plotted over the original data after a log transformation. On Fig. C the seasonal component are presented (calculated and from model). On Fig. D the trend after deseasoning the data and from model is presented.

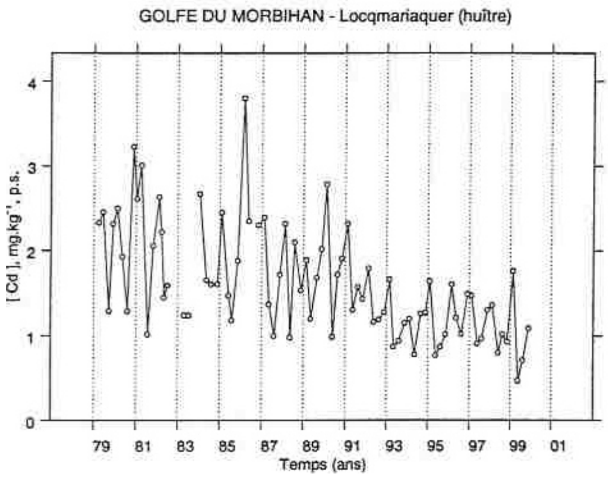


Figure A Original data.

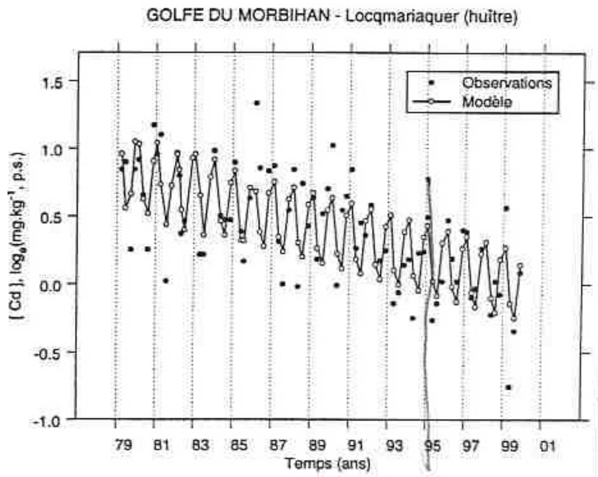


Figure B Original data and statistical model.

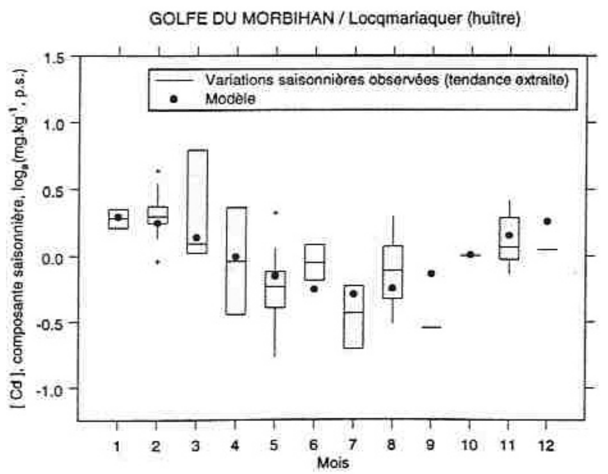


Figure C Seasonal components.

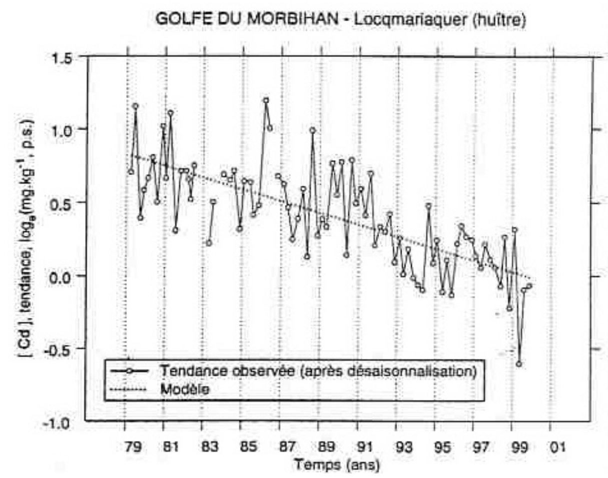


Figure D Detected trend.

Greece

The only data set of Greece in the MED POL Database is related to 1999. The national institute implementing the programme was requested for additional data for the purpose of trend analysis at one of the designated monitoring sites in the NMP and data for the 1993-2001 period was provided to the Secretariat accordingly. The 1999 data of that specific site is elaborated and presented within the whole period. The sampling strategy is seasonal but for this trend evaluation only one season was selected. In consultation with the national expert, September was agreed to be the pre-spawning period in the area, and all results refer to that season. It would be ideal to perform a de-seasonized trend evaluation to get most of the information from the data but that is far away from the scopes of this evaluation.

In order to understand the sampling variance, some exploratory statistics was performed and the within year variances were calculated. The results (Table 2.3.8a,b) showed low within year variance with few acceptable outliers well on track for a successful trend monitoring.

The trend evaluation results are fully presented in Table 2.3.9 and some of the graphical outputs in Fig. 2.3.4. The results show that the two analyzed stations have very similar trend patterns indicating that the wider area processes dominate the local conditions of the station. For FE a downward monotonic trend was detected (Fig. 2.3.4) but the lowess smoother method confirmed an upward trend for ZN.

Table 2.3.9 Trend evaluation results in *Mytilus galloproviancialis* for the period 1993-2001

Station	Parameter	Mann – Kendall test	Probability on false positive	Smoother	Trend size	Probability on false positive
C3	CD	NO	22,7 %	**UPWARD**	220 %	< 0,05 %
C3	CR	NO	35,6 %	**DOWNWARD**	21 %	< 0,05 %
C3	CU	NO	17,4 %	**DOWNWARD**	16 %	< 0,05 %
C3	FE	YES	2,4 %	**DOWNWARD**	50 %	< 0,05 %
C3	MN	NO	3,4 %	**DOWNWARD**	64 %	< 0,05 %
C3	NI	NO	46,0 %	**DOWNWARD**	12 %	< 0,05 %
C3	ZN	NO	3,8 %	**UPWARD**	106 %	< 0,05 %
C8A	CD	NO	22,7 %	**UPWARD**	90 %	< 0,05 %
C8A	CR	NO	35,6 %	**DOWNWARD**	39 %	< 0,05 %
C8A	CU	NO	12,5 %	**DOWNWARD**	19 %	< 0,05 %
C8A	FE	YES	49,0 %	**DOWNWARD**	46 %	< 0,05 %
C8A	MN	NO	35,6 %	**DOWNWARD**	8 %	< 0,05 %
C8A	NI	NO	37,8 %	**DOWNWARD**	30 %	< 0,05 %
C8A	ZN	NO	5,94 %	**UPWARD**	55 %	< 0,05 %

Table 2.3.8a Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mytilus galloproviancialis* at two stations in Greece in the period 1993-2001(concentrations are in μg/kg DW)

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	C3	1995	3	117	181	154	165	33,4	0,010
CD	C3	1996	5	395	705	529	512	124,6	0,010
CD	C3	1997	6	836	2746	1319	1018	730,0	0,038
CD	C3	1998	4	313	383	348	349	28,5	0,001
CD	C3	1999	5	203	713	390	342	190,9	0,038
CD	C3	2000	5	630	1357	1025	959	281,5	0,017
CD	C8A	1995	3	117	229	157	126	62,2	0,026
CD	C8A	1996	7	416	574	487	492	58,9	0,003
CD	C8A	1997	6	701	1575	1102	1107	336,4	0,019
CD	C8A	1998	4	17	369	252	312	160,9	0,408
CD	C8A	1999	5	163	376	281	318	86,3	0,022
CD	C8A	2000	3	437	659	539	520	111,7	0,008
CR	C3	1993	14	915	6164	3266	3056	1445,6	0,048
CR	C3	1994	18	1629	11829	5408	4717	3062,9	0,061
CR	C3	1995	8	1247	4640	2381	2134	1134,6	0,037
CR	C3	1996	5	1933	3893	2902	2769	743,2	0,013
CR	C3	1997	6	483	1825	1303	1378	490,2	0,045
CR	C3	1998	4	990	1265	1168	1209	122,1	0,002
CR	C3	1999	5	2358	3185	2754	2678	322,3	0,003
CR	C3	2000	5	5265	6521	5821	5583	562,4	0,002
CR	C8A	1993	16	1743	9435	4134	3658	1977,5	0,036
CR	C8A	1994	16	1788	15317	6756	5987	4110,9	0,086
CR	C8A	1995	7	1048	4319	2537	2417	1042,6	0,038
CR	C8A	1996	7	2632	4922	3665	3806	834,2	0,010
CR	C8A	1997	6	634	1842	1403	1440	414,1	0,027
CR	C8A	1998	4	1562	2163	1737	1611	287,8	0,005
CR	C8A	1999	5	2636	2951	2856	2920	132,2	0,000
CR	C8A	2000	3	4596	4767	4667	4636	89,4	0,000
CU	C3	1993	14	2926	6449	4404	4215	992,9	0,009
CU	C3	1994	18	2304	7577	3995	3397	1494,7	0,023
CU	C3	1995	8	5747	9472	8109	8171	1236,1	0,005
CU	C3	1996	5	6645	8016	7372	7364	517,9	0,001
CU	C3	1997	6	5753	7367	6368	6254	654,9	0,002
CU	C3	1998	4	4593	5297	4973	5001	306,8	0,001
CU	C3	1999	5	3829	5305	4204	3926	620,9	0,003
CU	C3	2000	5	4474	4924	4724	4665	191,1	0,000
CU	C3	2001	6	3796	4237	4050	4048	150,7	0,000
CU	C8A	1993	16	2256	8453	3461	3060	1479,1	0,020
CU	C8A	1994	15	1165	6263	3488	3033	1483,0	0,037
CU	C8A	1995	8	4913	8733	6736	6755	1091,7	0,005
CU	C8A	1996	7	5324	6841	5942	5897	499,7	0,001
CU	C8A	1997	6	4440	7242	5421	5216	959,7	0,005
CU	C8A	1998	4	4368	5076	4836	4949	317,7	0,001
CU	C8A	1999	5	3469	4025	3678	3590	220,8	0,001
CU	C8A	2000	3	3119	3239	3188	3206	62,1	0,000
CU	C8A	2001	6	3135	3820	3350	3257	247,6	0,001

Table 2.3.8b Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mytilus galloprovincialis* at two stations in Greece in the period 1993-2001.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
MN	C3	1993	12	15208	37427	28223	28008	6630,9	0,013
MN	C3	1994	17	5204	25641	13027	10308	6555,3	0,048
MN	C3	1996	5	15395	19348	17411	17292	1428,9	0,001
MN	C3	1997	6	8460	12606	10681	10659	1570,8	0,004
MN	C3	1998	4	7248	8454	7959	8067	530,6	0,001
MN	C3	1999	5	3641	7933	6760	7674	1812,2	0,021
MN	C3	2000	5	11166	15257	13387	13281	1488,6	0,002
MN	C3	2001	6	6892	8907	7730	7623	776,4	0,002
MN	C8A	1993	15	2431	6706	4255	4565	1270,8	0,017
MN	C8A	1994	15	1685	9372	4764	3707	2594,6	0,049
MN	C8A	1996	7	4766	14494	6638	5402	3476,8	0,028
MN	C8A	1997	6	3761	5454	4589	4664	729,5	0,005
MN	C8A	1998	4	4816	5297	4977	4898	218,0	0,000
MN	C8A	1999	5	4092	5667	4742	4586	578,7	0,003
MN	C8A	2000	3	3549	4867	4209	4210	658,7	0,005
MN	C8A	2001	6	4256	5190	4640	4563	394,3	0,001
NI	C3	1993	14	1188	3244	1983	1975	516,6	0,012
NI	C3	1994	18	1924	7448	3651	3206	1675,9	0,036
NI	C3	1995	8	5066	6310	5526	5357	446,4	0,001
NI	C3	1996	5	3695	4152	3901	3861	167,6	0,000
NI	C3	1997	6	1561	3603	2456	2417	731,4	0,017
NI	C3	1998	4	1889	2643	2218	2171	355,5	0,005
NI	C3	1999	5	445	2072	1327	1366	578,5	0,063
NI	C3	2000	5	2402	3247	2876	2912	317,6	0,002
NI	C3	2001	6	2894	4206	3674	3807	473,1	0,003
NI	C8A	1993	16	707	2992	1756	1778	667,9	0,034
NI	C8A	1994	16	1085	8646	3894	3379	2281,1	0,073
NI	C8A	1995	8	3898	6319	4839	4829	769,8	0,005
NI	C8A	1996	7	2673	3259	2991	3103	256,0	0,001
NI	C8A	1997	6	452	1317	867	798	381,0	0,039
NI	C8A	1998	4	385	1703	871	699	604,3	0,087
NI	C8A	1999	5	333	3757	2093	2297	1235,0	0,164
NI	C8A	2000	3	795	1815	1432	1686	555,8	0,039
NI	C8A	2001	6	3010	3406	3285	3336	142,5	0,000
ZN	C3	1993	14	54785	166517	85199	80112	32180,7	0,021
ZN	C3	1994	16	83507	164798	134068	143858	25012,4	0,008
ZN	C3	1995	8	98184	161123	133222	131447	21253,1	0,005
ZN	C3	1996	5	175650	252071	220817	230226	33581,2	0,005
ZN	C3	1997	6	146952	333556	226722	201230	71919,9	0,018
ZN	C3	1998	4	155050	177403	167346	168465	9714,6	0,001
ZN	C3	1999	5	71772	183203	138895	139385	42228,4	0,025
ZN	C3	2000	5	202887	275937	235829	216324	36386,7	0,004
ZN	C3	2001	6	173033	247586	214161	215597	28022,7	0,003
ZN	C8A	1993	16	69240	207339	151111	167773	41264,0	0,019
ZN	C8A	1994	15	61121	214272	134623	139320	40288,0	0,021
ZN	C8A	1995	8	73420	174343	149158	160726	33781,7	0,016

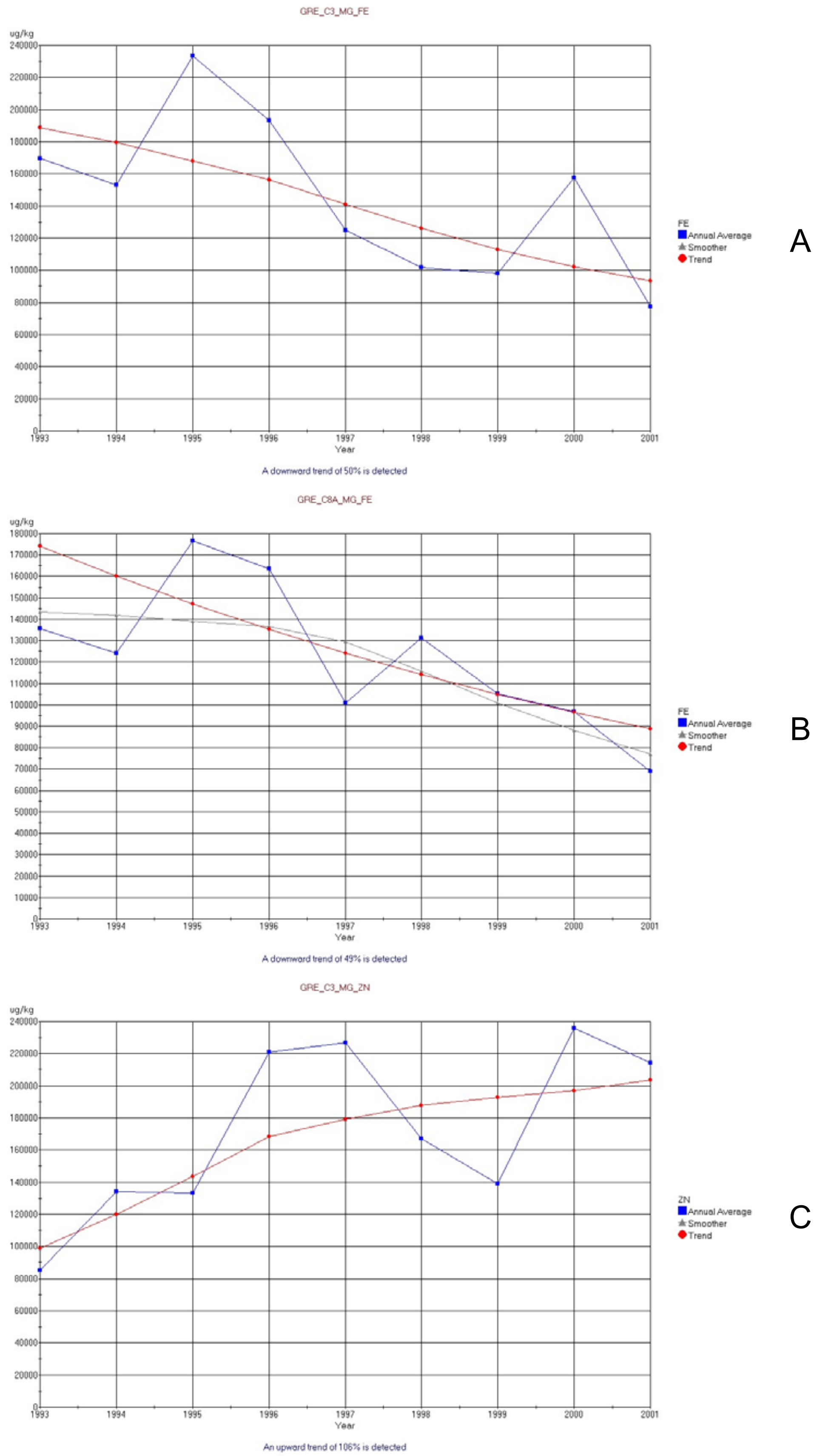


Figure 2.3.4 Graphical output from “Trend-Y-tector” software suite for FE at station C3 (A) and C8A (B), and ZN at station C3 (C).

Israel

Israel has regularly submitted data to the MED POL Database during the period from 1999 to 2003. It was agreed with the national MED POL designated institute to provide longer term data for the purpose of trend evaluation and additional data was provided for 1991-1998 thus to make available continuous data for more than a decade. Only the analysis for CD and HGT data will be reviewed in this report.

In the monitoring strategy of MED POL Phase III for the eastern Mediterranean, *Mullus barbatus* was chosen as the target monitoring organism. In addition, two bivalves, *Mactra corallina* and *Donax trunculus,* were adopted by Israel as biomonitoring species.

Considering that only four years of *M. barbatus* data was available, this data set could not be used for trend analysis. Therefore, only descriptive statistics for trace metals mass fraction in *M. barbatus* is presented in Table 2.3.10. In general, data shows low sampling variance with the exception of total mercury (HGT) for which the variances are substantially higher than the threshold of 0,060. The reason for such high variances is probably due to the values which are closer to the detection limit (DL). This is also true for cadmium for which all values are practically below DL. From explorative statistics (Fig. 2.3.5) it also emerged that the length class of sampled fish is large and different every sampling year. To minimize the sampling variance, a better sampling strategy has to be decided.

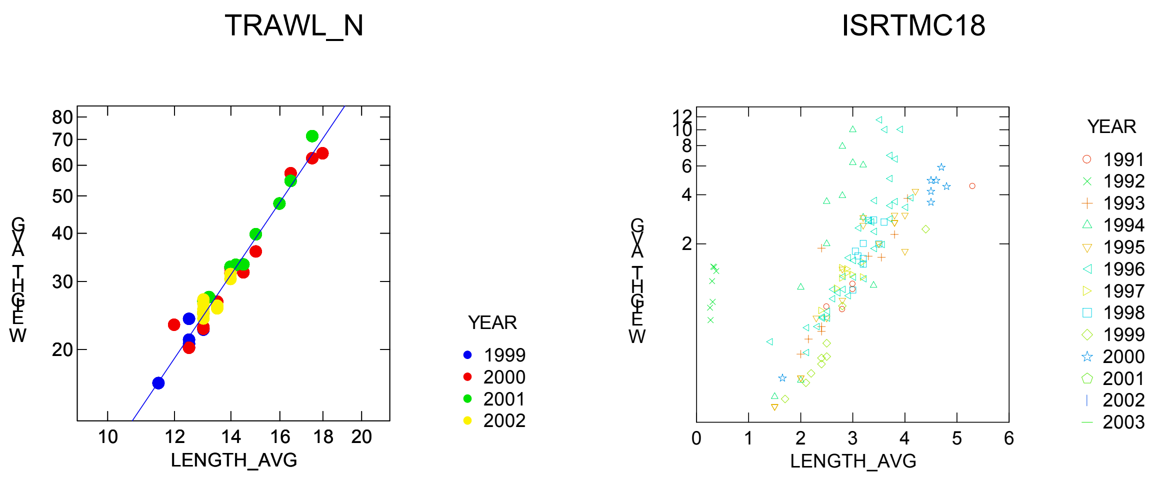


Figure 2.3.5. Length vs. Weight for *Mullus barbatus* at station TRAWL_N and *Mactra corallina* at station ISRTMC18 by year.

CRM analysis data were also provided and they indicate a good laboratory practice. CRM was analysed in parallel with environmental data but no replicate analysis was performed. In order to understand the underlying analytical variance such a practice has to be encouraged, specifically when data are used for trend evaluation. Israel regularly participated to the QA exercises (Table 2.3.11)

The data related to *M. corallina* for the period 1991-2003 were successfully used and trend analysis was performed (Table 2.3.12). Regarding CD, the negative Mann-Kendall test indicates that the trend is not monotonic or linear. The lowess smoother test suggests that the trend is not linear and characterised with an increase of CD mass fraction at the end of 1990s with a subsequent decrease at the end of the sampling period to lower than at the beginning values (e.g. Fig. 2.3.6). This trend can be observed practically on all stations. Similarly, HGT exhibits a pronounced upward trend on all stations. Frequently the Mann-Kendall test is positive indicating a monotonic (linear) upward trend on some stations (e.g. Fig. 2.3.6).

HGT and CD trends show that probably the area processes are dominant, and the local effects are not pronounced. It also demonstrates that *M. corallina* can be a good monitoring organism for the area.

Table 2.3.10 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metals mass fractions (μg/kg DW) of *Mullus barbatus* at station TRAWL_N (HFM9) along the coast of Israel in the period 1999-2002.

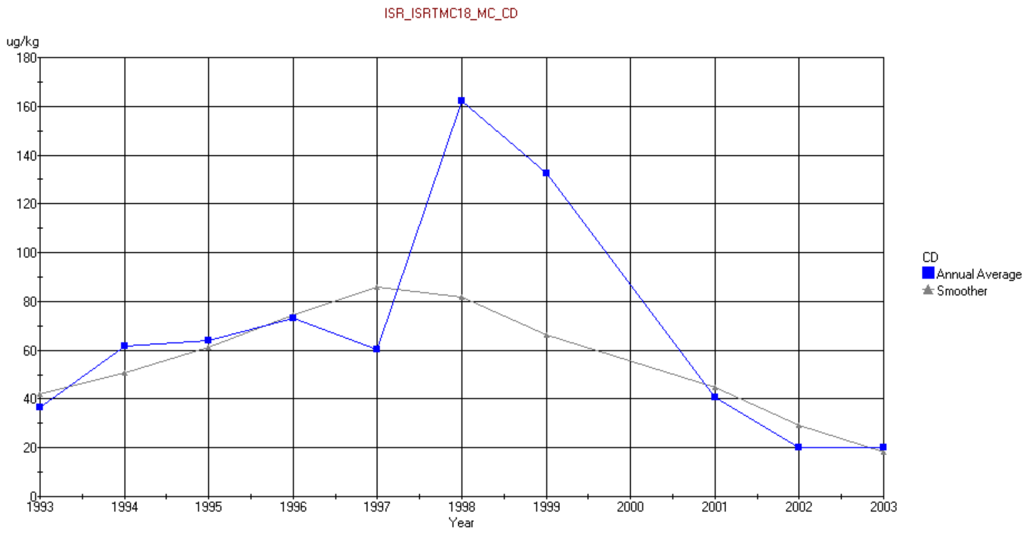
Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	TRAWL_N	1999	8	BDL	493	160	112	157,0	0,241
CD	TRAWL_N	2000	12			BDL			
CD	TRAWL_N	2001	9			BDL			
CD	TRAWL_N	2002	13			BDL			
CD	TRAWL_S	2002	12			BDL			
CU	TRAWL_N	1999	8	1512	3304	2009	1817	564,8	0,011
CU	TRAWL_N	2000	12	1247	1895	1542	1553	160,4	0,002
CU	TRAWL_N	2001	9	1301	2151	1773	1701	305,7	0,006
CU	TRAWL_N	2002	13	1466	2366	1965	1961	288,8	0,004
CU	TRAWL_S	2002	12	884	1530	1236	1270	236,9	0,007
FE	TRAWL_N	1999	8	10631	23186	17380	17778	3612,8	0,010
FE	TRAWL_N	2000	12	15087	40425	23040	20562	7333,2	0,016
FE	TRAWL_N	2001	9	15386	23662	18801	17990	2517,7	0,003
FE	TRAWL_N	2002	13	11366	45025	22392	20288	10919,3	0,043
FE	TRAWL_S	2002	12	5739	20589	13499	13795	4580,9	0,027
HGT	TRAWL_N	1999	8	21	275	139	135	115,5	0,243
HGT	TRAWL_N	2000	12	6	81	25	15	21,7	0,104
HGT	TRAWL_N	2001	9	92	232	175	180	41,6	0,014
HGT	TRAWL_N	2002	13	151	400	189	170	66,8	0,013
HGT	TRAWL_S	2002	12	88	2541	1143	926	857,6	0,207
MN	TRAWL_N	1999	8	624	948	781	763	122,7	0,005
MN	TRAWL_N	2000	12	570	1279	740	679	194,8	0,010
ZN	TRAWL_N	1999	8	13655	36912	24787	25260	7189,1	0,018
ZN	TRAWL_N	2000	12	10944	15825	13269	13284	1546,2	0,003
ZN	TRAWL_N	2001	9	12349	16377	14338	14459	1271,5	0,002
ZN	TRAWL_N	2002	13	12415	16373	14067	13858	1192,7	0,001
ZN	TRAWL_S	2002	12	9565	27242	15324	13482	4732,3	0,014

Table 2.3.11 Z-scores for trace metals in biota.

Year	Intercal. Code	CD_z	CR_z	CU_z	FE_z	HGT_z	MN_z	NI_z	PB_z	ZN_z
2002	MA-Medpol-6	0,70	0,10	2,80	6,40	-3,30	2,90			1,80
2003	IAEA-407	0,97		0,71	-0,62	0,13	-0,64			-0,80

Table 2.3.12 Trend evaluation results in *Mactra corallina* for the period 1991-2003.

Station	Parameter	Mann – Kendall test	Probability on false positive	Smoother	Trend size	Probability on false positive
ISRTMC14	CD	NO	46,8 %	**DOWNWARD**	90 %	< 0,05 %
ISRTMC18	CD	NO	26,4 %	**DOWNWARD**	91 %	< 0,05 %
ISRTMC22	CD	NO	50,0 %	**DOWNWARD**	89 %	< 0,05 %
ISRTMC23	CD	NO	44,0 %	**DOWNWARD**	73 %	< 0,05 %
ISRTMH1	CD	NO	10,6 %	**UPWARD**	126 %	< 0,05 %
ISRTMH2	CD	NO	17,4 %	**DOWNWARD**	43 %	< 0,05 %
ISRTMH8	CD	NO	50,0 %	**DOWNWARD**	90 %	< 0,05 %
ISRTMH9	CD	NO	34,8 %	**DOWNWARD**	90 %	< 0,05 %
ISRTMH10	CD	NO	36,7 %	**DOWNWARD**	50 %	< 0,05 %
ISRTMH11	CD	NO	50,0 %	**DOWNWARD**	77 %	< 0,05 %
ISRTMH12	CD	NO	29,1 %	**DOWNWARD**	88 %	< 0,05 %
ISRTMC14	HGT	NO	24,2 %	**UPWARD**	222 %	< 0,05 %
ISRTMC18	HGT	YES	1,9 %	**UPWARD**	1431 %	< 0,05 %
ISRTMC22	HGT	NO	33,4 %	**UPWARD**	256 %	< 0,05 %
ISRTMC23	HGT			**discontinued data**		
ISRTMH1	HGT	YES	2,4 %	**UPWARD**	432 %	< 0,05 %
ISRTMH2	HGT	NO	33,7 %	**UPWARD**	113 %	< 0,05 %
ISRTMH8	HGT	YES	0,3 %	**UPWARD**	708 %	< 0,05 %
ISRTMH9	HGT	NO	14,2 %	**UPWARD**	290 %	< 0,05 %
ISRTMH10	HGT	NO	13,3	**UPWARD**	73 %	< 0,05 %
ISRTMH11	HGT			**discontinued data**		
ISRTMH12	HGT	NO	15,2 %	**UPWARD**	256 %	< 0,05 %



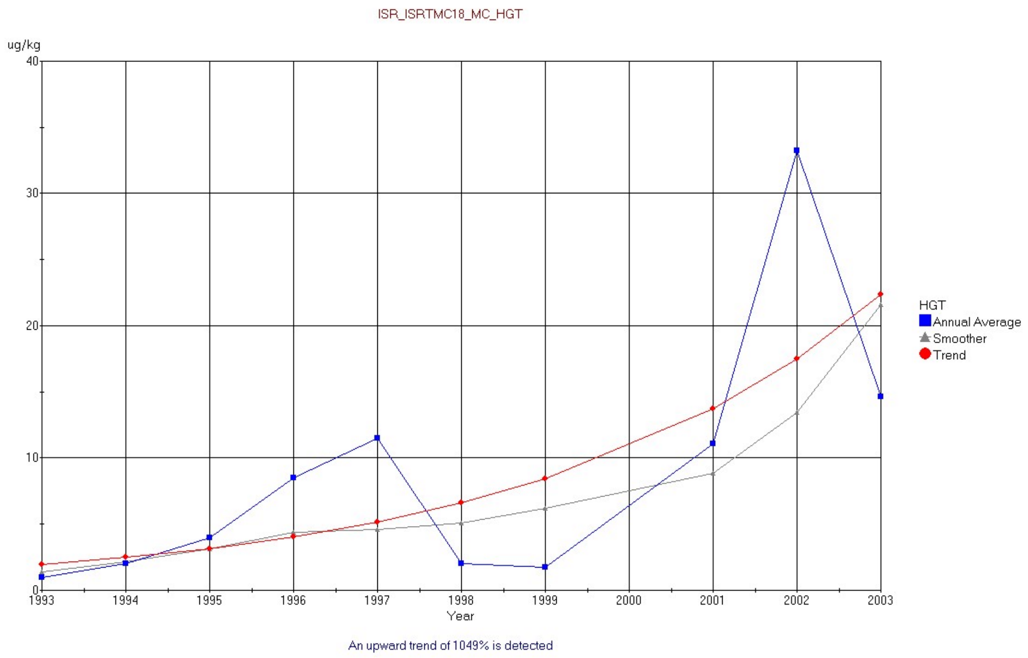


Figure 2.3.6. Graphical output from "Trend-Y-tector" software suite for CD and HGT at station ISRTMC18.

Slovenia

The Slovenian data show a serious and strict maintenance of the decided sampling strategy. Such approach is essential for a successful trend monitoring. The data descriptive statistics are presented in Table 2.3.13 and Figure 2.3.7. The within year sampling variance is very low and far below the threshold of 0,060. The acceptable z scores, z<<2 (Table 2.3.14), allow to assess trends with each observation given equal statistical weight. The number of sampled years (5) is on the edge to perform a valuable assessment. The results of the assessment are presented in Table 2.3.15 and indicate that a monotonic, upward or downward, trend is not present (negative Mann-Kendall test). The smoother (lowess was not applied due to N<7 years) indicate that probably non-linear trends are present. For CD mass fraction at station TM (Fig. 2.3.8), a non-linear trend result as a substantial downward trend. The statistical test shows a very low probability of a false positive test.

During the statistical evaluation and trend assessment emerged that Slovenia was not regularly submitting data related to CRM analysis as part of the routine QA. The CRM analysis is essential in understanding the contribution of the analytical variance to the total environmental and analytical variance.

Table 2.3.13 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mytilus galloprovincialis* at stations along the Slovenian coast in the period 1999-2004 (concentrations are in μg/kg DW)

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	24	1999	1	1110	1110	1110	1110		
CD	24	2000	5	1040	1280	1116	1100	96,6	0,001
CD	24	2001	5	940	980	964	970	15,2	0,000
CD	24	2002	5	567	787	674,4	683	80,6	0,003
CD	24	2003	5	910	1180	1046	1070	101,6	0,002
CD	24	2004	5	900	970	926	920	27,0	0,000
CD	TM	1999	1	1270	1270	1270	1270		
CD	TM	2000	5	1000	1110	1050	1020	51,0	0,000
CD	TM	2001	5	670	880	790	790	77,8	0,002
CD	TM	2002	5	829	1110	987,2	999	100,7	0,002
CD	TM	2003	5	550	670	606	590	45,6	0,001
CD	TM	2004	5	590	670	640	650	31,6	0,000
HGT	24	1999	1	120	120	120	120		
HGT	24	2000	5	104	134	117,2	116	10,8	0,002
HGT	24	2001	5	80	87	84,4	85	2,7	0,000
HGT	24	2002	5	102	123	111,2	112	8,2	0,001
HGT	24	2003	5	134	156	143,2	138	10,1	0,001
HGT	24	2004	5	69	139	115,4	131	29,3	0,016
HGT	TM	1999	1	110	110	110	110		
HGT	TM	2000	5	190	261	239,2	253	29,2	0,003
HGT	TM	2001	5	63	82	71,2	70	7,9	0,002
HGT	TM	2002	5	118	139	132,4	136	8,3	0,001
HGT	TM	2003	5	104	119	112	113	6,8	0,001
HGT	TM	2004	5	100	170	132,2	132	26,2	0,007
CD	24	1999	1	1110	1110	1110	1110		
CD	24	2000	5	1040	1280	1116	1100	96,6	0,001
CD	24	2001	5	940	980	964	970	15,2	0,000
CD	24	2002	5	567	787	674,4	683	80,6	0,003
CD	24	2003	5	910	1180	1046	1070	101,6	0,002
CD	24	2004	5	900	970	926	920	27,0	0,000

Table 2.3.14 Z-scores for trace metals in biota.

Year	Intercal. Code	CD_z	CR_z	CU_z	FE_z	HGT_z	MN_z	NI_z	PB_z	ZN_z
2001	IAEA-405					0,4				
2003	IAEA-407					0,22				

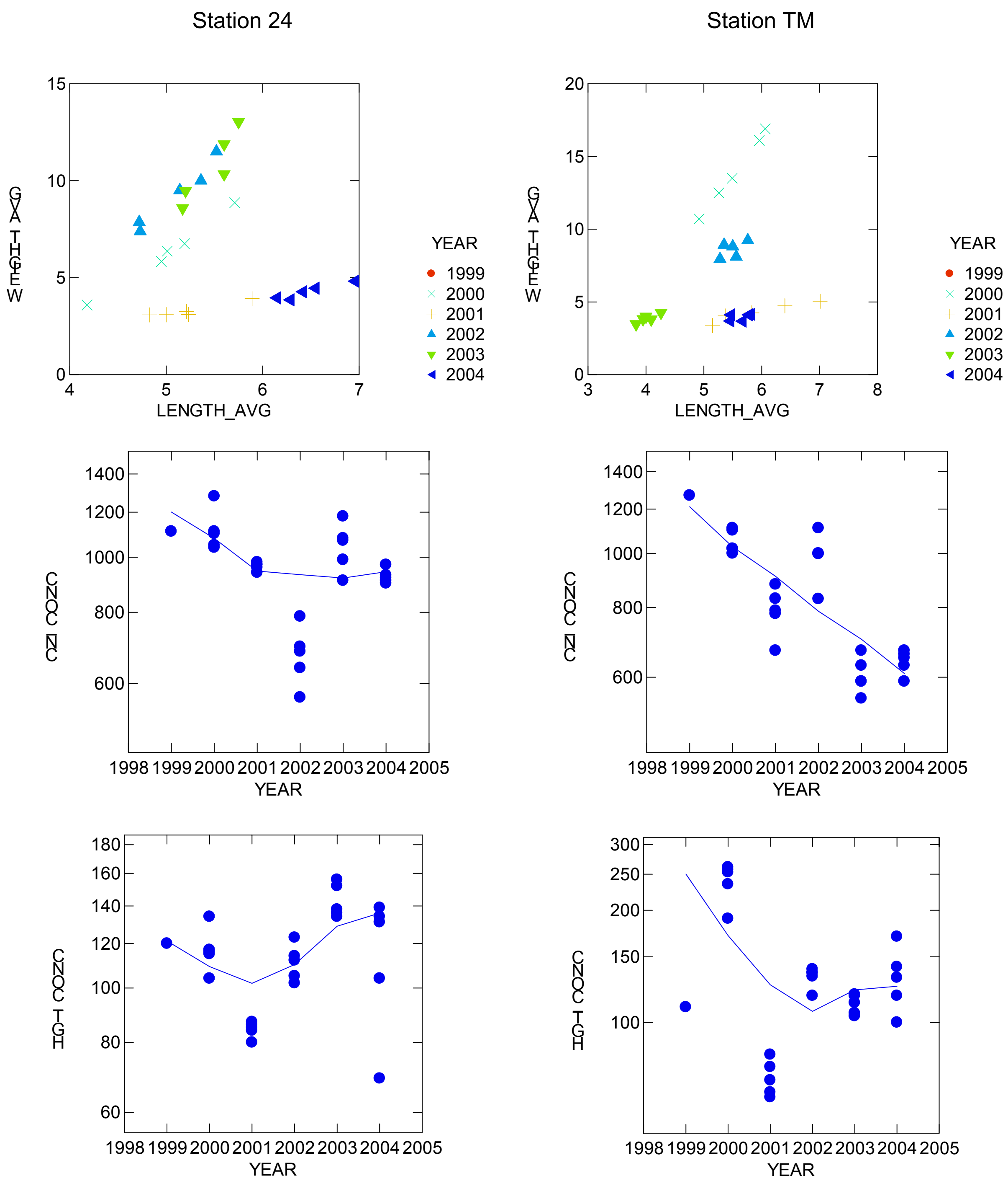


Figure 2.3.7 Values (Log scale) of cadmium and total mercury mass fraction in *Mytilus galloprovincialis* (MG) by year at station 24 and TM in Slovenian coastal waters. A lowess smother was applied to the data.

Table 2.3.15 Trend evaluation results.

Station	Parameter	Mann – Kendall test	Probability on false positive	Smoother	Trend size	Probability on false positive
0024	CD	NO	12,9 %	**DOWNWARD**	13 %	< 0,05 %
0024	HGT	NO	50,0 %	**UPWARD**	12 %	< 0,05 %
00TM	CD	NO	3,01 %	**DOWNWARD**	47 %	< 0,05 %
00TM	HGT	NO	50,0 %	**DOWNWARD**	12 %	< 0,05 %

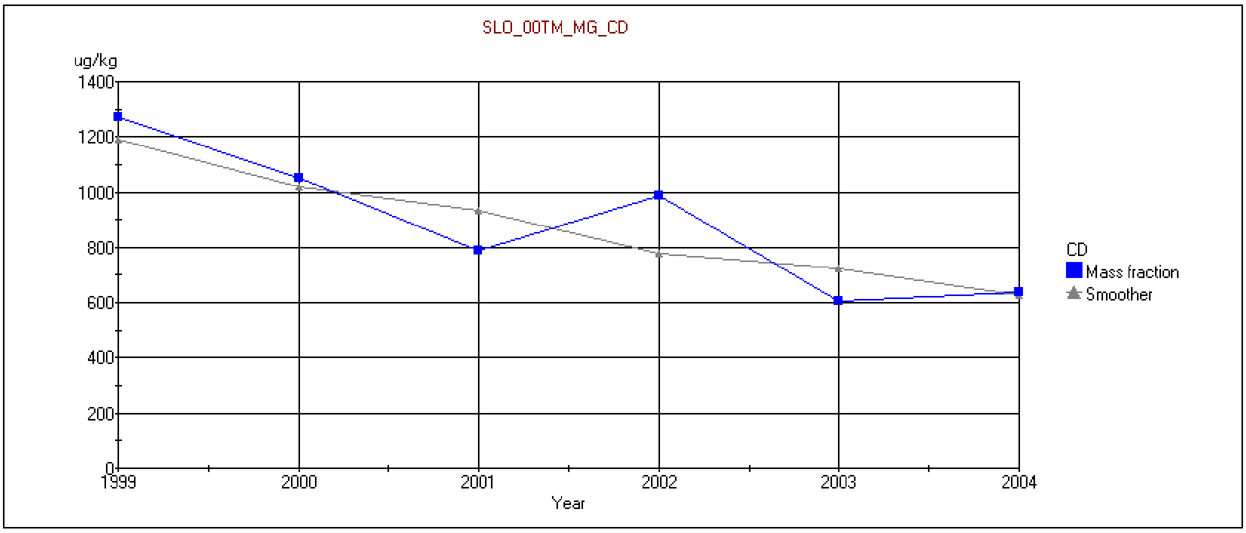


Figure 2.3.8 Trend evaluation results (from Trend-Y-tector suite) of cadmium mass fraction in *Mytilus galloprovincialis* (MG) by year at station TM in Slovenian coastal waters.

Tunisia

Since the last evaluation (UNEP(DEC)MED WG.243/3, 2003) one more year of data was submitted to the Secretariat. No trend evaluation is possible at the moment but some indications still emerge. The descriptive statistics (Table 2.3.16) show that the within year variance is very low indicating a good sampling and probably good analytical practice as well. Part of the differences in values between the two submitted years can be explained with the differences in sampling months (Table 2.3.16). The sampling month varies randomly with station and year showing that the pre-spawning period for the sampled species *Ruditapes decussatus* (RD) was not identified. In future a better sampling strategy has to be decided. It was also observed that, for the species *Ruditapes decussatus,* sampling during 2002 and 2003 is only 1-2 months apart at two stations (G1 and M1), which is not acceptable.

The within year variance is very low (Table 2.3.16) and far below the threshold of 0,060. Even the analytical variance can not be determined, only one value with no replicates for CRM analysis was submitted in 2002 and it is not expected that the analytical practice can significantly influence the future trend evaluation. As suggested for other countries, it would be valuable to analyse five replicates during the CRM analysis so that in future with the QA exercises (data presented in Table 2.3.17) data can be used for a weighted trend assessment.

Table 2.3.17 Z-scores for trace metals in biota.

Year	Intercal. Code	CD_z	CR_z	CU_z	FE_z	HGT_z	MN_z	NI_z	PB_z	ZN_z
2001	IAEA-405	-6,70		-1,80					-4,10	
2002	MA-Medpol-6	1,80		-1,90	1,40		2,80			0,90

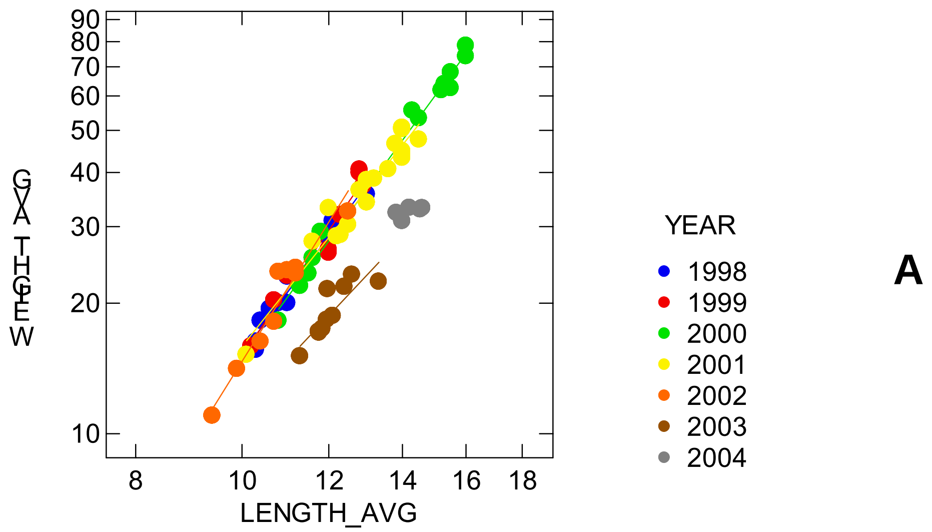
Table 2.3.16 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mytilus galloprovincialis* (MG) and *Ruditapes decussatus* (RD) at stations along the Tunisian coast in the period 2001-2003(concentrations are in μg/kg DW)

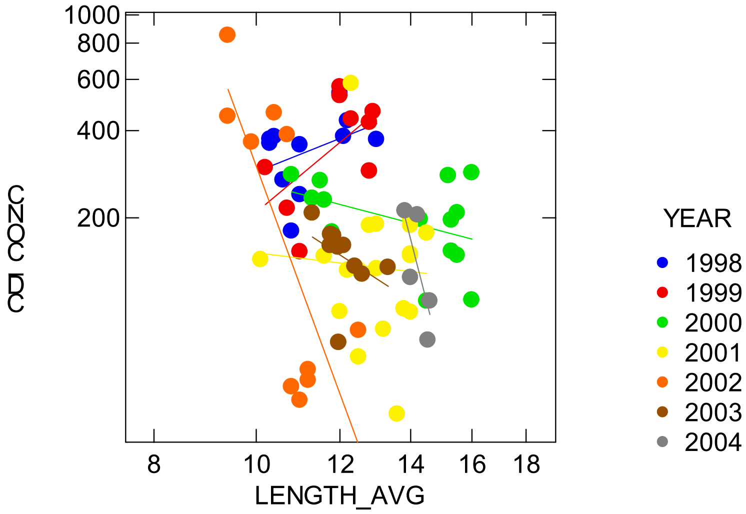
Species	Parameter	Station	Year	Month	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
MG	CD	B3	2001	5	4	812	946	877	876	70,5	0,001
	CD	B3	2002	3	4	258	342	284	267	39,4	0,003
	CD	B3	2003	4	4	326	409	370	373	34,9	0,002
	HGT	B3	2001	5	4	398	512	472	490	51,6	0,002
	HGT	B3	2002	3	4	418	491	463	471	32,3	0,001
	HGT	B3	2003	4	4	306	343	323	322	15,9	0,000
	PB	B3	2001	5	4	1980	3112	2413	2279	511,0	0,008
	PB	B3	2002	3	4	703	1439	999	927	356,1	0,024
	PB	B3	2003	4	4	572	847	677	645	126,0	0,006
RD	CD	B3	2001	5	4	398	495	432	418	43,2	0,002
	CD	B3	2002	3	4	233	356	321	347	58,7	0,008
	CD	B3	2002	4	4	191	284	227	217	40,1	0,005
	CD	G1	2001	10	4	426	596	508	505	70,7	0,004
	CD	G1	2002	12	4	287	312	301	302	11,9	0,000
	CD	G1	2003	2	4	250	382	298	307	57,4	0,006
	CD	M1	2001	10	3	402	436	420	421	17,0	0,000
	CD	M1	2002	12	3	254	353	295	277	51,8	0,005
	CD	M1	2003	1	4	228	326	273	275	52,2	0,007
	CD	S2	2001	10	4	398	454	422	417	26,4	0,001
	CD	S2	2002	2	4	183	213	197	195	13,6	0,001
	CD	S2	2003	1	4	234	362	308	303	57,5	0,007
	CD	T2	2001	5	4	295	401	340	332	45,5	0,003
	CD	T2	2002	2	4	298	394	332	318	44,6	0,003
	CD	T2	2003	3	4	263	298	280	280	15,1	0,001
	HGT	B3	2001	5	4	198	296	261	274	44,2	0,006
	HGT	B3	2002	3	4	132	148	142	144	6,9	0,000
	HGT	B3	2003	4	4	130	206	163	158	32,6	0,007
	HGT	G1	2001	10	4	146	195	168	166	20,6	0,003
	HGT	G1	2002	12	4	106	165	132	128	25,1	0,007
	HGT	G1	2003	2	4	270	360	302	309	40,5	0,003
	HGT	M1	2002	12	3	222	246	238	246	13,8	0,001
	HGT	M1	2003	1	4	63	106	75	80	20,1	0,011
	HGT	S2	2001	10	4	123	149	136	137	11,2	0,001
	HGT	S2	2002	2	4	135	182	153	148	20,5	0,003
	HGT	S2	2003	1	4	132	295	158	186	74,5	0,024
	HGT	T2	2001	5	4	229	297	276	290	31,9	0,003
	HGT	T2	2002	2	4	197	241	217	214	19,1	0,001
	HGT	T2	2003	3	4	265	492	396	414	100,3	0,014
	PB	B3	2001	5	4	149	384	220	173	111,0	0,036
	PB	B3	2002	3	4	223	278	245	240	24,9	0,002
	PB	B3	2003	4	4	686	765	717	718	33,8	0,000
	PB	G1	2001	10	4	178	326	242	232	71,5	0,016
	PB	G1	2002	12	4	268	325	299	301	24,5	0,001

Species	Parameter	Station	Year	Month	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
	PB	G1	2003	2	4	238	361	300	301	51,0	0,006
	PB	M1	2002	12	3	486	588	547	568	54,0	0,002
	PB	M1	2003	2	4	322	418	384	397	42,8	0,003
	PB	S2	2001	10	4	487	698	584	575	106,9	0,006
	PB	S2	2002	2	4	126	192	167	176	29,8	0,007
	PB	S2	2003	2	4	234	468	350	350	95,8	0,015
	PB	T2	2001	5	4	523	786	633	611	110,8	0,005
	PB	T2	2002	2	1			670			
	PB	T2	2003	3	4	467	565	511	506	44,8	0,001

Turkey

Turkey has submitted data since 1998 for trace metals mass fraction in *Mullus barbatus* and has verified all the data set in 2005 before the present analysis was performed. The data now represents a valuable set of data of seven years. The descriptive statistics (Table 2.3.18) show variable within year variances which in some cases fairly exceeds the 0,060 threshold. In the beginning, a higher variability could be expected because during the first three years a single organism was analysed and later 5-10 samples with 4-5 pooled organisms. From the length vs. weight relationship (Fig. 2.3.9a) it can be noticed that the sampled population of fish was not always the same. In the first five years the relationship was homogenous differing from 2003 and 2004 where a clear shift observed indicating that probably a different fish population was sampled. This difference is most pronounced at Mersin station (Fig. 2.3.9a) but the mass fraction of trace metals seems not to be dependent on fish size (Fig. 2.3.9b). In order to avoid the doubts on any significant trends found at such circumstances, a more strict sampling practice should be adopted which would ensure the most suitable sample set for temporal trend analysis.





B

Figure 2.3.9 (A) Length vs. weight of *Mullus barbatus* and (B) values of cadmium mass fraction in *Mullus barbatus* by length at Mersin in Turkey.

Table 2.3.18 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mullus barbatus* at stations along the coast of Turkey in the period 1998-2004(concentrations are in μg/kg DW)

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	GOKSU	1998	10	102,0	364,2	201,5	161,5	98,4	0,043
CD	GOKSU	1999	11	117,8	488,5	255,0	244,5	105,4	0,032
CD	GOKSU	2000	8	59,1	309,5	129,5	105,7	82,8	0,059
CD	GOKSU	2001	8	51,5	310,6	119,8	92,7	82,6	0,056
CD	GOKSU	2002	5	83,1	107,5	96,8	97,9	9,0	0,002
CD	GOKSU	2003	9	549,0	811,5	661,5	649,4	85,5	0,003
CD	GOKSU	2004	5	88,0	142,4	113,5	114,6	22,4	0,007
CD	MERSIN	1998	11	180,0	538,0	353,4	372,4	96,2	0,017
CD	MERSIN	1999	9	152,8	565,3	375,4	426,6	142,4	0,037
CD	MERSIN	2000	14	103,2	285,9	205,0	202,8	62,5	0,022
CD	MERSIN	2001	19	42,0	580,7	157,2	143,5	111,9	0,054
CD	MERSIN	2002	10	46,9	850,9	280,5	223,2	268,6	0,246
CD	MERSIN	2003	10	74,3	207,6	150,9	159,4	35,6	0,015
CD	MERSIN	2004	5	75,7	211,4	143,9	124,5	61,1	0,037
CD	TIRTAR	1998	11	22,4	421,7	200,1	158,1	133,8	0,186
CD	TIRTAR	1999	10	68,1	441,8	223,4	219,3	101,6	0,048
CD	TIRTAR	2000	11	22,4	371,8	172,4	170,9	122,2	0,207
CD	TIRTAR	2001	11	53,3	533,8	172,6	151,4	128,8	0,072
CD	TIRTAR	2002	5	57,9	199,6	97,2	77,6	58,7	0,047
CD	TIRTAR	2003	7	342,1	759,5	601,0	634,2	130,2	0,012
CD	TIRTAR	2004	5	42,1	65,4	52,0	52,4	8,9	0,005
HGT	GOKSU	1998	10	28,6	144,4	92,2	108,5	39,1	0,055
HGT	GOKSU	1999	11	34,6	153,3	84,5	70,2	41,3	0,050
HGT	GOKSU	2000	8	91,6	189,9	151,3	156,4	29,5	0,009
HGT	GOKSU	2001	8	49,3	176,5	123,6	129,3	45,5	0,037
HGT	GOKSU	2002	5	335,3	969,1	678,7	640,4	263,6	0,035
HGT	GOKSU	2003	9	117,3	222,1	168,6	165,6	33,7	0,008
HGT	GOKSU	2004	5	31,5	65,1	50,2	56,3	15,2	0,020
HGT	MERSIN	1998	11	54,0	170,0	97,6	98,3	35,1	0,023
HGT	MERSIN	1999	9	61,7	263,2	129,9	123,1	58,0	0,033
HGT	MERSIN	2000	14	60,4	416,7	207,0	183,0	97,2	0,045
HGT	MERSIN	2001	19	101,5	721,7	290,9	251,2	177,0	0,069
HGT	MERSIN	2002	10	90,4	150,2	122,9	121,1	19,1	0,005
HGT	MERSIN	2003	10	36,9	385,0	94,7	58,5	105,4	0,092
HGT	MERSIN	2004	5	102,7	146,3	125,6	123,5	18,8	0,004
HGT	TIRTAR	1998	11	55,4	166,9	98,9	110,5	34,1	0,023
HGT	TIRTAR	1999	10	48,4	159,6	95,4	90,0	34,7	0,026
HGT	TIRTAR	2000	11	63,0	361,5	143,8	117,5	90,8	0,063
HGT	TIRTAR	2001	11	87,2	229,4	165,7	170,6	45,9	0,019
HGT	TIRTAR	2002	5	95,3	266,4	149,3	114,3	71,8	0,035
HGT	TIRTAR	2003	7	68,2	133,2	102,5	103,4	19,5	0,008
HGT	TIRTAR	2004	5	54,7	93,4	69,0	66,7	15,3	0,008

The analysis of the analytical variance (Table 2.3.19) and results of the QA exercise (Table 2.3.20) show an excellent laboratory practice and from the analytical point of view the trend evaluation has not to be down-weighted.

Table 2.3.19. Analysis of analytical variance in DORM-2 CRM (Dogfish muscle by NRCC) for data submitted by Turkey.

Year	1999		2000		2001		2002		2003	
		Log(ω)		Log(ω)		Log(ω)		Log(ω)		Log(ω)
$\omega(HgT)\cdot10^6$	4,29	0,63	4,50	0,65	4,40	0,64	4,60	0,66	4,64	0,67
4,64±0,26*	4,41	0,64	4,60	0,66			4,50	0,65	4,51	0,65
Variance		0,00007		0,00005				0,00005		0,00008
$\omega(Zn)\cdot10^6$	25,47	1,41	20,40	1,31	20,60	1,31	27,30	1,44		
25,6±2,3*	23,99	1,38	24,50	1,39	29,50	1,47	25,30	1,40		
	23,70	1,37	24,00	1,38	24,20	1,38	23,60	1,37		
	24,94	1,40								
	24,76	1,39								
	24,40	1,39								
Variance		0,00013		0,00190		0,00610		0,00100		
$\omega(Cd)\cdot10^6$	0,05	-1,35					0,04	-1,40		
0,043±0,008*	0,04	-1,42					0,04	-1,38		
Variance		0,00270						0,00022		
$\omega(Cu)\cdot10^6$	2,59	0,41	2,16	0,33	2,80	0,45	2,33	0,37		
2,34±0,16*	2,73	0,44	2,02	0,31	2,13	0,33	2,31	0,36		
	2,42	0,38	2,74	0,44	2,35	0,37	2,29	0,36		
Variance		0,00069		0,00484		0,00362		0,00001		

* reference values

Table 2.3.20 Z-scores for trace metals in biota .

Year	Intercal. Code	CD_z	CR_z	CU_z	FE_z	HGT_z	MN_z	NI_z	PB_z	ZN_z
2003	IAEA-407					-0,18				-0,82

The trend evaluations on the overall data set are presented in Table 2.3.21. In general, the detected trend is small or inexistent and presents only variations around a certain value. No significant downward or upward trend was detected with the exception of cadmium at Mersin station where a significant monotonic downward trend was observed (Fig.2.3.10).

Table 2.3.21 Trend evaluation results

Station	Para-meter	Period	Mann - Kendall test	Probability on false positive	Lowess Smoother	Trend size	Probability on false positive
GOKSU	CD	1998-04	NO	18,4 %	**UPWARD**	3 %	< 0,05 %
GOKSU	CR	2000-04	NO	40,5 %	**UPWARD**	2 %	0,63%
GOKSU	CU	1998-04	NO	6,68 %	**UPWARD**	59 %	< 0,05 %
GOKSU	HGT	1998-04	NO	38,2 %	**DOWNWARD**	46 %	< 0,05 %
GOKSU	ZN	1998-04	NO	50,0 %	**UPWARD**	111 %	< 0,05 %
MERSIN	CD	1998-04	YES	1,79 %	**DOWNWARD**	58 %	< 0,05 %
MERSIN	CR	2000-04	NO	40,5 %	**DOWNWARD**	41 %	< 0,05 %
MERSIN	CU	1998-04	NO	11,5 %	**DOWNWARD**	63 %	< 0,05 %
MERSIN	HGT	1998-04	NO	50,0 %	**DOWNWARD**	13 %	< 0,05 %
MERSIN	ZN	1998-04	NO	50,0 %	**NO**	9 %	< 0,05 %
TIRTAR	CD	1998-04	NO	18,4 %	**DOWNWARD**	39 %	< 0,05 %
TIRTAR	CR	2000-04	NO	23,3 %	**DOWNWARD**	38 %	< 0,05 %
TIRTAR	CU	1998-04	NO	18,4 %	**DOWNWARD**	59%	< 0,05 %
TIRTAR	HGT	1998-04	NO	50,0 %	**DOWNWARD**	16 %	< 0,05 %
TIRTAR	ZN	1998-04	NO	27.4 %	**UPWARD**	25 %	< 0,05 %

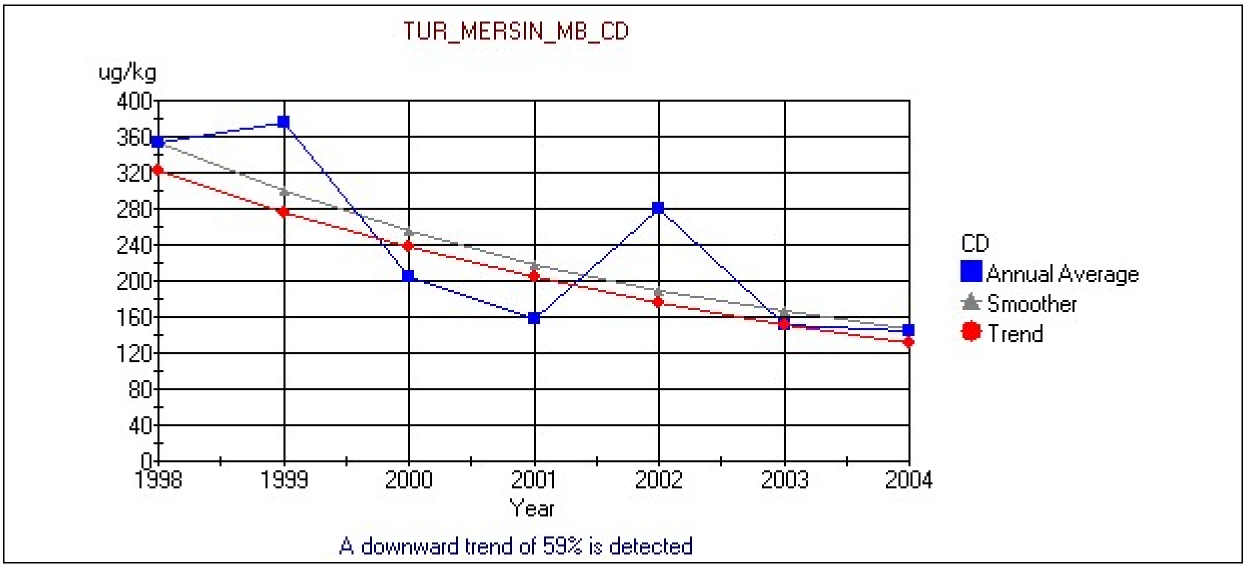


Figure 2.3.10 Trend evaluation results (from Trend-Y-tector suite) of cadmium mass fraction in *Mullus barbatus* (MB) by year at Mersin station in Turkey coastal waters.

Conclusions

The performed evaluation shows that the trend monitoring of trace metals in biota can be used to assess a change with time of the environmental levels of chemical contaminants. It was particularly evident when longer data series were evaluated which had been provided by countries with long-term monitoring programmes maintained in time. This can be used as an important tool for the assessment of the effectiveness of control measures taken at the pollution hot spots and also for state assessment.

Some problems were identified during the data analysis and trend evaluation, mainly dealing with the lack of maintaining the initial sampling strategy. **To overcome these problems, countries are encouraged to write a detailed programme manual where all issues regarding a successful programme realisation would be addressed. The manual has to deal with objectives and detailed methodological approach aiming to successfully maintain the programme over time (positioning, sampling, methods, and data elaboration, exchange and presentation).** From the trend monitoring point of view, the best sampling strategy always aims at attaining the best information on the sampling variance and through that a valuable determination of the underlying trend. As a result, it is good to avoid pooling when ever possible. **The suggested strategy for smaller organisms, mainly molluscs, that are not always sufficient for all analyses, is to use 5 samples with 15 pooled specimens. If one sampled organism, mainly fish, provides enough sample for all analyses, the use of a sample set of single specimen from 15 to 25 (preferred) samples is suggested if the underlying variances are not know. The samples should be collected in a length stratified manner:** divide the size distribution in three or five classes (log scale and depending on size: MG -1 cm; MB - 2 cm.) and sample the central one; sample always the same size class.

The used statistical suite (Trend-Y-tector) developed for the OSPAR countries by the Netherland National Institute for Coastal and Marine management (RIKZ) is easy to use and can be used as a trend evaluation tool.

2.4 Review of coastal water monitoring activities

MED POL Phase III monitoring programmes are designed to cover two main types of marine sites, i.e. hot spots and coastal/reference areas. *Hot spots* are defined as intensively polluted or high risk areas (discharge sites, harbors, estuaries etc) under the direct impacts of land based sources of pollution. Monitoring of these areas is more important at the local level and is closely linked to the control measures taken at the source of pollution. Therefore, the data generated is expected to be used for management purposes at the national level. The identified hot spots needed to be included in the MED POL monitoring programmes and geo-referenced stations were expected to be the object of site-specific temporal trend monitoring.

The monitoring of *coastal and reference areas* was expected to contribute to the assessment of trends and the overall quality status of the Mediterranean Sea through a regional network of selected fixed stations. These areas should be representative for less or unpolluted marine waters, away from direct impacts of pollutants.

When the MED POL Phase III national monitoring programmes and the content of the database were examined together, it appeared that only some countries had well designed coastal water monitoring activities with a satisfactory number of stations integrated in terms of monitored matrices, sampling frequencies etc. Other countries had detailed monitoring programmes at well identified monitoring areas surrounding the major hot spots; however, when the length of their coastline was considered, the number of monitoring stations appeared insufficient. The last group of countries had only very few stations.

Considering the above, it would be reasonable to conclude that, in general, the MED POL Phase III programmes were far from achieving the required objective of a comprehensive coastal water monitoring and, as a result, it would be difficult to assess the status of Mediterranean coastal waters at the regional level. Also it should be re-called here once more that half of the Mediterranean countries did not participate in the monitoring activities.

2.5 Evaluation of the Data Quality Assurance Programme

Quality assurance of data is compulsory for all monitoring programmes. Environmental monitoring data for the MED POL programme is transmitted from a variety of laboratories and the accurate identification and interpretation of pollution trends rely on the consistency, reliability and comparability of the data generated by these laboratories. Intercomparison exercises have served as effective external performance tests for MED POL laboratories but they are only one facet of data quality assurance, and should be supported by regular analysis of certified reference materials and production of analytical quality control charts by the laboratory (Reference Methods, no 57). As implied in the previous sections, trend analysis of the collected data can only be made by applying appropriate statistical methods to calculate both sampling and analytical variances. The only way to illustrate the latter is the replicate analyses of certified reference materials or of an in-house working reference material, and to include these results when submitting trend monitoring data to MED POL.

The IAEA-MESL has had the prime responsibility of running a data quality assurance programme (DQA) for MED POL for the last 30 years. This effort was also successfully conducted during the MED POL Phase III. An overall and detailed evaluation of activities and the achieved results will be presented during the Meeting and published afterwards as a MAP Technical Series Report. The *abstract of the evaluation* is presented below.

<< *Reliable and harmonized data quality is a fundamental prerequisite for the regional assessment of marine pollution. Good accuracy is important for geochemical mapping of contamination. Good precision is essential for trend monitoring. The IAEA-MESL has been a partner with MED POL for 30 years, with prime responsibility for running a data quality assurance programme (DQA).*

The DQA comprises several components:

- *Reference methods*
- *Provision of reference materials and standard solutions*
- *Training in the analysis of marine pollutants in sediments and biota*
- *Training in good laboratory practice, including notably QA/QC procedures*
- *Laboratory performance studies (intercomparison exercises, proficiency tests)*
- *Split sample analyses*
- *Provision of expert advice on monitoring and assessment of pollution issues*
- *Provision of expert advice on emerging pollution issues*

This presentation reviews the DQA during MED POL Phase III (1996-2005). Particular emphasis is placed on the laboratory performance studies. Such proficiency tests have been held regularly for the determination of both organic and inorganic contaminants. In the alternate years, the test material is either a sediment or biota sample. Laboratories are given about six months to complete analyses and provide results to MESL. The organic compounds encompass petroleum hydrocarbons, including notably polycyclic aromatic *hydrocarbons (PAHs); polychlorinated biphenyls (PCBs); several chlorinated pesticides, especially DDT and its breakdown products, and a range of sterols on some occasions. Several metals are tested, especially mercury and cadmium, together with methylmercury in recent studies.*

Overall, participation from laboratories in the region has been disappointing. Data are interpreted in terms of a z-score. A combination of z-scores for a range of substances permits classification of the overall performance on a scale of 1 (good) to 4 (poor). Laboratories are given some advice on improving performance. Despite being mandatory for MED POL – designated laboratories, many laboratories have provided results only intermittently. Whereas the improvement in the regional capability to determine some substances has been noted, the analysis of organic contaminants continues to pose a major analytical challenge for laboratories in the Mediterranean region. >>

2.6 Evaluation of monitoring of inputs and loads

In MED POL Phase III, the monitoring of loads from land-based sources of pollution was considered within the objectives of trend monitoring programme. In this context, monitoring of identified point sources (outfalls of municipal waste water and industrial effluents), rivers and streams, pollutants transported via atmosphere and assessment of diffuse sources were all included in the programme.

Considering the above objectives, most of the MED POL Phase III NMPs have included monitoring of inputs of urban waste water, industrial effluents and of rivers/streams (see Table 2.1) . For the former group, countries have implemented it together with the compliance monitoring of effluents and, with the exception of two cases, rivers were included in all programmes. Although the programmes are expected to provide the necessary data and information for the estimation of loads and/or to provide directly the calculated loads, only few of them provided the necessary information and mostly concentration levels were provided. Two reasons can be identified; the institutes could not obtain the discharge data usually gathered automatically and by other organizations and/or they did not have the capacity to measure the water discharges with the required frequencies and techniques. In addition, the complexity of the different methods of estimation of riverine fluxes (MTS no.151) increase the difficulties to obtain such information.

Inputs from effluents by industrial, municipal and mixed source, were provided to the MED POL monitoring database by only few countries. Several of them have presented comprehensive data sets in terms of sampling frequencies, coverage of a wide number of sampling points and provision of water discharge data. The database contains 640 records for industrial-BOD5 of four countries. 97% of these records belongs to the period 2001-2003 and are presented in Figure 2.6.1 with some simple statistical information. BOD is chosen as an example since a regional plan for the reduction of BOD loads from industrial discharges was adopted by the Contracting Parties (MTS no.144) within the framework of SAP.

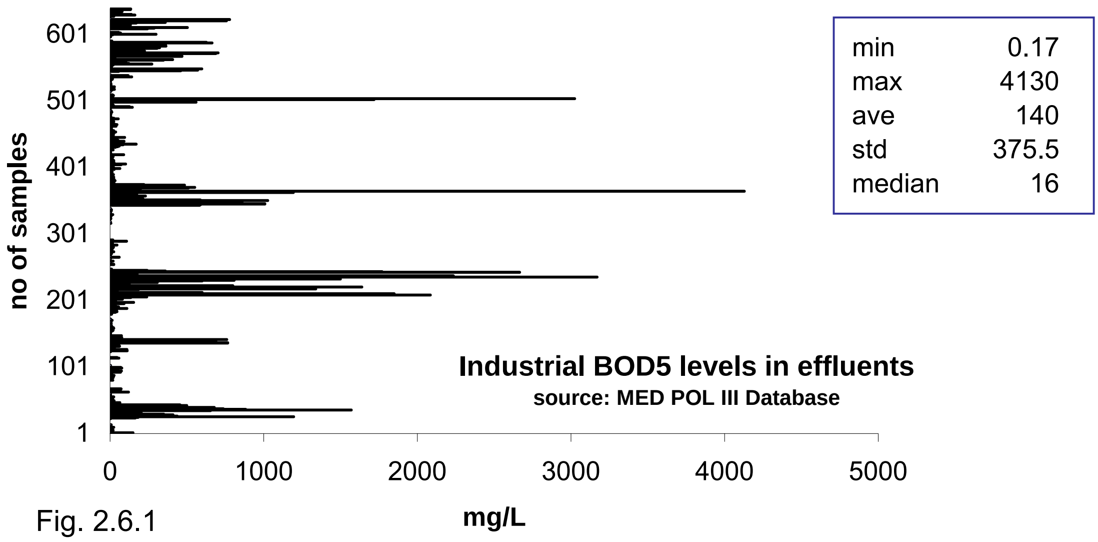


Fig. 2.6.1

According to the once a month samplings at an industrial effluent, the BOD levels could be presented as in Figure 2.6.2.

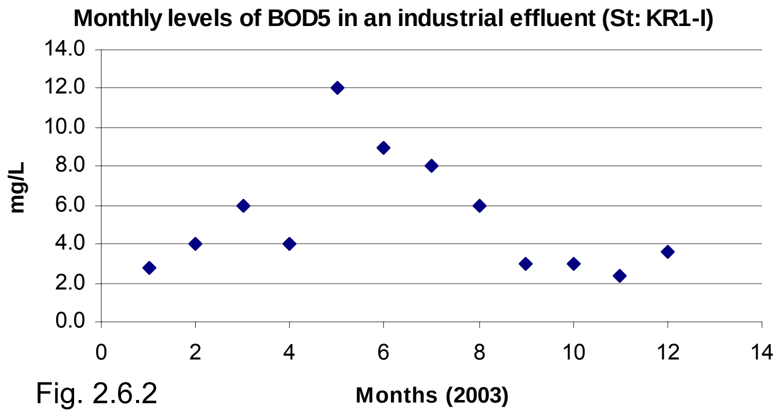
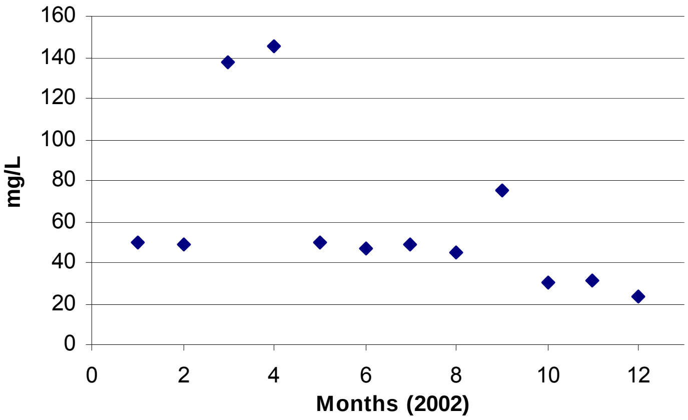


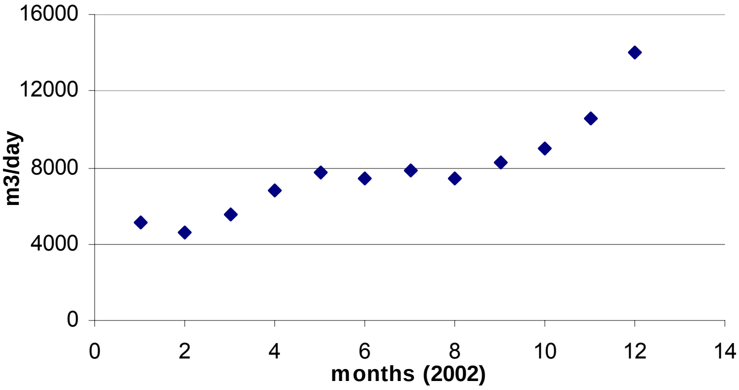
Fig. 2.6.2

Water discharge values were also available to estimate the annual load from this specific industrial effluent (Fig. 2.6.2) which is also possible for a number of additional cases having similar datasets. However, further elaboration of data and also of the programme objectives is needed in order to examine the value of such data sets considering the complementary nature of this data with those deriving from the NBBs studies (refer also Section 2.2).

Similar to the one related to industrial effluents, an other example could be the data obtained on a municipal BOD5 discharge (Fig. 2.6.3). The annual flux of this point source could be estimated at the level of 150 ton/year; obtained by adding up the monthly averages of BOD-load calculated from monthly BOD levels and water discharges displayed below.



Monthly levels of BOD5 in a municipal effluent (St: BI)



Average water discharge per month

Fig. 2.6.3

Similarly, more examples of pollutant loads from municipal discharges might be given based on the data available in the MED POL monitoring database.

During 1999-2004 two surveys were also conducted on the municipal wastewater treatment plants in Mediterranean coastal cities of more than 10,000 inhabitants. The surveys aimed to identify the amount of population served by treatment plants, also providing information on the plants themselves and on the amounts of treated or untreated sewage that reaches the Mediterranean Sea. The results of both surveys showed that municipal wastewater is discharged directly into the immediate coastal zone, either untreated or subject to various treatment procedures, but still carrying increased loads of nutrients, such as nitrogen and phosphorous. In many cases, specific data was not available, and only the estimation by calculations provided additional information (MTS no. 157).

Rivers and streams were included in seven NMPs and only four countries have provided data on pollutant levels and inputs in the 2000-2004 period. Using the same approach applied to the BOD-load to river data, the MED POL Database contains 325 records for three countries only (Croatia, Slovenia, Turkey). They are presented here (Fig.2.6.4) with simple statistical information on the BOD levels. Only few of the measurements made at 19 Mediterranean rivers and streams have exhibited concentrations above 5 mg/L (which indicates serious pollution levels; MTS no. 141, pg53) which basically relate to the summer and autumn periods. On contrary, discharge values reached maximum values at spring period. When the annual loads were calculated from seasonal values of levels and discharges, the difference between the dry (summer) and wet (spring) period of BOD-load might become 20-fold (see Table 2.6.1) which shows the importance of a properly set sampling strategy.

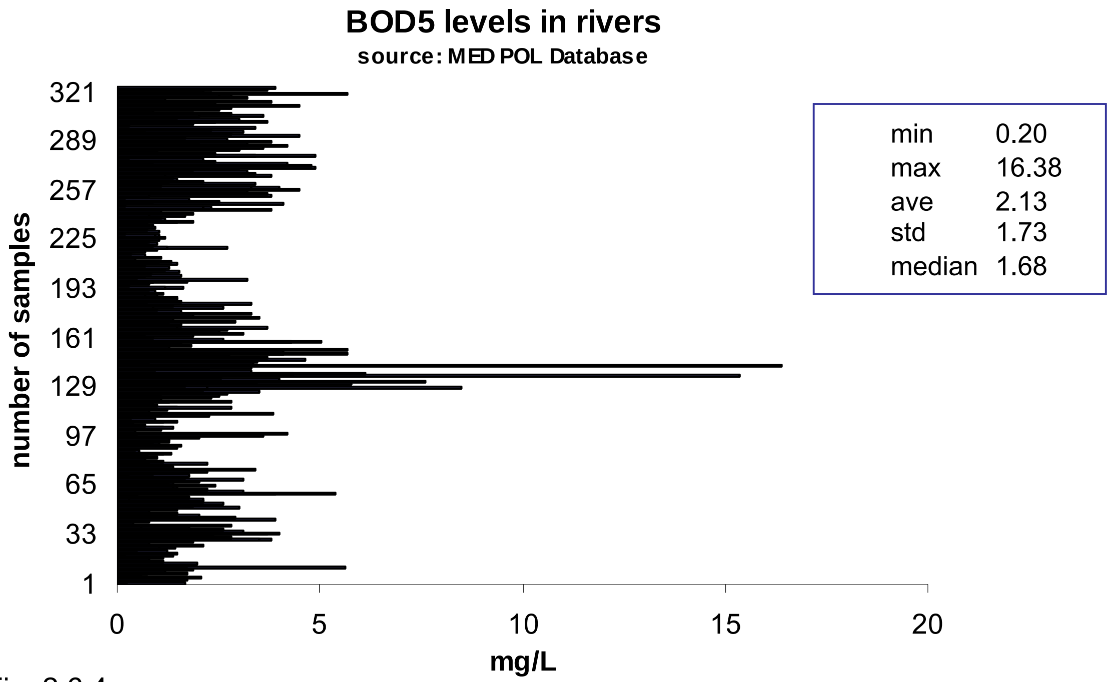


Fig. 2.6.4

Table 2.6.1 Example Case for seasonal measurements of BOD levels, water discharges and estimated annual loads in one of the Mediterranean rivers (St:00DN)

Date	Q, m3/day	BOD, mg/L	Load, t/y
19/02/2004	10714	3.99	16
10/05/2004	139363	2.56	130
11/08/2004	1210	15.35	7
18/11/2004	34301	6.13	77

It is obvious and also generally accepted that water discharges determine the magnitude of the material loads to the marine environment rather than the concentration levels. Therefore, a thorough estimation of at least the water discharges will help to obtain the correct estimation of material loads too. However, it was also suggested that the flooding periods or events carry most of the material to the sea and therefore should be included in the sampling design which is not always possible with discrete sampling techniques.

Figure 2.6.5 shows that spring period water discharges of eleven North Eastern Mediterranean rivers and streams are considerably higher than the seasonal values of the rest of the year, except one case at which winter discharge is the highest. The values represent means of observations of 30-40 years and the raw data belongs to the national data source for which evaluations at the expert level might provide valuable information to overcome the gap mentioned in the recent assessment (MTS no.141) made for water and material discharges to the Mediterranean Sea.

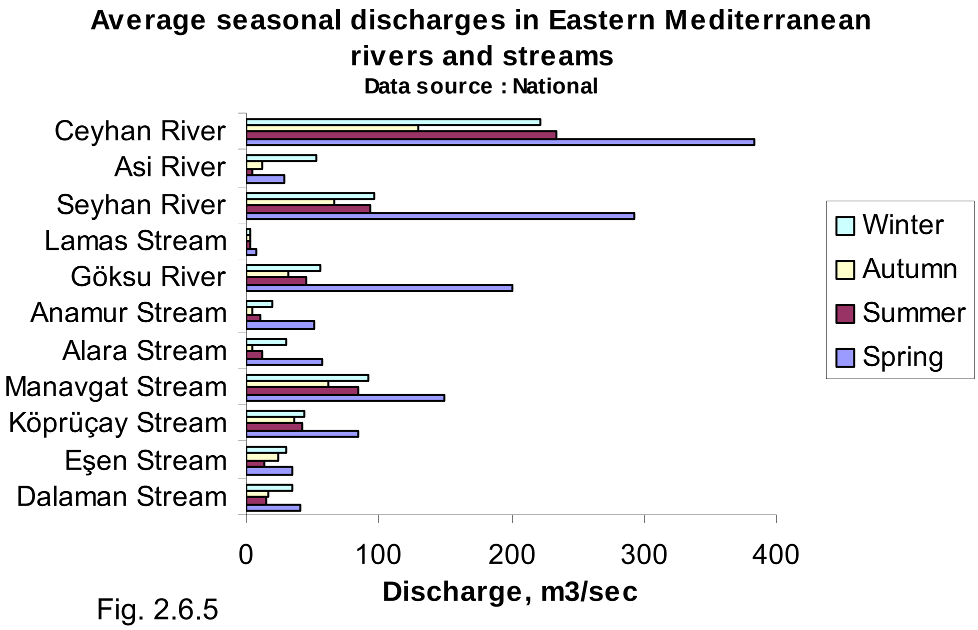


Fig. 2.6.5

Estimation of inputs of material carried to the coastal marine environment via rivers/streams is important both at the local level and sub-regional level basically when the effects of these inputs are considered at these scales. The information and data gathered through the NMPs should also be evaluated in order to fill in the gaps (MTS no 141) of overall estimates of levels and loads at the Mediterranean scale.

In parallel to the ongoing monitoring activities within the NMPs, training courses on river monitoring were organized by MED POL in 2004. The guidelines (MTS no. 151) for river [including river estuaries] pollution monitoring programme as well as methods of estimation of loads of pollutants were presented at the courses to a large number of experts from different organizations in their countries.

A brief summary of the assessment and the major outcomes of the training courses are summarized in Annex II to this report.

Regarding the monitoring activities for ***airborne pollution***, MED POL Database has a good coverage of dry and wet deposition data for trace metals and nutrients for the South East Mediterranean covering the period 2000-2004 provided by Israel. The data owners have published their results in scientific journals and international conferences assessing the atmospheric deposition and its contribution to the overall material balance of the Mediterranean Sea as well as their possible impacts. MED POL has also partially supported a research project on the atmospheric nitrogen and phosphorus inputs and potential impacts (IOLR Report H22/2004) implemented by the same research institute. The revised report is presented to this meeting as an information document (UNEP(DEC)/MED WG.282/Inf 3)

There are also overall assessments made by UNEP and WMO and published as MAP Technical Reports Series between 1994 and 2001. While estimating the atmospheric loads for the Mediterranean, the data gap related to the south Mediterranean countries has often been mentioned by the competent organizations.

Finally, the ***diffuse transport*** of material from the Mediterranean watersheds was dealt with by MED POL, basically for nutrients, through cooperation with different global and regional initiatives; EUROHARP (www.euroharp.org) and IOC-NEWS (http://www.marine.rutgers.edu/globalnews/). UNEP/MAP through its MED POL Programme has supported the activities of IOC-NEWS/Mediterranean Focus in two phases in 2003 and 2004. The first working group report was provided as Annex IV of UNEP/DEC(MED) WG.243/3 and the second working group report submitted to UNEP/MAP by IOC is presented to this meeting as an information document (UNEP(DEC)/MED WG.282/Inf 4).

2.7 Evaluation of pilot biological effects monitoring activities

Within the framework of MED POL Phase III monitoring activities, biological effects monitoring has been implemented through pilot programmes. This activity was considered crucially important for MED POL since it is the only monitoring component that will provide direct information on the impacts of the pollutants to marine life. The initial monitoring criteria set for the programme is provided in MAP Technical Reports Series (MTS no.120). For the programme definition as well as for some theoretical information we can also refer to the working document of the second review meeting of monitoring activities (UNEP(DEC)/MED WG.243/3).

As wellknown, technical/scientific support to the activity has been provided, on behalf of MED POL, by the University of Alessandria, Italy, which is also responsible for the quality assurance programme that included the organization of regional and individual training courses and intercomparison exercises. Further details of the 2004-05 activities are provided in the paragraph on "Data Quality Assurance" below.

Table 2.1 gives information on the participation of countries in the programme. Some details of the pilot programmes and projects are provided below on a country basis.

Pilot programmes/projects

Albania included biological effects monitoring in NMP to measure two biomarkers (LMS, MT) and the programme was basically implemented during 2003 and 2004 by two Institutes. The programme is very limited at the moment, however, it is well supported by the trend monitoring contaminants data in biota (wild *Mytilus galloproviancialis*). The sampling stations, period and the organism are the same for both components of monitoring as required by the MED POL objectives. On the other hand, it was also recommended to perform measurements at least at two sampling periods per year, which was not yet achieved. In terms of data provision, only MT results were submitted until now. The implementing laboratory received training and applied the methods given in UNEP/RAMOGE (1999).

Algeria included the biomarker studies in the NMP in 2004 which still needs to be re-organized at the institutional level. One laboratory gained expertise through scientific and technical cooperation with the University of Alessandria. Unfortunately, it is not yet a MED POL designated laboratory participating in the NMP.

Croatia implemented the programme in 1999 within the NMP. In this case, the programme was considered routine monitoring rather than a pilot activity performed at 28 stations with sampling frequency of four times a year. One of the sampling periods coincides with the trend monitoring sampling period at the same stations, both performed in wild *Mytilus galloproviancialis.* Toxicity and genotoxicty were also included in the parameter list besides DNAx and MT which are two of the five recommended biomarkers in the MED POL Programme (see paragraph on "data quality"). The fast micro method was used (Batel et al., 1999)[5] for DNA integrity which is different to that recommended in UNEP/RAMOGE (1999). The MT content was measured by using

[5] R. Batel *et al* (1999). A microplate assay for DNA damage determination (Fast Micromethod) in cell suspensions and solid tissues. Anal. Biochem., 270, 195-200.

UNEP/RAMOGE (1999). Even though there are some discontinuities in the submitted data, it could be concluded that all the parameters were measured together in 2004 and in the annual report of the same year a brief evaluation of the results was also made.

Greece has included the biological effects studies in the NMP. However, the activity, partially supported by MED POL during 2001-2005, was implemented at the project level by the three institutes at the 3 different areas and stations mentioned in the NMP. The biomarkers measured were LMS, MT, DNA alteration and few additional biomarkers preferred by one laboratory. The laboratories worked with both wild and caged mussels (MG) with a sampling frequency of twice per year. Unfortunately, one of the institutes has became inactive for the last 2 years, while the other two are active both in monitoring and research. The project reports submitted to MED POL were quite detailed, but unfortunately, mostly lacking the evaluation of chemical pollution data. In 2004, chemical pollution data (TM) and results were also obtained for one of the study areas.

Although *Israel* has the expertise on the subject, biological effects monitoring was not included in the NMP. In 2005, one institute was partially supported by MED POL to start a monitoring activity for one year in coordination with the Ministry of Environment. The biomarkers measured were AChE inhibition, Neutral red retention assay (NRR), Metallothioneins content, Micronuclei frequency, CYP1A1and EROD (7-ethoxyresorufin O-deethylase) and the experimental introduction of novel biomarker - “Displaced Haemolymph GST Activity (D-GST). The three sites mentioned in the NMP will be monitored 3 times per year. A report will be provided in 2006.

Morocco included the biological effects monitoring in the NMP in 2004 but is still at the level of institutional arrangements. The authorities were informed about a laboratory which was already well known in the region and had scientific cooperation with University of Allessandria. It was agreed with the MED POL National Coordinator and one of the programme implementing institutes that contacts with the competent laboratory would be made to benefit from the experience gained in this specific field.

Slovenia had biological effects monitoring as part of the NMP and has provided data since 2001 for two biomarkers -DNAx and MT- on a continuous basis. The recommended methodologies by UNEP/RAMOGE (1999) were adopted. The sampling strategy is twice per year for wild mussels and in one of these periods the programme was supported by the contaminant data obtained for trend monitoring in biota. For a reliable statistical analysis of the samples, five parallel samples were taken at each sampling occasion since 2003.

Syria included the activity in its NMP in 2003 as capacity building in the initial phase. In 2004, an investigator from the designated laboratory visited the University of Alessandria for individual training and participated in the intercomparison exercise organized in the same year. The results were very good and the activities are expected to be launched by the laboratory.

Tunisia implemented the activity as part of its NMP having good capacities in several laboratories. LMS, DNAx, MT, EROD and stress on stress (the full battery of biomarkers proposed by MED POL) included in the programme. Regarding the data transmission, data was obtained for the 2001-2003 period, however, there are discontinuities in the data series for some biomarkers.

As proposed before, an important point would be to integrate the biological data with the results of the chemical analysis (also emphasizing the importance of collecting the two data on the same sample or, at least, in the same sites and at the same time). At present, most of the pilot activities were organized to obtain such coupled datasets on chemical contaminants levels and biomarkers.

Data Quality Assurance

During the last two years (2004-2005) of the quality assurance programme, a high standard of data quality has remained within the UNEP/MAP Mediterranean biological effects monitoring programme, and the following project targets were achieved:

1) To set up a monitoring programme for the evaluation of biological effects of pollutants, utilising standardised, or (in some cases) similar, organisms, e.g. bivalves (usually the common blue mussel, *Mytilus* sp.) and fish (usually *Mullus* sp.), as well as a standardised battery of biomarkers. The biomarker battery contains the five parameters proposed by the programme and, as a result, lysosomal membrane stability (cellular biomarker of stress), micronuclei frequency (cellular biomarker of genotoxicity), metallothionein content (cellular biomarker of heavy metal exposure) were monitored in both fish and bivalves. Furthermore, EROD (cellular biomarker of exposure to organic aromatic xenobiotic compounds) was monitored in fish, and “stress on stress” (a biomarker of stress at the organism level) was monitored in bivalves.
2) To intercalibrate the results within the programme, and thus enable a general overview of the biological impact of pollution in the selected sentinel organisms.

The quality assurance programme was based on:

1) Training courses providing assistance to new researchers to facilitate integration in the group of scientists already involved in biomonitoring activities in Mediterranean countries, as well as the distribution of a manual and a video from UNEP/MAP to explain better how to utilise the different biomarker methods (the video was realised in collaboration with RAMOGE).
2) A well established annual biomarker intercalibration workshop in order to maintain a high quality of the biomarker data produced within the programme, and to guarantee the comparability of the results. Five laboratories attended the 2004 intercalibration activity for LMS, seven laboratories for MT and one laboratory for EROD. The results were provided to the MED POL Secretariat.

The success of the Mediterranean biological effects monitoring programme and of the quality assurance approach is confirmed by the fact that 12 countries (Spain, France, Italy, Greece, Syria, Israel, Algeria, Tunisia, Morocco, Slovenia, Turkey, and Croatia), with 18 laboratories implicated, together covering the major part of the Mediterranean coastal areas, have asked to participate in the biomarker intercalibration activities in 2005, with the intention to participate in the MED POL activities during the next years, and to develop their own national biological effects monitoring programmes.

The biomarker monitoring activities in the participating countries have now moved from the initial phase of learning the know-how, considering the research methodologies used for the evaluation of biological effects of pollutants. Therefore, it is time to propose a further evolution in terms of the organisation of the MED POL biomonitoring programme.

Proposal for future activities

1) Utilisation of caged organisms

This approach will better evaluate the relationships between biological effects and chemical data of stress-inducing pollutants accumulated in the tissues. It is proposed that the programme should mainly utilise bivalves (the common blue mussel, *Mytilus* sp. when possible) in the caging experiments. This is due to the biological characteristics of this group of organisms (filter-feeding, sessile, benthic species), and the still natural feeding situation upon caging. Furthermore, mussels can be transported for analysis in the laboratory in cold, humid boxes in a simple and inexpensive way, thus guaranteeing animals in an optimum condition for the biomarker analyses.

2) Organisation of the biomarker monitoring programme based on a 2-tier approach

Mussels should remain in cages for 3-4 weeks, a period of time long enough for toxic chemicals present in the water to accumulate in the tissues of these filter feeding organisms, yet short enough to avoid significant changes in the development of the gonads. Under these conditions, the observed changes in the physiology of the specimens, as evidenced by the biomarker battery, is mainly related to the effects of the toxicants, despite possible fluctuations in other parameters at the caging sites, such as temperature, food availability etc.

The use of caged organisms in field studies and biomonitoring activities allows a higher degree of standardisation of the results, and a simpler mode of comparison between animals caged at unpolluted reference sites, and those caged at potentially polluted sites. This strategy also permits a proper analysis of chemicals accumulated in the organisms during the caging period. In fact, a relationship between biological effects and concentration of pollutants is often not seen in wild animals, since harmful compounds may have very different biological half lives in mussels, ranging from days (e.g. copper, 6 days) to months and years (e.g. cadmium and persistent organic pollutants; POPs). Furthermore, it must be taken into consideration that specimens from wild populations may be at different stages of gonad maturity, therefore rendering different biological responses and exhibiting different capacity of pollutant accumulation. As an example, lipophilic compounds such as PAHs and PCBs readily accumulate in the lipid-rich eggs.

Another important point is regarded with the planning of a “biomarker mussel watch” programme. To render this biomonitoring tool suitable for an extended application by National Environmental Agencies (NEAs), a two-tier approach should be employed rather than expecting NEAs to finance the analyses of 6-8 biomarkers for the verification of the potential pollutant-related effects at tens (or hundreds) different marine coastal sites.
Tier 1. The possibility of using a highly sensitive and low cost biomarker, such as lysosomal membrane stability or lipofuscin accumulation, is suggested at the screening level. The more polluted sites will instead be evidenced by utilising survival time of mussels emerged in air, a simple, low cost analysis with an obvious end parameter, a mortality as an end point parameters.
Tier 2. This approach is only utilised at a limited number of sites, namely those where individuals display no effect as stress on stress on mortality but a significantly altered lysosomal membrane stability (or another screening biomarker) with respect to reference individuals (at least 20 % variation), possibly directly related to the effects of pollution. In this case, the biomarker battery will be extended to 6-8 parameters, and an evaluation tool such as “The Expert System”, which was developed within the frames of the BEEP project, or other biomarker integration systems (e.g. Narbonne et al., 1999; 2005)[6] will rank the stress syndrome of mussels from the different sites. Also in this case, the biological effects will be related to the amount of toxic chemicals accumulated in mussel tissues during the caging period.

Obviously, the definition of a suitable biomarker battery is instrumental to obtain data that can be integrated in an index and in this way objectively rank the degree of pollutant-induced

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[6] Narbonne J.F., Aarab N., Clerandeau C., Daubeze M., Narbonne J., Champeau O., Garrigues P. “Scale of classification based on biochemical markers in mussels: application to pollution monitoring in Mediterranean coasts and temporal trends”. Biomarkers; 10(1):58-71 (2005)

stress in mussels from different field sites. The biomarker battery utilised to evaluate the stress syndrome, which in The Expert System ranks individuals from A = “unaffected by pollution”, to E = “pathologically stressed”, could be decided by a MED POL expert board, but it is important to add that The Expert System allows the interpretation of any biomarker with an established dose/response curve (Dagnino et al., DiSAV BEEP).

In addition, a low-density mussel microarray, containing 24 genes related to stress response, has recently been developed. This technology could be utilised as a molecular tool to rank the development of a stress syndrome in laboratories active in the field of Environmental Molecular Biology. Moreover, laboratories that do not have all facilities necessary to run the microarray analysis can easily, and at a low cost prepare tissue extracts to be shipped to another laboratory.

2.8 Evaluation of pilot eutrophication monitoring activities

After the official approval of the Eutrophication Monitoring Strategy of MED POL by the National Coordinators’ Meeting (UNEP(DEC)/MED WG.231/14), the Secretariat launched the activities in 2003 and developed five pilot programmes during 2004-2005 (see Table 2.1). DQA and capacity building activities were also organized during 2003-2005.

Supplementary studies for the programme were also organized. In fact, as foreseen in the mid/long term of the Strategy, data/information search for pilot sites, the use of satellite techniques at the regional level and the development of biological indicators of eutrophication in the Mediterranean were tackled during 2003-2005.

Pilot programmes

As discussed at the second review meeting of monitoring activities in 2003 (UNEP(DEC)/MED WG.243/3), MED POL was to start the implementation of the short-term strategy during 2004 through the launch of a number of pilot programmes in line with the adopted programme objectives and criteria. The goal was to gradually include all the eutrophication hot spots (affected areas and/or areas under considerable pressure of nutrient and organic material inputs) starting with a limited number of countries. The preliminary list of affected areas proposed by the same meeting (UNEP(DEC)/MED WG.243/4) was also taken into account while establishing contacts with countries.

The first pilot programmes aimed to include all three site typologies defined in the Strategy, i.e. affected coastal areas, areas where intense aquaculture activities are found and coastal lagoons under eutrophication threat. The programmes were formulated considering the criteria and steps defined in the Strategy. The content of the first programmes as well as their implementation status is summarized here below.

- Slovenian coastal waters (An affected coastal strip at the Northern Adriatic)

The Slovenian MED POL NMP has included a component of eutrophication monitoring supporting most of the common eutrophication indicators and the TRIX index since 1999. The programme was then modified in 2004 according to the required sampling strategy of the MED POL Eutrophication Monitoring Strategy and the NMP was revised (2004) accordingly.

The programme now includes two sites; Bay of Koper and Bay of Piran with two transects –3 stations per each transect- and one reference station. The sampling frequency is 6 times per year for parameters supporting TRIX index and seasonal for biological parameters (phytoplankton determinants). In 2004 sampling was carried out in months 2, 5, 6, 8, 9 and 11.

The programme is supported by the data sets and information on loads of nutrients and organic material related to the selected sites.

The report for the year 2004 included a comprehensive analysis of data and results including an evaluation of findings on TRIX index. The respective data sets were loaded to the MED POL database in 2005.

- Mersin Bay, Turkey (coastal site under considerable pressure (nutrient and organic material discharges)

The activity was formulated as a pilot project in 2004 and funded with national resources in 2005. After the completion of the first year of work, the project was included in the MED POL-NMP.

The project provides a refined evaluation of the site characteristics as well as information on pressures. The area is subject to discharges of municipal wastes from Mersin city and to inputs of two large rivers (Seyhan and Ceyhan; see Section 2.6).

The project includes 4 transects with overall 15 sampling points including one reference station. The first field work was conducted in May 2005 and 6 cruises were planned until the end of the year (two cruises in month 5 and one for each months 7, 9, 10 and 11). For the 2nd year of implementation the cruises are planned as;

1. Late January-early February 2006: to sample the well-mixed period in the coastal region and discharge zone
2. March 2006: to study late-winter bloom period
3. May 2006: to study the post-bloom spring condition
4. July 2006: to see thermally-stratified summer properties of the system
5. September-October 2006: to cover autumn period
6. November 2006: to study cooling and mixing period of the surface water in the region

The number of sampling points is smaller for parameters which are not relevant to TRIX index like phytoplankton determinants and particulate organic material.

The first data sets and the report are expected in the first half of 2006. The data will than be loaded to the MED POL database.

The project is supported by the data sets and information on loads of nutrients and organic material reaching the area via rivers and municipal effluent which is already included in the NMP.

- Limmasol Bay, Cyprus (off-shore site for Tuna ranching cages)

Besides the already ongoing eutrophication monitoring programme for the coastal waters of Cyprus, a pilot MED POL eutrophication programme was developed at a fish caging site and it was included in the MED POL-NMP which was revised in 2005.

All the indicators of the Strategy except phytoplankton determinants were included in the programme with a sampling network of 16 stations at two transects (including a reference station) which are at the same and opposite directions of the prevailed current. The sampling frequency was initially set as 3 times per year thus providing enough samples for the annual estimation of TRIX index.

The programme is at the first year of implementation and the first data sets are expected in late 2006.

The study should be complemented by information on the inputs of nutrients (organic material) regarding the fish caging process; sediment quality (chemical and biological) studies might provide useful information on the impacts of the caging process.

- Gulf of Gabes, Tunisia (an affected area by natural and anthropogenic pressures) :

The Gulf of Gabes is a large area known to have high chlorophyll levels throughout the year. In summer and autumn months red tide events were also observed. A monitoring programme for the area had already been established both for coastal and open waters with a large number of monitoring parameters including phytoplankton studies and measurement of algal biotoxins. Diversity indexes were used from 1996 to 2000 to understand the trophic level of the Gulf.

The existing monitoring activities have recently been modified according to the MED POL Strategy. Four very near shore stations will be monthly monitored along the coastal waters whereas 3 perpendicular transects to the coast with frequent number of stations will be monitored 4 times per year. All the indicators including phytoplankton determinants are included in the study.

After the first year of implementation of the project (2005-2006), the strategy might be modified depending on the reliability of the TRIX results obtained.

- Nador Lagoon, Morocco (an affected coastal lagoon)

Mediterranean coastal lagoons are very important sites for biodiversity protection and as nurseries for marine species. In spite of the huge importance of these systems which are considered as coastal transitional sites usually under the pressure of anthropogenic inputs, they were never included in the MAP/MED POL objectives although they are, by definition, withinthe geographical coverage of the Barcelona Convention. The MED POL Eutrophication Strategy has provided the first technical framework to deal with Mediterranean coastal lagoons.

Nador Lagoon, having a large surface area of 114 km^2, exhibits serious environmental problems created by partially or untreated waste water from urban settlements, intensive aquaculture, industrial effluents from a river tributary as well as agricultural activities.

As a first step, a diagnostic report was prepared by a national expert in 2005 and afterwards a visit to the lagoon was organized by the national experts and the MED POL consultant in September 2005. Although the diagnostic report provides a detailed analysis of the available information and data, it was concluded that the information regarding ecological state of the lagoon is quite limited and there are gaps in nutrient and sediment quality data. The visit to the site was considered very helpful and it was reported that the lagoon has still richness in biodiversity in spite of the observed serious anthropogenic disturbances.

As a step forward, a proposal for a monitoring plan was prepared to better understanding the present ecological quality status of the lagoon. A study should be organized in 2006 after which an optimum monitoring strategy could be developed for the Lagoon.

Data Quality Assurance

The draft manual developed for sampling and analysis methods for the nutrient and chlorophyll analysis (UNEP(DEC)/MED WG.231/Inf.9) was improved and relevant methods on physical and biological parameters of the monitoring Strategy were included. It was recently published as a MAP Technical Series Report (MTS no.163).

A first set of proficiency test samples on nutrients were distributed initially to the MED POL laboratories participating in the above mentioned pilot programmes as well as to few others. The exercise was organized by IAEA/MEL in 2005 and results were obtained from 8 laboratories. For the organization of such future exercises, MED POL might need to develop cooperation with other competent bodies (e.g QUASIMEME).

After the first training course for technical operators of the eutrophication monitoring programme organized in 2003 in Cesenatico (Italy, Emilia-Romagna region), a second one took place in 2-5 November 2004. Both courses were organized, on behalf of MED POL, by three Italian institutes (ICRAM, CRM and ARPA-ER/SOD) and the activity was coordinated by ICRAM. 18 institutes from 14 Mediterranean countries were covered by the programme and 21 people were trained. Some of the represented institutes in both activities were already participating in the MED POL programme while others were now prepared to contribute to the MED POL Eutrophication monitoring programmes. During the courses, lectures, presentations and practices were performed on various topics of coastal eutrophication programme (UNEP(DEC)/MED WG.243/4, UNEP(DEC)/MED WG.259/2). One of the trainees was also supported for his attendance to an advanced phytoplankton course on taxonomy and systematics organized by a competent institute in 2005.

Participation of Mediterranean experts to the relevant workshops were also supported during 2004-2005.

Data and information search for affected or potentially problem areas

Since eutrophication is considered a long-term process, historical data was considered to be useful for the study site. Besides, any relevant data and information regarding the environmental status –past and present- would be complementary to the pilot studies. Therefore, any scientific study on the area, records of events and cases in gray literature and technical reports and information on socio-economic development of the catchment's area would be required.

In line with the above objectives, gathering of such information was initiated in 2005 in relation to two selected pilot sites; Nador Lagoon and Mersin Bay. The required information for Nador Lagoon was gathered by examining scientific/technical information and data on hand published in scientific literature, national reports and in all other sources. The information was collected on the hydrology, geomorphology, chemical and environmental characteristics, plantation of the lagoon as well as the man-induced and natural pressures on it. The information required for the Mersin Bay (MB) would not only focus on the pilot site but also on other affected and potentially risk areas in the vicinity of MB, like Iskenderun Bay (at the east), Goksu estuary and its lagoons (at the west) and Yumurtalik Lagoon (at the east). This enlarged area is the most productive water body in the north-eastern Mediterranean being affected by three major rivers (Ceyhan, Seyhan and Goksu; see

Section 2.6), agricultural diffuse inputs, industrial and municipal wastes as well as atmospheric deposition. As a result, the institute involved has been asked to collect the following information:

- Evaluation of inputs of nutrients and organic material from major point sources: rivers, municipal/industrial discharges and of diffuse sources of nutrients (estimation with surface run-off , atmospheric sources etc.) if any information available in literature
- Evaluation of available literature and data on the quality of coastal waters taking into account the eutrophication indicators (nutrients, N/P ratios, Chl-a, phytoplankton blooms, frequency of blooms and dominant groups, optical parameters, satellite images etc)
- Gathering historical records of eutrophication events (formation of hypoxia/anoxia, harmful algal blooms, fish kills)

This huge work -if could be achieved- could also serve as basis for the new eutrophication monitoring activities in any of the neighboring sites (e.g. any of the lagoons, or Iskenderun Bay)

For the future steps related to data and information search, it is also necessary to complete similar studies for the other pilot sites/areas in the Mediterranean.

Biological indicators

As mentioned before, the MED POL eutrophication monitoring strategy foresees the development of biological indicators to be included gradually in the pilot monitoring programmes. The initial views of the experts was to include benthos and phytoplankton indicators. Some of the common and widely accepted phytoplankton variables were already included in the Strategy and in the present pilot programmes as well. Regarding benthic communities, the species composition, abundance and biomass were initially proposed for consideration supported by chemical data obtained from the sediments.

In the meantime, the development MED POL pollution indicators were handled in three groups including biological indicators (UNEP(DEC)/MED WG. 231/17), On the basis of the proposed 3 core sets, indicators fact sheets were developed (UNEP(DEC)/MED WG. 264/Inf.14) and a testing procedure is ongoing. However, this initiative should be examined carefully for the specific needs of eutrophication issue.

In addition, other programmes (e.g. OSPAR studies) and working group products (i.e. products IOC WG on benthic indicators) were also taken into account.

An initial draft proposal was prepared to be discussed and commented by the meeting.

Additional studies

A joint INFO-RAC/MED POL proposal for a research project on the integration of remote sensing and in situ data was initiated in 2005. Selection of test sites was made by the Center experts by taking into consideration the availability of satellite and in-situ data in different databases. The World Ocean Database and the MED POL Database were used as an initial attempt. Some data sets from the MED POL database (for the year 2003) was provided to the Center for initial tests.

Another research activity was proposed to Hellenic Center of Marine Research (Greece) to find out whether the available data of common eutrophication indicators (TP, DIN, DO and

Chl) would be supporting the testing and possible use of TRIX index for the Greek coastal waters.

Conclusions:

The first statistical analysis of data –as regards to TRIX- obtained from MED POL pilot programmes and the other national data sources should be made in the 2006-2007 period.

In parallel to the provision of support to the ongoing pilot monitoring programmes and their expansion to neighboring areas wherever necessary, new pilot activities will be organized for different regions of the Mediterranean Sea.

Efforts to obtain historical data and information for the pilot site or the expanded area should continue and cover all the pilot activities. This information would be an important contribution to the eutrophication assessment planned for 2006-2007.

Biological indicators of eutrophication should be decided upon and the new biological parameters should be included in the monitoring strategy.

Data quality assurance activities should be re-organized basically for laboratory performance.

3. Revision of Sediment Monitoring Strategy

After the first evaluation of the database for the trend monitoring of contaminants in coastal water sediments was made in 2003 (UNEP(DEC)/MED WG.243/3), it was concluded that the MED POL Phase III programme objectives preliminarily set, were not enough to achieve the temporal trend of any selected contaminant for a selected site, and also the programmes were implemented with different objectives. The major reason for this was the various difficulties in studying with sediments, especially when it is considered for routine monitoring of pollution levels and temporal trend of changes. The second review meeting of monitoring activities therefore, recommended the revision of the sediment monitoring strategy and the first step towards this was made early in 2005 by the organization of an expert meeting. The meeting thoroughly discussed a number of critical issues, and decided to continue its activities with an initial work plan of different stages. The findings and recommendations of this meeting will be presented later in the text.

The theory behind the use of sediments as a tool in environmental monitoring is the knowledge that the finer particles of the sediment originate from the suspended particulate matter, and that these particles are the carriers of non-soluble contaminants. Fine material (inorganic and organic) and associated contaminants are preferentially deposited in areas of low hydrodynamic energy, while in areas of higher energy, fine particulate matter is mixed with coarser sediment particles which are generally not able to bind contaminants. This dilution effect will cause lower and variable contaminant concentrations in the sediment. Obviously, grain size is one of the most important factors controlling the distribution of natural and anthropogenic components in sediments. It is therefore essential to normalize the effects of grain size in order to provide a basis for meaningful comparisons of the occurrence of substances in sediments of various granulometry and texture within individual areas, among areas or over time.

The MED POL Phase III sediment monitoring strategy was initially set with the following objectives (MTS no.120 and UNEP(DEC)/MED WG.128/2)

- ❖ Sediments were considered to be a major sink for most contaminants and are closely inter-related to several other compartments of the marine environment (e.g. biota). Therefore, it was recommended to the Mediterranean countries as part of an integrated-monitoring programme

- ❖ The undisturbed superficial sediments, because of their simple methodology, was recommended for monitoring in the most stable hydrographic conditions of the year. This site should also be suitable for sediment core analysis

- ❖ The recommended contaminants to be monitored in sediments are total Hg, Cd, Zn, Cu and high molecular weight halogenated hydrocarbons

- ❖ Data produced for contaminants should be completed with other sedimentary data sets; water content, org-C, total extractable lipid content, grain size distribution etc. (for normalization of contaminant data)

- ❖ Other essential features were defined as: harmonization of baseline studies, strict quality assurance/control programme

- ❖ A statistically sound design was required for sediment monitoring: use of statistical power analysis approach. (However, components of variance for sediment to support the above approach was not well documented for the sediments)

- ❖ The number of samples required for each sampling site could not be identified, even though the fact that the sediment samples are usually collected in areas close to the sources of contamination (rivers, outfalls) were the sedimentation rate is very variable and replicate samples have to be taken

- ❖ Finally it was recommended to perform monitoring at only one sampling station at each hot spot site, once per year in the most stable hydrographic conditions

The practice of monitoring with sediments in MED POL Phase III: All the countries participating in MED POL Phase III, that are measuring the ratio of contaminants in sediments (see Table 2.1), use annual frequency, with one sample per station and sample the sediment surface layer usually by using grab samplers. However, such a sampling strategy is not sufficient to address temporal trends. The countries also used different size fractions for contaminant measurements, but are still being consistent within their own programme designs.

Normalization of the results against any of the normalizers (Reference Methods for Marine Pollution Studies, No.63) was not considered in any of the programmes. In the context of temporal trend surveys, normalization is a process that reduces the variance of the data set by taking account of differences in grain size distribution and mineralogy (gross sediment composition) between samples. Both the selected trace metals and the organic contaminants will co-vary strongly with such factors and grain size, clay mineral and organic carbon content. Differences in these co-factors between samples will often be reflected in differences in the concentrations of the target contaminants.

Terms of revision of the strategy: The expert meeting organized on 14-15 April 2005 examined the ongoing strategy in MED POL as well as the different practices in the Mediterranean region and the OSPAR area. The meeting discussed the overall and specific monitoring objectives, selection criteria of monitoring sites, the sampling strategy that needs to be applied and the normalization procedure. As regards to sampling strategy, setting up the monitoring station network, sampling layer, sieving, sampling frequency, number of samples and the sampling instruments were all considered. The meeting also discussed and highlighted the importance of the identification of background values to trace the anthropogenic contamination in the Mediterranean as well as the importance of baseline surveys at the Mediterranean level where such data is missing. Further details of the meeting can be found in the report of the meeting (UNEP(DEC)/MED WG.273/2).

The meeting consisted of two days intensive work, however, it was not possible to agree on common views/guidelines for sediment monitoring. It was stressed that the meeting could only be considered as an initial step of the process of revision of the present strategy of trend monitoring of pollutants in coastal water sediments. In spite of this, the presentations and the discussions provided valuable inputs to prepare a first version of the revised strategy where recommendations and advice might be provided to the laboratories. The following steps of work were proposed by the meeting to be achieved in the *short-term*:

- Preparation of the first version of the revised monitoring strategy for coastal water sediments based on the discussions and the material presented at the expert meeting.
- Studies at the expert level will be launched for obtaining normalization errors
- Studies on background levels of pollutants at the Mediterranean sub-regions will be followed and promoted

As for the preparation of the first version of the revised strategy, IAEA/MEL has prepared a draft in cooperation with the MED POL Secretariat which includes the outcome of the expert meeting. The *methods for sediment sampling and analysis* is presented to this meeting as an information document (UNEP(DEC)/MED WG.282/Inf.5) to be reviewed and discussed. The final version of the first revision will then be prepared and countries and laboratories will be contacted for further modifications of their programmes. The Secretariat is also planning to update the revised strategy as and when needed.

In order to improve the knowledge and the application of the normalization of the contaminant's results, the MED POL Secretariat has initiated a project with IOLR who has experience and data to achieve the work. The Secretariat foresee the cooperation of the Institute with the OSPAR/ICES Working Group on sediments for the achievement of certain steps of the work. The first report will be ready in early 2006.

Finally, for the background values, a report on the pre-industrial TM content of the open Mediterranean sediments is under preparation by a scientist from IFREMER who also contributed to the expert meeting organized by MED POL. In this work, deep cores taken from both Western and Eastern deep waters will be analysed for pre-industrial TM levels. However, the background values obtained from this study might not be representing the background values for the near-shore coastal waters; especially the river mouths where the nature of the drainage basin will be very important. Such contributions would be very important for the Secretariat and will be expected from the Mediterranean scientific community.

The MED POL Secretariat is planning to keep the communication in the expert group alive to discuss the new outputs of MED POL on the subject and the new findings in the area. This will certainly facilitate the terms of the possible future revisions of the strategy.

4. Conclusions

The formulation and implementation of coastal water monitoring programmes is a legal obligation for all the Contracting Parties to the Barcelona Convention according to Art. 12 of the Convention and Art. 8 of the LBS Protocol. In both legal texts, mention is also made to cooperation with a regional competent body for the organization of such activities. The MED POL Programme of the Mediterranean Action Plan has had the responsibility for the organization of monitoring activities to address and assess pollution at the regional level since its earlier phases, more concretely since the early 1980s and through its Phase II and III. Therefore, the MED POL Secretariat has been inviting countries for more than two decades to formulate NMPs and, accordingly, to sign monitoring agreements with MAP/MED POL since the beginning of Phase II and through Phase III. A Data Quality Assurance Programme and other means of capacity building activities have been organized since the inception of the Programme (1975 Phase I) to support the organization and implementation of NMPs and ensure the quality of data and information obtained.

In spite of the binding nature of the monitoring activities and the importance given to the organization of pollution monitoring activities at the regional level, the level of participation of the countries in the monitoring activities has remained moderate during both phases of the MED POL Programme. In Phase II, major discontinuities in data provision occurred while in Phase III the number of participating countries lessened but data has been gathered more systematically. As a result, during MED POL Phase III interruptions in the implementation of NMPs (and in the provision of data) have not been a major problem except in few cases. In addition, in Phase III data was collected with more clear objectives and uniform sampling strategies which allowed the gathering of data for the mandatory components and elements of the Programme in a single database. This has also facilitated the regular evaluation of data (e.g. trend monitoring data) and the identification of the problems in the programme design in a timely manner and optimizations where necessary.

In MED POL Phase III, in addition to the low participation at the regional level, the geographical coverage of coastal waters monitoring stations at the national level was also limited. In most cases, the NMPs were limited to a small number of sites and only to few monitoring stations. However, an attempt was made to cover the identified hot spots in the NMPs to a large extent.

Regarding the major goal of MED POL Phase III, i.e. the prevention and control of pollution, the compliance monitoring activities have had a key role. Some of the objectives of the activity, such as the completion of the baseline studies for the pollutant discharges (NBBs, 2003) and the assessment of the implementation of control measures, have already been dealt in the framework of the work plan of SAP. The compliance monitoring has represented an added value to the SAP activities since it covered effluent quality control where criteria and standards already existed. However, effluent quality control was poorly achieved during MED POL Phase III in terms of provision of compliance reports for the effluents (e.g. industrial effluents) by the countries even if they had included it in the monitoring agreements. An overall evaluation of this component could in any case be made at a later stage together with the results obtained from the SAP reporting exercises being performed by the countries. Good results were instead achieved within the compliance monitoring by the quality control for health-related conditions carried out by the countries, especially for bathing waters. The compliance reports were properly provided (sometimes in relation to more than one regulation) demonstrating good practices at the national level.
The Secretariat believes that the strategy related to compliance monitoring has to be revised considering the use and importance of its individual components at the national and regional scales and the need to make this type of monitoring an even better tool for the long-term implementation of the SAP.

The second major component of the monitoring activities in MED POL Phase III was the temporal trend monitoring of pollutants in coastal waters; basically at pollution hot spots. The expected outcomes of the activity have been two-fold; to provide a statistically sound tool for the evaluation of the contamination status of coastal waters and hot spots in time, and to monitor the effectiveness of the policy measures taken (e.g. pollution reduction plans and actions). Countries that participated in the trend monitoring activity were well informed of the specific design objectives of the programme and the response was the adoption of the required strict sampling strategy at the national level even in cases where a temporal trend monitoring activity did not exist. At the moment, most of the programmes show a good temporal trend monitoring activity. The programmes should continue following the same course taking into account the recommendations of the second and third review meetings of monitoring activities which were based on precise data analysis.
The next step could be the analysis of the results (information on trends) for each monitoring site to establish links with the available information on inputs as well as the measures taken to reduce pollution. Normally, any change in pollution levels at the source of pollution is expected to influence the long-term trends in the hot spot and even in the less polluted coastal waters.
As related to the new possible monitoring sites, each country has to exert utmost efforts to include all pollution hot spots in their monitoring programmes by taking into account the priority areas along their coasts and the sector of activities identified in the NAPs.

The monitoring of inputs and loads of the land-based sources of pollution from various sources were included in the scope of the MED POL Phase III monitoring activities. Data were provided by a limited number of countries on inputs from point discharges (industrial and municipal) and river inputs.
The still limited data collected on the point discharges is anyhow valuable at the national level and could be used to verify the values included in the NBBs where emission factors were used to estimate inputs from point sources. However, further elaboration of the objectives of the monitoring activity on point discharges is needed and a decision has to be made if it should still be a part of the future monitoring activities or not, taking into account the related exercise included in the implementation plan of the SAP.
Regarding the inputs via rivers and streams, the gathered data could serve to complete the regional assessment made on river inputs. In any case, this activity should be considered an integral component of the NMPs in view of the requirements of the LBS Protocol.

The biological effects monitoring was an innovative component of the MED POL Phase III that considered the effects of pollutants at the organism level. The component helped to develop the capacity to measure a battery of biomarkers at the regional level and to successfully include it in some of the NMPs in parallel to the levels of pollution monitoring in the same matrix. The biological effects monitoring activity should be further developed and continue to be a component of the MED POL monitoring and assessment activities in the future.

The eutrophication monitoring was a new concept for the scope of MED POL Phase III. All the components of the ecosystem in a problem area should be taken into account and integrated into a monitoring system including the biological components as well. The activity has been developed during the last four years of the MED POL Phase III and has recently quite advanced and has produced a planning for future activities. Since the developed Strategy for the monitoring of eutrophication is quite new and open to any possible modification, it should continue to be the basis for the eutrophication monitoring in the Mediterranean basin. The results of this activity will certainly provide a good basis for the planned assessment of eutrophication of the coastal waters of the Mediterranean Sea.

The MED POL Secretariat aims to complete its database content of Phase III (1996-2005) through the inclusion of comparable data sets and information available at national data sources. This has also been one of the recommendations of the last Contracting Parties Meeting held in Portoroz (COP14), Slovenia, 8-11 November 2005. The Secretariat aims to integrate this information with the present content of its database to be used in an Information System that is going to be developed in cooperation with, and the support of, INFO/RAC during next biennium. Moreover, the Secretariat also aims to publish the overall findings of the monitoring activities at the regional level for the period of MED POL Phase III. To achieve this, the present Meeting is expected to provide its views on the organization of the work.

Considering the further recommendations of COP14 and the approved MED POL Phase IV principles and objectives, the Mediterranean countries have been once more invited to continue to cooperate with MAP/MED POL and make efforts to substantially strengthen and improve their cooperation, in particular regarding the formulation and implementation of monitoring programmes with common objectives and criteria. In this context, the Meeting could possibly suggest new approaches and mechanisms for the proper organization of the monitoring activities in Phase IV which will be taken into account by the Secretariat on the assumption that monitoring activities are and will continue to be the basis for the effective control and elimination of pollution and should therefore be performed adequately.

ANNEX I

ANNEX I

Yearly and Country Statistics of MED POL-III Database

MEDPOL Database

Yearly Statistics

Year	Number of Stations	Number of Samples	Number of Parameters	Number Of Values
1996	21	137	13	873
1997	21	146	16	1090
1998	24	83	7	393
1999	206	1327	108	7930
2000	162	1182	117	7982
2001	307	2006	87	17310
2002	178	1358	70	7507
2003	156	1272	83	7176
2004	58	696	77	4159
Total	***445****	***8207***	***97****	***54420***

*Only unique stations and parameter are counted

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MEDPOL Database

Yearly Statistics

Item	*Country*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Number of parameters	Albania	11	3				24	
	Croatia	8	94	28	16		19	20
	Cyprus	2	38	20	37	32	22	
	France	5	20	16	18	18	21	
	Greece	37	10					
	Israel	10	15	22	24		25	16
	Slovenia	64	33	30	23		18	28
	Tunisia	13	17					
	Turkey	4	5	10	23	5	27	28
Total (Only unique parameters are counted)	**Number of parameters**	*7*	*108*	*117*	*87*	*70*	*83*	*77*
Number of samples	Albania	4	4				26	
	Croatia	47	180	727	83		63	337
	Cyprus	4	115	52	161	149	64	
	France	69	123	109	128	86	47	
	Greece	443	17					
	Israel	330	393	296	227		322	30
	Slovenia	142	316	332	309		295	245
	Tunisia	219	446					
	Turkey	10	127	115	139	54	74	58
Total	**Number of samples**	*83*	*1327*	*1182*	*2006*	*1358*	*1272*	*696*

Number of stations	Albania	2	2				2	
	Croatia	27	33	106	18		17	25
	Cyprus	4	37	39	72	43	28	
	France	19	20	19	19	19	18	
	Greece	47	4					
	Israel	32	24	23	23		25	1
	Slovenia	28	23	23	20		16	19
	Tunisia	40	41					
	Turkey	1	15	20	22	12	10	11
Total	**Number of stations**	*24*	*206*	*162*	*307*	*178*	*156*	*58*
Number of values	Albania	22	12				236	
	Croatia	171	2273	8983	465		459	678
	Cyprus	8	597	286	669	1028	227	
	France	345	1016	756	1082	602	465	
	Greece	2342	100					
	Israel	2101	2407	1921	1559		1946	181
	Slovenia	1195	1699	3151	2438		1876	2299
	Tunisia	745	1233					
	Turkey	40	508	461	737	170	880	765
Total	**Number of values**	*393*	*7930*	*7982*	*17310*	*7507*	*7176*	*4159*

MEDPOL Database

Country Statistics

Station Type: Coastal or Reference
Monitoring Activity: State Monitoring

Country	*Number of stations*	*Number of stations not in Program*	*Stations without data*	*Number of stations without coordinates*	*Number of samples*	*Number of parameters*	*Number of values*
Albania	1	0	1	0	0	0	0
Cyprus	35	26	4	3	50	28	198
France	25	25	0	0	845	22	6229
Greece	48	0	36	10	96	20	439
Israel	27	17	0	0	650	18	4110
Slovenia	11	1	0	1	904	55	6340
Tunisia	1	0	1	0	0	0	0
Turkey	5	2	0	0	13	18	83
Total	***153***	***71***	***42***	***14***	***2558***	***97****	***17399***

*Only unique parameters are counted

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MEDPOL Database

Country Statistics

Station Type: Coastal or Reference
Monitoring Activity: Trend Monitoring

Country	Number of stations	Number of stations not in Program	Stations without data	Number of stations without coordinates	Number of samples	Number of parameters	Number of values
Albania	1	0	0	1	3	24	24
Cyprus	5	1	0	0	84	27	1229
Greece	19	3	13	0	64	14	373
Israel	24	18	0	0	730	18	4454
Slovenia	3	0	0	0	520	49	3140
Tunisia	4	0	0	0	81	13	211
Turkey	6	1	3	0	224	39	1367
Total	***62***	***23***	***16***	***1***	***1706***	***100****	***10798***

*Only unique parameters are counted

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MEDPOL Database

Country Statistics

Station Type: Hot Spot
Monitoring Activity: State Monitoring

Country	Number of stations	Number of stations not in Program	Stations without data	Number of stations without coordinates	Number of samples	Number of parameters	Number of values
Croatia	21	0	3	0	461	29	1311
Cyprus	33	3	3	0	188	8	647
Greece	26	0	10	0	100	20	436
Israel	9	0	0	0	382	18	2474
Slovenia	6	0	0	0	260	38	3560
Tunisia	1	0	0	0	7	8	15
Turkey	7	0	0	0	160	34	941
Total	**103**	**3**	**16**	**0**	**1558**	**86***	**9384**

*Only unique parameters are counted

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MEDPOL Database

Country Statistics

Station Type: Hot Spot
Monitoring Activity: Trend Monitoring

Country	*Number of stations*	*Number of stations not in Program*	*Stations without data*	*Number of stations without coordinates*	*Number of samples*	*Number of parameters*	*Number of values*
Albania	2	0	0	0	40	24	318
Croatia	8	0	0	0	295	29	1169
Greece	10	9	0	8	176	27	1062
Israel	9	0	0	0	382	18	2474
Tunisia	1	0	0	0	7	8	15
Turkey	3	0	0	0	140	33	804
Total	***33***	***9***	***0***	***8***	***1040***	***66****	***5842***

*Only unique parameters are counted

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ANNEX II

ANNEX II

State-of -the –Art of rivers inputs monitoring programme in the Mediterranean region

Major findings of the assessment report (MAP Technical Series no.141) and the Training Courses :

Data -The most complete *data records* can be found for the large northern rivers, which are the Po, Rhone and Ebro rivers. For many of the investigated parameters, we present data records covering the last 30 years, allowing the tracking of the their temporal evolution and the identification of most recent trends. These trends could often be confirmed by the data on other rivers, indicating that these trends may be extrapolated to larger scales. The pollution state of rivers can evolve rapidly and an assessment cannot be done without mentioning the corresponding reference period. Trend analyses therefore took an important place in our study.
Because of the scarceness of data, we did not extend our investigation to other pollutants such as hydrocarbons and/or pesticides.

Mediterranean particularities - An assessment of the environmental state of the rivers in the Mediterranean area cannot be understood without taking into account the particularities of this region. This concerns mainly the strong variability of the water discharge, and the strong anthropogenic pressure on the water resources. The first point is important because of the often extreme draughts in summer, average pollution loads may more easily cause environmental damage than in rivers of other climates with a more regular water flow. Regular monitoring of water quality is also more difficult under these conditions because it requires higher sampling frequencies. The second point translates the fact that the rivers are highly affected by artificial river damming and anthropogenic water extraction. In the Ebro River alone more than 180 reservoirs have been constructed. It is evident that this can have a strong impact on the natural functioning of the river systems, and may increase their vulnerability for environmental harm.

Water discharge – Water discharge plays a key role in the transport of riverine matter to the sea. Even if the average concentrations of different pollutants can be determined with reasonably good precision, flux estimates can only be as good as the estimates for the corresponding water discharges.

We reconstructed the evolution of riverine runoff to the Mediterranean up to the beginning of the last century in order to evidence the major changes that may have occurred. It is probably for the first time that water riverine budgets for the entire Mediterranean Sea have been determined with such detail. It can be shown that there occurred a continuous decrease in water discharge because of both climate change and anthropogenic water use.

Actual water discharge to the entire Mediterranean Sea was estimated to about 330 km3/yr, which is only 55% of what it has been at the beginning of the 20th century. The decrease especially accentuated after the 1970s, with strongest reductions in the Alboran and Aegean Sea. Only for the Rhone and the Po rivers, the two largest river basins, the average runoff seems to remain at constant levels, which means that their relative importance in the overall water supply to the Mediterranean Sea may have considerably increased.

Sediment fluxes – Sediment fluxes are the second key parameter controlling the riverine transfer of terrestrial matter to the sea. Because of the strong seasonality of climate, the presence of elevated mountain ranges, the wide dominance of younger, softer rocks, and a long history of human activity, Mediterranean rivers tend to have very high values of natural sediment fluxes. We estimate that the natural sediment supply to the Mediterranean Sea may have been in the range of 730 Mt/yr, corresponding to average sediment yield of about 580 t/km2/yr. Because of the massive constructions of reservoirs, however, the actual sediment flux may be less than 200 Mt/yr. These figures are based on general extrapolations and associated with considerable uncertainty. Their refinement would require the development of sophisticated modeling tools, which is beyond the scope of this study. A major problem in the evaluation of sediment fluxes is the extreme temporal variability of the fluxes in the Mediterranean climate. The sampling frequency of classical monitoring programs on water quality does not allow the determination of reliable sediment fluxes, which also means that the evaluation of the fluxes of particulate pollutants is not possible unless this is changed.

Organic and bacteriological pollution – Organic pollution is a greater problem in the rivers of the Mediterranean countries than in the rivers of the northern European countries. It is normally related to effluents from point sources such as household or industry wastewater. Also bacterial pollution is often originating from the same sources, although wastewater from agriculture may also be a major source for this pollution type. The extent to which these wastewaters are discharged into surface waters naturally depends on the wastewater treatment facilities available. Sewage plants are expensive, and money is more seriously missing in the southern than in the northern countries. Nevertheless, also in southern Europe, the treatment of municipal and industrial wastewater has significantly improved during the past 10 to 15 years, even if this evolution was less rapid than in the north European countries. Good examples are the Rhone and the Po rivers, where the BOD loads depict a three- to fivefold reduction over the 1980-1990 period, respectively. In the Ebro River, however, the loads rather tend to increase towards recent years, showing that wastewater treatment is not improved everywhere to the same extent.

However, the contributions of organic rich wastewater loads do not necessarily lead to elevated organic matter contents in the Mediterranean rivers. Dissolved organic carbon (DOC) concentrations are quite low compared to other world rivers, which can be explained by the steep morphologies, the often low drainage intensities and the carbon poor soils in the Mediterranean area. DOC largely reflects the organic compounds origination from the leaching of soil organic matter, which are chemically rather inert and which are not necessarily available for rapid biological decomposition in the river waters.

Nutrients – In our assessment on nutrients, we mainly focused on the levels of dissolved nitrate, dissolved phosphate and total phosphorous. The latter can strongly be controlled by the fluxes of particulate matter, for which the data availability can be insufficient to determine reliable averages. We normally assumed that the evolution of total phosphorous entirely followed the evolution of phosphate, although this has, of course, not necessarily to be the case.

In general, nutrient pollution is moderate in the Mediterranean rivers compared to the rivers of north-western Europe and/ or North America, reflecting the general land use practices and population densities in the Mediterranean countries. Fertilizer application, for example, is less intense in the south than in the north. This is true for all nutrient forms, but spatially the patterns of nitrogen and phosphorous pollution do not closely match, since both nutrients do not have the same origins. Nitrate loads are normally dominated by diffuse pollution from agricultural sources, whereas phosphorous compounds depend more closely upon point sources such as municipal sewage discharge. As a consequence, highest nitrate concentrations are found in rivers characterized by intense agricultural land use in the drainage basins, such as the Po River in Italy. Highest phosphate levels are typical for the rivers suffering from pollution due to urban wastewater inputs, such as the Besos River in Spain who receives the municipal effluents of Barcelona.

Also the temporal evolutions of the nitrate and phosphate loads in the Mediterranean rivers are different. For nitrate, the overall riverine input to the Mediterranean Sea increased continuously. It may almost have doubled from about 330 ktN/yr for <1975 to about 600 ktN/yr for >1995, even if during most recent years, the increase seems to slow down. Also phosphate loads strongly increased from about 15 ktP/yr for <1975 to about 40 ktP/yr for 1985-1990, but then dropped down to about the initial values as a result of the widely applied ban of phosphorous detergents and the general improvement of wastewater treatment facilities. The start of this decrease is not uniform in the different rivers, but the improvement is a widespread phenomenon.

Heavy metals – Because of the strong affinity of heavy metals to the solid phases in river water, the pollution state can be assessed best when looking at the heavy metal concentrations in the total suspended solids (in mg/kg). Our values witness a general impact of pollution in the Mediterranean rivers, especially for Hg, Cd, and Pb. However, when compared to the levels in the Seine or the Rhine rivers, one notes that the heavy metal concentrations are often two or three times lower in the Mediterranean rivers. Pollution is therefore less important compared to the river basins in northwestern Europe, in agreement with the lower industrial development in the Mediterranean countries. It is also possible that, because of the high natural sediment yields (see above), dilution of urban and industrial sources by high levels of suspended solids may also contribute to the lower heavy metal contents.

Trends for the temporal evolution of the pollution levels are difficult to establish for heavy metals because of the lack of high quality data. Many monitoring programs only measure total metals without filtering the samples, although the utility of this information is restricted. On the other hand, one has to point out that the contamination problem is still a major problem for the analysis of heavy metals.

Management-During the biennium 2004-2005 MEDPOL, with the assistance of GEF and FFEM, carried out sub-regional and national training courses related to quantification of inputs of pollutants into the Mediterranean Sea during which countries representatives presented papers describing national experiences related to the matter.

Several conclusions could be drawn off as follows:

1- in southern and eastern Mediterranean countries most of the water masses carried out through rivers , except for the Nil river and flood periods ,do not reach the Mediterranean sea.

2- Most of the materials reaching the Mediterranean sea through rivers are generated from the northern part of the region(European the Adriatic countries and Turkey).

3- In the majority of the countries except France, Italy and Spain monitoring programmes related quantification of inputs from rivers into the sea are either lacking or not comprehensive.

4- All countries established rivers monitoring programme as part of monitoring of national fresh water quality.

5- Most of the Mediterranean experts in the matter are experiencing problems related to data availability and exchange .

6- Mediterranean countries are lacking of necessary human resources to deal with monitoring of rivers inputs. A comprehensive and intensive training programme should be designed and implemented.

7- Horizontal cooperation between different Mediterranean countries could enhance the transfer of know how in the matter.

Annex III

Annex III
List of Abbreviations

AchE	Acetylcholinesterase inhibition
BOD	Biochemical Oxygen Demand
CD	Cadmium (Cd)
CRM	Certified Reference Material
CYP1A1	Cytochrome 1A1
DDT	Dichloro-Diphenyl Trichloroethane
D-GST	Displaced Haemolymph GST Activity (D-GST)
DNAx	DNA damage
DQA	Data Quality Assurance
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
EQO	Environmental Quality Objectives
EROD	7-ethoxyresorufin O-deethylase
EUROHARP	European Harmonized Procedures for Quantification of Nutrient Losses from Diffuse Sources
FFEM	Fonds Français pour l'Environnement Mondial
GEF	Global Environmental Facility
GST	Glutathione S-transferase
HGT	Total mercury
IAEA-MESL	International atomic Energy Agency-Marine Environment Studies Laboratory
IOC	Intergovernmental Oceanographic Commission
ICES	International Council for the Exploration of the Sea
LBS	Land Based Sources
LMS	Lysosomal membrane stability
MB	*Mullus barbatus*
MC	*Mactra corallina*
MED POL	Programme for the Assessment and Control of Pollution in the Mediterranean Region
MG	*Mytilus galloproviancialis*
MT	Metallothioneins content
NAPs	National Action Plan(s)
NBBs	National Baseline Budget(s)
NMP	National Monitoring Programme
NRR	Neutral Red Retention assay
OCs	Organic Contaminants
OSPAR	Oslo and Paris Commissions
PAHs	Polycyclic Aromatic Hydrocarbons
PB	Lead (Pb)
PCBs	Polychlorinated biphenyls
POPs	Persistent Organic Pollutants
QA/QC	Quality Assurance/Quality Control
QUASIMEME	Quality Assurance Laboratory Performance Studies for Environmental Measurements in Marine Samples
SAP	Strategic Action Programme
TMs	Trace Metals
TRIX	Trix index
UNEP	United Nations Environment Programme
WHO	World Health Organisation