

Implementation of the Trilateral Monitoring and Assessment Program (TMAP)

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**Common Wadden Sea Secretariat
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PREFACE

1. Decision of the Stade Conference on the TMAP implementation

The report "Implementation of the Trilateral Monitoring and Assessment Program (TMAP)" was elaborated by the Trilateral Monitoring and Assessment Group (TMAG) in fulfillment of §67 of the Leeuwarden Declaration (1994). The work has been carried out in the framework of the DEMOWAD project co-financed by the European Commission under the LIFE Program.

The report entails proposals on the implementation of the different parts of the Wadden Sea monitoring program by defining priority parameter groups and developing implementation scenarios taking into account technical and financial implications.

In the framework of the preparation of the Eighth Trilateral Governmental Conference (TGC) in Stade (Germany) in October 1997, a draft version of this report was considered by the Trilateral Working Group (TWG) and the Senior Officials (SO).

As a result of the negotiations, a proposal for the implementation of a common package of TMAP parameters was elaborated based on the minimum proposal of the TMAG, stated in its report (the so-called "A-minus-scenario"), and presented to the Stade Conference.

At the Stade Conference, the Ministers expressed their appreciation about the work exercised by the TMAG in elaborating the report. They agreed to implement the common package of parameters as in **Table 1** and, to this end, establish, as soon as possible, the necessary financial and organizational preconditions for its implementation including the associated data management (Stade Declaration §§ 20 - 21).

The Ministers also agreed to an evaluation of experiences with this common package at the next Wadden Sea Conference (Stade Declaration § 22).

2. Present status of the TMAP

The development of the TMAP has made considerable progress since the publication of the draft report in April 1997:

- A common package of TMAP parameters have been adopted by the Ministers and will be implemented together with the associated data management as laid down in the report. It covers all important categories of Wadden Sea monitoring except microbiological parameters (mainly because of technical limitations). Several parameters which were monitored only in one or two countries in regular programs will now be monitored in all three countries using common guidelines. Furthermore, the parameter 'Contaminants in Bird Eggs' will be implemented as a completely new parameter group in regular Wadden Sea monitoring.
- A TMAP Manual entailing guidelines of selected parameter groups have been adopted. Modifications were agreed regarding the TMAP guidelines which, in most cases, are minor changes to the proposed draft guidelines. Activities have already started to implement these guidelines into the national monitoring programs, including the associated data management, and to organize the coordinated assessment of the derived monitoring data.
- The prototype of a TMAP data management system was developed and installed in each country as described in the report. For two selected parameter groups, the prototype has successfully demonstrated the functionality of the trilateral data exchange and can be accessed via the Internet (<http://cwss.www.de/demowad/>). In all Wadden Sea countries structures will be set up to maintain and further develop this prototype.

3. The TMAP and the Wadden Sea Plan

At the Trilateral Governmental Conference in Stade in October 1997, a management plan, the Trilateral Wadden Sea Plan, was adopted. The plan aims at implementing the common ecological targets and targets on cultural and historical aspects. The plan is structured according to the target categories. For each target category, a trilateral policy and a common management strategy have been adopted, as well as, trilateral projects and actions, necessary for the implementation of the targets.

The TMAP is an important instrument of the Wadden Sea Plan when evaluating the progress made in implementing the targets. Based on the common package of the TMAP, basic information about the status of most of the targets will be obtained because the targets were the major criteria for the selection of the parameter groups of the common package. Common monitoring strategies and assessment procedures, as well as, a modern data exchange system will make the required information faster and easier available than in the past.

The TMAP also supports the Wadden Sea Plan by making the results of monitoring available to relevant authorities, interest groups and local citizens as laid down in the Wadden Sea Plan (Chapter I, § 15). Furthermore, the Internet website of the Common Wadden Sea Secretariat (CWSS) supports a more effective communication and information regarding the implementation of the Wadden Sea Plan.

Table 1: Common Package TMAP. The parameters in the Common Package will be monitored according to the agreed common TMAP Guidelines.

Category		Parameter Group
Contaminants	1	TBT in water and sediment
	2	Metals in sediment
Nutrients	3	Inorganic nutrients in water
Salt Marshes	4	Spatial extension
	5	Agricultural utilization: grazing
Benthos	6	Macroalgae
	7	Eelgrass
	8	Macrozoobenthos communities
	9	Blue Mussel beds
	10	Contaminants in Blue Mussel
Plankton	11	Phytoplankton
Fish	12	Contaminants in Flounder
	13	Mussel/Cockle/Shrimp fishery
Beaches and Dunes	14	Spatial extension
Birds	15	Breeding birds: numbers and distribution
	16	Breeding birds: contaminants in bird eggs
	17	Migratory birds: numbers of waterbirds in counting units
	18	Beached Bird Survey (BBS)
Seals	19	Population parameters by aerial survey
Recreational Activities	20	Boats at sea
	21	No. of guided tours
	22	Air traffic
General Parameters	23	Coastal protection measures
	24	Geomorphology
	25	Flooding
	26	Land use
	27	Weather conditions
	28	Hydrology

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0. EXECUTIVE SUMMARY

0.1 Introduction

The Trilateral Monitoring Expert Group (TMEG) elaborated a basic concept for an integrated Trilateral Monitoring and Assessment Program (TMAP) for the entire Wadden Sea in the period 1992 - 1993. In 1993, the concept was adopted by the Senior Officials and the program started with a sub-set of parameters based on the existing and not yet harmonized national monitoring programs in January 1994. Since then, the program has been further developed by the Trilateral Monitoring and Assessment Group (TMAG). The work is presently carried out within the "DEMOWAD" project which runs from 1 April 1995 to 31 March 1998 and is co-financed by the LIFE program of the European Commission.

Joint monitoring programs for breeding and migratory birds and seals have already been trilaterally implemented and are part of the TMAP.

The general aim of trilateral Wadden Sea monitoring, assessment and research is basically twofold, namely

- to provide a scientific assessment of the status of the ecosystem based on the parameters derived from the Issues of Concern and Hypotheses of the TMAP and
- to assess the status of implementation of the Ecological Targets.

0.2 The parameters

It is proposed to implement the program by a step-wise approach taking into account methodological and financial aspects, as well as the relevance of the parameters for the overall assessment of the TMAP hypotheses and the Ecological Targets. The Parameter Groups are hence ranked into different priorities A, B and C regarding their implementation.

- The A-parameters are important for assessment and management (TMAP-hypotheses and ecotargets) and can be implemented with relatively low effort. Draft guidelines for the Priority A-parameters were elaborated in 1996 and nationally discussed in 1997.
- The B-parameters are also essential for the TMAP but because of the technical effort needed, the implementation is only possible after appropriate methods/guidelines have been elaborated. They should be implemented after the A-parameters have been implemented.
- The parameters with priority C are also essential for the TMAP but are of less importance relative to A and B and need a relatively high technical implementation effort (e.g. development of new methods, additional research projects).

The majority of the A-parameters will, as a starting point, provide some of the information necessary for the evaluation of the TMAP hypotheses and the ecotargets, however, gaps remain. Therefore, additional parameters (B and C) must be implemented as soon as possible to cover the most essential aspects of the TMAP hypotheses and provide the basis for evaluating the targets.

0.3 The costs

The A-parameters must be regarded as a minimum requirement for what can be regarded as a 'reasonable' program. For this reason the A-parameters were taken as the starting point for the development of the intermediate and cost-neutral scenarios.

The TMAG made an estimation of the additional costs for a running harmonized program consisting of only the A-parameters. The total yearly amount of additional costs for **all A-Parameter** groups was estimated at approx. 2.6 million DM.

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Of the 41 A-parameter groups seven can be implemented without additional costs. After some minor amendments another five groups could be added. Regarding a cost-neutral scenario, the TMAG was unanimous in its feeling that this can **not** be regarded as a harmonized trilateral monitoring program.

The TMAG identified 9 parameter groups as being possible candidates for implementation at a later stage. The major criterion in this evaluation was the relevance of the parameters for the assessment of the Ecotargets. The result of this evaluation was a so-called '**A-minus scenario**', consisting of 33 parameter groups. The additional costs for this scenario were estimated at approx. 1.3 million DM.

Because pilot project or other once-only implementations efforts are necessary for a number of parameter groups, the TMAG proposes to make available in the coming three years a fixed budget of DM 300,000 yearly.

0.4 Data handling

During 1996 and 1997, the DEMOWAD data handling project developed a data handling unit to exchange TMAP data and to deliver them to trilateral groups and experts using Internet facilities. Each unit consists of a storage component (the TMAP database), a catalogue/retrieval and a network component. It can be installed at each national Wadden Sea center with the application of limited technical and personnel requirements.

Prerequisites for an efficient trilateral data handling are quality assured and centrally stored data in Wadden Sea data centers on the national level which then will be transferred to the identically structured TMAP databases installed at each of the national Wadden Sea data centers.

The following efforts are required to implement and operate the trilateral data handling system:

- At the national level, the TMAP data has to be transported from the local level to the national data centers so that they can be transferred to the TMAP database of the DEMOWAD unit. Administrative agreements on copy rights, delivery and assessment of TMAP data are necessary to operate the system.
- At the trilateral level, the entire TMAP data handling and the further development of the system have to be coordinated and controlled.

The time frame of the trilateral data handling system is closely related to the implementation plan of the TMAP parameters.

0.5 Ecological research

Ecosystem research studies the environment in a broader perspective. Its tasks are the discrimination between natural fluctuations and human impacts with the aim to find the causes of changes observed in the ecosystem. A further task is to continuously improve the efficiency of the monitoring program.

Research efforts within the trilateral framework should focus on the following items during the next three to six years:

- **Remineralization Capacity:** The accumulation of organic matter and remineralization processes in the Wadden Sea.
- **Effects of Coastal Protection Measures and Climate Change:** The effects of coastal engineering, coastal protection and land reclamation on the one side, and the climate change-induced rise of the sea level on the other side.
- ***Crangon crangon*:** The population dynamics of brown shrimp *Crangon crangon* and the brown shrimp fisheries.
- **Remote Sensing:** The introduction of remote sensing techniques for the TMAP.

0.6 TMAP: Organizational structure

Monitoring and Assessment

In light of the experiences from the 1994-1997 intercessional period, a redefinition of the Terms of Reference of the TMAG is necessary taking into account that the TMAG is a coordination and supervision body at the meta level. This should also be reflected in the membership in the TMAG. As a consequence the TMAP should delegate tasks to the expert level as much as possible. This in turn implies that sufficient expertise must be made available at the national expert level, i.e. participation in expert workshops and ad-hoc expert groups and contributions to the assessment work.

From this perspective, it can already be proposed to maintain the present TMAG ad-hoc Working Groups, the TDG and the QSR Group.

At the CWSS, the employment of the monitoring coordinator must be continued for the secretarial assistance of the TMAG and for the organization and coordination of the work of different ad-hoc expert groups. The work of the TMAG should be formulated in the form of concrete projects as much as possible, including time schedule, responsibilities and a budget. This applies especially for the work on the QSR.

Data handling

An essential condition for the assessment of monitoring data is that data is made available fully and in time. Although considerable progress was made in the past years, the availability of data is still one of the bottlenecks in the assessment process.

The TDG must continue to implement the data handling system for all TMAP parameters and work closely together with the ad-hoc expert groups. This includes especially the elaboration and refinement of TMAP guidelines concerning common procedure for the trilateral data processing.

At the national level, appropriate manpower must be made available for these tasks through the employment of data handling coordinators (0.5 personyear) at all data centers. Additionally, manpower must also be made available to transport the data from the local level to the national data centers (1 personyear) depending on the amount of data which has to be handled.

At the trilateral level, a data handling manager (1 personyear), currently employed within the DEMOWAD project, should continue employment at the CWSS to coordinate the national activities on the implementation of the data exchange system. This coordinator will also be responsible for the further elaboration of the collection and dissemination of trilateral data, most notably via internet.

1. INTRODUCTION

The integrated “Trilateral Monitoring and Assessment Program” (TMAP) was developed following a decision of the 6th Trilateral Governmental Conference in Esbjerg in 1991, where the ministers decided “to cooperate in scientific research and monitoring” and to further implement a Common Wadden Sea Monitoring Program pursuant to decisions of the 1988 Governmental Conference ‘to continuously evaluate the ecological state of the Wadden Sea as a whole, in order to be able to decide on relevant trilateral policy measures’.

Following this decision, the Trilateral Monitoring Expert Group (TMEG) elaborated a basic concept for an integrated Trilateral Monitoring and Assessment Program (TMAP) of the entire Wadden Sea in the period 1992 - 1993.

In 1993, the concept was adopted by the Senior Officials and the program started in January 1994 with a subset of parameters based on the existing and not yet harmonized national monitoring programs. In parallel, the program was further developed in order to harmonize the running national monitoring programs and to implement new parameters.

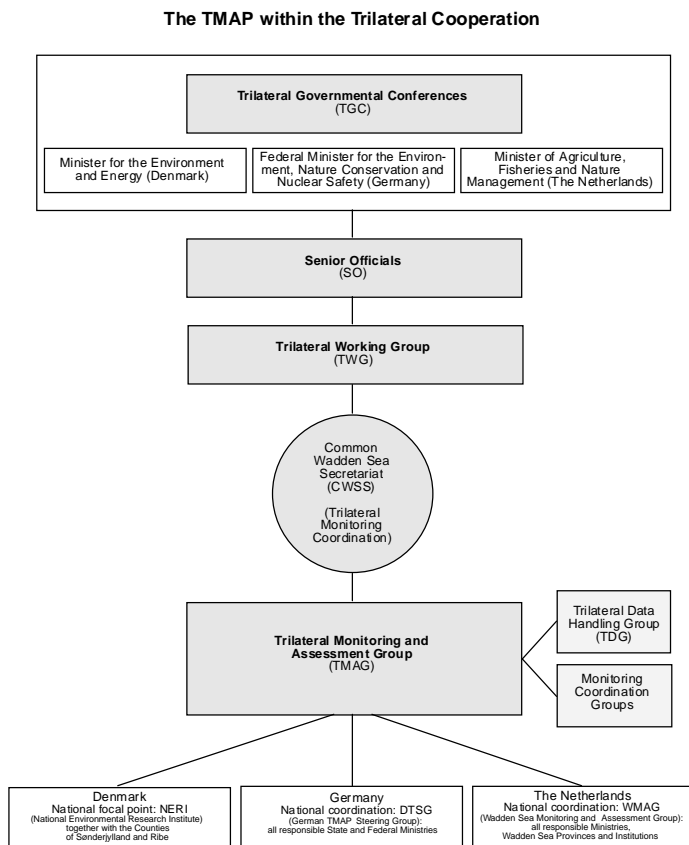


Figure 1: TMAP Organizational Structure

In 1994, the Trilateral Monitoring and Assessment Group (TMAG) was established as a permanent working group under the Trilateral Working Group (TWG) to further elaborate the concept and to implement the TMAP. The TMAG is also responsible for the coordination of ecological research, the development of a trilateral data handling structure and the preparation of assessment reports of the Wadden Sea ecosystem at regular intervals.

The TMAP is an integral part of the national monitoring programs of The Netherlands, Germany and Denmark. Therefore, all responsible monitoring authorities are involved in the development and the execution of the TMAP. Additionally, ongoing developments on the national level regarding the refinement of the national programs were considered in the TMAP.

The work is presently carried out within the “DEMOWAD” project which runs from 1 April 1995 to 31 March 1998 and is co-financed by the LIFE program of the European Commission.

1.1 Objective and Structure

The general aim of trilateral Wadden Sea monitoring, assessment and research is basically twofold, namely

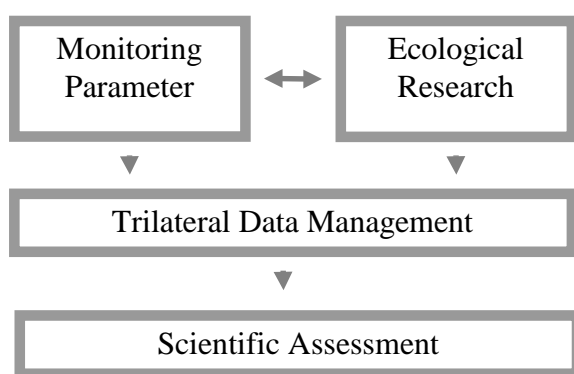
- to provide a scientific assessment of the status of the ecosystem and
- to assess the status of implementation of the Ecological Targets.

Both categories of information are essential for the development and evaluation of trilateral Wadden Sea conservation policies and management.

The main purpose of monitoring the ecosystem and human activities is to collect data necessary for a scientific evaluation of the status of the ecosystem and the intensity and impact of human use.

The scientific assessment is an important basis for the formulation of policies and measures.

Scientific knowledge is a prerequisite for the development of appropriate monitoring, application of assessment criteria and the formulation of ecological policy goals.



The TMAP combines a comprehensive set of physical, chemical, biological and socio-economical parameters with concomitant ecosystem research. This research looks for causes of observed changes, its environmental significance and the need and possibilities for management measures. Furthermore, it gives a foundation for the selection of parameters and measuring strategies of the monitoring part and thus adapting it to current needs and knowledge.

All parts of the monitoring program are integrated in a common structure for the collection, processing and exchange of data (see Figure 2).

Figure 2: Parts of the TMAP

1.2 Issues of Concern, Hypotheses and Ecological Targets

As indicated above, the TMAP serves two goals, the scientific assessment of the status of the ecosystem and the assessment of the implementation status of the ecological targets (ecotargets). The first task is mainly a scientific one, whereas the second is relevant for management.

The ecotargets have been formulated in a general and open-end way. Their purpose is to indicate the direction of policy and management. The scientific assessment provides insight in questions about the status and development of disturbance of the ecosystem, i.e. disturbance, pollution and habitat destruction.

The assessment of the status of the ecosystem is based upon so-called "Issues of Concern". These were derived from the Quality Status Report (QSR) 1993 in which all possible anthropogenic impacts on the Wadden Sea ecosystem were evaluated and assessed. Those issues for which problems already existed or could be anticipated were given highest priority and were included in the monitoring program. For each "Issue of Concern", hypotheses were formulated and monitoring parameters deduced. Through this procedure a close connection between the general objectives of the program and the selection of the parameters to be monitored was provided for.

The TMAP encompasses five "Issues of Concern":

- I Effects of climate change on the morphology,
- II Effects of pollutant inputs (nutrients and contaminants) on processes, species and communities,
- III Effects of fisheries on species and communities,

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- IV Effects of recreational activities on species,
- V Effects of agricultural utilization on salt marsh communities.

The parameters to be monitored were derived from hypotheses formulated for each issue. A list of hypotheses and deduced parameters is in **Annex 1**.

The trilateral conservation policy and management is directed towards achieving common Ecological Targets (ecotargets) which were adopted at the Trilateral Governmental Conference in Leeuwarden in 1994.

The aim is to achieve the full scale of habitat types which belong to a natural and dynamic Wadden Sea. Each of these habitats needs a certain quality (natural dynamics, absence of disturbance, absence of pollution) which can be reached by proper conservation and management. The quality of the habitats shall be maintained or improved by working towards achieving Ecological Targets which have been agreed for six habitat types. Targets on the quality of water and sediments are valid for all habitat types. Supplementary, targets on birds and marine mammals have been adopted as well as targets on landscape and cultural aspects. A full list of all ecotargets is in **Annex 2**.

The extent to which the TMAP parameters provide sufficient information for assessing the Issues of Concern and the progress in the implementation of the ecotargets is covered in Chapter 2.

1.3 The Trilateral Wadden Sea Plan

In order to realize the targets, a management plan, the Trilateral Wadden Sea Plan, was adopted at the Trilateral Governmental Conference in in Stade in October 1997.

The Trilateral Wadden Sea Plan is structured according to the target categories. For each target category, trilateral policy and management and proposals for trilateral projects and actions necessary for the implementation of the targets have been adopted.

The TMAP supports the implementation of the Wadden Sea Plan by making the results of the monitoring available to relevant authorities, interest groups and local citizens as laid down in the Wadden Sea Plan (Chapter I, § 15).

1.4 EC Habitat Directive

“Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora” is commonly known as Habitat Directive. It complements the 1979 Bird Directive. The Habitat Directive is a major contribution by the European Union to the Biodiversity Convention agreed by more than 150 countries at the 1992 Rio Earth Summit.

The Habitat Directive is an important instrument for policy and management of the European Commission (EC). It has the aim to ensure that biodiversity is maintained through conservation of important, rare or threatened habitats and the habitats of certain species. The Directive also aims to make a contribution to sustainable development of the sites.

Regular surveillance of the conservation status of the natural habitats and species covered by the Directive has to be undertaken by the member states (Art. 11). The main results of this monitoring has to be reported to the EC every six years (Art. 17).

The TMAP also contributes the requirements of the Habitat Directive regarding the surveillance of the conservation status of the natural habitats and species.

The extent to which the TMAP provides sufficient information for the Habitat Directive is covered in Chapter 2.

1.5 Other International Monitoring Programs

Interconnections exist between the TMAP and the Joint Assessment and Monitoring Program (JAMP) of the OSPAR. The JAMP is presently also in its implementation phase and the work in the TMAP is being tuned with the JAMP developments in order to enhance mutual benefit and to avoid redundancies.

Furthermore, the results of the ICES work (in coordination with OSPAR and HELCOM) will be integrated in the elaboration of the TMAP guidelines.

The Coordinating Groups of the monitoring programs for breeding and migratory birds stated, that the states bordering the Wadden Sea have committed themselves to monitor birds in the Wadden Sea as contracting parties to a number of international agreements, conventions and treaties. In particular, the Ramsar, Bonn and Bern Convention, the EC-Bird resp. Habitat Directive, the African-Eurasian Waterbird Agreement specifically include surveillance / monitoring activities and the Memorandum of Intent between the Wadden Sea and the Wash resp. Guinea-Bissau are also important for breeding and migratory birds.

2. THE PARAMETERS

2.1 Stepwise implementation

Workshops

As a first step in the harmonization of the national monitoring programs, the TMAG organized a number of trilateral expert workshops in the period March 1995 - January 1996. The aim of the workshops was to evaluate the whole TMAP on a scientific basis in conjunction with the existing national programs, and to propose appropriate monitoring methods.

The workshops addressed the following issues:

- Methods in monitoring chemical substances,
- Salt marshes/Geomorphology/Recreational activities,
- Benthos/Fish,
- Chemical substances,
- Eutrophication,
- Decomposition.

At the workshops, all hypotheses and parameters of the TMEG concept from 1993 were discussed and recommendations were made for a common monitoring strategy (monitoring areas, frequencies, methods). For a number of parameters, it became obvious, however, that additional work was needed, because of a lack of common guidelines, or because further research was needed before the parameters could be applied in the monitoring program.

The results of the workshops were published as “Wadden Sea Ecosystems, No. 6: TMAP Expert Workshops 1995/1996”.

Expert Groups

The Trilateral Seal Expert Group (TSEG), Joint Monitoring Migratory Birds Group (JMMB) and the Joint Monitoring Breeding Birds Group (JMBB), which exist since around 1990, have addressed the same issues as the above workshops.

Priorities

An important finding of the expert workshop was that, for technical and financial reasons, the whole program could not be implemented in one step. Therefore, the TMAG decided to follow a step-wise approach in the implementation of the TMAP parameters taking into account methodological and financial aspects, as well as the relevance of the parameters for the overall assessment of the TMAP hypotheses and the Ecological Targets. To this end the **Parameters** were first grouped into 82 functional **Parameter Groups**, for example ‘Area of salt marsh’, ‘Ships in marinas’ or ‘Organochlorines in Mytilus’ containing several individual parameters. The Parameter Groups were then ranked and labeled as A-, B- and C-priority according to the following criteria:

- technical effort needed for the implementation,
- importance for the Issues of Concern,
- importance for the ecotargets,
- “power” of the parameter in a long-term monitoring program (cost-benefit) and
- whether the parameter groups are already part of national monitoring programs.

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On the basis of this ranking, of which the full results are given in **Annex 3**, the Parameter Groups were classified into priorities A, B and C.

The A-parameters are important for assessment and management (TMAP-hypotheses and ecotargets) and can be implemented with relatively low effort.

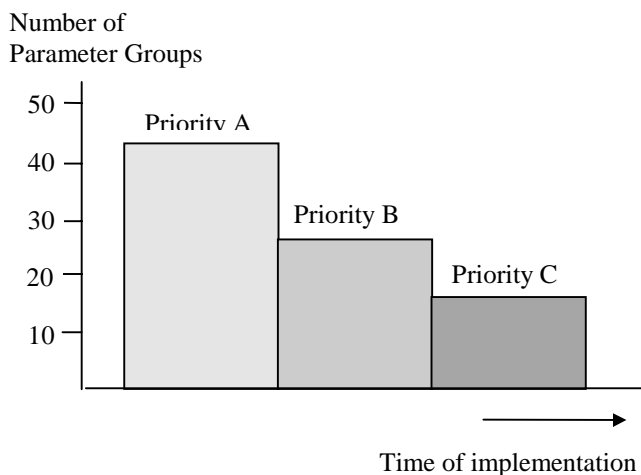


Figure 3: Implementation schedule for A-, B- and C-Parameter Groups

The B-parameter Groups are also essential for the TMAP but because of the technical effort needed, implementation is only possible after appropriate methods/guidelines have been elaborated. They should be implemented after the A-parameters have been implemented.

The Parameter Groups with priority C are also essential for the TMAP but are of less importance relative to A and B and need a relatively high technical implementation effort (e.g. development of new methods, additional research projects needed).

The implementation schedule for the three priority classes is given in Figure 3.

On the basis of this scheme, guidelines for the Priority A-parameters were elaborated first, aiming at their finalization before the Governmental Wadden Sea Conference in 1997 and their subsequent implementation thereafter.

Draft guidelines for the A-parameters were discussed with all authorities in charge of the national monitoring programs. Guidelines for monitoring seals, breeding and migratory birds, which were also ranked as A-parameters, were not included in the national consultations because the trilateral groups for monitoring birds and seals were commissioned with these tasks.

On the basis of these national consultations, the TMAG made a detailed estimation of the effort needed for the inclusion of the guidelines in the national monitoring programs. This analysis is addressed in Section 2.3.

The full list of Parameter Groups is given in **Annex 4**. For each Parameter Group, information is provided on the priority class (A, B or C), parameters, methods, relevant Issue of Concern, existing running program and status of TMAP draft guidelines.

2.2 Information quality of A-parameters

The TMAG concept was developed as an integrated ecosystem concept. This implies that data of all ecosystem levels and compartments are needed for a proper analysis of the quality status of the ecosystem. Hence all parameters of the concept are relevant.

For practical reasons, it was decided to implement those parameters first which are sufficient for a basic evaluation of the Issues of Concern and the ecotargets and for which a relatively low implementation effort is anticipated. It must be ensured however that the Priority A-parameters provide at least the basic information that is necessary for the evaluation of the TMAP hypotheses and the ecotargets.

To this end, the TMAG extensively evaluated the Class A-parameters with the aim to identify possible gaps in the information quality.

The 82 functional **Parameter Groups** were grouped into 12 main **Categories** (Figure 4) Further details can be found in **Annex 4**.

For each main Category, it was evaluated whether the information quality provided by the A-parameters was sufficient for a proper basic assessment of the Issues of Concern and the ecotargets.

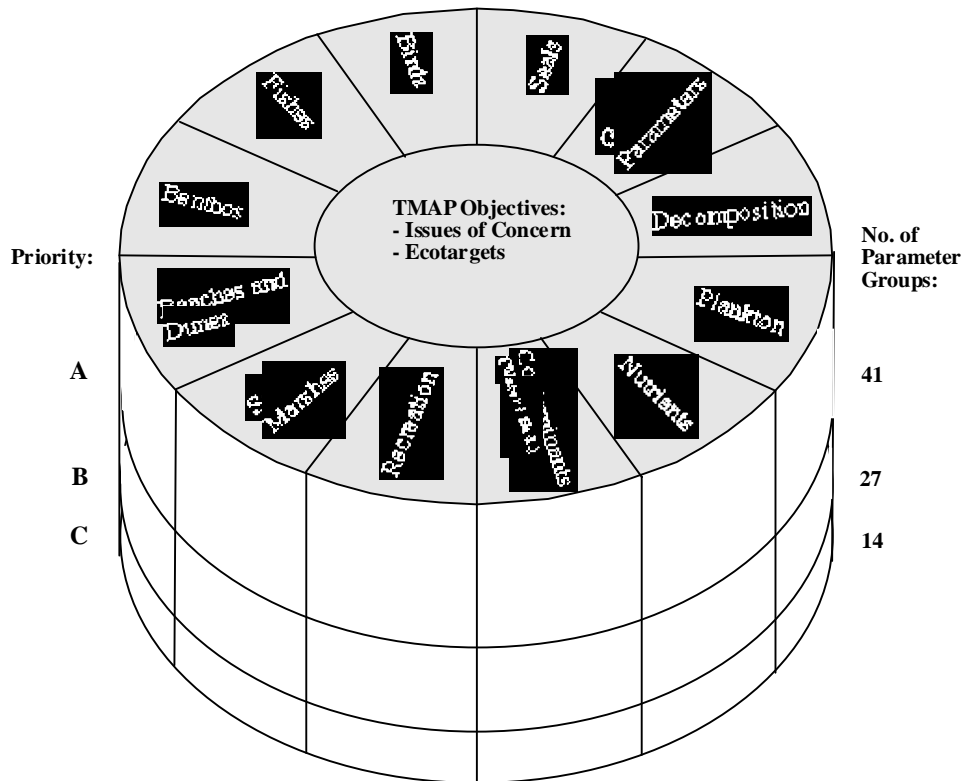


Figure 4: Main Categories and number of Parameter Groups per priority class

The results can be summarized as follows:

- The majority of the A-parameters will, as a starting point, provide some of the information necessary for the evaluation of the TMAP hypotheses, however, gaps remain. After adding the priority B- and C parameters, the full program will give more detailed information.
- In a few cases the A-parameters do not cover all important aspects of the TMAP hypotheses. For such cases, it has to be safeguarded that the B- and C-parameters will be implemented as soon as possible.

For most of the ecotargets, the A-parameters of the TMAP give basic information which is needed for the evaluation of the targets. Some B- and C-parameters are also required, if a more detailed analysis or quantification is necessary. For specific questions, e.g. identification of causal relationships, specific surveys or research projects may be necessary.

2.3 Analysis per Category

In this chapter, the information quality of the A-parameter groups is briefly specified for each of the 12 main categories. The full analysis is given in **Annex 5**.

1) Contaminants in water, suspended matter and sediment

THE PARAMETERS

In water, only monitoring of TBT concentrations is carried out as A-parameter. An assessment of other contaminants (metals, organochlorines, pesticides, PAH) in water or suspended matter is therefore not possible at this stage.

For sediment, only TBT and heavy metals are included in the A-parameter list. No information will be available for other contaminants. Additionally, important sediment characteristics like net sedimentation are not covered by the A-parameters.

Only selected contaminants and compartments are covered by the A-parameters. However, this will allow a basic assessment of the TMAP hypotheses and ecotargets.

2) Nutrients

The A-parameters entail the concentrations of inorganic nutrients in water. This will give basic information about spatial and seasonal distribution of nutrients in the Wadden Sea which is necessary for the assessment of the TMAP hypotheses and ecotargets.

Because of the high variability and the complex processes regarding the nutrient cycle, additional parameters (B-parameters) are very important for the scientific evaluation of the data, e.g. flux of nutrients between sediment and water column, input of nutrients from different sources, remineralization processes in sediment and water column.

3) Decomposition

The A-parameter group does not cover decomposition parameters in water and sediment (microbial parameters, nutrient and organic carbon cycles in sediment and water). For technical reasons, these important parameters can only be implemented later. Therefore the relevant TMAP hypotheses "Changes in the chemical cycle and in the natural processes" and the ecotargets "Tidal areas, Quality of water and sediment" cannot be assessed sufficiently.

4) Salt Marshes

The A-parameters give information on the location and area of salt marshes and a rough classification of the vegetation types (by remote sensing) for the entire area which would be sufficient to give the basic information for the TMAP hypotheses (effects of nutrient inputs, agricultural utilization and climate change) and the ecotargets (salt marshes). Additionally, information about agricultural utilization (grazing intensity) will be compiled.

Salt marsh community parameters (vegetation and fauna at selected areas) are not included in the A-parameters. They are however important for the assessment of the effects of pollution input, agricultural utilization and climate change on salt marsh habitats.

5) Benthos

Phytobenthos (intertidal)

The proposed A-parameters (macroalgae, eelgrass) are sufficient for the analysis of TMAP hypotheses regarding input of nutrients (effects species and communities) and the ecotargets (eutrophication).

Because benthic microalgae are not included in the A-parameter, changes in the primary production due to changes in the input of nutrients cannot be assessed.

Zoobenthos

The effects of inputs of pollutants on intertidal macrozoobenthos species and communities at selected areas can be derived from the A-parameters. They also contribute to the ecotargets for the tidal area.

However, the representativity of monitoring areas cannot be checked without having information from the whole area or an entire tidal basin (C-parameter). Furthermore, no statements for the ecotargets on tidal areas can be made regarding the whole Wadden Sea area.

Contaminant concentrations of key species (*Arenicola*, *Nereis*) are also not covered by the A-parameters.

Crangon parameters (species parameters, contaminants) are not included in the A-parameter list. Therefore, no assessment with regard to TMAP hypotheses and ecotargets is possible.

Sabellaria

The A-parameters provide sufficient information for the analysis of the TMAP hypotheses (effects of fisheries) and the ecotarget on *Sabellaria*.

Blue Mussels

The A-parameters give information about the location and area of the beds and the *Mytilus* stocks at selected areas, which is sufficient for the analysis of the TMAP hypotheses (effects on mussel beds and *Mytilus* from fisheries and input of pollutants) and ecotargets (blue mussels, tidal areas). This includes also the concentrations of selected contaminants (heavy metals, organochlorines, PAH) in blue mussels.

The monitoring of the benthic communities in selected mussel beds is not covered by the A-parameters; therefore no information will be available about the function of mussel beds as habitat for other species.

6) Plankton

The A-parameters for phytoplankton and zooplankton can be regarded as sufficient for the TMAP hypotheses (input of pollutants) and ecotargets (eutrophication).

7) Fish

Fish populations

The A-parameters will only give information about selected key species (eelpout, flounder plaice) with regard to the TMAP hypotheses (effects of pollutants and fisheries on these species) and ecotargets (tidal areas).

The parameters concerning changes in the fish communities (pelagic and demersal) were classified as B and C parameter for technical reasons. Therefore, they cannot be assessed with regard to the TMAP hypotheses and the ecotargets (tidal areas).

General fishery parameters

The A-parameters regarding fishery parameters give basic information on fishery activities (fishing amount, fishery statistics). Additional parameter which are also important (like fishing areas and periods, shrimping by-catch composition and discard) are not included in the A-parameters.

8) Dunes

Monitoring data gathered by remote sensing will give sufficient information to assess the ecotargets (dunes).

9) Birds

The A-parameters concerning breeding birds give a good overview on all levels of the system (contaminants in bird eggs, breeding success, numbers and distribution of selected breeding birds). They will give sufficient basic information for the TMAP hypotheses (climate, pollution, fisheries, recreation, agricultural utilization). The A-parameters concerning migratory birds (numbers of waterbirds in counting units) are basically sufficient for the TMAP hypotheses.

Concerning the quantification of the ecotargets on birds for all habitat types (favorable conditions), additional parameters are needed as proposed by the Trilateral Birds Expert Group (food availability, natural flight distances, moulting and roosting areas).

The monitoring of beached birds (Beached Birds Survey, including oil analysis) gives sufficient information for the TMAP hypotheses and the ecotargets.

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Primarily monitoring should be carried out in order to increase the protection of species (birds) involved at an international level. Monitoring in the Wadden Sea has already shown that high proportions of bird populations using the East Atlantic Flyway are dependent on the Wadden Sea and that a large proportion of the European breeding population of certain species breed in the area. Although the Wadden Sea is of outstanding importance for birds, migratory birds also require other breeding and staging sites within the East Atlantic Flyway.

The Wadden Sea states thus have a number of responsibilities and duties with regard to the Wadden Sea, as stop-over in the East Atlantic Flyway, and as a breeding area. One of these duties is the monitoring of the population levels of the bird species using the area. The present TMAP is thus only one reason among others for carrying out bird monitoring in the Wadden Sea. The monitoring programs for breeding and migratory birds are adapted to fulfil the international commitments of the Wadden Sea states. Most of the parameters of these programs fit into the framework of the TMAP as well. However, as in other parameter groups such as benthos, it might be necessary to revise and / or add some of the parameters on the basis of concomitant research studies in the future, in order to answer the TMAP-hypotheses sufficiently.

10) Seals

The A-parameters (numbers and distribution, selected population parameters, contaminants) entail the basic information needed for the TMAP hypotheses (effects of pollutants). More detailed parameters may be required to assess the ecotargets (natural reproduction capacity).

The TMAP parameters do not cover the grey seal and the harbor porpoise. Therefore the ecotarget on marine mammals is not covered sufficiently. Moreover, because the off-shore zone is not part of the monitoring area, information is lacking for that area.

11) Recreational activities

The A-parameters cover all important recreational activities including boats at sea and in harbors, as well as, air traffic. Therefore, sufficient information will be available for the TMAP hypotheses and ecotargets (tidal areas).

Because general tourism parameters (overnight stays, bed capacity, no. of visitors, harbor capacity, socio-economic data) are not covered by the A-parameters, serious gaps have been detected.

12) General parameters

The A-parameters comprise morphology, hydrology, weather conditions, land use and coastal protection measures and will supply sufficient information for the TMAP. With regard to ecotargets (tidal areas), information can be gathered from the A-parameters morphology and coastal protection measures. However, for a more detailed assessment, additional information is required.

The results are summarized in **Table 1**.

Table 1: Information quality of A-parameter groups for each category

Category	Hypotheses	Ecotargets
Contaminants (water + sed.)	••	••
Nutrients	••	•••
Salt marshes	••	•••
Benthos:		
- Phytobenthos	••	•••
- Zoobenthos	•	•
- Sabellaria	•••	•••
- Blue Mussels	••	•••

- sufficient basic information
- not completely sufficient information, gaps exist
- insufficient information

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Plankton	•••	•••
Fish (incl. fishery)	•	•
Dunes	•••	•••
Birds	•••	••
Seals	••	•
Recreational activities	••	••
General parameters	••	••

2.4 TMAP and Habitat Directive

The Habitat Directive is an important management instrument of the European Commission. It aims at maintaining and developing biodiversity and contribute to sustainable development. Several aspects of the Habitat Directive are relevant for the TMAP. In the following sections, it is summarized how the TMAP contributes to the Directive.

2.4.1 Monitoring

In the Habitat Directive, surveillance of the conservation status of habitats and species is requested in particular with regard to priority natural habitat types and priority species (Article 11 of the Habitat Directive, Annex I and II of the Habitat Directive, Annex I of the Birds Directive).

The TMAP will provide sufficient information concerning the habitats listed in Annex I of the Habitat Directive. The A-parameter groups cover the monitoring of locations and areas of habitats related to beaches, dunes, salt marshes and tidal areas. Furthermore, for a number of habitats, human activities which may have an influence on the conservation status of the habitats (e.g. recreational activities, coastal protection measures, fisheries) are regularly monitored in the TMAP (see Table 2).

Regarding the monitoring of Annex II species, the TMAP provides sufficient information only for the Harbour seal (*Phoca vitulina*) because other marine mammals have not yet been included in the TMAP (see Table 3).

No information is available on the A-parameters of the TMAP concerning the development of fish communities especially the status of priority species such as houting (*Coregonus oxyrhynchus*). This gap has to be considered during the further development of the TMAP.

Other Annex-II species are abundant only in a few regions of the Wadden Sea. Therefore, they have not been included in the TMAP (e.g. *Microtus*, *Liparis*). Information has to be gathered by surveillance on the national level.

Monitoring of birds in the TMAP is carried out by the Joint Monitoring Groups of Breeding and Migratory Birds according to the requirement of the Birds Directive. The Annex I species of the Birds Directive are covered by the ongoing monitoring.

2.4.2 Reporting

Every six years, a report of the conservation measures and their impact on the conservation status of habitats and species together with the main results of the surveillance is required (Article 17 of the Habitat Directive).

In the TMAP, the monitoring results are regularly assessed and published. For selected monitoring themes, such as monitoring of breeding and migratory birds, trilateral reports have been published yearly since 1994. An assessment of the status of the whole Wadden Sea ecosystem is carried out by the TMAG and published on the occasion of the Trilateral Governmental Conferences. These reports are available every 3 - 4 years and can also be used to fulfill the reporting requirements of the Habitat Directive.

By implementing a data management system for the TMAP, the monitoring data together with the necessary meta information will be available for the Habitat Directive more rapidly than in the past.

2.4.3 Research

Research and scientific work should be initiated in order to fulfill the requirements of the Directive regarding the following topics (Article 18 of the Habitat Directive):

- Biodiversity (Article 2)
- Management measures (Article 2)
- Consideration of economic, social and cultural requirements, and regional and local characteristics (Article 2)
- Monitoring methods and strategies (Article 11)
- Criteria for selecting sites (Article 4)

- Land-use planning (Article 4).

Research is an integrated part of the TMAP (see section 5 Ecological Research). Research projects have been proposed in section 5.2.

Additional projects are envisaged in the Trilateral Wadden Sea Plan especially regarding management measures and the consideration of socio-economic, as well as, cultural and historical aspects.

Table 2: Habitats to be considered under the EC Habitat Directive (Annex I) and the related TMAP parameter groups.

Corine Code	Annex I Habitats relevant for the Wadden Sea	Occurrence	Related TMAP parameter groups (priority A,B,C)
11.25	Sandbanks which are slightly covered by sea water all the time	x	Geomorphology (A) Benthic biotopes (subtidal) (C)
13.2	Estuaries	x	Geomorphology (A) Salt marshes (A) Coastal protection measures (A) Recreational activities (A) Land use (A)
14	Mudflats and sandflats not covered by sea at low tide #	x	Geomorphology (A) Coastal protection measures (A) Recreational activities (A) Blue Mussel beds (A) Benthic biotopes (subtidal) (C)
-	Large shallow inlets and bays	x	Geomorphology (A) Coastal protection measures (A)
17.2	Annual vegetation of drift lines #	not NL	Beaches and Dunes (A)
15.11	<i>Salicornia</i> and other annuals colonizing mud and sand	x	Salt marshes (A) Geomorphology (A)
15.12	<i>Spartina</i> swards (<i>Spartinion</i>)	x	Coastal protection measures (A)
15.13	Atlantic salt meadows (<i>Glauco-P.</i>)	x	Recreational activities (A)
16.211	Embryonic shifting dunes #	x	Beaches and dunes (A)
16.212	Shifting dunes along the shoreline with <i>Ammophila arenaria</i> (white dunes) #	x	Groundwater level on islands (A) Coastal protection measures (A)
16.221 to 16.227*	Fixed dunes with herbaceous vegetation (grey dunes) #	x	Recreational activities (A)
16.23*	Decalcified fixed dunes with <i>Empetrum nigrum</i> #	x	
16.25	Dunes with <i>Hypophae r.</i> #	not SH	
16.26	Dunes with <i>Salix arenaria</i> #	x	
16.31 to 16.35	Humid dune slacks	x	
31.11	Northern Atlantic wet heaths with <i>Erica tetralix</i> #	not Nds	
31.2*	Dry heaths (all subtypes) #	x	

Note: * = priority natural habitat types according to Article 1 of the Habitat Directive;

X = existent in all Wadden Sea regions;

not NL, SH, Nds, NL = non-existent in the mentioned region;

= habitats, also existent on islands

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Table 3: Main species to be considered under the EC Habitat Directive (Annex II) and the related TMAP parameters

Animals	DK	SH	Nds	NL	Related TMAP Parameter groups (priority A,B,C)
Rodentia					
* <i>Microtus oeconomus arenicola</i>	n-e	n-e	n-e	X	none
Phocidae:					
<i>Halichoerus grypus</i> (V)	X	X	X	X	none
<i>Phoca vitulina</i> (V)	X	X	X	X	Seal population (A)
Cetacea					
<i>Phocoena phocoena</i>	X	X	X	X	none
Fish					
Petromyzoniformes #:					Demersal and pelagic fish communities (B)
<i>Lampetra fluviatilis</i> (V)		X			Fishery parameters (A)
<i>Petromyzon marinus</i> (o)		X	X		Fishing areas and periods (B)
Salmoniformes:					Shrimping by-catch composition and discard (B)
* <i>Coregonus oxyrhynchus</i>	X	X	X	X ?	
Clupeiformes: #					
<i>Alosa spp.</i> (V)	n-e	X ?	X ?	X ?	
Plants					
Orchidaceae:					
<i>Liparis loeselii</i>	n-e	n-e	n-e	X	none

Note: * = priority species according to Article 1 of the Habitat Directive
 X= existent; n-e = non-existent; # = lack of information

2.5 Main Gaps

From the analysis in the previous Section 2.3, it must be concluded that gaps in the assessment of the TMAP hypotheses and the ecotargets will occur if only the A-parameters are implemented. Therefore, the parameter groups of the following Table 4 should also be implemented as soon as possible.

Category	Parameter Group	Priority
Decomposition:	Changes in chemical cycles (chemistry of soils, sediments and water column), remineralization, microbial processes in the sediment	C
	Nutrients in sediment	B
Salt marshes	Vegetation communities	B
	Invertebrate fauna	C
Benthos	Benthic microalgae: primary production	C
	Location and area of zoobenthos biotopes (intertidal flats)	C
	Crangon (species parameters and contaminants)	B,C
Fish	Arenicola and Nereis (contaminants)	C
	Fish communities (pelagic and demersal)	B, C
	Fishery (fishing areas and periods, shrimping by-catch composition and discard)	B
Birds	Food availability, natural flight distances, moulting and roosting areas, additional parameters for breeding success	Ecotarget
Tourism	Overnight stays, no. of visitors, socioeconomics	C
Marine mammals	Inclusion of harbor porpoise	Ecotarget
Estuaries	Additional monitoring stations in estuaries, additional human use parameters	Ecotarget

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3.1 Implementation scenarios

In Section 2.1, it was described how a subset of parameters was selected on the basis of five criteria. Three of the criteria are quality criteria, namely the relevance for the Issues of Concern, the relevance for the ecotargets and the power of the parameter.

The A-parameters must therefore be regarded as a minimum requirement for what can be regarded as a 'reasonable' program. Therefore, the A-parameters were taken as the starting point for the development of the intermediate and cost-neutral scenarios.

'A-scenario'

The TMAG made a detailed estimation of the additional costs for a running harmonized program consisting of only the A-parameters. The total yearly amount of additional costs was estimated at approx. 2.6 million DM. A breakdown of this sum for the four countries/federal states and the parameter groups is given in **Annex 6**.

As a next step the TMAG screened the A-parameters again with the aim to reach a cost-neutral scenario.

Of the 41 A-parameter groups, 7 can be implemented without additional costs for the running program. After some minor amendments another 5 groups could be added (see also Annex 6). Nevertheless, the TMAG was unanimous in its opinion that this **cannot** be regarded as a harmonized trilateral monitoring program.

'A-minus scenario'

Of the remaining 29 groups, 9 were identified, in what was experienced as a painful process, as being possible candidates for implementation at a later stage (see Annex 6: postponed parameter groups). The major criterion in this evaluation was the relevance of the parameters for the assessment of the Ecotargets.

The result of this evaluation was a so-called 'A-minus scenario', consisting of 33 parameter groups (see Annex 6). It must be regarded as a minimum starting package, which should be extended in the coming years with the 'postponed' parameter groups.

The additional costs for the 'A-minus scenario' were estimated at approx. 1.3 million DM.

Development costs

For both options, it is important to note that only the additional costs of the running program (sampling and analyzing) have been estimated. For a number of parameter groups, most notably *Sabellaria*, it will be necessary to carry out pilot studies or other once-only activities before regular monitoring can start.

For these studies, the TMAG proposes to make a fixed budget available in the coming three years of DM 300,000 yearly.

3.2 Cost Analysis per Category

A cost analysis was undertaken for all A-Parameter Groups for which draft guidelines were elaborated. Presently, a cost estimation for B- and C-Parameter Groups is not available because additional effort is still required before common guidelines for this parameter can be developed.

For each parameter group, a proposal is made whether it should be part of the starting package (implementation) or implemented in the following three years (postponement).

1) Contaminants in water, suspended matter and sedimentStatus

Running program only for metals in sediment in DK, FRG, NL.

Estimated costs

The A-parameter TBT in water column is a new parameter which requires a high analytical effort which increases the costs of the program. The costs could be reduced if only one laboratory would be in charge of the analyses for the entire Wadden Sea ("one-lab-approach").

Metals in sediment are part of running programs in all countries. However, harmonization effort is required (e.g. frequency, normalization procedures) which would improve the trend detection and the spatial assessment.

Proposal

Implementation of the parameter groups "TBT in water" and "metals in sediment".

2) NutrientsStatus

Running programs in DK, FRG, NL.

Estimated costs

The A-parameters entail the concentrations of inorganic nutrients in water. Costs will increase due to a modified sampling strategy (e.g. transect sampling in coastal waters and estuaries, high frequency sampling at existing monitoring stations). It would improve the trend detection (in winter) and the spatial assessment of nutrient concentrations, as well as, the assessment of eutrophication effects (e.g. phytoplankton blooms).

Proposal

Implementation of the parameter group "inorganic nutrients in water".

3) Decomposition

Decomposition parameters are not included in the A-Parameter Group.

4) Salt MarshesStatus:

Running programs in NL, single surveys in DK, FRG.

Estimated costs

The A-parameters on location and area of salt marshes and a rough classification of the vegetation types can be compiled from existing programs or single surveys. The harmonization effort is relatively low. The installation of a regular monitoring (e.g. by aerial photography) will increase the costs in some cases. Costs may decrease due to the use of advanced remote sensing techniques (e.g. new satellite sensors) which will reduce field surveys.

Information about agricultural utilization (grazing intensity) can be compiled with low additional costs.

Proposal

Implementation of the parameter group "location and area of salt marshes".

5) Benthos**Phytobenthos (intertidal)**Status

DK: regular aerial surveys; FRG: regular aerial surveys; NL: single surveys.

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Estimated costs

The A-parameters (macroalgae, eelgrass) are covered by running programs in all three countries except for macroalgae in The Netherlands and eelgrass in Niedersachsen. Therefore, additional effort is needed to get comparable information also from the western Wadden Sea regions. Regarding macroalgae, only low harmonization efforts are required in Germany and Denmark, which can be accomplished with a relatively low budget.

Costs may decrease in the future because of the use of more advanced remote sensing techniques.

Proposal

Implementation of the parameter group “macroalgae” and “eelgrass”.

Zoobenthos

Status

Running programs (selected areas, twice per year) in DK, FRG, NL.

Estimated costs

The monitoring of intertidal macrozoobenthos species and communities at selected areas is already part of running national monitoring programs. Only slight modifications are needed with regard to the harmonization of the programs for which no extra costs are anticipated.

Proposal

Implementation of the parameter group “intertidal zoobenthos communities”.

Sabellaria

Status

FRG single projects.

Estimated costs

An increase of costs for a regular monitoring of Sabellaria is anticipated. Because appropriate methods are still lacking, only a rough estimation can be given.

Proposal

Postponement of the parameter group “Sabellaria reef”. Before starting a regular monitoring program, more information on Sabellaria (location of reefs) has to be gathered by a one-off survey. Extra costs are required for this project in which also appropriate monitoring methods have to be developed.

Blue Mussels

Status

Running programs (except for selected contaminants) in DK, FRG, NL.

Estimated costs

Monitoring of intertidal blue mussel beds is ongoing in all three countries but not yet harmonized, e.g. with regard to methods and spatial extension. Additional costs are expected for that work. It will give actual information on the development of intertidal mussel beds (ecotargets) which presently is not available for the whole area. The use of remote sensing techniques for monitoring of mussel beds may decrease costs in the future.

Monitoring of *Mytilus* stocks (species) will increase the costs of the program but will give more information on the development of mussel beds as an important habitat.

As regards the monitoring of contaminants in mussels, additional finances will be required in all countries for the analysis of additional contaminants, for example Organo-Hg (the biological relevant Hg-compound) and toxaphene (new pesticide).

Proposal

Implementation of the parameter groups “location and area of mussel beds” and “contaminants in mussels”. Postponement of the “*Mytilus* stocks (species parameters)”.

6) Plankton

Status

DK, FRG; NL: running programs for phytoplankton; DK: running program also for zooplankton.

Estimated costs

Phytoplankton is already part of ongoing monitoring programs in all three countries. However, harmonization is needed and additional costs are expected due to an increase of the sampling frequency in The Netherlands and Niedersachsen. This would improve the detection of phytoplankton blooms and their interpretation.

For zooplankton monitoring, which is a new parameter, relatively high costs are expected. Information on zooplankton is necessary to assess the phytoplankton developments which is mainly controlled by zooplankton grazing.

Proposal

Implementation of “phytoplankton” and postponement of “zooplankton”.

7) Fish

Fish populations

Status

Running programs (except selected contaminants) in DK, FRG, NL.

Estimated costs

The appropriate monitoring of fish key species, as well as, fish communities require a relatively high harmonization effort in all countries. Consequently additional costs are expected due to necessary modifications and extension of ongoing fish monitoring programs.

The inclusion of eelpout as a key species for monitoring contaminants, as well as, new contaminants (e.g. Organo-Hg, toxaphene) will lead to an increase of the costs.

Proposal

Postponement of the parameter group “fish key species” and implementation of the parameter group “contaminants in eelpout and flounder”.

General fishery parameters

Most of the A-parameters on mussel/cockle/shrimp fishery can be gathered from official statistics and therefore no additional costs are expected.

Proposal

Implementation of the parameter groups “general fishery parameters”. Postponement of the parameter “hours of fishing”.

8) Dunes

Status

Single surveys in DK, programs in FRG, NL.

Estimated costs

Data can be gathered from existing sources without high costs. The actual costs will depend on the frequency and methods used. However, harmonization and further elaboration of the program, e.g. the use of remote sensing techniques, will require additional funding. In the long run, costs may decrease because of the use of advanced remote sensing techniques.

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Proposal

Implementation of the parameter group “dunes”.

9) Birds

Programs for breeding and migratory birds

Status

Trilateral programs.

Estimated costs

Monitoring of numbers and distribution of breeding birds and number of waterbirds in counting units (migratory birds) is already carried out in the framework of trilateral programs.

Proposal

Continuation of the running trilateral programs for monitoring of breeding and migratory birds.

Breeding success, contaminants in bird eggs

Status

Trilateral pilot projects (1996/97). Currently no regular programs.

Estimated costs

Additional costs will arise for the monitoring of breeding success and contaminants in bird eggs. Based on experiences from the pilot phases, relatively low budgets are required for these new parameters compared to other new parameters. Costs regarding contaminants in birds eggs could be kept low if one laboratory ("one-lab-approach") will be designated for the chemical analyses of bird eggs from the whole Wadden Sea.

Proposal

Implementation of the parameter group "contaminants in bird eggs" and postponement of "breeding success". Because trilateral guidelines for monitoring of breeding success were already elaborated by a pilot project, they should be implemented into national programs as far as possible.

Beached Bird Survey

Status

Running programs (without oil analysis) in DK, FRG, NL, however to a different extent.

Estimated costs

The monitoring of beached birds (Beached Birds Survey) is carried out mainly by NGOs in cooperation with regional authorities. To implement this TMAP parameter only relatively low financial means are needed (e.g. travel costs). However, the oil analysis of the beached birds will require additional funding. The Beached Bird Survey, including oil analysis is also planned to be implemented in the framework of the JAMP. In Germany, a project including oil analysis is planned for the period until 2001 covering also parts of the Baltic Sea. The one-lab-approach should be considered with regard to oil analyses of bird feathers to keep additional costs low.

Proposal

Implementation of the parameter "beached birds surveys" and postponement of the parameter "oil analysis of oiled birds".

10) Seals

Status

Trilateral program for numbers and distribution; irregular sampling in DK, FRG, NL for immunology and contaminants in tissue.

Estimated costs

The A-parameters numbers and distribution including selected population parameters are part of an ongoing trilaterally coordinated program. Additional costs are expected for the implementation of the population

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parameters immunological status and pollutants in tissue, which are also A-parameters, but a cost estimation is not possible at this stage.

Proposal

Continuation of running trilaterally coordinated programs. Implementation of the parameter group “pollutants in tissue”. Postponement of the parameter group “immunological status”.

11) Recreational activities

Status

Several running programs or official statistics are available in DK, FRG, NL.

Estimated costs

Sufficient information on the A-parameters is available from different sources and therefore no additional costs are expected. Because the data sources are very heterogenous, the effort of gathering the data may be relatively high.

Proposal

Implementation of the parameter groups “boats at sea, human activities, guided tours, air traffics”.

12) General parameters

Status

Several running programs or single surveys in DK, FRG, NL.

Estimated costs

The A-parameters comprise morphology, hydrology, weather conditions, land use and coastal protection measures to be gathered from different sources or running programs. No major increase of costs is anticipated. However, if a more detailed assessment is requested, additional cost will have to be anticipated.

Proposal

Implementation of the parameter groups “coastal protection measures, geomorphology, flooding, land use, weather conditions, hydrology”. Postponement of the parameter “ground water level”.

3.3 Cost development

In order to reduce the costs of the monitoring program as already indicated above, the following is recommended:

- for new parameters but also for some existing ones, specialized laboratories should be selected on a trilateral basis to perform analyses for the whole Wadden Sea area (“one-lab-approach”); this would also reduce substantially the anticipated costs for intercalibration and quality assurance;
- the elaboration of new remote sensing methods and the more efficient use of existing ones will also improve the cost benefit ratio;
- it may not be necessary to measure all parameters in all three sections of the Wadden Sea with the same intensity;
- the costs of ongoing programs could be reduced by better coordination of monitoring in the border areas.

In summary, most of the ongoing programs can be harmonized with relatively low efforts and low costs. In some cases, a trilateral harmonized program could even lead to a decrease of the costs due to a better use of available resources, e.g. by an “one-lab-approach” or by reducing the number of sampling stations in border areas.

The implementation of trilateral harmonized remote sensing techniques including reporting and assessment may result in a decrease of costs for a number of field surveys which are still necessary in order to gain information about the total Wadden Sea cooperation area. Furthermore, the monitoring of different parameters may be combined, thus also increasing the cost-benefit ratio of monitoring by remote sensing. However, the elaboration and implementation of such remote sensing methods to be included in the regular monitoring program needs additional effort. Therefore, it is recommended to initiate a trilateral project with the aim to develop remote sensing techniques which can be used in the TMAP and for the assessment of the ecotargets (see chapter 5 on Ecological Research).

Additional costs can be expected for a number of parameters which will be implemented within the new JAMP. The proposed JAMP guidelines will be applied to the TMAP and specified for the appropriate parameters (e.g. contaminants in blue mussels, fish and bird eggs, sediment and water; eutrophication parameters like nutrients, phytoplankton, macroalgae; beached bird survey). The JAMP guidelines are still under consideration and are anticipated to be elaborated until the end of 1997.

An increase of costs can also be anticipated regarding the implementation of quality assurance (QA) which covers sample handling and analytical procedures. There is an urgent need for QA procedures for monitoring of chemicals, as well as, for biological monitoring. Relevant work is being undertaken within the OSPAR, ICES and the EC and will be included in the ongoing monitoring programs successively in the framework of the regular evaluation of these programs.

3.4 Implementation

The TMAP parameters will be implemented progressively taking into account methodological and financial aspects, as well as the requirement of the parameters for the overall assessment of the TMAP hypotheses and the ecological targets.

A general time frame can be indicated according to the given A-, B- and C-priorities:

- Preparation phase: expert consultations, proposal of monitoring methods including data handling.
- Development phase: further elaboration and testing of trilateral guidelines including data handling structure; if necessary execution of pilot project or additional expert consultations.
- Implementation phase: implementation of the guidelines at the national level, execution of monitoring; if necessary further elaboration of the guidelines including data handling structure.

TABLE 5: Time frame implementation TMAP

Priority	Presently	1998 - 2000	2001 - 2003	after 2003
A-parameter	Development	Implementation		
B-parameter	Preparation	Development	Implementation	
C-parameter		Preparation	Development	Implementation

The time frame of the implementation of the respective parameter group depends mainly on:

- the existence of appropriate and applicable monitoring techniques; otherwise they will have to be developed during research or during pilot projects;
- sufficient financial and personnel resources available at the national level to implement the trilateral guidelines in the national monitoring programs.

Because the different parameter groups are in a different stage of elaboration, the implementation scheme as indicated in Table 5 is a general outline of the TMAP implementation plan with regard to the A-, B- and C-parameters.

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For each parameter group, the further steps are entailed in detail in **Annex 4**.

4. DATA HANDLING

During 1996 and 1997, the DEMOWAD data handling project was carried out to start the development of the basic components of a trilateral harmonized data exchange system with

- a common data exchange format for the TMAP data,
- a data catalogue and data retrieval system and
- a network communication system between the national databases and the trilateral users.

4.1 Data handling unit

The DEMOWAD data handling unit, as elaborated in **Annex 7**, was developed to support the national databases to exchange TMAP data and to deliver them to trilateral groups and experts. Each unit consists of a storage, a catalogue/retrieval and a network component as indicated in Figure 4.

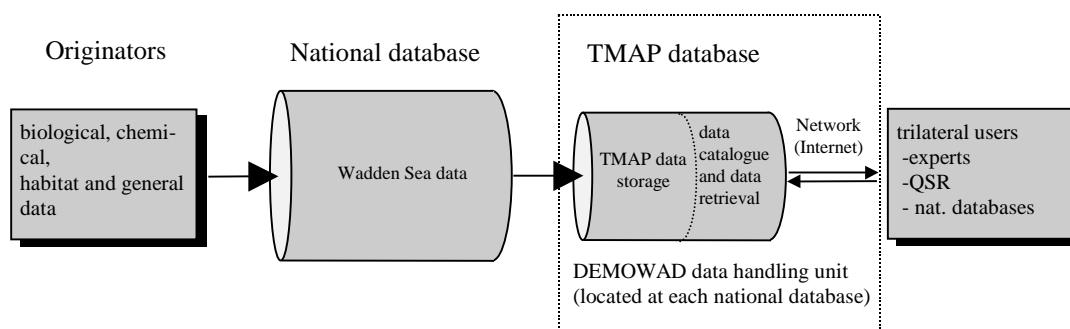


Figure 4: Data flow from national to trilateral level

Prerequisites for an efficient trilateral data handling on the national level are quality assured data centrally stored in Wadden Sea data centers on the national level. The structure of such data is however specific for each of the three countries. Data to be used in the TMAP will therefore be stored in so-called “TMAP databases” which are installed at each of the national Wadden Sea data centers and have identical structures. The integrated data catalogue continually provides an overview of the stored data and, by a dynamic interface to the Internet, allows for a direct data retrieval in the trilateral data exchange format. The main characteristics of the system are a high flexibility, minimal maintenance and extension costs, high data security, easy connection to other information systems and user-friendliness.

During the prototype test (implementation of data on breeding bird counts and heavy metals in mussels), DEMOWAD data handling units were installed at the RIKZ Haren (NL) at the DONAR database, at the NERI Roskilde (DK) at the DAWAD database and at the GKSS Geesthacht (FRG) at the WATiS.

4.2 Requirements and efforts of a trilateral data exchange

Based on the experiences and results of the prototype test, the necessary requirements and efforts needed for the installation of the trilateral data handling system can be estimated.

The data handling unit described above can be installed at each national Wadden Sea database location with the application of limited technical and personnel requirements. The national databases and data centers remain independent and autonomous and the organizational structure of the data handling in each country must therefore not to be changed or modified to meet the needs of the trilateral data processing.

The following tasks and personnel and financial efforts on the national and trilateral level must be applied to ensure the further development and operation of an effective TMAP data handling, as entailed in further detail in **Annex 7**.

DATA HANDLING

a. national level

Tasks

- realization of the technical requirements necessary for a data exchange of all TMAP parameters at all national Wadden Sea data centers, as indicated in Annex 7;
- implementation of the basic DEMOWAD unit, as indicated in Annex 7;
- administrative agreement on copy rights, delivery, processing and assessment of TMAP data
- delivery of validated and quality assured data;
- data transfer from the national to the TMAP data bases;
- maintenance, conceptual and implementation work to operate and extend the trilateral data handling.

Personnel effort

- to transport the local data from the originators to the national database: 1 person per data center depending on the amount of data to be handled (preliminary estimation);
- to operate the trilateral data handling units: 1/2 person - experienced - per data center (preliminary estimation);
- to extend the trilateral data handling unit: to be defined in the framework of projects.

Financial requirements (only for operation and excluding personnel costs)

- workstation or PC as server, network software (Web-server, Ftp-server, Internet software), programming environment to develop trilateral data handling tools;
- database with relational database management system;
- permanent access to Internet;
- possibly additional effort to avoid the firewall problem (e.g. commercial provider for Internet connection, hard and software).

b. trilateral level

Tasks

- coordination of the TMAP data handling group consisting of experts from all national Wadden Sea data centers;
- coordination of the trilateral data handling operation;
- coordination of the implementation of structures for further parameter groups;
- coordination of projects to update and extend the trilateral data handling tools;
- support of trilateral working groups and the CWSS.

Personnel requirement

1 person experienced in environmental data handling, data base management and networks.

Financial requirements (only for operation and excluding personnel costs):

PC with Internet access and Internet software.

4.3 Time frame - implementation of the data handling

The data of the TMAP priority A, B and C-parameters have to be stored in the mentioned above TMAP databases to be available for the trilateral level. The time frame of the trilateral data handling system is therefore closely related to the implementation plan of the TMAP parameters.

TABLE 6: Time frame implementation of data handling

Priority	Presently	1998 - 2000	2001 - 2003	after 2003
A-parameter	Prototype test	Implementation		
B-parameter		Preparation	Implementation	
C-parameter			Preparation	Implementation

Prototype test: Basic installation of the DEMOWAD data handling unit and the implementation of the A-parameter groups '*breeding bird counts*' and '*heavy metals in blue mussels*'.

Preparation: Trilateral expert consultations to obtain complete information of a parameter group; arrangements and agreements on data delivery.

Implementation: Development of proper data structures and the trilateral exchange format; input of already existing data into the database; furthermore, adaptation of the data catalogue and network program to handle the new parameters.

5. ECOLOGICAL RESEARCH

5.1 Aims of ecological research in the TMAP

The research component is the flexible element of the TMAP. Ecosystem research studies the environment on a broader perspective including features regarded as subordinate given the present status and knowledge of the ecosystem. The foremost tasks of ecosystem research is to discriminate between natural fluctuations and human impacts to find the causes of changes observed in the ecosystem. A further task is to continuously improve the efficiency of the monitoring program. These tasks are essential for two goals of policy and management: the capability of providing evidence for man-made causes, and the capability of interpreting and predicting the reactions of the ecosystem correctly.

Several items for research derive from the Issues of Concern of the monitoring program (TMEG 1993):

- Changes and phenomena in the ecosystem, as induced by natural events or human activity, may become evident only after a certain time lag. One major goal of research is to find out about this time lag. This concerns the observation of spatial patterns and cyclic processes. By integrating the data from monitoring into the research data, the order of magnitude of the time lag and the controlling factors may be identified.
- Synergistic effects of pollution, fishery, recreation and coastal engineering may occur which induce or further enhance changes and phenomena in the ecosystem.
- Direct evidence of pollution impacts on individual species needs to be provided with the goal to identify parameters which can be routinely measured and which are indicative for the quality of the environment.
- The pathways and accumulation of contaminants in the food web need precise documentation and conclusions for the monitoring program.
- Accumulation and decomposition of organic material and its pathways in the system are important key processes in the Wadden Sea. As a first result, additional parameters for the monitoring program have to be elaborated.
- The “black spot” phenomenon.

5.2 Main items of ecological research

Priorities set by the TMAG in 1994

In 1994, the TMAG decided to set priorities among these topics and to identify research items that require special attention. These were:

- The effects of coastal engineering, coastal protection and land reclamation on the one side, and the climate change-induced rise of the sea level.
- The accumulation of organic matter in the Wadden Sea especially on the background of the lacking capacity of the system to compensate for this process. Both items were interrelated, but there were also links to the black spot phenomenon which became an issue in spring 1996.

Effects of contaminants

Monitoring the effects of contaminants on single species and individual organisms has received much attention in the past by the JAMP. The goal was to increase monitoring efficiency and arrive at assessment criteria for the state of the ecosystem by monitoring single species and their status. However, subsequent discussions revealed a number of open questions and shortcomings of direct effect monitoring and resulting assessment criteria. Most intriguing was that effects are specific and can only be attributed to one or a few contaminants while combined effects or effects of new pollutants remain subtle. Therefore and because of the potential

complexity of interactions, the effects of contamination in the Wadden Sea should be studied on the ecosystem level using the key species and key processes of the TMAP.

Results of the expert workshops

While research into the cause of observed changes is a prominent task for concomitant investigations of the ecosystem, the elaboration of new or alternative parameters and appropriate methods for the monitoring program must have high priority in the near future. Such research projects result in a proposal for a monitoring program which is tested for its feasibility and efficiency in a trilateral pilot project. Depending on the results of the pilot project, the project is then implemented as a regular long-term monitoring program in the framework of the TMAP.

During the expert workshops held in 1995/1996 further items for research emerged. Starting points were parameters or target items which required research efforts before they were to be implemented in a regular monitoring program. Most important were:

- remineralization processes,
- brown shrimp *Crangon crangon*, population dynamics and shrimp fishery impacts,
- certain organic contaminants (e.g., triazines).

Whereas monitoring brown shrimp stocks and fisheries affects an entire Issue of Concern, remineralization processes fulfill both, the criteria of concomitant research on observed changes or phenomenon and the elaboration, testing and implementing of new methods and variables.

Trilateral pilot projects that are currently going on or that were recently concluded are e.g., monitoring contaminants in bird eggs, monitoring breeding success in birds. In the near future, the application of remote sensing techniques to the various fields of the TMAP will receive a great deal of attention, since it is likely to increase its efficiency and it increases the power of the program over vast geographical scales.

5.3 Project proposals

In conclusion, research efforts within the trilateral framework should be focused on several items during the next three to six years. It is important that relevant ongoing and recently finished research programs are considered first so that they provide up-to-date results on which the concepts of new proposals can be based. The first step will always be a thorough compilation and subsequent assessment of the existing information.

The following research projects should have priority:

1) Remineralization Capacity

The accumulation of organic matter and remineralization processes in the Wadden Sea. This is a problem of trilateral importance and the symptoms show a striking geographical gradient. The funding sources for such a project may be located at the European level or alternatively local sources may be joint to a research network operating at different scales in the three states. During 1997, the relevant institutions will be gathered and exchange of experience in this field, followed by the identification of the relevant research topics be performed. The application is scheduled for the fall 1997. Depending on the outcome of this process, the project should run for a one- to three-year period. A pilot phase for the implementation of an appropriate monitoring program may start in the year 2000 or slightly earlier.

2) Effects of Coastal Protection Measures and Climate Change

The effects of coastal engineering, coastal protection and land reclamation on the one side, and the climate change-induced rise of the sea level on the other side. Climate change and the anticipated shifts and variations in the fields of weather, hydrology, ecology and economy are prominent issues not only for the Wadden Sea. It is, however, here that the adverse effects of human activities and of climate-induced changes will become most conspicuous. Therefore, research in this field should be stimulated. Given the scale of the phenomena, funding sources should be sought primarily at the European level. Starting in 1998, a trilateral venture should make use of existing programs to the largest possible extent. A three-year-research period should be envisaged so that a pilot phase for this monitoring element becomes possible around the year 2000.

3) Monitoring of Crangon

The population dynamics of brown shrimp *Crangon crangon* and the brown shrimp fisheries. Funding sources should be located at the European level. Starting in 1997, a trilateral venture should make use of existing projects to the largest possible extent.

A one or two-year-research period should be envisaged so that a pilot phase for this monitoring element becomes possible before the year 2000.

4) Application of Remote Sensing for the TMAP

The introduction of remote sensing techniques. Funding sources should be located at the European level. During 1997, the relevant institutions will be gathered and exchange experiences in this field, followed by the identification of the relevant research topics. The application is scheduled for the earliest possible date or the fall 1997 at the latest. Depending on the outcome of this process, the project should run for a one or two-year period. A pilot phase for the implementation of an appropriate monitoring program may start before the year 2000.

6. TMAP: ORGANIZATIONAL STRUCTURE

6.1 Status

In 1994, the Trilateral Monitoring and Assessment Group (TMAG) was installed as a permanent working group under the TWG with the following Terms of Reference:

1. Establishment of regular assessment reports of the Wadden Sea (QSR or other reports).
2. Implementation and execution of the TMAP.
3. Coordination of ecological research.
4. Development of a trilateral data handling structure.
5. Additionally, the TMAG was requested to integrate requirements for the assessment of the ecotargets into the TMAP.

Re. 1: The preparation of the QSR 1997 was delegated to a TMAP ad-hoc Working Group, the QSR Group. This Group has a coordinating function. The actual writing of basic material was delegated to experts. The preparation of special reports on breeding and migratory birds was done by the respective trilateral expert groups.

Re. 2: Most of the practical work regarding the TMAP implementation was carried out in expert workshops and at the CWSS.

Re. 3: The coordination and evaluation of relevant ecosystem research projects was discussed in the TMAG at several occasions. For priority reasons, this task has received limited attention.

Re. 4: The development of the data handling system was delegated to the Trilateral Data Handling Group. The task of this Group was to supervise the Demowad Project with regard to the definition of a trilateral data handling structure, the installation of the system and the execution of a prototype test for selected parameters. The practical work was carried out by four persons employed in the DEMOWAD project.

Re. 5: The ecotarget approach was developed separately from the TMAP. It is now being integrated into the TMAP structure. The TMAG has decided that proposals for the further specification and evaluation of the ecotargets should be developed by experts. The QSR Assessment part will be structured according to the ecotargets.

6.2 Assessment

6.2.1 TMAG

The tasks of the TMAG can be divided into two main categories, namely coordination/supervision and practical expert work.

The experiences from the past years have made clear that the TMAG has mainly been dealing with coordination and supervision tasks, in some cases (data-handling and QSR) at the meta-level.

Even with this level of delegation, the agenda of the TMAG was overloaded and the TMAG members had problems in meeting their duties in the intercessional periods.

To execute its tasks, the TMAG needs detailed expertise on a wide range of issues and therefore a continuous input from the expert level. With regard to the implementation of the TMAP, the TMAG depends completely on the cooperation of experts who are carrying out the monitoring at the national level. The TMAP expert workshops have shown that support from the expert side is essential for the running of the TMAP.

6.2.2 TDG

The TDG has been the mediator between the actual data handling work and the TMAG. The results achieved until now are a sound basis for further development of the data handling system for the TMAP. The major reason for the substantial progress made in this part of the DEMOWAD project has been the direct employment of experts in data handling.

Important future work is the definition of the reporting requirements for each parameter to be included in the TMAP guidelines.

6.2.3 QSR Group

This group is facing serious problems with the QSR preparation. The main reason is that it is dependent upon voluntary contributions from external experts. A serious delay in the submission of draft text contributions has occurred.

In addition, there are problems with the data delivery which cannot be solved at the expert level.

6.2.4 The CWSS

Within the TMAP, the CWSS has a coordinating function concerning

- the implementation and execution of the program,
- the handling of data,
- the establishment of assessment reports.

In principle the CWSS has a secretarial role in all these components, i.e. facilitation and coordination. In addition the secretariat has a substantial buffer and overload function for the technical work.

The CWSS was able to fulfill these tasks because a TMAP coordinator and a data handling expert were employed at the secretariat, the latter co-financed through the EU LIFE program.

6.3 Proposals

6.3.1 Monitoring and Assessment

In light of the experiences from the 1994-1997 intercessional period, a redefinition of the Terms of Reference of the TMAG is necessary.

The main point of departure in the formulation of the new Terms of Reference should be that the TMAG is a coordination and supervision body at the meta level. It should be considered whether the membership in the TMAG should reflect this function.

As a consequence the TMAP should delegate tasks to the expert level as much as possible. This in turn implies that sufficient expertise must be made available at the national expert level, i.e. participation in expert workshops and ad-hoc expert groups and contributions to the assessment work.

From this perspective, it can already be proposed to maintain the present TMAG ad-hoc Working Groups, the TDG and the QSR Group.

At the CWSS, the employment of the monitoring coordinator must be continued for the secretarial assistance of the TMAG and for the organization and coordination of the work of different ad-hoc expert groups.

It seems furthermore wise to formulate the work of the TMAG as much as possible in the form of concrete projects, including time schedule, responsibilities and a budget. This goes especially for the work on the QSR.

6.3.2 Data handling

An essential condition for the assessment of monitoring data is that data is made available fully and timely. Although considerable progress was made in the past years, the availability of data is still one of the bottlenecks in the assessment process.

The TDG must continue to implement the data handling system for all TMAP parameters and work closely together with the ad-hoc expert groups. This includes especially the elaboration and refinement of TMAP guidelines concerning common procedure for the trilateral data processing.

At the national level, appropriate manpower must be made available for these tasks through the employment of data handling coordinators responsible for the DEMOWAD unit at all data centers (0.5 personyear). Additionally, manpower must also be made available to transport the data from the local level to the national data centers (1 personyear, depending on the amount of data to be handled).

TMAP: ORGANIZATIONAL STRUCTURE

At the trilateral level, a data handling manager, currently employed within the DEMOWAD project, should continue employment at the CWSS to coordinate the national activities on the implementation of the data exchange system. This coordinator will also be responsible for the further elaboration of the collection and dissemination of trilateral data, most notably via internet.