Mediterranean GIG
Section 3 – PHYTOPLANKTON

JUNE 15, 2007 -VERSION

3.1 Intercalibration approach

Participation of countries in the Phytoplankton subgroup:

Cyprus
France
Greece
Italy
Slovenia
Spain (Valencia, Catalonia, Balearic Islands)
+ Croatia (Accession Country)

Data availability

The examination of the datasets provided by each MED-GIG Member States highlighted a huge data heterogeneity, mainly due to different monitoring schemes. Table 1 summarized the main features of the datasets, highlighting the availability of key features (sites, parameters, vertical profile and amount of data) needed for the typological identification of water bodies.

MS	N° Sites	N° Records	Period	Freq (d)	Profile	Temp Sal data
France	8	1250	1997-2006	7	not available	available
Italy	11	2541	2001-2004	15	available	available
Slovenia	2	332	1997-2004	30	available	available
Cyprus	48	158	2005	60	not available	not available
Spain	117	1109	1991-2006	regional	available	available
Croatia	19	1784	2000-2004	120	not available	available
Greece	5	1225	2000-2004	30	available	available

Data used are referred to Chl *a* concentrations measured in "coastal waters", as defined in the Directive: *"within the 1 nautical mile distance from the coastline",*
A common decision is to recommend the use of nearshore data only (500-1500 m from the coast), (while for the IC all "coastal" data have been considered, as reported above), when not differently advised by MS[1].

Typology

Phytoplankton experts defined that the 4 Mediterranean Coastal IC types, (see Section 1 General Part), based primarily on the substratum composition and the depth profile, cannot be applied to the

[1] NOTE from Spain: From 90s in Spain there has been an important effort to sample Chl-*a* stations located at inshore (over the line coast). In the main of cases these data are the base of the methods used along the country and the base of the part of the results Spain shares in this intercalibration exercise. Although no other MSs work with this kind of data, it is important to stress that all the reference conditions and boundaries proposed in this intercalibration exercise are referring to the nearshore.

IC for the current BQE, within the Mediterranean basin: the classification criterion is based mainly on the morphological features of the bottom and therefore it is not so meaningful in a "phytoplankton perspective".
A new typology has been developed, mainly focused on hydrological parameters characterizing water bodies' dynamics and circulation. The typological approach is based on the introduction of the static stability parameter (derived from temperature and salinity values in the water column): such a parameter, having a robust numerical basis, can describe the dynamic behaviour of a coastal system. The group agreed then to adopt surface density as a proxy indicator for static stability as both Temperature and Salinity are relevant in the dynamic behavior of a coastal marine system: both are involved in circulation and mixing dynamics and all information is then nested in the surface density parameter (Russo et al., 2006, submitted).

On the basis of surface (density (σ t) values three major water types have been defined:

	Type I	Type II	Type III
σ t (density) (kg m^{-3})	<25	25<d<27	>27

The same three water types are defined below as salinity classes, since for Spain (Catalonia) variability due to seasonal fluctuation is marginal: using relationships between density and salinity, Spain calculated the following table (at 18°C)

	Type I	Type II	Type III
Annual Mean Salinity (psu)	<34.5	34.5<d<37.5	>37.5

This type subdivision based only on salinity, is perfectly comparable with the previous ones, based on density, agreed by the rest of Mediterranean MSs. For more details about the use of salinity instead of density see the Annex: Spain MS report on phytoplankton element.

The three different water types, in an ecological perspective, can be described as follows:
Type 1 coastal sites highly influenced by freshwater inputs
Type 2 coastal sites not directly affected by freshwater inputs
Type 3 coastal sites not affected by freshwater inputs

A further distinction has been suggested and approved by the MSs, regarding the splitting of the coastal water type 3 in two different sub basins, the Western and the Eastern Mediterranean one, according to the different trophic conditions: [2]
Type 3 WM
Type 3 EM

[2] The Levantine Basin of eastern Mediterranean is characterized as nutrient-deficient and therefore ultra-oligotrophic in comparison to the Atlantic Ocean (Berman et al., 1984). Furthermore, eastern Mediterranean is more P-limiting to the growth of phytoplankton, in contrast to the general dogma that N is the more limiting nutrient in marine systems (Krom et al., 1991). Recent studies made on phytoplankton biomass in the deeper waters of eastern Mediterranean reveal that prevailing oligotrophic conditions result in low chlorophyll-a concentrations ranging from 0.1 to 0.2 μg L^{-1} (Krom et al., 1992). It has also been shown that chlorophyll-a concentrations off the coast of Cyprus are among the lowest in the region and ranged from 10 to 90 ng L^{-1} (Bianchi et al., 1996). Recent studies along the coastal waters of Cyprus confirmed its oligotrophic status (Argyrou, 2005, 2006).

The coastal waters of Cyprus are classified as Type III (no freshwater input – density greater of 27), due to their hydrographical features and the prevailed physicochemical characteristics; in fact mean salinity of coastal waters of Cyprus is 39,1 psu. The annual mean of Chl a for the years 2004 to 2006 ranged from 0,07 to 0,11 μg L^{-1} while, the calculated 90th Percentile ranged from 0,09 to 0,2 respectively. The overall average level of Chl a for the entire period, 2004 to 2006, was 0,086 and the respective 90th Percentile was 0.188. These values were used for the assessment of the ecological status of the coastal waters of Cyprus according to the Eutrophication Scale, which was developed by Ignatiades et al. (1992) and Karydis (1999), and further modified by Siokou & Pagou, 2000; Pagou, 2000) based on nutrient and phytoplankton data collected from several coastal and marine areas from Greece.

Furthermore, Spain proposed the subdivision of type II, which include marine waters with intermediate salinities) in two subtypes: type II-A and type II-B [3].
Types presence in the different MSs was reviewed, and finally defined, as shown in the following **Table 1**

1.1.1.1.1.1 Types description			France	Spain	taly	Slovenia	Croatia	Greece	Cyprus
Type I		Highly influenced by freshwater input	**X**		**X**				
Type II	A	Moderately influenced by freshwater input (continent influence)	**X**	**X**	**X**	**X**			
	B	Influenced by Atlantic waters		**X**					
Type III	W	Not influenced by freshwater input	**X**	**X**	**X**		**X**		
	E	Not influenced by freshwater input						**X**	**X**

Based on this new Typology and on the available data for the different types in the Member States, Intercalibration was performed as follows:

for **Type I** France is not able at the moment to provide enough data to be compared with the Italian data; therefore no Intercalibration is performed for this typology at the present phase

for **Type II** Spain had to make distinction within the same type (as specified below (3)). As this subdivision is not found in the other Mediterranean MS, IC performed on Type II does not include the Spanish Type II B (influenced by Atlantic waters)

for **Type III** the distinction between Type III Western Mediterranean and Type III Eastern Mediterranean was already agreed for evident ecological differences within the 2 Mediterranean basins. Only Greece and Cyprus belong to the Eastern Mediterranean basin, therefore Type III E Intercalibration was performed only between these 2 countries

3.2 National methods that were intercalibrated

Since we did not elaborate a methodology based on a common data set, which would be then adopted at national level of each MS, we compared boundaries (Chl-*a* concentrations and EQRs) derived from national methods having different status at present (under development, finalized,

[3] The South of Spain (the main part of Andalusian coast) is clearly affected by the influence of the Atlantic waters, so the natural salinity, nutrients and Chl-*a* concentrations do not correspond with type III. Moreover the lower salinities of before defined type II were explained by freshwater inputs, coming mainly from the continent. It should be emphasized that in the vicinities of Gibraltar Strait there are also lower salinities that come from the Atlantic, and that is why this subdivision in Type II-A (the original one) and Type II-B (affected by atlantic influence) was proposed by Spain. For more details consult the *Annex: Spain MS report on phytoplanckton element.* It should be also considered the relationship between the reference conditions and boundaries defined by the NEA GIG for the atlantic waters in the western part of the Gibraltar Strait.

officially accepted). Available methodologies descriptions are detailed or cited in the Annex 1: National methods included in the intercalibration.

Only one parameter of the BQE phytoplankton was considered for this phase of the Intercalibration process: Chlorophyll *a* concentration as parameter/indicator for biomass.
Common statistical analysis on Chl-*a*, nutrients and physico-chemical data, and some multivariate techniques have been performed in order to facilitate the reaching of a wide agreement for the intercalibration process. Since a methodology based on a common data set, which would be then adopted at national level of each MS, was not elaborated, different metrics of this parameter and different statistical approaches for setting the boundaries (derived from national methods, where defined) were analysed and compared. Boundaries are in terms of Chl-*a* concentrations and EQRs that have different status of implementation/finalization, at present in the Mediterranean Member State (see Table below). Different metrics of this parameter and different statistical approaches for setting the boundaries were compared.
The finally agreed approach that has been followed for the intercalibration, is an the hybrid option, as described in the Intercalibration Guidance as follows:
"Boundary values are first established with national classification assessment methods (as in Option 3). The subsequent comparison of the boundary values could then be done with the help of a common metrics method (as in Option 2)."

National methods adopted, mostly, three kinds of metrics: percentile90th, annual geometric mean (geomean) and average. Depending on the MS the metrics were calculated using only surface data or water-column integrated data, covering different period (e.g. one year in case of geomean and 5 to 6 years when using percentile 90th. The metrics used by MSs are shown in the table below.

Table 2

MS	**Percentile90th**	**Average** (A-arithmetic, G-geometric**)**	**Based on** :Raw data (R)/Geomean (G)
France	X		R
Spain	X	A	R
Italy	X		G
Slovenia		G	R
Greece	X	A	
Cyprus	X	A	

3.3 Reference conditions and class boundary setting

For the 3 intercalibrated types every MS defined reference conditions, boundaries and EQRs applying their own methodologies. These methodologies are detailed or cited in the Annex 1.
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Reference conditions

Reference conditions will be different according to different water types.
Each MS proposed its own reference conditions based on their phytoplankton experts' knowledge. All of them based their calculations of reference conditions by selecting High status stations from their monitoring programmes. For more details of the methods see Annex 1: National MSs reports on phytoplankton element.
Type-specific reference conditions, as suggested by MSs, are listed in table 3, below.

Table 3. Type-specific Reference conditions, expressed as surface Chl *a* concentration (μg /L)

RC	Type II-A	Type III WM	Type III EM	Metric
France	<2	<1	*	Percentile90th
Spain	1.9	1.10	*	Percentile90th
Spain	0.98	0.46	*	Average
Italy	0.77	0.4	*	Percentile 90th (Geomean)
Slovenia	0.99	*	*	Annual (geomean)
Greece	*	*	0.08	Annual average
Cyprus	*	*	0.08	Annual average

* Not applicable

Setting of Boundaries

In the following table the MSs boundary, as chl *a* concentration, (μg /L), for each water type are listed:

		Reference	H/G	*EQR H/G*	G/M	*EQR G/M*	*Metric*	
T1	France						Percentile 90th	TRUE VALUES
	Italy	1,8	2,4	*0,75*	3,5	*0,51*	Geometric mean	
T2 - A	France	<2	2		4		Percentile 90th	TRUE VALUES
	Spain	1,9	2,3	*0,83*	3,5	*0,54*	Percentile 90th	
	Spain	0,98	1,15	*0,85*	1,72	*0,57*	Mean	
	Italy	0,77	1	*0,77*	1,24	*0,62*	Geométric mean	
	Slovenia	0,99	1,28	*0,78*	1,62	*0,61*	Geometric mean	
T3 – Western Med	France	<1	1		2		Percentile 90th	TRUE VALUES
	Spain	1,1	1,3	*0,85*	1,8	*0,61*	Percentile 90th	
	Spain	0,46	0,54	*0,85*	0,7	*0,66*	Mean	
	Italy	0,4	0,51	*0,78*	0,64	*0,63*	Geométric mean	
T3 – Eastern Med	Cyprus	0,08	0,1	*0,8*	0,4	*0,2*	Percentile 90th	
	Greece	0,08	0,1	*0,8*	0,4	*0,2*	Percentile 90th	

3.4 Results of the comparison and Harmonization:

Phytoplankton experts from MSs decided to adopt a final agreement based on 90th percentile on raw data and, at least, monthly sampling frequency. In order to make MSs values more comparable Slovenia and Italy decided to translate their own values in new boundaries calculated using the same metric as the other MSs (90th percentile). For details on MS calculations see Annex 1.

Using the same metric the proposed boundaries by each country were very similar, thus the group came to the agreement reported in the following paragraph.

Harmonisation of boundaries and EQR values

The boundary values are expressed for the metric 90th percentile, assuming that at least 5years data are available, with monthly sampling, in the surface layer.

Type I: not intercalibrated, only Italy has enough data

Type II

Type	MS	REFERENCE	H/G	EQR	G/M	EQR
T2 - A	Slovenia France Spain Italy	1.9	2.4	*0.80*	3.6	*0.53*

Type III

Type	MS	REFERENCE	H/G	EQR	G/M	EQR
T3 – Western Med	France Spain Italy	0.9	1.1	*0.80*	1.8	*0.50*
T3 – Eastern Med	Cyprus Greece	0.08	0.1	*0.80*	0.40	*0.20*

3.6 Open issues and need for further work

A few suggestions have been pointed out by MS for an eventual further intercalibration activity:

1. Include species composition analysis or blooms frequency analysis for a better understanding of the system's behavior and efficiency/status
2. Improve dose/response analysis correlating pressures (nutrients) with trophic conditions

REFERENCES

Agència Catalana de l'Aigua (ACA), 2005. Caracterisation of surface water bodies and analysis of the risk of failing the objectives of the water framework directive (2000/60/CE) in the catalonian basins of the Ebro, the Garona and the Senia, and revision of the internal basins of Catalonia. IMPRESS document. Departament de Medi Ambient i Habitatge. (http://mediambient.gencat.net/aca/ca//planificacio/directiva/impress.jsp).

WFD CIS Guidance Document No. 14: Guidance on the intercalibration process 2004-2006

Harding Jr., L. W. & E. S. Perry.1997. Long-term increase of phytoplankton biomass in Chesapeake Bay, 1950-1994. Mar. Ecol. Prog. Ser., 157: 39-52.

Krom,D. M., N. Kress & S. Brenner. 1991. Phosphorus limitation of primary productivity in the eastern Mediterranean Sea. Limnol. Oceanogr., 36(3): 424-432.

Lipej L., P. Mozetič, M. Orlando Bonaca, B. Mavrič, M. Šiško & N. Bettoso. 2006. Evaluation of the Ecological Status of Coastal Waters in accordance with the European Water Framework Directive (Water Framework Directive, 2000/60/EC). Final national report. Marine Biology Station Piran, National Institute of Biology, October 2006, 180 pp. (in Slov.)

Mozetič, P., J. Francé, M. Šiško & O. Bajt. 2005. Spatial and temporal patterns of phytoplankton assemblages in a shallow coastal sea (Gulf of Trieste). In: Wassmann, P. & B. Ćosović (eds.): Eutrophication in the coastal zone of the eastern Adriatic Sea. South-eastern Europe Programme Symposium. April 27-May 1, 2005, Hvar, Croatia.

Vollenweider,R. A., A. Rinaldi & G. Montanari. 1992. Eutrophication, structure and dynamics of a marine coastal system: results of ten-year monitoring along the Emilia-Romagna coast (Northwest Adriatic Sea). Sci. Tot. Environ. [Vollenweider, R. A., R. Marchetti & R. Viviani (eds.)],. Suppl.: 63-106.

Wiltshire, K. H. & C. D. Durselen. 2004. Revision and quality analyses of the Helgoland Reede long-term phytoplankton data archive. Helogol. Mar. Res., 58(4): 252-268.

Argyrou, M. 2005. Report of the National Monitoring Programme of Cyprus for the Year 2004. Programme for the Assessment and Control of Pollution in the Mediterranean Region (MEDPOL /UNEP). Department of Fisheries and Marine Research, pp. 32.

Argyrou, M. 2006. Report of the National Monitoring Programme of Cyprus for the Year 2005. Programme for the Assessment and Control of Pollution in the Mediterranean Region (MEDPOL /UNEP). Department of Fisheries and Marine Research, pp. 41.

Berman, T., D.W. Townsend, S.Z. El-Sayed, G.C. Trees and Y. Azov. 1984. Optical transparency, chlorophyll and primary productivity in the Eastern Mediterranean near the Israeli Coast. Oceanol. Acta, 7: 367-372.

Bianchi, T.S., A. Demetropoulos, M. Hadjichristophorou, M. Argyrou, M. Baskaran and C. Lambert. 1996. Plant Pigments as Biomarkers of Organic Matter Sources in Sediments and Coastal Waters of Cyprus (eastern Mediterranean). *Estuarine, Coastal and Shelf Science*, 42: 103-115.

Ignatiades, l., Vounatsou, P., Karydis, M. (1992). A possible method for evaluating oligotrophy and eutrophication based on nutrient concentration scales. *Mar. Poll. Bull*., 24: 238-243.

Krom, M.D., Kress, N., Brenner, S. Gordon, L.I. (1991). Phosphorus limitation of primary production in the eastern Mediterranean Sea. *Limnol. Oceanogr*., 36: 424-432.

Krom, M.D., S. Brenner, N. Kress, A. Neori and L.I. Gordon. 1992. Nutrient dynamics and new production in a warm-core eddy from the Eastern Mediterranean Sea. Deep-Sea Research, 39: 467-480.

Karydis, M. (1999). *Evaluation report on the eutrophication level in coastal greek areas*. Univ. of Aegean, Mytilini, February 1999 (in greek).

Pagou, K. (2000). *Assessment of the trophic conditions in the Inner Thermaikos Gulf.* Technical Report for the Ministry of Environment, Planning and Public Works, NCMR, Athens, December 2000, 11pp.

Siokou-Frangou, I. & Pagou, K. (2000). *Assessment of the trophic conditions and ecological status in the Inner Saronikos Gulf.* Technical Report for the Ministry of Environment, Planning and Public Works, NCMR, Athens, March 2000,43pp. (in greek and english edition).