Monitoring Specifications

Date: 2010-03-03

Phytoplankton

ARGE BLMP - Working Group for the North Sea and Baltic Sea Monitoring Programme

At the 34th North German Environmental Ministerial Meeting held on 17 April 1997, the competent departments of the German Federal Government and of the federal states of Hamburg, Mecklenburg-Vorpommern, Lower Saxony and Schleswig-Holstein agreed to establish a joint working group co-ordinating the monitoring of the marine environment of the North and Baltic Seas (ARGE BLMP Nord- und Ostsee).

Members of ARGE BLMP are:

- Federal Ministry of Food, Agriculture and Consumer Protection
- Federal Ministry of Transport, Building and Urban Development
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
- Federal Ministry of Education and Research
- Authority for Urban Development and Environment of the Free and Hanseatic City of Hamburg
- Mecklenburg-Vorpommern Ministry for Agriculture, the Environment and Consumer Protection
- Lower Saxony Ministry for the Environment and Climate Protection
- Schleswig-Holstein Ministry for Agriculture, the Environment and Rural Areas

The Monitoring Manual describes the current measuring programme implemented under BLMP. The monitoring requirements of the different EC Directives (Marine Strategy Framework Directive, Water Framework Directive, FFH, Birds Directive), marine protection conventions (OSPAR, HELCOM, Trilateral Monitoring and Assesment Program) and other bodies of regulations have been taken into account in the Manual. The Monitoring Manual is available free of charge on the BLMP website at www.blmp-online.de/Seiten/Monitoringhandbuch.htm

Editorial information

Issued by
Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Sekretariat Bund/Länder-Messprogramm für die Meeresumwelt von Nord- und Ostsee (BLMP)
Bernhard-Nocht-Straße 78
20359 Hamburg

www.blmp-online.de

1 General

1.1 Subject area

Biological Monitoring - Flora - Phytoplankton

1.2 Definition

The totality of all vegetable organisms suspended in water that display no or only minimal active movement, so that changes of position - in particular in a horizontal direction - occur exclusively or quite overwhelmingly due to water currents.

1.3 Competent authority/ies

Federal Government:	UBA, BfN, BSH, BfG
Hamburg:	BSU
Mecklenburg-Vorpommern:	LUNG
Lower Saxony:	NLPV NI, NLWKN
Schleswig-Holstein:	LLUR, LKN-SH

1.4 Working group

Ad Hoc Working Group on Nutrients and Plankton

2 Monitoring requirements

2.1 Necessity

MSFD [1]

Article 10 (Establishment of environmental targets)

Article 11 (Monitoring programmes)

Article 8(1) (Assessment)

Comments

Description of the biological communities associated with the predominant seabed and water column habitats. This would include information on phytoplankton and zooplankton communities, including the species, and seasonal and geographical variability.

Article 9 (Determination of good environmental status)

WFD [2]

Article 8(1)

Comments

Under the WFD, phytoplankton must be investigated as a quality element in the context of surveillance monitoring in transitional and coastal waters, at least every six months to be precise (Annex V, 1.3.4). In the context of operative monitoring, phytoplankton represents an important indicator for eutrophication effects.

SWD

Articles 1, 2, 7 and Annex

Comments

The water quality of the shellfish waters must be monitored in order to guarantee the high quality of the shelled animals used for human consumption (shellfish and gastropods). The parameters to be monitored are listed in the Annex of the Shellfish Waters Directive, e.g. saxitoxin. Attention should accordingly be paid to toxin-producing species of algae when phytoplankton is monitored.

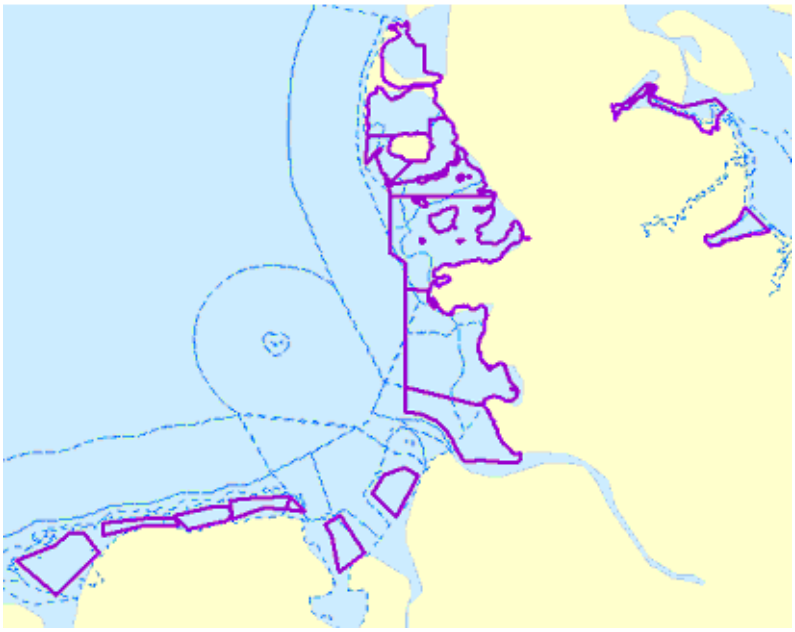

Figure 1: Shellfish waters in the North Sea and Baltic Sea (areas outlined in purple)

HELCOM

Baltic Sea Action Plan [3]

Comments

The Baltic Sea Action Plan, which is intended to ensure the Baltic Sea achieves a good ecological status by 2021, was adopted in November 2007. HELCOM will continue its long-standing activities identifying, monitoring and combating harmful influences on environmental quality in the Baltic Sea area.

See HELCOM Baltic Sea Action Plan

COMBINE

Comments

The main HELCOM monitoring activities are integrated under the COMBINE programme, which brings together the work done in the open sea and coastal waters. The COMBINE programme assesses the influence of the input of nutrients and other damaging substances on the ecosystem and identifies trends in the various compartments of the ecosystem, such as water, biota and sediment.

The German contribution to the monitoring of eutrophication and its effects: fixed sampling stations in the open sea, at which chlorophyll-a, species composition, the abundance of phytoplankton and biomass are investigated. A frequency of five times a year is specified for these investigations. In addition to this, it is recommended that further investigations be carried out with high frequencies (> 12 times a year).

Programme on Eutrophication and its Effects

Comments

Phytoplankton is regarded as one of the mandatory "core variables". It should be used to detect changes in biodiversity and the foodchain, as well as alterations in the population of primary producers. Particular attention should be devoted to immigrant species and toxic species.

OSPAR

JAMP Common Procedure

Comments

Procedure for the determination of the eutrophication status of the OSPAR marine region.

"7.5 For areas, including local areas located in wider non-problem areas, identified as problem or potential problem areas, a sufficient frequency and spatial coverage of all the parameters in the programme (chlorophyll a and indicator species) should be monitored and reported each year. For areas defined as non-problem areas, results relating to the monitoring of the assessment parameters listed in Category I should be reported once in 3 years." In this respect, levels of spatial and temporal resolution should be laid down specifically for each area. In the case of phytoplankton, the following indicator species should be investigated:

- Nuisance species: *Phaeocystis*, *Noctiluca*
- Potentially toxic species: *Chrysochromulina polylepis*, *Gymnodinium mikimotoi*, *Alexandrium* spp., *Dinophysis* spp., *Prorocentrum* spp.

Monitoring frequencies for the purposes of assessment under the OSPAR Common Procedure:

Problem areas und potential problem areas:	Each year
Non problem areas:	Every three years

TMAP [4]

Wadden Sea Plan (Stade Declaration, 1997)

Comments

The "Common Package" takes the following parameters for phytoplankton into consideration:

- Species composition, abundances of dominant and selected species according to the OSPAR-JAMP Eutrophication monitoring guidelines: phytoplankton species composition,
- Biomass measured by chlorophyll a (JAMP Guidelines)

The investigations are required for the description of eutrophication status.

2.2 Environmental targets

MSFD

Article 1: 'This Directive establishes a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest.'

It is still necessary for environmental targets to be assessed and specified.

WFD

Good ecological status is defined as follows for transitional and coastal waters (see WFD, Annex V, 1.2.3 and 1.2.4):

1. Transitional waters:

'There are slight changes in the composition and abundance of phytoplanktonic taxa.'

2. Coastal waters:

'The composition and abundance of phytoplanktonic taxa show slight signs of disturbance.'

Furthermore, the following targets are set for transitional and coastal waters:

'There are slight changes in biomass compared to type-specific conditions. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbance to the balance of organisms present in the water body or to the quality of the water.

A slight increase in the frequency and intensity of the type-specific planktonic blooms may occur.'

HELCOM

The aim of the Baltic Sea Action Plan is to ensure the Baltic Sea has a good ecological status by 2021. HELCOM will continue its long-standing monitoring programme for the identification and monitoring of environmental quality in the Baltic Sea area.

The main HELCOM monitoring activities are integrated under the COMBINE programme, which brings together the work done in the open sea and coastal waters.

The aim of COMBINE is to determine the extent and effects of anthropogenic inputs of nutrients on marine biota (Combine Manual-Eutrophication Programme). See also: HELCOM EcoQOs.

OSPAR

Eutrophication strategy and Common Procedure

Assessment of the eutrophication status of the marine environment:

'The overall ecological objective is to achieve by the year 2010 a healthy marine environment where eutrophication does not occur.'

Ecological Quality Objectives

Eutrophication status of the North Sea:

'All parts of the North Sea should have by 2010 the status of non-problem areas with regard to eutrophication, as assessed under the OSPAR Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area.'

The following ecological quality objectives have accordingly been set for phytoplankton:

1. Chlorophyll a - maximum and mean concentrations during the growing season should remain below a justified area-specific % deviation from the background not exceeding 50 %.

Apart from this, macrozoobenthos or fish should not be killed off as a result of eutrophication-related oxygen deficiency or toxic algae.

See also the specifications on Macrozoobenthos and the Ecological Quality Objectives (Annex 2).

In future, indicator species for eutrophication or maximum permissible abundances for nuisance and toxic species will be defined specifically for particular areas.

TMAP

Targets for water and sediment

'A Wadden Sea which can be regarded as a eutrophication non-problem area.'

Phytoplankton monitoring is carried out in order to survey the effects of changes in the inputs of nutrients:

See also TMAP Manual.

2.3 Threats

Phytoplankton (abundance and species spectrum) are threatened by:

- Eutrophication
- Ballast water, accidental introduction of alien species
- Climate change

2.4 Spatial allocation

	EEZ	12- nm zone	Coastal waters 1)	Transitional waters
MSFD	x	x	-	-
WFD	-	-	x	x
HELCOM	x	x	x	-
OSPAR	x	x	x	x
TMAP	-	-	x	x

1) Under the WFD: baseline plus one nautical mile

3 Monitoring concept

3.1 Description of monitoring network

North Sea

Phytoplankton monitoring is carried out by the following institutions in coastal waters: NLWKN (Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency) in Lower Saxony; LLUR (State Agency for Agriculture, Environment and Rural Areas) in Schleswig-Holstein; and IOW (Institute for Baltic Sea Research Warnemünde on behalf of BSH) in coastal waters and the German Bight. The Wadden Sea Station Sylt of the Alfred Wegener Institute provides its data for the monitoring of the Schleswig-Hostein Wadden Sea. The Biologische Anstalt Helgoland of the Alfred Wegener Institute provides its data for the monitoring of the waters around Heligoland.

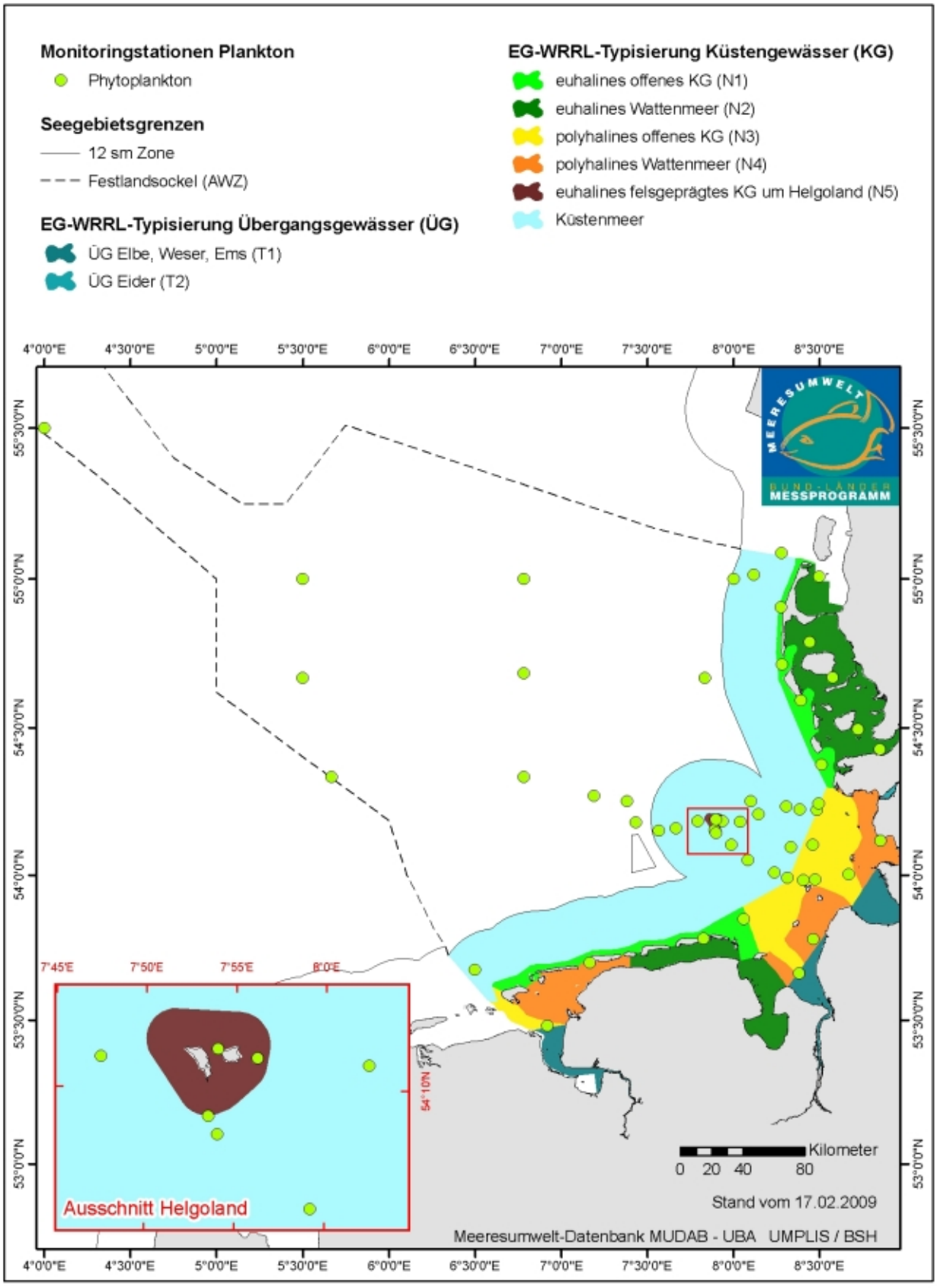

Figure 2: Map showing the stations intended for phytoplankton monitoring in the North Sea

Figure 2 as PDF-document

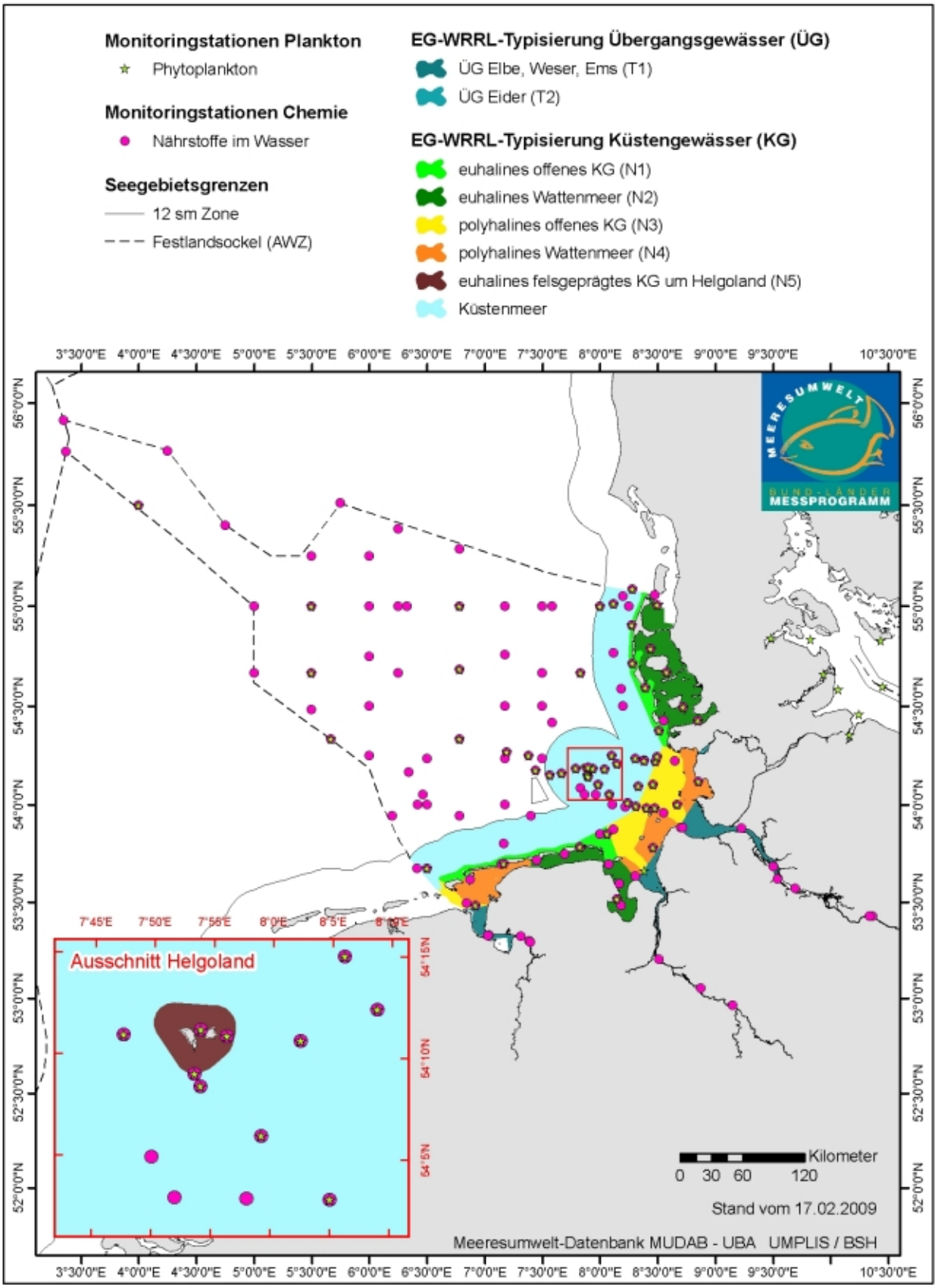

Figure 3: Map showing the stations intended for phytoplankton and nutrient monitoring in the North Sea

Figure 3 as PDF-document

Baltic Sea

Phytoplankton monitoring is carried out by the following institutions in coastal waters: LLUR (State Agency for Agriculture, Environment and Rural Areas) in Schleswig-Holstein; and LUNG (State Authority for Environment, Nature Protection and Geology) in Mecklenburg-Western Pomerania.

Monitoring in the open Baltic Sea (German EEZ) is carried out by IOW (Institute for Baltic Sea Research Warnemünde) on behalf of BSH as part of the monitoring activities for HELCOM. Five sea trips are undertaken each year for this purpose.

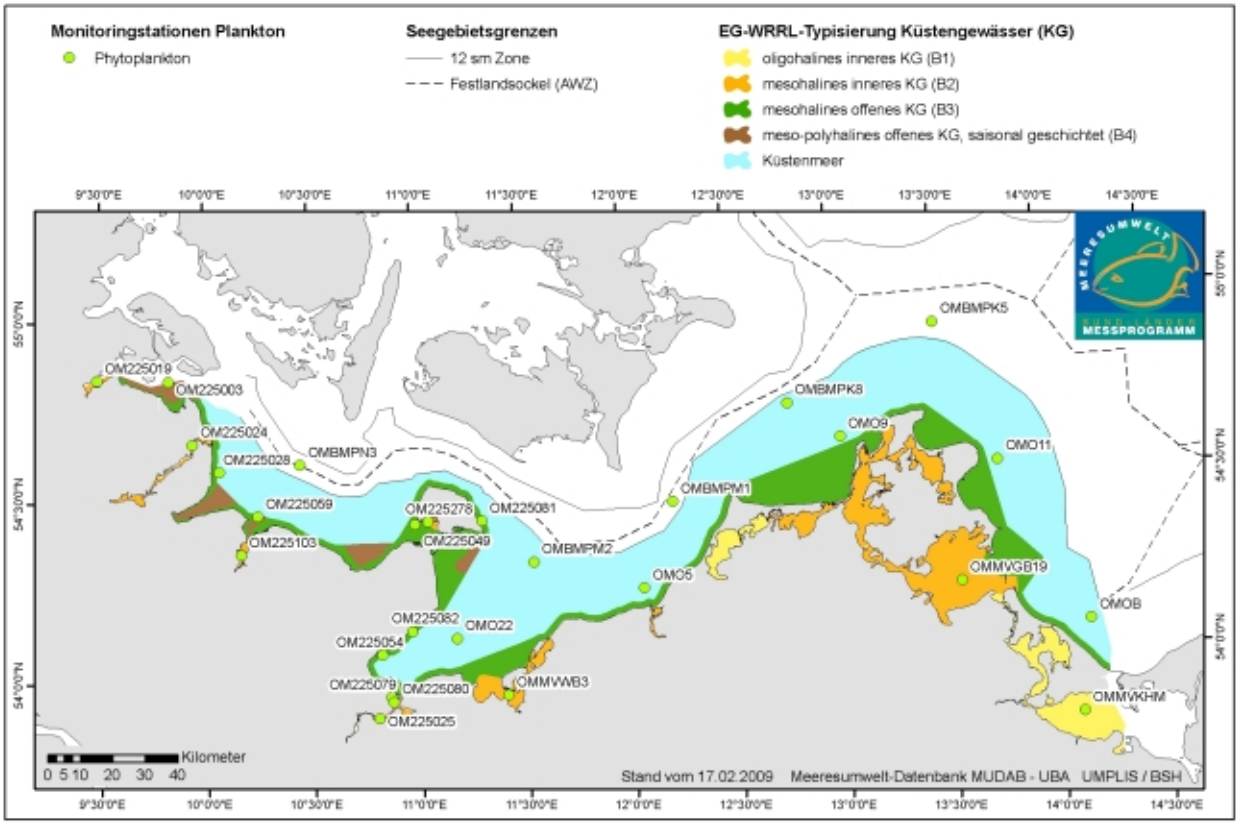

Figure 4: Map showing the stations intended for phytoplankton monitoring in the Baltic Sea

Figure 4 as PDF-Document

LUNG:

Eight monitoring stations: species spectrum, abundance and biovolume seven times a year
Sampling depth: 1 m.

3.2 Monitoring activities

North Sea and Baltic Sea

Phytoplankton

Methods:

Description of the methods

Phytoplankton samples are quantified microscopically in sedimentation chambers and Petri dishes. Apart from this, chlorophyll a content is determined as a measure of biomass.

The analysis of phytoplankton samples has to be undertaken in accordance with the sample standard operating procedure for laboratories involved in the German Marine Monitoring Programme (BLMP), which has been coordinated within the Programme: Testing Procedure SOP: Phytoplankton Investigations in Coastal Surface Waters (Qualitative and Quantitative), as most recently amended.

Zone:

Sublittoral

3.3 Additional parameters

The following parameters are required additionally for the assessments::

- Inputs of substances (rivers, atmosphere)
- NH4
- NO2
- NO3
- Oxygen content
- PO4
- Particulate nitrogen (PON)
- Particulate organic phosphorus (POP)
- Salinity
- Secchi depth
- SiO4
- Stratification conditions (temp., salinity)
- Temperature
- Total nitrogen (TN)
- Total organic carbon (TOC)
- Total phosphorus (TP)
- filterable substances (suspended matter)
- pH value

4 Assessment

4.1 Assessment procedures

North Sea and Baltic Sea

Title

Assessment Procedure - Phytoplankton - Transitional Waters

Guideline:

Various directives

Comments:

Transitional waters are characterised by high concentrations of suspended matter and wide fluctuations in salinity, which worsen the growth conditions for phytoplankton. 'For these reasons, and in accordance with the current state of knowledge, it does not appear expedient to monitor the ecological status of a type 1 transitional water area using phytoplankton.' (ARGE-Elbe, 2005 and Sub-Working Group on Phytoplankton)

North Sea

Title

Assessment Procedure - Phytoplankton - North Sea

Guideline:

Various directives

Comments:

The assessment of the ecological status of the North Sea and its coastal waters is based on several pillars, as both a comprehensive assessment based on phytoplankton species composition of the kind required by the Water Framework Directive and the assessment required for the MSFD still remain to be carried out.

The assessments include 1) a comparison with derived and partly intercalibrated background values for phytoplankton biomass, 2) an assessment of the temporal development of phytoplankton biomass in time series, 3) a combined assessment of species composition and biomass during the spring bloom and 4) an intercalibrated assessment of *Phaeocystis* bloom frequency.

- (1) Brockmann et al. calculated background values for phytoplankton biomass (Brockmann et al., 2006, see Table 1) on the basis of an extensive, comprehensive data set (research and monitoring data), taking background values for riverine inputs (without human influences) into consideration. These values permit a comprehensive assessment to be carried out.

Table 1: Background values for the 90th percentile of phytoplankton biomass (µg/l) in coastal waters and the German Bight (Brockmann et al., 2006; Brockmann, personal communication).

Area	Type	Background	Transition to good status (+50%)	Transition to moderate status (+50%)	Intercalibrated
German Bight	Salt>32	3	4.5	6.8	No
Wadden Sea	NEA 1/26c	3.3	5	7.5	With DK
Wadden Sea	NEA 3/4	4.8	7.2	10.8	No

- (2) The two stations that have been recording time series in the Wadden Sea for the longest are Norderney (since 1987) and Sylt (since 1984). The highest levels of temporal resolution (> 50 observations/year) are achieved at these stations. This assessment supplements the assessment developed by Brockmann et al. by demonstrating a statistically significant correlation between inputs of nutrients from rivers and phytoplankton biomass (van Beusekom, 2008, see Figures. 5 and 6).

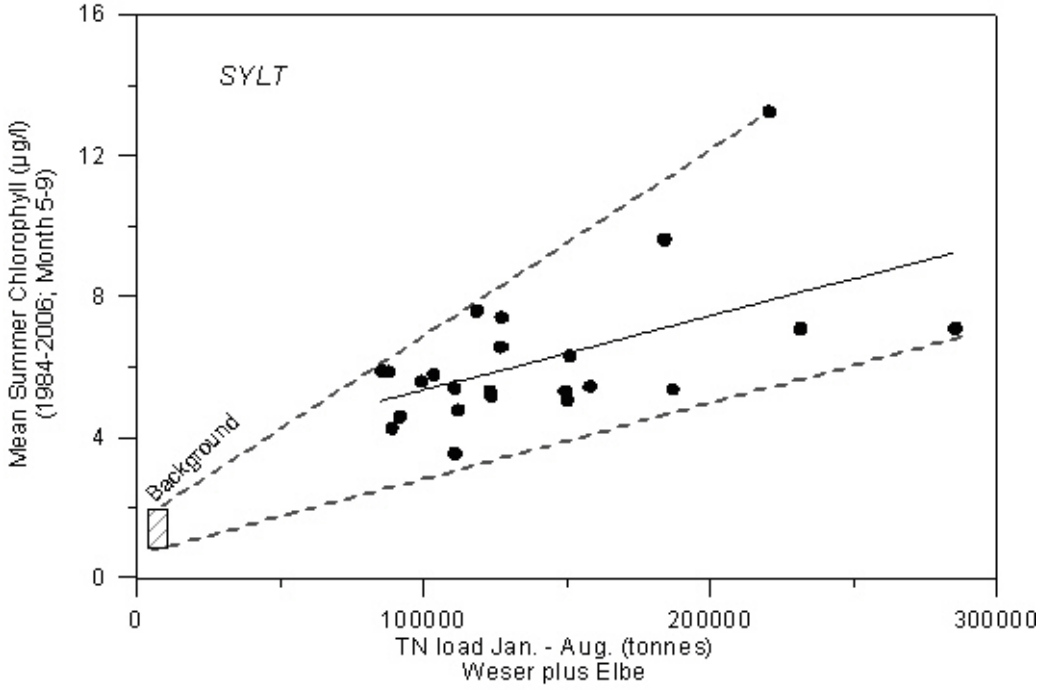

Abbildung 5: The correlation between mean phytoplankton biomass in summer in the Lister Tief (AWI long-term data, biomass as chlorophyll a, mean value for the months May to September) and the nitrogen loads of the rivers Weser and Elbe (sum of the months January to August)

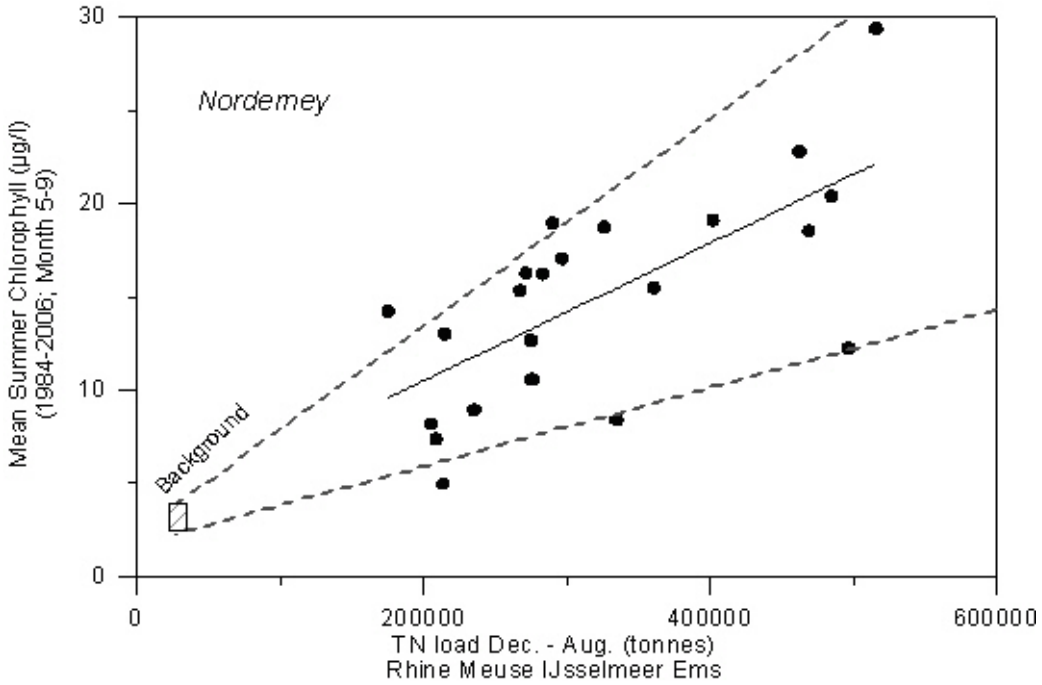

Abbildung 6: The correlation between the mean phytoplankton biomass in summer at Norderney (NLWKN long-term data, biomass as chlorophyll a, mean value for the months May to September) and the nitrogen loads of the rivers Rhine, Maas, IJsselmeer and Ems (sum of the months December of the previous year and January to August)

- (3) The Water Framework Directive requires an assessment based on phytoplankton species composition. Dürselen (2006) developed an assessment for spring phytoplankton on the basis of the available monitoring data, taking the background values determined by Brockmann et al. into consideration. The foundations for the assessment are chlorophyll a concentrations, total biovolume, the biovolume of Biddulphiales and the biovolume of individual indicator species; apart from this, the N and P conditions in the waters are also taken into consideration. The spring aspect (March to May) is examined because phytoplankton growth in spring builds on the accumulations of nutrients deposited in the water during the winter. This assessment system is currently being further developed in the light of the intercalibration process.

- (4) In parallel to the assessment by the multifactor assessment system based on Dürselen, coastal waters are categorised according to the limit values for *Phaeocystis* blooms and chlorophyll concentrations during the vegetation period generated during the intercalibration process.

Table 2: Assessment of the frequency of *Phaeocystis* blooms with cell count >10^6/l.

Gebiet	Type	Backround	Transition to good status (+50%)	Transition to moderate status (+50%)	Intercalibrated	Directive
Wadden Sea	NEA 3/4	8,3 %	9 %	17 %	Yes	WFD

The partly intercalibrated assessments based on background values (Brockmann et al.) and *Phaeocystis* bloom frequency are crucial because they are internationally intercalibrated. The assessment of the time series shows the correlation with riverine inputs and contributes to the assessment of the effectiveness of the measures taken in rivers. It has not yet been possible for an assessment based on species composition to be developed.

Directive: WFD, OSPAR

Baltic Sea

Title

Multifactor Assessment Procedure for the Parameters Species Spectrum and Biomass

Authors

Sagert et al. (2008, national)

Guideline:

Various directives

Comments:

Multifactor assessment procedure based on Sagert et al. (2008, national) for the parameters species spectrum and biomass: assessment by TN, chlorophyll a, sight depth, total biovolume, Cyanophyceae biovolume and Chlorophyceae biovolume.

The assessment of coastal waters in the Baltic Sea is also based on several approaches. A comprehensive assessment of the kind required by the WFD still remains to be undertaken. The different approaches are as follows:

- Multifactor assessment procedure based on Sagert/Selig (national) for species spectrum and biomass as parameters: assessment by taxonomic groups, TN, chlorophyll a and sight depth.
- Biomass (biovolume and C content) and species composition as parameters: after Wasmund et al. (2008) on the basis of historic data (national)
- Biomass as a parameter: intercalibrated as chlorophyll a within the Baltic GIG (international)
- HELCOM - EUTRO PRO (HEAT assessment tool). The development of this tool will be concluded in November.

Directive: WFD, HELCOM

There are various directives that have been developed either for coastal waters or the open sea.

They apply different categorisations for water quality assessment, e.g. the EU WFD uses a five-level scale, while the others merely use two classes.

These categorisations correspond as follows (excerpt from HELCOM, 2006, Figure 2.5):

EU Water Framework Directive (WFD)	**High (sehr gut)**	**Good (gut)**	**Moderate (mäßig)**	**Poor (unbefriedigend)**	**Bad (schlecht)**
HELCOM EUTRO (HELCOM 2006)	**Non-polluted water**		**Eutrophic conditions/polluted water**		
European Marine Strategy (EMS)	**Non-polluted water**		**Polluted water**		
HELCOM EcoQO project)[1]	**Non-polluted area**		**Polluted area**		
OSPAR COMPP)[2]	**Non-polluted area**		**Polluted area**		

)[1] Ecological Quality Objectives

)[2] OSPAR Comprehensive Procedure for the Identification of the Eutrohication Status of the Marine Area.

The strategy for the characterisation of water quality consists in defining a 'historic' background status, which is then to be restored. Deviations of up to 50 % from these background values (in terms of the phytoplankton parameters discussed here) would still be indicative of a good (non-polluted) status.

Re 1) Coastal waters:

Sagert et al. (2008) summarised data on possible background values for total nitrogen concentration (TN), chlorophyll a concentration (chl a) and sight depth (Secchi depth) from various sources, and determined correlations between them. In addition to this, the taxonomic composition of phytoplankton is also used as an indicator.

They summarise the results of their investigations in tables, which are reproduced here in Tables 4 and 5.

Table 4: Background values for chlorophyll a concentration (µg/l) in comparison to the basic variable TN (µmol/l) and the derived variables for class definition (sight depth (m) and percentage decline in sight depth relative to the relevant chlorophyll a value in comparison to the background value for sight depth (% s.d.)). In each case, the values give the boundary between two classes: H/G (High/Good), G/M (Good/Moderate), M/P (Moderate/Poor), P/B (Poor/Bad). *1 Kleines Haff, Peenestrom; *2

Type	PSU	Parameter	Background value	H/G	G/M	M/P	P/B
B1*1	0,5-5	TN	40	43	51	71	180
		Chl a*2	8,5	9,3	12,6	21,5	115
	1,8*5	Sight depth*3	2,5	2,2	1,7	1,1	0,3
		% s.d.	0	8	26	51	86
B2a	7,5*5	TN *6	14,5	15,4	18,5	25,6	71,0
		Chl a*2	1,6	1,8	2,4	4,1	21,5
		Sight depth*3	8,3	7,6	6,1	4,1	1,2
		% s.d.	0	8	27	51	86
B2b	13,7*5	TN *6	12,9	13,4	16,1	22,1	58,4
		Chl a*2	1,3	1,4	1,9	3,2	15,7
		Sight depth*3	9,8	9,0	7,2	4,9	1,5
		% s.d.	0	4-8	25-27	50	85
B3a	8,0*5	TN *6	14,0	14,6	18,0	24,3	64,5
		Chl a*2	1,5	1,6	2,3	3,8	18,5
		Sight depth*3	8,5	8,1	6,3	4,3	1,3
		% s.d.	0	3-7	26-28	50	85
B3b	13,1*5	TN *6	12,8	13,4	16,1	22,1	58,8
		Chl a*2	1,3	1,4	1,9	3,2	15,9
		Sight depth*3	9,7	9,0	7,2	4,9	1,5
		% s.d.	0	3-7	24-26	49-50	85
B4	10-20	TN *6	12,8	13,4	16,1	22,1	58,8
		Chl a*2	1,3	1,4	1,9	3,2	15,9
	15,7*5	Sight depth*3	9,7	9,0	7,2	4,9	1,5
		% s.d.	0	3-7	24-26	49-50	85
Calculated *Zostera* - B3b depth limit, salinity: 13.1 PSU; Equation 4 (Sagert et al., 2005)							
		Zc*4	9,3	8,6	6,7	4,2	0,6
Zostera - depth limit of concentrated populations (Schories et al., 2007)							
		Zc	>8,1	8,1	7,2	4,3	0,8

Table 5: Background values for total biovolume, the biovolume of Cyanophyceae and Cryptophyceae. The classes are defined on the basis of the class boundaries for TN set out in the table. In each case, the values give the boundary between two classes: H/G (High/Good), G/M (Good/Moderate), M/P (Moderate/Poor), P/B (Poor/Bad).

Type	Parameter	Background value	H/G	G/M	M/P	P/B
B1*1	TN [µmol l^{-1}]	40	43	51	71	180
	Biovolume [mm^3 l^{-1}]	1,8	2	2,5	3,9	13,3
	Cyanophyceae [mm^3 l^{-1}]	0,8	0,9	1,2	2,1	10,1
	Chlorophyceae [mm^3 l^{-1}]	-	-	0,1	0,3	1,9
B2a	TN [µmol l^{-1}]	14,5	15,4	18,5	25,6	71
	Biovolume [mm^3 l^{-1}]	0,48	0,52	0,66	1,01	3,89
	Cyanophyceae [mm^3 l^{-1}]	0,14	0,16	0,21	0,37	2,1
	Chlorophyceae [mm^3 l^{-1}]	-	-	0,02	0,03	0,27
B2b	TN [µmol l^{-1}]	12,9	13,4	16,1	22,1	58,4
	Biovolume [mm^3 l^{-1}]	0,4	0,45	0,55	0,85	3
	Cyanophyceae [mm^3 l^{-1}]	0,11	0,12	0,17	0,29	1,5
	Chlorophyceae [mm^3 l^{-1}]			0,01	0,02	0,18
B3a	TN [µmol l^{-1}]	14	14,6	18	24,3	64,5
	Biovolume [mm^3 l^{-1}]	0,45	0,5	0,65	0,95	3,4
	Cyanophyceae [mm^3 l^{-1}]	0,13	0,14	0,2	0,34	1,77
	Chlorophyceae [mm^3 l^{-1}]	-	-	0,01	0,03	0,22
B3b/B4	TN [µmol l^{-1}]	12,8	13,4	16,1	22,1	58,8
	Biovolume [mm^3 l^{-1}]	0,4	0,45	0,55	0,85	3
	Cyanophyceae [mm^3 l^{-1}]	0,11	0,12	0,17	0,29	1,52
	Chlorophyceae [mm^3 l^{-1}]	-	-	0,01	0,02	0,18

The background values for chlorophyll concentration are based on models or expert characterisations. Some of the background values for sight depth are based on historical data.

Re 2) The only reliable historical data on phytoplankton biomass and quantitative composition are from the coastal waters of the Kiel Bight (Wasmund et al., 2008). At the beginning of the 20th century, an average phytoplankton biomass (annual mean over the whole water column, in units of carbon) of 55 mg C/m^3 was determined in the Kiel Fjord, while the annual means for diatoms and dinoflagellates were roughly the same, and their sum constituted 90 % of the phytoplankton. The proportion of diatoms in the spring bloom was at least 80 %. These conditions were still found in the Flensburg Outer Fjord in the mid-20th century, so appear representative for the area.

Re 3) Table 6: The assessment of phytoplankton biomass (chlorophyll a) was intercalibrated internationally by the Baltic GIG for the water types (B3) B4 (international: CW B12b).

Background value	**High/Good**	**Good/Moderate**
1,2 (1,1 - 1,4)	1,3 (1,1 - 1,5)	1,9

Re 4) Neritic zone:

Binding European legislation for the open sea equivalent to the WFD is being developed (European Marine Strategy, EMS).

Various HELCOM projects, such as the Ecological Quality Objectives (EcoQOs), EUTRO and EUTRO-PRO are laying the foundations for the development of the HELCOM Eutrophication Assessment Tool (HEAT) and, ultimately, EMS as well.

Each of the Eutrophication Quality Objectives (EutroQOs) is determined by a background value and the acceptable deviation from this value.

The background paper drawn up by HELCOM EUTRO-PRO will be published in 2010. The relevant phytoplankton data for German outer coastal waters and open sea waters are set out here in advance in Table 7. The mean summer values (June-September) for sight depth and chlorophyll-a concentration (surface water) during the years 2003-2007 and the background value valid for the corresponding marine area are shown.

	Sight depth (m)		Chl. a conc. (µg/L)	
	2003 - 2007	Background value	2003 - 2007	Background value
Pomeranian Bay	4.9	8.5	6.7	1.5
Arkona Sea	N.m.		2	1
Darß-Zingst outer coast	4.7	9.7	1.9	1.3
Wismar Bight	3.5	9.7	5	1.3
Lübeck Bight	5.9	9.5	2.2	1.2
Mecklenburg Bight	N.m.		2	1
Fehmarn Belt	5.5	9.5	1.8	1.2
SW Kiel Bight	5.5	9.6	2	1.2
NW Kiel Bight & Flensburg Bight	6.2	9.7	2.2	1.2

N.m. = No adequate measured values

5 Quality assurance

- EQAT (phytoplankton, services provided by the State Reservoir Administration of Saxony (LTV) and the German Association for Drinking Water Reservoirs (ATT)))
- HELCOM (PEG training courses and intercalibration exercises)
- QUASIMEME (provider of intercalibration exercises: only chlorophyll a in concentrations < 5 µg/l)
- Quality Assurance Panel (at the UBA (workshops, intercalibration exercises, first draft of a species list, standardisation with DIN, CEN and ISO, support for the establishment of QM systems, drafting of sample SOPs, performance of audits))

Comments

The Quality Assurance Panel at the Federal Environment Agency is responsible for the coordination of quality assurance under the BLMP. Each of the monitoring institutions bears responsibility for establishing and administering its own quality management systems. The institutions involved in the BLMP coordinate their activities within the framework of the Working Group on Quality Assurance and the Quality Assurance Sub-Working Group on Plankton.

5.1 Monitoring institutions

- AWI
- IOW
- LLUR
- LUNG
- NLWKN

5.2 Guidance documents

- *AQS-Merkblatt zu den Rahmenempfehlungen der Länderarbeitsgemeinschaft Wasser (LAWA) für die Qualitätssicherung bei Wasser-, Abwasser-, und Schlammuntersuchungen, 2004:* 'Kontrollkarten (A-2)'.
- *DEV zur Wasseruntersuchung, 1997: 39. und 45. Lieferung: I: Strategien für die Wasseranalytik: Verfahrensentwicklung, Validierung und Qualitätssicherung in der Routine;* 74 pp.
- BLMP Quality Assurance Panel at the UBA, 2008: *Muster-Qualitätsmanagementhandbuch für Laboratorien des Bund/Länder-Messprogramms nach DIN EN ISO/IEC 17025 (BLMP Sample Quality Management Manual)*; Version: 01 of 1 February 2008; Federal Environment Agency.
- BLMP Quality Assurance Panel at the UBA, 2009: Prüfverfahren-SOP: Phytoplankton (Testing Procedure SOP: Phytoplankton); Federal Environment Agency (Version: 01 of 15 October 2009 in Member's Area).
- HELCOM, COMBINE Manual, 'Annex C-4: Phytoplankton chlorophyll a.'.
- HELCOM, COMBINE Manual, 'Annex C-5: Phytoplankton primary production.'.
- HELCOM, COMBINE Manual, 'Annex C-6: Phytoplankton Species composition, abundance and biomass.'.
- HELCOM: Checklist of Baltic Sea Phytoplankton Species.; Baltic Sea Environment Proceedings; 95; 2004)
- JAMP, 2004: *Guidelines on quality assurance for biological monitoring in the OSPAR area.*; ICES Techniques in Marine Environment Sciences; 32; 2004.
- JAMP, ASMO, 1997/5: Eutrophication monitoring guidelines - phytoplankton species composition..
- JAMP, ASMO, 1997: Eutrophication monitoring guidelines - chlorophyll a..

5.3 Standards

- DIN EN ISO 5667-3, 2004-05: Water quality - Sampling - Guidance on the preservation and handling of water samples (ISO 5667-3: 2003).
- ISO 5667-9, 1992-10: Water quality - Sampling - Part 9: Guidance on sampling from marine waters.
- DIN EN ISO/IEC 17025, 2005: General requirements for the competence of testing and calibration laboratories.
- DIN EN 14996, 2006: Water quality - Guidance on assuring the quality of biological and ecological assessments in the aquatic environment.
- DIN EN 15204: Water quality - Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermoehl technique).
- CEN, 2005: Water quality - Guidance on quantitative and qualitative sampling of marine phytoplankton (Draft).
- CEN, 2006: Phytoplankton biovolume determination using inverted microscopy (Utermöhl technique) (Draft).
- ISO 10260, 1992: Water quality - Measurement of biochemical parameters - Spectrometric determination of the chlorophyll-a concentration.
- DIN 38412-16, 1985: German standard methods for the examination of water, waste water and sludge; test methods using water organisms (group L); determination of chlorophyll a in surface water (L 16).

5.4 Current status

A BLMP Study Group decision (2006) obliged the BLMP laboratories to establish DIN EN ISO/IEC 17025 quality management systems. For this purpose, a Sample Quality Management Manual was drawn up in 2006/2007 by the Quality Assurance Panel in cooperation with the Quality Assurance Sub-Working Group on Quality Management. This manual has been available for subscription from the Quality Assurance Panel at the UBA since mid-2008 and is to be used as the basis for internal QM documentation at laboratories. The manual is designed as a loose-leaf collection, so that regular updates can be added as required. The intention is for it to be gradually supplemented with sample SOPs coordinated within the BLMP. As far as phytoplankton are concerned, Testing Procedure SOP: Phytoplankton Investigations in Coastal Surface Waters (Qualitative and Quantitative), Version: 01 of 15 October 2009, is already available. Testing Procedure SOP: Chlorophyll a Determination in Surface Waters is currently in preparation.

LUNG is already DIN EN ISO 17025 accredited.

Intercalibration exercises

- State Environmental Management Company Neusörnewitz, 2008: LÜRV B3 - Chlorophyll in Surface Water, 2008 (number of participating laboratories: 39, report: 2008)
- UBA/HELCOM/BLMP-RV, 2007: Phytoplankton Analysis 2007 (number of participating laboratories: 25, report: in preparation)
- German Association for Drinking Water Reservoirs, 2007: Phytoplankton Intercalibration Exercise (number of participating laboratories: 64, report: 2008)
- German Association for Drinking Water Reservoirs, 2005: Phytoplankton Intercalibration Exercise (number of participating laboratories: 21, report: 2006)
- HELCOM: PEG Phytoplankton Intercalibration 2003 (number of participating laboratories: 18, report: 2003)
- UBA/BLMP-RV, 2002: Comparability of Chlorophyll-a Determinations by Various Methods (number of participating laboratories: 11, report: November 2002)
- QUASIMEME intercalibration exercises: Chlorophyll a in Sea Water, twice a year
- UBA/BLMP-RV, 2001: Identification and Counting of Species in a Natural Phytoplankton Sample from the North Sea (number of participating laboratories: 12, report: 2001)
- BEQUALM: Phytoplankton Assemblage Analysis (number of participating laboratories: 42, report: 2001)
- BEQUALM: Phytoplankton Assemblage Analysis (number of participating laboratories: 40, report: 2000)
- HELCOM: PEG Phytoplankton Intercalibration 2000 (number of participating laboratories: 10, report: 2000)
- UBA/BLMP-RV, 1999: Identification of 20 Selected Species from the North Sea and Baltic Sea using Photographs (number of participating laboratories: 10, report: 1999)
- UBA/BLMP-RV, 1999: Identification and Counting of Four Selected Species from Algae Cultures (number of participating laboratories: 10, report: 1999)
- Third Biological Intercalibration Workshop (HELCOM), 1990, Visby (number of participating laboratories: 10, report: 1991)
- Second Biological Intercalibration Workshop (HELCOM), 1982, Rønne (Denmark) (number of participating laboratories: 7, report: 1982)
- Biological Workshop (HELCOM), 1979, Baltic Marine Environment Protection Commission, Stralsund (number of participating laboratories: 11, report: 1980)

Workshops

- UBA/BLMP-WS: Identification and Taxonomy of Marine Diatoms (2007)
- UBA/BLMP-WS: Identification and Taxonomy of Marine Dinoflagellates (2003)
- UBA/BLMP-WS: Taxonomy of Cyanobacteria and Coccal Green Algae and their Distribution in the Baltic Sea (2000)
- UBA/BLMP-WS: Small Naked Flagellates (1998)
- UBA/BLMP-WS: Processing of Hard-to-Identify Species (1998)

6 Literature

- HELCOM, (in preparation): *Integrated Thematic Assessment of Eutrophication in the Baltic Sea (HELCOM EUTRO-PRO)*
- HELCOM, 2006: *Development of tools for assessment of eutrophication in the Baltic Sea. Baltic Sea;* Baltic Sea Environment Proceedings; 104.
- Sagert, S., Selig, U. and H. Schubert, 2008: 'Phytoplanktonindikatoren zur ökologischen Klassifizierung der deutschen Küstengewässer der Ostsee'; *Rostocker Meeresbiol. Beitr.*; 20: pp. 45 - 69.
- Wasmund, N., Göbel, J. and B. v. Bodungen, 2008: `100-years-changes in the phytoplankton community of Kiel Bight (Baltic Sea)'; *J. Mar. Syst.*

7 Activities required to implement the concept

7.1 Changes to the current monitoring programme

7.2 Working steps required

If the current monitoring proposal is to be adapted and its implementation ensured, it will be necessary to secure the human and material resources this will require. In addition to this, the following measures are necessary:

Assessment

There is still no comprehensive assessment available for the WFD. In particular, the assessment based on phytoplankton species composition needs to be further developed. The assessments proposed by Dürselen (2006), Wasmund et al. (2008) and Sagert et al. (2008) need to be put through field testing. The assessment procedures must be developed at the national and international levels by the GIG groups.

According to the GIG, the other phytoplankton parameters should also be assessable by 2012 in addition to chlorophyll a (see WFD, abundance, composition, blooms). However, there is no data basis for the corresponding concepts, which means the sampling network and the quality of the sampling will have to make up for this deficiency.

There is still no assessment system available for the MSFD. An initial assessment and a description of good environmental status will have to be drawn up and environmental targets set by 2012.

Spatial and temporal resolution

The logistic effort involved in the concept that has been described for the implementation of the WFD monitoring requirements is difficult to afford, in particular with regard to the temporal resolution of ship-based measurements.

Due to the very great degree of effort required, the results of the first tests should be evaluated in the light of the following questions in order to minimise the monitoring effort:

- To what extent are measurements needed in winter?
- Would monthly measurements during the period from May to September be sufficient for the purposes of assessment?
- Can results from high-frequency permanent monitoring stations (>= 26 measurements per year) be used as supplementary information in order to reduce the monitoring frequency in the neighbouring water bodies or groups of water bodies? In order to increase the spatial and temporal resolution of phytoplankton data, the sampling should therefore be coordinated between the Länder so that it can be carried out with a division of labour between them.

Apart from this, it is necessary to use other procedures to supplement the ship-based measurements:

- Above all, remote sensing data should also be taken into consideration in off-shore waters in future.
- In so far as this would be expedient and technically possible at the stations in question, permanent monitoring stations should be upgraded with facilities for the measurement of chlorophyll content in order to obtain, e.g., data on bloom development with high levels of temporal resolution. This methodology is to be implemented in coastal waters, in particular, because remote sensing still cannot be applied there.
- Apart from this, research ships, official ships and ferries with automatic monitoring facilities (e.g. FerryBox) should be integrated into the system.

Quality assurance

The establishment of DIN EN ISO/IEC 17025 quality management systems under the BLMP should be concluded by 1 January 2012. By then, apart from the development of uniform quality standards (QM system), efforts should also be made to ensure that the participating institutions work largely in accordance with shared guidelines when the SOPs are being drafted. To this end, the following SOP for phytoplankton investigations is to be drawn up to supplement the Sample Quality Management Manual:

- SOP: Chlorophyll a Determination in Surface Waters ¿ completion planned for the first six months of 2010

The DIN EN ISO/IEC 17025 quality management system includes the following elements:

- documented validation/verification of the investigation methods deployed for the determination of performance characteristics,
- ongoing validation of the accuracy and precision of each procedure for the specific intended use, e.g. by means of control charts and the deployment of (certified) reference materials, as far as possible,
- the qualification and regular training of personnel for the procedures deployed,
- the regular performance of internal and external audits,
- regular participation in national and international interlaboratory comparisons, intercalibration exercises, training courses and workshops, and their evaluation.

The laboratories must guarantee the prompt and complete communication of the investigation results to MUDAB on the basis of the MUDAB data formats, including the QA data that have been defined as a minimum, which meet international standards (ICES).

Further steps to be taken as of 2010:

- Provision of the uniform species list including synonyms via the QA information system
- Drawing up of agreements on taxa that cannot be identified to species level
- List of independent experts for cases where identification is problematic
- Alternating workshops on taxonomic questions, methodology and evaluation procedures (to guarantee uniform minimum quality standards at all laboratories) and intercalibration exercises to ensure that, if possible, some form of external QA can be offered once a year (in this connection, of course, international workshops and intercalibration exercises that allow the UBA Quality Assurance Panel to hold events less frequently have to be taken into consideration). These activities are to be documented adequately and promptly.
- Establishment of a data management system for all participating institutions within the framework of the work of the Working Group on Data Management

Since workshops and intercalibration exercises cannot be offered annually by the Quality Assurance Panel (Biology Section), regular interlaboratory comparison analyses should be organised bilaterally and independently between the laboratories, the results of which should be presented and discussed in the Working Group on Quality Assurance or its sub-working groups.

Research needed

- Development of quick testing procedures for the analysis of algal toxins so that sampling only has to be initiated when this is needed (i.e. a limit value is exceeded).
- Quick tests for the automatic surveying of indicator species by means of molecular-biological techniques.
- Investigations of trigger factors (temperature) and control factors (grazing) in order to isolate the point at which the spring phytoplankton bloom commences.
- The precise pattern of conditions that leads to the development of summer blue algae blooms is a subject of international research. At present, it is not possible to make any statements concerning defined radiation, nutrient and wind conditions in the Baltic Sea (cf. Wasmund, 1997, Lips, 2005), so research continues to be needed.
- An initial assessment must be carried out for the MSFD. This assessment will be the foundation for the drafting of ecological quality objectives and corresponding observation programmes.
- An assessment based on species composition and the abundance of phytoplankton must be drawn up for the . Further research is needed in this field. The Alfred Wegener Institute holds very old data (going back to the beginning of the 20th century) and comprehensive time series on phytoplankton biodiversity (net phytoplankton), which could form the foundation for such an assessment.
- Integration of classic monitoring and automatic measuring procedures within a data-assimilating ecosystem model.

Footnotes

(1) Marine Strategy Framework Directive; Directive 2008/56/EC of 17 June 2008. This also applies to transitional waters and coastal waters covered by Directive 2000/60/EC, where pertinent aspects of the protection of the marine environment not dealt with in Directive 2000/60/EC are at issue.

(2) EC Water Framework Directive; Directive 2000/60/EC. The coastal waters subject to ecological assessment under the WFD extend 1 nautical mile beyond the baseline.

(3) Baltic Sea Action Plan, HELCOM 2007

(4) The monitoring requirements under TMAP were specified in the Wadden Sea Plan (Sylt, 2010) (see also TMAP Manual, section 2).