National Environmental Research Institute
Ministry of the Environment · Denmark

Monitoring and Assessment in the Wadden Sea

Proceedings from the 11. Scientific Wadden Sea Symposium
Esbjerg, Denmark, 4.-8. April 2005

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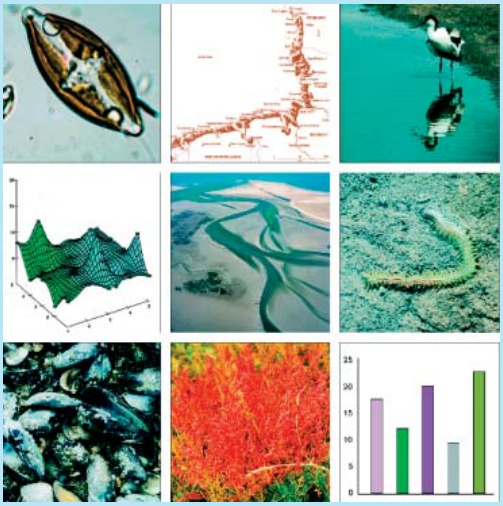

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Karsten Laursen (Ed.)

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Contents

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Foreword

The 11. International Scientific Wadden Sea Symposium, held from 4. – 8. April 2005 in Esbjerg, Denmark, brought together more than 150 scientists and policy makers. The symposium was organised by The National Environmental Research Institute, Dept. of Wildlife Ecology and Biodiversity in cooperation with the Common Wadden Sea Secretariat. The focus of the conference was 'monitoring', and under this heading, the existing TMAP (Trilateral Monitoring and Assessment Program), methodologies, experiences from the existing monitoring programs and results of new monitoring methods were the subject to scientific assessment. However, more policy related aspects were also addressed especially in relation to the EU-Directives (Habitats Directive, EU-birds Directive and the Water Framework Directive).
By focusing on the 'monitoring' theme, the symposium provided substantial input into the decision-making associated with the future development of the TMAP by the Trilateral Governmental Conference held in November 2005 on Schiermonnikoog. To this conference the symposium adapted a set of recommendations, which is available on the homepage of the Common Wadden Sea Secretariat: http://www.waddensea-secretariat.org/news/symposia/Esbjerg2005/Esbjerg-2005.html
The symposium was prepared and organized by a scientific committee representing a broad spectrum of scientist and administrators with many years of experiences from the Wadden Sea. The members of the scientific committee were: Peder Agger, Justus van Beusekom, Lillian van der Bijl, Bruno Ens, Kurt Thomas Jensen, Adolf Kellermann, Ingrid Kröncke, Harald Marencic, Wim Wiersinga, Wim Wolf and Karsten Laursen. The latter chaired the committee, organized the symposium and edited the proceedings in cooperation with the members of scientific committee, who refereed the papers assisted by Joop Bakker and Kees Koffijberg. Wim Wolf chaired the recommendation session and edited them in cooperation with Karel Essink. I am deeply grateful for the large effort from all these persons for preparing and carrying out the symposium.

Svend Bichel
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Effectiveness of the Wild Birds and Habitats Directives in the Wadden Sea area: will the tiger lose its teeth?

Jonathan Verschuuren

Jonathan Verschuuren, J. 2006: Effectiveness of the Wild Birds and Habitat Directives in the Wadden Sea area: will the tiger loose its teeth? In: Monitoring and Assessment in the Wadden Sea. Proceedings from the 11. Scientific Wadden Sea Symposium, Esbjerg, Denmark 4. – 8. April, 2005 (Laursen, K. Ed.). NERI Technical Report No. 573, pp. 7-12.

Almost the entire Wadden Sea area has been designated by Denmark, Germany and the Netherlands as a Special Protection Area under the Wild Birds Directive and as a Special Area of Conservation under the Habitats Directive. The new Water Framework Directive will, eventually, also have consequences for the area. What are the consequences of EU Directives aimed at protecting the Wadden Sea area? Provide these Directives effective protection against harmful activities? These questions have been dealt with through a case study on the decision-making process with regard to mechanical cockle fisheries in the Dutch part of the Wadden Sea in 2004. Also, data obtained from other European research projects into the effectiveness of the Directives have been analyzed. These studies indicate that especially the Wild Birds and Habitats Directives can be very effective tools for legal protection of the area. Especially case law by the European Court of Justice has rendered the Directives strong teeth. The Directives offer opportunities to protect the area, without neglecting economic interests, although the effectiveness still very much depends on the political will to take the Directives seriously, and/or on NGOs that go to court, invoking the provisions of the Directives. According to some, the Directives are too effective! Evaluation and amendments of the Wild Birds and Habitats Directives are to be expected within the next few years. The tiger may lose its teeth in this process.

Key words: law, Birds Directive, Habitats Directive, precautionary principle, case law

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Introduction

In this paper the consequences of EU-law for the protection of the Wadden Sea will be analysed. Quite a large number of Directives and Regulations apply to this area, legislation in the field of fisheries and the environment. Pieces of environmental legislation that apply to decision-making processes concerning the Wadden Sea for instance are a large variety of water related directives, nature conservation directives and general environmental law directives, such as the directive on Environmental Impact Assessment (Directive 85/337/EEC as amended by Directive 97/11/EC). Instead of giving a broad overview of all of these pieces of legislation, I decided to focus on the Wild Birds Directive (Directive 79/409/EEC) and the Habitats Directive (Directive 92/43/EEC), since it is beyond any doubt that these directives have a massive impact on decision-making concerning the Wadden Sea area. Over the past seven years I have researched the consequences of these directives on national environmental law by studying case law and legislation, not just in the Netherlands, but also in other EU member states, and I can only conclude that in all member states, conservation law has much improved, resulting in a far better legal protection of both important habitat types and individual species (Bastmeijer et al. 2001, Verschuuren 2002, Verschuuren 2003a, Verschuuren 2004a). Unfortunately, some dark clouds start to appear at the horizon. I will come back to that below.

In 2004, the European Court of Justice (ECJ) rendered a landmark decision on the Habitats Directive in a Wadden Sea case (ECJ 7 September 2004, case C-127/02, Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij. Also: Gellermann 2004, Verschuuren 2005). As a consequence, all environmental lawyers in the entire EU now know much about the Wadden Sea area in general

and about cockle fisheries in particular. It was a Dutch case in which the court was asked, by the Dutch highest administrative court, to explain important provisions of the Habitats Directive. I will use that case to explain the consequences of the Habitats Directive on decisions concerning activities that may be harmful to protected areas, either under the Wild Birds or the Habitats Directive (the same legal regime applies to both types of areas).

Material and methods

Law and legislation have been studied and analysed over the past few years. The main focus has been on Dutch law. The reason for that focus is the available material, i.e., the number of relevant court cases. In the Netherlands, the number of cases in which courts tested decisions against the Wild Birds and Habitats Directives is enormous, compared to other EU Member States, including Denmark and, to a lesser extent, Germany. Research has shown that in environmental law in general, the overall number of cases in the Netherlands is much higher than in other EU Member States (De Sadeleer et al. 2005). The same appears to be true for Wild Birds and Habitats Directive cases (Backes et al., forthcoming).

The case study focuses on the shellfish fisheries in the Dutch part of the Wadden Sea. The results of this research as well as research into the new landmark case of the ECJ forms the basis of this paper. This case on the Wadden Sea is relevant for all three Member States concerned. It may be an impetus for the three states to harmonize their laws and policies with regard to the implementation of both Directives in the Wadden Sea area. Laws and policies in the three states, including those with regard to Article 6 of the Habitats Directive, the important provision that forms the central subject of this paper, are now inconsistent (Oxford Brookes University 2003).

Results

The applicable legal regime: Article 6

Decision-making on the construction or extension of roads, railroads, ports or airfields, on building permits for houses or environmental permits for industry, or on other projects in areas designated under the Birds Directive or the Habitats Directive is largely regulated by Article 6(3) and 6(4) of the Habitats Directive. These provisions state that plans or projects likely to have a significant effect on a protected area can only go ahead after an assessment has shown that there are no negative consequences. When damage occurs (according to the assessment), the project can only proceed when some extremely strict requirements for exemption have been met. These have been laid down in section 4 and are threefold: a) there may not be an alternative to achieve the goal of the project, b) there have to be overriding public interests at stake, c) compensatory measures have to be taken (and in some cases the European Commission has to grant permission). Bearing in mind that the Birds Directive came into effect in 1981 with a provision on decision-making on projects negatively affecting an SPA that in 1992 was replaced by Article 6 of the Habitats Directive, it is astonishing that it took until 2004 before the ECJ had to decide in a preliminary ruling on fundamental questions regarding the central provision of the Habitats Directive. There were earlier decisions in which Article 6 played a role, but in none of these the Court went into much detail. This, for instance, is the case in case C-57/89 Commission v Germany (Leybucht dykes) (ECR 1991 I-883) and case C-96/98 Commission v France (Poitevin marshes) (ECR 1999, I-1853) - both on Article 4(4) of the Wild Birds Directive, the predecessor of Article 6 of the Habitats Directive -, and in case C-117/00 Commission v Ireland (Owenduff-Nephin Beg Complex) (ECR 2002, I-5335) - on Article 6(2) -. Article 6(3) and 6(4) were mentioned in the Lappel Bank case, but this case was, like several others, mainly on the selection of sites as an SPA and on defining the boundaries of the SPA (case C-44/95 Regina v Secretary of State for the Environment ex parte Royal Society for the Protection of Birds, ECR 1996, I-3805). It is beyond any doubt that the current decision will be influential on much of the decision-making under the Wild Birds and Habitats Directives throughout the EU in the coming years.

The facts of the case are quite familiar to those involved in research in the Wadden Sea area. In the Netherlands, there is a fierce debate on the fishing for shellfish, especially mussels and cockles, in the Wadden Sea area. While the EVA II-research on the consequences of mechanical cockle fishing, financed by the Dutch government, was going on, environmental NGOs, fishermen and the competent authorities met in court regularly. Under Dutch law, each year, the fishermen have to obtain a licence stating the amount of shellfish they are allowed to catch in the current season. The amount granted depends on the amount of shellfish present; a certain percentage of the total amount is reserved for the birds. Each licence was challenged before the competent administrative court. From a legal point of view the main question in these court procedures was whether or not Article 6 should be applied in cases like these and, if so, how.

What is a 'project'?

The first issue that had to be resolved is whether or not fishing is a 'project' that is governed by procedure of Article 6(3). One could argue that fishing,

like agriculture, is an ongoing, already existing activity from the past that is entirely different than a new project like the construction of building or a road. Many people, including the European Commission, always thought that the strict procedure of Article 6(3) did not apply to such activities. In its manual on Article 6, the European Commission explicitly states that Article 6(2) is 'applicable to the performance of activities which do not necessarily require prior authorisation, like agriculture or fishing.' (European Commission 2000a, p. 24). However, according to the Court, all interventions in the natural surroundings and landscape including those involving the extraction of mineral resources are subject to the procedure of Article 6(3). Doesn't this include practically any intervention, such as agriculture, recreation, fisheries, military activities, in other words: existing activities that were thought to not be regulated under Article 6(3)? The consequences of this decision cannot be thought of lightly. Any activity that is likely to have significant effects on the area is subject to Article 6(3)!

The precautionary principle

An appropriate assessment is necessary for projects that are likely to have a significant effect. The Court refers to the precautionary principle to explain the meaning of this provision. In case of doubt as to the absence of significant effects, an assessment must be carried out. The Court's intend is clear: it may not be easy to avoid making an assessment. The assessment has to show whether a project is damaging or not. Decision-making has to be based on facts, not on assumptions. In practice, under this condition, assessments will very often have to be carried out, since there usually is not that much knowledge on the (long term) effects of specific human activities on a specific habitat type or on a specific species. At the same time, we should acknowledge that uncertainties will always remain. Even the tremendous research effort that was delivered in the Netherlands to find out the consequences of shellfish fishing on the ecosystem of the Wadden Sea did not take away all uncertainties, and even came up with new ones. In my view, absolute certainty does not exist. At the end of the day, decision-makers have to assess the remaining uncertainties and potential consequences caused by these uncertainties. The European Commission also took this point of view (European Commission 2000b, sections 2 and 6.3.1).

What is 'significant'?

Unfortunately, the Court is very brief on the term 'significant'. The site's conservation objectives are decisive. Here, at first glance, the Court seems remarkably lenient: where a plan or project is likely to undermine the conservation objectives, the project must be considered to likely have a significant effect. Is this only the case when the site is totally lost for the habitat type or species for which is had been designated? Or when the quality of the habitat type deteriorates or the number of birds diminishes to such an extent that the area no longer qualifies as an SPA or SAC? These interpretations seem consistent with the word 'undermine'. Or is any damage to the conservation objectives 'significant'?

In national case law various approaches can be observed. In the Netherlands, courts sometimes argue that a negative effect is significant in case the area would no longer qualify as an SPA. In other decisions, courts consider any damage to the conservation objectives reason enough to have the competent authorities apply Article 6(3) (Verschuuren 2004b).

I support the latter view, as adequately put forward by the Advocate General in this case: If adverse effects resulting from projects were accepted on the grounds that they merely rendered the attainment of these objectives difficult but not impossible or unlikely, the species numbers and habitat areas would be eroded by them. It would not even be possible to foresee the extent of this erosion with any degree of accuracy because no appropriate assessment would be carried out. Indeed, long term viability of the area must be secured, so that must be the focus of any decision-making with regard to protected areas. It is remarkable to note that the Dutch and German versions of the judgement use the equivalent for the word 'endanger' rather than 'undermine', whereas the French version uses the equivalent of the word 'compromise' (compromettre).

Whatever the explanation of the word 'significant', the ECJ has placed so much emphasis on the precautionary principle, that it is clear that avoiding the duty to assess the consequences of a project will be very difficult, if not impossible. As already stated, there will almost always be uncertainty as to the potential consequences of a project, especially in a complex and dynamic ecosystem like the Wadden Sea, necessitating an assessment anyway. So in my view, the Court, by stressing the importance of the precautionary principle has rendered the discussion on the word 'significant' purely academic.

Appropriate assessment

The Court also clarifies the assessment itself. First of all, cumulative effects have to be taken into account. The project itself may not be harmful, but the project in conjunction with other projects may very well be harmful. Again, the Court does not fully clear up this point. Do only cumulative effects of future projects have to be taken into account, or the effects of existing projects as well (i.e., projects that were carried out in the past, such as an existing motorway)? And what about effects of autonomous develop-

ments, like the effects of climate change or invasive species? Both of these are effects play a big role in the Wadden Sea. In my view, such autonomous developments should be taken into consideration as well. The combined effects of fisheries and autonomous developments in the area might very well be much more harmful than the effects of fisheries alone. The problem here is that there is little that can be done to mitigate the effects of climate change. So it seems that the fishermen have to pay the bill!

Secondly, the assessment has to show that it is certain that the project will not adversely affect the integrity of the site. That is the case where no reasonable scientific doubt remains as to the absence of such effects. If doubt remains, the project cannot proceed unless Article 6(4) is applied. Again the precautionary principle plays a major role. It is applied in a very strict interpretation, much stricter than usual (Douma 2002 at 433). The strict interpretation is a consequence of the way Article 6(3) has been formulated. In this provision, the EC legislature opted for a strict implementation of the precautionary principle into a legal rule (Verschuuren 2003b). The Court rather tightly holds on to the literal text of Article 6(3).

Thirdly, it must be stressed that the effects on all conservation objectives must be assessed. For an area with such many conservation objectives, this is an enormous task. The Dutch part of the Wadden Sea has been designated for no less than 44 species of birds, five species of animals and nine habitat types. The potential effects of a project on all of these species and habitat types have to be assessed!

Discussion

Some critical remarks on this approach

The importance of this decision cannot be overestimated. As I already explained, it is a landmark decision that will be used by all courts throughout the EU in cases on areas protected under the Birds- and Habitats Directives. We already observed the impact in the Netherlands where courts strictly follow the words used by the European Court of Justice. The District Court of Amsterdam on 4 October 2004 annulled a licence for mechanical cockle fishing in the SPA Voordelta (part of the North Sea coastal zone), referring to the ECJ's judgement in case C-127/02. From a conservation point of view, the decision is hailed, especially by NGOs.

However, some critical remarks can be made as well. The cockle fisheries case itself shows the weaknesses of the directives. The conclusion of the EVA II-research project was that there are a number of factors that contribute to the decline of the number of shellfish-eating birds, some of which are beyond our control, such as climate change and -paradoxically- a successful European policy to decrease the level of eutrophication of surface waters, as well as the rapid proliferation of an invasive species (pacific oysters) (Ens et al. 2004). One of the factors is intensified fishing, which, by itself, accounts for a decline of around 15,000 oystercatchers. Mass mortalities of the common eider are probably due to over-fishing of intertidal mussel beds in the early 1990s, in combination with severe winter storms that delayed the recovery of the mussel beds. Other species, especially worm eating birds such as dunlins, have increased as a result of the disappearance of cockles and mussels. For policy makers, this leads to a tough situation. The SPA is not just designated for oystercatchers and eiders, but for a whole range of other species as well, including dunlins. Measures to restore the amount of food for shellfish-eating birds, will diminish the availability of food for worm eating birds and thus to a decline of these species. Also, one can rightfully ask whether taking the number of birds present in the year in which the area was designated as an SPA, is the right thing to do. As far as the western part of the Wadden Sea area is concerned, model calculations indicate the high level of eutrophication may have been the cause of an unnaturally high food supply in the past, and thus an unnatural high number of oystercatchers may have been present in the area (Ens et al. 2004). It is safe to assume that these numbers will never be achieved again, since nutrient loads are expected to decline further. In addition, the expected changes in climate might reduce the likelihood of large spatfalls of cockles and mussels, and the expected increase of the pacific oyster might go at the expense of other shellfish stocks (Ens et al. 2004). From a legal point of view this appears to be problematic. The dynamics of an ecosystem is not entirely consistent with the rather static conservation approach that the Wild Birds and Habitats Directives seem to take.

The future of shellfish fisheries in SPA Wadden Sea in the Netherlands

Meanwhile, the Dutch Parliament decided to ban mechanical cockle fishing from the Dutch Wadden Sea altogether, starting in 2005. This was not a direct consequence of the Court's judgement, but the outcome of a political debate on the future of the Wadden Sea area. The Minister decided to grant the fishermen one last licence for 2004. As usual, this licence was challenged by environmental NGOs. The European Court of Justice judgement came just a few days before the President of the Dutch Administrative Court had to render a decision in the (preliminary) suspension case on the 2004 licence (14 September 2004). He, obviously, decided that, given the judgement of the European Court, the licence had to be suspended awaiting formal sessions in court. A final decision in this case was taken in De-

cember 2004; as was expected, the Court annulled the permit (22 December 2004, Case Nos. 200000690/1-A and 200101670/1-A). On 9 February 2005, the 2002 permit was annulled as well, (Case No. 200305972/1). For the fishermen, the final decision was of no relevance, since the licence expired in January 2005 anyway.

In October 2004, the Dutch Minister of Agriculture, Nature, and Food Quality, published a new national policy for shellfish fisheries (Parliamentary Documents 2004). According to this policy document, mechanical cockle fisheries will be gradually abolished in other SPAs as well. The policy is aimed at a gradual transition to sustainable methods of shellfish fisheries (incl. mussels, oysters and other shellfish). Also, the policy document makes it clear that any fishing method that is likely to have a significant effect on a protected area will be subject to licensing under Article 6(3) of the Habitats Directive. In my view, it is correct not just to focus on mechanical cockle fisheries. Other methods can be harmful as well. Even handpicking of cockles, usually considered to be a sustainable fishing method, can have significant effects, for instance if a large number of people stroll through nesting areas of birds.

The future of the Wild Birds and Habitats Directives in the Wadden Sea area

Application of the provisions of the Wild Birds and Habitats Directives saw a slow start, all over Europe. In addition, especially as far as application of these Directives to the Wadden Sea is concerned, there has been an inconsistent start. Landmark decisions by the ECJ, such as the Wadden Sea shellfish case, usually have a big impact on legal practice in all EU Member States. Thus, this case may very well harmonize legal practice in the three Wadden Sea states, and in my view, is helpful in the efforts to integrate laws and policies with regard to the Wadden Sea, especially with regard to the application of Article 6.

In the Netherlands, the procedure of Article 6 of the Habitats Directive is used by interested stakeholders to look for possibilities to reconcile economic and conservation interests. Large, contested projects are negotiated by all parties involved, looking into nature protection issues for an entire region in an integrated fashion, and drawing up compensation plans to restore lost habitats. In my view, this development is based on the fact that courts in the last few years began to test projects against the provisions of the Habitats Directive. Because of the persistence of the European Commission, which continues to institute infringement procedures against EU Member States for failure to fulfil obligations under the Wild Birds and Habitats Directives, and because of the recent European Court decision in the cockle fisheries case, national authorities as well as national courts have come to realize the impact of these Directives.

NGOs have successfully seized the new opportunities offered by the European Directives to protest and combat the loss of biodiversity. The reason for the initial success of NGOs is simple: administrations were not accustomed to providing the amount of data, and legal arguments, that are now needed before a project that harms biodiversity can be approved. Courts tend to find administrative decisions inadequate, when the authorities are not able to present sufficient data. However, authorities, as well as developers now recognize that they need to develop their plans so as not to deteriorate protected areas or harm populations of endangered species. Their efforts must be applauded.

At the same time, the protests by these role players against the influence of the Habitats Directive on decision-making are becoming louder, not just in the Netherlands, but all over Europe. Until now, attempts to weaken the Habitats Directive have been averted. Instead, the European Commission has promised to evaluate the Wild Birds Directive and Habitats Directive in 2007. This evaluation has to show whether amendments are in order.

In my view the critique is not justified. Indeed, many decisions have been annulled by courts, especially in the Netherlands, but mainly because the competent authorities did not carry out an assessment at all, or did not follow the correct procedure. In the end, most projects were allowed, after the correct procedure was followed. Often, the assessment under Article 6 of the Habitats Directive shows that it possible to go ahead with a project, usually in a more or less adapted form, for instance, on a smaller, less harmful, scale, or with additional measures to mitigate the effects.

In my view, there will be two challenges for the near future. The first challenge is to adapt the rather static conservation approach that the legal system now takes to the dynamics of ecosystems. Joint research by lawyers and biologists has to show how this must be done without weakening the legal protection of protected areas. The second challenge is to reconcile habitat protection and economic activities. The Wild Birds Directive and Habitats Directive offer enough possibilities for the parties involved to negotiate such reconciliation. All parties involved in the Wadden Sea area (local residents, environmental NGOs, business corporations, public authorities), together will and can find ways to achieve the targets set by the Wild Birds Directive and Habitats Directive without disregarding all economic or social interests. To accomplish this, a strong Habitats Directive is necessary, a tiger that still has all its teeth!

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EU Directives and their effects on the ecosystem of the Wadden Sea

Franciscus Colijn & Stefan Garthe

Colijn, F. & Garthe, S. 2006: EU Directives and their effects on the ecosystem of the Wadden Sea. In: Monitoring and Assessment in the Wadden Sea. Proceedings from the 11. Scientific Wadden Sea Symposium, Esbjerg, Denmark, 4.-8. April 2005 (Laursen K. Ed.). NERI Technical Report No. 573, pp. 13-20.

Three EU Directives, the Bird Directive, the Habitat Directive and the Water Framework Directive, aim to protect the environmental quality or even specific groups of organisms, or habitats with their associated flora and fauna, in the European member states.

The realisation and control of these directives is not an easy task and therefore it seems relevant to assess to which extent these directives are helpful in reaching the goals of preservation, restoration or improvement of the ecosystem of the Wadden Sea.

It should be realized that systems such as the Wadden Sea are open in a sense that many of the species under these directives can freely migrate in and out of the Wadden Sea, or that habitats are exposed to large natural variability in abiotic environmental conditions. This paper evaluates two aspects: are these directives helpful in preserving the status of the Wadden Sea, and secondly can we assess this status in view of the directives. We used examples from different groups of organisms to answer these questions.

A conclusion of this paper is that at present the long-term effects of these directives cannot be evaluated because of the complexity of the system and the inability to discriminate between measures from the directives and other ongoing environmental improvements such as reduction of eutrophication and of the inputs of contaminants.

Keywords: Wadden Sea, ecosystem, conservation, EU directives, OSPAR, eutrophication

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Introduction

Since the late seventies the EU has started to formulate Directives. One of the first released was the so-called Wild Birds Directive (Anonymous 1979). The intention of this directive is that member States shall take measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for all the species of birds referred to in Article 1 (Wild Birds Directive: Anonymous 1979). The objective of the special measures is to conserve their habitat in order to ensure their survival and reproduction in their area of distribution. Therefore the Member States are urged to classify in particular the most suitable territories in number and size as special protection areas, taking into account their requirements in the geographical sea and land area where this Directive applies.

In 1992, the EU presented another Directive which is known as the Habitat Directive (Anonymous 1992). This directive on the conservation of natural habitats and of wild fauna and flora asks the Member States to create a coherent network of protected areas. The purpose of this network is to preserve terrestrial, freshwater and marine biological diversity. A special part of this directive is devoted to the protection of a number of marine mammals such as the harbour porpoise, the common seal and the grey seal. Other elements under the Habitat Directive are salt marshes and sea-grasses as traditional elements of the flora of the Wadden Sea.

In 2000 the EU promoted an important directive which is known as the European Water Framework Directive (WFD) (WFD 2000). This directive is meant to protect the aquatic systems, freshwater, as well as estuarine and coastal waters. Objectives are the maintenance of a good ecological status, control of environmental damage at the source, and use of

the precautionary principle, to enable an economic and social development of the EC countries, but with a regional differentiation. It urges for international co-operation and methodology development. For this purpose the WFD has compiled biological and physico-chemical quality elements (e.g. WFD 2000, Annex V), such as phytoplankton, macroalgae, angiosperms, benthic invertebrates and fish. Sensitivity, abundance and diversity within these groups are the key elements for the determination of the ecological status.

A rather specific case similar to the WFD is the OSPAR Directive (OSPAR 1997). The OSPAR Commission has adopted a so-called common procedure for the assessment of the eutrophication status of the maritime area of the OSPAR Convention area. This common procedure distinguishes three types of areas. Problem areas with evidence for an undesirable disturbance due to anthropogenic enrichment by nutrients, potential problem areas which have reasonable grounds for concern that disturbance may occur and non-problem areas for which concerns do not exist. For the Wadden Sea region specific criteria have been developed by van Beusekom et al. (2001).

In this paper we will evaluate to which extent these directives have been helpful to reach the goals of preservation and protection. For the WFD this is not yet possible, because the execution of the directive is not yet achieved. Because of the long-term effects of such directives a clear proof of their effectiveness will currently be impossible.

Material and methods

Published as well as unpublished material and information from different sources have been used for this paper. Information on birds has been taken from monitoring studies in the Wadden Sea such as data on Brent and Barnacle goose as well as several waders which were derived from studies published by the National Park Administration of Schleswig-Holstein (e.g. NPA 2000); data on gulls were made available from our own FTZ database; the data on the population size of common seals in the Wadden Sea are taken from the recent Reijnders et al. (2005) publication. Data on the distribution of marine mammals were taken from several sources such as Haelters et al. (2002), Camphuysen (2004) and unpublished data from running projects at the FTZ. Information about salt marshes and sea-grasses were taken from the Bakker et al. (2005) and Reise et al. (2005) papers. Data on eutrophication in the Wadden Sea are from van Beusekom et al. (2001), OSPAR (2003), van Beusekom et al. (2005) and van Beusekom (2005; unpubl.).

Results and Discussion

Wild Birds Directive

Nine examples of bird species which fall under the Wild Birds Directive are presented. The best documented long-term series on numbers of breeding pairs are available for the Sandwich Tern *(Sterna sandvicencis).* In Fig. 1 the development of breeding pairs is shown for different regions of the Wadden Sea, in Denmark, Schleswig-Holstein, Lower Saxony and the Netherlands.

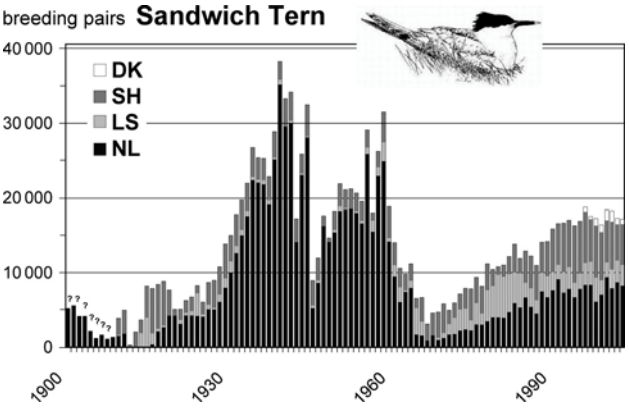

Figure 1. Breeding pairs of the Sandwich Tern in different parts of the Wadden Sea. DK: Denmark; SH: Schleswig-Holstein; LS: Lower Saxony; NL: the Netherlands; Source: Nationalparkamt, Tönning.

Although numbers for the early part of the 20th century are not completely reliable, the long-term development shows a few characteristics, such as a strong increase from the nineteen thirties onwards, and a strong decrease almost to extinction in the mid sixties. Afterwards a slow but steady increase has occurred with a stabilisation of the numbers at about half the maximal numbers of the nineteen forties. The decrease in the sixties was due to water pollution from the Rotterdam area by polychlorinated compounds which accumulated in the birds through the food-web (Koeman 1971). After reducing the discharges a slow but steady recovery took place. However the graph shows a substantial shift of the breeding colonies to the north (Rasmussen et al. 2000). The reason for this is unknown.

Two goose species in the Schleswig-Holstein part of the Wadden Sea show opposite directions of population developments (Fig. 2). Whereas the Barnacle Goose *(Branta leucopsis)* is steady increasing over the last two decades, the Brent Goose *(Branta bernicla)* shows a steady decline. For both species the overall changes in numbers, distribution and habitat utilization in the Wadden Sea seem to be mainly related to changes at the population level (Blew et al. 2005). No evidence has been found that changes in the decline or increase in either species, although feeding opportunities did change during the past

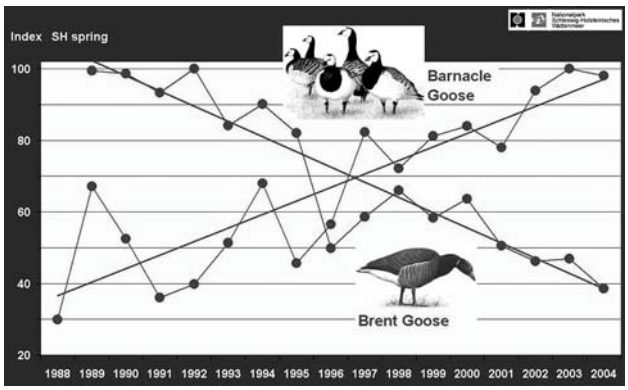

Figure 2. Development of numbers of two goose species: Barnacle and Brent Goose in Schleswig-Holstein (German Wadden Sea) Source: Nationalparkamt, Tönning.

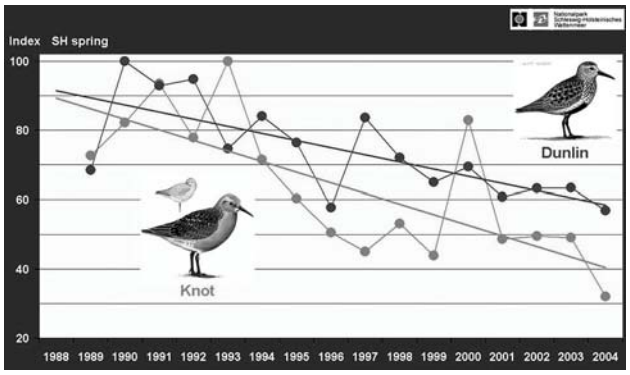

Figure 3. Development of numbers of Knot and Dunlin in Schleswig-Holstein; Source: Nationalparkamt, Tönning.

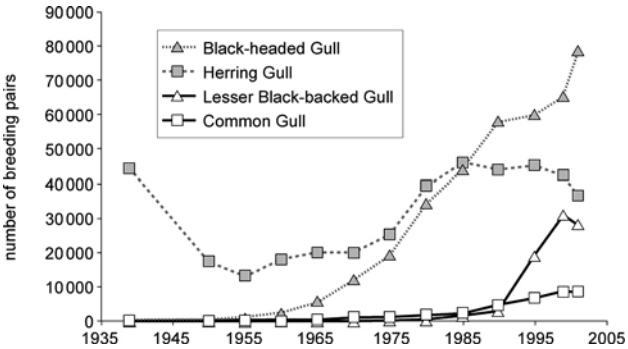

Figure 4. Development of numbers of four gull species along the German North Sea coast. Source: Garthe et al. (2000, unpubl.).

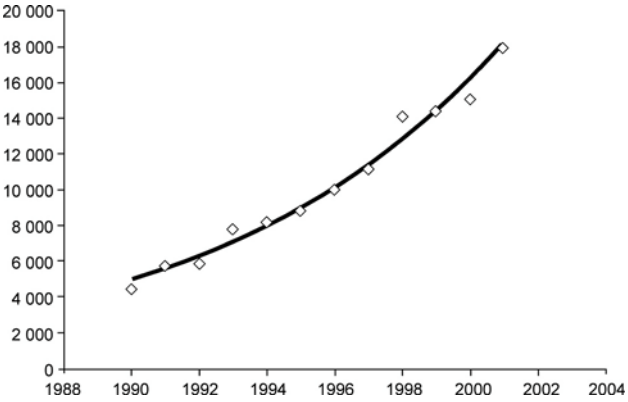

Figure 5. Growth rates of seals in the Wadden Sea on the basis of annual aerial counts (Source: Reijnders et al. 2005).

decades with the abandoning of livestock grazing in large parts of the salt marshes (Blew et al. 2005). Two other factors might have influenced the population size and distribution: a change in timing of migration, and the management of grasslands in the eastern part of the Wadden Sea (Blew et al. 2005).

In Fig. 3 two examples of the decline of typical Wadden Sea waders, are shown. Dunlin *(Calidris alpina)* and Knot *(Calidris canutus)* both show a steady decline over the last two decades. Although no final analysis exists, the supposition is that through a complex of factors the availability of food for these bird species has been reduced.

A final example shows the population size development of four different gull species with different food preferences and foraging strategies: the Black-headed *(Larus ridibundus)*, the *Herring (Larus argentatus)*, the Lesser Black-backed *(Larus fuscus)* and the Common Gull *(Larus canus)* (Fig. 4). All of them show a steady increase in numbers along the German North Sea coast since the mid-1950s. The last three species seem to stabilize in population size in the nineties whereas the numbers of the black-headed gull still increase. Part of the changes in these population sizes can be explained by food availability, especially for those species which have the ability to exploit both natural and anthropogenic food sources like discards and offal.

According to the Blew et al. (2005) review of overall trends in water birds utilizing the Wadden Sea, 22 out of 34 species considered experienced declines in the 1992-2000 period, of which 15 are statistically significant. This looks like an alarming development since the 1999 QSR. Moreover, similar declines have not been observed elsewhere, suggesting that the causes for these declines may be related to the Wadden Sea area (Blew et al. 2005). These declines prevent us from demonstrating an overall positive effect of the Birds Directive. However, a conclusion on the effectiveness of the Birds Directive cannot easily be drawn as the conditions might have been worse without such a protective status.

Habitat directive

Apart from special protection status for a selected group of marine mammals like harbour porpoise, common and grey seals, another element of the Habitat Directive (Anonymous 1992) is the creation of a coherent network of protected areas. For this purpose the whole Wadden Sea and larger parts of the coastal seas as well as the German Exclusive Economic Zone (EEZ) of the North and Baltic seas have been declared as protected areas or are candidates for such.

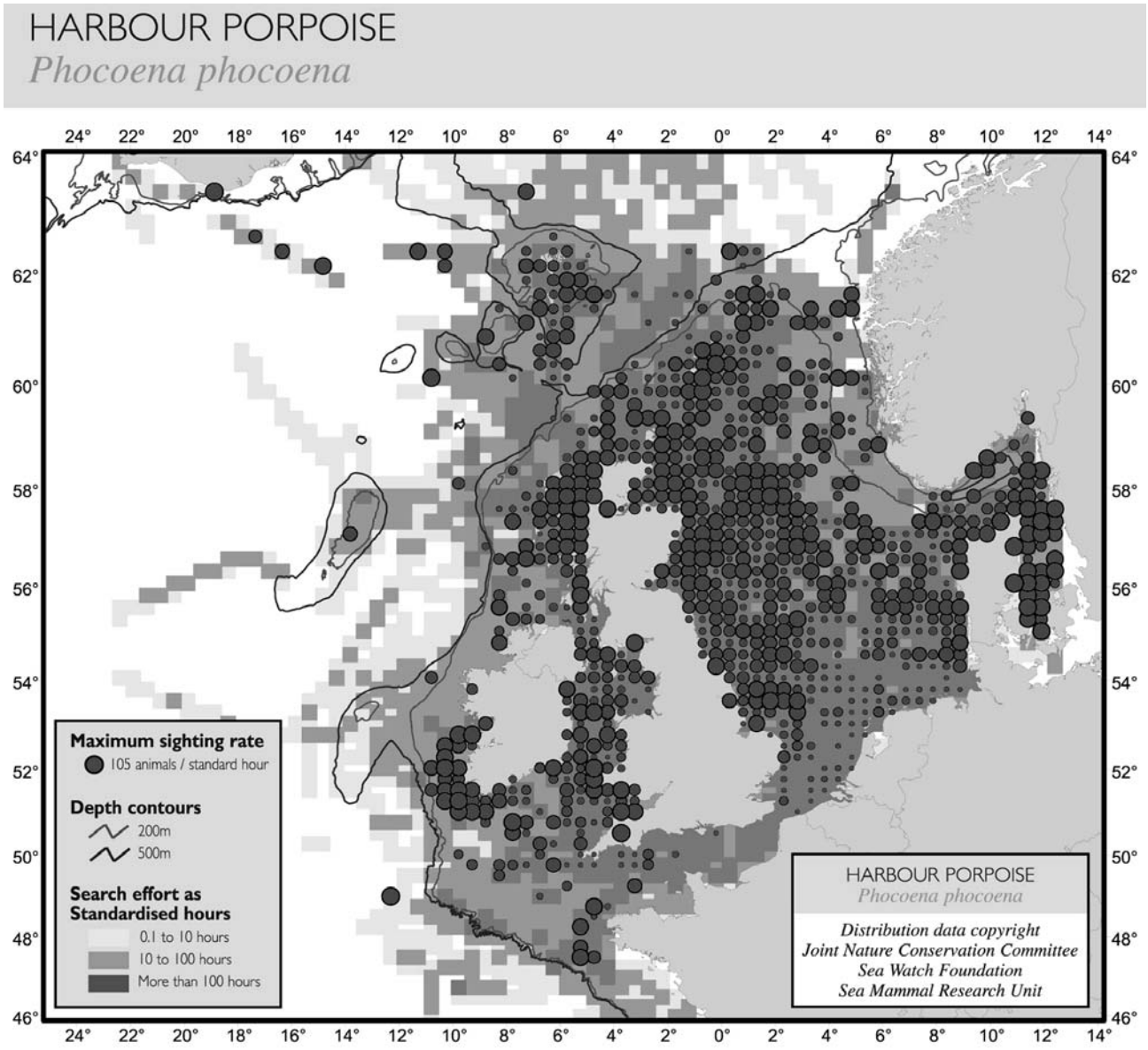

Figure 6. Counts of harbour porpoises in the North Sea and around the British Isles (Source: Reid et al. 2003).

Although seals were affected twice by Phocine Distemper virus epidemics during the last two decades which both about halved the population of the common or harbour seals (*Phoca vitulina*; Härkönen et al. 2006), the population still seems to be able to recuperate extremely fast based on the annual growth rates of the population (Fig. 5). Thus the population recovered within about 7 years to the pre-epidemic levels after the first devastating epidemic in 1988. A similar expectation exists for the present situation after another epidemic in 2002. This means that living conditions for seals inside the Wadden Sea and the adjacent coastal North Sea must be sufficiently good regarding food availability and resting places. Whereas indications for contaminant burdens are only partly available these do not seem to strongly affect the growth rate of the population, although the level of contamination is still beyond natural levels. On the basis of studies in the Netherlands after the first virus outbreak de Swart et al. (1996) concluded that contamination deteriorates the immune system that acts as a defense mechanism against virus attacks.

Harbour porpoises *(Phocoena phocoena)* are categorized according to the Habitat Directive as vulnerable. Our information on the numbers and distribution of these animals is much more scattered and less reliable than on harbour seals e.g., due to the way these animals live. Several sources however strongly suggest that the numbers of these animals increase (Haelters et al. 2002, Camphuysen 2004). A clear seasonal pattern was observed along the Dutch coast (Camphuysen 2004). Fig. 6 shows a compilation of observations in the North Sea as well as the waters surrounding the British Isles. Currently, many efforts are made to improve these population estimates based on flight and ships (Scheidat et al. 2004).

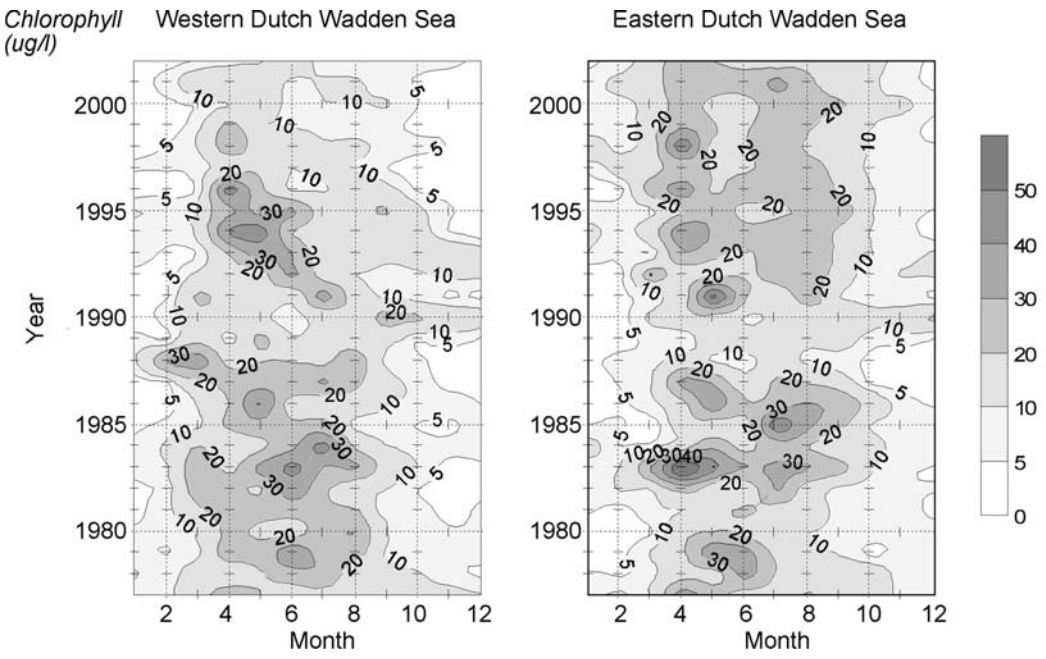

Figure 7. Specific Total Phosphate (TP) and Total Nitrogen (TN) loads in the Rhine, Maas, Scheldt (open symbols) and the Elbe-Weser (closed symbols); Source: van Beusekom et al. (2005).

Offshore from the Island of Sylt a protection area for harbour porpoises has been established, based on the relatively high density of animals, the all year occurrence and the presence of calves. More extended protective areas within the German EEZ have been proposed.

Other habitats which have obtained protective status are salt marshes and sea-grasses. Since 1994 a regular monitoring based on aerial surveys occurs. The data suggest a steady recovery in the North Frisian Wadden Sea (cf. Bakker et al. 2005, Reise et al. 2005). Because of the high long-term variability (e.g. 1991) it is difficult to find a clear cause for the ongoing increase. Reduction of eutrophication causing less epiphytes or an improved underwater light climate could be one of the possibilities.

Salt marshes have attracted much attention since they were under anthropogenic pressure through e.g. grazing by cattle and sheep. There is a continued discussion on the targets set such as 'natural salt marshes' which depicts a controversy between high diversity versus natural development. Over the last decades a clear decrease of the mainland salt marsh areas with intensive grazing can be observed in Schleswig-Holstein (Bakker et al. 2005). In conclusion, it seems that the Habitat Directive at least helps to consolidate the present situation showing no further declines in these specific habitats.

The European Water Framework Directive

Principles and objectives of the WFD are the protection and maintenance of the aquatic environment with a good ecological status, and a control of environmental damage at the source. At the same time an economic and social development of the EC, with a regional differentiation should be possible. International cooperation and the joint development of methodologies are emphasized for the WFD. Because the WFD is still in the phase of defining the biological and physico-chemical quality elements, and in a discussion on the criteria to be used for setting quality objectives, no conclusions regarding the original question can be drawn, but implementation of the WFD will put strong emphasis on improvements of the environmental and ecological quality of estuarine and coastal waters.

OSPAR Directives on Eutrophication

Very similar to the WFD is the development within the Oslo and Paris Convention (OSPAR) of directives for eutrophication. After a long international debate (de Jong 2006) the nations have adopted a so-called common procedure for the identification of the eutrophication status of the Maritime Area of the OSPAR Convention (OSPAR 1997). In this common procedure three types of areas are distinguished on the basis of a set of criteria: problem areas, potential problem areas and non-problem areas. Because eutrophication has regional characteristics, special region specific criteria were developed for the Wadden Sea (van Beusekom et al. 2001). These region specific criteria have been categorized into three groups: causative factors (cat. I), supporting factors (cat. II) and direct effects (cat. III).

A large amount of information is available on the eutrophication status of the Wadden Sea. As shown in Table I the Wadden Sea is assessed as problem area according to the assessment criteria by all three Wadden Sea countries. As an example of the causa-

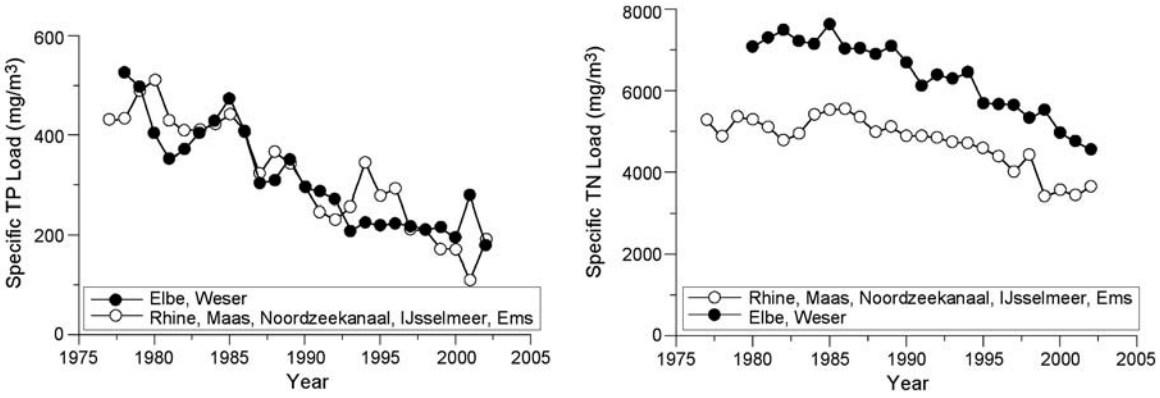

Figure 8. Long-term chlorophyll-a concentration in the Dutch western and eastern Wadden Sea.(Source: van Beusekom et al. 2005).

Table 1. Summary of the Wadden Sea Eutrophication Assessment by OSPAR (OSPAR 2003). All three Wadden Sea countries assessed the Wadden Sea as a problem area. + = increased trends, elevated levels, shifts or changes, - = no increased trends, no elevated levels, no shifts or changes, ? = not enough data to perform an assessment, NT = not taken into account, Empty cells = parameters not used.

	Netherlands	Germany	Denmark
Cat I: River. Input (50% above background)	+	+	+
Winter Concentrations*	+	+	+
N/P ratios	+	+	+
Cat II: Chlorophyll (Max. >22-24 µg/l)	+	+	+
Phytoplankton Indicator Species	+	+	-
Macrophytes	+	+	+
Cat III: Oxygen Problems	+	?	-
Changes/Kills of Macrobenthos	NT	?	-
Changes in organic matter	+	?	
Cat IV: Algal toxins	+	+	+

* Wadden Sea (>6-7 µM N), Estuaries (>18-30 µM N)

tive factors nutrient loads to the Wadden Sea have been used. Fig. 7 shows the specific total phosphate (TP) and total nitrogen (TN) loads from 1975 till 2002. The trends in these data are clear: TP has been reduced to one third of the 1975 values whereas the TN loads have been reduced by ca. 40%. Although the catchments show quantitative differences, the trend-like decrease is similar in both the Rhine and Elbe catchments.

Although the decreases in loads have been large and highly significant, it is much more difficult to observe consequences of these reductions for the direct effects such as phytoplankton biomass measured as chlorophyll-a. Fig. 8 shows the seasonal and decadal variability of chlorophyll-a for both the Western and Eastern Dutch Wadden Sea: at least a reduction in the intensity of the main blooms can be observed despite the high variability between years. A comparable decrease cannot be observed for the Sylt-Rømø Bight in the northern German Wadden Sea and for the island of Norderney in the Lower Saxonian part of the Wadden Sea (cf. van Beusekom et al. 2005).

In conclusion: some clear changes in nutrient loads have been detected whereas it seems to be more difficult to detect trends in the parameters linked to direct effects such as chlorophyll-a concentrations.

A question which has remained unsolved until today is whether the changed N/P ratio due to the enhanced reduction of phosphate as opposed to nitrogen compounds could have detrimental effects by causing an increased occurrence of toxic algae. Although many toxic algal blooms have been ob-

served along the European coasts over the last decade it is difficult to show that there is a causal link to the state of eutrophication (ICES 2003).

In conclusion, the decrease in riverine nutrient loads is starting to affect the eutrophication status of the Wadden Sea. Evaluation of chlorophyll and nutrient data from the Wadden Sea indicate that in some parts of the Wadden Sea the amount of organic matter turnover is decreasing. Also the summer chlorophyll concentration is decreasing in response to the decreasing riverine nutrient loads (van Beusekom et al. 2005). Long-term primary production data in the Western Dutch Wadden Sea decrease gradually since maximum values were reached during the 1990s (Cadee & Hegeman 2002).

Another eutrophication related change recorded in the Wadden Sea was the increase of green macroalgae from the late 1970's to a peak in 1990-1993. Now first signs of improvement are becoming visible. Regular observations in the northern Wadden Sea indicate that that the area covered with green macroalgae is gradually decreasing. In 2004 it reached for the first time the marginal occurrences prior to the 1980's (van Beusekom et al. 2005).

General conclusions

The level of protection of plants and animals, as well as of habitats has strongly improved over the last three decades. Plant and animal life shows large regional, temporal and spatial variability. Therefore conclusions on increase or decrease of selected animals and plant species are seldom related to simple cause and effect relationships. Multi-factorial causes are much more common in nature and hinder simple explanations. Therefore it is impossible to confirm either in a positive or negative sense that EU directives have had a direct impact on the ecosystem of the Wadden Sea or coastal shelf sea. This is different for the impact of the OSPAR eutrophication common procedure and its reduction measures taken after political action.

Long-term observations of selected animal and plant species are needed for scientific analyses of observed changes. Supporting experimental work will be needed to establish causal explanations. The establishment of LTER (Long Term Ecological Research) areas would be a good mechanism to improve our understanding of long-term changes in the marine environment.

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Monitoring demands for administration and managers

Anton Beck

Beck, Anton 2006: Monitoring demands for administration and managers. In: Monitoring and Assessment in the Wadden Sea. Proceedings from the 11. Scientific Wadden Sea Symposium, Esbjerg, Denmark, 4.-8. April, 2005 (Laursen, K. Ed.). NERI Technical Report No. 573, pp. 21-25.

As responsible for the implementation of EU nature directives, a.o. Birds and Habitats Directive and the Wadden Sea Cooperation I want to focus on "Monitoring Demands for Administration and Managers". The presentation will be divided into the following five sections:

- Wadden Sea monitoring and management history
- Wadden Sea monitoring and management challenges
- EU monitoring and management challenges
- Danish Experience
- Conclusion

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Wadden Sea monitoring and management history

More than twenty years ago, in 1982, the three Wadden Sea countries recognized their responsibilities for the conservation of the Wadden Sea ecosystem. This was made clear in the Joint Declaration, which created the basis for the Trilateral Wadden Sea Cooperation. This also marked the beginning of considerations of joint monitoring of the environment of the Wadden Sea. The principles and the general outline of a trilateral joint monitoring programme, including the associated data management, were adopted ten years later, in 1993, by the Senior Officials of the Wadden Sea Cooperation.

A few years later, in 1995, the DEMOWAD project was initiated. This project developed a set of monitoring guidelines and a prototype of data management, streamlined for Wadden Sea monitoring and assessment. Already in 1997, at the Stade Governmental Conference, the results of the DEMOWAD project led to the ministerial agreement to implement a Trilateral Monitoring and Assessment Programme (TMAP), which consisted of the Common Package of 28 parameter groups and the associated data management.

Until now, three Wadden Sea Quality Status Reports have been issued on this basis. The reports present comprehensive data collected from the years investigated, and form the basis for the present work. And what is more: the reports have provided important input to the political decisions on the further management of the Wadden Sea that have been made at the Governmental Conferences.

I fully share the view of Karel Essink (2006) in underlining the importance of the QSR as a tool for transforming monitoring results into the political decision-making and management, and would like to point at the importance of this bridge between data collection and the political/administrative decisions.

In the recent Governmental Conference at Esbjerg in 2001, the ministers agreed to have the TMAP Common Package, including the data handling system, implemented by the end of 2002, and to have it evaluated by 2004. Further, the ministers underlined the need to further optimize the TMAP for future requirements, in particular with regard to the EU Habitats Directive and the EU Water Framework Directive, and, to this end, to:

1) make use of data from existing monitoring programmes, and to evaluate possibilities of including them into TMAP without additional costs, and
2) prepare proposals for the further development of TMAP by the 2005 Governmental Conference.

Wadden Sea monitoring and management challenges

The evaluation of the data handling system, made by The Orbis Institute, was presented in 2004 and revealed also the future challenges for the Wadden Sea monitoring and assessment.

From a Danish point of view, the evaluation also marked a milestone for more general considerations regarding Wadden Sea monitoring. Especially in the context of the newly established, general Danish Environment and Nature Monitoring and Assessment Programme, NOVANA, this entered into force the 1st of January 2004, as well as in the context of EU monitoring, assessment and reporting obligations within the Habitats Directive, the Birds Directive and the Water Framework Directive. However, it is of course important to consider these developments in the context of limited resources.

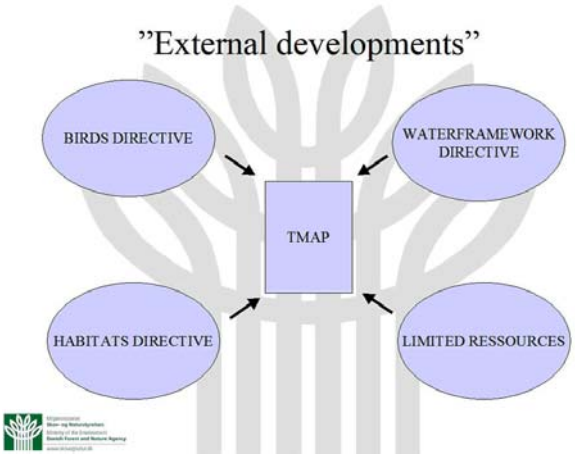

Figure 1. 'External developments' influencing the TMAP (Trilateral Monitoring and Assessment Program).

Thus - as a pre-conclusion - at the same time as developing the Wadden Sea monitoring programme during the last two decades, very important and significant changes have been made to the framework conditions for the Wadden Sea Cooperation, including its monitoring and assessment elements. This is the requirement from Brussels and from our ministries of finance. So, this is also becoming the fundamental challenge to the authorities responsible for monitoring administration and to managers.

EU monitoring and management challenges

EU has undertaken increasingly important developments which has consequences for Wadden Sea Cooperation with a special focus on monitoring and assessment.
During the last two decades, the EU has agreed on:

- First, the EC Birds Directive in 1979.
- Secondly, the EC Habitats Directive in 1992.
- And finally, the EU Water Framework Directive in 2000.

The designation process for the Habitat and Bird Directives has now almost been finalised in the Wadden Sea area and almost the entire area has been designated as EU Habitat and/or Bird protected areas – or as Natura2000 areas.

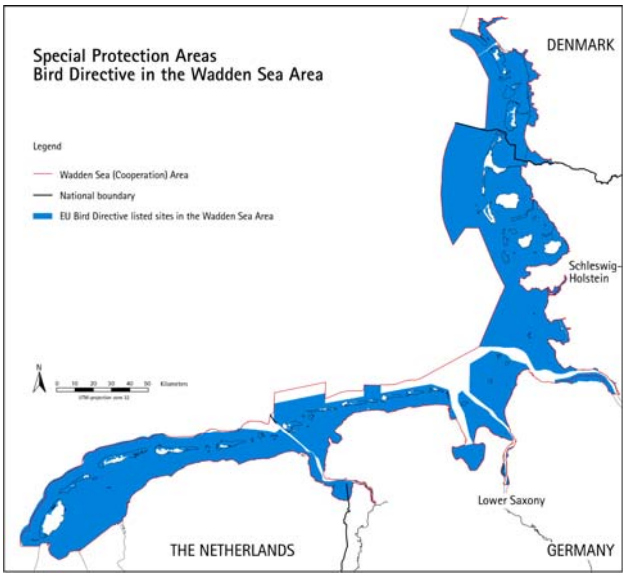

Figure 2. The cooperation area of the Wadden Sea with the Special Protection Areas (SPAs) indicated.

The designation of the special protected areas, and in addition of course also the designated habitat areas, is a new milestone as regards the future management of the Wadden Sea and the future monitoring requirements of the area.
The approach to nature protection within the EU is based on the following main aspects:

1) Immediate passive protection of the areas must be secured - that is, plans and projects, which may have significant, negative impacts on the species and natural habitats designated for protection in the areas, should not be initiated. Therefore, plans and projects cannot be approved without prior evaluation of the consequences.

2) Management of the areas must be active. Setting up specific targets for the state of the areas in order to safeguard or restore a favourable conservation status, and, moreover, requiring member states to implement the conservation measures required, in the form of management plans aiming at reaching the conservation targets set for the designated areas.

3) Monitoring and reporting to the European Commission on the state of nature, the measures taken and efforts made to comply with the directives. Monitoring is of course closely linked to the specific targets for the state of conservation of specific spe-

cies and natural habitats, thus illustrating whether the efforts made are sufficient.

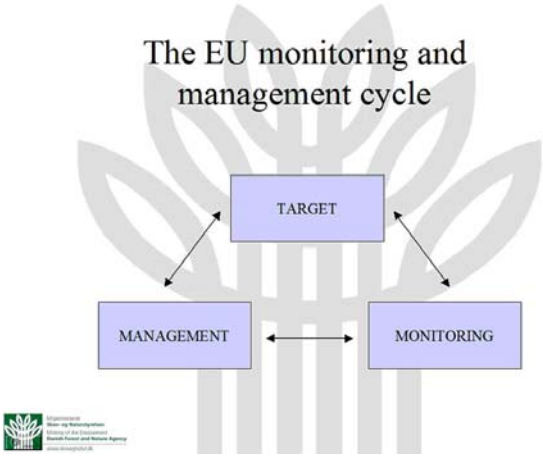

Figure 3. Principal elements in the EU monitoring and management cycle.

Therefore the EU directives provide a logical, systematic and transparent system for protection and active management, closely linked to monitoring. In fact, the same philosophy is represented in the "Policy circle" as presented by Karel Essink (2006) this afternoon. The basic approach is to set targets for the state of nature that specifically reflects the favourable conservation status for a given species or habitat. A monitoring programme is set up, with parameters that demonstrate the current status of conservation of the species or habitat. If necessary the specific efforts required to achieve the objectives are established through the management plans. Further the results of subsequent monitoring tell us the effect of the management plan and whether our efforts should be revised in order to achieve a favourable conservation status. Both the specific management plans and monitoring provide new know ledge, and, thus, enable us to adjust objectives in connection with the regular revisions. From an administrator point of view, this provides us with a logical, comprehensive management and monitoring system. This approach is also the basic philosophy of the Danish nature management model, and of the new Danish Environment and Nature Monitoring Programme. At the same time, it is closely linked to the targets and reporting obligations that Danish nature administrators must fulfil in accordance with the EU directives.

In Denmark it has been decided that the Natura 2000 Management plans for all the Danish Habitat sites – in total 254 – shall be finalised in 2009. That is the same deadline as the Water plans under the Water Framework Directive. Together, the three directives constitute a set of binding guidelines at EU level that apply also to the monitoring work done by the Trilateral Cooperation countries as the Wadden Sea as said now also has been designated as Bird and Habitats Directive areas. This is shown clearly in the presentations we have had today, and in the themes that will govern your discussions in the coming days.

What is important now is synergy and cohesion, in order to avoid duplication of work and waste of resources. Politically, the role of the EU is so important that, nationally, we have to focus more and more on the EU/Brussels context. This trend is underlined further by the changes in budgetary framework conditions which all three countries faced during the last couple of years. Both developments indicate that when we investigate and monitor, the goal must be crystal clear, and the results must have a useful purpose.

Danish experience

The Danish strategy for and approach to monitoring activities, should be based on a survey of demands, both administrative and management demands, as well as be related to operational targets. This will ensure that monitoring results clearly indicate whether the targets have been achieved, and whether developments are heading in a desirable direction. The purpose of monitoring is not only to collect data. The purpose is to satisfy the need for knowledge on the current state of the environment, about the development trend, and to see why developments might not be as expected.

A basic principle of monitoring should be to include parameters which we "need to know", in contrast to parameters which is "nice to know", and principle concerns also the TMAP.

I shall divide the following presentation into A) strategy and B) demands.

A) The monitoring strategy:

Our common Wadden Sea work aims at safeguarding nature and the good state of the environment. Therefore, our efforts only make sense if they help sustain these overall objectives. Monitoring as such will not enhance the state of nature and the environment, nor secure the habitats of the species involved. Meaningful monitoring is founded on scientific evidence, and is targeted towards political objectives and the need of administrators to know the state of nature and the environment.

The Danish monitoring is organised in accordance with the principle:"No monitoring without a goal". This means that, before monitoring is initiated, the proper objectives must be established. It is important that monitoring is viewed in a political-administrative context. However, to assess whether the goals are achieved, they must be operational. It is not operational to aim at a healthy and viable seal population without defining the meaning in terms of a measurable unit, for instance the number of

animals per hectare, the number of puppies per year etc. Only this will enable us to see if the development is going in the right direction and assess if the objectives have been met.

B) Monitoring demands

In Denmark, monitoring obligations under the EU-directives rank highest on the list of priorities. There is a need for monitoring of the Wadden Sea and hinterlands, in order to meet the monitoring obligations under the Habitats Directive, the Birds Directive and the Water Framework Directive, and determine whether the targets have been reached – that is the targets set in the Wadden Sea Plan and in later agreements and in accordance with the directives mentioned. Setting targets is a political-administrative task. For the Wadden Sea, setting of operational targets will take place at the Ministerial Conference this autumn. Before that, administrative tasks must be coordinated among competent national authorities and the common secretariat. Existing targets should be revised and be made operational before the next Ministerial Conference. If they cannot be measured, they should be left out. Each country is responsible towards the European Commission for their implementation of the monitoring obligations under the directives, and each country is responsible for reporting to the Commission. Meeting the monitoring obligations is a national task, closely linked to operational objectives established at national level. When this has been done, we must analyse whether it is possible to further coordinate monitoring among the three countries. There may be a need for national methodologies, time series etc, as well as it may not be the same aspects that are relevant in the four Wadden Sea water districts.

The Habitats Directive sets out requirements for the favourable conservation status of a number of habitats and species. For habitats, this overall objective ensures that their range should be stable or increasing, that the specific structures and functions should be maintained, and that the habitats should hold viable populations of character species of a favourable conservation status. As regards species, the populations must be viable, their natural range should not be reduced, not even on a long-term basis, and the habitats of populations should be safeguarded.

The need for determining whether the objectives for a favourable conservation status are met shows the need for operational targets. For instance, for the natural habitats, measurable criteria must be used to assess the overall objectives of area, structure and function. Therefore, Denmark has been using a scientific approach to establish a number of technical criteria for a favourable conservation status, related to measurable parameters – structure, function, area etc. – thus allowing us to determine whether the conservation status is favourable, and to follow developments of important parameters, for instance impacts. This approach facilitates work to forecast future developments, as well as nature management. Later in this symposium, some presentations will give you a more detailed account of the habitat-monitoring element of the Danish monitoring programme.

As regards the Water Framework Directive, nature management must include the river basins of the waters. In the monitoring of the waters, impacts will constitute an important part of monitoring activities. For the Wadden Sea, this approach means that monitoring efforts should include the sources of impacts, and should thus also focus on areas outside the areas of co-operation. Monitoring under the Water Framework Directive must be relevant to the nature of problems. Therefore, some issues may be relevant to monitor in one water district, while other issues may be more relevant in another of the four Wadden Sea districts. Examples could be issues like tourism, agriculture and recovery of gas – which all cause different impacts on the Wadden Sea, but with differing intensities, and, thus, of differing importance and relevance for monitoring in the overall area of cooperation.

Conclusion

Especially in the new context of the Wadden Sea area having been designated as EU Habitat and Bird protected areas, the lessons learnt for monitoring demands for administration and managers of the Wadden Sea Cooperation are the following:

- resources are limited; therefore priorities and synergies are required,
- each Member States is responsible to the European Commission for implementing the EU directives, and therefore each country must establish operational objectives for their waters and nature areas, but often of course in a dialogue and coordination with neighbouring countries as is the case with the Wadden Sea
- each country must take responsibility for monitoring seen in relation to the monitoring obligations under the directives. This means that monitoring must be targeted towards the problems. Therefore relevant and necessary monitoring does not have to be the same in all Wadden Sea water districts,
- the objectives set for the Wadden Sea under the Ministerial Declarations must be operational and evaluated carefully to EU-obligations. They must of course not conflict with the objectives of the directives, but add when reasonable and cost effective and create synergy,

Figure 4. Main conclusions

- monitoring must help determine whether the objectives are fulfilled, and, if not, monitoring should give us a clue as to the reasons why the objectives are not fulfilled. To this end the QSR's are a very important tool,
- in order to be able to outline the overall impacts and state of the environment across the Wadden Sea, we need to coordinate monitoring efforts, taking into account the common targets set across the Wadden Sea,
- when the national monitoring under the directives have been implemented the possibilities for further coordination trilaterally should be analysed, thus allowing us to view additional issues, and finally
- the reporting format etc. for Wadden Sea monitoring should be aligned with the reporting formats used for EU reporting. We should avoid cost-intensive individual reporting formats etc., which may hamper synergy and pooling of data.

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Trilateral Monitoring (TMAP) and Quality Status Report 2004 supporting conservation and management of the Wadden Sea

Karel Essink

Karel Essink 2006: Trilateral Monitoring (TMAP) and Quality Status Report 2004 supporting conservation and management of the Wadden Sea. In: Monitoring and Assessment in the Wadden Sea. Proceedings from the 11. Scientific Wadden Sea Symposium, Esbjerg, Denmark, 4.-8. April, 2005 (Laursen, K. Ed.). NERI Technical Report No. 573, pp. 27-36.

For any monitoring and assessment program the questions Why?, What?, Where? and How? are essential. It should be clear why monitoring is needed, or which purpose(s) should be served by monitoring. For the Trilateral Monitoring and Assessment Program (TMAP), such purpose is to periodically evaluate the agreed trilateral Targets as laid down in the Wadden Sea Plan of 1997. What had to be monitored to be able to evaluate these Targets was agreed upon by Denmark, Germany and The Netherlands by accepting the TMAP Common Package of parameters as suitable to provide the information necessary. The questions Where? and How? pertain to the sampling strategy and the analytical and statistical methods. In the case of TMAP, with different institutes and specialist groups performing in different sub-areas of the Wadden Sea, quality assurance and harmonization are other essential issues. An operational data exchange system completes the TMAP.

Periodic evaluation may or even should result in new or intensified management measures aimed at complying with the Targets set. If necessary, Targets need to be amended in response of advancing insight or changed policy priorities. As such, monitoring and assessment play an essential role in the so called 'policy cycle'.

In this contribution elements of the TMAP and evaluation results from the Quality Status Report Wadden Sea 2004 will be presented against the background of this policy cycle.

Key words: assessment, monitoring, policy cycle, targets, Wadden Sea

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Introduction

For the Trilateral Monitoring and Assessment Programme (TMAP) for the Wadden Sea as well as for any other monitoring programme the questions Why?, What?, Where? and How? are essential. It must be clear why monitoring is needed, or which purpose(s) is to be served by monitoring. For the TMAP, such purpose is the periodic evaluation of common Targets, trilaterally agreed between Denmark, Germany and The Netherlands and laid down in the Wadden Sea Plan (WSP 1997). What needs to be monitored to be able to evaluate these Targets, was agreed upon trilaterally by accepting the so called TMAP Common Package being a set of parameters suitable to provide the information necessary (Stade Declaration 1997). The questions Where? and How? pertain to the sampling strategy and the analytical and statistical methods. Sampling effort and observations need to be made in representative subsystems of the Wadden Sea ecosystem such as salt marshes, dunes, intertidal flats and subtidal habitats, and spread over its geographical range. Moreover, areas with known or expected human influence as well as reference areas with no or minimal human impact should be included (Colijn et al. 1995). In the case of TMAP, different institutes and specialist groups carry out the monitoring in the different sub-areas of the Wadden Sea. This makes harmonisation of methods and quality assurance essential issues. An operational data exchange system completes the TMAP without which the periodic assessment process would be seriously hampered.

The "Policy Cycle"

Periodic evaluation may or even should result in new or intensified management measures aimed at

complying with the Targets set. If necessary, Targets need to be amended in response of advancing insight or changed policy priorities. As such, monitoring and assessment are essential in the so called "policy cycle" (cf. Winsemius 1986). Generally, in the Policy Cycle the following phases are distinguished: 1) problem identification and acceptance, 2) policy formulation, 3) policy implementation, 4) management, and 5) evaluation (Figure 1).

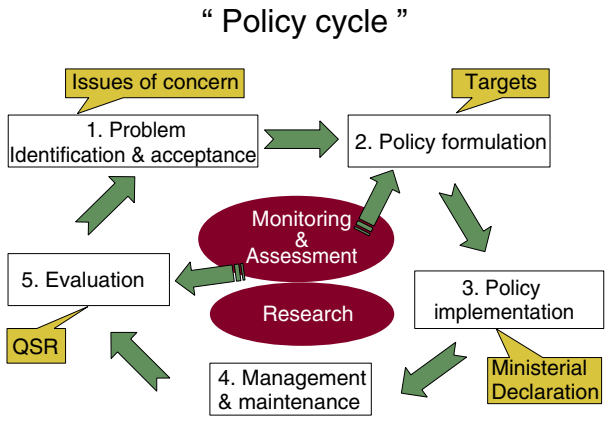

Figure 1. The 'Policy cycle' with the role of monitoring and assessment and of research in the trilateral Wadden Sea Cooperation

Problem identification and acceptance
This first phase in the policy cycle usually starts with an analysis of developments and trends which in the case of the international Wadden Sea may have consequences for e.g. its natural values, its attractiveness as living and recreational area for the human population, and its role as a turntable in large-scale ecological processes such as bird migration. Signals regarding developments and trends may come from society in general or from existing monitoring programmes. The accepted guiding principle for the trilateral Wadden Sea policy "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way" dates back to 1991 (Esbjerg Declaration 1991, § 1).

Policy formulation
Once problems have been identified and accepted, ideas have to be developed - first of all on the political level - on what directions could be taken towards problem resolution. Essential is to properly define what goal should be reached and within what time frame. After preparation of a policy proposal – mostly by one or more directly involved ministries – the final decision is taken by the parliament. In the case of the Wadden Sea Cooperation, the current policy and its goals have been specified in the form of the Targets as laid down in the Wadden Sea Plan of 1997. This Wadden Sea Plan was agreed upon by the 8th Trilateral Governmental Conference on the Protection of the Wadden Sea held in Stade, Germany, 1997.

Policy implementation
In the national arena, the implementation of fixed policy usually is a co-production of central (government bodies) and decentralized authorities. This usually implies the formulation of management plans which go into more detail. Examples of these are the Beheersplan Waddenzee 1996-2001 (Rijkswaterstaat 1996) for the Dutch Wadden Sea, and the recent blue mussel management plan for the Wadden Sea of Lower Saxony (Staatskanzlei 1998). For the Wadden Sea the implementation of the agreed trilateral policy is laid down in the Ministerial Declarations of the periodically held Governmental Conferences. The Esbjerg Declaration of 2001 entails a listing of agreed actions and priorities for the trilateral cooperation in the period 2002-2005. The Schiermonnikoog Declaration (2005) will describe the actions and priorities for the next period.

Management
The factual implementation of the Ministerial Declarations becomes the responsibility of a great variety of higher and lower authorities and agencies, responsible for management as well as for maintenance of relevant legislation and regulations. Management usually has a strong sectorial approach; sometimes authorities work together, e.g., in the Dutch Wadden Sea (RCW 2004). Management activities may range from closure to the public of birds' breeding and roosting areas in the relevant season to the execution of nature restoration works in dunes and salt marshes.

Evaluation
The final and most essential phase of the policy cycle is the evaluation, in which is being checked to what extent the set targets have been met. Evaluation may also involve an assessment of the effective use of financial resources related to the reaching of the target.

A prerequisite for a good evaluation is the availability of relevant monitoring data. For the trilateral Wadden Sea cooperation this prerequisite is largely fulfilled by the Trilateral Monitoring and Assessment Programme (TMAP) and the institution of periodic Quality Status Reports. Evaluation may lead to a reconsideration of policy priorities and management measures, and even to a re-definition of targets.

Targets for the Wadden Sea

The trilateral conservation policy with respect to the Wadden Sea is directed towards conservation

and/or restoration of all those habitat types that belong to a natural and dynamic Wadden Sea. For each of these habitat types a certain quality is envisaged to be reached by proper conservation and management measures.

Targets have been formulated for six habitat types, viz. salt marshes, tidal area, beaches and dunes, estuaries, offshore area and rural area, within which a number of sub-habitats were defined. Targets related to the chemical quality of water and sediment relate to all these habitat types. Supplementary targets have been agreed for birds (breeding as well as migratory species) and marine mammals (seals and harbour porpoise). The targets as included in the Wadden Sea Plan of 1997 (WSP 1997), together with their periodic assessment, play a central role in directing the trilateral conservation policy and related management.

The Trilateral Monitoring and Assessment Programme (TMAP)

A trilateral program, in short TMAP, is running to monitor the Wadden Sea, mainly aiming at providing data to be used for periodic assessment of the quality of the ecosystem of the Wadden Sea. Recognized "issues of concern" (climate change, input of pollutants, commercial fisheries, recreation and agricultural practice) were used as a guiding principle for parameter selection. Parameters were selected based on hypotheses regarding the various anthropogenic impacts on the ecosystem, and grouped to represent important habitats, organism groups and distinct species (TMAP 2000).

Table 1. The Common Package of TMAP parameters.

Chemical Parameters	**Habitat Parameters**
Nutrients	Blue Mussel beds
Metals in sediment	Salt marshes
Contaminants in blue mussel, flounder and bird eggs	Beaches and Dunes
TBT in water and sediment	
Oil rate of beached birds	
Biological Parameters	**Human Use Parameters**
Phytoplankton	Fishery
Macroalgae	Recreational activities
Eelgrass	Agriculture
Macrozoobenthos	Coastal protection
Breeding & migratory birds	**General (supporting) Parameters**
Harbour (= Common) Seals	

In 1997 a Common Package of parameters to be monitored in the TMAP was agreed upon (Stade Declaration 1997). An overview of the TMAP Common Package is presented in Table 1. The Trilateral Monitoring and Assessment Group (TMAG) has the task to implement the TMAP, which in essence is composed of several pieces of national monitoring programs.

An essential role within the TMAP, and more specifically the assessment process, is played by the TMAP data handling system. Four data units are being operated, viz. in Denmark, Schleswig-Holstein, Niedersachsen and The Netherlands. Structural, functional and organisational aspects as well as cost-effectiveness have recently been evaluated (Orbis 2004). The Trilateral Data handling Group (TDG), a subgroup under the TMAG, coordinates the necessary updates and amendments of the data units.

A process to optimise the TMAP and to further tune it to the requirements of EC Directives such as Birds Directive, Habitats Directive and Water Framework Directive, is presently ongoing.

Outcome of Evaluation (QSR 2004)

In the Wadden Sea Quality Status Report 2004 (Essink et al. 2005) a detailed account is given of the developments of various human activities in the Wadden Sea area and of the development of various ecosystem components (species, habitat forming species, habitats). An assessment of these developments provides an evaluation of the different targets as formulated in the Wadden Sea Plan (WSP 1997). In this chapter the main outcome of the target evaluation will be reviewed, and reference will be made to the policy cycle when appropriate. For detailed information the reader is referred to the actual 2004 Wadden Sea QSR. A review regarding hazardous substances (natural micropollutants and xenobiotics) is presented elsewhere in this volume (Bakker 2005). More and further detailed information on trends and developments is given in other papers of this volume.

Nutrients and eutrophication

Large inputs of nutrients such as phosphorus and nitrogen compounds were considered the cause of earlier eutrophication phenomena such as local oxygen deficiencies and blooms of the nuisance alga *Phaeocystis* sp. and green macroalgae (De Jong et al. 1999) or kills of fish and benthos such as occurred in the German Bight (Dethlevsen & Von Westernhagen 1983). Such phenomena were considered unacceptable for the Wadden Sea, which led to the target that the Wadden Sea "can be regarded as a eutrophication non-problem area". The prime action needed for development towards that target has since long

been accepted as policy and regulations have been aimed at a considerable decrease of nutrient discharge through rivers debouching in the Wadden Sea (OSPAR 1997). The 2004 Wadden Sea QSR, with data up to 2002, shows that riverine discharges of nutrients have continued to decrease. The decrease in discharge of nitrogen, however, was slower than that of phosphorus. Also in the water of the Wadden Sea nutrients concentrations have decreased, as have phytoplankton chlorophyll levels.

How to evaluate the target? How do we know that eutrophication problems do not occur in the Wadden Sea any more? On the basis of the Comprehensive Procedure, developed for the OSPAR Convention Area (OSPAR 1997), Wadden Sea specific evaluation criteria were developed in a trilateral project (Van Beusekom et al. 2001). Autumn concentrations of ammonia and nitrite were considered suitable indicators of the eutrophication status of the Wadden Sea. Mainly based on these criteria, it is concluded that the target is not yet met. The Wadden Sea may still be a eutrophication problem area, with a higher degree of eutrophication in the southern than in the northern part, notwithstanding the observed declines in green macroalgal cover and in duration of spring blooms of *Phaeocystis*.

Oil pollution and sea birds

Oil pollution at sea mainly originates from ships, and to a lesser extent from oil drilling rigs in the North Sea. The Wadden Sea Plan does not have a specific target regarding oil pollution. For the OSPAR Convention Area, however, an Ecological Quality Objective (EcoQO) regarding the effect of oil pollution on the marine ecosystem was developed as an operational tool and target (Bergen Declaration 2002). And thanks to the so-called Trilateral Beached Birds Survey, now incorporated in the TMAP, data are available to evaluate this EcoQO, which reads "The proportion of oiled common guillemots among those found dead or dying on beaches should be 10% or less".

Although reported oil spills off the Dutch and German coasts have declined since the 1990s, and oil rates among beached birds have generally also decreased, the OSPAR EcoQO has not been met. Oil rates among birds found dead inside the Wadden Sea are lower than on the North Sea beaches of the Wadden Sea, indicating that oil pollution is mainly an external threat. Hopefully, the designation in 2002 of major areas of the Dutch, German and Danish Wadden Sea as Particular Sensitive Sea Area (PSSA) will contribute to a further decrease of oil pollution (Reineking 2002).

Salt marshes

These habitats can be found on the Wadden Sea islands and along the mainland shore. The vegetation of salt marshes is strongly determined by the duration of submergence by sea water per tide, and therefore by their elevation as result of natural or man-influenced sedimentation. As a consequence, different vegetation types can be discerned, intersected by meandering creeks or brushwood groynes and man-made drainage systems.

For Wadden Sea salt marshes three targets were formulated. Due to land reclamation and endikement the area of salt marshes in the Wadden Sea had decreased considerably (e.g. Dijkema 1987). Therefore, trilateral policy agreed on aiming at an increased area of natural salt marshes. Realising that a considerable part of the salt marshes was artificial due to land reclamation and their geomorphology and vegetation strongly influenced by man-made drainage systems, an additional target was formulated, aiming for increased natural morphology and dynamics, including natural drainage patterns, of artificial salt marshes. Finally, for artificial salt marshes an objective was set of obtaining a more natural vegetation structure.

Monitoring and evaluating changes in salt-marsh area or extent of artificial drainage do not seem too difficult a task. Practice, however, is less cooperative. In salt marshes processes of change take quite some time, changes becoming noticeable only after several years. Artificial drainage systems (ditches), when not maintained any more, have proven rather persistent, making it difficult to decide, for example, when an artificial ditch has developed to a naturally meandering creek. Proper evaluation can only be done when these changes are monitored with full coverage of all salt marshes, and a consistent time series of GIS data is available. In practice, good data are available for only a part of the salt marshes. These data show a general increase of area of (semi-)natural salt marshes and a decrease of maintenance of artificial drainage, thus indicating a development towards the target.

The target of an improved natural vegetation structure of artificial salt marshes poses a problem. Firstly, the vegetation structure is very much dependent on local geomorphological conditions. Secondly, it was not possible to give a precise description of the vegetation that can develop and serve as an evaluation criterion. Thirdly, as mentioned before, long-term data are limited, and not all older data can be translated to the common typology for salt-marsh zones and vegetation types that was recently developed within the TMAP. A precise evaluation of the third salt-marsh target can therefore not be given. In areas, however, where human use of salt marshes (e.g., livestock grazing) was reduced, a more natural vegetation structure did develop.

Tidal area

The Tidal area includes the intertidal flats and subtidal areas as well as the organisms living in its waters and sediments. Characteristic for these areas is the dynamics of hydrology and geomorphology, especially in the tidal inlets and their outer deltas.

Natural dynamics, no disturbance

"A natural dynamic situation in the Tidal area, and an increased area of geomorphologically and biologically undisturbed tidal flats and subtidal areas" are the formulations for the relevant targets of the Wadden Sea Plan. As a consequence, policy implementation and management, phase 2 and 3 of the 'policy cycle', could simply (?) focus on human activities reducing or disturbing this natural dynamics.

Natural dynamics of the sea shore is limited by coastal defence constructions. In the last five years there was no significant increase of these constructions.

Dredging of shipping channels, sometimes adjacent to intertidal flats, causes disturbance of natural sedimentation-erosion processes, and can therefore be judged as deviation from the target. Effects on the ecosystem, if of any significance at all, have not been documented, neither through monitoring nor research.

Intertidal flats are important as habitat for bivalves and other benthos. Bivalves prefer high flats of fine grained sediment for the settlement of their juveniles. Research by Delafontaine et al. (2000) has shown that as a result of progressive endikement, making the Wadden Sea narrower, wave energy increased causing a depletion of fine grained material. It has been made plausible that in the Dutch Wadden Sea intensive fishery for cockles and seed mussels has contributed to a reduction of the area of such high intertidal mud flats (Ens et al. 2004). Consequently, it can be concluded that no increase has occurred of the area of geomorphologically and biologically undisturbed tidal flats.

Land reclamation and shellfish fisheries can to some extent be blamed for the loss of preferred settling habitat of bivalves, but not completely. Climatic factors do also play a role. Analysis of long-term data sets for the westernmost part of the Dutch Wadden Sea shows that the more frequent occurrence of mild winters causes an enhancement of predation on newly settled bivalve post-larvae by shrimps and shore crabs (Beukema & Dekker 2005). This illustrates the importance of being able, through wise monitoring and research, to discriminate between anthropogenic impact and natural causes.

Biogenic structures

In the Tidal area, a few species occur that form specific biogenic structures. Examples are subtidal reefs of the polychaetous worm *Sabellaria spinulosa*, sea grass fields consisting of *Zostera marina* and *Z. noltii*, and beds of the blue mussel *(Mytilus edulis).* For these biogenic structures the Wadden Sea Plan thrives for an increased area, and a more natural distribution and development.

Sabellaria reefs are extremely rare. Nowadays, one reef exists south of Amrum, and possibly two in the Jade. In former times, many more existed; it is not known what caused these to disappear. Monitoring of *Sabellaria* reefs is not included in the TMAP Common Package. This means that policy evaluation is completely dependent on fortuitous observations.

The long-term decline, since the 1930s, of sea grasses in the southern and central Wadden Sea seems to have come to a halt. And some slow recovery is evident in The Netherlands and Schleswig-Holstein. Yet, we still cannot speak of an overall increase in area and natural distribution of sea grass fields. The target of an increased area of *Zostera* fields is therefore not yet met in all sub-areas of the Wadden Sea.

When looking at the "policy cycle" it must be noted that in The Netherlands, having noticed the extremely slow recovery, evaluation resulted in an additional policy formulation viz. to investigate the possibility of re-introduction of sea grasses. This approach may contribute to sea grass recovery, especially in areas poor in natural seed production.

Regarding blue mussel beds there are conflicting interests of nature conservation and fisheries. Regulations have been implemented to safeguard the mussel bed habitat and at the same time allow mussel fisheries or mussel farming. Details of this are beyond the scope of this overview. A trilateral achievement was the new protocol for area measurement of intertidal mussel beds, which will enable future harmonized assessment.

As a result of consecutive spatfalls and of large areas having been without fisheries for seed mussels, a natural increase of intertidal mussel beds was observed during the 1990s. Since 1999, however, poor recruitment caused a decline.

Evaluation of data shows that in parts of the Wadden Sea the target of an increased area of natural intertidal mussel beds is met, but not yet so in other parts. Progress has been made with protection of young mussel beds at old or stable sites. At the same time, specialists realised that they do not yet fully understand the crucial spatfall process, nor the cause of regional differences in recruitment success. Such knowledge is indispensable for designing better management measures.

Concerning subtidal mussel beds, which are heavily exploited by mussel farmers, insufficient data is available to allow evaluation of the target.

Fish and shrimps

The occurrence of fish and shrimps, both not included in the TMAP, can be related to two more general Wadden Sea targets, viz. 1) an increased area of geomorphologically and biologically undisturbed tidal flats and subtidal areas, and 2) a favourable food availability for migrating and breeding birds.

With regard to the latter target, there is no evidence of general food shortage among fish and shrimp eating birds. With respect to the former target it needs to be clarified whether there is any causal relationship between the recorded offshore shift in the distribution of juvenile flatfish, especially dab and plaice, and the area and quality of intertidal flats and subtidal areas. This signal from national monitoring data deserves to be followed up by adequate research.

An evaluation regarding pelagic and migratory (diadromous) fish is hampered by absence of appropriate monitoring. Here a change in the TMAP is necessary with a view to the implementation of the EU Water Framework Directive in transitional waters (= estuaries).

Beaches and dunes

The Wadden Sea Plan targets regarding beaches and dunes refer to natural dynamics, natural vegetation succession and favourable conditions for birds. The latter target (on birds) will be dealt with in the section on breeding birds.

Natural dynamics

Due to the absence of both criteria and comparable data it is not possible to evaluate the dynamics of beaches and dunes. In fact, this is a shortcoming already in the beginning of the "policy cycle". Within the TMAP no parameters have been developed to enable an evaluation of the target. What can be said, however, is that natural dynamics of beaches has increased where coastal defence activities were stopped, for instance at head- and tail ends of islands.

Natural dynamics of dunes has increased only locally. The area with embryonal dunes, white dunes and primary dune slacks has not increased. Remnant coastal defence structures (e.g. sand dikes) still are an impediment to natural dynamics.

Complete natural vegetation succession

With regard to the target of an increased presence of a complete natural vegetation succession, it must be concluded that target has not been reached. About two-thirds of the dune areas consist of mid-successional dune type and other vegetation types are not present or show further decline. On some islands, species rich dune slack vegetations have degraded due to groundwater extraction, causing an accelerated succession to drier vegetation types. In some areas accelerated succession is remedied by traditional-type management measures restoring successional processes and species rich habitats.

How to proceed?

The Wadden Sea QSR reveals that too little specific data is available to enable a proper evaluation of the first two targets. On the one hand side, the targets have not been elaborated to objective and quantitative parameters to be monitored. The newly developed TMAP classification of dune types certainly will provide a helpful tool in this respect. On the other, there is a need to reconsider and redefine the trilateral targets against the background of (1) the high recreational pressure on the coastline, (2) the EU Birds- and Habitats Directives, and (3) sea level rise and its concomitant intensification of coastal defence.

Estuaries

Estuaries have since long attracted human population and its various activities, most of these being related to trading overseas as well as inland. As a consequence, industrial development boosted, and connected with this also shipping. Many estuarine habitats have disappeared or their extent is greatly reduced. As a counterweight to these human pressures the Wadden Sea Plan states as trilateral policy that valuable parts of estuaries will be protected and river banks will remain and, as far as possible, be restored in their natural state.

Few estuaries are present in the Wadden Sea, of which the Varde Å estuary has largely retained its natural characteristics. For reason not well known, not much effort was put into translating this rather broadly formulated target into operational parameters for monitoring. Hydrology of estuaries has been monitored rather intensively, without doubt because of its significance for shipping. So we know that increased deepening of shipping channels has changed high tide and low tide water levels and current velocities. Continuous dredging and dumping of the dredged material elsewhere is necessary.

Speaking of valuable parts, progressive human pressure has resulted in loss of tidal flats and brackish-water habitats. So called 'Red List' species, signalling their endangered status, do still occur in the estuaries of Elbe, Weser and Ems, which indicates that valuable habitats do still exist, but their extent is hardly known (cf. Von Nordheim et al. 1996). The larger estuaries of the Wadden Sea do not meet the target, as is concluded also in the relevant Water Framework Directive Reports of 2005 (EG-WRRL 2004a, b, c, 2005).

In terms of the 'policy cycle' policy implementation (phase 2) for estuaries has not yet started. Ap-

parently, management plans for the larger Wadden Sea estuaries have not yet been drafted or have not well been communicated trilaterally. Possibly, there is also a lack of essential information as a basis to design such management plans. The EU Water Framework Directive, urging the design of River Basin Management Plans, may put new life into the implementation of this Wadden Sea target.

Offshore area

The Offshore area is positioned seaward of the Wadden Sea islands, extending to the 3 mile limit, but including the Conservation Area beyond this limit. This seaward limit is artificial, not functional. Three targets apply to this area.

Natural morphology

Apart from coastal defence works on the Wadden Sea islands (e.g. sand nourishments on the foreshore, cross-shore dam at Texel) no evidence has become available regarding major negative developments in natural dynamics of the geomorphology of this area.

Food availability for birds

Important stocks of the bivalves *Spisula subtruncata* and *S. solida* occur in the Offshore area. These bivalves are a major food resource for diving duck species such as common scoter and eider. For eider they form an escape in case of adverse food conditions inside the Wadden Sea, e.g. due to severe winter or intense shellfish fishery. Therefore, the fishery on *Spisula* should be carefully managed in relation to conservation of these bird species.

Viable stocks of marine mammals

The Offshore area constitutes a part of the living range of harbour seal, grey seal and harbour porpoise, which do not only use the Wadden Sea proper but also large parts of the North Sea (see Marine Mammals).

Birds

Breeding birds

For more than 30 bird species, the Wadden Sea area is important as breeding area. Breeding habitats are present in salt marshes, dunes, pastures and on beaches. Two targets especially apply to breeding birds, viz. 1) a favourable food availability, and 2) a natural breeding success.

Food availability - The breeding populations of common eider (with more than 75% in the Dutch Wadden Sea), oystercatchers and probably also herring gull have declined mainly in the Dutch Wadden Sea. This is considered an effect of intense shellfish fisheries notwithstanding the management measure of having areas closed for fisheries and reserving certain amounts of cockle and blue mussel stocks for birds (Ens et al. 2004).

Breeding success - Measures aimed at protection of breeding sites of the little tern have proven successful. The significance of the beaches as breeding habitat for bird species such as great ringed plover and Kentish plover has further decreased. As this was already concluded in the previous Wadden Sea QSR (De Jong et al. 1999) it must be concluded that management measures have not been effective at all.

Increased predation pressure by mammalian predators, e.g. red fox, on the mainland caused some bird species to shift their breeding numbers from the mainland to the islands. May be, action is needed to protect the island breeding habitats by keeping mammalian predators away.

Migratory birds

In 22 out of 34 water bird species numbers have experienced declines over 1992-2000. This is an alarming and new development since the 1999 Wadden Sea QSR.

Favourable food availability and sufficiently large undisturbed roosting and moulting areas are the two major targets relevant for migratory birds.

Food availability - What can be said about food availability? Of the 22 species showing a decreasing trend, 19 were dependent on feeding on benthos, incl. bivalves, for 'fast refuelling' during their migration to the breeding and wintering areas. This is an indication of non-favourable food availability, although other risk factors may play a role. For the migratory bird species within this group and specialising in molluscs (e.g. eider, oystercatcher, knot and herring gull), food availability was impaired due to shellfish fishery. In conclusion, the target is not met.

In contrast, for herbivorous species (e.g., dark-bellied brent goose, Eurasian wigeon, barnacle goose) food availability seems not to be limited.

Undisturbed roosting and moulting - For three species important moulting areas exist in the Wadden Sea and offshore zone viz. for shelduck, common scoter and common eider. Protection of moulting shelduck has been improved through voluntary agreements with different user groups (e.g., fishermen, yachtsmen) aimed at avoidance of disturbance during the moulting season.

Although most high tide roosts are situated in well protected areas, disturbances do still occur due to outdoor recreation. Moreover, some species prefer high tide roosts on agricultural land, which are not well protected or not protected at all. Therefore, the target is not satisfactorily met.

Marine mammals
The common target for each of the most important marine mammal species in the Wadden Sea area is to have viable stocks and a natural reproduction capacity. Monitoring of harbour and grey seal in the Wadden Sea is organised in the framework of the Seal Management Plan 2002-2006 (SMP 2002) under the Bonn Convention. The implementation of the Seal Management Plan is done by the trilateral Wadden Sea cooperation.

Harbour (= common) seal
The harbour seal population that quickly recovered from two successive PDV-epizootics can be considered viable having a satisfactorily high reproduction capacity.

New is knowledge obtained through satellite transmitters mounted onto harbour seals, showing that these animals use the North Sea to a much greater extent than realised before. The reason for this is not yet investigated.

Grey seal
Grey seals have increased in the Dutch and Schleswig-Holstein part of the Wadden Sea. There are signs of expansion of the population to other parts of the Wadden Sea (e.g. Borkum Riff, Norderney). Although reproduction has increased, a major part of the population increase can be attributed to influx from populations along the east coast of Great Britain.

Protection of grey seals is not yet optimally organised, and the target cannot be evaluated with satisfaction due to insufficient data. Grey seal monitoring is not included in the TMAP Common Package.

Harbour porpoise
The Offshore area and adjacent North Sea, especially off Schleswig-Holstein, is important for harbour porpoise. Dedicated trilateral (TMAP) surveys with harmonized methods do not exist. As a consequence, the target cannot be evaluated due to insufficient information.

Discussion and Conclusions

New information, as made available in the 2004 Wadden Sea QSR, provides answers to questions and allows evaluating the targets of the Wadden Sea Plan. There are, however, several limitations.

As stated above, not all Wadden Sea Plan targets are operational, meaning that not all targets have been translated into well defined parameters to be monitored. In most cases, the TMAP Manual (TMAP 2000) provides such a parameter definition. In other cases, such as with respect to the natural dynamics of beaches and dunes, operational monitoring objectives have not yet been formulated.

Another aspect to be discussed is the mere absence of quantifiable targets. Most targets refer to an increase (e.g. area of sea grass fields) or a favourable situation (e.g. food availability for birds) without any further specification. Of course, policy makers wanted the targets to be that general, that vaguely formulated, allowing the partners in the Wadden Sea Cooperation some room for manoeuvre. The drawback of this is that when the time has come for evaluation the policy makers see themselves dependent of the opinions of various specialists regarding the targets being met or not. And specialists may not always be fully objective. The consequence would be to reconsider targets in such a way that they can easily be translated in objective and quantifiable monitoring objectives.

Having said that, and assuming that a nice set of well defined monitoring parameters has been agreed, is it then wise to only monitor those parameters that can tell us whether a certain quantified target is met? For example, a total area of sea grass fields with more than 10% cover of "X" thousand hectares, with a natural distribution over the different sub-regions of the Wadden Sea as x : y : z : ….? My answer is "no". It is of utmost importance to be able to discriminate between changes due to human activities, that directly or indirectly influence the target, and changes due to natural processes, e.g. climatic change. Moreover, the Wadden Sea is a wide open system, being influenced from land as well as from the North Sea. So, the policy makers must be prepared to fund monitoring programs that provide both these options.

New information usually also brings new questions to be answered. This is because we are working with a simplified notion of reality, in policy making, in management as well as in research. This Wadden Sea QSR comprises quite a number of recommendations for further research to fill gaps in our knowledge of the functioning of the Wadden Sea ecosystem. Among these gaps are apparent functional differences between northern and southern parts of the Wadden Sea, such as in the case of nutrient concentrations in relation to decreased discharges from the major rivers. An improved understanding of such regional differences will contribute to a better protection of the Wadden Sea.

The trilateral cooperation is not the only player in the Wadden Sea arena. The policy world around the Wadden Sea is changing. Most important in this respect are the European Directives, such as Birds, Habitats and Water Framework Directives. All these include obligations for nations, and in the case of the Water Framework Directive at the sub-nation scale of River Basin Districts. In comparison, the transnational character and experience of the Wad-

den Sea Cooperation is of particular added value. The Guiding Principle of the trilateral Wadden Sea policy "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way" (Esbjerg Declaration 1991) remains valid.

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The Role of TMAP Data Handling in Supporting Monitoring for EU Directives

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Crain, I.K. 2006: The role of TMAP Data Handling in Supporting Monitoring for EU Directives. In: Monitoring and Assessment in the Wadden Sea. Proceedings from the 11. Scientific Wadden Sea Symposium, Esbjerg, Denmark, 4.-8. April, 2005 (Laursen, K. Ed.). NERI Technical Report No. 573, pp. 37-43.

The TMAP data handling system has been developed and implemented in a series of stages spanning over ten years. The system was evaluated in 2004 as the TMAP data handling reached a very critical stage - the long-sought milestone of harmonized data availability, effectively achieving the Esbjerg Declaration target of having an *"operational data handling system"*.

TMAP Data Handling was designed to provide science-based monitoring, that is standardised time series data of observational variables. Such consistent long-term monitoring is essential to conducting assessments of status, conditions, and trends to support reasoned decision-making, and importantly, to monitor the on-going effects of decisions and actions. Its enormous value comes from it being harmonized across the three countries, and being consistent in quality and meaning over a long time frame – in some cases as long as 25 years – allowing for an ecosystems view of the Wadden Sea as a whole.

Although originally designed to address the specific Issues of Concern, the TMAP data and data handling system have great potential to support various aspects of obligations of nations to assess and report to EU Directives. Of particular relevance are the Habitats, Birds and Water Framework Directives. Improvements in the TMAP Data Handling would enable the extraction of information from the TMAP time-series in forms suitable for the development of consolidated indicators, and to support quantitative and qualitative assessments. While necessary, the TMAP monitoring data is not sufficient to meet all requirements. It will always be necessary to augment the time-series with the results of research studies, and socio-economic data.

The possibility exists to integrate TMAP-DH more closely with the EEA Reportnet process. Whatever the technological evolution, there would still remain a strong need for countries to coordinate their approaches to implementation of the Directives, including for site designation, design of management plans, River Basin designation, and monitoring regimes, and for a TMAP data Handling System that ensures harmonisation and can query, process and analyse the data to serve the objectives of the CWSC. Elimination of the time-series of Wadden Sea scientific monitoring observations would severely handicap decision-making regarding the Wadden Sea ecosystem.

Key words: Data handling, decision-making, EC Directives, environmental monitoring, information systems

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Introduction

It is fundamental to any decision-making process to have a base of consistent information to enable rational decision- making and to assess the effectiveness of decisions and resulting actions. A generic decision-making process involves a number of steps all of which need to be informed by relevant data sources (Figure 1).

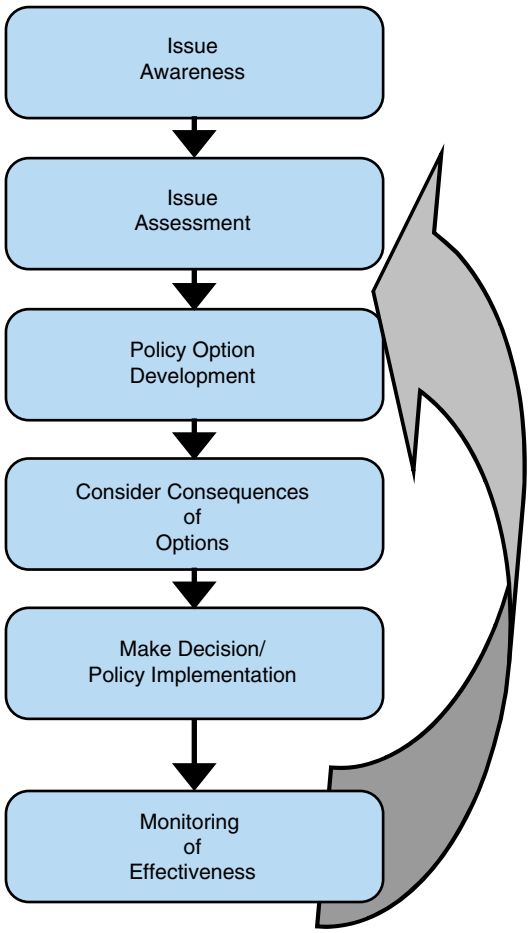

Figure 1. Generic Decision Making Process

It was recognised at an early stage of the Common Wadden Sea Cooperation that scientific monitoring of the state of the Wadden Sea ecosystem was essential. In the 1982 Joint Declaration on the Protection of the Wadden Sea, the Netherlands, Denmark and Germany recognized:

"their responsibilities for the conservation of the ecosystem and the biological values of this region and its components as well as natural beauty" and agreed to

"consult with each other in order to coordinate their activities and measures to implement … legal instruments with regard to the comprehensive protection of the Wadden Sea region as a whole including its fauna (marine terrestrial and avian) and flora with special emphasis on … seals and waterfowl"

The Declaration marked the beginning of considerations of joint monitoring of the environment of the Wadden Sea. It was also recognised that a "data handling" system was an essential component for managing the monitoring data across the area as a whole, hence datasets harmonised between the three countries. The general principles and outline of a trilateral joint monitoring program, including the associated data management, were adopted in 1993.

The TMAP Data handling system (TMAP-DH) was developed and implemented in a series of stages over 10 years, commencing with an EC-funded demonstration pilot project called DE-MOWAD. During that time, a common data model and practical harmonisation procedures were agreed, and TMAP Data Units were established in each of the three countries (2 in Germany for a total of 4 locations). At each of the four Data Units, a relational database has been established following the common model, national time-series data have been entered for many of the Common Package of parameters, and most importantly, a common Internet-based data access service has been developed making the data available for download. By late 2004 TMAP Data Handling reached a very critical stage - the long-sought milestone of harmonised data availability, effectively achieving the Esbjerg Declaration target of having an "operational data handling system". At that point it was highly appropriate to invite an evaluation. This was conducted by the Orbis Institute and resulted in a report of findings (CWSS 2004) including 29 recommendations for future steps.

Principles of environmental monitoring

It has been recognised for many decades that systematic long-term monitoring of environmental conditions is essential for effective decision-making (Figure 1) on conservation and sustainable development. Scientifically based data should at best serve three main purposes – creating an understanding of cause-and-effect relationships (hence informed decisions on mitigation of problems), early warning of potential problems (enabling timely decisions on avoidance measures), and assessment of the impact of decisions (enabling adjustment and refinement).

These purposes lead to the key characteristics required of monitoring data (and data handling):

- Scientific validity – systematic collection, valid measurement methods
- Continuous time series on a consistent basis
- Harmonised data so that they can be aggregated and integrated
- Interpretable in a meaningful way.

Long term monitoring of the environment is now frequently undertaken by governmental bodies at

all levels, from local community to global, and by NGOs, and through volunteer programs. At the global level, monitoring was one of the early cornerstones of UNEP and its "Earthwatch" concept. Shortly after the inauguration of UNEP, the Global Environmental Monitoring System (GEMS) was formed and became one of the primary Programme Activity Centres of UNEP. GEMS had components that monitored air, water, radiation, human health (as related to the environment) and terrestrial ecosystems. The latter spawned the Global Resource Information Database (GRID) project that evolved into a number of regional centres using remote sensing and Geographic Information System (GIS) technology to accumulate information on land cover and change, and to provide capacity building at regional and national levels.

Many countries have introduced national environmental statistical systems, and various approaches to State-of-the Environment monitoring. Many of the international conventions explicitly recognise the need for monitoring, and there are several international initiatives such as the Global Environmental Outlook ("GEO Process") and the Millennium Ecosystem Assessment, as well as regional efforts such as the "Environment for Europe" process that are currently active.

In spite of the known benefits and current global activities, long term ecological monitoring is not well established overall, nor consistently funded and supported. In the 1990s, for instance, UNEP-GEMS was dismantled and devolved in part to more specialised agencies, with the formation of three linked "observing systems" – Global Ocean Observing System (GOOS), Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). The first two of these have clear focus – GOOS under IOC, and GCOS under WMO linking to Climate Change Convention activities. GTOS (which would include coastal marine monitoring such as TMAP) is less focussed and weakly supported. One specific GTOS product is the Terrestrial Ecosystem Monitoring Site (TEMS) database. This is a very loosely connected network with no effective harmonisation or standards and relies entirely on the voluntary participation of the site managers.

Many national monitoring programmes have started and then failed to continue, and examples of regional monitoring programmes are rare. Lack of funding and support for monitoring is a universal problem. Some of the issues and problems are:

- Lack of universal agreement on what needs to be monitored
- Underestimation of the effort required to achieve harmonisation
- Underestimation of the effort required to organise, manage and provide access to the information base
- Dependency on NGOs and volunteers for data collection
- Lack of demonstrable immediate value – that is, monitoring not being tied to a specific issue of concern or question of interest to legislators
- Disconnection from high-level indicators – it is often unclear how the 'scientific" data should be interpreted, and how data could or should be aggregated into useful indicators.

The lack of support forces long-term monitoring programmes to "partner" in an opportunistic (not necessarily strategic) way, often with minimal resources to introduce the standards needed for long-term consistency, or to develop appropriate information systems for information analysis, synthesis, and communication. This limits the value of the information that has not been collected with a particular goal in mind, or is assembled from programme information and research studies that have no integrated systematic framework. This results in circularity – these weaknesses in the monitoring data quality further reduce the potential for support.

TMAP, in spite of recognised value, is clearly not immune from these common issues, and the resource expenditures necessary to continue monitoring and data handling are being questioned.

Relevant findings of the TMAP-DH evaluation

It is not the purpose of this paper to repeat the extensive findings and recommendations of the TMAP Data Handling Evaluation (CWSS 2004), rather to focus on issues relevant to the role of TMAP-DH with regard to the EC Directives. Some of the more relevant findings follow.

Data Handling Design is based on hierarchical logic

The Evaluation confirmed that TMAP Data Handling is correctly mandated and fully relevant. To trace the analysis in reverse order:

- A "data handling system" is essential to organise and manage the quantitative data resulting from monitoring activities.
- Monitoring data is recognized as being the "core" and the selected 28 parameter groups are agreed to be appropriate and necessary.
- The monitoring activities are essential to assessment of the achievement of the established Ecological Targets mandated in the Wadden Sea Plan.
- The Wadden Sea Plan is a direct response to the primary objectives of the Cooperation with regard to "conservation of the ecosystem" and "protection of the Wadden Sea area as a whole".

The logical flow is therefore correct – the Ecological Targets evolve from identification of Issues of Concern; the monitoring programme was developed to gather the required data; parameters have been selected to help assess the Targets; the data handling system was developed to manage the selected parameter data.

This is a very positive finding. The monitoring, data handling and reporting regimes of the majority of Multinational Environmental Agreements (MEAs) emphasise administrative compliance (existence of action plans and legal transpositions), and/or collect data on the basis of what is easily available, traditionally collected, or other ad-hoc approaches – rather than identifying monitoring data needs related to identified issues of concern and agreed objectives or targets. TMAP and TMAP-DH are remarkable in this regard; there are few other examples worldwide where such a logical top-down approach has been applied (Olsen & Nickerson 2003).

Values of TMAP Data

The successful harmonisation, and long term time-series are two key characteristics that make the TMAP data sets much more valuable than the national datasets from which they are derived. Monitoring is at the core of the Trilateral Wadden Sea Cooperation; it is recognised as essential to being able to treat the ecosystem as a whole. The values that TMAP monitoring data can provide therefore include:

- Support for research studies
- Support for national decision-making and policy development
- Support for public awareness and NGO activities
- Support for conservation management at the local level (e.g. national park) in an ecosystem context
- Supporting data for assessment against the Ecological Targets (e.g. the QSRs)
- Support for other Wadden Sea assessments as required
- Rapid identification of abnormal or alarming situations
- Enabling of joint projects, actions and harmonised legislation
- Facilitation in meeting international conservation obligations
- Raw data for aggregation to assist with national, European and international reporting obligations.

The logical top-down process by which TMAP parameters have been selected, and harmonisation measures developed and implemented (and documented in the TMAP Manual, CWSS 1997) ensure that the scientific data collected is relevant to the issues and the decision-making process for the Wadden Sea ecosystem. It should be emphasised that TMAP time-series monitoring data is necessary, but not sufficient, for assessment of the Targets – there will always be a need for other kinds of observations (such as localised research studies on processes) which need not be, or should not be "monitored" in multiple locations, or at regular specified time intervals.

Of the list of values or uses given above perhaps only the first three could be achieved without the TMAP data handling, indicating that the added effort of harmonisation provides many (potential) benefits – benefits that are directly connected to the objectives of the TWSC, as well as potential value-added benefits.

"At the risk of being repetitive, much of the value of the TMAP data comes from them being collected in systematic programmes, with harmonised methods consistently over a continuous period of time – so that baselines can be established and trends extracted and tested for significance. This contrasts sharply with the limited value of equally large collections of data that might be assembled from disparate research studies of unsystematic observations over periods of time, where interpretation is difficult due to unrepresentative sampling methodologies and unknown amounts of observer bias. TMAP data has been specifically selected from systematic programmes with known methodologies and sampling protocols, and that process of selection and harmonisation has involved considerable investment. While, as mentioned above, the data must be augmented from time to time by specific research studies, such one-time investigations cannot be a substitute for the time-series data when making assessments and consequent policy decisions and actions." (CWSS 2004 p. 30).

TMAP Data Handling and the EC directives

While the original conception of TMAP-DH was to support the Wadden Sea Plan and inform the TWSC in decision-making concerning the conservation of the Wadden Sea ecosystem as a whole, one of the directions of evolution in subsequent years of the Cooperation has been to invite consideration of how TMAP (the programme) can better support obligations to other multilateral instruments that may affect the conservation of the ecosystem. The Esbjerg Declaration of 2001 (CWSS 2002) makes a specific reference to considering how TMAP-DH can be optimised *"for future requirements, in particular with regard to the Targets, the EU Habitats Directive and the EU Water Framework Directive"*. The concept is to re-use TMAP data to support inputs to other instruments in such a way that national costs are avoided, or that TMAP could provide parallel functionality both with regard to multilateral as well as trilateral

commitments. The value of TMAP would then be increased by the cost offsets.

The recent Oxford Brookes report (Wadden Sea Forum 2003) conducted a thorough review from a legal and management point of view of a range of instruments (with an emphasis on the EC Directives) and how they interact in the region. That study noted a number of organisational and administrative issues that present concerns and barriers to effective interaction. Apart from the EC Directives, the three countries are party to some 70 international agreements with reporting obligations. This paper focuses on the potential use of TMAP data in support of reporting obligations to the Directives, rather than the jurisdictional and policy issues, and does not discuss the other MEAs.

The EC Directives are binding on the nations of the TWSC. The Directives are therefore important policy drivers and of high priority for national response. The Birds and Habitats Directives have been in force for some time and TMAP–DH has already taken cognisance of them. The Water Framework Directive (WFD) is currently in the process of implementation by the EU member states. The growing importance of these to the TWSC is evidenced in recent Trilateral Declarations. It is therefore essential to consider to what extent value-added use can be made of TMAP data to support reporting obligations under these Directives. It is also important to have realistic expectations of the potential influence a regional monitoring programme like TMAP can have on national obligations to the EC. The Wadden Sea conservation area, for all its environmental importance, is only one instance out of many of each nation's suite of concerns and the implementation of the Directives necessarily requires a national perspective. National solutions must be found that suit national policies, processes and institutions that are geographically and contextually remote from the Wadden Sea.

As further context, it should be noted that TMAP-DH is not a "reporting obligation" on the three countries of the TWSC, but is a time-series database of observations designed to support assessments and reporting, i.e. it is not an end product, but an intermediate product (a data archive) that can contribute to a number of end-products.

To briefly summarise the requirements of the three key Directives:

The Birds and Habitats Directives both call for countries to designate a series of protected sites. In establishing the sites, nations submit detailed information on a consolidated form referred to as the Natura 2000 Questionnaire. This approach serves to integrate and harmonise data input for the two types of site. It is not entirely clear what on-going reporting will be required in respect of these Directives. A report every six years is prescribed ("Report on Implementation Measures") which is to include an assessment of the "conservation status" of the specified habitat types and listed species, along with results of "surveillance" (monitoring). While there is an agreed need to clarify and possibly subdivide marine habitat classes, it is clear from the evaluation (CWSS 2004) that TMAP data are a solid base to support such reporting as well as for the generation of indicators and/or assessments of conservation status of habitats and species.

The Water Framework Directive calls for countries to delineate River Basin Districts (RBDs), characterise them, develop River Basin Management Plans and associated monitoring programmes. The management plans are to include "environmental objectives" – the status of which would be assessed through a monitoring programme. There is considerable latitude permitted in implementation, and in interpretation of just what constitutes a management plan or a monitoring programme, and this may vary between RBDs as well. On the other hand the Directive does specify, in its Appendix V, a list of variables that should be measured, and how these might relate to assessment of "status" of a RBD. This list closely parallels the TMAP parameters (CWSS 2004).

Like the Birds and Habitats Directives, the WFD requires the assessment of the "ecological status" and the "chemical status" of the RBDs. These status assessments are to be seen against defined quality elements and relative to "reference conditions".

A common characteristic of these Directives is the reporting (regular but infrequent) on "status" based on assessment and aggregated indicators. To accomplish this, the Directives specify or imply the necessity of a continuous scientific monitoring regime to support the assessments. TMAP is in a good position to support the assessment of the status of sites, species, habitats, and ecosystems under the Birds and Habitats Directives, and is already considerably harmonised with these Directives. To a lesser extent it can contribute to the required assessments of pressures and impacts.

TMAP data is also already closely aligned to the monitoring needs of WFD and likely only needs tuning of TMAP parameters (sample locations, frequency) to be fully compatible. There is a potential important role for TMAP data in establishing "reference conditions" for transitional and coastal waters.

TMAP-Data Handling and the EU Dataflows

European countries are parties to an overlapping network of conventions, treaties, agreements and

other instruments, as well as binding EC Directives. Many of these have obligations to report various kinds of data and narrative information at varying frequencies to a range of different authorities. This, coupled with the programmes to assess the state of the European environment and associated "DPSIR" indicators, create an information exchange and delivery process of labyrinthine complexity. The need to reduce this complexity and minimise reporting burdens on countries has been recognised for some time. The response has been a far-reaching programme, coordinated by the EEA, to streamline European "dataflows" – particularly as related to indicators and reporting obligations. The very laudable goal is *"deliver once – report to many"*, that is, countries should only have to provide data once and have it distributed to appropriate authorities to satisfy multiple obligations (EEA 2003).

The overarching system, the European Environmental Information System (EEIS), interacts with various international institutions and the EEA to meet reporting obligations, and to provide information for decision-makers and the public (Jensen 2002).

The related Reportnet is defined as a *"suite of IT tools optimized to support the business processes of a data collection network building on a shared information infrastructure"*, and comprises a number of components aimed at facilitating information harmonisation and reporting. These include a Reporting Obligations Database (ROD), Data Exchange Modules (DEMs), and a Data Dictionary that link National Repositories and European Data Warehouses to promote harmonisation and consistency in the development of relevant indicators. It is expected that countries will have similar national networks and processes to link national data repositories, and will link institutions through EIONET. The Reportnet concept is shown in Figure 2 below.

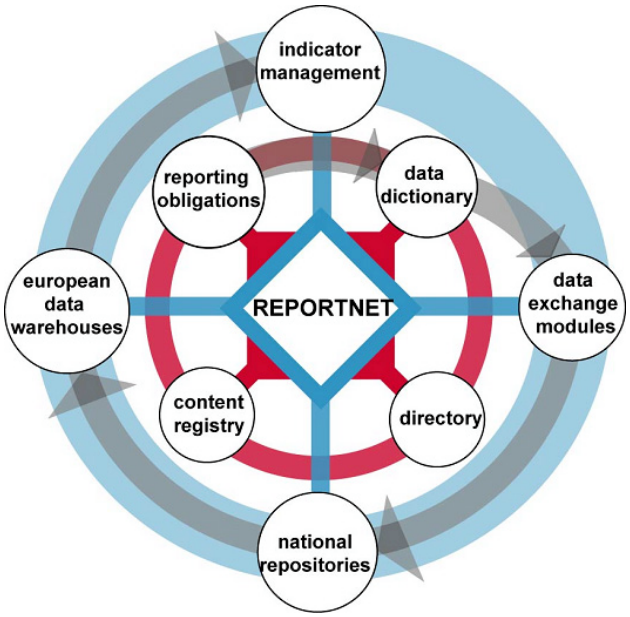

Figure 2. The Reportnet Concept (Diagram courtesy of the EEA).

The result of this approach to streamlining is an EEIS that is itself very complex. Implementation of the concept has advanced unevenly on many fronts and there are a number of issues of technological harmonisation still being addressed.

The EEIS and Reportnet concepts have significant similarities in principle to recommended technology direction of TMAP-DH integration (and possible sharing) of data held in decentralised databases (Saarenmaa et al 2002). Automated extraction of relevant data from National Repositories is proposed using technology and the concept of "mapping" similar to that proposed for TMAP-DH in the TMAP-DH Evaluation (CWSS 2004). On the other hand there are very significant differences in scope and intent. The emphasis of the EEIS and Reportnet process is on meeting reporting obligations to various instruments, rather than assessing the status of targets based on issues of concern. This is a distinct difference from the intent of TMAP and affects the data content and level of aggregation. Many of these reporting obligations require highly aggregated statistics and indicators, as well as narrative assessments of status, provision of legal transpositions (e.g. submissions of laws and regulations), and descriptions of actions and plans. The TMAP database, on the other hand, is a time series of mainly unaggregated science-based observations – designed to be a base for developing indicators and assessments (through aggregation and interpretation) to support reporting, such as the Quality Status Reports and others. The provision of data in a harmonised form to the TMAP-DH is not a "Reporting Obligation" and is not identified in the ROD as such.

There have been initial discussions in the CWSC meetings on the possibility of reducing or eliminating inputs to the TMAP database on the basis that Reportnet and EEIS may serve the purpose. In theory there are potential advantages to taking this approach – that is to extend the *"deliver once – report to many"* concept to deliver data to Reportnet for subsequent use for TWSC assessments. If feasible, it could eliminate the need for TMAP Data Units, and TMAP-DH would be replaced by some service of the EEA Reportnet process, to be used for TWSC assessment activities and production of the QSRs.

Achieving this (at least in the short to medium term) would appear to be problematical in a number of ways that are discussed in the following section.

Concluding discussion

In the short to medium term it does not appear that the Reportnet process would be able to provide the information necessary for the TWSC to assess Targets as they now stand. One of the key principles of

the TWSC is to consider the Wadden Sea as a single ecosystem – hence the requirements for harmonised monitoring. These aspects will almost surely be lost if data submission to the Reportnet process (and feed back for TWSC assessments) are limited to those necessary under the EC Directives.

National monitoring systems equivalent to TMAP will continue to be required to support the aggregated assessments delivered to the EEIS, and must be harmonised in order to meet the principle of the TWSC to consider the Wadden Sea as a whole. Therefore replacing the TMAP-DH with services of the Reportnet cannot be done without changes to the principles, and hence the Targets and Common Data Package.

The time-series of scientific monitoring data is essential, and a data handling system with the same (possibly increased) functionality as TMAP-DH will always be required in order to extract, analyse and summarise the data for use in establishing base lines and supporting indicators of "status".

This is not to say that there could not and should not be closer ties and technological integration with the EEIS. One possibility being to establish TMAP-DH as a "European Data Warehouse" with official status as part of Reportnet. This could lead to the consolidation of the TMAP "databases" into a data warehouse (which could be technically distributed).

Whatever the technological evolution, there would still remain a strong need for countries to coordinate their approaches to implementation of the Directives, including for site designation, design of management plans, RBD designation, and monitoring regimes, and for a TMAP Data Handling System that ensures harmonisation and can query, process and analyse the data to serve the objectives of the CWSC.

Put simply, elimination of the time-series of Wadden Sea scientific monitoring observations and the means to analyse them (TMAP-DH) is not an option as it would severely handicap decision-making regarding the Wadden Sea ecosystem.

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Eutrophication Proxies in the Wadden Sea: Regional Differences and Background Concentrations

J.E.E. van Beusekom

Van Beusekom, J.E.E. 2006: Eutrophication Proxies in the Wadden Sea: Regional Differences and background Concentrations. In: Monitoring and Assessment in the Wadden Sea. Proceedings from the 11. Scientific Wadden Sea Symposium, Esbjerg, Denmark, 4.-8. April, 2005 (Laursen, K. Ed.). NERI Technical Report No. 573, pp. 45-51.

Two Wadden Sea specific eutrophication proxies based on summer and autumn conditions are compared to the more commonly used winter nutrient concentrations. Winter NOx concentrations do not show large regional differences in the Wadden Sea. This contrasts with two Wadden Sea specific Wadden Sea proxies, mean summer chlorophyll and autumn [NH_4 + NO_2]. Both proxies correlate well with riverine Total Nitrogen (TN) input in the Southern Wadden Sea but only summer chlorophyll correlates with riverine TN input. Both proxies correlate significantly, supporting that they both reflect the Wadden Sea eutrophication status. Based on the Wadden Sea specific eutrophication proxies it is concluded that the Southern Wadden Sea has an about two-fold higher eutrophication status than the Northern Wadden Sea. Whereas winter nutrient concentrations may be used to reflect the primary production potential in open sea settings, they do not reflect this potential in areas where eutrophication is driven by advection (import) of organic material.

Key words: Wadden Sea, Phytoplankton, Nutrients, Eutrophication, Eutrophication Proxies, Pre-industrial Conditions

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Introduction

Eutrophication is one of the factors influencing the quality of the Wadden Sea area. Since the earliest nutrient measurements in the Wadden Sea (e.g. Postma 1954, Postma 1966) a clear increase has been documented (e.g. de Jonge & Postma 1974, Hickel 1989, van Beusekom et al. 2001). Among the negative effects associated with the increased nutrient loads are *Phaeocystis*-blooms (Lancelot et al. 1987), a decline in seagrass (de Jonge & de Jong 1992), increased blooms of green macroalgae (Reise & Siebert 1994) and anoxic sediments (Black Spots, de Jong et al. 1999a). One of the challenges in assessing the ecological quality of the Wadden Sea is to develop indicators or proxies that reflect the eutrophication status. After a short description of the present eutrophication status as reported in the newest Quality Status Report 2004 (Marencic et al. 2005), a more detailed elaboration on the use of eutrophication proxies is given.

A trilateral Target was adopted to aim for „A Wadden Sea which can be regarded as an eutrophication non-problem area". A concept for identifying eutrophication problem and non-problem-areas for the Wadden Sea was developed by van Beusekom et al. (2001) in the framework of OSPAR (1997). Regularly, Quality Status Reports document changes in the ecological quality of the Wadden Sea. The Quality Status Report 2004 extends the analyses made for the QSR 1999 (de Jong et al. 1999b) and the results of the above mentioned exercise to develop "Wadden Sea Eutrophication Criteria" (van Beusekom et al. 2001). In this report, recent trends in nutrient loads, nutrient concentrations and in phytoplankton and macroalgae biomass are described. A Target Evaluation and Recommendations are given. The main results can be summarized as follows:

Major conclusions on eutrophication in the QSR 2004

Riverine nutrient input shows a gradual decrease since the mid-1980's. This is reflected by the phosphate concentrations in winter in the Wadden Sea that decreased since the mid 1980's to winter levels of about 1 µM. Salinity normalized nitrate+nitrite concentrations in the German Bight in winter reflect the decreasing TN load, but in the Wadden Sea proper no consistent trend is detectable yet.

The decreasing nutrient input (TN loads by Rhine and Meuse) had a significant effect on the phytoplankton biomass (as chlorophyll) in summer in most of the Southern Wadden Sea. In the North-

ern Wadden Sea a less clear picture emerges. Only in the Sylt-Rømø-Bight, (decreasing) summer chlorophyll levels correlate with riverine TN input. Toxic blooms are observed in all parts of the Wadden Sea, but no increasing trend or relations with nutrient input are evident. Since the QSR 1999, the most conspicuous blooms were in 1998 and 2000 along the Danish west coast, where large, ichthyotoxic *Chattonella* blooms were observed. The main nuisance blooms were due to *Phaeocystis*. Long term data from the Marsdiep (Western Dutch Wadden Sea) show a decreasing trend in bloom duration. Present macroalgae abundance is below the maximum levels observed during the early 1990's.

The decreasing nutrient input (TN loads by Rhine and Meuse) had a significant effect on the autumn NH_4+NO_2 values in the Southern Wadden Sea. The autumn NH_4+NO_2 values are a good indicator of organic matter turnover in the Southern Wadden Sea (van Beusekom and de Jonge 2002). In the Northern Wadden Sea a less clear picture emerges. In the Sylt-Rømø-Bight an increasing trend of autumn NH_4+NO_2 values was observed suggesting an increased organic matter turnover but a decreasing trend in autumn NO_3 values was observed that correlated with TN input. Data from the other parts of the Northern Wadden Sea did not reveal any trends.

Regional differences

The data analysis highlights regional differences in Wadden Sea eutrophication. In general, the summer phytoplankton biomass and the autumn NH_4+NO_2 values in the Southern Wadden Sea are about two times higher than in the Northern Wadden Sea. This suggests a more intense eutrophication of the Southern Wadden Sea. The reason for this fundamental difference is not yet known, but a possible relation with a more efficient particle accumulation in the southern Wadden Sea has been proposed (van Beusekom et al. 2001). The geographical distribution of phytoplankton biomass reflects the importance of nutrient loads as higher values are observed near the main freshwater sources (Rhine-Meuse-IJsselmeer and Elbe-Weser).

Background values

Compared to background TN concentrations in rivers entering the North Sea of about 45 µM (~0.6 mg/l, Laane 1992) present day mean TN values of 4-5 mg/l are about 7-8 times higher. The present day organic matter turnover rates in the Wadden Sea (as indicated by NH_4+NO_2 values) are about 3-5 times higher than the rates expected with background riverine TN loads. Brockmann et al. (2004) developed background values of TN and Chlorophyll a for the German Bight. They found about 3-5 times higher TN and Chlorophyll levels in the Wadden Sea compared to pristine conditions.

Scope of the present paper

Whereas eutrophication reflects processes like enhanced primary production and remineralisation, most monitoring programmes do not include such process studies. This lack of data becomes especially apparent when trying to reconstruct the historic development of Wadden Sea eutrophication. In such cases proxies have to be developed that reflect the intensity of certain processes. Van Beusekom et al. (2001) suggested that the intensity of the seasonal cycle of NH_4 and NO_2 reflects the intensity of organic matter remineralisation. This concept was applied in the QSR 2004. In addition, a new proxy was developed: the mean summer chlorophyll concentration as an index of pelagic primary production. In this paper, I will discuss the use of both proxies as indicators of Wadden Sea eutrophication. Based on these proxies I will highlight region specific differences in the eutrophication status and suggest region specific background values for these proxies.

Material and Methods

Area description

The Wadden Sea is a shallow coastal sea with extensive tidal flats covering about 50% of the area (Fig. 1). The Wadden Sea region includes an area extending from Den Helder in the Netherlands to the Skallingen peninsula in Denmark, about 500 km of coastline. It is a strip of tidal flats, sandbanks and barrier islands. On average this strip is some 10 km wide, although in some areas it can reach a width of over 30 km. The Wadden Sea area covers approximately 13,000 km^2. Its environment is very dynamic. Wind, tidal forces and water turbulence cause the formation and erosion of the typical landscape elements of the area, the tidal flats, salt marshes, sandbanks and islands. The tidal range is about 1.5 m in the westernmost and northernmost part and increases to about 3 m in the central part near the estuaries of the rivers Elbe and Weser.

Data

The data used in the paper have been described in the QSR 2004. In short: Riverine input data are based on monitoring data that were interpolated to daily loads (Lenhart & Pätsch 2001, updated until 2002). Chlorophyll and nutrient data were derived from the TMAP Data Units. Additional data for the Sylt Rømø Basin are from the AWI time series (van Beusekom, unpublished).

All statistical analyses were made with the statistical package STATISTICA 5.5.

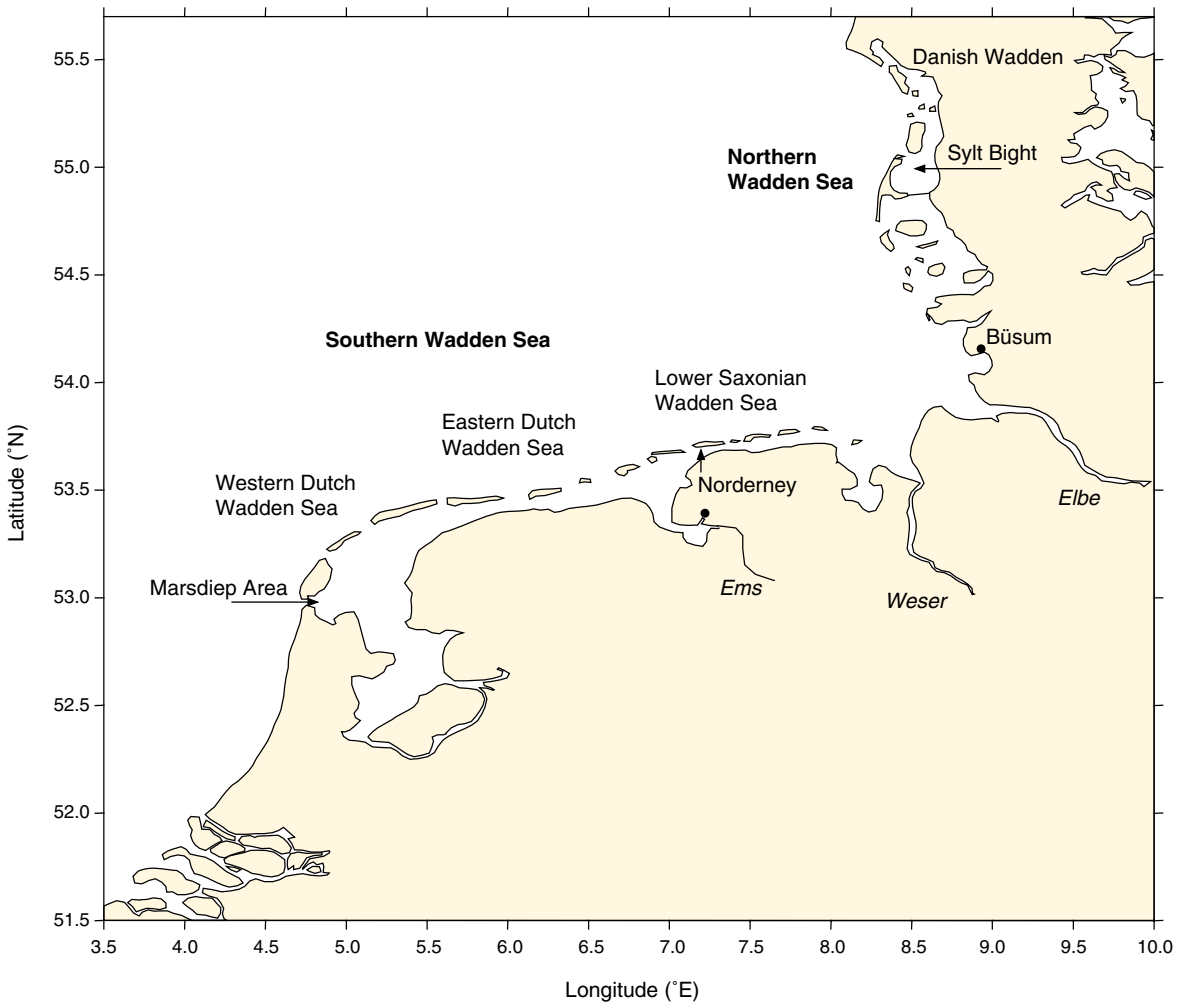

Figure 1. Map of the Wadden Sea with the main subareas used in the data analysis.

Results

Winter Nutrient concentrations as eutrophication indicators?

Winter concentrations generally reflect the amount of nutrients available for phytoplankton growth and are frequently used as an indicator of eutrophication (e.g. Hydes et al. 1999, Ærtebjerg et al. 2003). Also in the QSR 1999 winter nutrient concentrations were evaluated as an indicator of eutrophication status. This exercise was repeated for the QSR 2004 and the general conclusion was that no large interregional differences were observed. Here, some additional data are presented to corroborate this conclusion. Figure 2a presents the mean NOx concentrations as observed during winter (December – March). The concentrations were normalized to a salinity of 27 based on the regression between NOx and salinity. Details of this approach are described by Bakker et al. (1999). The overall mean winter concentrations are 58 µM. The geographical distribution of the normalized concentrations shows highest values near the major fresh water sources (IJsselmeer, Ems,

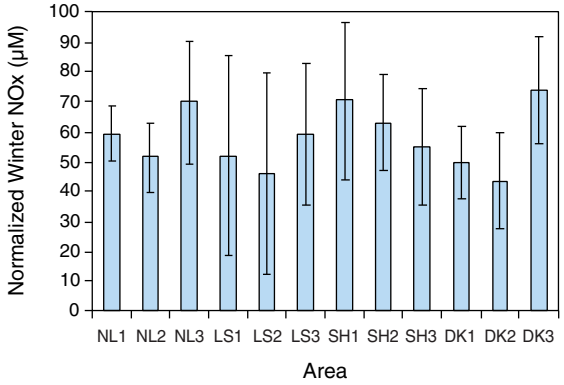

Figure 2a. Mean winter NOx (NO_3 + NO_2) concentrations normalized to a salinity of 27 in the 12 subareas of the Wadden Sea.

Weser, Elbe, Varde AA, Fig. 2b). In general, the concentrations in the Southern part (56 µM) and in the Northern part (59 µM) are comparable. These results suggest that winter NOx concentrations do not resolve any regional differences.

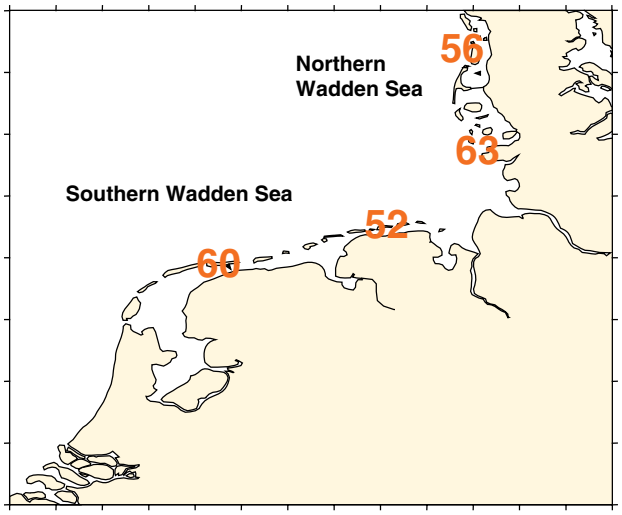

Figure 2b. Mean geographical distribution of winter NOx (µM) for the Dutch Wadden Sea (NL1-3); the Lower Saxony Wadden Sea (LS1-3), the Schleswig-Holstein Wadden Sea (SH1-3) and the Danish Wadden Sea (DK1-3).

New Eutrophication proxies: Autumn NH_4 + NO_2 and Summer Chlorophyll

In the QSR 2004 and in the Wadden Sea Eutrophication Criteria-study two proxies were developed that reflect the eutrophication status of the Wadden Sea: Mean summer chlorophyll concentrations and the autumn NH_4 + NO_2 concentrations. The use of mean summer chlorophyll concentrations was based on the assumption that increased nutrient turnover will support a higher phytoplankton biomass. Mean summer chlorophyll (May – September) gave good correlation with riverine nutrient input in the Western Dutch Wadden Sea, at Norderney (both Southern Wadden Sea) and near Sylt (Northern Wadden Sea). The results are presented in Table 1. The geographical distribution of the mean summer chlorophyll concentrations for each of the time series used in this study shows large spatial differences with values from the Southern Wadden Sea being about two times higher than in the Northern Wadden Sea (Fig. 3).

The mean NH_4 + NO_2 concentrations in autumn (September – November) correlated significantly with riverine Total Nitrogen input (Rhine Meuse) for the Southern Wadden Sea, but not for the Northern Wadden Sea (van Beusekom et al. 2005). The geographical distribution of the mean concentration for each of the time series used shows a similar pattern as for summer chlorophyll with almost two times higher concentrations in the Southern Wadden Sea than in the Northern Wadden Sea.

In the Southern Wadden Sea both eutrophication proxies –summer chlorophyll and autumn NH_4 + NO_2 – show good correlations with riverine Total Nitrogen input. For the Northern Wadden Sea this is less clear: Only for the Sylt time series a significant correlation between summer chlorophyll and

Table 1. Comparison of summer chlorophyll levels (µg/l; May-September) in different parts of the Wadden Sea and their correlation with TN input via Rhine and Meuse. In case of a significant correlation a factor relating riverine input with chlorophyll levels is given. This factor is the slope of the regression multiplied by 10^6 divided by the mean chlorophyll level. The "statistical significance" of the correlation with the Rhine/Meuse time-series is probably related to the size of this river system reflecting both the general precipitation pattern over North Western Europe and Europe-wide changes in the use of fertilizers, implementation of water treatment plants, changes in land use and burning of fossil fuels Data source: TMAP Data Units, DONAR, LANU (J. Goebels), NLOE (M. Hanslik), AWI (van Beusekom), Lenhart & Pätsch (2001).

Area	Period	Mean	Trend/-factor	Correlation
Western Dutch Wadden Sea	1976-2002	18.0	Yes/2.7	r^2 = 0.43 n = 27 p = 0.0002
Eastern Dutch Wadden Sea	1976-2002	19.9	No Trend	
Lower Saxon Wadden Sea (Norderney)	1988-2002	16.6	Yes/2.1	r^2 = 0.308 n = 18 p = 0.008
Southern Schleswig-Holstein	1990-2002	14.2	No Trend*	r^2 = 0.002 n = 13 p = 0.868
Northern Schleswig-Holstein	1990-2002	7.4	No Trend*	r^2=0.12 n = 13 p = 0.245
Sylt-Rømø-Bight	1984-2002	6.3	Yes/2.7 **	r^2 = 0.345 n = 19 p = 0.008
Danish Wadden Sea	1990-2002	8.6	No Trend*	r^2 = 0.18 n = 12 p = 0.15

* Also no trend with Elbe input;
**Also correlated with Elbe input (r^2 = 0.29; p = 0.0158)

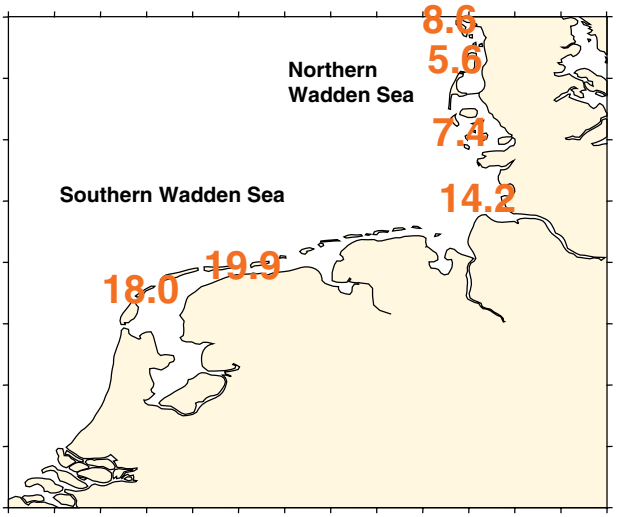

Figure 3. Distribution of the mean values of summer chlorophyll (May-September) in the Wadden Sea. All values are given in µg/l. The period for which the data were averaged is given in Table 1.

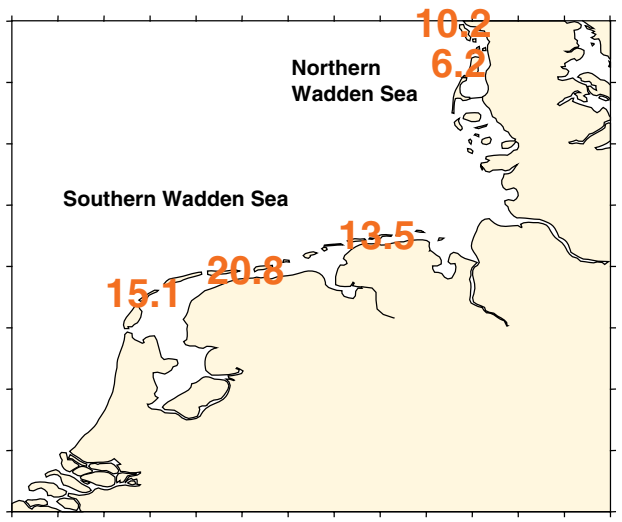

Figure 4. Distribution of mean autumn [NH_4 + NO_2] in the Wadden Sea. All values are in µM. The period for which the data were averaged is given in Table 1.

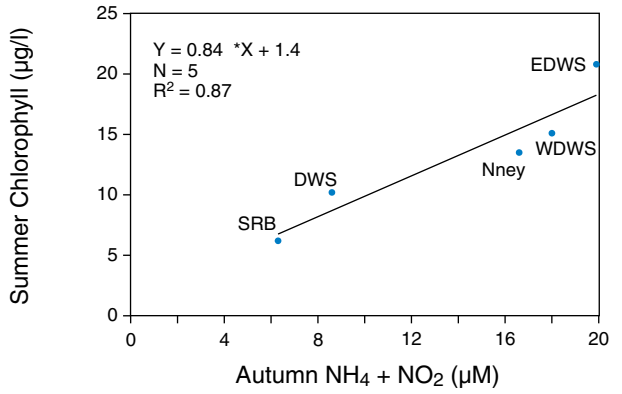

Figure 5. Correlation between the two eutrophication proxies summer chlorophyll and autumn [NH_4 + NO_2)]. SRB: Sylt Rømø Bight, DWS: Danish Wadden Sea, Nney: Norderney, WDWS: Western Dutch Wadden Sea, EDWS: Eastern Dutch Wadden Sea.

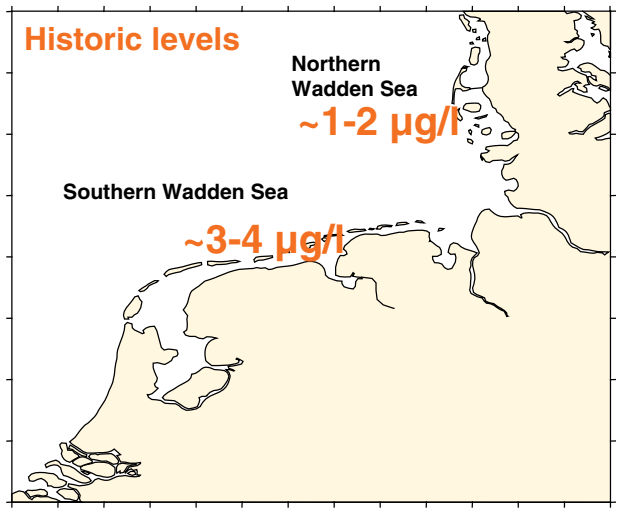

Figure 6. Estimated geographical distribution of historic summer chlorophyll levels (µg/l; May-September) in the Wadden Sea.

riverine Total Nitrogen input was found. Nevertheless, the geographic distribution of the autumn NH_4 + NO_2 (Fig. 4) shows similar spatial trends as found for summer chlorophyll.

If both proxies reflect the eutrophication status properly, they should be correlated. In Figure 5, mean summer chlorophyll is plotted against mean autumn NH_4 + NO_2 for each of the time series where both data are available. The correlation between both proxies is very significant (R^2 = 0.87; p = 0.020; n = 5), and further supports that they reflect the eutrophication status properly.

Regional differences in background values of eutrophication proxies

Although both eutrophication proxies do not show a significant correlation in all Wadden Sea areas, in both the northern and the southern Wadden Sea significant correlations are found with at least one proxy. The excellent correlation between these proxies further supports that both proxies reflect the general eutrophication status. At present the Wadden Sea is about five times more eutrophic than during pre-industrial times (van Beusekom et al. 2001, van Beusekom 2005). As a first estimate of the pre-industrial levels of the eutrophication proxies [autumn NH_4 + NO_2] and summer chlorophyll, a five times lower level can be assumed. Figure 6 and 7 present the geographical distribution of eutrophication proxies under pre-industrial conditions.

Discussion

Winter concentrations are used as a general indicator of the eutrophication status (Hydes et al. 1999, Aertebjerg et al. 2003). The rationale behind this approach is that these concentrations reflect the production potential by primary producers. For the development of Wadden Sea eutrophication criteria (van Beusekom et al. 2001), this proxy was not used because the analysis of carbon budgets suggested that the import of organic matter from the adjacent North Sea was the main driver of Wadden Sea eutrophication (see also van Beusekom et al. 1999, van Beusekom & de Jonge 2002). The present results corroborate this: Whereas winter NOx concentrations do not show any interregional differences between the Southern and the Northern Wadden Sea, the new proxies – Autumn NH_4 + NO_2 and Summer Chlorophyll – do resolve these differences. Both proxies suggest an about two-fold higher eutrophication status of the Southern Wadden Sea as compared to the Northern part. The reason for these differences is not clear yet. Van Beusekom et al. (2001) suggested that in the Southern Wadden Sea particle accumulation is more efficient due to stronger salinity gradients between the Wadden Sea and the open North Sea. This agrees with higher

mean annual suspended matter levels in the Dutch Wadden Sea of about 30 mg/l (e.g. de Jonge & de Jong 2002) as compared to 16 mg/l in the Sylt Rømø Basin (1999-2004, van Beusekom unpublished data). A possible explanation for the discrepancy is that due to the better light conditions, the Northern Wadden Sea uses a lower amount of available nutrients more efficiently than the more turbid Southern Wadden Sea.

In this context it is interesting to note that the distribution of sea grass reflects the same geographical pattern as the eutrophication proxies (Reise et al. 2004). It is, however, still unclear to what extent the higher nutrient load or the more turbid conditions contribute to observed regional patterns.

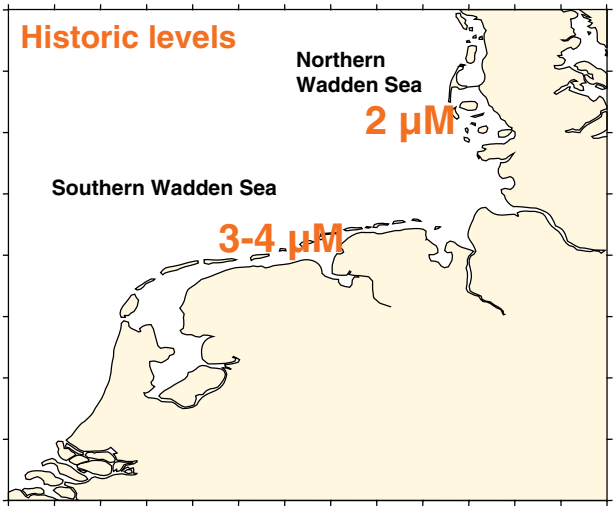

Figure 7. Estimated historic distribution of the autumn [NH_4 + NO_2] levels in the Wadden Sea.

The estimates for background concentrations for autumn NH_4 + NO_2 presented in Figure 7 are in good agreement with previous estimates by van Beusekom et al. (2001), who suggested background values of about 2.5 – 4 µM [NH_4 + NO_2]. A comparison of present levels (last two decades) with the historic estimates suggests a five-fold increase of the present eutrophication status. This does not necessarily imply that production and remineralisation levels were also five fold lower. The comparison of present day production levels between the Southern and Northern Wadden Sea suggested that under less turbid conditions, the available nutrients are used more efficiently. There is evidence to suggest that the historic Wadden Sea was less turbid than the present Wadden Sea (de Jonge & de Jong 1992, 2002, van Beusekom 2005). Taking in account the less turbid historic conditions, van Beusekom (2005) suggested production levels of about 86 gC m-2 a-1 and remineralisation levels of about 108 gC m-2 a-1 for a hypothetical Wadden Sea setting with low direct freshwater input. These values are about three – four-fold lower than present day levels.

Conclusions

Whereas winter nutrient concentrations may be used to reflect the primary production potential in open sea settings, they do not reflect this potential in areas where eutrophication is driven by advection (import) of organic material.

Autumn [NH_4 + NO_2] concentrations and summer chlorophyll levels are good indicators of the eutrophication status of the Wadden Sea.

The Southern Wadden Sea has an about two-fold higher eutrophication status than the Northern Wadden Sea.

The lower nutrient loads in the northern Wadden Sea are partly compensated by better light conditions allowing a more efficient use of the available nutrients.

Pre industrial autumn [NH_4 + NO_2] values are about 3 - 4 µM in the Southern Wadden Sea and ~2 µM in the Northern Wadden Sea, pre industrial summer chlorophyll values are about 3 - 4 µg/l in the Southern Wadden Sea and 1-2 µg/l in the Northern Wadden Sea.

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