Report of the

TMAP-WFD Workshop on Reference Values

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Common Wadden Sea Secretariat
Trilateral Monitoring and Assessment Group

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1. Introduction

The workshop was organized by the Trilateral Monitoring and Assessment Group (TMAG) with the aim of discussing the development of Wadden Sea specific reference values in the implementation process of the Water Framework Directive. The justification for such a meeting is the obvious necessity of having comparable reference values within the Wadden Sea irrespective of the specific WFD River Basin Districts.

The Terms of Reference of the workshop are in **Annex 1**. The workshop was attended by 34 persons from institutions in charge of implementing the WFD and the TMAP. The list of participants is in **Annex 2,** the final program is in **Annex 3**. The workshop documents (background documents, presentations, reports) are available on the workshop website: http://www.waddensea-secretariat.org/workshops/wfd-tmap.html

The Trilateral Wadden Sea Cooperation and the EU Water Framework Directive

The three Wadden Sea countries, the Netherlands, Germany and Denmark, have been working together since 1978 with the aim to protect the Wadden Sea as an ecological entity. The trilateral Wadden Sea Plan (adopted in 1997) is valid for the whole Wadden Sea Area (see Figure 1) and is the common management framework for these three Wadden Sea countries.

In the Joint Declaration (1982), the three Wadden Sea countries agreed to coordinate their policy and management on the protection of the Wadden Sea. This concerns also the implementation of a number of international legal instruments, amongst others, the EU Directives on Birds and on Habitats and, most recently, the Water Framework Directive (WFD) (Ministerial Declaration, Esbjerg 2001, §§ 48-49). The ministers further agreed to optimize the TMAP with regard to the requirements of the EU Water Framework Directive and the EU Habitat Directive (ED § 81).

Ministerial Declaration, Esbjerg 2001:

Water Framework Directive
*48. To **recall** the coming into force of the "Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy" in December 2000. This Directive provides a strong impetus for coordinated water management of both surface water and groundwater for all river basins in the European community, including coastal waters extending up to one nautical mile and, in respect of the chemical status, all of the territorial waters.*
*49. To **underline** the importance of close cooperation with regard to the Wadden Sea Area when implementing the Water Framework Directive and, because it is foreseen that the Wadden Sea Area will be part of a number of adjacent River Basin Districts for all of which separate River Basin Management Plans have to be developed, to establish an overview of how the trilateral cooperation for the protection of the Wadden Sea can assist in this task, taking into account, inter alia, the identification of synergism and the avoidance of duplicating work.*

TMAP
*81. To further **optimize** the TMAP for future requirements, in particular with regard to the Targets, the EU Habitats Directive and the EU Water Framework Directive, and to this end*
81.1 to make use of data from existing monitoring programs and to evaluate possibilities of including them into the TMAP without additional costs;
81.2 to prepare proposals for the further development of the TMAP by the next Trilateral Governmental Conference

At first joint workshop on WFD and Wadden Sea was held in Hamburg in January 2004, where representatives from the three countries concerned with the WFD implementation and the TMAP discussed the possibilities on a closer coordination of monitoring and management activities in the Wadden Sea with regard to the WFD. The workshop underlined that the implementation of the WFD in the Wadden Sea requires an intensive cooperation of all concerned authorities, at the national as well as at the trilateral level. A close coordination

in the Wadden Sea is necessary to safeguard coherence between the EU Directives on Habitats, Birds, Water Framework, and the Trilateral Cooperation. This concerns not only monitoring but also policy and management aspects. The conclusions and recommendations of this workshop are in **Annex 4**.

The Trilateral Working Group (TWG 04-1) endorsed the workshop recommendations concerning a.o. to enhance the information exchange and coordination, and to develop a common understanding of monitoring and management goals on a Wadden-Sea-wide level. The TWG agreed to organize joint workshops on specific themes with relevance to the WFD implementation and the TMAP. As a first step, it was agreed to organize a joint expert workshop on reference values by end of 2004.

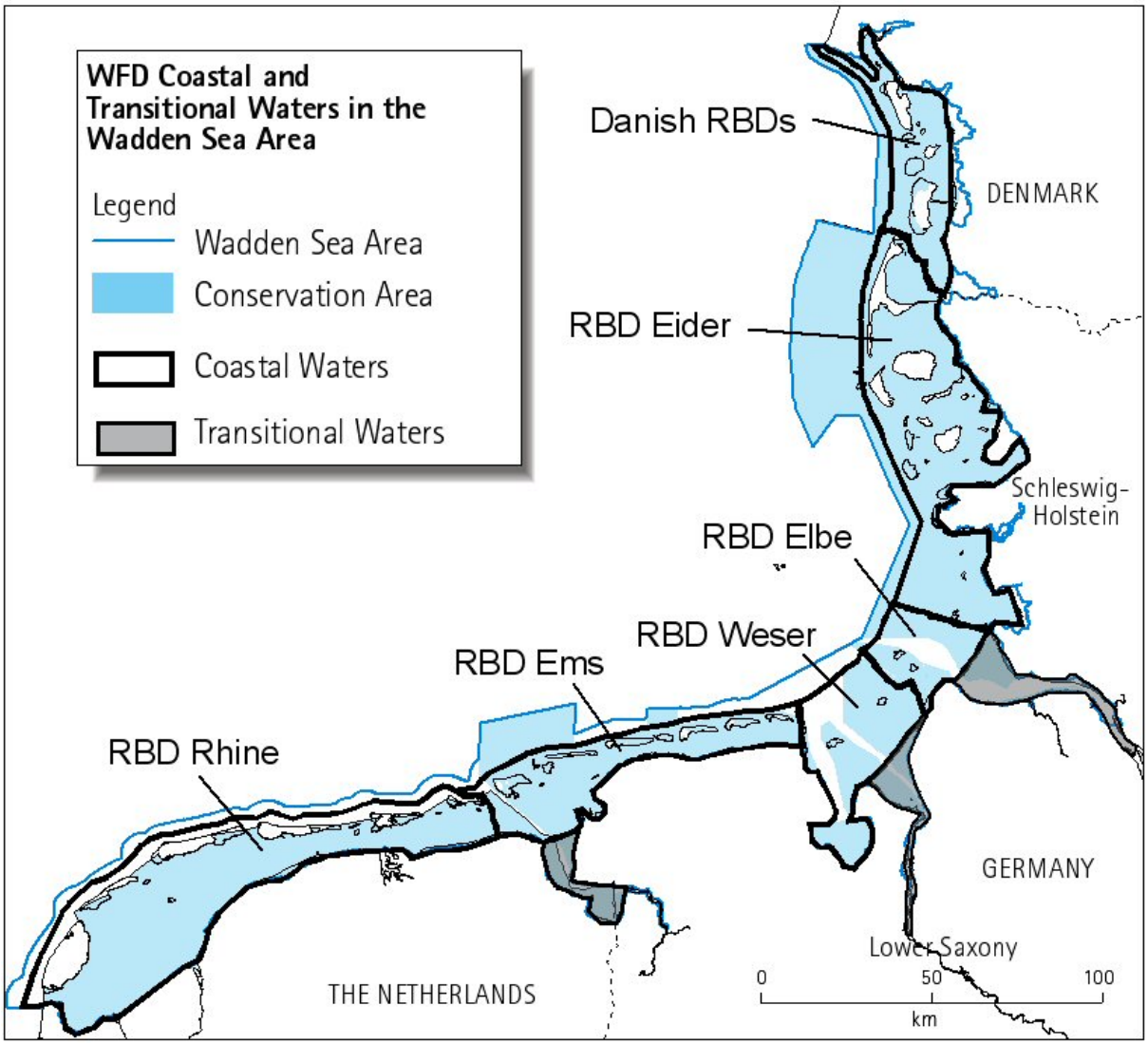

Figure 1: Delimitation of WFD coastal and transitional waters and RBDs in the Wadden Sea Area. The Wadden Sea Area is assigned to different River Basin Districts (RBDs) (coastal waters up to 1 sm from the baseline respectively up to 12 sm with regard to the physico chemical quality elements).

According to the WFD, the Wadden Sea is assigned to different River Basin Districts (RBD) which are the main management units of the WFD (see Figure 1).

2. Objectives of the Workshop

The expert workshop shall discuss the experiences in the development of Wadden Sea specific reference values for the WFD and its implication for the Wadden Sea monitoring and management. The aims of the workshop are:

- to exchange information and experiences with the development of reference values in the three countries and the different River Basin Districts,
- to try to find a coherent approach for definition of reference values for the Wadden Sea, for coastal waters as well as for transitional waters.

The following tasks were given to the workshop:

1. Presentation of an overview on the development of reference values in RBDs in NL, FRG and DK.

2. What are the differences regarding reference values between the countries/RBDs? And how must one deal with these differences?

3. How to coordinate the further process in order to find a coherent approach for the Wadden Sea?

3. WFD Implementation

3.1 Status of WFD implementation in the Wadden Sea

Mr. Harald Marencic (CWSS) presented an overview current status of WFD implementation in the Wadden Sea countries on the basis of the available drafts of the “Report 2005” which have to be prepared for each River Basin District (RBD) according Article 5 WFD.

In these reports, an identification and first characterization of water bodies have to be carried out together with a preliminary assessment of the likelihood that water bodies will not reach good status in 2005). With regard to the designation of coastal waters as natural waters and of transitional waters as HWMB a common approach has been found for the whole Wadden Sea. With regard to the preliminary assessment of the ecological status it was concluded that “Wadden Sea will probably not reach the environmental objectives / good status by 2015“ mainly because of eutrophication.
The reports also revealed there were still gaps of information monitoring data, as well as, lacking of reference values and quantitative criteria.

Within the WFD, a reference condition is defined as a condition in which a water body has suffered no, or only very minor anthropogenic impacts to its hydromorphology, physico-chemistry, and biology. This can be a past but also a present situation. The reference condition can be derived from observations, historical data or modeling, or where necessary expert judgment.

3.2 Reference values – experiences from the QSR 2004

Mr Karel Essink (TMAG Chairman) presented first results from the Wadden Sea QSR 2004 which is currently being prepared by the TMAG.
For the second time (after the QSR 1999) the assessment has been based on the targets of the Wadden Sea Plan which has been the common framework for monitoring and management in the Wadden Sea for the last 10 years.

The results of the target assessment were presented for

1. Nutrients & Eutrophication
2. Hazardous substances
3. Salt marshes
4. Zostera fields
5. Blue mussel beds
6. Macrozoobenthos

It was underlined that the Targets give an indication in which direction a habitat should be developed rather than define measurable parameters for a “good” status. Although such a specification of the targets, also with regard to regional differences, has not been done, the QSR could deduce concrete recommendations for management.

- WSP Targets:
  - Defined in rather general terms,
  - Defined as ‘directions’ (increase, decrease),
  - Not explicitly defined in terms of measurable parameters,
  - To be specified for different regions,
- Evaluation criteria:
  - Not always defined explicitly,
- Reference values:
  - Partly available from long-term monitoring
  - Partly absent; to be defined

According to the decisions at the Ministerial Conference (Esbjerg, 2001, ED § 81) the TMAP will be revised in the period 2004 – 2006. This TMAP Revision will be done in a three step approach:

- Definition of common monitoring objectives
  - Combining requirements of EU Directives and Targets
- Development of common monitoring program
  - E.g., quantifiable monitoring objectives
- Streamlining of assessment & reporting activities
  - Multi-use of national, trilateral and EU-reporting

3.3 Development of reference values for the Dutch Wadden Sea

Mr. Marinus Bokhorst (RIKZ Haren) presented the Dutch activities to develop reference values and assessment tools for coastal and transitional water bodies. A first draft reports was prepared in July 2004 but had to be further elaborated during the next months (van der Molen 2004).

It appeared that the main difficulty was to set values on composition and abundance of biological quality elements (phytoplankton, macroalgae, angiosperms, macrofauna and fish).

Further guidance is expected from the EU level in 2005 with regard to the assessment of eutrophication.

With regard to the intercalibration process (coordinated by the NEA-GIG), he pointed out that the three countries have no common intercalibration site in the Wadden Sea: Germany and the Netherlands share NEA-3 and NEA-4 whereas Denmark and Germany share NEA 1 and NEA 6.

He underlined the necessity to find a coherent approach together with the EU Habitats Directive and the Wadden Sea Plan. The proposed Interreg IIIB project HARBASINS may be an appropriate tool to liaise the different networks on national and international level.

4. Eutrophication

Eutrophication status of the Wadden Sea

Mr. Justus van Beusekom (AWI Sylt) presented an overview of recent trends in river nutrient inputs and eutrophication proxies (Seasonal Cycle of NH4 + NO2, Summer Phytoplankton Biomass) and comparison with historic levels as prepared for the QSR Update 2004.

It could be shown that interannual differences are related to variation in riverine freshwater discharge. A decreasing trend was found in specific nutrient loads (input normalized to flow rate) for TP and TN: TN decrease: 2.1 - 2.2% per year; TP decrease: 3.3 - 2.5 % per year

Significant effect of Rhine/Meuse in the Southern Wadden Sea were observed with regard to the seasonal cycling of nutrients (autumn values NH4 + NO2) in the southern Wadden Sea (Western Dutch Wadden Sea, Eastern Dutch Wadden Sea, Norderney) whereas no significant relations were found in the Northern Wadden Sea (Nordfriesland, Denmark).
This is also reflected in the summer chlorophyll concentrations (mean concentrations 14 – 19 µg/l in the southern parts, 7 – 8 µg/l in the northern parts)

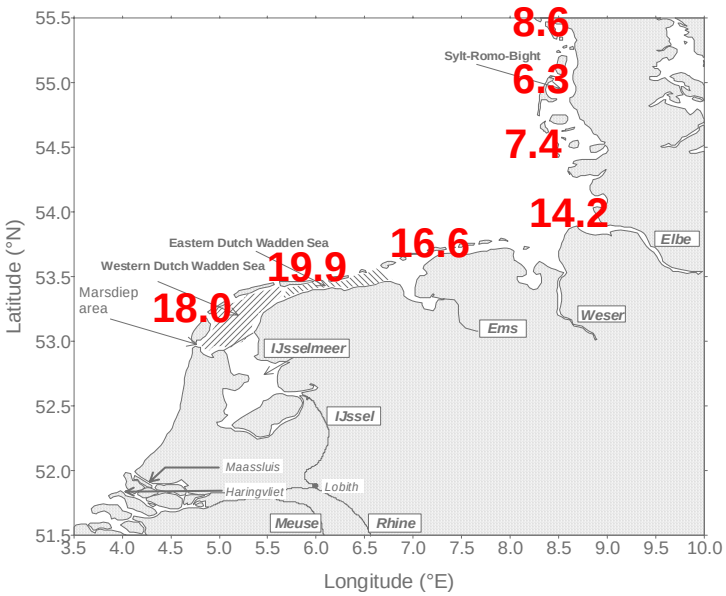

Figure 1: Spatial distribution of summer chlorophyll (Beusekom,TMAP-WFD Workshop).

The following conclusion could be made:

- Large Inter-annual Differences in Nutrient Discharge,
- Decreasing Trend in Nutrient Loads,
- Decreasing Trends in Eutrophication Status,
- No Universal Indicator (yet)
    - Southern Wadden Sea: NH4 + NO2
    - Entire Wadden Sea: Summer Chlorophyll (some areas)

- Presently: about 5 Times above Pre- Industrial Levels
- Southern Wadden Sea more eutrophic than the Northern Wadden Sea

Discussion:
- take reference values for inputs form pre-industrial level, based on expert judgment (Laane 1992)
- in the southern Wadden Sea better accumulation of organic material than in Northern part,
- remineralization steering eutrophication: yes – input of organic matter driving force

Reference conditions in transitional and coastal waters

Presentation Mr. Uwe Brockmann and Mr. Dilek Topcu, Uni Hamburg

Based on natural background concentrations of TN and TP in rivers and the assumed reference concentrations offshore, linear correlations with salinity are used for the calculation of reference values along the German North Sea coast. These and linear correlations of TN and TP with DIN and DIP during winter and between TN and chlorophyll during the growing season are used for the calculation of pristine inorganic winter-nutrients and chlorophyll concentrations. Rough estimates of phytoplankton primary production and calculated chlorophyll references are used to estimate maximum biomass of macrozooplankton during pristine conditions. Ranges of reference values are based on variability of recent mean salinity gradients. For some examples pristine and recent concentrations were compared.

Historical maps:
- total N and P: pristine concentrations about 1/5 of recent values
- DIN / DIP 10 – 15 µmol / 0.55 µmol (inner parts, tidal flats)
- Chl-a: 2 – 2.5 µg/l (mean), 10 – 15 µg/l (max.)

Growth limits of macrophytes (modeling spatial distribution: results: major occurrence in North Friesland)

Pristine macrozoobenthos biomass from pristine Chl-a concentrations: maximum possible biomass 10 g AFDW/m²
Recent values: partly lower than pristine (but: response of biomass on increasing organic matter input not linear)

Conclusions:
- Approach allows quantitative relations of eutrophication parameters,
- can be applied for assessment (regional maps), also in other areas,
- further improvement of reference data necessary,
- understanding of processes to be improved (nuisance / toxic species)

Discussion.
- zoobenthos and changes sediment types ? (Smit)
- different depth of NS and WS to be included in model (Smit)

Historical phosphate concentrations in the Wadden Sea

Presentation Mr. Gerd Liebezeit, Terramare Wilhelmshaven

It was examined whether blue mussels could be used as an indicator for nutrients status by determining phosphate in the inorganic fraction of the mussel shell. Historical values of phosphate concentrations were found in shells from a depth of 3 – 5 meters.

First results showed that this could be a promising technique to determine reference values from historical phosphate concentrations. Further investigations would be necessary to examine the main factors influencing the phosphate concentrations in the mussel shell (shell age, relation of P in shell and water).

Discussion
- check accumulation process of P in mussel shells,
- check different shell layers in old mussel beds,
- check also for cockles, “old” shells at RWS DNN available,

Nutrient gradients in the East Frisian Wadden Sea

Presentation Mr. Götz Flöser, GKSS Geesthacht

Nutrient concentrations in the East Frisian Wadden Sea are not uniform over space and time. In winter, higher nutrient concentrations from the sluice outlets are transported into the North Sea without being consumed by primary production. The production of nutrients by decomposition of organic matter is low as well.
In summer, concentrations of dissolved nutrients are generally much lower due to the consumption by high biological productivity, but steep gradients evolve towards the mainland. These gradients are stable and can be observed from May to October.
There are two processes that can generate these gradients of dissolved nutrient concentrations: 1) elevated nutrient production due to decreasing grain size and thus higher decomposition rate of organic matter and 2) lower diffusion in the water phase due to lower current velocity and water depth.
The combination of these effects can lead to a steeply increasing nutrient concentration towards the mainland. If this working hypothesis is correct, the observed gradients are natural ones and should be considered when doing budget calculations.

Discussion
- gradient from filter feeder activity
- also gradient in NL
- probably local sources and processes

Phytoplankton as Quality element in the WFD

Presentation Mr. Michael Hanslik (NLÖ Norderney) presented the results of the BMLP working group „Phytoplankton“

Species composition:
Proposals for a list with the historical species of the German North Sea and other European coastal water bodies are available (Phytoplankton species reference lists).
It is recommended the check already existing "historical" species lists and consolidation under the point of view of their usability (for example current species names including the older synonyms).

Abundance:
Specification of the exact historical abundance of the "natural" species inventory seems not to be realistic.
It is recommended to use qualitative specifications as "sporadically", "regularly", "often", "dominant", "bloom forming", so that comparability becomes more easer to historical descriptions and clear changes in the density can be registered furthermore

Algal blooms:
The relevance of algal blooms for the quality of the coastal water bodies of the North Sea and Baltic Sea is until now unclear. For instance, there are too big differences between

neighboring water bodies of same type (and probably the same quality); moreover the replacement of one bloom by an other is not interpretable.
It is recommended to use bloom intensity and bloom duration only as an additional criterion to the abundance for describing changes.

Biomass:
Phytoplankton biomass can be specified in different forms (mg of carbon per liter, biovolume and chlorophyll). For chlorophyll, reliable values for historical situations can be compiled.
Another possibility is calculation of chlor0phyll from historical nutrient data as it is done by BROCKMANN.
It is recommended:
Testing of the "chlorophyll model BROCKMANN" in the different types of coastal waters of the North Sea by comparison of the measured chlorophyll maxima and mean values with the modeled reference and evaluation on the basis of expert's knowledge and according to OSPAR.
Analysis of available Phytoplankton time rows of the East Frisian and North Frisian coast concerning the seasonal pattern, the dependence on the nutrient and salt gradient and the correlation of Phytoplankton biomass and chlorophyll a.
Comparison of the phytoplankton close to coast with coast-uninfluenced to form references of the seasonal cycle.
Intercalibration study with the measurement of the density of dominant species, the Phytoplankton biomass (mg C/l as well as biovolume) and the chlorophyll a concentration to calibrate the ratio cell biomass to chlorophyll and to record the different physiological states of the cells.
Verification whether a multifactorial evaluation system developed for the Baltic Sea and containing Phytoplankton biomass (chlorophyll and biovolume) and physico-chemical quality elements is applicable in the North Sea. Therefore modeled nutrient-reference values of the German North Sea and the Baltic Sea are available (BROCKMANN).
Evaluation of available Phytoplankton time series of the Elbe on the differences along a nutrient and salt gradient and tests of the transferability of the Baltic Sea reference conditions on the transitional water of the Elbe.

Eutrophication assessment in WFD

Presentation Mr. Victor de Jonge, Uni Groningen

Some examples on
- factors influencing eutrophication: light irradiance, nutrient influx and concentrations, flushing time and residence time,
- species composition phytoplankton high dynamic and fluctuations, how to judge and evaluate?
- Natural background values: before use of fertilizer in agriculture
- Suspended matter: highly influenced by wind; increased concentration due to dredge soil disposal (dumping near Rotterdam can be seen in the Wadden Sea; Reference values of SPM in Marsdiep 20g/m^3 is now 5 fold increase

Open questions:
- production and species composition
- effects on increased temperature (e.g. fish in North Sea)

Therefore focus on food web via Ecological Network Analysis (see WFD workshop January 2004)
- importance of zooplankton and meiobenthos in the ecosystem (Bair, Asmus, Asmus 2004)
- reference dynamic situation and resilience (pattern analysis, Grimm et al. 1993)

Discussion
- adaptation of monitoring network to ENA, e.g. to regional approaches
- basic research to get more knowledge on ecosystem functioning
- funding ENA pilot project ? NL Wadden Academy?

Perspectives for the WFD from ERSEM ecosystem simulations

Presentation Mr. Hermann Lenhart, Uni Hamburg

On the basis of the ecosystem model ERSEM (Eurpean Regional Seas Ecosystem Model) different studies were presented with the focus of their application for the WFD.

The scenarios with the COCOA (Continental Coastal Application) by Lenhart (1997, 2001) showed that a 50 % reduction in the nutrient river loads of N and P did not lead to a proportional reduction in the biological parameters, e.g. the net primary production is reduced by up to 20 % near the coast. In contrast, the reduction in the winter nutrient concentration was up to 40 %. Furthermore it became clear that a target has to be set what changes in the ecosystem will be judged as an improvement for the system. Here the WFD sets a clearer reference frame especially with the use of Ecological Quality Indicator.

The studies by Pätsch and Radach (1997) and by Wirtz (2002) highlighted two different aspects for a model approach within the WFD. The long term simulation by Pätsch and Radach (1997) showed that an ecosystem, which is kept on the river input level of 1955, differs in its integrated net primary production in relation to the actual state of the ecosystem, e.g. Atlantic inflow, intensity of the thermocline in summer etc. The study by Wirtz (2002) resulted in very low background concentrations for nutrients for the German Bight and the Wadden sea region, which are related to a careful representation of the appropriate boundary conditions and the processes within the Elbe estuary.

With the perspective of reduction strategies within the catchment area results from the EUROCAT project were presented (Windhorst et al., 2005; Hoffmann et al., 2004). Here the output from the nutrient emission model MONERIS was used as input for the ERSEM application COCOA and different scenarios (BAU: Business as usual; PT: Policy Target; DG: Deep Green) were performed. The comparison of local scenarios representing a nutrient reduction within the Elbe river input alone vs. a North Sea wide reduction of all rivers entering the North Sea revealed considerable differences for the German Bight area, which can be interpreted as the effect of trans-boundary processes.

It was concluded that for the application of ecosystem models within the WFD a suit of indicators is needed which are also available as state variables within ecosystem models. Furthermore the responsiveness of the different indicators to changes has to be tested. In order to simulate reference conditions generally accepted boundary conditions are needed. Finally the conclusion was drawn that in addition to the North Sea ecosystem models locally refined estuary and Wadden Sea models are needed, in order to be able to simulate both, the reference conditions and the reduction scenarios based on measures within the catchment area.

Conclusions Session Eutrophication

Fundamental differences exist between the Southern and Northern Wadden Sea, therefore regional specific approach has to be followed when defining reference values. The reasons for these differences can not yet be completely explained.

The process of trapping of particulate organic material should be examined in more detail, because it is one of the most important factors for changes in the eutrophication process.

Tuning of OSPAR and WFD approach is currently ongoing (WFD document on “Review of eutrophication in European water policy and conceptual framework); this has to be included in the overall approach.

a. Nutrients

Reference values for nutrient concentrations can be calculated for the Wadden Sea area. For the German Wadden Sea background values have been developed by Brockmann which allow also an spatial analysis. Reference values were calculated for DIN 10 – 15 µmol and for DIP 0.55 µmol (inner parts of the Wadden Sea). The recent values of total N and P are about 5 fold higher than the historical concentrations.
For the Dutch and Danish Wadden Sea, the TMAP data could be used to calculate background values applying the Brockman model.

For the entire Wadden Sea, a specific indicator has already been developed and applied in the QSR 2004 on a regional level (Beusekom et al. 2001). The seasonal cycle of nitrogen reflects the nutrient situation in the Wadden Sea better than winter concentrations do. In all Wadden Sea regions, the present values are about 5 fold higher compared to values reflecting the “non-problem conditions”.

Table 1: Classification of the Wadden Sea into Non-Problem, Potential Problem and Problem areas based on autumn concentrations of NH4 + NO2 (µM) as proposed by van Beusekom et al. (2001). The division in sub-regions is based on the availability of seasonal data. The present autumn values refer to values during the 1990‘s (1990-1997). Non-problem conditions were based on background values for the Western Dutch Wadden Sea.

Sub-region	Non-Problem conditions	Potential Problem conditions	Problem conditions	„Present“ values (1997-2002)
Western Dutch Wadden Sea	<3.0 µM	3.0 µM <> 8.3 µM	> 8.3 µM	9.9µM
Eastern Dutch Wadden Sea	<4.0 µM	4.0 µM <> 10.2 µM	> 10.2 µM	19.8µM
Lower Sax. Wadden Sea	<3.2 µM	3.2 µM <> 8.2 µM	> 8.2 µM	10.1µM
Sylt Rømø Bight	<1.9 µM	1.9 µM <> 4.2 µM	> 4.2 µM	6.1µM
Danish Wadden Sea	<2.5 µM	2.5 µM <> 6.5 µM	> 6.5 µM	10.2µM

b. Phytoplankton

Chlorophyll concentrations: summer concentrations give reliable values; annual mean gives only a rough estimation.

For the German Wadden Sea it was suggested to use background values as developed by Brockmann (spatial resolution for German coast available): Chlorophyll a: 2 – 2.5 µg/l (mean), 10 – 15 µg/l (max.)

Phytoplankton species and abundance: more difficulties, species and abundance “doesn’t tell anything”, use chlorophyll and primary conditions, use functional species groups, fluxes; also taxonomic difficulties
Concrete historical specifications to the biomass of phytoplankton are available for chlorophyll. Another possibility is the modeling from historical nutrient data as it is done by BROCKMANN for the chlorophyll.
Testing of the "chlorophyll model BROCKMANN” in the different types of coastal waters of the North Sea by comparison of the measured chlorophyll maxima and mean values with the modeled reference and evaluation on the basis of expert's knowledge and according to OSPAR.

An analysis of available phytoplankton time series concerning the seasonal pattern should be carried out taking into account the dependence on nutrient and salt gradient and the correlation of phytoplankton biomass and chlorophyll a.

5. Macrophytes and Zoobenthos

References and Status designation of the Dutch Wadden Sea

Mr. Paul de Graaf (RWS DNN Leeuwarden) presented the current status of development of reference conditions for the Dutch Wadden Sea. Based on the WFD Guidance documents, reference values and classification tools have been proposed for salt marshes and seagrass in coastal waters:

Tidal salt marshes:
- Area covered: High: >30,000 ha; Good: >20,000 ha
- Quality (balanced distribution of vegetation zones):High: 6; Good: 4-5

Seagrass:
- Area covered (% total water body): High: >10%; Good: >5%
- Quality (mean coverage):
  High: Dwarf grass-wrack: >60% or Eelgrass: >30%;
  Good: Dwarf grass-wrack: >40% or Eelgrass: >20%

Because of significant, irreversible hydromorphological changes caused by diking and embankments, it was concluded that the GES could not be reached by 2015. According to the WFD the Wadden Sea could be regarded as HMWB. As a result the designation of the Dutch Wadden Sea may differ from the German and Danish Wadden Sea coastal waters which will be designated as natural waters. In order to follow a coherent approach in the Wadden Sea, it was decided to adapt goals and measures for salt marshes and seagrasses to the present hydromorphological situation.
This illustrated that the formulation of reference values strongly depends on the definition of the framework and boundaries (basic assumption) in which these values should be applied including the definition of the GES.

He also underlined the necessity to harmonize the different approaches for adjacent river basins between EU member states. This key issue will be addressed in the proposed Interreg IIIB project HARBASINS.

Discussion:

Ms. Schanz explained the important functional role of seagrasses in the Wadden Sea and its indicator role for the ecosystems's health. A change in the system will be reflected by the seagrass development. However, the specific causes for the observed developments could only be partly explained by now, e.g. the relation to eutrophication, turbidity and hydrological changes. The reasons for the differences in the regional distribution (over 80% of seagrasses can be found in North Friesland) are also not know and should be examined in more detail.
Because of changes in the hydrology and turbidity, as well as sediment composition in the Wadden Sea, it can not be expected that seagrass will reach its former extension again; especially with regard to the subtidal seagras beds which have completely disappeared.

Mr. Knudsen informed that in Denmark, the Wadden Sea is not specifically addressed with regard to seagrass but that in the other coastal areas depth distribution of seagrass would be taken as an assessment criteria. He suggested to use the observed shift from seagrass to macroalgae in the Wadden Sea as an additional criteria. He further suggested to examine which potential the present area has to serve as habitat for seagrass.

With regard to salt marshes, the proposed 30,000 ha for the Dutch area was in general regarded too high as reference condition. It was pointed out that in increase of salt marsh area could be achieved but would result in a loss of tidal flats which would be in contradiction to the conservation aims.

Mr. Heiber informed that, in Germany, it has not yet been decided how to deal with salt marshes in coastal waters. As in transitional waters, the extent (ha) and the quality (vegetations zones, equilibrium status) of salt marshes (incl. reeds) may be applied as assessment criteria. He referred to an recently published report "Study to determine reference values respectively natural variability of chemical and biological marine monitoring parameters, part North Sea, German Bight" (Heiber et al. 2004). In this study, literature and data were compile and resulted in an overview of data available from historical works. Long-term developments of the different components are considered with respect to possible trends and phenomena. Based on the results of this investigation, proposals are derived for reference values for transitional and coastal waters.

Conclusions: Macrophytes / Angiosperms

- use existing boundary conditions for development of reference values for seagrass and salt marshes (preparation of potential habitat maps?)

Criteria:

- seagrass: size of seagrass fields (area) in intertidal and subtidal (ha and % of total area), quality (coverage of seagrass fields, % and main species), unclear how to handle the regional differences in distribution and quality,
- macroalgae: % coverage of tidal flats, main species composition (in Germany: subtidal brown and red algae: depth limit)
- salt marshes: area of salt marshes (ha) and quality (distribution of vegetation zones).
- TMAP Salt marsh group to prepare proposal based on TMAP data.
- Ad-hoc group seagrasses / macroalgae to prepare Wadden Sea proposal based on TMAP data.

Macrozoobenthos What can we learn from long-term monitoring data?

Mr. Essink (RIKZ Haren) presented long term series of macrozoobenthos monitoring

- changes in species composition: decreases of species (e.g. oyster beds) and increase of polychaetes adapted to disturbed habitats: conclusion: less than GES
- in parallel, the biomass of polychaetes increased, whereas the biomass of bivalves (large fluctuations due to strong winters) shows no trend.
- Centers of distribution of bivalves shifted to higher intertidal levels with more muddy sediments, mainly due to epibenthic predation pressure
- Changes of sediment characteristics: Sediment at lower intertidal levels got coarser; Loss of fine grained sediment due to “coastal squeeze”. Result: Loss of preferred settling habitat for juvenile bivalves.
- Difference alternatives as starting point for the development of reference conditions.

The workshop discussed the results and questioned whether large fluctuation in space and time, as observed in bivalve biomass, can be used as for the definition of for reference values.

It was further underlined that historic values (from 50 – 100 years ago) cannot directly be transferred to the current situation because the hydromorphological conditions and habitat characteristics have bee changed significantly. Therefore, historical values have adapted (e.g. by ecosystem modeling, use of habitat maps, or best expert judgment) to the current system conditions.

Compilation of benthic metrics and their suitability for the assessment of the ecological status of coastal and transitional water in Germany - macrozoobenthos-

Ms. Karin Heyer (Uni Hamburg) presented the study which is part of the project “Assessment of the eutrophication status of transitional and coastal waters of the North Sea (OSPAR and WFD)” by Uwe Brockmann and is supported by the Environmental Agency of Germany (UBA).

She pointed out the macrozoobenthos is good indicator of the system for several reasons:

- It has generally limited mobility and can‘t avoid adverse conditions. Therefore it reflects local environmental conditions.
- Partly the organisms are long-lived, so they integrated for a longer period.
- Species determination is comparable simple.
- There is a lot of knowledge in autecology.
- There are much more data, than for other animal groups.

But there is a great difficulty because the structure of the benthos also reflects anthropogenic stress and natural variation such as sediment characteristics. Mostly it is impossible to separate the causes for the variation to anthropogenic or natural (e.g. serve winters) impacts.

- non-linear response of species number, abundance and biomass to disturbance,
- regional differences zoobenthos time series (biomass increase in Marsdiep due to increased chlorophyll concentrations, but no similar development in the other areas)

Test of different indices in the Schleswig-Holstein Wadden Sea (LANU stations in the inner intertidal areas and outer subtidal) (Borja et al. 2000, 2003). Results:

- Changes in the macrobenthos due to anthropogenic impacts are measurable, but not in all regions in the same way.
- On the basis of index values it is not possible to draw conclusions on the sort of impact.
- Only the AMBI index gives for all stations and dates plausible results, but not the Shannon-Weaver Index.

- Reference conditions have to be defined, because a high level of the parameters biomass, species or individual numbers can result from very good ecological situation as well as at the beginning of an impact.
- Species lists have to be checked for the Wadden Sea
- Classification schemes and classification of the species to the 5 groups have to be adapted to the Wadden Sea conditions.
- The AMBI should be tested at more Wadden Sea stations and should be correlated with other parameters e.g. TOC or grain sizes.

She presented the experiences from the US EMAP (Environmental Monitoring and Assessment Programme) and an example for an assessment method in the Chesapeake Bay. Different metrics (from seven indicators) are combined to asses the status of an habitat. For zoobenthos, the Estuarine Benthic Index of Biotic Integrity was applied (after Weisberg et al. 1997).

In the discussion it was underlined that species list and weighting factors have to be adapted to the specific situation of the Wadden Sea, e.g. the sensitivity to additional inputs (because the Wadden Sea has per se an high level of organic input) and to hydrodynamic changes. The proposed indices should be further tested with available TMAP data and modified with regard to specific pressures (organic matter, pollutants, fishery, hydrodynamics).

Intertidal blue mussel beds

Mr. Nobert Dankers (Alterra Texel) shortly reported about the results of the monitoring of intertidal blue mussel beds in the TMAP. The development of blue mussel beds can extent over a period of ten years during which the size of beds and single patches, as well as the internal structure can vary extremely due to irregular spatfalls but also storms and ice shear. Therefore, a “mussel bed site” may be more appropriate unit for an assessment than a single mussel bed. Experiences with this approach have been gained in Lower Saxony.

With regard to calculation of a reference condition of mussel beds he referred to the Dutch study on potential habitats for blue mussel beds which resulted in coverage of blue mussel beds on intertidal flats of about 4%. Additional quality criteria for blue mussel beds are age of beds, density of patches, and age structure of mussels.

EQA coastal and transitional waters by use of benthos: conceptual approach & first practical application

Marinus Bokhorst (RIKZ Haren) presented a concept of a scale-dependent classification system for macrobenthic communities in transitional/coastal waters (meso-/macrotidal).
A first application of this concept carried out for fully mixed transitional waters (Westerschelde and Eems-Dollard) and sheltered, meso-/macrotidal coastal waters (Oosterschelde, Waddensea) by the RIKZ (Fred Twisk).

The scale-dependent classification system covers three levels:

- Level 1: Scale of the water body – functional
    - Species list for the whole waterbody based on literature (Reference = 75% of this list)
    - Benthos biomass – primary production relation (Herman et al., 1999, Adv. Ecol. Res.) Reference = Biomass (g AFDW per m2) = -1.5 + 0.105 * prim. prod. (g C per m2 per year)
- Level 2: Ecotopes/habitats in the water body – spatial organization, habitat diversity
    - Type and extent of habitat types in a water body, given its morphodynamic characteristics.
    - System completeness in terms of habitats

  - Dutch classification ~ EUNIS
  - Salinity, depth, hydrodynamics (sediment compostion)
  - Eco-elements: e.g. musselbeds
- Level 3: Biological quality within ecotopes – community structure, species diversity
  - Six ecotopes distinguished,
  - Species composition and abundance was estimated for each ecotope (based on literature) = reference condition
  - AMBI index (Borja et al. 2000) calculated for each ecotope

It appeared that AMBI was not directly applicable to transitional waters (both in the mesohaline as in the polyhaline areas) because, a.o., organic enrichment in estuaries is natural and not necessarily negative. Furthermore, because of different weighting factors of high and low dynamic areas, the AMBI does not reflect the ecological quality correctly. Therefore, metrics should be defined habitat-specific.
Based on these experiences, the concept will be further elaborated. Additional data from actual monitoring has to be included, e.g. species composition for each habitat type. It is still open how to deal with invasive species in this concept.

Conclusions macrozoobenthos

- Adapt historical values to the current situation in definition of reference values.
- Include “natural” annual fluctuations and long term developments of biomass and abundance in development of reference conditions and assessment procedures
- Consider long-term changes in sediment composition (sediment maps),
- Further elaboration of a scale dependent classification system for macrofauna,
- Extend test of AMBI index by inclusion of additional stations (data from TMAP),
- The different benthos indices may not appropriately reflect the quality of the system.
- The AMBI is currently tested in NL and FRG and should be adapted to the Wadden Sea.
- Relate changes in benthos to specific pressures (organic matter, pollutants, fishery, hydrodynamics).
- The relationship between biomass of macrofauna, chlorophyll and primary production should be considered as a possible indicator. This requires a better monitoring of primary production for the entire Wadden Sea.
- Preparation of a list of sensitive benthos species by trilateral experts (lead TMAG) using TMAP data
- Estimation of the area of potential habitats for blue mussel beds (e.g. NL Habitat Map).
- Development of reference conditions for blue mussel beds have take into account the high fluctuations over a longer time span. Historic data should be assessed together with recent more reliable data of the last 10 – 20 years and in the light of the changed hydrodynamics.
- Coverage of 4% intertidal blue mussel beds as reference values may serve as a starting point and has to be tested with TMAP data.

6. Conclusions and Recommendations

6.1 General

The process of defining reference values for the Wadden Sea coastal and transitional waters is seriously hampered by several factors, such as loss of pristine undisturbed areas, high variability in space and time, lack of data and models, and differences in expert judgment.
Development of reference conditions in the Wadden Sea is mostly be done by using historical data, but also, as appropriate and in hierarchical order, data from modeling or expert judgment. Additionally, for specific properties, reference conditions may bed defined based on relatively undisturbed areas in the Wadden Sea or similar areas along other comparable coasts.
Using historical data for development of reference conditions requires an adaptation of these data to the current situation e.g. with regards to changed hydromorphology and climate.
Another important aspect is the selection of boundary conditions for definition of reference conditions. Different approaches were observed in the Wadden Sea for deriving reference conditions: either from historical times before large embankments occurred or by taking the existing situation (coastal defense, shipping) as a starting point.
The development of assessment tools for the WFD is not yet completely tuned with trilateral agreements (Wadden Sea Plan) and activities in the framework of the Habitats Directives ("favorable conservation status") and OSPAR.

Recommendations

1. Translation of historical values into the current situation by modeling or expert judgment.
2. Description of reference situation based on undisturbed parts of the system or specific properties relatively undisturbed parts of the Wadden Sea or similar areas along other comparable coasts.
3. Coherent definition of boundary conditions for the deriving reference conditions for the entire Wadden Sea.
4. The development of assessment tools for the WFD (reference conditions, classification) should be tuned with Wadden Sea Plan, the Habitats and Birds Directive as well as OSPAR procedures.

6.2 Eutrophication

There was a general agreement that the present nutrient loads and coupled processes were a factor 5 – 6 above the reference values.
Reference values for nutrients and chlorophyll can be calculated for the entire Wadden Sea. In addition, the seasonal cycling of nutrients can be applied as most appropriate indicator for the eutrophication status of the Wadden Sea as outlined in the QSR 2004.
Input of particulate organic matter strongly influences the eutrophication status of the Wadden Sea.
Species composition and abundance of phytoplankton as a classification tool are difficult to apply in transitional and coastal waters of the Wadden Sea. More guidance is expected from the WFD document on eutrophication which is currently being prepared (see also WFD ISPRA Workshop on Eutrophication) in order to tune the WFD assessment (Good Ecological Status) with the OSPAR approach (Non-problem area).
The analysis of functional phytoplankton groups may be more appropriate than the use of taxonomic units (single species).

Recommendations:

1. Regional specific / water body type specific nutrient and chlorophyll values can be derived for the entire Wadden Sea
    a. DIN 10 – 15 µmol, DIP 0.55 µmol
    b. chlorophyll a: 2 – 2.5 µg/l (mean), 10- 15 µg/l (max)
    c. NH4+NO2: 1.9 – 4.0 µm (autumn concentrations)
2. Extension of the Brockmann model to the entire Wadden Sea by using TMAP data.
3. Analysis of available phytoplankton times series concerning species composition and functional groups.

6.3 Macrophytes/Angiosperms

For safety of the mainland the present dikes along the Wadden Sea coast remain necessary. Therefore the existing boundary conditions should be taken as a starting point for development of reference values for seagrass and salt marshes.
For seagrass the metrics would be (1) size of seagrass fields (area) in intertidal and subtidal (ha and % of total area), and (2) quality (coverage of seegrass fields, % and main species). Because of the regional differences in distribution and quality, regional specific reference values must be developed.
For macroaglae, % coverage of intertidal flats could be used. Reference values can be derived from long-term data sets.
For salt marshes, the area of salt marshes (ha) and quality (distribution of vegetation zones) could be used based on the harmonized TMAP salt marsh typology.

Recommendations

1. TMAP Salt marsh group to prepare proposal based on TMAP salt marsh typology.
2. Ad-hoc group seagrasses / macroalgae to prepare Wadden Sea proposal based on TMAP data.

6.4 Macrozoobenthos

Macrozoobenthos is a good indicator of the status of the system. However, it is difficult to distinguish between the causes for the observed changes (various anthropogenic cause or natural causes). Development of reference conditions and assessment procedures have also to take into account the “natural” large fluctuation of species composition and abundance of macrofauna in space and time, as well as, long-term changes in sediment composition.
The relationship between biomass of macrofauna and chlorophyll, as well as primary production should be considered as a possible indicator. This requires a better monitoring of primary production for the entire Wadden Sea.
The use of AMBI may be appropriate but needs further adaptation to the Wadden Sea conditions and testing to Wadden Sea specific data. The AMBI has to be connected with the WFD parameters abundance and diversity. A scale-dependent classification system (water body, habitat, community) may be appropriate but requires further elaboration.
For blue mussel, as a special element of the Wadden Sea macrozoobenthos, a coverage of 4% of intertidal flats with blue mussel beds seems reasonable as reference value but requires further testing.

Recommendations

1. Further elaboration of a scale-dependent classification system (water body, habitat, community) for macrofauna,
2. Further development and adaptation of AMBI for the Wadden Sea (selection of sensitive species, adaptation of weighing factors)
3. Testing of AMBI using data from additional stations from the TMAP.

4. Preparation of a map with potential habitats for blue mussel beds (extension of the NL habitat map) in conjunction with sediment maps.
5. Testing of the proposed reference value of 4% for blue mussel beds with data from the TMAP.
6. Further examination of quantitative relations between phytoplankton (biomass, primary production) and macrofauna (biomass, abundance, species composition).

6.5 Organizational

The workshop underlined the importance to consider transboundary influences between River Basin Districts in the Wadden Sea but also influences from outside the Wadden Sea (e.g. transport of nutrients and particulate organic matter with regard to eutrophication). These aspects have not yet received the desired attention in the framework of the WFD implementation. Differences were observed between the countries concerning the definition of reference conditions in coastal and transitional waters also with regard to the work planning and time schedule.
The workshop therefore was the opinion that the development of reference values should be coordinated within the entire Wadden Sea and that the TMAP should be used as a platform for such activities. This should also be tuned with requirements of the Habitats and Birds Directive.

Recommendations

1. Further cooperation in the implementation of the WFD, HD and BD in the Wadden Sea using the Trilateral Wadden Sea Cooperation and the TMAP as a common platform to assist in this task.
2. The Wadden Sea Plan targets can be used for assessment of the good ecological status but require to be operationalized. This should not only be done on a scientific level but also with participation of managers and stakeholders
3. Use of the existing working structures (TMAG and subgroups) and of TMAP data for these activities.
4. Further improvement of transboundary cooperation by joining the proposed Interrreg IIIB project “HARBASINS”.
5. Communication with and input to the relevant WFD activities on the EU level (Coast WG, NEA-Geographical Intercalibration Groups, thematic workshops).

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Websites:

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http://forum.europa.eu.int/Public/irc/env/Home/main

EEA EIONET
http://www.eionet.eu.int/

Wasserblick
www.wasseblick.net

Europese Kaderrichtlijn Water
http://www.kaderrichtlijnwater.nl

Wadden Sea
www.waddensea-secretariat.org/workshops/wfd-tmap.html

Download of daily river data:
ftp.ifm.uni-hamburg.de/pub/data/riverload/

Annex 1 Terms of Reference

TMAP – WFD Workshop on Reference Values
Center of Marine and Atmospheric Sciences
Hamburg
29 – 30 November 2004

Introduction

The three Wadden Sea countries, the Netherlands, Germany and Denmark, agreed to coordinate their policy and management on the protection of the Wadden Sea including the implementation of the relevant EU Directives (Joint Declaration 1982, Ministerial Declaration, Esbjerg 2001).
Based on the recommendations of the workshop “Water Framework Directive (WFD) and Wadden Sea” in Hamburg, 27 – 28 January 2004 the Trilateral Cooperation agreed to continue the coordination of monitoring and management with regard to the implementation of the WFD (see: www.waddensea-secretariat.org).
The upcoming workshop on Reference Values has been initiated with the aim of discussing the development of Wadden Sea specific reference values in the implementation process of the Water Framework Directive. The justification for such a meeting is the obvious necessity of having comparable reference values within the Wadden Sea irrespective of the specific WFD River Basin Districts.

Objective

The expert workshop shall discuss the experiences in the development of Wadden Sea specific reference values for the WFD and its implication for the Wadden Sea monitoring and management. The aims of the workshop are:

- to exchange information and experiences with the development of reference values in the three countries and the different River Basin Districts,
- to try to find a coherent approach for definition of reference values for the Wadden Sea, for coastal waters as well as for transitional waters.

Program

In the first part of the meeting the participants are invited to present their activities and projects with regard to the development of Wadden Sea specific reference values.
In the second part, the workshop will be structured by thematic subgroups. Building upon the presentations of the first part, subgroups should discuss whether differences can be observed in the three countries or RBDs, how to deal with these differences and how to coordinate the further process in the future.

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Center of Marine and Atmospheric Sciences
Hamburg
29 – 30 November 2004

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Annex 3 Workshop Program

TMAP – WFD Workshop on Reference Values
Center of Marine and Atmospheric Sciences
Hamburg
29 – 30 November 2004

Program

Monday 29.11.04

Introduction

13:00 Karel Essink (RIKZ): *Welcome and introduction to the workshop*

13:10: Harald Marencic (CWSS): *Status of WFD Implementation in the Wadden Sea*

13:35 Karel Essink (RIKZ*): Reference values – experiences from the TMAP and QSR 2004*

14:00 Marinus Bokhorst (RIKZ): *Development of Reference Values in the Dutch Wadden Sea*

14:30 – 14:50 Coffee break

Eutrophication

14:50 Justus van Beusekom, AWI Sylt: *Eutrophication status of the Wadden Sea*

15:15 Uwe Brockmann, Dilek Topcu, Uni Hamburg: *Reference conditions in transitional and coastal waters*

15:40 Gerd Liebezeit, Terramare: *Assessment of historical phosphate concentrations in the Wadden Sea*

16:00 Götz Flöser, GKSS: *Nutrient gradients in the East Frisian Wadden Sea*

16:20 – 16:45 Coffee Break

16:45 Michael Hanslik NLÖ: *Phytoplankton as quality element in the WFD*

17:10 Victor de Jonge, Uni Groningen: *Eutrophication criteria*

17:30 Hermann Lenhart, Uni Hamburg: : *Perspectives for the WFD from ERSEM ecosystem simulations*

17:50 – 18:30 Plenary discussion

20:00 Workshop Dinner

Tuesday 30.11.04

Macrophytes & Zoobenthos

9:00 Paul de Graaf, RWS DNN: *Reference values for s alt marshes and seagrass in relation to Heavily Modified Water Bodies (HMWB)*

9:30 Karel Essink: *QSR 2004: Long-term development of zoobenthos in the Wadden Sea*

10:00 – 10:20 Coffee break

10:20 Karin Heyer, Hamburg, *Compilation of benthic metrics and their suitability for the assessment of the ecological status of coastal and transitional waters in Germany.*

10:40 Norbert Dankers, Alterra: *Blue Mussel Beds*

11:00 Marinus Bokhorst, RIKZ *Dutch approach regarding zoobenthos*

11:20 – 12:30 Plenary Discussion / Summary and Follow-up

Annex 4 TMAP WFD Workshop on 27 – 28 January 2004

"Water Framework Directive and Wadden Sea Cooperation"
Workshop, Hamburg, 27 – 28 January 2004
Final Version, April 2004

As a result of the discussions in the sub-groups and in a final plenary, the following conclusions and recommendations have been deduced:

Conclusions

1. The implementation of the WFD in the Wadden Sea requires an intensive cooperation of all concerned authorities, at the national as well as at the trilateral level.

2. The work of the Trilateral Cooperation covers, to a large extent, the work required for the WFD with regard to targets, monitoring and management.

3. A close coordination between the WFD and other relevant management and monitoring activities in the Wadden Sea is necessary to safeguard coherence with the EU Directives on Habitats and Birds, the trilateral policy of in integrated management of the Wadden Sea, other international conventions and further relevant aspects like ICZM.

4. The information exchange and coordination of these activities have not yet been optimized for the Wadden Sea because different institutions/persons are involved, time schedules are not synchronized and priority setting is different.

5. The definition of specific management aims, monitoring strategies and quality objectives for the WFD and HD in the Wadden Sea should be coordinated on the trilateral level.

6. The experiences of the Trilateral Cooperation (Wadden Sea Plan, Targets, TMAP) could provide a basis for a joint implementation of the WFD and HD in the Wadden Sea.

Recommendations

1. Information exchange and coordination in the Wadden Sea Area

It is recommended:

EU Working Group Coast 2.A

1. to take into account the present trilateral policy with respect to integrated management of the Wadden Sea,

RBD working level

2. to consider the tenor of the trilateral agreement (Wadden Sea Plan, targets, TMAP) and other relevant aspects like ICZM, and to enhance the information flow to the trilateral working groups,

TWG:

3. to promote the connection of the WFD implementation on the national level with the trilateral work, and to ensure a steady and close cooperation between involved institutions with regard to the Wadden Sea,
4. to coordinate the implementation of the WFD in the Wadden Sea with the implementation of the Habitat and Bird Directives and the activities of the Trilateral Cooperation.

TMAG:

5. organize regular information flow on the WFD and HD implementation status on the trilateral level,
6. to enhance the information flow to the RBD working level by including WFD experts in the regular TMAG work.

2. Development of a common understanding of monitoring and management goals

It is recommended:

TWG

7. to develop a common understanding of the WFD notions “good ecological status”, respectively “favorable conservation status” for the Wadden Sea and to specify them on the basis of the existing Wadden Sea Plan targets,

TMAG

8. to evaluate the current TMAP with regard to the demands of the WFD, HD and BD
9. to prepare proposals for modification / specification of the TMAP (according § 81 ED) to fulfill the demands of the EU Directives based on common Wadden Sea objectives,
10. to develop proposals for Wadden Sea specific reference values as further specification of the Wadden Sea Plan targets.

3. Follow-up activities

The outcome of discussions was that two types of future meetings were considered worth while:

11. Workshop on Wadden Sea specific reference values

    A meeting of a “Wadden Sea Intercalibration Group” with experts from each country involved in the development of reference conditions (e.g. Uda Tuente, Jens Brøgger Jensen, Janette van Buuren) to discuss the development of Wadden Sea specific reference values for the WFD. The justification for such a meeting is the obvious necessity of having common reference values within the Wadden Sea irrespective of which River Basin District a specific part of the Wadden Sea belongs to.
    Time: [September 2004].

12. Follow up workshops on specific themes

    Specific Wadden Sea themes (e.g., monitoring strategies and methods, assessment procedures and criteria) should jointly be discussed between the trilateral working level and the working level concerned with the implementation of EU Directives (WFD, HD, BD)
    Justification: The necessity of maintaining a coherent Wadden Sea approach, development of specific monitoring and assessment techniques for the Wadden Sea, taking into account the transboundary character of the Wadden Sea.
    Time: as appropriate, possibly in combination with thematic TMAP workshops, to be organized by the TMAG.