Monitoring Specifications

Date: 2010-03-02

Macrozoobenthos

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 - Fauna - Macrozoobenthos

1.2 Definition

For the purpose of these specifications, macrozoobenthos are defined as all invertebrate organisms that live on and in the seabed and are retained by a sieve with 1 mm mesh. Smaller sieve meshes are also used in estuaries and silt sediments.

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 Benthos and Benthic Habitats

2 Monitoring requirements

2.1 Necessity

MSFD [1]

Article 11 [2]

Comments

Under the Marine Strategy Framework Directive, it is necessary to draw up monitoring programmes that should encompass the variables listed in Article 8 (cf. also Annex III, Table 1 of the MSFD), including macrozoobenthos.

Article 8(1) and Article 11, Annex III, Table 1 [3]

Comments

The results of macrozoobenthos monitoring are required for the initial assessment of marine waters. These should encompass the following parameters:

- invertebrate fauna on the seabed
- species composition,
- biomass and
- annual/seasonal variability.

See MSFD Annex III, Table 1.

HD [4]

Article 11 [5]

Comments

Member States shall undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2 with particular regard to priority natural habitat types and priority species.

Macrozoobenthos species that are characteristic of habitats are to be monitored in connection with the habitats in question. See the specifications for the following HD habitat types:

- Sandbanks (Natura 2000 Code 1110)
- Estuaries (Natura 2000 Code 1130)
- Mudflats and sandflats (Natura 2000 Code 1140)
- Coastal lagoons (Natura 2000 Code 1150)
- Large shallow inlets and bays (Natura 2000 Code 1160)
- Reefs (Natura 2000 Code 1170)

Monitoring frequencies are not prescribed. Nor is it possible to derive them unequivocally from the reporting cycles (every six years). More detailed information on this topic will be found in the assessment schemes that are currently being drawn up.

The "conservation status" of a natural habitat is defined by, among other things, the conservation status of the species that are characteristic of it.

WFD [6]

Article 8(1)

Comments

Under the WFD, benthic invertebrate fauna must be investigated as a quality element in transitional and coastal waters at least every three years in the context of surveillance monitoring (see Annex V, 1.3.3 and 1.3.4: monitoring of benthic invertebrate fauna in coastal and transitional waters).

In the context of operative monitoring, macrozoobenthos represent an important indicator.

HELCOM

Baltic Sea Action Plan [7]

Comments

A range of EcoQOs are described by HELCOM for all four segments of the Baltic Sea Action Plan, in which respect macrozoobenthos is to be surveyed for the eutrophication and biodiversity segments, in particular

COMBINE

Comments

The COMBINE Manual lists macrozoobenthos as a mandatory "core variable". The annual monitoring required is focussed on the "response of the different biological compartments" to eutrophication (see Combine Manual, Part C, Annex C-9). In this respect, the following are highlighted as eutrophication effects:

- Increased biomass
- Decline in species diversity
- Deterioration and loss of macrozoobenthos where there is oxygen deficiency.

OSPAR

JAMP (see Theme B: Biological diversity and ecosystems)

Comments

- Monitoring of the distribution of species and habitats.
- Assessment of the ecosystem status in order to determine the extent of anthropogenic degradation.

JAMP Common Procedure

Comments

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

When they occur, cases of macrozoobenthos mortality are to be surveyed as secondary eutrophication effects in problem areas and potential problem areas.

List of Threatened and/or Declining Species and Habitats [8]

Comments

Hitherto, the following species found in German waters have been included in the list:

- Arctica islandica (Linnæus, 1767),
- Nucella lapillus (Linnæus, 1758),
- Ostrea edulis (Linnæus, 1758).

Mapping European Seabed Habitats (MESH) [9]

Comments

Under OSPAR, species and habitats have been specified and described in the MESH programme. At the moment, a monitoring strategy is being developed for these species and habitats. It is also intended that "ecological objectives" should be taken into consideration (see 2.2, Environmental targets).

TMAP [10]

Wadden Sea Plan (Stade Declaration, 1997)

Comments

The monitoring programme for macrozoobenthos is based on the JAMP programme (i.e., see OSPAR).

Shellfish banks and Sabellaria reefs (Lower Saxony) are specified in the Stade Declaration as trilateral targets (see 2.2).

Technical necessity

Monitoring frequencies

Overview of the minimum requirements with regard to monitoring frequency for macrozoobenthos under the various directives and programmes. Usually, no binding statements are made with regard to the numbers of stations because they are dependent on the heterogeneity of the structures that are in place.

	WFD - surveillance	WFD - operative	HD	MSFD	OSPAR	HELCOM	TMAP
Frequency	At least every three years	At least annually	At least every six years	At least annually, seasonally	At least annually	At least annually	Every one to three years

2.2 Environmental targets

MSFD

Article 10(1) states: "On the basis of the initial assessment made pursuant to Article 8(1), Member States shall, in respect of each marine region or subregion, establish a comprehensive set of environmental targets and associated indicators for their marine waters so as to guide progress towards achieving a good environmental status in the marine environment, taking into account the indicative lists of pressures and impacts set out in Table 2 of Annex III, and of characteristics set out in Annex IV."

HD

The aim of this Directive shall be to contribute towards ensuring bio-diversity through the conservation of the natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies (Article 2(1)).

Macrozoobenthos are to be taken into consideration as an element in the monitoring of the conservation status of habitats (see list of habitat type specifications in 2.1).

WFD

The ecological status of the biological, chemical and hydromorphological parameters is measured against a defined reference condition. The aspiration is for all surface waters to have a "good" ecological status by 2015:

"The level of diversity and the abundance of invertebrate taxa is slightly outside the range associated with the type-specific conditions. Most of the sensitive taxa of the type-specific communities are present." (See WFD, Annex V, 1.2.3-1.2.4).

HELCOM

Ecological Quality Objectives

1. A healthy Baltic Sea environment with diverse biological components functioning in balance. The environment should have a good ecological status and support sustainable economic and social activities (HELCOM, 25/2004).

2. The Baltic Sea Action Plan [5] calls, among other things, for a Baltic Sea unaffected by eutrophication with natural distribution and occurrence of plants and animals (eutrophication segment). In the segment on biodiversity, the focus is on the near-natural functioning of ecosystems and habitats, in which respect macrozoobenthos communities play a particular role.

OSPAR

Eutrophication status according to OSPAR (Common Procedure)

The "general goal" is "to achieve by the year 2010 a healthy marine environment where eutrophication does not occur."

Ecological Quality Objectives

1. Nutrients and eutrophication effects: influence of eutrophication on changes in and loss of macrozoobenthos - macrozoobenthos should not die off as a result of oxygen deficiency caused by eutrophication and/or the occurrence of toxic algae.

2. Density of sensitive species

See also the revised list of EcoQOs (OSPAR Commission 2006, Annex 2) and Biological Effects (imposex in dog whelks (Nucella lapillus)).

TMAP

The intention is to survey the influence on macrozoobenthos exerted by changes in inputs of nutrients and pollutants, salinity and exposure. Changes in natural processes, species composition, abundances (dominance structures) and the biomass of macrozoobenthos must be observed over time for this purpose.

Another goal is to achieve favourable food availability (for higher trophic levels) (see TMAP-Manual, section 2, part 2).

Trilateral target: "an increased area of, and more natural distribution and development of natural shellfish beds, Sabellaria reefs and Zostera fields."

2.3 Threats

Suitability as indicators

Macrozoobenthos indicates indirect eutrophication effects at an early stage. In this respect, there are, firstly, changes in species composition. Secondly, among other things, oxygen deficiency caused by eutrophication can lead to the loss of macrozoobenthos.

Apart from this, macrozoobenthos are, among other things, indicators for the following impacts and changes:

- Effects of activities on the seabed, dredging works, dumping sites, built structures, trawl fishing
- Input of pollutants
- Changes in morphology and hydrography
- Changes in the climate

2.4 Spatial allocation

	EEZ	12- nm zone	Coastal waters 1)	Transitional waters
MSFD	x	x	x	x
HD	x	x	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

The monitoring concept has been drawn up on the basis of the international obligations set out in section 2.1 and is furthest advanced for the WFD. As the work on the concept continues, it will be harmonised in detail with the activities required by the other directives. A detailed description of the procedures for each individual investigation will be found in the sample standard operating procedure for German Marine Monitoring Programme (BLMP) laboratories: SOP: Macrozoobenthos. The individual sections of these specifications make reference to the relevant SOPs.

North Sea

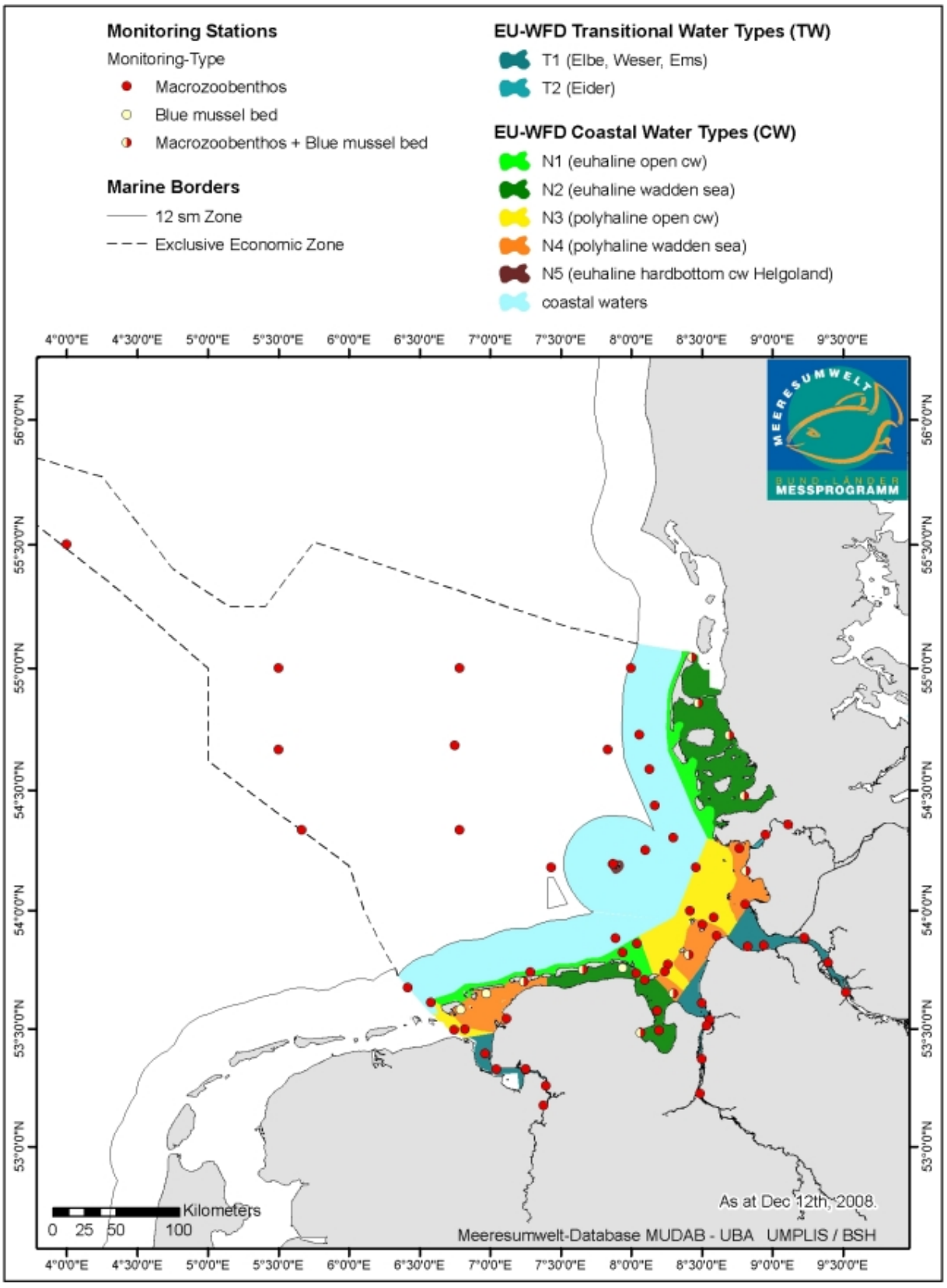

Figure 1: Network for the monitoring of macrozoobenthos in the North Sea: It is still necessary for a representative network of stations to be specified. Proposals have been made for testing stations in the coastal and transitional waters of the Länder and are currently being trialled in the field. They are to be aligned more closely in terms of their intensity and orientation.

Figure 1 as PDF-document

Coastal waters and transitional waters

In Lower Saxony, a selection of stations in the sublittoral and eulittoral zones of coastal and transitional waters is sampled periodically for the assessment of macrozoobenthos. The different sediments and water depths have been taken into consideration at the sites in question. Overall, macrozoobenthos are sampled once a year in the coastal waters of Schleswig-Holstein at six sublittoral stations and twice a year at six stations in the Wadden Sea (eulittoral zone).

In addition to this, blue mussels are monitored in both areas in the context of shellfish management (see below).

In transitional waters, there is provision for one transect in each salinity zone with sublittoral and eulittoral stations, in addition to which the annual BfG stations are used (estuary monitoring).

High Sea/EEZ - IOW on behalf of BSH

The monitoring network for the EEZin the North Sea encompasses 12 stations, which are sampled by IOW each year in spring and autumn. As many benthic communities as possible and various sediment properties and depth levels have been taken into consideration.

Shellfish banks

Alongside the point monitoring activities at the stations of the monitoring network described above, area-wide investigations also have to be carried out to survey eulittoral shellfish banks. Until now, not enough has been known about the locations and sizes of sublittoral shellfish banks for them to be incorporated into the monitoring.

Comments

Macrozoobenthos constitute a significant formative and characteristic element of various habitat types. For this reason, the sampling and, in some cases, areal surveying of the most important habitats of each habitat type or water are necessary in order to assess the status of the habitat types, conservation areas and water quality. In individual cases, it is necessary to decide which habitats/ecotopes best characterise the status of the waters for assessment purposes.

Baltic Sea

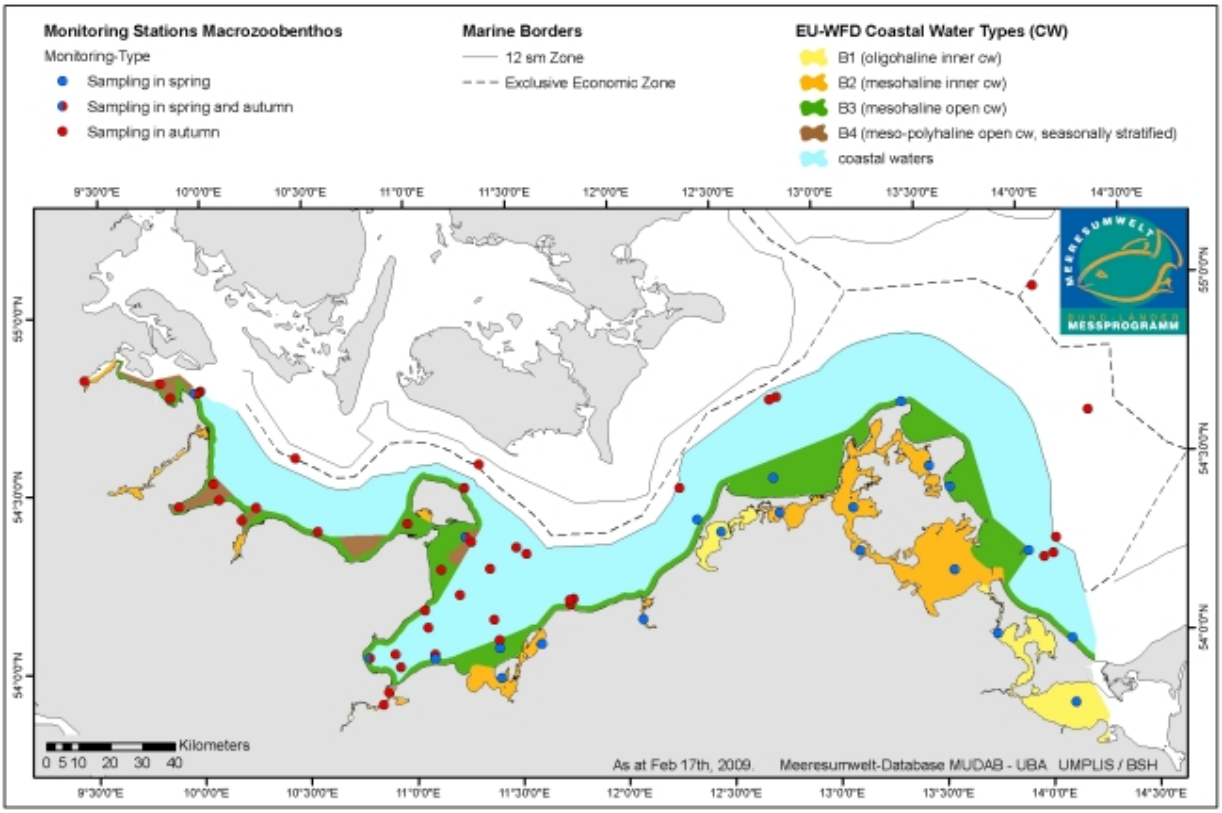

Figure 2: Network for the monitoring of macrozoobenthos in the Baltic Sea

Figure 2 als PDF-document

Coastal waters and transitional waters

The shallow water areas (<15 m water depth) on the Schleswig-Holstein Baltic Sea coast are sampled once a year in spring at 14 stations for the monitoring of soft seabeds. Areas of deep-water mud (>15 m) are examined in autumn at 18 stations on account of seasonal oxygen deficiencies. Phytal fauna are surveyed together with the macrophyte investigations at eight transects in the summer.

On the Mecklenburg-Vorpommern Baltic Sea coast, the representative monitoring network for the investigation of soft seabed fauna is made up of 19 stations in shallow water areas (<15 m water depth), which are sampled once a year in spring, and 12 stations in areas of deep-water mud (>15 m water depth), which are sampled once a year in autumn. Phytal fauna are investigated together with the macrophyte investigations in summer at approx. ten stations.

High sea/EEZ - IOW on behalf of BSH

The monitoring network for the EEZ in the Baltic Sea is made up of eight stations, which are sampled by IOW once a year in autumn. Traditionally, the stations selected are the HELCOM stations, which have been investigated periodically since the early 1980s. The single exception is Station 18, which lies off the coast in 20 m water depth, but is located in the territorial waters of Mecklenburg-Vorpommern. Since long monitoring series are also available for this station, and this section of the coast is indicative for oxygen deficiency and incoming currents from the Kiel Bight, it has also been incorporated into the routine operation of the monitoring network.

3.2 Monitoring activities

North Sea

Macrozoobenthos - North Sea - Not including Shellfish Banks - Eulittoral

Methods:

Sediment samples are taken using box corers and piston corers. In addition to this, visual surveys involving measurements (e.g. surveying of coordinates for the delimitation of a community) or counts (e.g. organisms of one species/unit of area that can be easily identified macroscopically) are carried out.

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9

Number of samples

Piston/box corers: five to ten parallels

Laboratory methods

Determination of species composition, abundance and biomass: ignition loss or wet mass (see comments on biomass in the section on shellfish banks). The size classes for molluscs and echinoderms are to be determined separately.

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9

Frequency:

Under the WFD, provision has been made for benthic invertebrate animals to be monitored with a minimum frequency of three years. This minimum frequency is set for waters with low natural variability and negligible disturbing factors. However, the inner and outer waters in the German marine areas exhibit high degrees of natural variability and dynamism. The monitoring network is therefore to be designed in such a way that it takes account of this temporal and spatial variability.

More frequent sampling, at least at some of the network of stations, is therefore imperative if compliance with the reporting duties is to be possible. For instance, evaluation of the monitoring programmes that have been in operation to date shows that, in some cases, annual sampling with samples being taken at various times of year is to be recommended for the purposes of trend analysis.

It is believed that, in this case - i.e., in combination with the data from the network of permanent monitoring units -, it would be sufficient to carry out sampling every six years at the other stations, which are required to survey the spatial variability of macrozoobenthos (areal monitoring units).

The times when samples are taken are to be coordinated depending on the type of water and the issue being addressed. In the North Sea, the monitoring of macrozoobenthos should be carried out in summer as a rule (see also *SOP: Macrozoobenthos*, section 9).

The definitive specifications concerning the frequency of monitoring will depend, among other things, on the assessment schemes for the Habitats Directive that are currently being developed. Furthermore, the MSFD requires evidence about annual and seasonal variability (Annex III, Table 1).

Macrozoobenthos - North Sea - Shellfish Banks

Methods:

Distribution in the eulittoral zone:

The location and extent of the populations on blue mussel banks are determined on the basis of medium-scale aerial images and, to a certain extent, GPS-supported inspections on foot.

Distribution in the sublittoral zone:

In combination with video recordings, grab samples and diving operations, acoustic remote sensing may offer options when the sublittoral distribution of shellfish banks, seagrass meadows, reefs and sandbanks are surveyed. Limits are set on the deployment of optical remote sensing by the high degree of turbidity in the Wadden Sea. Results concerning the deployment of acoustic remote sensing are expected in early 2010 at the latest (research project conducted by the Senckenberg Institute Wilhelmshaven).

Status:

The blue mussel is a typical habitat-forming species in the Wadden Sea. They also have to be monitored in the context of the monitoring of biogenic reefs (1170, sublittoral zone) and vegetation-free mudflats, sandflats and flats of mixed substrate (1140, eulittoral zone) (see also: Monitoring Manual, HD Habitat Type: Reefs).

The quality of blue mussel banks is determined by investigating selected shellfish banks and taking samples in the field. The quality of a blue mussel bank is judged using the following population-biology parameters:

- Areal extent of the bank
- Coverage (percentage of the total area of a shellfish bank occupied by shellfish beds)
- Stocking density (percentage of the shellfish beds occupied by shellfish)
- Biomass (living weight)
- Abundance
- Length-frequency distribution (age structure)

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9.1.2.7.

Accompanying fauna and flora

In Lower Saxony and Schleswig-Holstein, samples of the accompanying fauna on the shellfish banks are taken at selected stations. These activities still remain to be incorporated into the WFD and Habitats Directive assessments.

General remarks on biomass as a parameter:

The WFD does not require the determination of biomass. However, changes in biomass give the first indications of changes in eutrophication processes. OSPAR, TMAP, HELCOM and their monitoring programmes are directly focussed on the surveying of eutrophication processes.

Apart from this, the determination of biomass can be used for the purposes of compliance with the MSFD, the conventions on the protection of the seas and the Habitats Directive, which constitute the grounds on which it is undertaken. The expense involved in determining biomass is relatively insignificant compared to the costs for the whole sample.

Frequency:

General:

Shellfish banks should be monitored at least once a year in spring

Distribution:

Annual monitoring. The occurrence, distribution, extent and quality of shellfish banks are subject to major annual fluctuations. If it is to be possible to compare and assess them between years and within the banks, surveys are required at least annually. Furthermore, formation is also dependant on local weather conditions (e.g. storm events).

Status:

Once or twice a year

Individual shellfish banks are sampled monthly in order to obtain higher levels of temporal resolution with regard to their development over the course of the year.

Macrozoobenthos - North Sea - Sublittoral

Methods:

- 0.1-m² van Veen grab; 30 - 80 kg, 0.2-m² van Veen grab; potentially Reineck box corer and other methods
- Frame dredge: 1-m width, 0.5 - 1-cm mesh
- Sieve: 0.5 - 1-mm mesh (sometimes 250 µm in transitional waters)
- In future, greater use should be made of sonar systems/video techniques for supporting purposes

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9

Number of samples

Grab: at least five parallels

Dredging: at least one tow

Laboratory methods

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9

Frequency:

Under the WFD, provision has been made for benthic invertebrate animals to be monitored with a minimum frequency of three years. This minimum frequency is set for waters with low natural variability and negligible disturbing factors. However, the inner and outer waters in the German marine areas exhibit high degrees of natural variability and dynamism. The monitoring network is therefore to be designed in such a way that it takes account of this temporal and spatial variability.

More frequent sampling, at least at some of the network of stations, is therefore imperative if compliance with the reporting duties is to be possible. For instance, evaluation of the monitoring programmes that have been in operation to date shows that, in some cases, annual sampling with samples being taken at various times of year is to be recommended for the purposes of trend analysis.

It is believed that, in this case - i.e., in combination with the data from the network of permanent monitoring units -, it would be sufficient to carry out sampling every six years at the other stations, which are required to survey the spatial variability of macrozoobenthos (areal monitoring units).

The times when samples are taken are to be coordinated depending on the type of water and the issue being addressed.

The definitive specifications concerning the frequency of monitoring will depend, among other things, on the assessment schemes that are currently being developed for the Habitats Directive. The MSFD demands evidence about annual and seasonal variability (Annex III, Table 1).

In the North Sea, the monitoring of macrozoobenthos should as a rule be carried out in summer/autumn (see *SOP: Macrozoobenthos*, section 9.)

Baltic Sea

Macrozoobenthos - Baltic Sea

Methods:

A detailed description of the methods for macrozoobenthos investigations in marine sediments (soft seabed) will be found in the sample standard operating procedure for BLMP laboratories: *SOP: Macrozoobenthos* (section 9).

Methods of sampling

- 0.1-m² van Veen grab; 30 - 80 kg, 0.2-m² van Veen grab;
- Frame dredge
- Hard seabeds: frame
- Sieve: 1-mm mesh
- Frame with net bag (250 µm) for phytal fauna (MarBIT)
- In future, greater use should be made of sonar systems for supporting purposes
- Divers
- Video

Number of samples

Frame: ten to 20 parallels

Grab: three to five parallels (HELCOM: three parallels)

Dredging: at least one tow

Laboratory methods

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9

Additional parameters:

See *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, section 9

Frequency:

Under the WFD, provision has been made for benthic invertebrate animals to be monitored with a minimum frequency of three years. This minimum frequency is set for waters with low natural variability and negligible disturbing factors. However, the inner and outer waters in the German marine areas exhibit high degrees of natural variability and dynamism. The monitoring network is therefore to be designed in such a way that it takes account of this temporal and spatial variability. More frequent sampling, at least at some of the network of stations, is therefore imperative if compliance with the reporting duties is to be possible. For instance, evaluation of the monitoring programmes that have been in operation to date shows that, in some cases, annual sampling with samples being taken at various times of year is to be recommended for the purposes of trend analysis. This is also required by the assessment systems that are in use.

It is believed that, in this case - i.e., in combination with the data from the network of permanent monitoring units -, it would be sufficient to carry out sampling every six years at the other stations, which are required to survey the spatial variability of macrozoobenthos (areal monitoring units).

The times when samples are taken are to be coordinated depending on the type of water and the issue being addressed. E.g. it is recommended that samples be taken from shallow water in the Baltic Sea in early spring (after the thaw), but from deep, oxygen-deficient areas in autumn. The definitive specifications concerning the frequency of monitoring will depend, among other things, on the assessment schemes that are currently being developed for the Habitats Directive. The MSFD demands evidence about annual and seasonal variability (Annex III, Table 1).

The HELCOM standards also require annual sampling, which is carried out in autumn in the coastal waters and EEZs of both Länder.

The assessment for the WFD is carried out in accordance with the MarBIT assessment procedure:

- Hard seabed and phytal: June-July
- Soft seabed: March-April; but autumn in deep, oxygen-deficient areas.

3.3 Additional parameters

4 Assessment

4.1 Assessment procedures

North Sea and Baltic Sea

Title

Macrozoobenthos

Guideline:

Various directives

Comments:

At present, the assessment procedures are furthest advanced for the WFD, and some may also be suitable for application under the Habitats Directive. In consequence, procedures intended for the WFD predominate in this section. Their suitability for an HD assessment is to be examined by looking at practical examples. The possibility of their use for the MSFD also still needs to be clarified on the basis of the relevant requirements.

North Sea

Title

Multimetric AZTI Marine Biotic Index (M-AMBI)

Authors

Borja et al. (2000), Muxika et al. (2007)

Metrics: Ambi index, number of species, diversity (Shannon)

Guideline:

WFD

Stretch of Water:

Coastal waters

Comments:

The M-Ambi was developed for estuaries and coastal areas by Borja et al. (2000) on the basis of the work of Grall and Glemarec, 1997. The index assesses alterations in the spectrum of species within five ecologically based groups (sensitivity to organic enrichment). In this respect, a change in the values may be characterised by, e.g., an increase in opportunistic species compared to the background level (AMBI). In addition to this, the number of species and Shannon-Wiener diversity are used as metrics. Given the combination of individual values and the incorporation of specific background levels, only EQRs will be given here.

The assessment is based on the following internationally coordinated class boundaries (only the classes high/good and good/moderate are intercalibrated).

Ecological status	High	Good	Moderate	Poor	Bad
M-Ambi	>0,85	<0,85-0,7	<0,7-0,4	<0,4-0,2	<0,2

The method was modified after the first field tests (adaptation of class boundaries as set out above in accordance with Heyer, 2007). A first assessment was carried out with up-to-date data from the monitoring of coastal waters between 2006 and 2009 (Heyer, 2008, Grotjahn et al., 2008, Heyer, 2009).

Detection of pressures:

After various tests in the course of intercalibration, organic enrichment and hazardous substances were designated as the essential pressures the M-Ambi is intended to detect. Its validity is still controversial, even following test runs in the field, since it was possible to identify a clear dependence on sediment type. Eutrophication is not inevitably coupled with organic enrichment in sediment. It is necessary to wait for more experience of this assessment method to be gained in the field.

It is felt further development and trialling are needed to improve the derivation of background values (local background levels, species numbers) and the selection of particularly suitable stations (sediments). The application of station assessments to water bodies is also under discussion. Alternatively, the Dutch BEQI (Van Hoey et al., 2008) and MarBIT (Meyer et al., 2007) systems are currently being trialled. Both procedures still remain to be adapted or further developed for the North Sea.

Heligoland

The MarBIT procedure is being tested and applied to *Laminaria* rhizoid fauna on wave cut platforms and fauna in the Tiefe Rinne. The procedure is currently being optimised.

Shellfish banks (see section on shellfish banks)

The MarBIT procedure is being tested and applied to eulittoral shellfish banks. The procedure is currently being optimised.

North Sea

Title

Estuary Typology Procedure (AETV)

Authors

Krieg (2005)

Metrics: Estuary Typology Index (AeTI), number of species, abundance

Guideline:

WFD

Stretch of Water:

Transitional waters

Comments:

An assessment procedure for the Elbe (AETV) has been developed by Krieg. The Estuary Typology Index (AeTI) used for this purpose represents an adaptation of the Potamon Typology Index (PTI) to the conditions in transitional waters and, apart from species composition and abundance, assesses above all the presence of species that are closely autoecologically associated with the estuary (type-specific species).

The assessment is based on the following class boundaries (which have not yet been intercalibrated):

Ecological status	**High**	**Good**	**Moderate**	**Poor**	**Bad**
AETV	>0,92	0,92-0,8	0,8-0,55	0,55-0,27	<0,27

Apart from the Elbe, the approach has also been tested on the transitional waters in the Ems, Eider and Weser (Krieg 2008), and used for the initial WFD assessment in the Elbe, the lower Ems and the Lower Weser. Assessment with the M-Ambi system is preferred in the outer transitional waters, i.e. the mesohaline and polyhaline zones, of the Weser and the Ems on account of their extensive habitat structures. Alternatively, BEQI (Van Hoey et al., 2008) and M-Ambi are being tested in transitional waters. A hierarchical approach based on the procedures developed in the Netherlands and Belgium (after Escaravage et al. 2004) is being examined in the Weser and Ems; apart from this, other parameters for the assessment of fauna at community level are currently being trialled.

Detection of pressures:

The loss of type-specific species is detected, other functional relationships still need to be field tested and specified.

Habitats Directive:

Thus far, the assessments have been carried out in conformity with the standards set out in the WFD. Work is still ongoing on the incorporation of the HD requirements into the system.

Baltic Sea

Title

Marine Biotic Index Tool (MarBIT)

Authors

Meyer et al., 2007

Metrics: MarBIT index = Median of species diversity, abundance, disturbance-sensitive taxa, tolerant taxa

Guideline:

WFD

Comments:

MarBIT (Marine Biotic Index Tool) was developed by Meyer et al. (2005, 2007) for the ecological assessment of coastal water bodies in the Baltic Sea. It is WFD-compliant, has a five-level assessment scale, includes type-specific background conditions (species lists for each habitat) and is applicable in all occurring habitats (soft seabed, hard seabed, phytal). The approach works with the parameters prescribed by the WFD: species diversity, abundance, disturbance-sensitive taxa and tolerant taxa. Each of these parameters is assessed with its own independent index. Each individual index generates a value that is scaled to the interval between 0 and 1. The MarBITindex calculated from these values is given as a median of the individual values.

The assessment is based on class boundaries that have not hitherto been coordinated. There are plans for them to be coordinated during the second round of intercalibration carried out by the Baltic GIG.

Ecological status	High	Good	Moderate	Poor	Bad
MarBIT	0,8-1	0,6-0,8	0,4-0,6	0,2-0,4	0-0,2

Pressures/vulnerabilities that may be detected:

Secondary eutrophication effects (oxygen deficiency, silting), organic contamination (sewage works), morphological changes (shipping channels, obstructions) (it is still unclear whether MarBIT responds sensitively to inputs of hazardous substances).

The current data basis is still not sufficient in order to be able to make precise statements about the detection of different types of pressure.

The results of field trials in Schleswig-Holstein and Mecklenburg-Vorpommern produced plausible assessment results.

It is felt further development is needed with regard to the selection of particularly suitable stations and the application of the assessment results to the whole water body (sampling of suitable habitats, areal extent, uncolonised areas).

Baltic Sea

Title

Benthic Quality Index (BQI)

Authors

Rosenberg et al. (2004)

Guideline:

MSFD

Stretch of Water:

EEZ

Comments:

In view of the steep natural salinity gradients from the west (>25 psu) to the east (<5 psu) of the Baltic Sea, it has been possible to show that unmodified indices (e.g. Shannon, BQI, AMBI) cannot be applied (Zettler et al., 2007). Apart from this, it has been shown that the size of the samples can have a decisive influence on the calculations (Fleischer et al., 2007). With the aid of a macrozoobenthos database administered by the Leibniz Institute of Marine Sciences (GEOMAR) in Kiel and the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), which is both spatially and temporally comprehensive, it has been possible to adapt the Swedish BQI index to the specific conditions in the Baltic Sea (Fleischer and Zettler, 2009). The index used has been modified in such a way that the scope of sampling has no influence on the calculations for the most part. Apart from this, the sensitivity/tolerance of the most relevant representatives of macrozoobenthos (125 taxa) were calculated in dependence on two depth levels (below and above 20 m) and for five salinity levels. The abundance, the number of species and the sensitivity/tolerance of the species are incorporated into the calculations. These lists have been made available so that anyone in the Baltic Sea catchment area can carry out calculations with the relevant values and characterise their EcoQ elements.

5 Quality assurance

- NMBAQC
- 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 DIN EN ISO/IEC 17025 quality management systems. The institutions involved in the BLMP coordinate their activities within the framework of the Working Group on Quality Assurance and its sub-working groups, as well as the Ad Hoc Working Group on Benthos and Benthic Habitats.

5.1 Monitoring institutions

- IOW
- LLUR
- BSH
- NLWKN
- NLPV NI
- AWI

5.2 Guidance documents

- 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: Makrozoobenthos-Untersuchungen in marinen Sedimenten (Weichboden), (P-SOP-BLMP-MZB_v01) (Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed))*; Federal Environment Agency (Version: 01 of 15 October 2009 in the Members' Area).
- HELCOM, *COMBINE Manual*, 'Annex C-8: Soft bottom macrozoobenthos.'
- JAMP, 2004: *Guidelines on quality assurance for biological monitoring in the OSPAR area.*; ICES Techniques in Marine Environment Sciences; 32; 2004.
- JAMP, ASMO, 1997: *Eutrophication monitoring guidelines - benthos*: 'Technical Annex 1: Hard bottom macrophytobenthos, soft-bottom macrophytobenthos and hard-bottom macrozoobenthos'.
- JAMP, ASMO, 1997: *eutrophication monitoring guidelines - benthos*: 'Technical Annex 2: Soft-bottom macrozoobenthos'

5.3 Standards

- 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 15196, 2006: Water quality - Guidance on sampling and processing of the pupal exuviae of Chironomidae (Order Diptera) for ecological assessment.
- DIN EN ISO 16665: Water quality - Guidance for quantitative sampling and sample processing of marine soft-bottom macrofauna.
- DIN EN ISO 19493, 2007: Water quality - Guidance on marine biological surveys of hard-substrate communities.

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 macrozoobenthos is concerned, *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)*, Version 01 of 15 October 2009 is available. The testing procedure SOPs on diving and video investigations, and the amended *Testing Procedure SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)* for transitional waters are currently in preparation.

Intercalibration exercises

- UBA/BLMP-RV 2004: Determination of Selected Macrozoobenthos Species in a 'Near-Natural' Macrozoobenthos Sample from the Western Baltic Sea (number of participating laboratories: 16, report: November 2004)
- NMBAQC/BEQUALM: Ring Test Exercise 23 (number of participating laboratories: 15, report: 2004)
- NMBAQC/BEQUALM: Macrobenthos Exercise 11 (number of participating laboratories: 10, report: 2004)
- NMBAQC/BEQUALM: Ring Test Exercise 22 (number of participating laboratories: 13, report: 2003)
- UBA/BLMP-RV: Identification of Selected Macrozoobenthos Species from the North Sea and Baltic Sea (number of participating laboratories: 13, report: October 2001, corrected version: May 2002)
- UBA/BLMP-RV: Identification of 25 Selected Macrozoobenthos Species (number of participating laboratories: 11, report: January 2000)
- Intercalibration Exercise on Sampling Methods for Macrobenthos, ICES Benthos Methods WG (number of participating laboratories: 6, report: January 1985)

Workshops

- UBA/BLMP-WS: Mollusca, Polychaeta, Oligochaeta (2004)
- HELCOM/BEQUALM: Benthos Taxonomic Workshop (2000)
- UBA/BLMP-WS: Polychaeta (1998)
- UBA/BLMP-WS: Amphipoda (1998)
- ICES/HELCOM: Benthos Taxonomic Workshop (1997)
- ICES/HELCOM: Workshop on Quality Assurance of Benthic Measurements in the Baltic Sea (1996)
- ICES/HELCOM: Workshop on Quality Assurance of Benthic Measurements in the Baltic Sea (1994)

6 Literature

- Borja A., Franco, J. and V. Pérez, 2000: 'A marine biotic index to establish the ecological quality of soft-bottom benthos within European estuarine and coastal environments'; *Mar. Poll. Bull.*; 40 (12): pp. 1100 - 1114.
- Fleischer, D. and M. L. Zettler, 2009: 'An adjustment of Benthic ecological quality assessment to effects of salinity'; *Mar. Poll. Bull.*; 58 (2009): pp. 351 - 357.
- Fleischer, D., Grémare, A., Labrune, C., Rumohr, H., Vanden Berghe, E. and M.L. Zettler, 2007: 'Performance comparison of two biotic indices measuring the ecological status of water bodies in the southern Baltic and Gulf of Lions'; *Mar. Poll. Bull.*; 54 (2007): pp. 1598 - 1606.
- Grall J. and M. Glémarec, 1997: 'Using biotic indices to estimate macrobenthic community pertubations in the Bay of Brest'; *Estuarine, Coastal and Shelf Science*; 44 (Suppl. A): pp. 43-53; Science for Management in Coastal and Estuarine Waters: Proceedings of the 25th Annual Symposium of the ECSA: Part 3, Dublin, 11 - 16 September 1995.
- Grotjahn, M., Petri, G., Fischer, U. and W. Heiber, 2008: *EG WRRL - Praxistest Makrozoobenthos - Erprobung und Optimierung der Probennahmemethoden und der Bewertungsverfahren für Makrozoobenthos in den niedersächsischen Übergangs- und Küstengewässern*; Berichte des NLWKN; 82 pp. and 112 pp.
- Heyer, K., 2007: *Intercalibration Report (NEA GIG): Assessment of German Coastal Waters (NEA1/26, NEA3/4) by Benthic Invertebrates*; commissioned by NLWKN; 13 pp.
- Heyer, K., 2009: 'Bestimmung von deutschen Referenzwerten für das "MAMBI-Bewertungsverfahren" und Neuberechnung der Daten des NLWKN Praxistests sowie der Hamburger und Schleswig-Holsteiner Monitoringstationen'; unpublished report for NLWKN; 52 pp.
- Meyer, T., Berg, T. and K. Fürhaupter, 2007: 'Ostsee-Makrozoobenthos Klassifizierungssystem für die Wasserrahmenrichtlinie'; unpublished final report on MariLim commissioned by the University of Rostock; 129 pp.
- Meyer, T., Reincke, T., Fürhaupter, K. and S. Krause, 2005: *Ostsee-Makrozoobenthos-Klassifizierungssystem für die Wasserrahmenrichtlinie*; technical report on MARILIM for the Schleswig-Holstein State Agency for Nature and Environment; 73 pp.
- Muxika, I., Borja, A. and J. Bald, 2007: 'Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive'; *Mar. Poll. Bull.*; 55 (1-6): pp. 16 - 29.
- Van Hoey, G., Drent, J., Ysebaert, T. and P. Herman, 2007: *The Benthic Ecosystem Quality Index (BEQI), intercalibration and assessment of Dutch coastal and transitional waters for the Water Framework Directive*; NIOO Rapporten; 2007-02.
- Zettler, M.L., Schiedek, D. und B. Bobertz, 2007: 'Benthic biodiversity indices versus salinity gradient in the southern Baltic Sea'; *Mar. Poll. Bull.*; 55 (2007): pp. 258 - 270.

7 Activities required to implement the concept

7.1 Changes to the current monitoring programme

The strict deadlines set in the European Directives require very concrete, binding coordination processes between the Länder, the German Federation and the institutes that are implementing the programme. This work is undertaken within the Working Group on Surveying and Assessment and, for the present specifications, the Ad Hoc Working Group on Benthos and Benthic Habitats. Furthermore, recent scientific findings and the experience gained from the application of the procedures make the continued updating of the monitoring concept indispensable.

A review of the monitoring network and monitoring frequency at the regional level, adapted to take account of water conditions and reporting duties, is to be carried out. In particular, considerably more investigations will need to be carried out in future in the sublittoral zone of the North Sea, where there is still a need for development in order to lay the foundations for assessment activities (e.g. areal mapping methods using hydroacoustics). In the Baltic Sea, stations are to be specified in B1 and B2 water bodies.

WFD

North Sea

The monitoring network operated by the Länder has been reorganised and modified or expanded in order to cover characteristic communities and individual water bodies.

Baltic Sea

The monitoring network operated by the Länder has been reorganised and modified or expanded in order to cover characteristic communities and individual water bodies.

HD

The monitoring activities carried out to date may not satisfy the requirements imposed by the Habitats Directive. An appropriate monitoring concept must be developed in coordination with the monitoring for the purposes of the WFD.

The habitat types must be monitored inside and outside the marine HD areas (see conservation targets). The macrozoobenthos monitoring required in the various habitats is described in the monitoring specifications for the habitats in question. The definitive specifications for the monitoring concept will depend on the assessment schemes that are currently being developed for the Habitats Directive.

7.2 Working steps required

Monitoring

Drafting of a monitoring concept for the purposes of the Habitats Directive and harmonisation with the stations/methods used for the WFD. Exploitation of synergies and avoidance of duplicated work. In future, it will be necessary to carry out a similar harmonisation exercise in response to the requirements set out in the MSFD.

Some of the information given in these specifications on the following points will have to be formulated more precisely once the assessment procedures have been optimised:

- Location of the sampling
- Frequency
- Parameters
- Number of parallels
- Methods
- Coordination with macrophyte monitoring (phytal fauna)
- Extensive coordination with the monitoring for biological effects is expedient.
- The monitoring concept still needs to be harmonised with the monitoring in the North Sea EEZ implemented by BSH since 2008. IOW has been commissioned with the performance of this biological monitoring. Investigations are carried out at 12 stations in the Sea EEZ area, which are visited on two trips a year (spring and autumn) (in addition to this, they are also visited five times for the monitoring of zooplankton and phytoplankton). Whether this frequency, two dates a year, is maintained will depend primarily on the experience of sampling in 2008. The intention is for these arrangements to be coordinated once again after this date.

Quality assurance

The establishment of DIN EN ISO/IEC 17025 quality management systems under the BLMP should be concluded by 1 January 2012.

In this context, 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 current *Sample Quality Management Manual* is to be amended and the following SOPs for macrozoobenthos drawn up:

- *SOP: Macrozoobenthos Investigations in Marine Sediments (Soft Seabed)* - amended version covering transitional waters, completion planned for the first six months of 2010
- *SOP: Macrozoobenthos Investigations by Means of Diving Investigations* - completion planned for the first six months of 2010
- *SOP: Macrozoobenthos Investigations by Means of Video Investigations* - completion planned for the second 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,
- storage of reference and comparative collections,
- 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 and its periodic revision to reflect agreements reached concerning the (re)designation of taxa
- List of independent experts for cases where identification is problematic
- Alternating workshops on taxonomic questions, methodology (priority: grab and diving operations), 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.
- Continuation of the Environmental Research Plan project to draw up identification keys (Polychaeta, Chironomidae)
- Uniform data management system operated by all institutions involved

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 and the Ad Hoc Working Group on Benthos and Benthic Habitats. As a matter of principle, attention is to be paid to continuity among the staff involved in the processing of long-term monitoring series, as well as steps to ensure they are appropriately qualified.

Assessment

OSPAR

An appropriate monitoring concept, which includes macrozoobenthos, has been put forward for the assessment of the eutrophication status of the North Sea under the Common Procedure (see also Phytoplankton, Macrophytes and Zooplankton) (monitoring carried out by IOW in the North Sea).

WFD

Assessment systems have been developed and tested for both the North Sea and the Baltic Sea. The results obtained to date will be the subject of further discussions. There is therefore not only a need for continued coordination within the expert bodies responsible, but also for development work in order to highlight alternatives for this kind of assessment. The assessment activities that have been undertaken should be validated in the near future.

HD

Monitoring strategies for the Habitats Directive assessment have still not been drawn up and will have to be taken into consideration when macrozoobenthos is monitored in future.

MSFD

The profile of requirements and the responsibilities for implementation are being clarified at present. The MSFD will be incorporated into the monitoring concept and assessment methodology once this process has been concluded.

Further activities/issues

- The zoobenthos investigations carried out by other institutions (including BFAFi, vTI, Geomar and AWI) should be taken into consideration in planning and incorporated into the BLMP concept.
- The distribution of shellfish banks should be surveyed by means of side-scan sonar with appropriate investigations for the remote sensing of their areal distribution, the characteristics and structure of the substrate in the eulittoral and sublittoral zones, and the surveying of seagrass meadows and reefs.
- The calibration of methods for the determination of weight and a specification of the cases (taxa) to which each method is applicable (ignition loss, wet weight and dry weight) are needed urgently for quality assurance purposes.
- At present, only two type N3 water bodies can be sampled in the coastal waters off Schleswig-Holstein subject to ecological assessment because the methods for monitoring in the sublittoral zone of the Wadden Sea (tidal channels, Wadden Sea currents) are insufficiently reproducible. In consequence, there is a need for research to develop methods in this field.

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) Version: proposal of the Secretariat-General of 13 November 2006.

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.

(3) Version: proposal of the Secretariat-General of 13 November 2006.

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.

(4) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

(5) Article 11 (monitoring of habitats and all species listed in Annexes II, IV and V) imposes the obligation to monitor the conservation status of all habitats (listed in Annex I) of Community interest. In consequence, this provision is not limited to NATURA 2000 areas, but habitat types outside the Habitat Directive areas are also to be included in the monitoring as appropriate.

(6) 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.

(7) Baltic Sea Action Plan, HELCOM 2007

(8) The OSPAR Commission has set itself the objective of recording all species and habitats that need to be protected. This list is used by OSPAR to guide the setting of future priorities for its further work on conservation and the protection of marine biodiversity.
OSPAR is currently drawing up instructions for the monitoring of the species and habitats on the list.

(9) Species and habitats have been specified or described under OSPAR (MESH programme). At present, a monitoring strategy is being developed for this purpose. The intention is for it to take account of "ecological objectives" as well (see Environmental targets).

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