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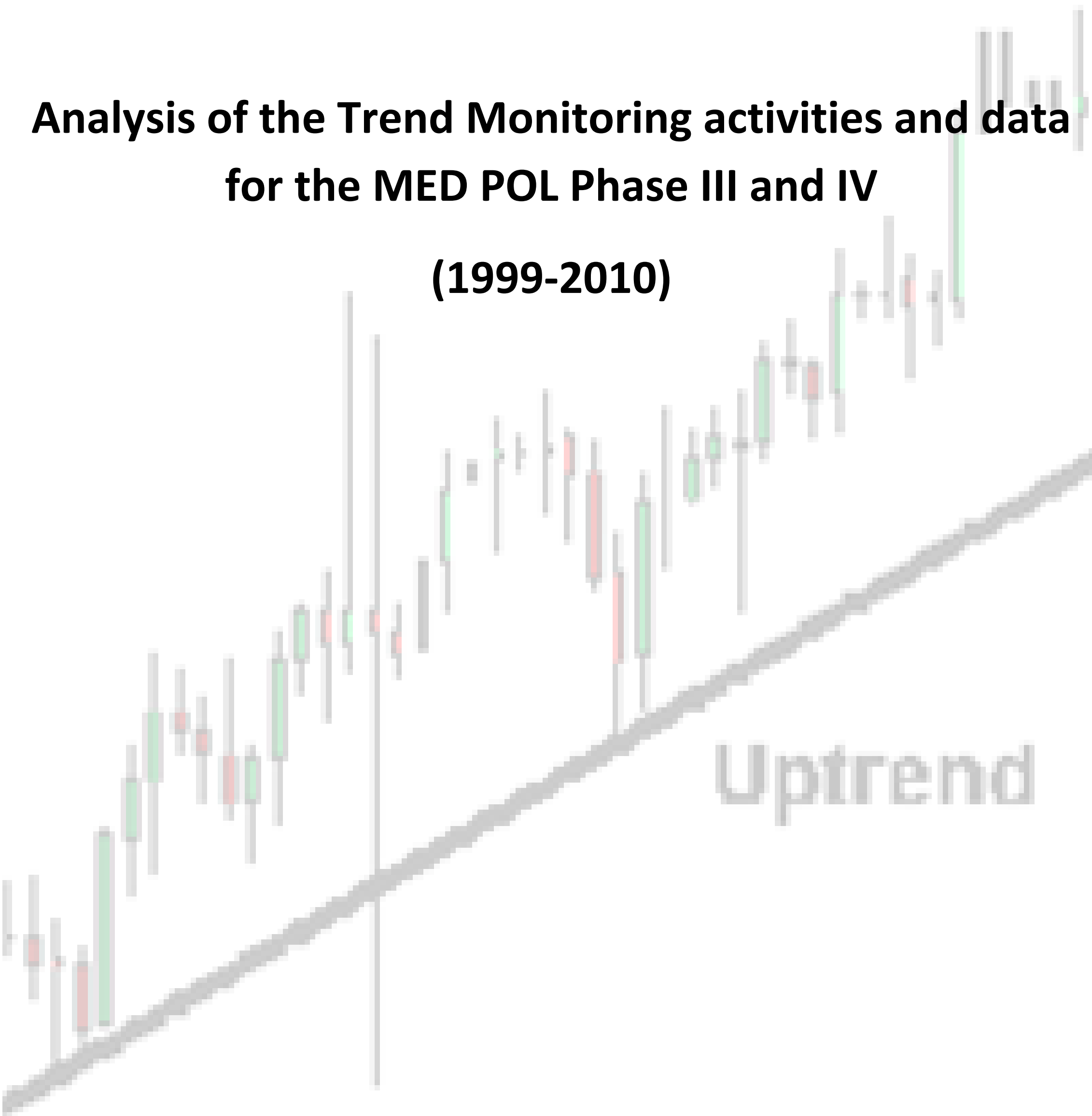
ANALYSIS OF THE TREND MONITORING ACTIVITIES AND DATA FOR THE MED POL PHASE III AND IV (1999-2010)

UNEP/MAP
Athens, 2011

Analysis of the Trend Monitoring activities and data for the MED POL Phase III and IV

(1999-2010)



October 2011

PREAMBLE

The Report on the analysis of trend monitoring activities and data for the period 1999-2010 presents a detailed analysis of variances and trends – where possible - of hazardous substances concentrations at selected stations in different countries. The trend evaluation was only performed on datasets from sampling sites with more than five years of ongoing monitoring, which were fulfilling the programme’s requirements. For the trend detection, the software PIA was used, which analyses trends in time-series datasets by applying a standard statistical analysis. The Report has been prepared by Dr. Robert Precali (Center for Marine Research, Croatia), under the supervision of UNEP/MAP - MED POL.

Contents

Introduction

In this type of report most of the introduction, to the eyes of a national expert in the field, is well known and always skipped during the reading process, but for a novice or entry level personnel serve as an useful set of information. One of the major component of the MED POL Phase III monitoring activities was the monitoring of contaminants at Mediterranean hot spots and coastal waters to attain site-specific temporal trends with 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 underlying each monitoring practise. In 2005 a second attempt was made mainly to identify the weakest parts of the adopted sampling strategy. In 2009 when the 10 years benchmark was reached a detailed analysis of variances and trends – where possible - for each monitoring site were performed. 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 was also aimed in the evaluation. For this report the dataset was extended to 2009 and as for the previous evaluation a detailed analysis of variances and trends – where possible - for each monitoring site were performed. The report for the 2009 evaluation served as a base but additionally a detailed long-term time series power analysis was done. An innovative statistical suite was used.

Inorganic and organic contaminants data collected for biota and sediments were both attempted to be evaluated for each sampling site included in the MED POL database. The data sets were huge and encompassing time consuming steps of data preparation and analysis. Therefore, it was mainly concentrated to inorganic contaminants (TMs) data and a complete analysis was performed. Results for organic contaminants will also be presented in this report. As was case in previous reports all country based analysis will be recorded separately on CDs to be provided to the respective countries and laboratories. The CDs are also including reference material and the software suite used for the analysis.

1. 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 fulfilment of the defined goals.

The present evaluation is mainly intended to go even a step further and to identify the main problems in trend detection as to understand if the main goal.

Requirements and criteria

After around ten year of ongoing programmes some countries still have no more than five 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- fulfil the designed objectives, only the compliance of within year variance with threshold values could be checked.

However, the trend evaluation can be performed on countries with more than five years of ongoing programmes and an attempt will be performed only for data series that fulfil this requirement. For the trend detection, the software suite PIA was used. PIA is a computer program for analysing trends in time-series datasets by applying a standard statistical analysis that has been adopted by the Arctic Monitoring and Assessment Programme (AMAP) for use in its temporal trend assessment activities. PIA© was developed by Anders Bignert (anders.bignert@nrm.se).*Investigation of within year variances*

In general, the statistical objective for the 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 reject 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) 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 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 judgement is needed to select the appropriate one. OSPAR 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.

The basic statistical methodology applied when running PIA is a robust regression-based analysis to detect trends in time-series datasets (Nicholson et al., 1995).

The standard run in PIA calculates annual geometric means from the input data and uses these as the annual 'index' values that are tested for linear trends, as described below, and a 3-year running-mean smoother that is compared with the (log) linear regression in the tests for non-linear trend components.

Important features in the statistical output are based on the concept of 'statistical power', i.e., the chance to detect a true trend, which, in percentage terms, can be quantified as 100% minus the risk of a Type II error (that is, falsely concluding that there is no change when there actually is a change). The 'statistical power' depends on the inherent random (unexplained) variation in a dataset. The potential of any dataset to show a statistically significant change over time depends on its statistical power; a low variation implies higher statistical power, and that smaller changes can be detected, or that the time period required to detect a given change will be shorter.

Options can be set using commands in the 'directive' file to modify the standard analysis so that, for example, medians are used instead of geometric means as the annual index values. The 95% confidence interval for the median is estimated by a method described in Dixon and Massey (1969). Similarly, PIA can be directed to apply a 'loess' smoother (Cleveland, 1979) (with a window defined by the user) instead of the 3-year running-mean smoother.

Log-linear regression analyses

Log-linear regression analyses are performed for the entire investigated time period. The slope of the line describes the yearly percentage change. A slope of 5% implies that the concentration is halved in fourteen years, whereas 10% corresponds to a similar reduction in seven years and 2% in 35 years. See table 1 below.

Table 1. The approximate number of years required to doubling or halving the initial concentration assuming a continuous annual change of 1%, 2%, 3%, 4%, 5%, 7%, 10%, 15% or 20% per year.

	1%	2%	3%	4%	5%	7%	10%	12%	15%	20%
Increase	70	35	24	18	14	10	7	6	5	4
Decrease	69	35	23	17	14	10	7	6	4	3

Non-parametric trend test

The regression analysis pre-supposes, among other things, that the regression line provides a good description of the trend. The leverage effect of points at either the end of the line is a well-recognized problem. An exaggerated slope, caused 'by chance' due to one (or a few) points at either end of the line increases the risk of a 'false positive', i.e, a significant result when no real trend exists. A non-parametric alternative to the regression analysis is the Mann-Kendall trend test (Gilbert, 1987; Helsel and Hirsch, 1995). This test generally has lower power than the regression analysis, it counts the number of consecutive years where the concentration increases or decreases compared with the year before, but does not take differences in the magnitude of the concentrations into account. If the regression analysis yields a significant result but the Mann-Kendall test does not, one explanation could be the lower power of the Mann-Kendall test. An alternative explanation might be the undue influence (leverage) of endpoints in the time series on the regression slope. Hence, the Kendall's 'tau' value and the corresponding p-value are reported. The Kendall's 'tau' ranges from 0 to 1, like the traditional correlation coefficient 'r', but will generally be lower. 'Strong' linear correlations of 0.9 or above correspond to tau-values of about 0.7 or greater (Helsel and Hirsch, 1995, p. 212). In an evaluation comparing several other trend tests, this test was recommended by the US EPA for use in water quality monitoring programmes with annual samples (Loftis et al., 1989).

Non-linear trend components

An alternative to the regression line to describe the development of changes in concentration over time is some kind of 'smoothed' trend line. The smoother by default is a simple 3-point running-mean smoother fitted to the annual geometric mean values. In cases where the regression line is badly fitted, the smoothed line may be more appropriate. The significance of this line is tested by means of an Analysis of Variance, where the variance explained by the smoother and by the regression line is compared with the total variance. This procedure is described by Nicholson et al. (1995).

Explanation of trend statistics

This is a typical PIA statistical suite trend statistics output:

Trend statistics:

Slope = -2.6% (-4.9, -.38)
SD(lr)= .30, 7.0%, 16 yr
Power = .52/.25/11%
y(06) = .27(.18, .41)
r2 = .38, p < .025 *
tau =-.51, p < .015 *
SD(sm)= .18, p < .008 *

Slope = reports the slope, expressed as the yearly percentage change, together with its 95% confidence interval.

SD(lr) = reports the square root of the residual variance around the regression line, as a measure of between-year variation, together with the lowest detectable change in the current time series with a power of 80%, one-sided test, alpha=0.05. The last figure on this line is the estimated number of years required to detect an annual change of 5% with a power of 80%, one-sided test, alpha=0.05.

Power = reports the power to detect a log-linear trend in the time series (Nicholson and Fryer, 1991). The first figure represents the power to detect an annual change of 5% with the number of years in the current time series. The second figure is the power estimated as if the slope were 5% a year and the number of years were ten. The third figure is the lowest detectable change for a ten-year period with the current between-year variation at a power of 80%. This test assumes the time-series is based on annual sampling.

y(xx) = reports the concentration estimated from the regression line for the last year in the time-series (as indicated by the value of xx), together with a 95% confidence interval. Provided that the regression line is relevant for describing the trend, the residual variance may be more appropriate than the within-year variance in this respect.

r2 = reports the coefficient of determination (r2) together with a p-value for a two-sided test (H0: slope = 0), i.e., a significant value is interpreted as a true change, provided that the assumptions of the regression analysis are fulfilled.

tau = reports Kendall's 'tau', and the corresponding p-value for this non-parametric trend test.

SD(sm) = reports the square root of the residual variance around the smoothed line. The significance of this line could be tested by means of an Analysis of Variance. The p-value is reported for this test. A significant result will indicate a (significant) non-linear trend component.

2. Country based evaluation of data

The country based evaluation of data is essential in the understanding of pollution fate in the environment. It arise from the fact that the pollution is managed at the country level. Usually most of the activities are to be considered in relation to the assessment of the efficacy of control measures. Control measures are introduced in response to perceived impacts on the marine environment, and are designed to control (limit or reduce) the scale or occurrence of the impacts.

During the phase of trend monitoring design (1998-2001) MEDPOL countries tacitly agreed and in general, the statistical objective for the national programmes was set to detect a minimum linear trend of 10 % per year in 10 years with a power of 90%.

In this evaluation the main goal is to understand if after 10 years the statistical objectives for the national programmes is achieved or need adjustment in defining a better sampling strategy. Part of the previous report is replicated also in this report to understand better the fulfilment of the statistical objectives and to facilitate the reader. Analytical variance and intecalibration result will not be discussed since countries has not provided.

Albania

Albania has not provided additional data since the last evaluation.

I 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. At the same time also a change in the location of sampling sites occurred (Fig. Alb.1), the sites were moved closer to urban agglomeration of Durres and Vlore.

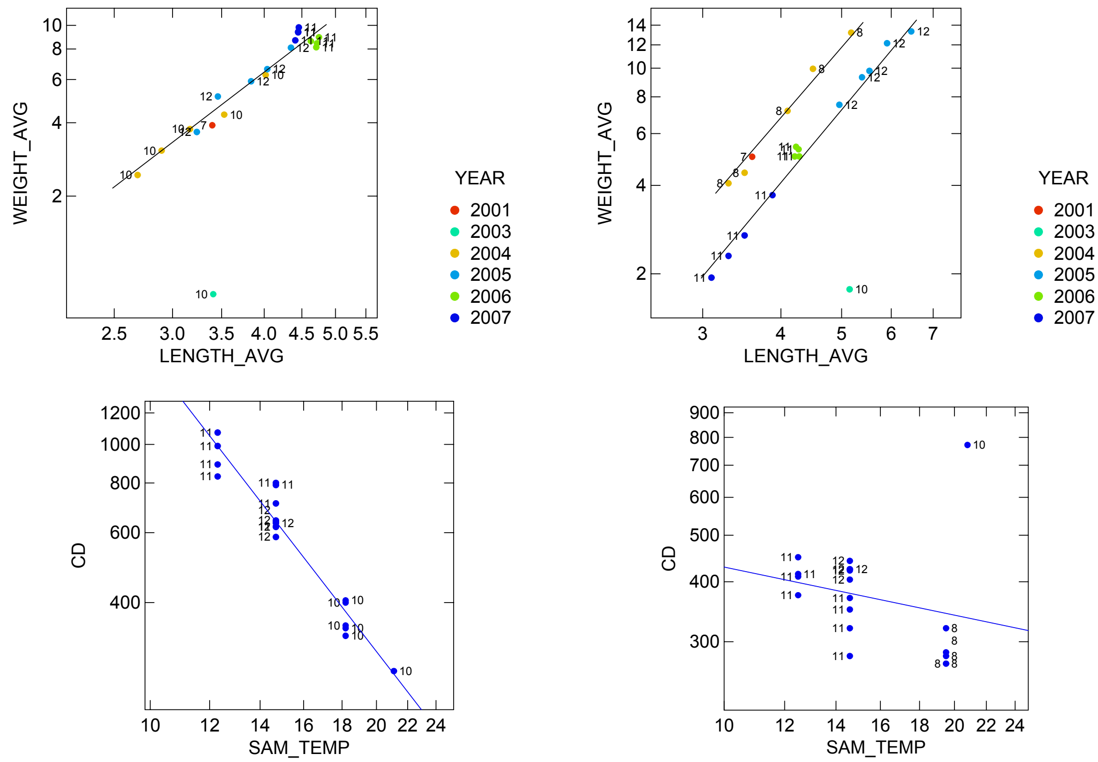
Figure Alb.1. Sampling stations.

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 Alb.1. The within year sampling variance was estimated for 2004 data and is very low and far below the threshold of 0,060.

From exploratory statistics (Fig. Alb.3) 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. Alb.2) 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) and size fraction (the central on a log scale) has to be adopted and maintained in future.

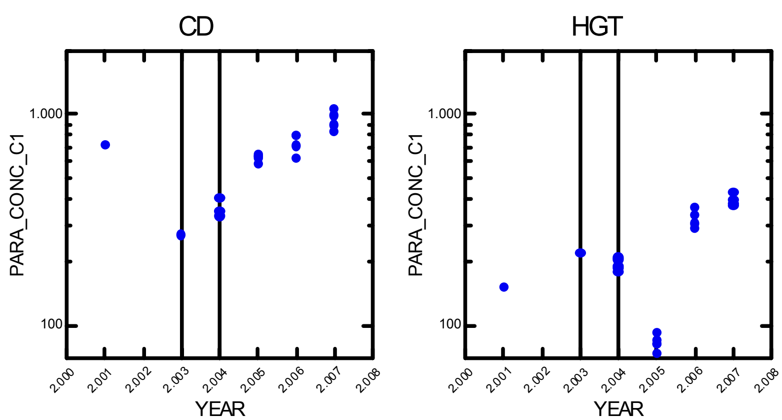
Table Alb.1. Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Mytilus galloprovincialis* at stations along the Albanian coast in the period 2001-2007.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	C1.2	2001	1	721,2	721,2	721,2	721,2		
CD	C1.2	2003	1	269,0	269,0	269,0	269,0		
CD	C1.2	2004	5	330,0	405,0	366,0	350,0	34,2	0,002
CD	C1.2	2005	5	584,8	643,5	624,4	633,8	23,6	0,000
CD	C1.2	2006	4	620,0	800,0	730,0	750,0	83,7	0,003
CD	C1.2	2007	4	830,0	1 070,0	945,0	940,0	106,3	0,002
CD	C2.2	2001	1	288,0	288,0	288,0	288,0		
CD	C2.2	2003	1	771,0	771,0	771,0	771,0		
CD	C2.2	2004	5	270,0	320,0	285,0	280,0	20,6	0,001
CD	C2.2	2005	5	404,1	442,0	423,5	424,8	13,5	0,000
CD	C2.2	2006	4	280,0	370,0	330,0	335,0	39,2	0,003
CD	C2.2	2007	4	375,0	450,0	412,5	412,5	30,7	0,001
HGT	C1.2	2001	1	152,1	152,1	152,1	152,1		
HGT	C1.2	2003	1	219,0	219,0	219,0	219,0		
HGT	C1.2	2004	5	180,0	210,0	194,6	190,0	12,5	0,001
HGT	C1.2	2005	5	74,0	92,1	83,1	82,3	6,6	0,001
HGT	C1.2	2006	4	290,0	360,0	322,5	320,0	31,2	0,002
HGT	C1.2	2007	4	372,0	425,0	393,0	387,5	23,4	0,001
HGT	C2.2	2001	1	241,6	241,6	241,6	241,6		
HGT	C2.2	2003	1	421,0	421,0	421,0	421,0		
HGT	C2.2	2004	5	405,0	440,0	418,0	415,0	13,5	0,000
HGT	C2.2	2005	5	325,0	440,8	380,9	381,0	45,3	0,003
HGT	C2.2	2006	4	702,0	795,0	735,3	722,0	41,0	0,001
HGT	C2.2	2007	4	480,0	530,0	505,0	505,0	20,8	0,000
CR	C1.2	2001	1	3.969,7	3.969,7	3.969,7	3.969,7		
CR	C1.2	2003	1	3.930,0	3.930,0	3.930,0	3.930,0		
CR	C1.2	2004	5	3.970,0	4.800,0	4.332,0	4.160,0	361,3	0,001
CR	C1.2	2005	5	7.860,0	11.880,0	8.994,0	8.200,0	1.672,9	0,005
CR	C1.2	2006	4	8.150,0	9.800,0	9.000,0	9.025,0	689,2	0,001
CR	C1.2	2007	4	9.500,0	11.700,0	10.600,0	10.600,0	901,8	0,001
CR	C2.2	2001	1	12.486,9	12.486,9	12.486,9	12.486,9		
CR	C2.2	2003	1	1.630,0	1.630,0	1.630,0	1.630,0		
CR	C2.2	2004	5	1.250,0	1.600,0	1.438,0	1.450,0	148,6	0,002
CR	C2.2	2005	5	6.820,0	11.180,0	9.718,0	10.580,0	1.775,8	0,008
CR	C2.2	2006	4	9.100,0	10.500,0	9.950,0	10.100,0	619,1	0,001
CR	C2.2	2007	4	16.200,0	18.700,0	17.525,0	17.600,0	1.053,2	0,001
PB	C1.2	2001	1	1.387,9	1.387,9	1.387,9	1.387,9		
PB	C1.2	2003	1	1.640,0	1.640,0	1.640,0	1.640,0		
PB	C1.2	2004	5	3.790,0	3.960,0	3.856,0	3.850,0	68,8	0,000
PB	C1.2	2005	5	5.380,0	5.990,0	5.662,0	5.670,0	237,2	0,000
PB	C1.2	2006	4	3.900,0	4.770,0	4.305,0	4.275,0	371,2	0,001
PB	C1.2	2007	4	3.950,0	4.900,0	4.412,5	4.400,0	390,2	0,001
PB	C2.2	2001	1	4.031,4	4.031,4	4.031,4	4.031,4		
PB	C2.2	2003	1	2.380,0	2.380,0	2.380,0	2.380,0		
PB	C2.2	2004	5	2.550,0	2.700,0	2.618,0	2.600,0	61,0	0,000
PB	C2.2	2005	5	5.450,0	6.000,0	5.694,0	5.540,0	263,6	0,000
PB	C2.2	2006	4	3.190,0	3.800,0	3.520,0	3.545,0	254,7	0,001
PB	C2.2	2007	4	3.680,0	4.390,0	4.030,0	4.025,0	313,2	0,001

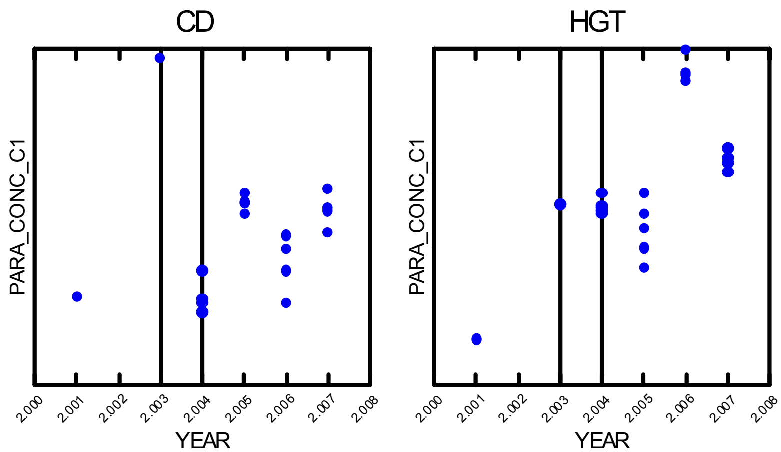


C1.2 **C2.2**

Figure Alb.2. Length to weight relationship in *Mytilus galloprovincialis* (MG) by year and values (Log scale) of Cadmium mass fraction by seawater temperature at station C1.2 and C2.2 with superimposed month of sampling.



Station C1.2

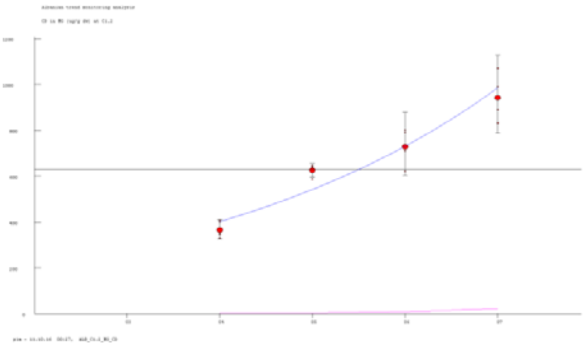


Station C2.2

Figure Alb.3. Values (Log scale) of trace metals mass fraction in *Mytilus galloprovincialis* (MG) by year at station C1.2 and C2.2 in Albanian coastal waters.

Tentatively a trend elaboration with PIA statistical suite for an available 4 years data period (2004-2007) was attempted. A summary is given in Fig. Alb.4. From the elaboration it's clear that only important trends will be detected for such a short period. At station C1.2 for cadmium a 30% upward trend was identified. The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 9.1%. For a period of 10 years, a power of 88% would be expected (consult Power in Trend Statistics on Fig. Alb.4.).

Cadmium

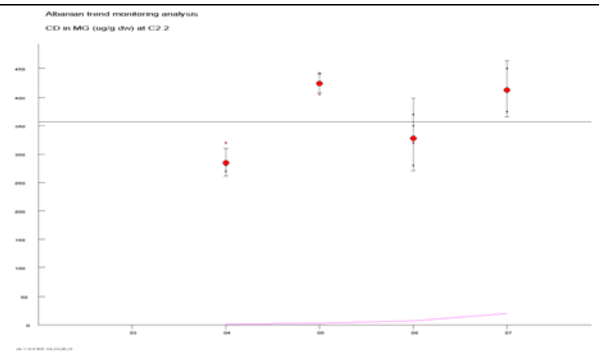


C1.2

The data series show a 30% yearly increasing trend (with a 95% confidence interval of 5.8, 54%)

Trend statistics:

Slope = 30% (5.8, 54)
SD(lr)= .13, 46%, 11 yr
Power = .09/.88/5.2%
y(07) = 984(626, 1546)
r2 = .93, p < .042 *
tau =1.00, p < .042 *
SD(sm)= .00, p < .001 *



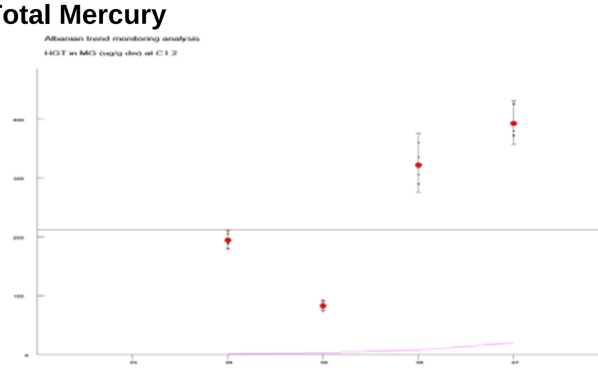
C2.2

The data series show no significant log-linear trend

Trend statistics:

Slope = 35% (-90, 160)
SD(lr)= .65, >99%, 29 yr
Power = .06/.09/30%
y(07) = 357(35, 3691)
r2 = .42, p < .356
tau = .67, p < .174
SD(sm)= .00, p < .001 *

Total Mercury

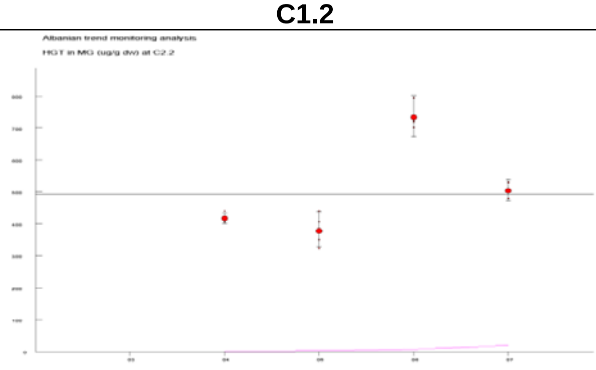


C1.2

The data series show no significant log-linear trend

Trend statistics:

Slope = 8.5% (-28, 45)
SD(lr)= .19, 77%, 14 yr
Power = .07/.54/7.9%
y(07) = 406(205, 802)
r2 = .34, p < .420
tau = .33, p < .497
SD(sm)= .00, p < .001 *



C2.2

The data series show no significant log-linear trend

Trend statistics:

Slope = 12% (-46, 70)
SD(lr)= .30, >99%, 18 yr
Power = .06/.25/13%
y(07) = 592(200, 1746)
r2 = .29, p < .458
tau = .33, p < .497
SD(sm)= .00, p < .001 *

Figure Alb.4. Values (Log scale) of trace metals (Cd and HgT) mass fraction in *Mytilus galloprovincialis* (MG) by year at station C1.2 and C2.2 in Albanian coastal waters and trend statistics.

Croatia

Croatia provided data for contaminants levels in biota and sediments. In biota mass fraction of trace metals (Cu, Cd, total Hg and Pb) and organic compounds (DDTP - Dichloro-Diphenyl Trichlorethane pp, DDTS - opDDT + ppDDT, PCBA - Chlorinated biphenyl congeners as Aroclor 1254 and PCBB - Chlorinated biphenyl congeners as Aroclor 1260) and for sediments mass fraction of trace metals (Cd, total Hg and Pb) were provided. To the previous data elaboration set (2002-2005) only data for the 2009 was provided resulting in a tree years (2006-2008) data gap.

Trace metals in biota

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 tables Cro.1 and Cro.2, 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 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 cannot be used as a reliable threshold.

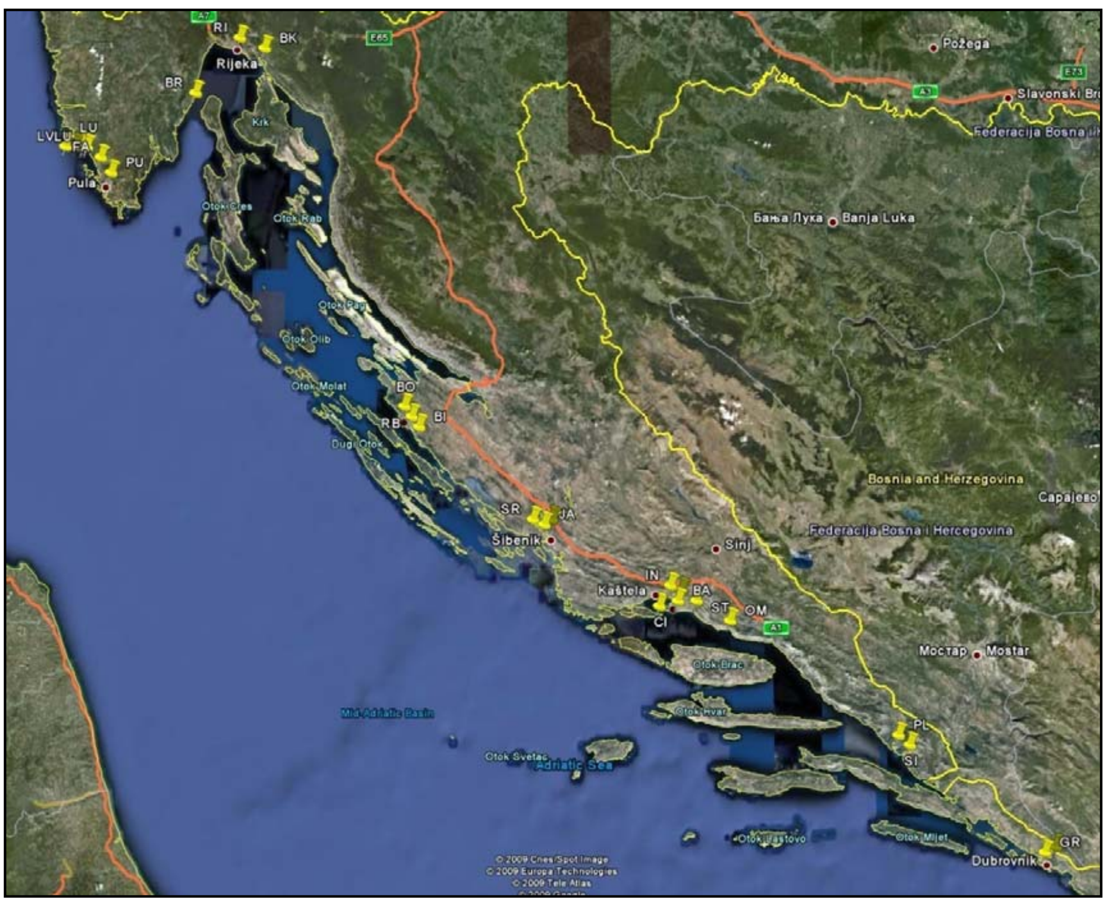


Figure Cro.1. Sampling stations along the Croatian coast.

At this stage, only four successive years (2002-2005) + 2009 data are 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. Cro.2) when both seasons were sampled in a year.

As observed in the previous elaboration an interesting change in value can be observed at station IN (Inavinil – Kaštela Bay) were higher total mercury levels were measured and problems related to mercury contamination reported. In 2004 an order of magnitude higher levels than the already high values were measured (Table Cro.2 and Fig. Cro.2). Data for 2009 still are high, half of the previously observed changes. The length vs. weight relationship for the MG samples (Fig. Cro.3) does not show any irregularity in sampling. Only a change in MG size with year can be noted that maybe indicates a shift in station location, closer to source of pollution.

Table Cro.1 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for cadmium (CD) in *Mytilus galloprovincialis* at selected stations along the Croatian coast in the period 2000-2009.

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	GR	2005	5	1049,7	1202,6	1140,8	1168,9	62,1	0,001
CD	GR	2009	1			1145,0			
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	IN	2005	5	723,5	896,7	784,3	748,3	72,4	0,002
CD	IN	2009	5	784,0	910,0	797,0	821,4	51,1	0,001
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	LV	2005	5	1020,6	1130,2	1089,3	1086,0	44,00	0,000
CD	LV	2009	5	782,0	1134,0	1058,0	1025,2	139,5	0,004
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	MA	2005	5	650,8	728,6	684,7	683,5	32,14	0,000
CD	MA	2009	5	819,0	1209,0	967,0	990,8	159,6	0,005
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	SI	2005	5	410,6	534,0	463,0	431,1	55,3	0,003
CD	SI	2009	5	832,0	975,0	916,0	901,8	59,1	0,001
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

CD	VR	2005	5	359,2	406,7	380,6	386,9	19,50	0,000
CD	VR	2009	5	546,0	866,0	746,0	718,4	133,7	0,007

Table Cro.2 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for total mercury (HGT) mass fraction in *Mytilus galloprovincialis* at selected stations along the Croatian coast in the period 2000-2009.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	LOG_C1
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	GR	2005	5	196,6	242,2	214,0	206,3	20,02	0,002
HGT	GR	2009	1			670,0			
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	IN	2005	5	7593,6	8454,4	7966,7	7898,9	370,41	0,000
HGT	IN	2009	5	3711,6	4975,7	3879,1	4117,7	509,9	0,003
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	LV	2005	5	128,0	144,5	137,7	139,7	6,81	0,000
HGT	LV	2009	5	326,3	471,7	417,1	414,1	56,7	0,004
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	MA	2005	5	71,2	91,2	79,4	75,2	8,30	0,002
HGT	MA	2009	5	155,2	172,5	166,3	164,2	7,8	0,000
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	SI	2004	5	78,6	94,6	85,8	85,3	5,97	0,001
HGT	SI	2009	5	175,5	206,1	184,0	186,5	12,2	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
HGT	VR	2005	5	204,4	218,3	212,6	216,7	6,43	0,000
HGT	VR	2009	5	266,3	360,7	286,9	296,6	37,8	0,003

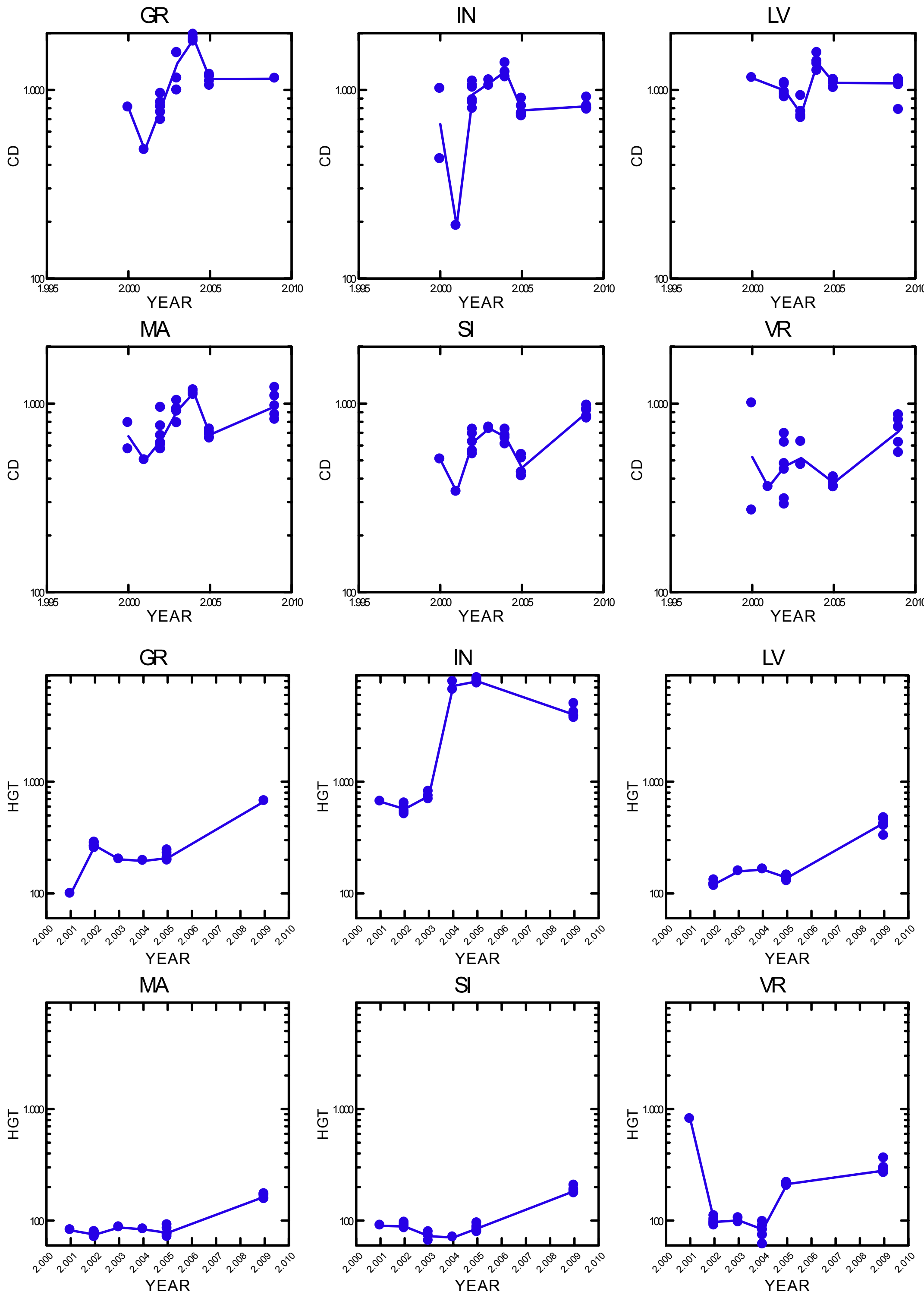
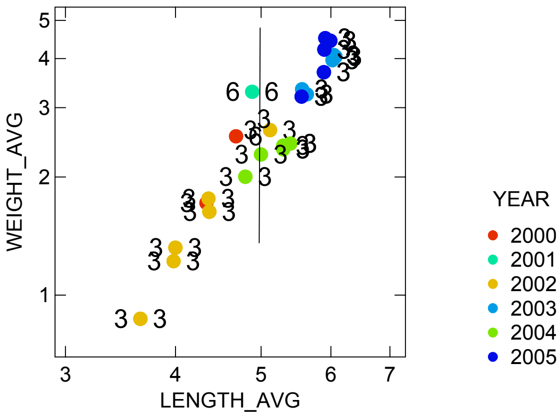
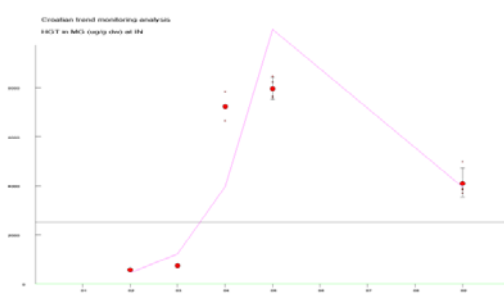


Figure Cro.2 Values (Log scale) of cadmium (CD) and total mercury (HGT) mass fraction in *Mytilus galloprovincialis* (MG) by year at selected station in Croatian coastal waters.

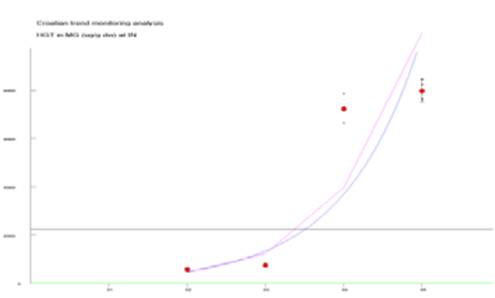
The trend statistics at station (Inavinil – Kaštela Bay) indicate that the lowest detectable change in the current time series (with a power of 90% and one-sided test, alpha=5 %) is >99%. 43 years of data are required to detect an annual change of 5% (with a power of 90% and one-sided test, alpha=5 %). The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 5.3%. For a period of 10 years, a power of 6.0% would be expected. The lowest detectable change for a ten-year period with the current between year variation at a power of 90% is 61%. Such a poor statistics and trend detection power is result of the substantial data gap because at list the non linear trend detection has to be significant due to a huge stepwise change in HGT mass fraction between 2003 and 2004. That is clearly shown when the data for 2009 is not used in the elaboration.





The data series show no significant log-linear trend

Trend statistics:
Slope = 27% (-44, 97)
SD(lr)= 1.2, >99%, 43 yr
Power = .05/.06/61%
y(09) = 810(.00, .00)
r2 = .33, p < .316
tau = .60, p < .142
SD(sm)= .59, p < .075



The data series show a 102% yearly increasing trend (with a 95% confidence interval of -26, 229%)

Trend statistics:
Slope = 102% (-26, 229)
SD(lr)= .66, >99%, 29 yr
Power = .06/.09/31%
y(05) = (.00, .00)
r2 = .86, p < .082
tau =1.00, p < .042 *
SD(sm)= .00, p < .001 *

Figure Cro.3 Length vs. weight and trend evaluation results (from PIA suite) for total mercury (HGT) mass fraction for *Mytilus galloprovincialis* samples collected at IN station.

Organic compounds in biota

Croatia submitted also data for mass fractions in biota of the next organic compounds :DDTP - Dichloro-Diphenyl Trichlorethane pp, DDTS - opDDT + ppDDT, PCBA - Chlorinated biphenyl congeners as Aroclor 1254 and PCBB - Chlorinated biphenyl congeners as Aroclor 126. For the same grid of stations (Fig.Cro.1) data relate to the period 1999-2005 and suffer the same problems in sampling strategy as for trace metals. The shift in sampling season in 2002 from June to March, but additionally no replicates were provided. These substantially lower the data quality from the statistical point of view that no trend can be evaluated. We can only do simple elaboration as is a box plot (Fig.Cro.4) in order to understand the between year variability at the sampled stations. At this stage a clear change in the sampling strategy with an sounded statistical objective has to be done. This simple elaboration can help to find those stations that together with an expert knowledge will help to identify a reduced set worth to be monitored.

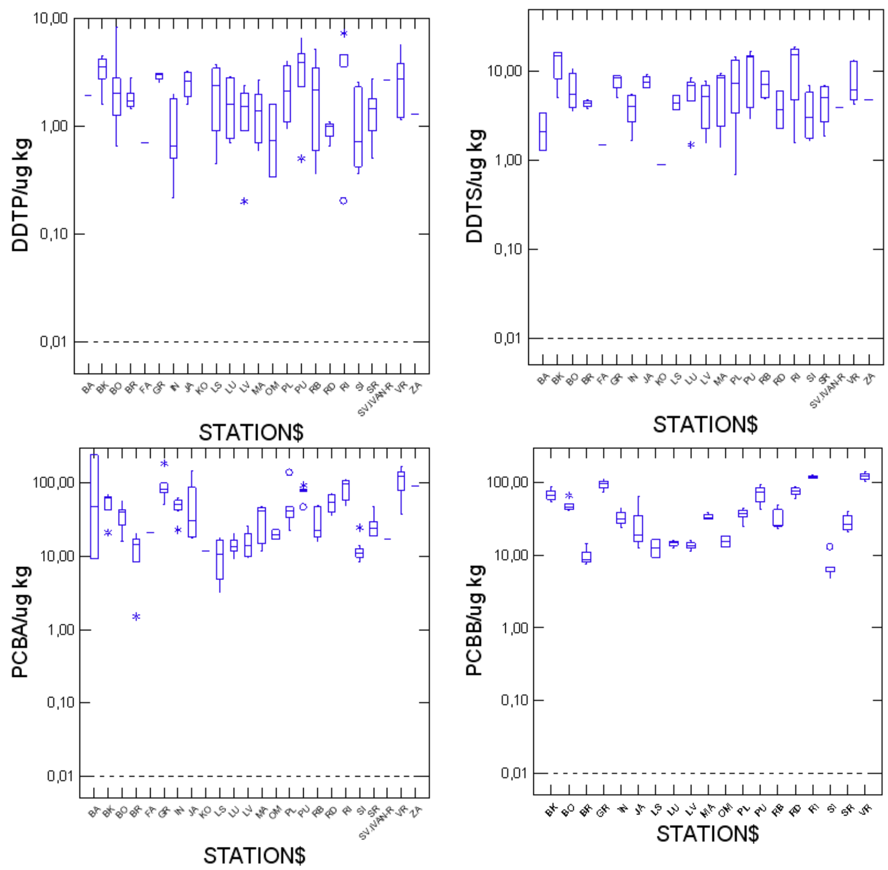


Figure Cro.4 Box plot of mass fraction of organic compounds (DDTP, DDTS, PCBA and PCBB) in *Mytilus galloprovincialis* by sampled station.

Trace metals in sediments

Croatia submitted also data for mass fractions of trace metals (Cd, HgT and Pb) in sediments. Data were provided for six hotspot stations (Fig.Cro.5), for 4 years (2002, 2003, 2005 and 2009) and no replicates. These structure of data from the statistical point of view don't allow trend to be evaluated. We can only do simple elaboration as is a box plot (Fig.Cro.6) in order to understand the overall variability at the sampled stations. At this stage a clear change in the sampling strategy with an sounded statistical objective has to be done.

Figure Cro.5. Sediment sampling stations along the Croatian coast.

Not only the sampling strategy has to be changed but also the acquiring of supporting data in order to allow normalization of data for a proper trend evaluation as geographical comparison. In 2006 a guideline was provided to address problem with sediment analysis (Methods for sediment sampling and analysis, WG.282-Inf.5-Rev.1). Applying this guidelines is now a must in order to have a successful sediments monitoring. Data provided for 2009 are not in compliance with this manual.

As identified for biota the station IN (Inavinil – Kaštela Bay) show higher total mercury levels and suggest problems related to mercury contamination. Probably the contaminated sediment served as secondary source of mercury.

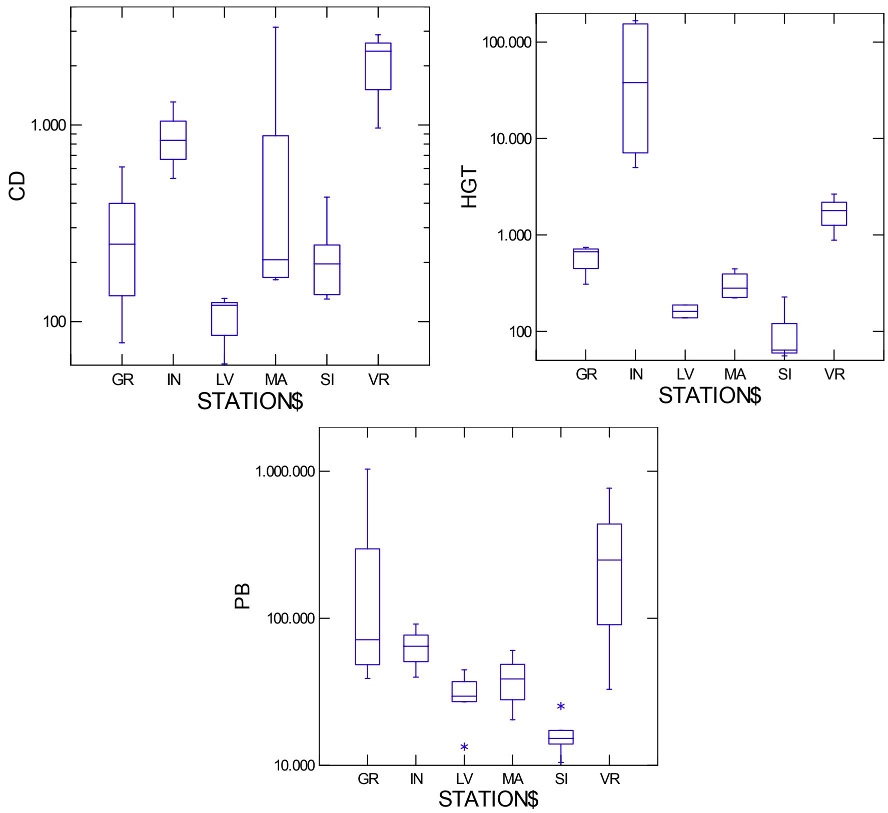


Figure Cro.6 Box plot of mass fraction of trace metals (Cd, HgT and PB) by sampled station.

Cyprus

Cyprus has not provided new data from the last evaluation. For Cyprus the last report is from here on replicated to facilitate the reader.

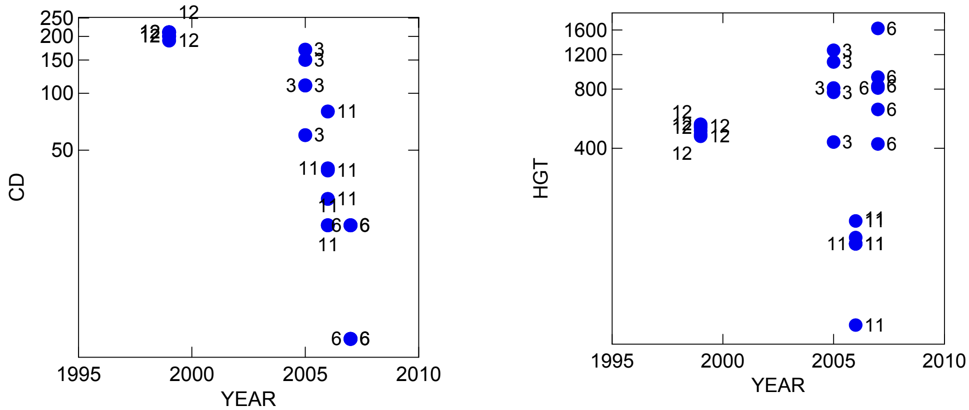
In 2003, Cyprus changed the laboratory in charge of the TM analysis and data were submitted to the Secretariat after 2005. Two stations, Limasol and Larnaca (Fig. Cyp.1), were regularly sampled for *Mullus barbatus* as mussel are not present in the area. With the change of laboratory the sampling position also changed. The new positions are from 4 to 6 km from the previous and introduced additional variance in the time series. The data descriptive statistics are presented in Table Cyp.1. The within year sampling variance is low and below the threshold of 0,060 and well on track for the programme objectives fulfilment.

Figure Cyp.1. Sampling stations along the Cyprus coast.

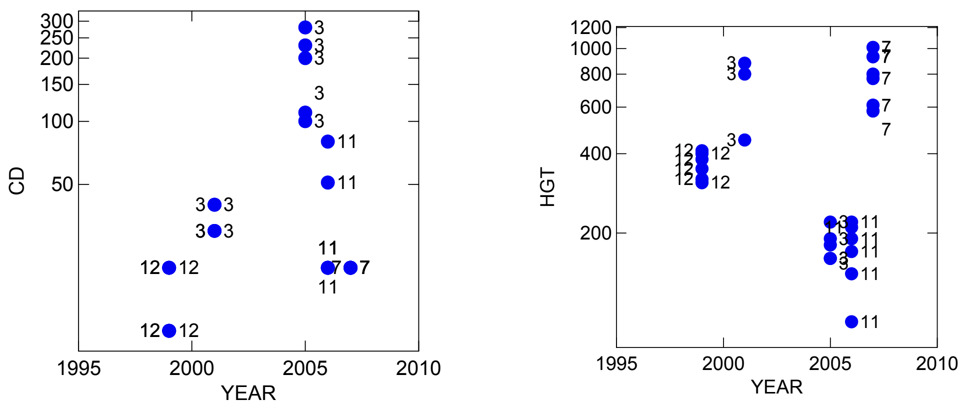
From exploratory statistics (Table Cyp.1 and Fig. Cyp.2) in the data, some questionable patterns were identified. Substantial changes in the levels can be observed between years. One of the possible explanations is the sampling in different seasons (March in 2005 and November in 2006 for both stations, and June and July for stations Limassol and Larnaca respectively) and the seasonal cycle become the dominant signal in the data. It is clear that a more concise sampling strategy for the sampling period (pre-spawning) and size fraction (the central on a log scale) has to be adopted and maintained in future.

Table Cyp.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 *Mullus barbatus* at stations along the coast of Cyprus in the period 1999-2007.

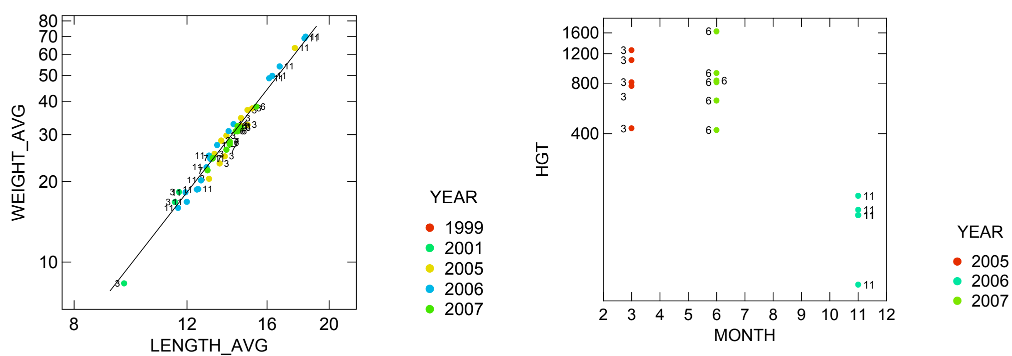
Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	FISH1	1999	6	190	210	203,0	205,0	8,2	0,000
CD	Limassol	2005	5	60	170	120,0	110,0	42,4	0,031
CD	Limassol	2006	6	20	80	37,7	33,3	22,5	0,052
CD	Limassol	2007	6	5	20	12,5	12,5	8,2	**0,109**
CD	FISH2	1999	6	10	20	15,0	15	5,5	0,027
CD	FISH2	2001	5	30	40	34,0	30	5,5	0,005
CD	Larnaca	2005	5	100	280	184,0	200,0	77,7	0,040
CD	Larnaca	2006	6	20	80	35,2	20,0	25,2	**0,072**
CD	Larnaca	2007	6	20	20	20,0	20,0	0,00	0,000
CD	Paphos	2005	3	130	240	173,3	150,0	58,6	0,019
CD	Paphos	2006	5	19	140	75,8	100,0	53,9	**0,176**
HGT	FISH1	1999	6	460	530	497	500	28,0	0,001
HGT	Limassol	2005	5	430	1260	874,0	810,0	321,0	0,033
HGT	Limassol	2006	6	50	170	125,0	130,0	39,9	0,035
HGT	Limassol	2007	6	420	1630	873,3	820,0	411,2	0,038
HGT	FISH2	1999	6	310	410	362	365	41,7	0,003
HGT	FISH2	2001	3	450	880	710	800	228,7	0,025
HGT	Larnaca	2005	5	160	220	182,0	180,0	24,9	0,003
HGT	Larnaca	2006	6	92	220	170,3	180,0	47,9	0,020
HGT	Larnaca	2007	6	580	1010	783,3	785,0	170,1	0,009
HGT	Paphos	2005	3	150	740	346,7	150,0	340,6	**0,160**
HGT	Paphos	2006	5	570	1560	888,0	740,0	393,0	0,028
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	Limassol	2005	5	2.340	4.250	3.204,0	2.730,0	916,0	0,015
CU	FISH2	1999	6	990	1470	1293	1320	164,5	0,004
CU	FISH2	2001	5	1460	2480	1900	1800	382,7	0,007
CU	Larnaca	2005	5	2.010	2.370	2.232,0	2.280,0	145,0	0,001
CU	Limassol	2005	5	2.340	4.250	3.204,0	2.730,0	916,0	0,015
FE	FISH1	1999	6	25160	26740	26150	26505	696,3	0,000
FE	FISH2	1999	6	34650	49130	40363	38610	5505,1	0,003
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



FISH1 - Limassol



FISH2 - Larnaca



All stations **FISH1 - Limassol**

Fig. Cyp. 2. Values (Log scale) of cadmium (CD) and total mercury (HGT) mass fraction in *Mullus barbatus* by year at Limasol and Larnaca stations in Cyprus coastal waters. *Mullus barbatus* length vs. weight relationship at all sampled stations. Total mercury (HGT) mass fraction vs. month at Limassol station. To the data the sampling month is superimposed.

Israel

Israel submitted data regularly to the MED POL Database from 1999 to 2009. Mass fraction of trace metals in biota and sediments were provided.

Trace metals in biota

Three trawling areas for *Mullus barbatus* and more than 15 stations for other biota (molluscs and fishes) along the cost represent a solid grid for the implementation of trend monitoring (Fig. Isr.1). For practical reason, huge amount of output data, only the analysis for CD and HGT data will be provided in this report.

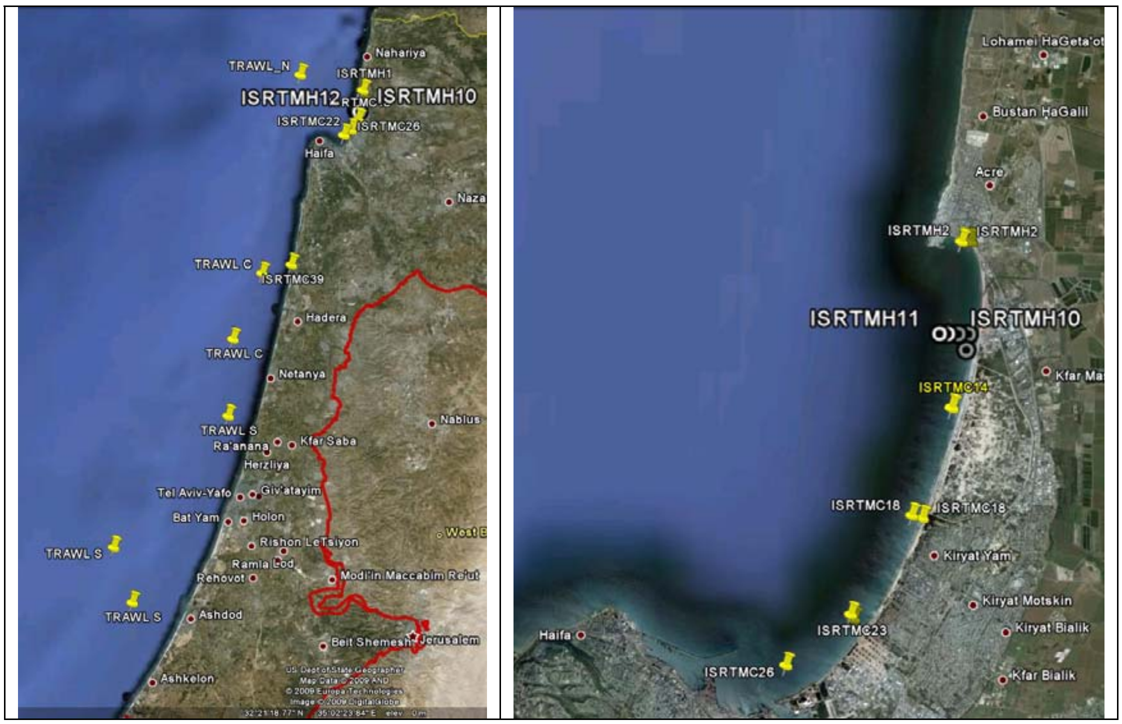


Figure Isr.1. Sampling stations along the Israel cost and in details for Haifa Bay.

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

Since only six years of *M. barbatus* data was available, this data set could be used for exploratory trend analysis. Therefore, only descriptive statistics for trace metals mass fraction in *M. barbatus* was presented in Table Isr.1. In generally, data show low sampling variance with the exception for total mercury (HGT) for which the variances were substantially higher than the threshold of 0,060. The reason for such high variances has to be investigated. All cadmium values were close to the detection limit (DL). From explorative statistics (Fig. Isr.2) it also emerged that the length class of sampled fish was large and changed by sampling year. To minimize the sampling variance, the sampling strategy has to be refined.

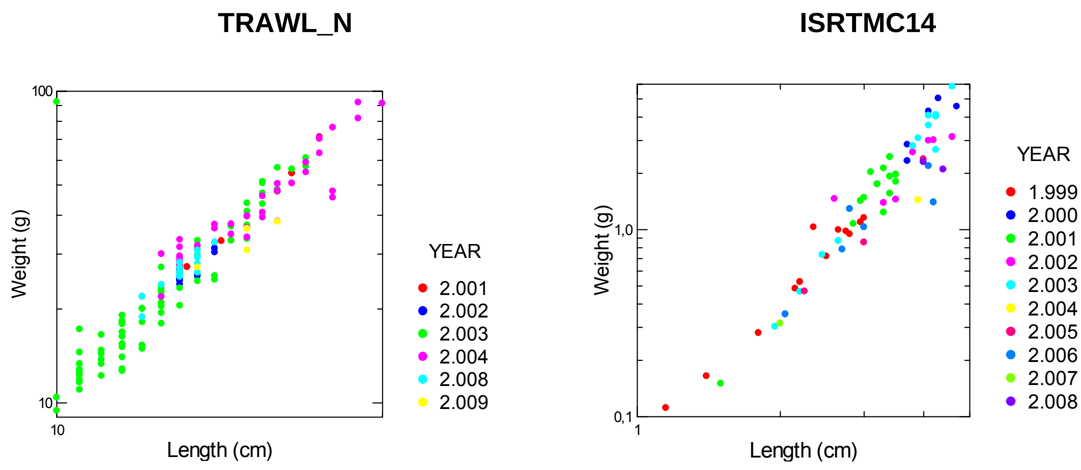


Figure Isr.2. Length vs. Weight for *Mullus barbatus* at station TRAWL_N and *Mactra coralina* at station ISRTMC14.

Trend evaluation with the PIA statistical suite show no significant trend for CD and HGT in *Mullus barbatus* at Trawl stations N and S, but also show that the measured values are very close to the detection limit (Fig.Isr.3. and 4).

In this evaluation for *M. corralina* data the period 2001-2009 was investigated. Earlier a much longer data period (from 1991) was used, but it was noticed that due to methodology changes in 2001 the previous data were less reliable. If we re-evaluate the stations in front of the chloralkaly plant in Haifa Bay (Fig.Isr.5) where previously an significant upward trend was noticed the output of the trend evaluation don't indicate it any more.

If the trend statistics is considered, for example, for station ISTTMC12:

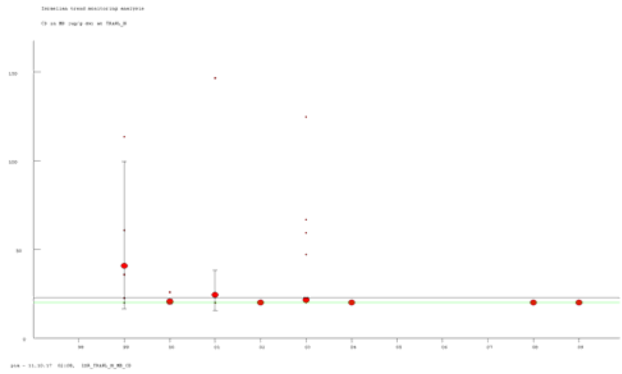
The lowest detectable change in the current time series (with a power of 90 % and one-sided test, alpha=5 %) is 30 %. 19 years of data are required to detect an annual change of 5 % (with a power of 90 % and one-sided test, alpha=5 %). The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 9.2 %. For a period of 10 years, a power of 20 % would be expected. The lowest detectable change for a ten-year period with the current between year variation at a power of 90 % is 15 %.

It can be noticed that after 10 years of monitoring with this quality of data a 15 % trend will be detected with a power of 90 %, and similarly for all other investigated stations. At this point the *M. Corallina* is at the edge to be acceptable as a monitoring organism from the main statistical objective of the programme (10 % trend detected with a power of 90 %). Maybe slightly changing the sampling strategy can improve the data quality and *M. corralina* can be a good monitoring organism for the area.

Table Isr.1. 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 in dry weight of *Mullus barbatus* at station TRAWL_N, TRAWL_C and TRAWL_S along the coast of Israel in the period 1999-2009.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	TRAWL_N	1999	8	20,0	113,5	40,4	25,5	32,5	**0,073**
CD	TRAWL_N	2000	12	20,0	25,8	21,1	20,0	2,1	0,002
CD	TRAWL_N	2001	9				BDL		
CD	TRAWL_N	2002	13				BDL		
CD	TRAWL_N	2003	11				BDL		
CD	TRAWL_N	2004	19	20,0	124,7	31,5	20,0	26,8	0,057
CD	TRAWL_N	2008	16				BDL		
CD	TRAWL_N	2009	4				BDL		
CD	TRAWL_C	1999	11				BDL		
CD	TRAWL_C	2000	7	20,0	22,7	20,0	20,8	1,3	0,001
CD	TRAWL_C	2003	5				BDL		
CD	TRAWL_C	2005	10				BDL		
CD	TRAWL_C	2006	14				BDL		
CD	TRAWL_C	2007	15				BDL		
CD	TRAWL_S	2001	12				BDL		
CD	TRAWL_S	2002	22				BDL		
CD	TRAWL_S	2003	12				BDL		
CD	TRAWL_S	2004	15				BDL		
CD	TRAWL_S	2006	22				BDL		
CD	TRAWL_S	2007	4				BDL		
CD	TRAWL_S	2008	14				BDL		
CD	TRAWL_S	2009	34	35,0	47,9	35,0	35,9	3,0	0,001
HGT	TRAWL_N	1999	3	9,2	57,0	9,8	25,3	27,4	**0,201**
HGT	TRAWL_N	2000	11	1,5	112,3	3,6	15,2	32,4	**0,249**
HGT	TRAWL_N	2001	18	24,2	135,5	59,7	76,9	39,6	0,055
HGT	TRAWL_N	2002	13	29,7	102,4	38,4	43,8	18,9	0,019
HGT	TRAWL_N	2003	73	14,4	234,7	50,1	59,5	37,4	0,056
HGT	TRAWL_N	2004	37	19,8	161,9	44,2	53,5	31,3	0,057
HGT	TRAWL_N	2008	16	18,2	78,5	33,1	37,6	17,8	0,033
HGT	TRAWL_N	2009	4	59,4	83,0	74,7	73,0	10,3	0,004
HGT	TRAWL_C	1999	5	8,0	94,3	19,4	35,7	36,6	**0,221**
HGT	TRAWL_C	2000	4	0,9	13,0	3,2	5,1	5,4	**0,232**
HGT	TRAWL_C	2003	5	8,5	60,6	11,4	29,7	27,5	**0,193**
HGT	TRAWL_C	2005	10	20,3	51,8	22,6	29,2	10,9	0,022
HGT	TRAWL_C	2006	14	15,9	95,9	42,4	44,4	22,1	0,050
HGT	TRAWL_C	2007	15	23,5	386,1	60,2	95,2	88,8	**0,084**
HGT	TRAWL_S	1999	8	1,9	6,8	3,7	4,3	1,8	0,035
HGT	TRAWL_S	2000	3	1,9	5,0	4,2	3,7	1,7	0,054
HGT	TRAWL_S	2001	25	11,4	89,3	32,2	39,6	21,6	0,057
HGT	TRAWL_S	2002	40	24,9	1284,8	138,9	272,5	304,8	**0,228**
HGT	TRAWL_S	2003	32	16,6	1763,7	101,5	279,6	402,9	**0,303**
HGT	TRAWL_S	2004	21	13,1	67,1	21,1	27,9	15,7	0,048
HGT	TRAWL_S	2005	16	9,5	13,9	11,1	11,3	1,2	0,002
HGT	TRAWL_S	2006	15	20,7	94,2	32,0	35,8	16,9	0,020
HGT	TRAWL_S	2007	17	10,8	27,5	15,9	17,4	5,0	0,014
HGT	TRAWL_S	2008	14	15,2	53,2	26,4	29,8	14,0	0,041
HGT	TRAWL_S	2009	34	19,7	256,5	40,7	54,4	52,3	**0,076**

Cadmium

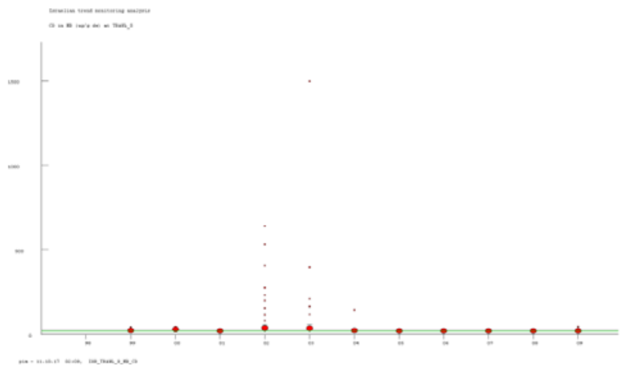


Trawl_N

The data series show a 3.9% yearly decreasing trend (with a 95% confidence interval of -9.5, 1.6%)

Trend statistics:

Slope = -3.9% (-9.5, 1.6)
SD(lr)= .22, 14%, 15 yr
Power = .23/.43/9.1%
y(09) = 18 (13, 26)
r2 = .33, p < .134
tau =-.57, p < .048 *
SD(sm)= .19, p < .127



Trawl_S

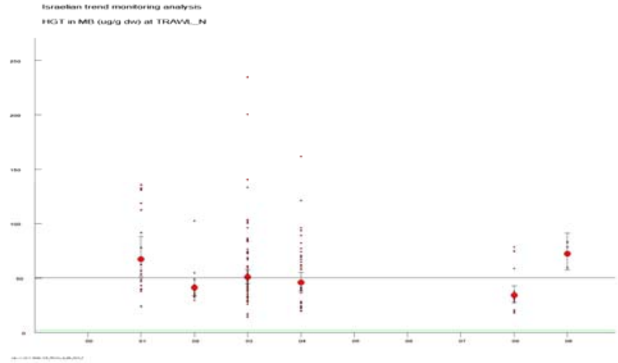
The data series show no significant log-linear trend.

Trend statistics:

Slope = -3.4% (-8.2, 1.3)
SD(lr)= .22, 7.9%, 15 yr
Power = .54/.41/9.3%
y(09) = 20 (15, 27)
r2 = .23, p < .137
tau =-.29, p < .216
SD(sm)= .23, p < .578

Figure Isr.3. Trend evaluation (PIA statistical suite) for Cadmium mass fraction in *Mullus barbatus* at stations TRAWL_N and TRAWL_S.

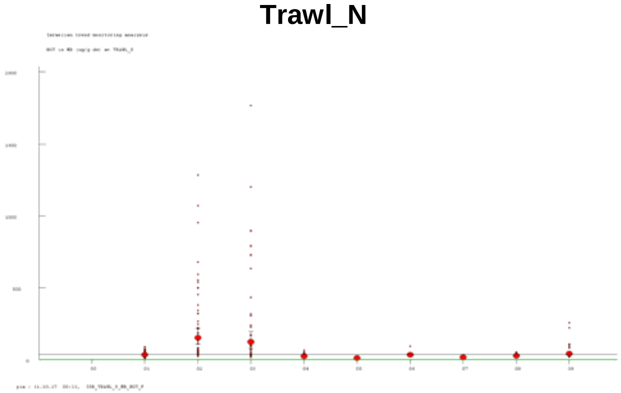
Total mercury



Trawl_N

The data series show no significant log-linear trend.

Trend statistics:
Slope = 12% (-7.0, 31)
SD(lr)= .75, 56%, 32 yr
Power = .06/.08/35%
y(09) = 68 (19, 247)
r2 = .29, p < .168
tau = .36, p < .216
SD(sm)= .73, p < .259

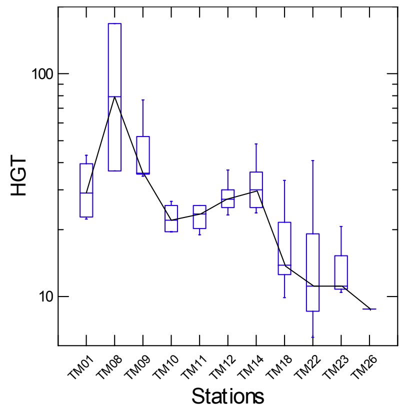


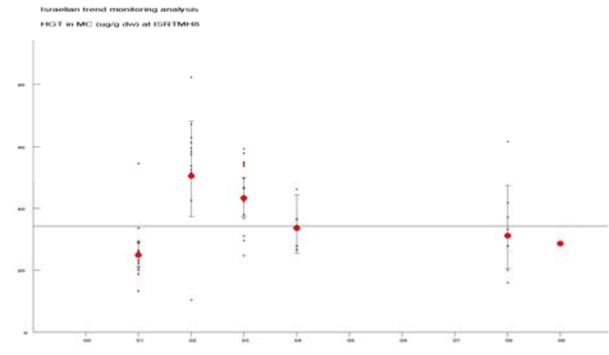
Trawl_S

The data series show no significant log-linear trend.

Trend statistics:
Slope = 11% (-15, 37)
SD(lr)= 1.2, 51%, 43 yr
Power = .06/.06/62%
y(09) = 42 (9.1, 197)
r2 = .10, p < .351
tau = .16, p < .484
SD(sm)= 1.1, p < .194

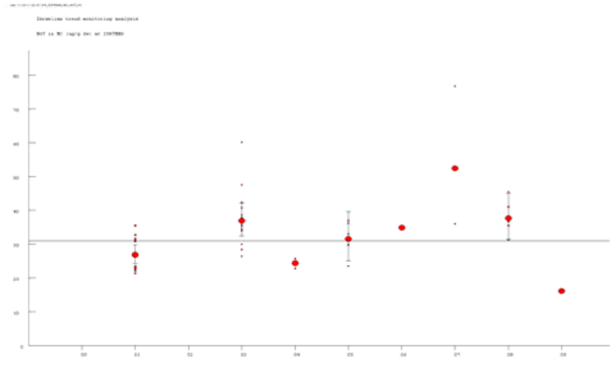
Figure Isr.4. Trend evaluation (PIA statistical suite) for total Mercury mass fraction in *Mullus barbatus* at stations TRAWL_N and TRAWL_S.





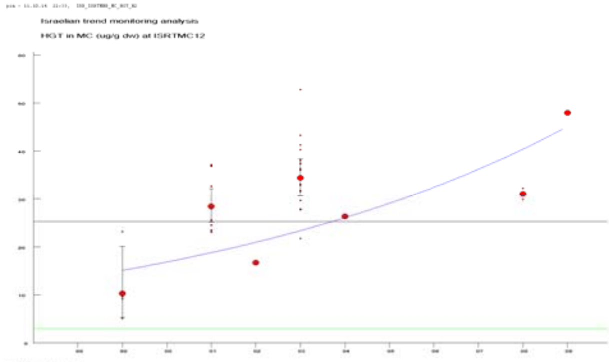
ISRTMH08
The data series show no significant log-linear trend.

Trend statistics:
Slope = .76% (-12, 13)
SD(lr)= .40, 27%, 21 yr
Power = .10/.16/17%
y(09) = 40 (22, 75)
r2 = .00, p < .858
tau =-.14, p < .621
SD(sm)= .37, p < .121



ISRTMH 09
The data series show no significant log-linear trend.

Trend statistics:
Slope = -.76% (-14, 12)
SD(lr)= .38, 25%, 21 yr
Power = .11/.17/17%
y(09) = 30 (17, 54)
r2 = .00, p < .861
tau = .14, p < .621
SD(sm)= .35, p < .175



ISRTMH 12
The data series show no significant log-linear trend.

Trend statistics:
Slope = 11% (1.0, 21)
SD(lr)= .34, 30%, 19 yr
Power = .09/.20/15%
y(09) = 45 (24, 84)
r2 = .62, p < .037 *
tau = .62, p < .051
SD(sm)= .34, p < .136

Figure Isr.5. Trend evaluation (PIA statistical suite) for total mercury mass fraction at stations in front of the chloralkaly plant in Haifa Bay.

Trace metals in sediments

Israel regularly submitted data since 1999 for trace metals mass fraction sediments (Fig. Tur.5). Data were collected on grid of 25 stations from 1999.

Figure Isr.6. Sampling station for trend evaluation of trace metals in sediments.

The main problem with contaminant levels in sediment is that the data has to be tuned to give result that is in accordance with the revised methodologies from 2005. Israel applied the suggested methodologies after 2006 but only same aspect is visible through data, mainly because the database is not structured to receive this important additional information. From exploratory data analysis (Fig. Isr.7) applied on total mercury mass fraction easily can be seen all the weakness of the data: no replicates, huge variability, gaps in data etc.

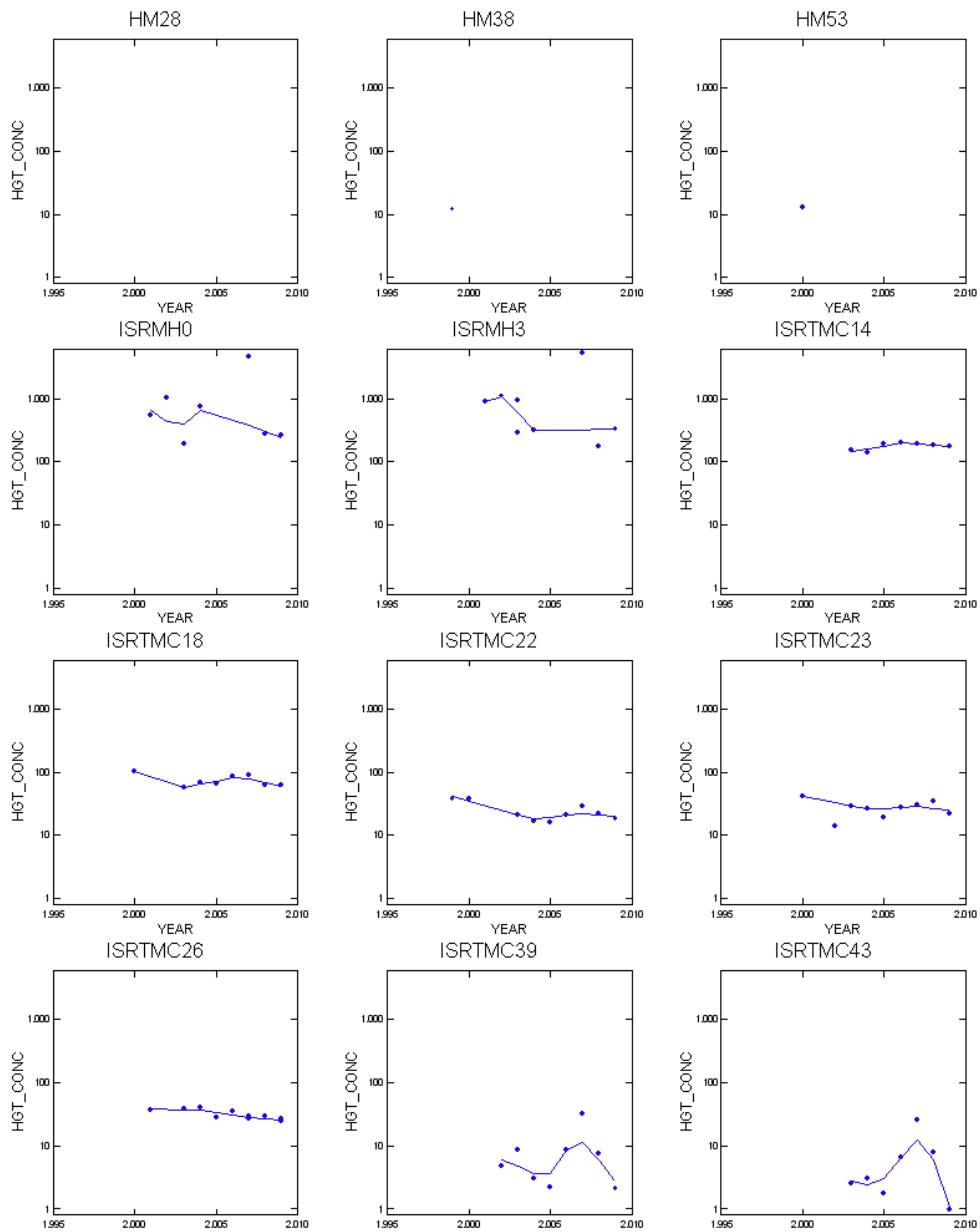


Figure Isr.7. Exploratory data analysis for total mercury mass fraction in sediments at 24 stations in Israel coastal waters

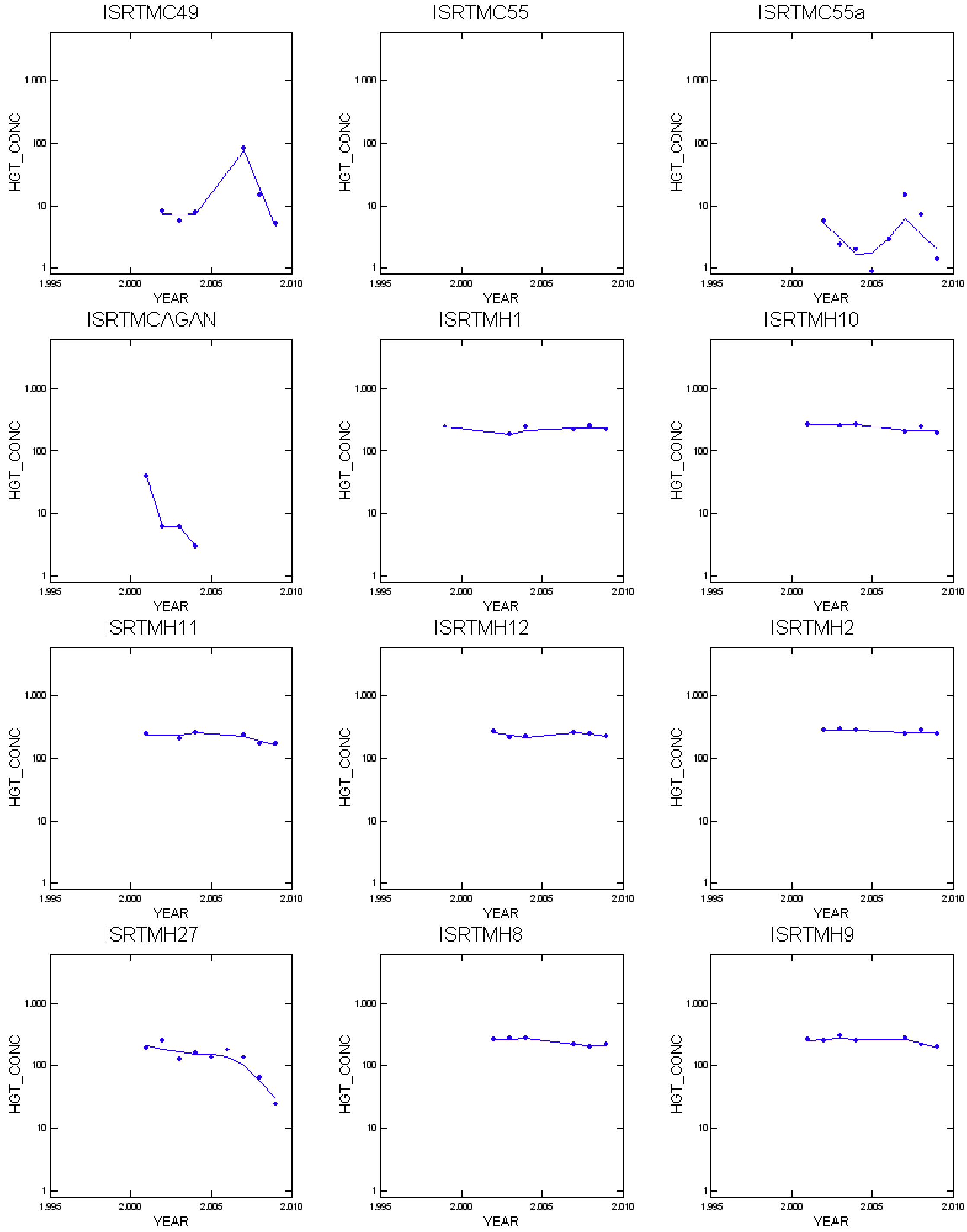
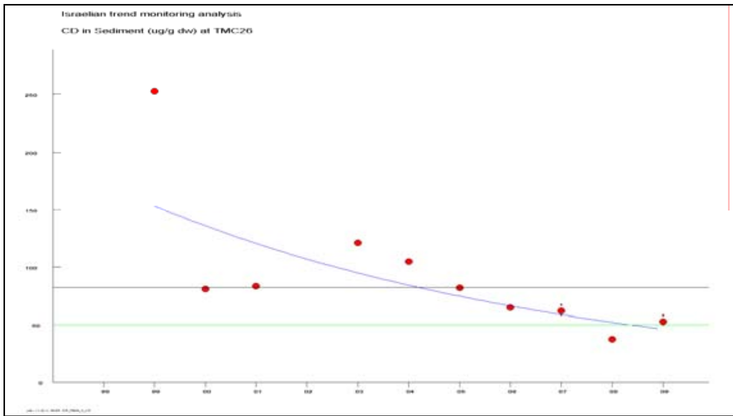


Figure Isr.7. Continued.



The data series show a 12% yearly decreasing trend (with a 95% confidence interval of -20, -4.5%)

Trend statistics:

Slope = -12% (-20, -4.5)
SD(lr)= .34, 15%, 19 yr
Power = .20/.20/15%
y(09) = 46 (30, 71)
r2 = .63, p < .006 *
tau =-.69, p < .006 *
SD(sm)= .37, NS

Figure Isr.8. Trend evaluation results (from PIA suite) of total mercury mass fraction at station ISTMC26 in Israel coastal waters

Morocco

This is the first data series that Morocco provided to the database. Until now no data were elaborated for this country. Data related to the mass fraction of trace metals (Cd, HgT and Pb) in *Mytilus galloprovincialis* were provided for the period 1999-2006 at 7 stations (Fig.Mor.1). For most of the stations only sporadic data were provided and only station S1 in the area of Oued Laou is complete. No replicates were provided but instead from 4-5 values sampled on different days during January-March period.

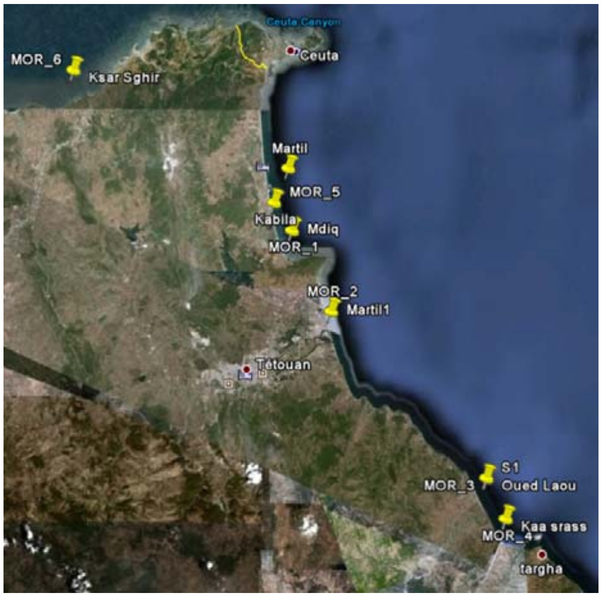
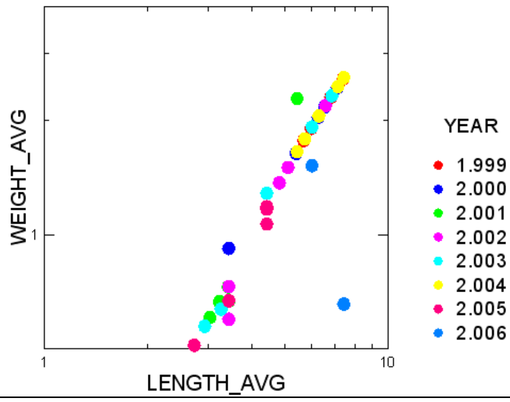


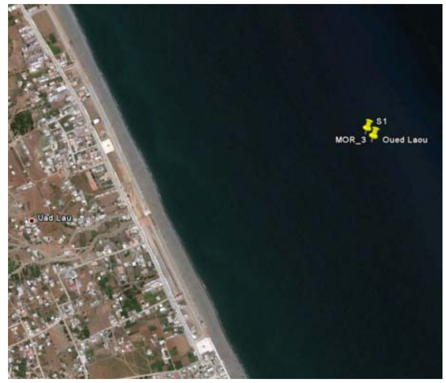
Figure Mor.1. Sampling stations along the Morocco coast.

From the analytical statistics for station S1 (Tab.Mor.1) it is evident that the within year variance is not stable and low thus indicating a non optimal sampling strategy. Variance higher than the threshold of 0,060 were mainly observed. Probably this is connected with sampling over a larger seasonal belt than to have replicates for a single yearly one in the prespawning season.This is also confirmed from the trend analysis with PIA statistical suite (Fig.Mor.2) were a rather low power after 10 years of data is predicted (Cd – 23 %; HgT – 8 %; Pb – 7%). Even data suggest a downward trend for all tree contaminants the huge data variance don't permit to exclude the false positive trend. A tuning of the sampling strategy willhelp to improve the statistical power of the monitoring programme.

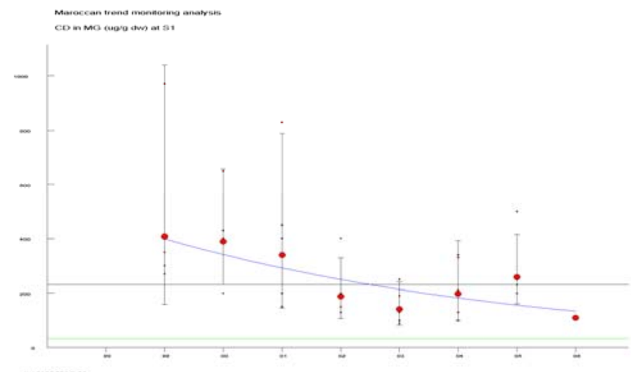
Table Mor.1 Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for total mercury (HGT) mass fraction in *Mytilus galloprovincialis* at station S1 on the Morocco coast in the period 2000-2007.

Parameter	Year	N	Min	Max	Avg	Median	STD	LOG_C1
CD	1999	4	270	970	325	472,5	333,3	**0,065**
CD	2000	5	200	650	400	416,0	159,8	0,034
CD	2001	5	150	830	400	406,0	269,1	**0,087**
CD	2002	5	130	400	150	206,0	111,5	0,038
CD	2003	5	90	250	130	152,0	67,2	0,035
CD	2004	5	100	340	210	222,0	110,8	0,057
CD	2005	5	200	500	230	276,0	127,0	0,027
CD	2006	2			110	110,0		
CD	2007	2			50	50,0		
HGT	1999	4	160	400	250	265,0	99,5	0,026
HGT	2000	5	20	320	150	158,0	106,6	**0,204**
HGT	2001	5	50	260	140	154,0	85,9	**0,082**
HGT	2002	4	100	1600	825	837,5	612,9	**0,275**
HGT	2003	3	20	350	30	133,3	187,7	**0,452**
HGT	2004	5	50	300	110	150,0	97,7	**0,087**
HGT	2005	4	60	100	95	87,5	18,9	0,011
HGT	2006	2			13	13,0		
HGT	2007	2			20	20,0		
PB	1999	4	1100	3870	2525	2505,0	1131,3	0,052
PB	2000	5	390	830	580	578,0	162,1	0,014
PB	2001	5	50	920	580	514,0	330,0	**0,254**
PB	2002	5	380	1400	1000	904,0	429,2	0,057
PB	2003	5	200	3500	550	1166,0	1366,2	**0,241**
PB	2004	5	550	3750	1530	1632,0	1261,9	**0,101**
PB	2005	5	450	2500	1150	1180,0	818,2	**0,090**
PB	2006	2				110,0		
PB	2007	2				200,0		





Cadmium

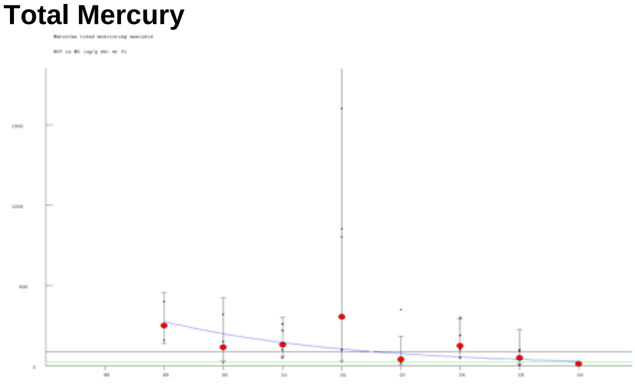


The data series show a 16% yearly decreasing trend (with a 95% confidence interval of -27, -3.8%)

Trend statistics:

Slope = -16% (-27, -3.8)
SD(lr)= .31, 21%, 18 yr
Power = .13/.23/14%
y(06) = 134(81, 219)
r2 = .63, p < .018 *
tau =-.64, p < .026 *
SD(sm)= .33, p < .581

Total Mercury

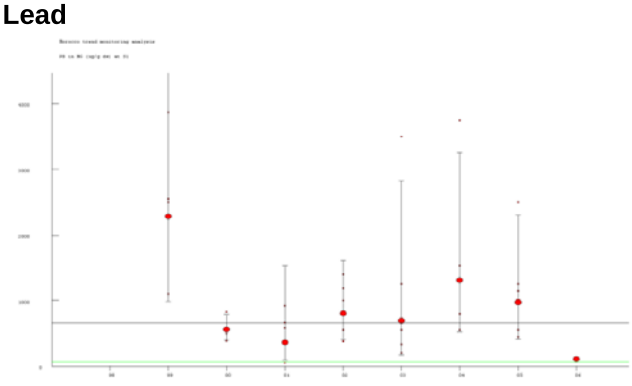


The data series show no significant log-linear trend

Trend statistics:

Slope = -32% (-60, -4.7)
SD(lr)= .73, 54%, 31 yr
Power = .06/.08/34%
y(06) = 29 (9.1, 91)
r2 = .58, p < .028 *
tau =-.50, p < .083
SD(sm)= .67, p < .148

Lead



The data series show no significant log-linear trend

Trend statistics:

Slope = -18% (-50, 15)
SD(lr)= .87, 67%, 35 yr
Power = .06/.07/42%
y(06) = 358(91, 1406)
r2 = .22, p < .236
tau =-.14, p < .621
SD(sm)= .86, p < .295

Figure Mor.2 Length vs. weight and trend evaluation results (PIA suite) for Cadmium (CD), total mercury (HGT) and Lead (PB) mass fraction for *Mytilus galloprovincialis* samples collected at S1 station.

Slovenia

Slovenia to the database provided data for contaminants levels in biota and sediments. In biota mass fraction of trace metals (Cd and total Hg) and organic compounds (PAH -) for sediments were provided. To the previous data elaboration set (2002-2005) data for the 2007-2009 period were added.

Trace metals in biota

Two stations are regularly monitored for trend monitoring of trace metals in biota along the Slovenian cost (Fig.Slo.1). The data show a serious and strict maintenance of the decided sampling strategy. Such approach is essential for a successful trend monitoring.

Figure Slo.1. Sampling stations along Slovenian coast.

The data descriptive statistics are presented in Table Slo.1 The within year sampling variance is very low and far below the threshold of 0,060. The acceptable within year sampling variance allow to assess trends with each observation given equal statistical weight and the number of sampled years (11) to perform a valuable assessment. The results of the assessment are presented on Fig.Slo.3 and 4 and indicate no valuable monotonic, downward trend both for CD and HGT. Mass fraction of CD at station TM () showed a significant nonlinear trend. When the trend analysis is done for the period 1999-2006, as in the previous evaluation, a same monotonic downward trend is detected (Fig.Slo.4). The values for total mercury mass fraction (Fig.Slo.3) didn't show any trend and indicate just an oscillation of the values around $120 \cdot 10^{-9}$ on both stations.

When the trend analysis is interpreted for CD mass fraction at station 24 we are very close to fulfil the statistical objectives of the programme. The data series show no significant log-linear trend. The lowest detectable change in the current time series (with a power of 90% and one-sided test, alpha=5 %) is 10 %. 17 years of data are required to detect an annual change of 5% (with a power of 90% and one-sided test, alpha=5 %). The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 35%. For a period of 10 years, a power of 27% would be expected. The lowest detectable change for a ten-year period with the current between year variation at a power of 90% is 12%. The smoother explains significantly more than the log-linear regression line, hence the time series contains non-linear trend components.

Table Slo.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 *Mytilus galloprovincialis* at stations along the Slovenian coast in the period 1999-2009.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	24	1999	1				1110		
CD	24	2000	5	1040	1280	1116,0	1100	96,6	0,001
CD	24	2001	5	940	980	964,0	970	15,2	0,000
CD	24	2002	5	567	787	674,4	683	80,6	0,003
CD	24	2003	5	910	1180	1046,0	1070	101,6	0,002
CD	24	2004	5	900	970	926,0	920	25,5	0,000
CD	24	2005	5	570	670	618,0	610	41,5	0,001
CD	24	2006	5	760	880	810,0	820	51,0	0,001
CD	24	2007	5	790	910	860,0	850,0	46,4	0,001
CD	24	2008	5	1040	1300	1050,0	1104,0	110,6	0,002
CD	24	2009	5	650	880	770,0	764,0	91,8	0,003
CD	TM	1999	1				1270		
CD	TM	2000	5	1000	1110	1050,0	1020	51,0	0,000
CD	TM	2001	5	670	880	790,0	790	77,8	0,002
CD	TM	2002	5	829	1110	987,2	999	100,7	0,002
CD	TM	2003	5	550	670	606,0	590	45,6	0,001
CD	TM	2004	5	590	670	640,0	650	29,8	0,000
CD	TM	2005	5	470	560	504,0	490	39,7	0,001
CD	TM	2006	5	580	690	628,0	620	43,2	0,001
CD	TM	2007	5	1000	1180	1030,0	1054,0	73,0	0,001
CD	TM	2008	5	870	990	970,0	952,0	47,1	0,000
CD	TM	2009	5	780	940	890,0	872,0	66,1	0,001
HGT	24	1999	1	120	120	120,0	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	27,6	0,016
HGT	24	2005	5	90	110	98,2	96	7,5	0,001
HGT	24	2006	5	80	114	102,6	108	13,5	0,004
HGT	24	2007	5	140	159	156,0	152,0	7,9	0,001
HGT	24	2008	5	133	192	153,0	157,0	22,7	0,004
HGT	24	2009	5	57	98	89,0	85,4	16,4	0,009
HGT	TM	1999	1	110	110	110,0	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	112,0	113	6,8	0,001
HGT	TM	2004	5	100	170	132,2	132	24,7	0,007
HGT	TM	2005	5	98	120	109,6	110	10,5	0,002
HGT	TM	2006	5	97	121	108,6	110	10,1	0,002
HGT	TM	2007	5	104	126	121,0	118,2	8,3	0,001
HGT	TM	2008	5	110	137	128,0	127,0	10,7	0,001
HGT	TM	2009	5	65	83	70,0	73,4	8,1	0,002

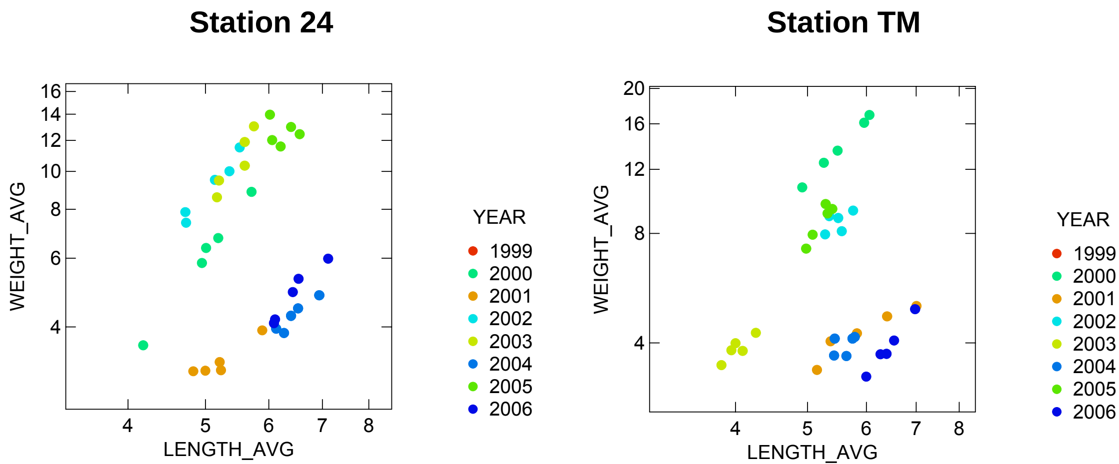
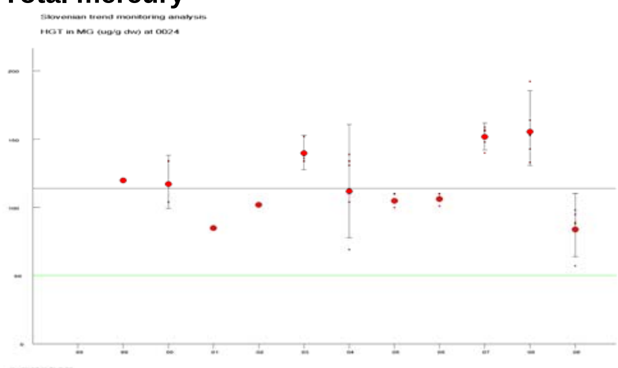


Figure Slo.2. Length vs. weight for *Mytilus galloprovincialis* (MG) by year at station 24 and TM in Slovenian coastal waters.

Total mercury

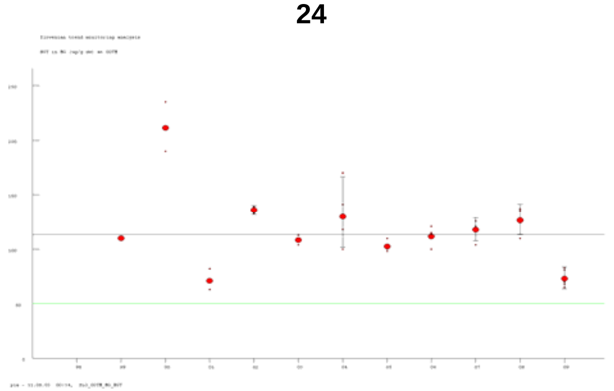


24

The data series show no significant log-linear trend.

Trend statistics:

Slope = .80% (-3.9, 5.5)
SD(lr)= .22, 7.7%, 15 yr
Power = .56/.43/9.1%
y(09) = 119(90, 156)
r2 = .02, p < .706
tau = .05, p < .815
SD(sm)= .23, p < .792



TM

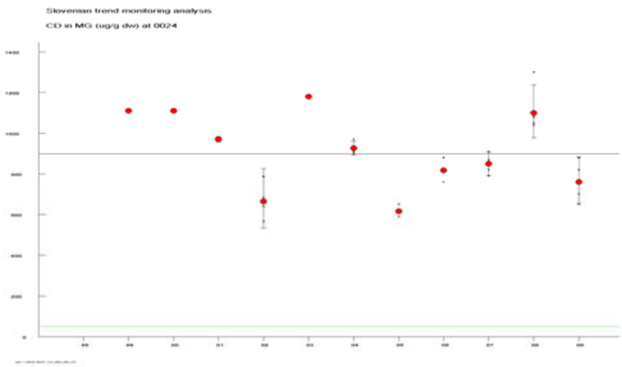
The data series show no significant log-linear trend.

Trend statistics:

Slope = -2.8% (-9.2, 3.6)
SD(lr)= .30, 11%, 18 yr
Power = .33/.25/13%
y(09) = 99 (68, 144)
r2 = .10, p < .358
tau =-.13, p < .586
SD(sm)= .33, NS

Figure Slo.3. Trend evaluation results (from PIA suite) for total mercury mass fraction in *Mytilus galloprovincialis* (MG) by year at stations 24 and TM in Slovenian coastal waters

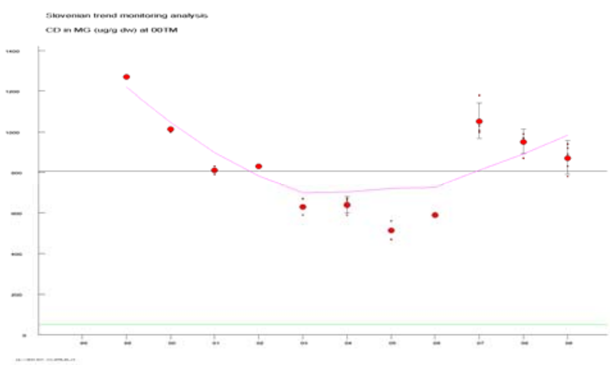
Cadmium



24

The data series show no significant log-linear trend.

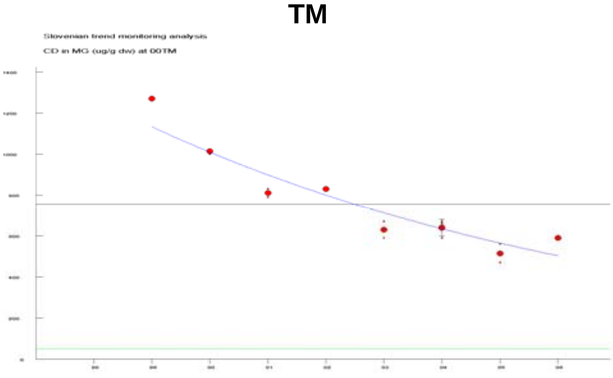
Trend statistics:
Slope = -2.3% (-7.0, 2.4)
SD(lr)= .22, 7.7%, 15 yr
Power = .55/.43/9.2%
y(09) = 800(606, 1056)
r2 = .12, p < .290
tau =-.33, p < .157
SD(sm)= .23, p < .695



TM

The time series contains non-linear trend components.

Trend statistics:
Slope = -2.0% (-8.2, 4.1)
SD(lr)= .29, 10%, 17 yr
Power = .35/.27/12%
y(09) = 727(505, 1046)
r2 = .06, p < .478
tau =-.20, p < .392
SD(sm)= .20, p < .023 *



TM < 2007

The data series show a 12% yearly decreasing trend (with a 95% confidence interval of -16, -7.4%)

Trend statistics:
Slope = -12% (-16, -7.4)
SD(lr)= .11, 6.9%, 10 yr
Power = .66/.94/4.6%
y(06) = 503(421, 600)
r2 = .88, p < .001 *
tau =-.79, p < .006 *
SD(sm)= .10, p < .113

Figure Slo.4. Trend evaluation results (from PIA suite) for cadmium mass fraction in *Mytilus galloprovincialis* (MG) by year at stations 24 and TM in Slovenian coastal waters.

Organic compounds in sediments

Slovenia is the only country that provided data on mass fraction of organic compounds in sediments. Data are related to Polyaromatic Hydrocarbons (PAH). Annual values, with no replicates at 7 stations for the whole period (1999-2009) are provided. At this stage due to data inconsistency: units mismatch, dray and wet data with no D/W ratio provided, BDL not handled properly; no further statistical analysis will be undertaken. Additionally no normalization of data is possible as the data exchange format do not allow entering additional standardized parameter. This is not to blame Slovenia but to boost the additional work to be performed after the expert meeting to revise the strategy for trend monitoring of pollutants in coastal water sediments held in Athens in 2005 (http://195.97.36.231/acrobatfiles/05WG273_2_eng.pdf), and mainly related to the implementation of the Methods for sediment sampling and analysis presented at Palermo in 2005 (http://www.sednet.org/download/wg-282-inf-5-rev-1.pdf). In the mean time also a document on the normalization procedure was made available http://www.sednet.org/download/0604_herut_and_sandler_report.pdf.

Tunisia

Tunisia to the database provided data for trace metals mass fraction in biota and sediments. To the previous data elaboration set (2002-2008) data for-2009 were added.

Trace metals in biota

Five stations were regularly sampled (Fig. Tun.1). One station is in the lagoon of Bizerte, where two organisms were sampled, both bivalves, (*Mytilus galloprovincialis* and *Ruditapes decussates*). On other stations only the last one.

Figure Tun.1. Sampling stations.

The descriptive statistics (Table Tun 1-3) show that the within year variance is very low, and far below the threshold of 0,060, indicating a good sampling and probably also analytical practice.

Part of the differences in values between the o submitted years can be explained with the differences in sampling months (Table Tun.1-3). The sampling month vary randomly with station and year showing that the pre-spawning period for the sampled species were not identified and in future a better sampling strategy has to be identified. A substantial downward trend for both cadmium and total mercury was observed on most of the stations.

When the trend analysis is interpreted for CD mass fraction in *Mytilus galloprovincialis* at station B3:

The data series show a 27% yearly decreasing trend (with a 95% confidence interval of -37, -18%). This trend is statistically significant (p< .001; i.e. a true change, assuming the assumptions of the regression analysis are fulfilled. The lowest detectable change in the current time series (with a power of 90% and one-sided test, alpha=5 %) is 16 %. 16 years of data are required to detect an annual change of 5% (with a power of 90% and one-sided test, alpha=5 %). The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 18%. For a period of 10 years, a power of 33% would be expected. The lowest detectable change for a ten-year period with the current between year variation at a power of 90% is 11%.

We are very close to fulfil the statistical objectives of the programme. For *Ruditapes decussates* the trend analysis show a weaker power after 10 year. That is not showing us that *M. galoprovincialis* is a better organism for trend monitoring then *R. decusattes*, but that same improvements in the sampling strategy may result in lowering the overall variance and both organisms will be acceptable from the statistical point of view.

Table Tun.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* (MG) at stations along the Tunisian coast in the period 2001-2008.

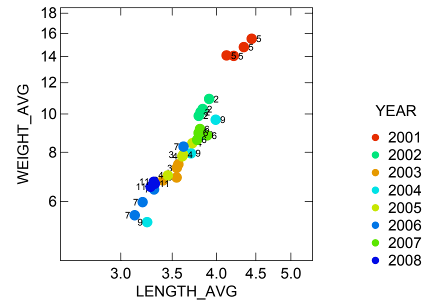
Species	Parameter	Station	Year	Month	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
MG	CD	B3	2001	**5**	4	812	946	877,3	876	70,5	0,001
	CD	B3	2002	**3**	4	258	342	283,5	267	39,4	0,003
	CD	B3	2003	**3**	4	326	409	370,0	373	34,9	0,002
	CD	B3	2004	**1**	4	273	286	278,5	278	5,6	0,000
	CD	B3	2005	**3**	4	170	219	200,3	206	21,1	0,002
	CD	B3	2006	**5**	4	125	174	144,5	140	20,8	0,004
	CD	B3	2007	**5**	4	131	139	133,8	133	3,8	0,000
	CD	B3	2008	**12**	4	88	102	93,3	92	6,1	0,001
	HGT	B3	2001	**5**	4	398	512	472,3	490	51,6	0,002
	HGT	B3	2002	**3**	4	418	491	462,8	471	32,3	0,001
	HGT	B3	2003	**3**	4	306	343	323,3	322	15,9	0,000
	HGT	B3	2004	**1**	4	108	136	124,0	126	11,9	0,002
	HGT	B3	2005	**3**	4	127	177	144,0	136	22,8	0,004
	HGT	B3	2006	**5**	4	59	62	60,5	61	1,3	0,000
	HGT	B3	2007	**5**	4	56	60	57,0	56	2,0	0,000
	HGT	B3	2008	**12**	4	60	73	67,3	68	5,4	0,001

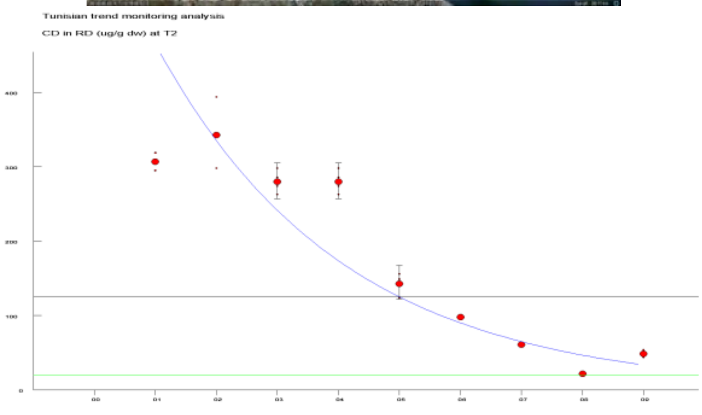
Table Tun.2. Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for trace metal mass fractions in *Ruditapes decussatus* (RD) at stations along the Tunisian coast in the period 2001-2008.

Species	Parameter	Station	Year	Month	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
	CD	B3	2001	5	4	398	495	432,0	418	43,2	0,002
	CD	B3	2002	3	4	233	356	320,8	347	58,7	0,008
	CD	B3	2003	4	4	191	284	227,0	217	40,1	0,005
	CD	B3	2004	8	4	191	284	227,0	217	40,1	0,005
	CD	B3	2005	2	4	268	309	288,0	288	17,0	0,001
	CD	B3	2006	3	4	151	169	161,0	162	7,5	0,000
	CD	B3	2007	5	4	40	45	42,3	42	2,2	0,001
	CD	B3	2008	12	3	42	46	43,7	43	2,1	0,000
	CD	B3	2009	10	1				63		
	CD	G1	2001	10	4	426	596	508,0	505	70,7	0,004
	CD	G1	2002	12	4	287	312	300,5	302	12,0	0,000
	CD	G1	2003	2	4	250	382	306,8	298	57,4	0,006
	CD	G1	2004	1	3	257	330	291,0	286	36,8	0,003
	CD	G1	2005	1	3	334	435	386,7	391	50,6	0,003
	CD	G1	2006	6	3	346	366	357,7	361	10,4	0,000
	CD	G1	2007	5	4	215	280	249,0	251	30,6	0,003
	CD	G1	2008	12	4	331	412	390,0	409	39,4	0,002
	CD	G1	2009	10	1				703		
	CD	M1	2001	10	3	402	436	419,7	421	17,0	0,000
	CD	M1	2002	12	3	254	353	294,7	277	51,8	0,005
	CD	M1	2003	1	4	228	326	275,0	273	52,2	0,007
RD	CD	M1	2004	9	3	204	255	234,7	245	27,0	0,003
	CD	M1	2005	12	4	911	984	956,5	966	31,8	0,000
	CD	M1	2006	1	4	336	398	365,8	365	27,3	0,001
	CD	M1	2007	4	4	206	292	246,8	245	36,4	0,004
	CD	M1	2008	10	3	387	408	397,0	396	10,5	0,000
	CD	M1	2009	10	1				21		
	CD	S2	2001	10	4	398	454	421,5	417	26,5	0,001
	CD	S2	2002	2	4	183	213	196,5	195	13,6	0,001
	CD	S2	2003	1	4	234	362	302,8	308	57,5	0,007
	CD	S2	2004	6	4	260	339	289,8	280	36,3	0,003
	CD	S2	2005	5	4	289	444	381,0	396	65,5	0,006
	CD	S2	2006	6	4	339	370	352,0	350	13,1	0,000
	CD	S2	2007	4	4	374	500	443,3	450	53,1	0,003
	CD	S2	2008	10	4	327	353	334,3	329	12,6	0,000
	CD	S2	2009	10	1				430		
	CD	T2	2001	5	4	295	401	340,0	332	45,5	0,003
	CD	T2	2002	2	4	298	394	332,0	318	44,6	0,003
	CD	T2	2003	3	4	263	298	280,3	280	15,1	0,001
	CD	T2	2004	9	4	263	298	280,3	280	15,1	0,001
	CD	T2	2005	4	4	124	156	143,3	147	13,7	0,002
	CD	T2	2006	7	4	94	117	101,5	98	10,5	0,002
	CD	T2	2007	6	4	56	64	60,8	62	3,4	0,001
	CD	T2	2008	11	3	22	28	25,7	27	3,2	0,003
	CD	T2	2009	10	1	44	54	49,0	49,0	7,07	0,004

Table Tun.3. 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 *Ruditapes decussatus* (RD) at stations along the Tunisian coast in the period 2001-2008.

Species	Parameter	Station	Year	Month	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
	HGT	B3	2001	5	4	198	296	260,5	274	44,2	0,006
	HGT	B3	2002	3	4	132	148	142,0	144	6,9	0,000
	HGT	B3	2003	4	4	130	206	162,8	158	32,6	0,007
	HGT	B3	2004	8	4	130	206	162,8	158	32,6	0,007
	HGT	B3	2005	2	4	238	343	271,5	253	48,3	0,005
	HGT	B3	2006	3	4	129	191	156,0	152	25,9	0,005
	HGT	B3	2007	5	4	18	20	19,0	19	1,2	0,001
	HGT	B3	2008	12	3	13	16	14,7	15	1,5	0,002
	HGT	B3	2009	10	1				70		
	HGT	G1	2001	10	4	146	195	168,3	166	20,6	0,003
	HGT	G1	2002	12	4	106	165	131,5	128	25,1	0,007
	HGT	G1	2003	2	4	270	360	308,5	302	40,6	0,003
	HGT	G1	2004	1	3	98	119	110,3	114	11,0	0,002
	HGT	G1	2005	1	3	86	152	111,7	97	35,4	0,017
	HGT	G1	2006	6	3	62	70	67,0	69	4,4	0,001
	HGT	G1	2007	5	4	16	23	19,8	20	2,9	0,004
	HGT	G1	2008	12	4	25	26	25,8	26	0,5	0,000
	HGT	G1	2009	10	1				18		
	HGT	M1	2002	12	3	222	246	238,0	246	13,9	0,001
	HGT	M1	2003	1	4	63	106	79,8	75	20,1	0,011
	HGT	M1	2004	9	3	28	35	32,3	34	3,8	0,003
	HGT	M1	2005	12	4	83	107	92,8	91	11,1	0,003
RD	HGT	M1	2006	1	4	34	44	37,5	36	4,4	0,002
	HGT	M1	2007	4	4	36	44	41,0	42	3,8	0,002
	HGT	M1	2008	10	3	9	13	10,7	10	2,1	0,007
	HGT	M1	2009	10	1				21		
	HGT	S2	2001	10	4	123	149	136,3	137	11,2	0,001
	HGT	S2	2002	2	4	135	182	153,3	148	20,5	0,003
	HGT	S2	2003	1	4	132	295	185,8	158	74,5	0,024
	HGT	S2	2004	6	4	50	62	54,8	54	5,1	0,002
	HGT	S2	2005	5	4	50	83	59,8	53	15,6	0,011
	HGT	S2	2006	6	4	40	69	48,8	43	13,8	0,013
	HGT	S2	2007	4	4	51	54	52,5	53	1,3	0,000
	HGT	S2	2008	10	4	18	30	22,0	20	5,7	0,011
	HGT	S2	2009	10	1				35		
	HGT	T2	2001	5	4	229	297	276,3	290	31,9	0,003
	HGT	T2	2002	2	4	197	241	216,5	214	19,1	0,001
	HGT	T2	2003	3	4	265	492	396,3	414	100,4	0,014
	HGT	T2	2004	9	4	265	492	396,3	414	100,4	0,014
	HGT	T2	2005	4	4	296	344	313,0	306	22,2	0,001
	HGT	T2	2006	7	4	104	150	136,0	145	21,7	0,006
	HGT	T2	2007	6	4	40	50	47,0	49	4,8	0,002
	HGT	T2	2008	11	3	16	26	19,3	16	5,8	0,015
	HGT	T2	2009	10	2	90	90	90,0	90,0	0,00	0,000



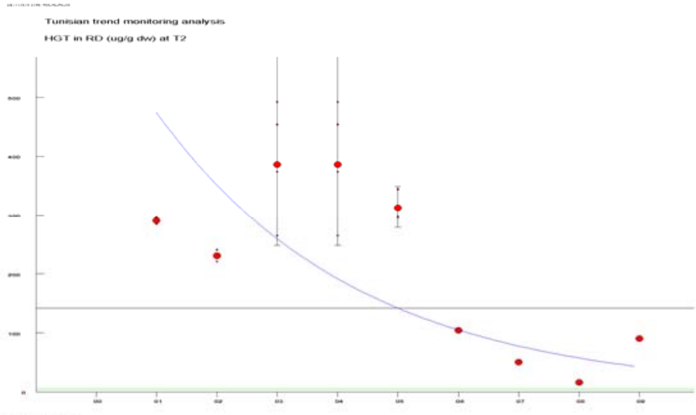


Cadmium

The data series show a 33% yearly decreasing trend (with a 95% confidence interval of -45, -20%)

Trend statistics:

Slope = -33% (-45, -20)
SD(lr)= .41, 22%, 21 yr
Power = .12/.15/18%
y(09) = 34 (19, 61)
r2 = .85, p < .001 *
tau =-.87, p < .001 *
SD(sm)= .40, p < .301



Total mercury

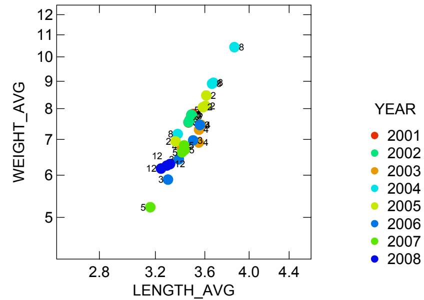
The data series show a 30% yearly decreasing trend (with a 95% confidence interval of -53, -6.9%)

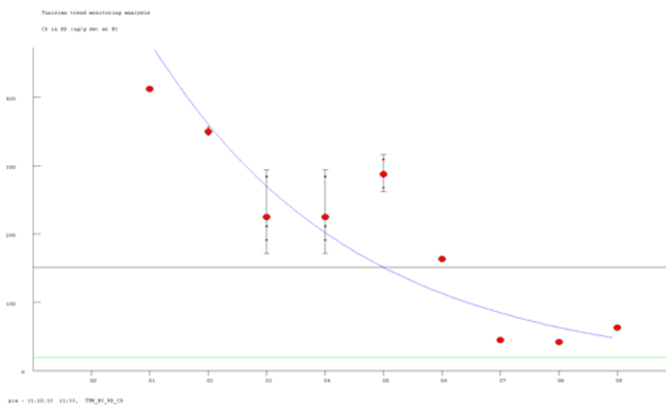
Trend statistics:

Slope = -30% (-53, -6.9)
SD(lr)= .76, 44%, 32 yr
Power = .07/.08/36%
y(09) = 42 (14, 129)
r2 = .57, p < .018 *
tau =-.54, p < .045 *
SD(sm)= .77, p < .402

Station T2 – *Ruditapes decussatus*

Figure Tun.2. Length vs. weight and trend evaluation results (PIA suite) for cadmium and total mercury (HGT) mass fraction for *Ruditapes decussatus* samples collected at T2 station.



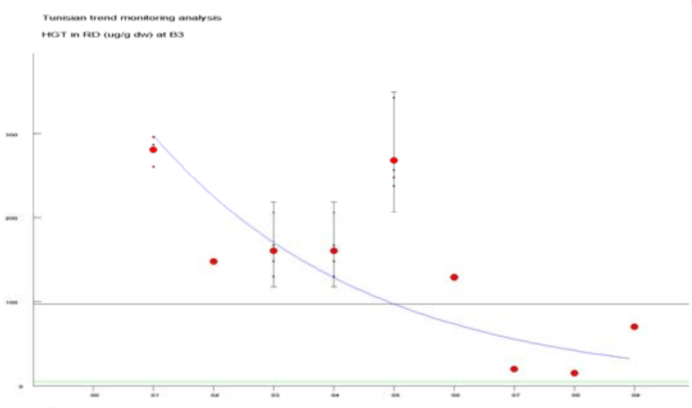


Cadmium

The data series show a 29% yearly decreasing trend (with a 95% confidence interval of -42, -16%)

Trend statistics:

Slope = -29% (-42, -16)
SD(lr)= .43, 23%, 22 yr
Power = .12/.14/19%
y(09) = 47 (25, 88)
r2 = .80, p < .001 *
tau =-.76, p < .004 *
SD(sm)= .45, p < .648



Total mercury

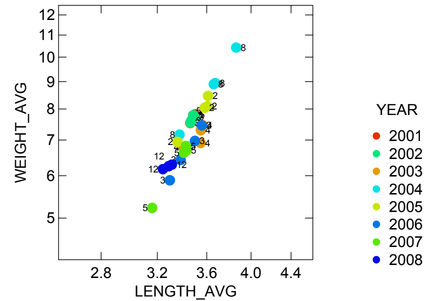
The data series show a 28% yearly decreasing trend (with a 95% confidence interval of -52, -4.1%)

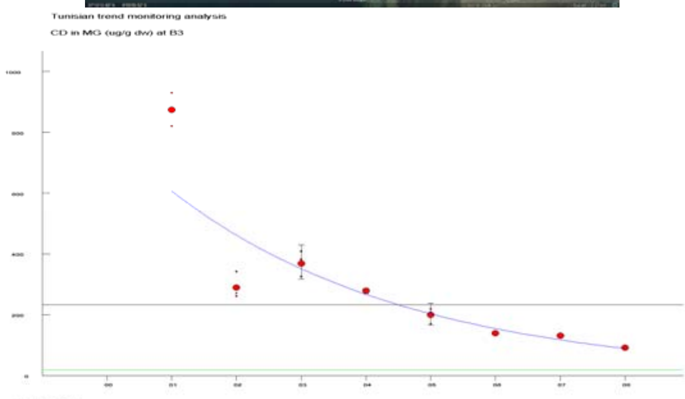
Trend statistics:

Slope = -28% (-52, -4.1)
SD(lr)= .78, 46%, 33 yr
Power = .07/.08/37%
y(09) = 32 (10, 99)
r2 = .52, p < .027 *
tau =-.59, p < .026 *
SD(sm)= .84, p < .719

Station B3 – *Ruditapes decussatus*

Figure Tun.3. Length vs. weight and trend evaluation results (PIA suite) for cadmium and total mercury (HGT) mass fraction for *Ruditapes decussatus* samples collected at B3 station.



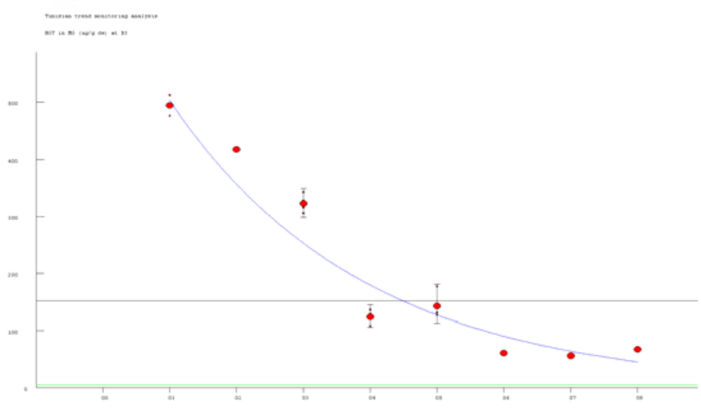


Cadmium

The data series show a 27% yearly decreasing trend (with a 95% confidence interval of -37, -18%)

Trend statistics:

Slope = -27% (-37, -18)
SD(lr)= .25, 16%, 16 yr
Power = .18/.33/11%
y(08) = 89 (60, 133)
r2 = .89, p < .001 *
tau =-.93, p < .001 *
SD(sm)= .26, p < .454



Total mercury

The data series show a 28% yearly decreasing trend (with a 95% confidence interval of -52, -4.1%)

Trend statistics:

Slope = -28% (-52, -4.1)
SD(lr)= .78, 46%, 33 yr
Power = .07/.08/37%
y(09) = 32 (10, 99)
r2 = .52, p < .027 *
tau =-.59, p < .026 *
SD(sm)= .84, p < .719

Station B3 – *Mytilus galloprovincialis*

Figure Tun.4. Length vs. weight and trend evaluation results (PIA suite) for cadmium and total mercury (HGT) mass fraction for *Mytilus galloprovincialis* samples collected at B3 station.

Trace metals in sediments

Tunisia provided data on mass fraction of trace metals (Cd, HgT and Pb) in sediments. Annual values, with no replicates at 5 stations for a three year period (2006-2009) are provided. At this stage due to data inconsistency mainly related to units mismatch and BDL not handled properly and due to short sampling period no further statistical analysis will be undertaken. Additionally no normalization of data is possible as the data exchange format do not allow entering additional standardized parameter. The same comment as for Slovenia is valid. On Fig. Tun.4. are presented the data just to get a sense about the levels of contamination.

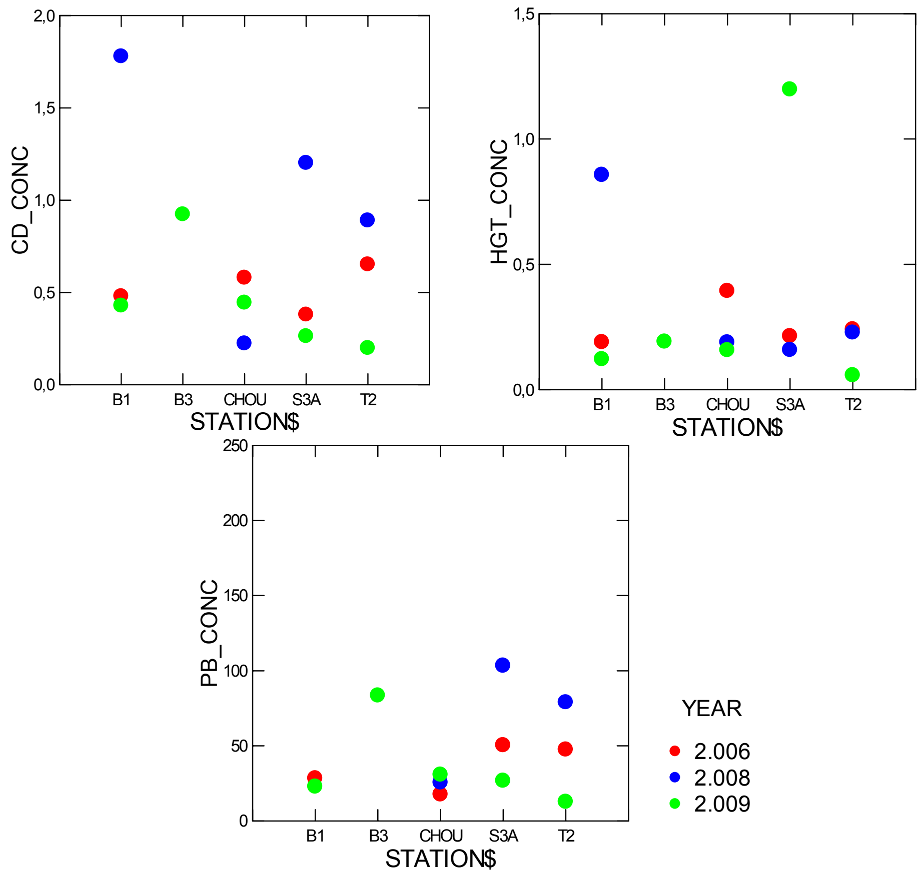


Figure Tun.4. Mass fraction of cadmium CD), total mercury (HGT) and lead (PB) in sediments along the Tunisian coast.

Turkey

Turkey is near Croatia the only country that provided data on mass fraction of trace metals and organic compounds in biota and trace metals in sediments.

Trace metals in biota

Turkey regularly submitted data since 1998 for trace metals mass fraction in *Mullus barbatus* (Fig. Tur.1) and verified all the data set in 2010 before the present analysis was performed.

Figure Tur.1. Sampling station for trend evaluation of trace metals in *Mullus barbatus*.

The data now represents a valuable set of data of twelve years. The descriptive statistics (Table Tur.1) show a relatively variable within year variance which in some cases fairly exceeding the 0,060 threshold. In the beginning, a higher variability could be expected because during the first three years single organism was analysed and later 5-10 samples with 4-5 pooled organisms. From the length vs. weight relationship (Fig. Tur.2A) it can be noticed that the sampled population of fish was not always the same. In the first five years the relationship was homogenous and after 2003 a clear shift was observed indicating that probably a different fish population was sampled. When compared to other countries (Fig.Tur.2B) that become even more evident On the other hand, the mass fraction of trace metals seems not to be dependent on fish size (Fig. Tur.2C).

In generally, the detected trend is small or inexistent and represent only variations around a certain value for cadmium mass fraction (Fig. Tur.3). Instead for total mercury mass fraction a substantial change in accumulation of this trace metal in *Mullus barbatus* is observed (Fig. Tur.3). This change coincide with the identified shift in the population metrics (length vs. weight) of *Mullus barbatus* in the area. When outliers are eliminated (Fig. Tur.4) for total mercury mass fraction a upward trend become apparent.

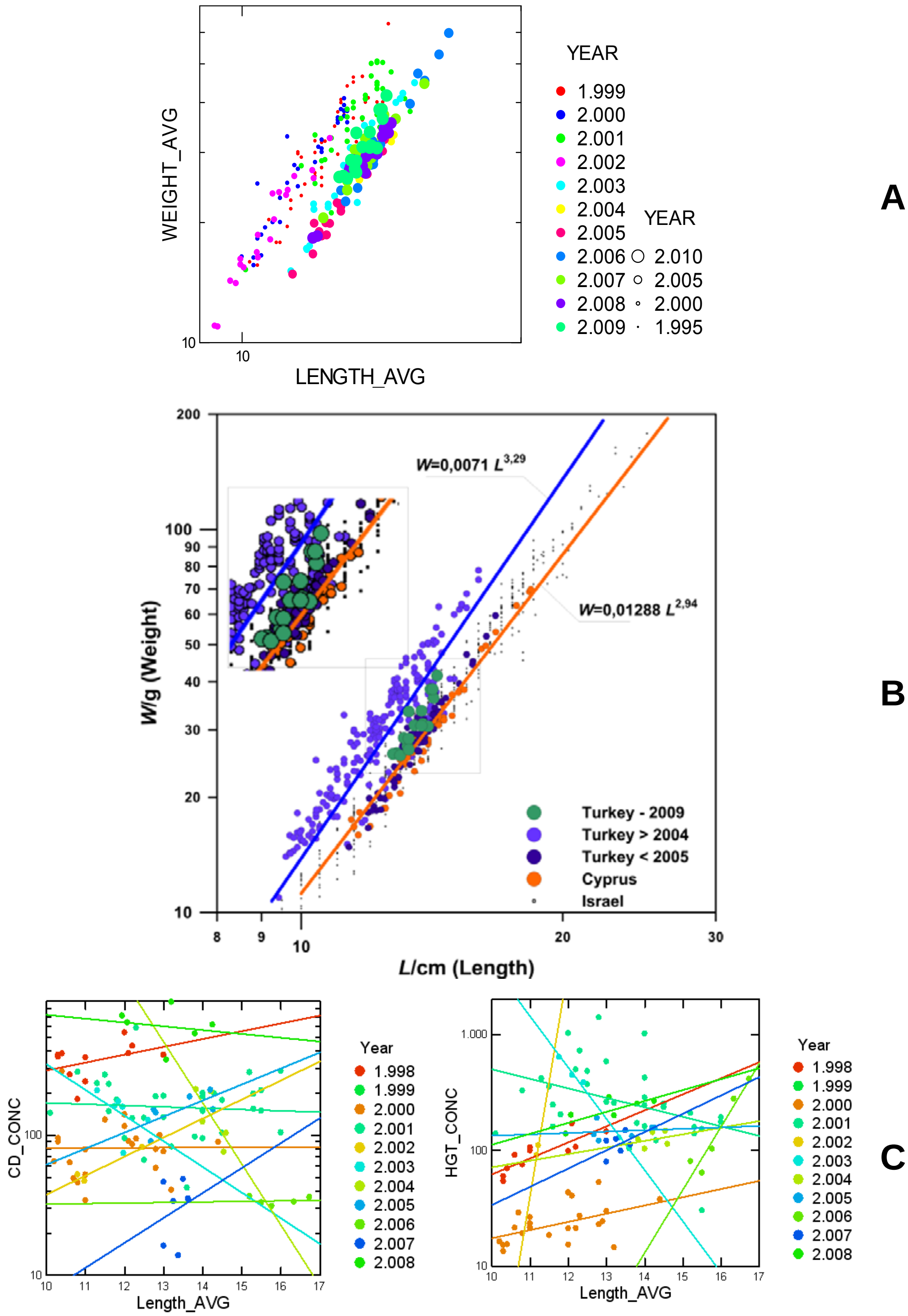


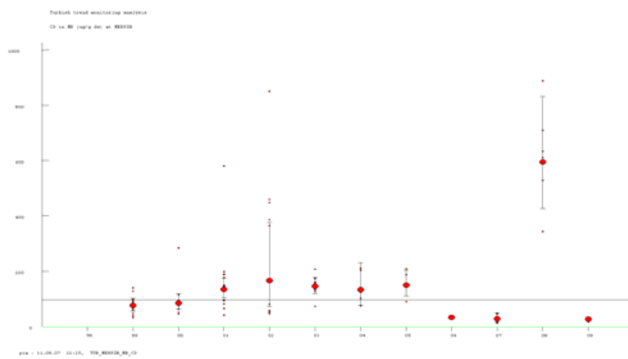
Figure Tur.2. (A) Length vs. weight of *Mullus barbatus* with year, (B) for countries of the eastern Mediterranean, and (C) values of cadmium and total mercury mass fraction in *Mullus barbatus* by length at Mersin in Turkey.

Table Tur.1. Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for cadmium mass fractions in *Mullus barbatus* at stations along the coast of Turkey in the period 1999-2009.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
CD	GOKSU	1999	20	15,0	127,7	47,8	52,0	27,3	0,057
CD	GOKSU	2000	10	6,7	51,6	21,1	23,2	13,1	0,059
CD	GOKSU	2001	8	51,5	310,6	92,6	119,8	82,6	0,056
CD	GOKSU	2002	5	83,1	107,5	97,9	96,8	9,0	0,002
CD	GOKSU	2003	9	549,0	811,5	649,4	661,5	85,5	0,003
CD	GOKSU	2004	5	88,0	142,4	114,6	113,5	22,4	0,007
CD	GOKSU	2005	6	143,5	194,4	169,1	168,0	18,4	0,002
CD	GOKSU	2006	6	46,9	128,4	54,4	71,0	32,9	0,032
CD	GOKSU	2007	6	48,7	82,6	54,9	58,9	12,6	0,007
CD	GOKSU	2008	6	83,0	286,5	119,8	139,4	74,4	0,035
CD	GOKSU	2009	6	26,0	76,0	56,0	51,8	21,3	0,040
CD	MERSIN	1999	12	34,2	140,3	84,1	84,7	37,3	0,043
CD	MERSIN	2000	11	45,8	284,4	85,9	97,9	65,0	0,043
CD	MERSIN	2001	19	42,0	580,7	143,5	157,2	111,9	0,054
CD	MERSIN	2002	10	46,9	850,9	223,2	280,5	268,6	**0,246**
CD	MERSIN	2003	10	74,3	207,6	159,4	150,9	35,6	0,015
CD	MERSIN	2004	5	75,7	211,4	124,5	143,9	61,1	0,037
CD	MERSIN	2005	6	89,8	209,6	151,7	155,8	41,1	0,016
CD	MERSIN	2006	5	31,1	36,5	33,4	34,0	2,2	0,001
CD	MERSIN	2007	6	13,8	48,4	34,4	32,3	14,6	0,054
CD	MERSIN	2008	6	343,8	888,7	622,4	619,4	181,7	0,019
CD	MERSIN	2009	6	17,0	33,0	29,0	27,7	5,8	0,011
CD	TIRTAR	1999	11	4,6	88,8	9,1	24,8	29,2	**0,205**
CD	TIRTAR	2000	11	5,4	326,3	62,7	79,5	90,6	**0,288**
CD	TIRTAR	2001	11	53,2	533,8	151,3	172,6	128,8	**0,072**
CD	TIRTAR	2002	5	57,8	199,6	77,6	97,2	58,7	0,047
CD	TIRTAR	2003	7	342,0	759,5	634,2	601,0	130,2	0,012
CD	TIRTAR	2004	5	42,1	65,4	52,4	52,0	8,9	0,005
CD	TIRTAR	2005	6	65,7	136,9	95,9	97,9	26,6	0,014
CD	TIRTAR	2006	6	15,1	64,0	43,8	42,5	16,1	0,047
CD	TIRTAR	2007	6	12,9	25,1	21,1	20,7	4,5	0,011
CD	TIRTAR	2008	6	51,3	95,8	71,8	72,1	14,7	0,008
CD	TIRTAR	2009	6	54,0	87,0	76,5	74,5	11,7	0,006

Table Tur.2. Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for total mercury mass fractions in *Mullus barbatus* at stations along the coast of Turkey in the period 1999-2009.

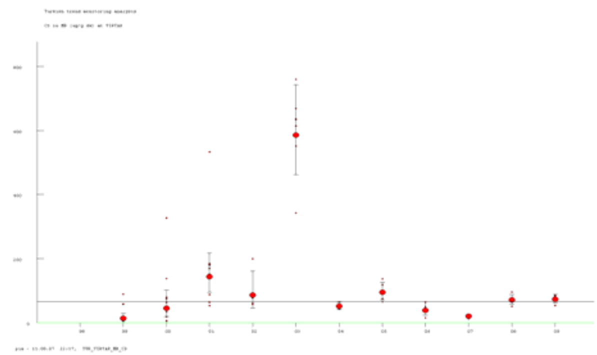
Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
HGT	GOKSU	1999	20	7,4	35,3	14,9	17,3	7,7	0,036
HGT	GOKSU	2000	10	10,1	31,8	24,3	22,0	7,1	0,030
HGT	GOKSU	2001	8	49,3	176,5	129,3	123,6	45,5	0,037
HGT	GOKSU	2002	5	335,3	969,1	640,4	678,7	263,6	0,035
HGT	GOKSU	2003	9	117,3	222,1	165,6	168,6	33,7	0,008
HGT	GOKSU	2004	5	31,5	65,1	56,3	50,2	15,2	0,020
HGT	GOKSU	2005	6	129,9	275,6	150,7	185,2	70,4	0,024
HGT	GOKSU	2006	6	165,0	281,3	243,9	229,5	51,0	0,010
HGT	GOKSU	2007	6	128,0	617,5	283,3	315,4	163,7	0,049
HGT	GOKSU	2008	6	160,9	288,3	188,2	204,6	50,1	0,010
HGT	GOKSU	2009	6	87,0	100,0	96,5	95,5	4,9	0,001
HGT	MERSIN	1999	12	14,4	52,8	25,3	27,3	11,9	0,032
HGT	MERSIN	2000	11	13,4	40,3	21,2	21,9	7,6	0,018
HGT	MERSIN	2001	19	101,5	721,7	251,2	290,9	177,0	**0,069**
HGT	MERSIN	2002	10	90,4	150,2	121,1	122,9	19,1	0,005
HGT	MERSIN	2003	10	36,9	786,0	458,9	413,1	265,0	**0,246**
HGT	MERSIN	2004	5	102,7	146,3	123,5	125,6	18,8	0,004
HGT	MERSIN	2005	6	120,5	189,6	146,0	148,4	24,6	0,005
HGT	MERSIN	2006	5	63,8	413,2	102,8	187,5	152,5	**0,125**
HGT	MERSIN	2007	6	79,3	147,9	116,0	113,6	23,5	0,009
HGT	MERSIN	2008	6	138,2	285,9	225,8	223,4	54,3	0,013
HGT	MERSIN	2009	6	241,0	334,0	283,0	283,7	36,9	0,003
HGT	TIRTAR	1999	11	9,3	44,7	21,5	22,2	9,7	0,034
HGT	TIRTAR	2000	11	12,0	166,9	26,0	66,9	58,9	**0,215**
HGT	TIRTAR	2001	11	87,2	229,4	170,6	165,7	45,9	0,019
HGT	TIRTAR	2002	5	95,3	266,4	114,3	149,3	71,8	0,035
HGT	TIRTAR	2003	7	68,2	133,2	103,4	102,5	19,5	0,008
HGT	TIRTAR	2004	5	54,7	93,4	66,7	69,0	15,3	0,008
HGT	TIRTAR	2005	6	94,6	126,6	109,2	110,3	13,9	0,003
HGT	TIRTAR	2006	6	90,7	242,7	168,5	164,4	55,4	0,025
HGT	TIRTAR	2007	6	81,2	256,4	182,9	169,9	72,2	0,045
HGT	TIRTAR	2008	6	311,9	570,8	415,3	427,8	87,9	0,008
HGT	TIRTAR	2009	6	102,0	159,0	128,5	128,5	18,3	0,004
HGT	GOKSU	1999	20	7,4	35,3	14,9	17,3	7,7	0,036



Mersin

The data series show no significant log-linear trend.

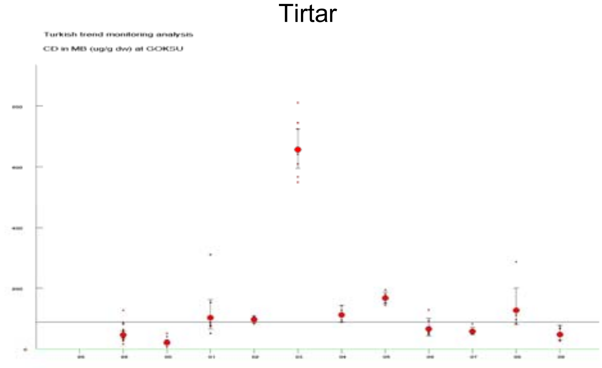
Trend statistics:
Slope = -4.8% (-25, 16)
SD(lr)= .95, 38%, 37 yr
Power = .07/.07/47%
y(09) = 76 (23, 257)
r2 = .03, p < .616
tau =-.09, p < .697
SD(sm)= 1.0, p < .763



Tirtar

The data series show no significant log-linear trend.

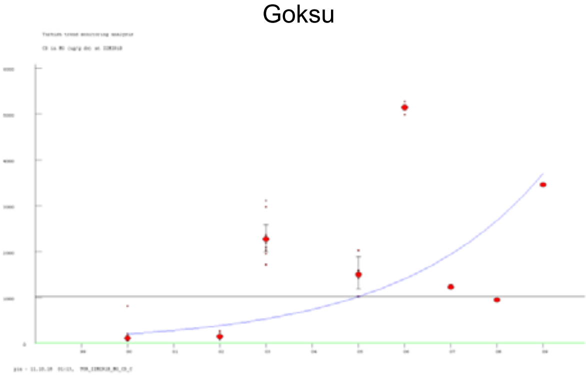
Trend statistics:
Slope = .67% (-22, 23)
SD(lr)= 1.0, 43%, 39 yr
Power = .07/.06/52%
y(09) = 68 (18, 256)
r2 = .00, p < .904
tau = .02, p < .938
SD(sm)= .90, p < .122



Goksu

The data series show no significant log-linear trend.

Trend statistics:
Slope = -2.3% (-7.0, 2.4)
SD(lr)= .22, 7.7%, 15 yr
Power = .55/.43/9.2%
y(09) = 800(606, 1056)
r2 = .12, p < .290
tau =-.33, p < .157
SD(sm)= .23, p < .695

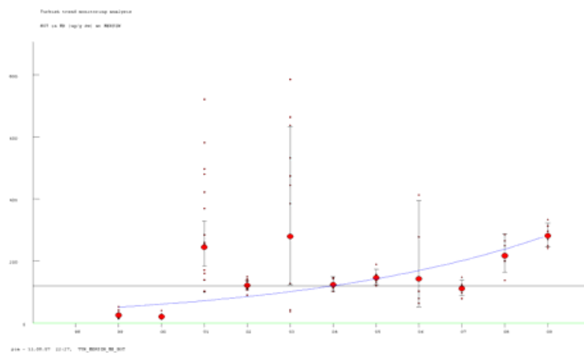


IZMIR1B

The data series show no significant log-linear trend.

Trend statistics:
Slope = 32% (1.3, 63)
SD(lr)= 1.0, 86%, 39 yr
Power = .06/.06/52%
y(09) = 370(799,)
r2 = .52, p < .043 *
tau = .36, p < .216
SD(sm)= 1.0, p < .201

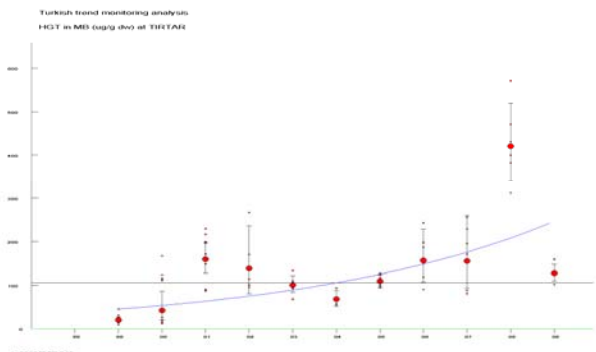
Figure Tur.3. Trend evaluation results (from PIA suite) of cadmium and total mercury mass fraction in *Mullus barbatus* (MB) by year at Mersin, Tirtar and Goksu station and *Mitilus galoprovinciallis* at Izmir1B station in Turkey coastal waters.



Mersin

The data series show no significant log-linear trend.

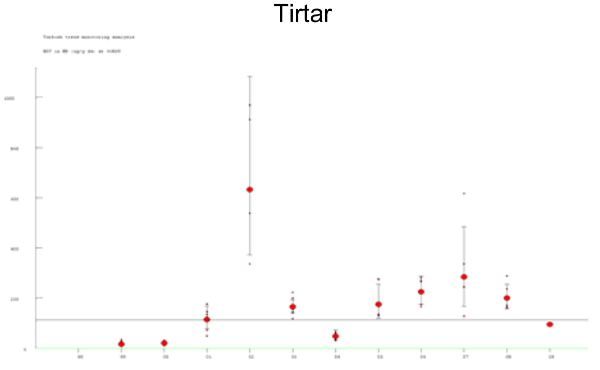
Trend statistics:
Slope = 17% (1.5, 33)
SD(lr)= .72, 28%, 31 yr
Power = .09/.08/34%
y(09) = 283(113, 709)
r2 = .41, p < .034 *
tau = .38, p < .102
SD(sm)= .65, p < .172



Tirtar

The data series show no significant log-linear trend.

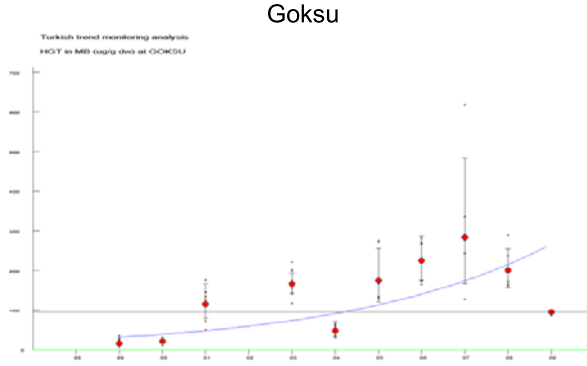
Trend statistics:
Slope = 17% (4.3, 30)
SD(lr)= .58, 22%, 27 yr
Power = .12/.10/27%
y(09) = 246(117, 519)
r2 = .51, p < .014 *
tau = .42, p < .073
SD(sm)= .61, p < .557



Goksu

The data series show no significant log-linear trend.

Trend statistics:
Slope = 17% (-4.8, 39)
SD(lr)= 1.0, 41%, 38 yr
Power = .07/.07/50%
y(09) = 266(73, 972)
r2 = .26, p < .109
tau = .38, p < .102
SD(sm)= 1.0, p < .368



Goksu – after outliers removal

The data series show a 21% yearly increasing trend (with a 95% confidence interval of 4.7, 38%)

Trend statistics:
Slope = 21% (4.7, 38)
SD(lr)= .74, 35%, 31 yr
Power = .08/.08/35%
y(09) = 266(102, 699)
r2 = .52, p < .018 *
tau = .56, p < .025 *
SD(sm)= .69, p < .204

Figure Tur.4. Trend evaluation results (from PIA suite) of cadmium and total mercury mass fraction in *Mullus barbatus* (MB) by year at Mersin, Tirtar and Goksu station in Turkey coastal waters, and at Goksu after outliers removal.

When the trend analysis is interpreted for total mercury mass fraction at Tirtar station with the best statistical output:

The data series show no significant log-linear trend. The lowest detectable change in the current time series (with a power of 90% and one-sided test, alpha=5 %) is 22 %. 27 years of data are required to detect an annual change of 5% (with a power of 90% and one-sided test, alpha=5 %). The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 12%. For a period of 10 years, a power of 9.9% would be expected. The lowest detectable change for a ten-year period with the current between year variation at a power of 90% is 27%.

We are still not in position to fulfil the main statistical objectives of the programme. The main reason for this is the huge overall variance of the data.

Organic compounds (OC) in biota

Turkey to the database also provided data for mass fraction of organic compounds (DDD - opDDD + ppDDT, DDE - opDDE + ppDDE, DDT - opDDT + ppDDT, DIE - Dieldrin PAH – Polyaromatic Hydrocarbons, PCBA - Chlorinated biphenyl congeners as Aroclor 1254 and PCBB - Chlorinated biphenyl congeners as Aroclor 1260) in biota and sediments. Data were provide for the period 2003-2009 and the same stations (Fig. Tur.1) and samples.

The descriptive statistics for DDT (Table Tur.3) show a relatively variable within year variance which in some cases fairly exceeding the 0,060 threshold, indicating a huge within year variance. The reasons for can be multiple and has to be critically evaluated after the data is verified because many problem in data handling was identified also for the trace metals with which are sharing the same samples. This is the first time the results on organic compound in biota are evaluated for trend. DDT is presented as an example, but just a walkthrough look to other OC confirm the huge variability. For DDT also the trend evaluation is presented on Fig. Tur.5.

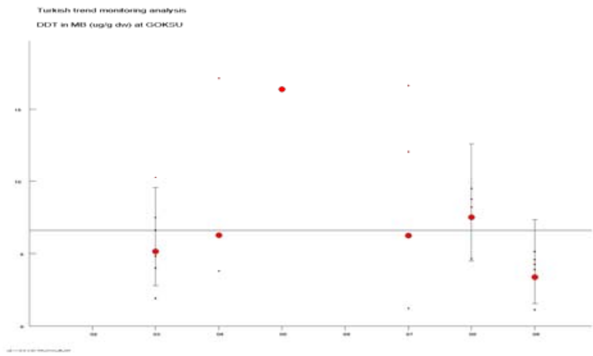
Table Tur.3. Number of samples (N), minimum (Min), maximum (Max), average (Avg), median, standard deviation (STD) and within year variance (Ψ^2) for DDT mass fractions in *Mullus barbatus* at stations along the coast of Turkey in the period 2003-2009.

Parameter	Station	Year	N	Min	Max	Avg	Median	STD	Ψ^2 (LOG_C)
DDT	GOKSU	2003	6	1,9	10,2	5,7	5,9	2,9	**0,065**
DDT	GOKSU	2004	3	3,8	17,1	3,8	8,2	7,7	**0,143**
DDT	GOKSU	2005	1				16,4		
DDT	GOKSU	2007	3	1,2	16,6	12,0	10,0	7,9	**0,382**
DDT	GOKSU	2008	4	4,7	9,5	8,5	7,8	2,2	0,020
DDT	GOKSU	2009	5	1,1	5,2	4,3	3,8	1,6	**0,074**
DDT	MERSIN	2003	9	0,5	1,8	1,5	1,4	0,4	0,029
DDT	MERSIN	2004	5	0,6	2,0	1,2	1,2	0,5	0,044
DDT	MERSIN	2005	6	0,6	2,3	1,3	1,3	0,5	0,033
DDT	MERSIN	2006	2	2,0	2,1	2,0	2,0	0,1	0,000
DDT	MERSIN	2007	5	0,1	0,8	0,7	0,5	0,4	**0,298**
DDT	MERSIN	2008	6	0,0	0,2	0,1	0,1	0,1	**0,082**
DDT	MERSIN	2009	4	0,1	0,2	0,1	0,1	0,0	0,012
DDT	TIRTAR	2003	7	0,1	2,8	0,1	0,9	1,3	**0,505**
DDT	TIRTAR	2004	5	1,3	2,6	1,3	1,6	0,6	0,017
DDT	TIRTAR	2005	6	1,4	2,7	1,5	1,8	0,5	0,012
DDT	TIRTAR	2006	3	0,7	2,4	0,8	1,3	1,0	**0,093**
DDT	TIRTAR	2007	6	0,6	3,5	1,6	2,0	1,3	**0,096**
DDT	TIRTAR	2008	6	0,2	4,0	2,4	2,3	1,3	**0,242**
DDT	TIRTAR	2009	5	0,2	0,5	0,4	0,4	0,2	0,048

When the trend analysis is interpreted for DDT mass fraction at Mersin station with the best statistics:

The data series show no significant log-linear trend. The lowest detectable change in the current time series (with a power of 90% and one-sided test, alpha=5 %) is 87 %. 34 years of data are required to detect an annual change of 5% (with a power of 90% and one-sided test, alpha=5 %). The power of the time series to detect a log-linear trend of 5% with the number of years in the current time series is 5.7%. For a period of 10 years, a power of 7.4% would be expected. The lowest detectable change for a ten-year period with the current between year variation at a power of 90% is 39%.

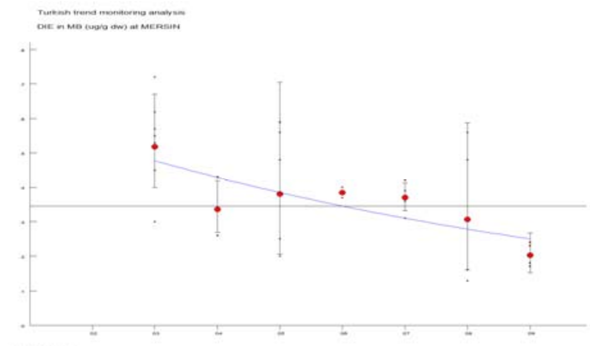
We are still not in position to fulfil the statistical objectives of the programme. The main reason for this is the huge overall variance of the data. Probably the statistical objectives of the programme has to be revised.



DDT

The data series show no significant log-linear trend.

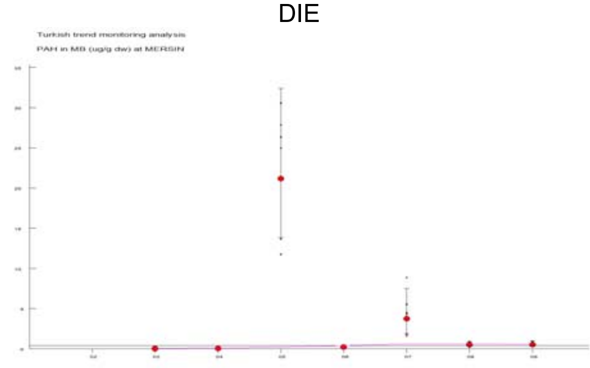
Trend statistics:
Slope = -49% (-89, -9.2)
SD(lr)= .82, 87%, 34 yr
Power = .06/.07/39%
y(09) = .12(.03, .50)
r2 = .67, p < .025 *
tau =-.52, p < .099
SD(sm)= .79, p < .141



DIE

The data series show no significant log-linear trend.

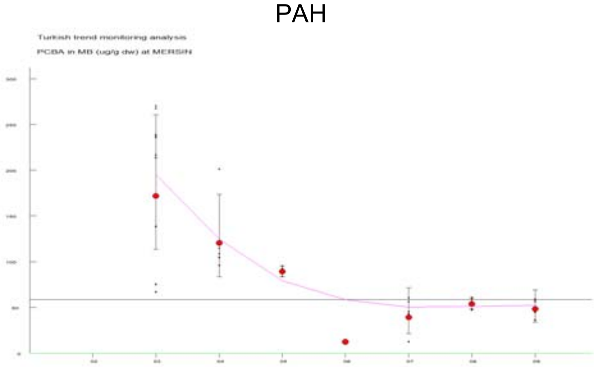
Trend statistics:
Slope = -11% (-20, -2.0)
SD(lr)= .18, 15%, 13 yr
Power = .21/.58/7.5%
y(09) = .25(.18, .34)
r2 = .67, p < .025 *
tau =-.62, p < .051
SD(sm)= .18, p < .199



PAH

The data series show no significant log-linear trend.

Trend statistics:
Slope = 55% (-69, 179)
SD(lr)= 2.5, >99%, 70 yr
Power = .05/.05/100%
y(09) = 2.0(.02, 176)
r2 = .21, p < .306
tau = .43, p < .176
SD(sm)= 2.3, p < .083



PCBA

The data series show no significant log-linear trend.

Trend statistics:
Slope = -22% (-60, 16)
SD(lr)= .78, 82%, 33 yr
Power = .06/.08/37%
y(09) = 30 (7.6, 118)
r2 = .31, p < .191
tau =-.52, p < .099
SD(sm)= .73, p < .095

Figure Tur.4. Trend evaluation results (from PIA suite) of mass fraction odDDT - opDDT + ppDDT, DIE - Dieldrin PAH – Polyaromatic Hydrocarbons and PCBA - Chlorinated biphenyl congeners as Aroclor 1254 in *Mullus barbatus* (MB) by year at Mersin, Tirtar and Goksu station in Turkey coastal waters.

Trace metals in sediments

Turkey regularly submitted data since 1998 for trace metals mass fraction sediments (Fig. Tur.5). Data were collected on grid of 25 stations from 1999 but consistently from 2003 and in replicates (3-5) as suggested in the methodology acquired in 2005 from2006

Figure Tur.5. Sampling station for trend evaluation of trace metals in sediments.

As described for Slovenia the main problem with contaminant levels in sediment is that the data has to be tuned to give result that is in accordance with the revised methodologies from 2005. Turkey applied the suggested methodologies but only same aspect is visible through data, mainly because the database is not structured to receive this important additional information. From exploratory data analysis (Fig. Tur.6) applied on total mercury mass fraction easily can be seen all the weakness of the data: no replicates before 2006, huge variability, gaps in data etc. The trend analysis due to the small number of data do not show acceptable statistical outputs (Fig, Tur.7).

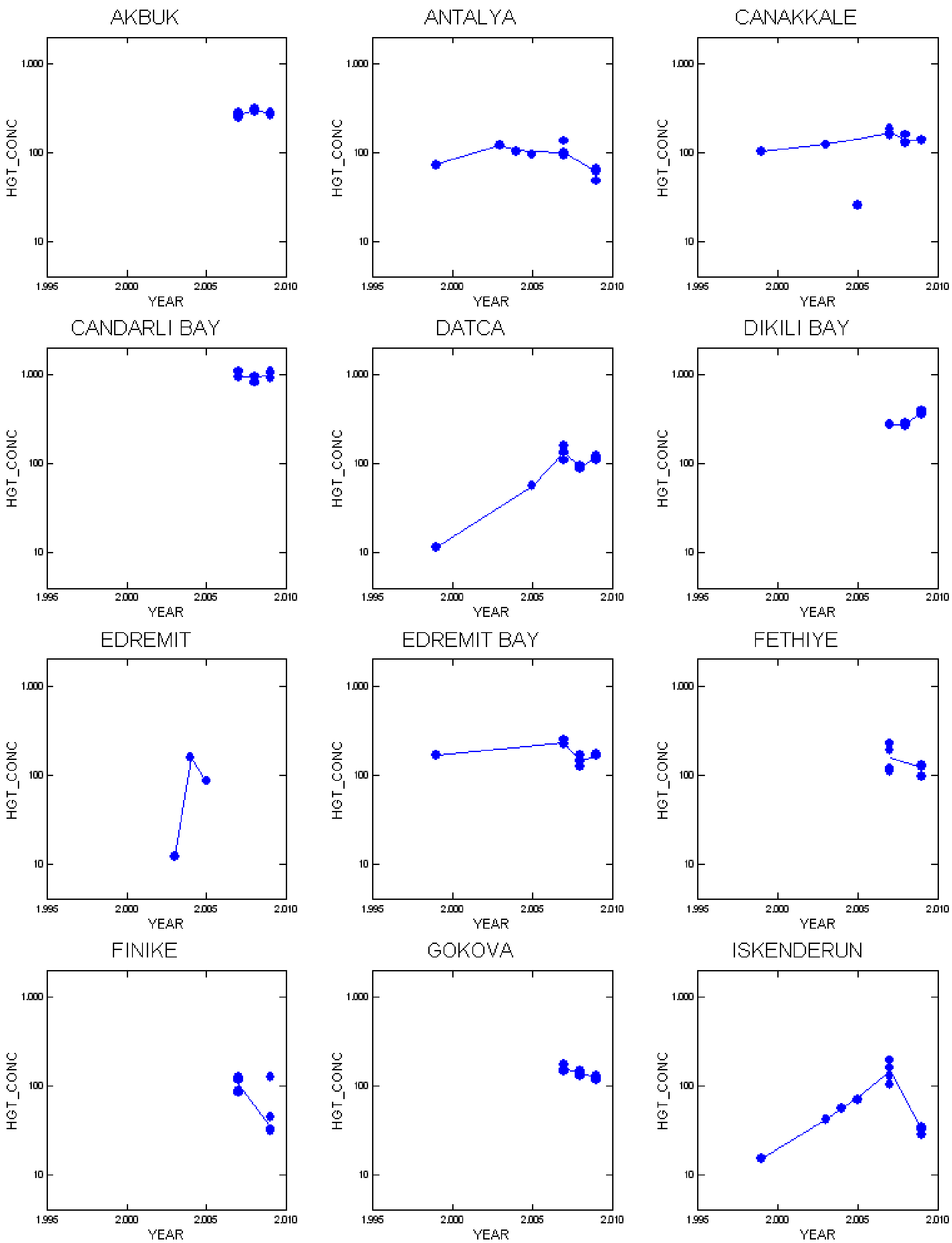


Figure Tur.6. Exploratory data analysis for total mercury mass fraction in sediments at 24 stations in Turkey coastal waters

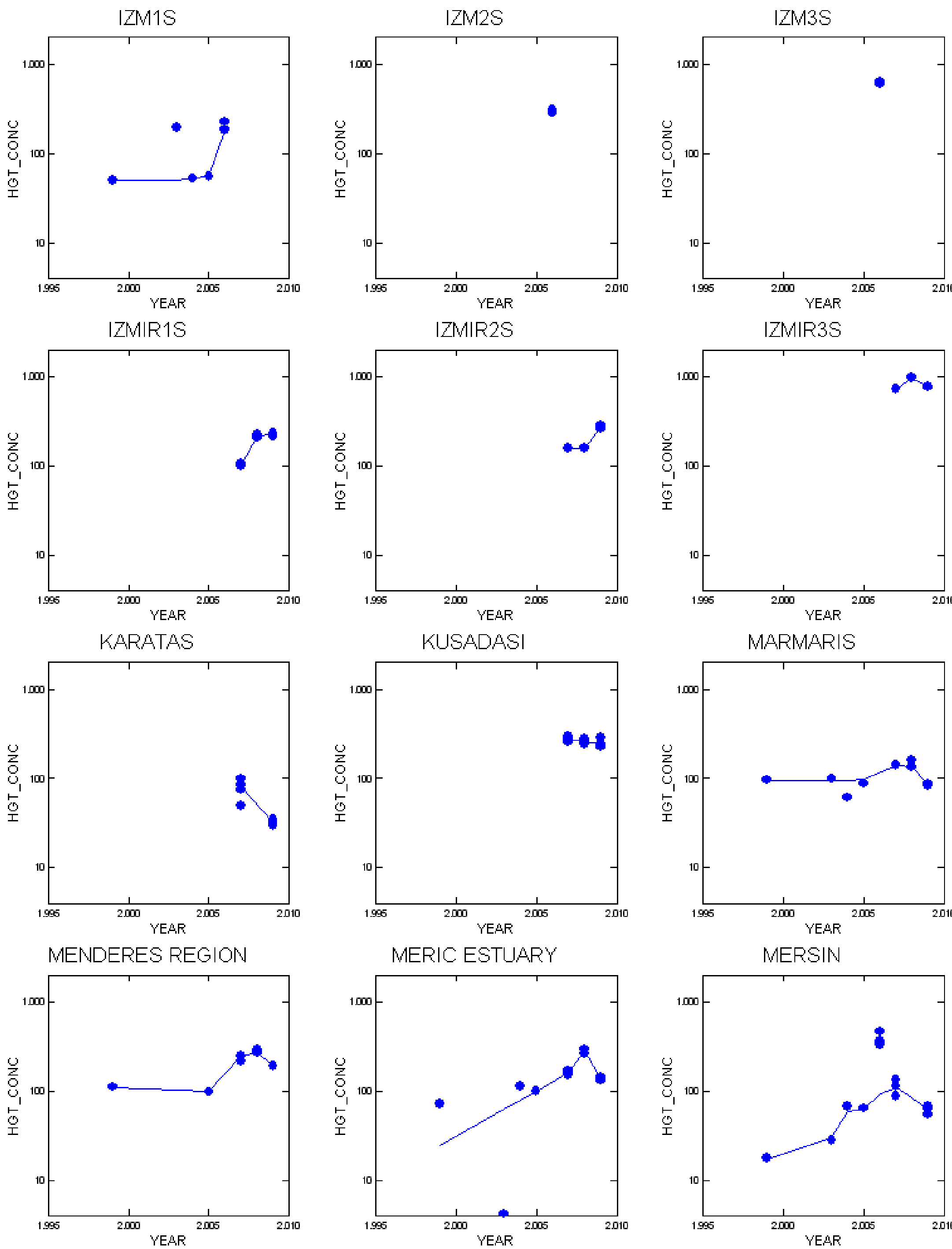
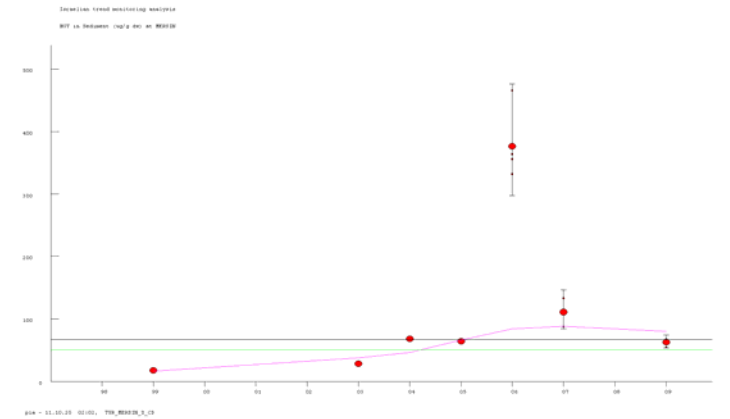


Figure Tur.6. Continued.



The data series show no significant log-linear trend.

Trend statistics:
Slope = 20% (-7.1, 47)
SD(lr)= .82, 87%, 33 yr
Power = .06/.07/39%
y(09) = 155(38, 627)
r2 = .42, p < .116
tau = .43, p < .176
SD(sm)= .74, p < .078

Figure Tur.8. Trend evaluation results (from PIA suite) of total mercury mass fraction at Mersin station in Turkey coastal waters

3. All countries evaluation of data

It is very important to understand what is the state of pollution at the Mediterranean level primarily from the view of the implementation of the Barcelona convention. Data for TM mass fraction in biota was aggregated and for the ones (cadmium and total mercury) suggested on the Mediterranean scale and on the basis of the past MED POL monitoring data for measurement in temporal trend monitoring programmes, adapted for comparison. All data were checked and outliers eliminated. In this evaluation a very simple approach was used. Box and Whisker graphs are ideal as they show us also the additional information on the data variance. Data were normalised (log transformed) and only 2005-2006 data used as those two years are the last when we had data for all the evaluated countries. The last acquired data 2007-2009 is not so homogenous as many countries has not provided data of the same quality (details in evaluation by country). This indicate that the data for 2005-2006 for the moment give as the best overall picture of the contamination levels at the Mediterranean level.

On Fig. Med.1 data for cadmium and total mercury mass fraction are presented by sampled organism and country. Data for copper, chromium, iron and zinc are presented in Fig.2 and will not be discussed because they need additional validation.

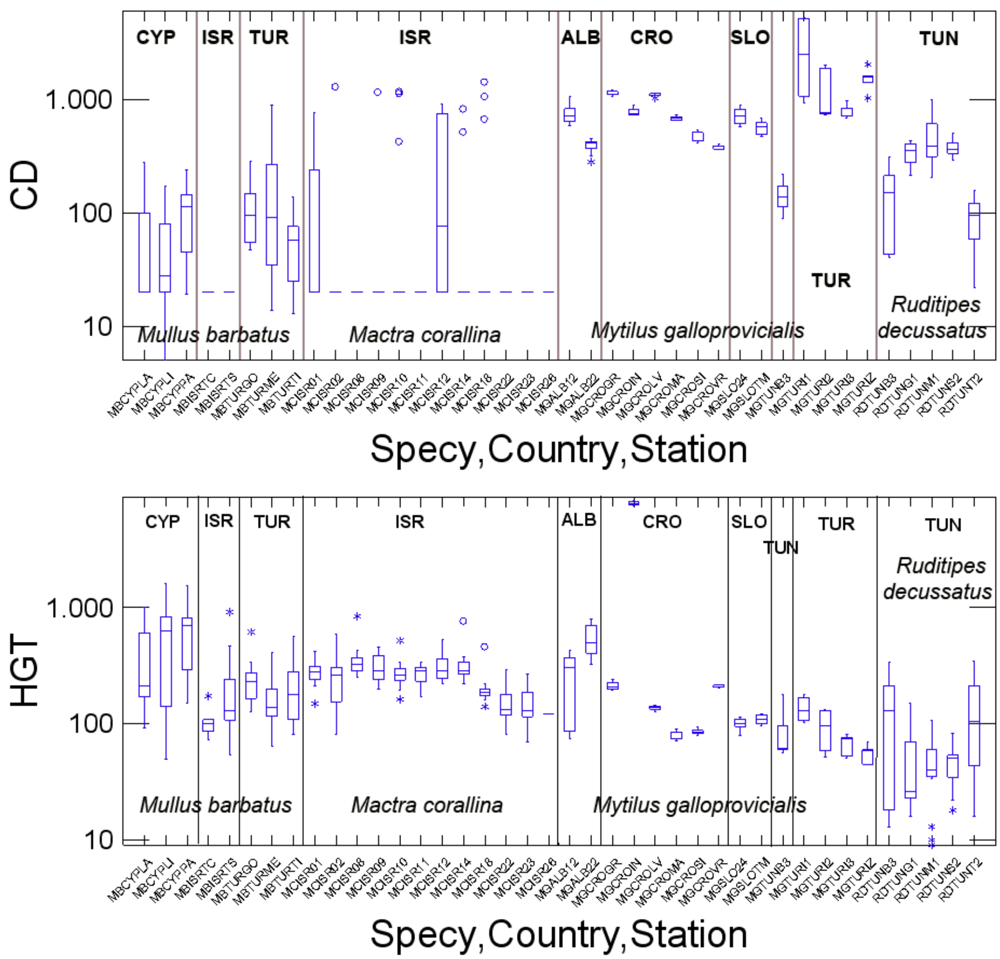


Figure Med.1. Box and Whisker plot for cadmium (CD) and total mercury (HGT) mass fraction by species, country and station for the period 2005-2006.

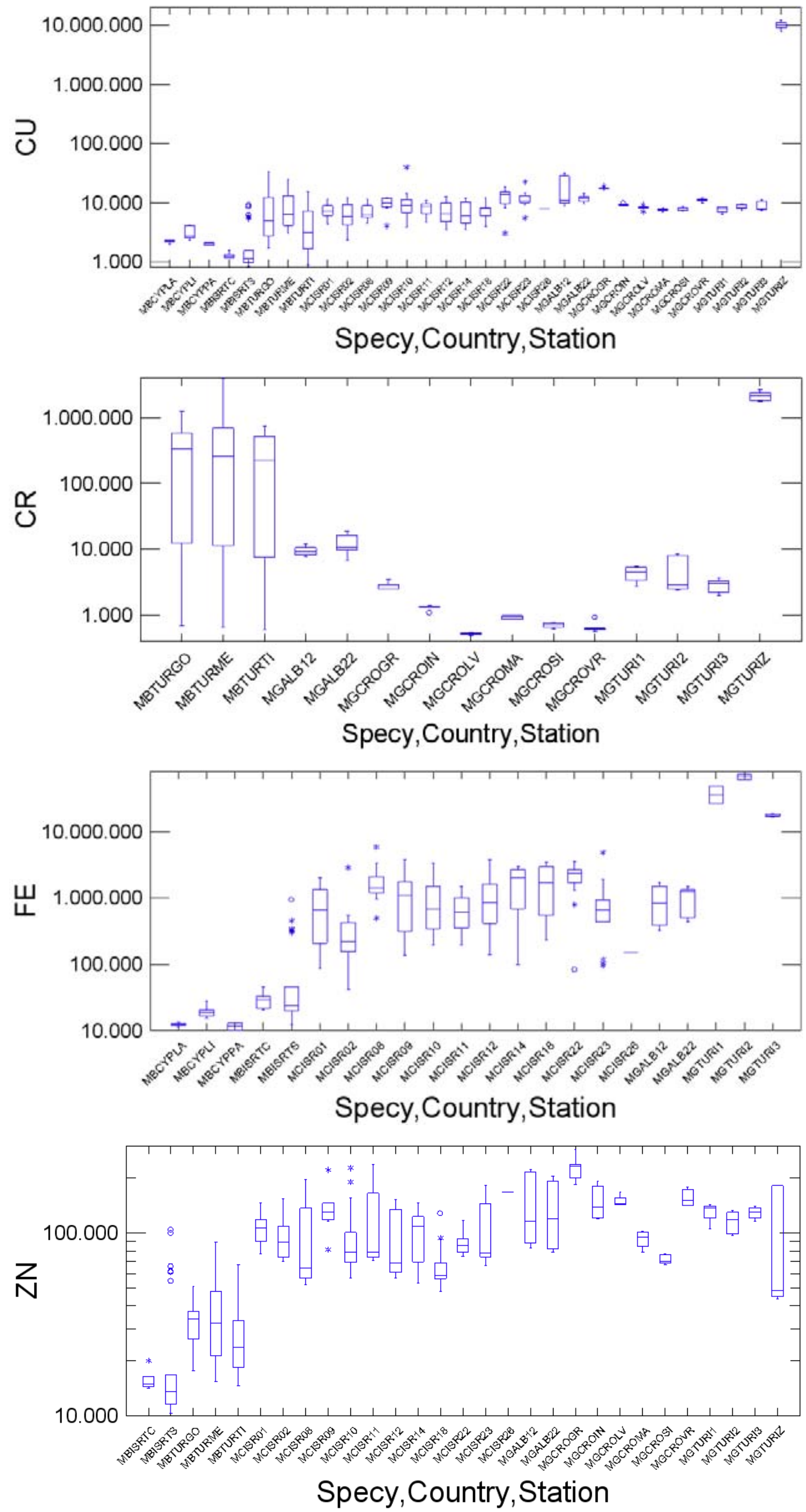


Figure Med.2. Box and Whisker plot for copper (CU), chromium (CR), iron (FE) and zinc (ZN) mass fraction by species, country and station for the period 2005-2006. Note: This is an output from exploratory statistics and need additional data validation.

The data for both CD and HGT(Fig.Med.1) show different level of accumulation by sampled organisms. For CD the levels in *Mullus barbatus* were of near one order of magnitude lower than in mollusc (*Mactra corallina*, *Mytilus galloprovincialis*, *Ruditipes decussatus*) showing us what can be the first choice organism for long trend monitoring. The levels of CD in *Mullus barbatus* are similar for Cyprus and Turkey samples as are the levels in *Mytilus galloprovincialis* for Adriatic countries (Albania, Croatia and Slovenia). The values observed in Tunisia (*Ruditipes decussatus*) are intermediate to the *Mullus* and *Mytillus* ones. The lowest values were observed for Israel, both for *Mullus* and *Mactra*, where most of the values were below the detection limit. The highest values were measured in Mytilus galloprovincialis from Izmir bay clearly indicating a hot spot. On the other hand, values for most of the countries show us that are mainly naturally occurring values or representing processes at a wider scale.

The levels for HGT mass fraction don't show such clear patterns of accumulation as for CD. The highest values were observed for Cyprus (*Mullus barbatus*), although even for Turkey and Israel the levels are higher, showing the different levels between eastern Mediterranean and the rest. The Israel case is clear as it is partialy related to the chloralkaly plant in Haifa, the area most of the samples are coming from (Herut *et al*., 1995). The highest values, for *Mytilus galloprovincialis*, were observed in Albania. The values for other countries were in the same range with something lower ones for Tunisia. The highest value, one order of magnitude higher than the rest, was observed in Kaštela Bay (Croatia) very close to a mercury contaminated area from a chloralkaly plant (Kljaković-Gaspić, Z. *et al.*, 2006). This site need further investigation in order to understand if this shift is related to a remobilisation of contaminated sediments, the source of contamination is dismissed in 1990, or to methodological problems as change of the sampling location.

The data for every location were compared for underlying trends (Table Med.1). In general for trace metals mass fraction in biota significant downward trend for cadmium and total mercury mass fraction was identified only for Tunisia. In Israel few non linear trend were identified for cadmium. Both trend are consistent (Table Med.1) and need further investigation. The upward trend for total mercury observed for Israel during the previous elaboration was nor confirmed.

Table Med 1. Evaluated trends by country, sampled organism and station for cadmium and total mercury mass fraction. Evaluation performed with PIA statistical suite.

Station	Species	Tissue	Contam.	N	First year	Last year	Years with data	Detected trend	Type of trend	Slope (%)	r^2	p	tau	p	SD(sm)	p	Power for 10 a (%)	Trend after 10 a (%)
Albania																		
C1.2	MG	WST	HgT	18	2004	2007	4	YES	UP	30	0,93	<0,042	1,00	<0,042	-	-	88	5,2
			Cd	18				NO	-	35	0,42	<0,356	0,67	<0,174	-	-	9	30
C2.2			HgT	18	2004	2007	4	NO	-	8,5	0,34	<0,420	0,33	<0,497	-	-	54	7,9
			Cd	18				NO	-	12	0,29	<0,458	0,33	<0,497	-	-	25	13
Croatia																		
GR	MG	WST	HgT	21	2001	2009	7	D.D.										
			Cd	23				D.D.										
IN			HgT	27	2001	2009	7	D.D.										
			Cd	29				D.D.										
LV			HgT	26	2001	2009	6	D.D.										
			Cd	26			7	D.D.										
MA			HgT	27	2001	2009	7	D.D.										
			Cd	26				D.D.										
SI			HgT	27	2001	2009	7	D.D.										
			Cd	28				D.D.										
VR			HgT	27	2001	2009	7	D.D.										
			Cd	29				D.D.										
Cyprus																		
Larnaca	MB	FI	HgT	17	2005	2007	3	D.D.										
			Cd	17				D.D.										
Limassol			HgT	17	2005	2007	3	D.D.										
			Cd	17				D.D.										
Paphos			HgT	17	2005	2007	3	D.D.										
			Cd	17				D.D.										
Israel																		
Trawl_N	MB	FI	HgT	175	1999	2009	8	NO	-	12	0,29	<0,168	0,36	<0,216	0,73	<0,259	7,9	35
			Cd	166			8	YES	DOWN	-3,9	0,33	<0,134	-0,57	<0,048	0,19	<0,0,127	43	9,1
Trawl_S			HgT	225	1999	2009	11	NO	-	11	0,10	<0,351	0,16	<0,484	1,1	<0,194	6	62
			Cd	212			11	NO	-	-3,4	0,23	<0,137	-0,29	<0,219	0,23	<0,578	41	9,3
ISRTMH2	MC	WST	HgT	25	1999	2009	6	YES	NON LIN	0,7	0,01	<0,862	-0,07	<0,851	0,31	<0,001	19	15
			Cd	37			7	YES	NON LIN	6,2	0,05	<0,628	-0,10	<0,758	0,97	<0,046	6	54

Station	Species	Tissue	Contam.	N	First year	Last year	Years with data	Detected trend	Type of trend	Slope (%)	r^2	p	tau	p	SD(sm)	p	Power for 10 a (%)	Trend after 10 a (%)
ISRTMH8	MC	WST	HgT	68	2001	2009	8	NO	-	0,8	0,00	<0,858	-0,14	<0,621	0,37	<0,121	16	17
			Cd	75	1999	2009	9	YES	NON LIN	-13	0,43	<0,056	-0,35	<0,185	0,37	**<0,017**	10	26
ISRTMH9			HgT	46	2001	2009	8	NO	-	-0,8	0,00	<0,861	0,14	<0,621	0,35	<0,175	17	17
			Cd	75	1999	2009	9	YES	NON LIN	-13	0,43	<0,056	-0,35	<0,185	0,37	**<0,017**	10	26
ISRTMH10			HgT	19	2001	2007	4	D.D.	-	-	-	-	-	-	-	-	-	-
			Cd	25	1999	2007	6	YES	DOWN	-35	0,41	<0,169	-0,75	<0,036	1,3	NS	6	73
ISRTMH12			HgT	44	2001	2009	8	YES	UP	11	0,56	**<0,032**	0,64	**<0,026**	0,29	<0,305	26	13
			Cd	43	1999	2009	7	YES	NON LIN	-8,0	0,56	<0,053	-0,62	<0,052	0,24	**<0,009**	24	13
ISRTMC14			HgT	44	2001	2008	8	NO	-	7,2	0,33	<0,133	0,36	<0,216	0,29	NS	30	12
			Cd	52	1999	2008	10	NO	-	-14	0,35	<0,068	-0,45	<0,068	0,52	<0,133	10	27
ISRTMC18			HgT	43	1999	2008	9	NO	-	19	0,43	<0,053	0,39	<0,144	0,55	<0,066	8	32
			Cd	46	1999	2008	9	YES	NON LIN	-14	0,40	<0,066	-0,30	<0,253	0,36	**<0,023**	11	24
ISRTMC22			HgT	33	2001	2008	7	NO	-	17	0,57	**<0,048**	0,52	<0,099	0,40	<0,110	16	18
			Cd	43	1999	2008	7	NO	-	-14	0,43	<0,109	-0,06	<0,859	0,52	<0,063	10	27
ISRTMC23			HgT	18	2001	2007	4	NO	-	5,1	0,15	<0,611	0,33	<0,497	-	-	16	17
			Cd	23	1999	2007	5	NO	-	-10	0,56	<0,146	-0,36	<0,380	-	-		
Morocco																		
S1	MG	WST	HgT	36	1999	2006	8	NO	-	-32	0,58	**<0,028**	-0,50	<0,083	0,67	<0,148	8,1	34
			Cd	36				YES	DOWN	-16	0,36	**<0,018**	-0,64	**<0,026**	0,33	<0,581	23	14
Slovenia																		
24	MG	WST	HgT	36	1999	2009	11	NO	-	0,8	0,02	<0,706	0,05	<0,815	0,23	<0,792	43	9,1
			Cd	36				NO	-	-2,3	0,12	<0,290	-0,33	<0,157	0,23	<0,695	43	9,2
TM			HgT	38	1999	2009	11	NO	-	-2,8	0,10	<0,358	-0,13	<0,586	0,33	NS	25	13
			Cd	34				YES	NON LIN	-2,0	0,06	<0,478	-0,20	<0,392	0,20	**<0,02**	27	12
Tunisia																		
B3	MG	WST	HgT	18	2001	2008	8	YES	DOWN	-34	0,90	**<0,001**	0,79	<0,006	0,29	<0,165	24	13
			Cd	20				YES	DOWN	-27	0,89	**<0,001**	0,93	**<0,001**	0,26	<0,454	33	11
B3	RD	WST	HgT	20	2001	2009	9	YES	DOWN	-28	0,52	**<0,027**	-0,59	**<0,026**	0,84	<0,719	7,6	37
			Cd	20				YES	DOWN	-29	0,80	**<0,001**	-0,76	**<0,004**	0,45	<0,648	14	19
G1			HgT	19	2001	2009	9	YES	DOWN	-33	0,81	**<0,001**	-0,83	**<0,002**	0,42	<0,131	12	21
			Cd	19				NO	-	4,0	0,12	<0,356	0,17	<0,532	0,25	<0,072	24	13
M1			HgT	18	2001	2009	9	YES	DOWN	-34	0,69	**<0,011**	-0,62	**<0,032**	0,64	NS	9,6	27
			Cd	18				NO	-	5,8	0,07	<0,522	0,07	<0,805	0,60	<0,362	9,7	27
S2			HgT	19	2001	2009	9	YES	DOWN	-21	0,80	**<0,001**	-0,61	**<0,022**	0,32	<0,610	24	13
			Cd	21				NO	-	4,7	0,24	<0,181	0,39	<0,144	0,26	<0,634	34	11
T2			HgT	21	2001	2009	9	YES	DOWN	-30	0,57	**<0,018**	-0,54	**<0,045**	0,77	<0,402	7,8	36
			Cd	21				YES	DOWN	-33	0,85	**<0,001**	-0,87	**<0,001**	0,40	<0,301	15	18

Station	Species	Tissue	Contam.	N	First year	Last year	Years with data	Detected trend	Type of trend	Slope (%)	r^2	p	tau	p	SD(sm)	p	Power for 10 a (%)	Trend after 10 a (%)
Turkey																		
Goksu	MB	FI	HgT	87	1999	2009	11	NO	-	17	0,26	<0,109	0,38	<0,102	1,0	<0,368	6,5	50
			Cd	87				NO	-	3,4	0,02	<0,709	0,09	<0,697	0,85	<0,188	6,8	45
Mersin			HgT	96	1999	2009	11	NO	-	17	0,41	**<0,034**	0,38	<0,102	0,65	<0,172	8,1	34
			Cd	96				NO	-	-4,8	0,03	<0,616	0,09	<0,697	1,0	<0,763	6,7	47
Tirtar			HgT	80	1999	2009	11	NO	-	17	0,51	**<0,014**	0,42	<0,073	0,61	<0,557	9,9	27
			Cd	80				NO	-	0,7	0,00	<0,904	0,02	<0,938	0,90	<0,122	6,4	52
Izmir1B	MG	WST	HgT	63	2000	2009	10	NO	-	15	0,38	<0,099	0,43	<0,138	0,68	NS	9,1	29
			Cd	63				NO	-	32	0,52	**<0,043**	0,36	<0,216	1,0	<0,201	6,4	52

D.D- data discontinued; NON LIN – nonlinear trend; NS – not signficant

r^2 = reports the coefficient of determination (r^2) together with a p-value for a two-sided test (H_0: slope = 0), i.e., a significant value is interpreted as a true change, provided that the assumptions of the regression analysis are fulfilled.

tau = reports Kendall's 'tau', and the corresponding p-value for this non-parametric trend test.

SD(sm) = reports the square root of the residual variance around the smoothed line. The significance of this line could be tested by means of an Analysis of Variance. The p-value is reported for this test. A significant result will indicate a (significant) non-linear trend component.

4. General remarks

In order to understand the quality of the underlying data and to qualify trend monitoring as a valuable tool in the management of pollution some general remarks has to be stated.

1) the database and supplied data used in this evaluation needs further validation. Many short-ends emerged that partially influenced the outputs also of this evaluation. For the purpose of this evaluation data were partially corrected, although still some doubtful data exists.
2) few sources of error during data supply were identified:
   a. erroneous data supply – mainly connected with wrong measurement units
   b. partial handling of below data limit mark – usually declared but missing the value.
3) Change of sampling strategy could introduce additional variance to the data – change of location, not identified prespawning period, sampling in different months.

Organic pollutants

Organic pollutants represent a part of the parameters used for trend monitoring. The choice of the organic contaminants to be monitored is according to the needs of the country monitoring programme. It is location dependent and depend upon whether there is a past or present input of sufficient scale.

Regarding the problems found during this evaluation and due to the number of variables (parameters) for organic pollutants it is difficult to evaluate the trends mainly because of the data quality in the database. The dataset quality has to be investigated and identified the main problems related to the data transfer and handling. One big limit at this moment is for sure the handling of values Below the Detection Limit and their correct values in the database. From preliminary screening a considerable number of data are close to this values.

Sediments

In accordance with the recommendations of the second review meeting of MED POL-Phase III monitoring activities held in 2003, an expert meeting to revise the strategy for trend monitoring of pollutants in coastal water sediments was organized during April 2005. On the trace of the meeting during 2006 a revised manual was accepted (Methods for sediment sampling and analysis, UNEP(DEC)/MED WG.282/Inf.5/Rev.1).

In order to analyse the data for trend monitoring of contaminants in sediments we need at list the first three years of data with the revised methodology to be in the data base and then with the older data compared and were data quality will permit trend evaluation performed. To handle the data after the revised methodology the data form for the transfer to the database has to be revised.

5. Conclusions

The performed trend evaluation showed that the trend monitoring of trace metals in biota can be used for the assessment of a change with time in the environmental levels of chemical contaminants. That particularly emerged when from the use of the new statistical suite that address the trend power in an better way. Thus trend monitoring can be an important tool for the assessment of the effectiveness of control measures taken at the pollution hot spots and also for the assessment of state of marine environment.

Even substantially improved after the last trend data evaluation in 2009, some problems were identified mainly dealing with the lack of maintaining the declared sampling strategy. The weakest part of the programme is steel the data transfer and manipulation. To overcome these problems, involved 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 to successfully maintain the programme over time (positioning, sampling, methods, and data elaboration, exchange and presentation).

From the last evaluation: from the trend monitoring point of view the best sampling strategy always leads with attaining the best information on the sampling variance and with that a valuable determination of the underlying trend. Keeping that in mind it is good to avoid pooling whenever 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 a use from 15 to 25 (preferred) samples is suggested if the underlying variances are not know. The sample 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 (PIA) is a computer program for analysing trends in time-series datasets by applying a standard statistical analysis that has been adopted by the Arctic Monitoring and Assessment Programme (AMAP) for use in its temporal trend assessment activities. PIA© was developed by Anders Bignert (anders.bignert@nrm.se).

6. References

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