Report on the second application of the

OSPAR Comprehensive Procedure to the Dutch marine waters

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Main text

1. Summary

This report contains the second application of the OSPAR Comprehensive Procedure to assess the eutrophication status of the Dutch marine waters for the five-year period 2001-2005. A comparison with previous years addressed in the first application of the Comprehensive procedure for Dutch North Sea waters and estuaries has been made.

Despite a reduction of phosphate (40 to 50 %) and nitrogen (20 to 30 %) in riverine inputs and emission reductions at source of 45% (N) and 78% (P) in the Netherlands during the past 30 years, five out of seven sub areas of the Dutch continental shelf are classified as a problem area in terms of eutrophication. Two offshore areas in the northern part, namely Oyster Grounds and Dogger Bank, are considered to be initially problem areas during the stratification period, but finally classified as non-problem area.

In the Coastal waters, the Wadden Sea, the Western Scheldt and the Ems Dollard estuary winter DIN and DIP concentrations were above elevated level, but in some areas, in particular in the Wadden Sea, a reduction could be observed in the last few years. In all near coastal waters a decreasing trend for chlorophyll can be seen from coast to offshore, but except for the Ems-Dollard estuary (probably due to high turbidity), the level remained above elevated level.

The offshore waters showed a different picture. Here the winter nutrient concentrations were below assessment levels, indicating no nutrient enrichment. The classification as problem area for the well-mixed offshore Southern Bight is based on the direct effects of eutrophication, expressed in concentrations above assessment levels of chlorophyll-*a* and of nuisance phytoplankton indicator species *Phaeocystis*. This is probably caused by transboundary transport of waters flowing from the Channel, NL and Belgium . In the offshore sedimentation area, Oyster Grounds, and in the shallow sandy area Dogger Bank, chlorophyll-*a* concentrations were below assessment level. The abundances of three (toxic) indicator species as only parameters above the elevated level initially resulted in the classification as problem area, but in the final classification as non-problem areas. For the nuisance phytoplankton indicator species like *Phaeocystis* the spatial gradient in concentrations in the Dutch Southern part of the North Sea coincides with the spatial gradients in nutrients. This is not the case for the toxic species, which are most abundant in the northern offshore areas Oyster Grounds and Dogger Bank during stratification. At the moment there is an ongoing discussion about the causal relations between the occurrence and abundance of toxic phytoplankton indicator species used in the holistic list of the comprehensive procedure and nutrient enrichment. It is recommended to further elaborate work on these relations to justify a correct classification of the eutrophication status of marine waters, through literature and cause-effect ecophysiological studies.

2. Introduction

This report on the Eutrophication status of the Dutch marine waters is based on the Common Assessment Criteria for the Eutrophication status of the OSPAR Marine Area as agreed on by OSPAR in 2005 (OSPAR, 2005a; Ref. No. 2005-3; the successor of Ref. No. 2002-20), the guidelines on the contents of the national assessment under the Common Procedure (Annex 6 of the EUC Summary Report 2006) and the Examples for reporting results of annual assessments for 2001-2005 (Annex 5 of the EUC Summary Report 2005). It describes the assessment of Dutch marine waters for the period of 2001-2005 and compares the results with the period 1996-2000 and with the first application of the Comprehensive Procedure (EUC/ETG 02/02/Add.06-E).

3. Description of the assessed area

The Dutch continental shelf (Fig. 1) is affected by the discharges of the catchment areas of Rhine, Meuse, Scheldt and Ems, from which the Rhine catchment is the largest one with contributions from Switzerland, Germany, France, Luxemburg and the Netherlands. The water of the Rhine, Meuse and

Scheldt flows along the coast in the direction of Germany, forming the so-called “coastal river”. The annual mean salinity in the “coastal river” is below 30, due to the high fraction of freshwater, which implies that the nutrient concentrations close to the coast will remain high as long as the rivers have high nutrient loads. Based on differences in physical and eco-morphological features the Dutch continental shelf is subdivided into seven sub areas, of which the eutrophication status has been assessed separately (see Fig. 1). The sub areas are:

- Coastal waters (salinity < 34.5)
- Wadden Sea
- Western Scheldt
- Ems-Dollard estuary
- Offshore waters (salinity > 34.5) divided into:
  - Southern Bight offshore
  - Oyster Grounds and
  - Dogger Bank.

3.1 Sub areas

Coastal waters (salinity < 34.5) These are the waters closest to the Dutch coast with a salinity below 34.5. The water depth varies from 5 m close to the coast to 30 m farther from the coast in the northern part. The sediment consists mainly of fine sandy sediments. The coastal waters are strongly influenced by discharges from the river Rhine, and to a lesser extent Meuse and Scheldt.

Wadden Sea The Wadden Sea is situated in the northern part of the Netherlands. It is a shallow area with channels, gullies and tidal flats. A row of barrier islands forms the northern border of this coastal sea. The salinity varies between 15 and 34.5, with annual mean over the 5-year period of 29. Part of the Wadden Sea sediments are silty, while others are sandy or mixed. The Wadden Sea is influenced by water from the Dutch coast and from Lake IJssel. Mainly the river Rhine feeds both sources.

Western Scheldt The Western Scheldt is the estuary in the south-west of the Netherlands between the Dutch-Belgian border and the North Sea. It forms an important shipping route to Antwerp Harbor. The drainage basin is composed of catchments of numerous small streams, feeding larger tributaries such as rivers Leie, Dender and Rupel. It covers one of the most populated and industrialized areas of the Europe. The estuary is a typical heterotrophic ecosystem, where primary production is low due to limited light penetration. The estuary is well mixed and the tidal range is up to 6 meters. The salinity varies between 0 and 31-34, with an annual mean between 14 and 17.5.

Ems-Dollard estuary The Ems-Dollard is an estuary situated between the Dutch-German border and the Wadden Sea. The area consists of extensive tidal mudflats and salt marshes. The quality of water, sediment and marine habitats is, to an important degree, affected by activities in the catchment area of the Ems River and by outlets along the Dutch part of the estuary. The salinity varies between 3-7 and 30-32, with an annual mean between 21 and 23.

Offshore waters salinity > 34.5) In the first application, carried out in 2002 the three offshore areas were assessed as two water bodies, i.e. Offshore waters and Dogger Bank. The Offshore part of the Dutch continental shelf is, however, not a homogeneous water mass, reasons to subdivide the total offshore area in the following three sub areas:

> **Southern Bight offshore**, the southern part of the Dutch continental shelf is not very deep (30 m) and well mixed. The sediment is partly coarse and partly fine sandy. The total amount of nitrogen and phosphate originates from the waters flowing from the Channel, NL and Belgium.
>
> **Oyster Grounds** form the middle part of the Dutch continental shelf. In contrast to the offshore Southern Bight, which is well mixed throughout the year, this area is deeper (on average 45 m) and stratified during some summers. The sediment is a mixture of fine sand and silt. The Oyster Grounds receive waters from UK and from the Atlantic Ocean in almost equal proportions, with minor contributions from the Channel, NL and France.
>
> **Dogger Bank**, the utmost part of the Dutch continental shelf receives mainly waters from the northern boundary (Atlantic Ocean) with small contribution form UK, France and the southern border (Channel).

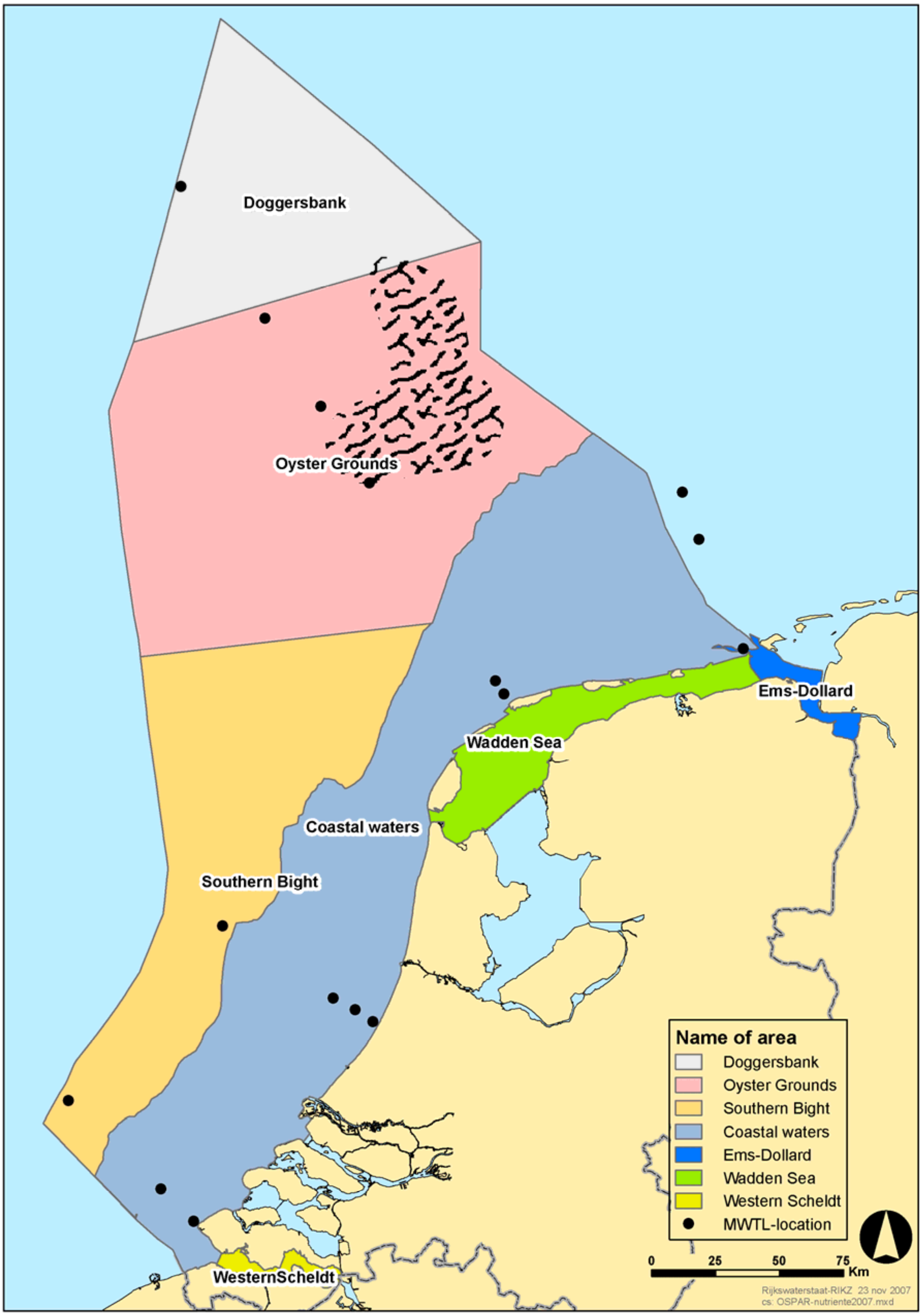


Fig. 1. The Dutch continental shelf with the seven sub areas: Coastal waters (the border of the Coastal waters is the decadal average 34.5 isohaline), Wadden Sea, Western Scheldt, Ems-Dollard estuary, and Offshore waters (salinity > 34.5) divided into: Southern Bight offshore, Oyster Grounds and Dogger Bank. Sampling stations in Coastal waters and Offshore water are indicated. Shaded area is the Oyster Grounds proper.

4. Methods and data

In Tab. 1 the parameters of the holistic checklist are given with their dimensions, the sample location in the water column and the time period of sampling. In general sampling was done biweekly in summer and monthly in winter. Also the area-specific natural background concentrations and elevated levels are given. The area-specific phytoplankton indicator species are given with the corresponding elevated bloom concentrations.

Macrophytes have not been assessed in the Dutch marine waters. Seaweeds are not relevant in the Dutch estuarine and marine waters and sea grasses occur only in small areas in the Wadden Sea. This in contrast to the past, before the building of the IJsselmeer Dam, when there were large sea grass fields in the Wadden Sea. Changes or kills in zoobenthos and fish mortality are not monitored and the same counts for algal toxins (DSP/PSP mussel infection events).

Concentrations of total organic carbon are included as well as dissolved and particulate concentration. For these parameters, however, no assessment levels have been set.

As extra parameters (not mentioned in Tab. 1) the annual mean concentrations of total nitrogen (TotN) and total phosphorus (TotP) are given, and the oxygen saturation in terms of percentage has been calculated, taking into account salinity and temperature.

Silicate measurements are available, but the data have not been used in the assessment, under the assumption that silicate discharges are hardly affected by anthropogenic influences.

For details on the measuring methods, see Tab. 1. In Tab. 2 the data availability has been given and in Fig. 1 the monitoring stations, which lie mainly on transects perpendicular to the coast.

Table 1. The parameters of the holistic checklist with unit, location and time period of sampling, the area-specific natural background concentrations and assessment levels, and the area- specific phytoplankton indicator species with the corresponding elevated bloom concentrations. C = Coastal Waters; Wa = Wadden Sea; We = Western Scheldt; ED = Ems-Dollard; S = Southern Bight offshore; O = Oyster Grounds; D = Dogger Bank. [1]90-percentile is new in comparison with 2002, when mean and maximum were used; [2] Assessment level used for *Phaeocystis* is new in the Dutch regional assessment.

Category	Assessment Parameters	Time period and frequency	Statistic	Sample location	unit	Range of reference and elevated values	C	Wa	We	ED	S	O	D
I. Degree of Nutrient Enrichment	Riverine total nitrogen inputs and direct discharges (RID)	Whole year	Annual total		KT N/y	Elevated inputs and/or increased trends of total nitrogen							
	Riverine total phosphorus inputs and direct discharges (RID)	Whole year	Annual total		KT P/y	Elevated inputs and/or increased trends of total phosphorus							
	DIN concentrations	Winter: XII-I-II; 1x per month	Mean	Surface: -1m	μmol/ l	Background Elevated level	20 30	6.5 7.0	20 30	20 30	10 15	10 15	10 15
	DIP concentrations	Winter: XII-I-II; 1x per month	Mean	Surface: -1m	μmol/ l	Background Elevated level	0.6 0.8	0.5 0.7	0.6 0.8	0.6 0.8	0.6 0.8	0.6 0.8	0.6 0.8
	N/P ratio	Winter: XII-I-II;	Mean N/mean P	Surface: -1m	mol/mol	Redfield N/P = 16 Elevated level >25							
II. Direct Effects	Chlorophyll <u>a</u> concentration	Growing season III- IX (incl) 2 x per month	Mean	Surface: -1m; at halfh depth; near bottom	μg/l	Background Elevated level	5 7.5	8 12	3 4.5	6 9	1.5 2.3	1.5 2.3	1.5 2.3
			90-percentile[1]	Surface: -1m; at halfh depth; near bottom		Background Elevated level	10 15	16 24	6 9	12 18	3 4.5	3 4.5	3 4.5
	Phytoplankton indicator species *Phaeocystis spp* *Noctiluca scintilans* *Chrysochromulina spp.* *Gymnodinium mikimotoi* *Alexandrium spp.* *Dinophysis spp.*	Whole year 1 à 2x per month	Maximum number of cells/l	Surface: -1m; at halfh depth; near bottom	Cells/l	Elevated bloom level > 10^7 cells/l[2] > 10^4 cells/l > 10^6 cells/l > 10^5 cells/l > 10^2 cells/l > 10^2 cells/l							
	Macrophytes incl.macroalgae	Not relevant											
III. Indirect Effects	Degree of oxygen deficiency	Whole year 1 à 2x per month	Minimum	Bottom: +3m Surface : -1m	mg/l	< 6 mg/l							

	Changes/kills in Zoobenthos and fish mortality	Not included.				
	Organic Carbon/Organic Matter	Not included.				No assessment level.
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	Not included, no mussel culture				

4.1 Inventory of available data for the overall area assessed and sub-areas

Tab 2. The sub areas with the monitoring stations and the available data. N and P, Nitrogen and Phosphorus, are measured as total (TotN and TotP) and as dissolved (DIN and DIP) concentrations. Temperature and salinities of all samples are known, so the oxygen saturation percentage could be calculated.

Area	Stations	Chl-a µg/l	Org C mg/l	O2 mg/l	Phyto cells/l	N and P µmol/l
Coastal waters	GOERE6	+	+	+	+	+
	NOORDWK10	+	+	+	+	+
	NOORDWK2	+	+	+	+	+
	NOORDWK20	+	+	+	+	+
	ROTTMPT3	+	+	+		+
	ROTTMPT50	+	+	+		+
	ROTTMPT70	+	+	+		+
	SCHOUWN10	+	+	+		+
	TERSLG10	+	+	+	+	+
	TERSLG4	+	+	+	+	+
	WALCRN2	+	+	+	+	+
	WALCRN20	+	+	+	+	+
Wadden Sea	BLAUWSOT					+
	DANTZGND					+
	DANTZGT	+	+	+	+	+
	DOOVBOT					+
	DOOVBWT	+	+	+		+
	MARSDND	+	+	+	+	+
	VLIESM	+	+	+		+
	ZOUTKPLG					+
	ZOUTKPLZGT	+	+	+		+
	ZUIDOLWOT	+	+	+	+	+
Western Scheldt	APPZK2					+
	HANSWGL	+	+	+	+	+
	LAMSWDBI59					+
	SCHAARVODDL				+	
	TERNZBI20	+	+	+		+
	VLISSGBISSVH	+	+	+	+	+
	WIELGN					+
Ems-Dollard	BOCHTVWTM					+
	BOCHTVWTND					+
	GROOTGND	+	+	+	+	+
	HUIBGOT	+	+	+	+	+
Southern Bight offshore	NOORDWK70	+	+	+	+	
	WALCRN70	+	+	+	+	
Oyster Grounds	TERSLG100	+	+	+	+	
	TERSLG135	+	+	+	+	
	TERSLG175	+	+	+	+	
Dogger Bank	TERSLG235	+	+	+	+	

4.2 Calculation and quality of time series

All data originate from the Dutch national monitoring programme (MWTL). The data are stored in the database DONAR, after they have passed quality assurance checks. Most data are available from 1985, but only data from 1995-2005 have been presented (see: www.waterbase.nl). The assessment period (2001-2005) is compared with the period 1995-2000. Additional algal species in surface algal blooms (mostly of *Noctiluca*) observed in airborne surveys are monitored. Although these data are not part of the assessment, they are presented in Annex 8.

The time series of the nutrients, organic carbon (total, particulate and dissolved) and oxygen consist of mean values of the assessed parameters. For some of the parameters the values have been averaged over the whole year and for other parameters over a number of months, see Tab. 1. The nutrients and are measured only at the surface and so is oxygen in well-mixed waters, but oxygen in stratified waters is measured additionally at half depth and at 3 m from the bottom. Oxygen saturation has been calculated, using the equation as given in http://en.wikipedia.org/wiki/Oxygen_saturation. As the conclusions based on oxygen concentrations are identical to those based on saturation percentages (see 5.6.2), only the oxygen concentrations have been presented in the assessment.

For chlorophyll-a both the mean and the 90-percentile values over the growing season (March – September, inclusive) have been used.

Phytoplankton species are counted as cells/l and the annual maximal values of the area-specific indicator species are used for the assessment in combination with species-specific assessment levels. Care has been taken with synonyms; species with old names have been taken together with species with revised names. The duration of a bloom has not been used as assessment parameter, as it is a rather speculative value, because of the low sampling frequency (in summer biweekly, in winter monthly). Suggested is to adapt the phytoplankton species parameter as used in the WFD, being the frequency of extreme blooms instead of the maximum number of cells (see Annex 9).

RID data (OSPAR, 2000 – 2006; 2005b) have been used for the nutrient loads entering the Dutch marine waters.

An estimation has been made of the total atmospheric deposition into the Dutch part of the North Sea, based on the EMEP programme (Bartnicki & Fagerli, 2006; OSPAR, 2007).

Transboundary nutrient transport estimation have been extracted from a model study, carried out in 2006 by WL | delft hydraulics (Blauw et al., 2006).

4.3 Methods for consideration of environmental factors in the assessments

The main environmental factors that play a role in the assessment of Dutch estuarine and marine waters are the riverine inputs from Rhine, Meuse, Scheldt and Ems. These discharges and the accompanying nutrient loads are monitored and taken into account in the assessment.

Another factor, which is relevant only part of the year, especially in deeper waters is thermal stratification during summer on the Oyster Grounds and to a lesser extent also on the Dogger Bank. During the stratified period samples are taken not only at the surface, but also at the thermocline and near the bottom. All parameters are monitored, of which oxygen concentration is the most relevant one.

5. Eutrophication assessment

5.1 Assessment period

The assessment period is the period of 2001-2005 (inclusive). As comparison the results for the period of 1995-2000 (incl) have been used. The assessments for each of the sub areas are given in Annexes 1-7.

As for the former assessment (2002) the results for the coastal waters are normalized to a salinity of 30. In the Wadden Sea, the Western Scheldt and the Ems-Dollard no correction for salinity has been applied, in contrast to the 2002 assessment. The reason for this is that in the estuaries, Wadden Sea, Western Scheldt and Ems Dollard, the salinity-nutrient gradient is not linear due to fundamentally different nutrient dynamics from those in the coastal waters. Moreover there are insufficient measuring stations along this salinity gradient to estimate the proper salinity-nutrient relationship.

5.2 Parameter-related assessment based on background and assessment levels

Category I

riverine inputs and direct discharges of total nitrogen and total phosphorus

Tab. 3 and Fig. 2 give the total direct and indirect loads from the Netherlands extracted from data reports (OSPAR, 2000-2006; 2005b) on the Comprehensive Study of Riverine Inputs and Direct Discharges (RID).

Tab. 3. Riverine inputs and direct discharges of total nitrogen (TotN) and total phosphorus (TotP) in kT y^{-1} into Dutch marine waters between 1996 and 2004. Source: OSPAR 2000-2006.

	1996	1997	1998	1999	2000	2001	2002*	2003	2004
TotN	306	286	375	391	364	382	429	219	265
TotP	22	18	20	21	20	14	29	12	16

* The riverine inputs of 2002 are higher than in the other years, due to a very wet year.

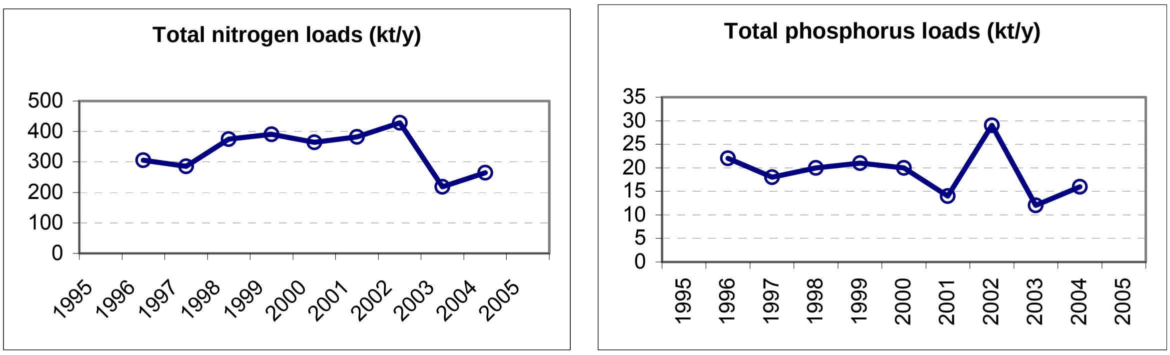


Fig. 2. Riverine inputs and direct discharges of total nitrogen and total phosphorus in kT/y of all river and direct loads into Dutch marine waters between 1996 and 2004. Source: OSPAR 2000-2006.

Next to the RID data river loads from the database of IfM Hamburg are given per assessment sub area. The loads of all rivers, discharging on a coastal or estuarine sub area are summed together. These loads are compiled for use in coupled hydrodynamical-ecological models. Loads from 1985 to 2002 into the coastal areas give a clear image of a possible trend (Fig. A.1, of Annex 1-4).

Atmospheric deposition

In the summary report on atmospheric deposition (OSPAR, 2007) data on atmospheric deposition in the Greater North Sea, originating from the EMEP programme have been published. The data comprise observations and model output. The Greater North Sea has been divided into a number of regions. Region 6 is the eastern part of the southern North Sea with a surface area of 49000 km^2. It encompasses a major part of the Dutch Continental Shelf, which is around 57000 km^2. The difference between the two areas is a factor 1.16. From these data, taking into account the difference in surface area of region 6 and the Dutch Continental Shelf it has been estimated that in the years 2001 to 2004 on average 15% (with a range from 12 to 18%) of the total nitrogen input to the Dutch Continental Shelf originates from atmospheric deposition (Tab. 4).

Table 4. Atmospheric deposition and total loads of nitrogen into the Dutch part of the North Sea (DCS). An estimation has been made of the contribution of the atmospheric deposition to total nitrogen (TotN) load (%).

	modelled TotN dep in region 6 (kt N y^{-1})*	estimated TotN dep in DCS (kt N y^{-1})	river input in DCS (kt N y^{-1})	contribution of atmos dep to TotN load in DCS (%)
2001	52.4	61.0	382	14
2002	48.3	56.2	429	12
2003	42.4	49.3	219	18
2004	43.4	50.5	265	16
2005	---	---	---	---
mean		**54.2**	**324**	**15**

* source: Bartnocki & Fagerli (2006)

winter DIN and DIP In the estuaries and the coastal waters the measured winter mean concentrations of DIN and of DIP are above the assessment level, while they are below the assessment level in the three offshore sub areas. In the Wadden Sea a slight trend can be seen in the last three years both for DIN and for DIP. In the Coastal waters, Western Scheldt and Ems-Dollard only for DIN such a trend can be seen. In the offshore sub areas there is no clear trend either in DIN or in DIP.

annual TotN and TotP In general the trends in the annual mean TotN and TotP are the same as in winter DIN and DIP, with one exception: The annual mean TotP concentration on the Oyster Grounds and the Dogger Bank (and to a lesser extent in the offshore Southern Bight) have increased since 2001!

winter N/P ratio For the offshore sub areas the N/P ratio is below the elevated value of 25 and even below the Redfield value (16), but for all other sub areas it is above these levels.

Area-specific phytoplankton indicator species On the Dutch continental shelf and in the estuaries the following indicator species are assessed (with between brackets the area-specific assessment levels):

Alexandrium spp. (10^2 cells/l) This species did not appear in Wadden Sea, Western Scheldt and Ems-Dollard in the assessed period. In the Coastal Waters it appears in three of the five years, in the offshore Southern Bight only in one year and in the Oystergrounds and Dogger Bank in four and five years, respectively.

Chrysochromulina sp. (10^6 cells/l) appears only in the offshore sub areas. In the offshore Southern Bight only in two of the years and further offshore in all years.

Dinophysis spp. (10^2 cells/l). Only in the Western Scheldt this species is absent throughout the year 2001 – 2005. In the other sub areas it is present in 3, 4 or 5 years.

Karenia mikimotoi (syn. Gymnodinium mikimotoi) (10^5 cells/l) In none of the years in none of the sub areas this species has been found. In several years of the earlier 5-years period the species was found but the concentrations remained below the elevated level.

Noctiluca scintillans (10^4 cells/l) This heterotrophic species remains below the elevated bloom concentration in all sub areas and in all years. However, surface algal blooms have been observed through airborne surveys monitoring (Annex 8).

Phaeocystis sp. (10^7 cells/l was 10^6 cells/l). The nuisance alga *Phaeocystis* appears in all years in the Coastal waters and in the Wadden Sea. In the transitional waters Western Scheldt and Ems-Dollard it is present in two years, while it does not appear in the Oyster Grounds and Dogger Bank.

Category II (direct effects):

maximum and mean chlorophyll-a In the 2002 assessment both the maximum and mean value of the chl-*a* concentrations during the growing season (March – September, incl.) were used as assessment parameters. The area-specific level were the same for both the maximum and the mean values. In this assessment we have opted for the mean and the 90-percentile value, each with its own assessment level. Based on the relation between the mean and the 90-percentile of available measurements of the Dutch monitoring program the rule of thumb: 90-perc = 2 x mean has been used. Both assessment levels give the same results in the Coastal waters in all cases except for one year. In the Coastal waters, Wadden Sea and

Western Scheldt a decreasing trend for the last five years can be seen, but the level remains above the elevated level. In the Ems Dollard the chl-*a* concentrations are below the assessment level, probably due to high turbidity. In the Oyster Grounds and Dogger Bank the chl-*a* concentrations are well below the assessment level without any clear trend.

In none of the species a clear trend can be seen. Comparing the presence of the area-specific indicator species in the assessment period with the 5-year period before (1995-2000) shows small differences in both directions (Tab. 4). The variability is most probably due by interannual differences in meteorological forcing.

Table 5. Number of years in the period 2001-2005 with blooms above the elevated level for the Dutch indicator species. C = Coastal Waters; Wa = Wadden Sea; We = Western Scheldt; ED = Ems-Dollard; S = Southern Bight offshore; O = Oyster Grounds; D = Dogger Bank. Values between brackets indicate the number of years with blooms of the species in the 5-year period before (1995-2000); the largest number is printed in bold. In those cases where the numbers of years were the same in both periods the number is given only once.

	Indicator species	**C**	**Wa**	**We**	**ED**	**S**	**O**[1]	**D**[1]
Potential toxic algae	*Alexandrium* spp.	3	0 (**1**)	0 (**1**)	0	1 (**3**)	5	4 (**5**)
	Chrysochromulina sp	2 (**5**)	**5** (1)	0	**1** (0)	**2** (0)	5	**5** (4)
	Dinophysis spp	5	**4** (2)	0 (**1**)	3	**4** (3)	5	4 (**5**)
	Karenia mikimotoi	0	0	0	0	0	0	0
Nuisance algae	*Noctiluca scintillans*	0	0	0	0	0	0	0
	Phaeocystis sp	5	5	2 (**3**)	3	4	0	0

[1]Offshore stratified areas

Although there is no detectable temporal trend, there is a clear spatial gradient for *Phaeocystis*. This species has blooms close to the coast (Coastal waters, Southern Bight offshore and Wadden Sea) in all years. In the more turbid estuaries Western Scheldt and Ems-Dollard it blooms about every other year and it never reaches bloom conditions in the offshore waters, Oyster Grounds and Dogger Bank. This spatial gradient coincides with the spatial gradient in nutrients. This is not the case for the toxic phytoplankton species *Alexandrium spp., Chrysochromulina sp* and *Dinophysis spp,* which are most abundant in the offshore, part of the year stratified, areas Oyster Grounds and Dogger Bank during the stratification period. This finding agrees with the results of Van Duren (2006), who found that there is no relation between nutrient concentrations, either N or P, and the occurrence of indicator species, except for *Phaeocystis*. Other authors (Granelli et al .1987), however indicate that there could be a causal relationship between high nitrate input (from rivers, or from the bottom into the stratified layers) and the excess of abundance in toxic dinoflagellates, such as *Karenia mikimotoi* (a species that is not found in densities above the assessment level in any of the Dutch sub areas during the assessment period).

macrophytes including macroalgae Because macrophytes are unimportant in the Dutch marine and estuarine waters this quality element is not taken into account for the assessment.

Category III (indirect effects):

oxygen deficiency, minimal O2 concentration In the well-mixed Coastal waters and offshore Southern Bight the oxygen concentrations never reach values <6 mg/l. In the sub areas Wadden Sea, Western Scheldt and Ems-Dollard in 1 à 4 years of the assessment period oxygen concentrations occurs below 6 mg/l. With a lower assessment level of 5 mg/l only the Wadden Sea still scores positive (minimum O_2 concentration lower than 5 mg/l). In the stratified sub area far offshore the O_2 concentration reached low values (3.26 mg/l) on the Oyster Grounds in only one of the years (2003) during several weeks in a row.

changes/kills in zoobenthos not monitored, so have not been taken into account in the assessment.

organic carbon/organic matter Although the concentrations of dissolved (DOC), particulate (POC) and total (TOC) organic carbon of the past 11 years show variation, there is no visible trend.

Assessment levels have not been set, but Fig. 3 shows the ranges for DOC, POC and TOC in the surface layer in all sub areas and for the stations of stratified waters also the range of the concentrations near the bottom are given. The range of concentrations of DOC, POC and TOC at the surface are much higher in the coastal and estuarine waters than in the offshore waters, with highest values in the Ems-Dollard estuary. The organic carbon concentrations near the bottom are in general of the same order as in the surface layer.

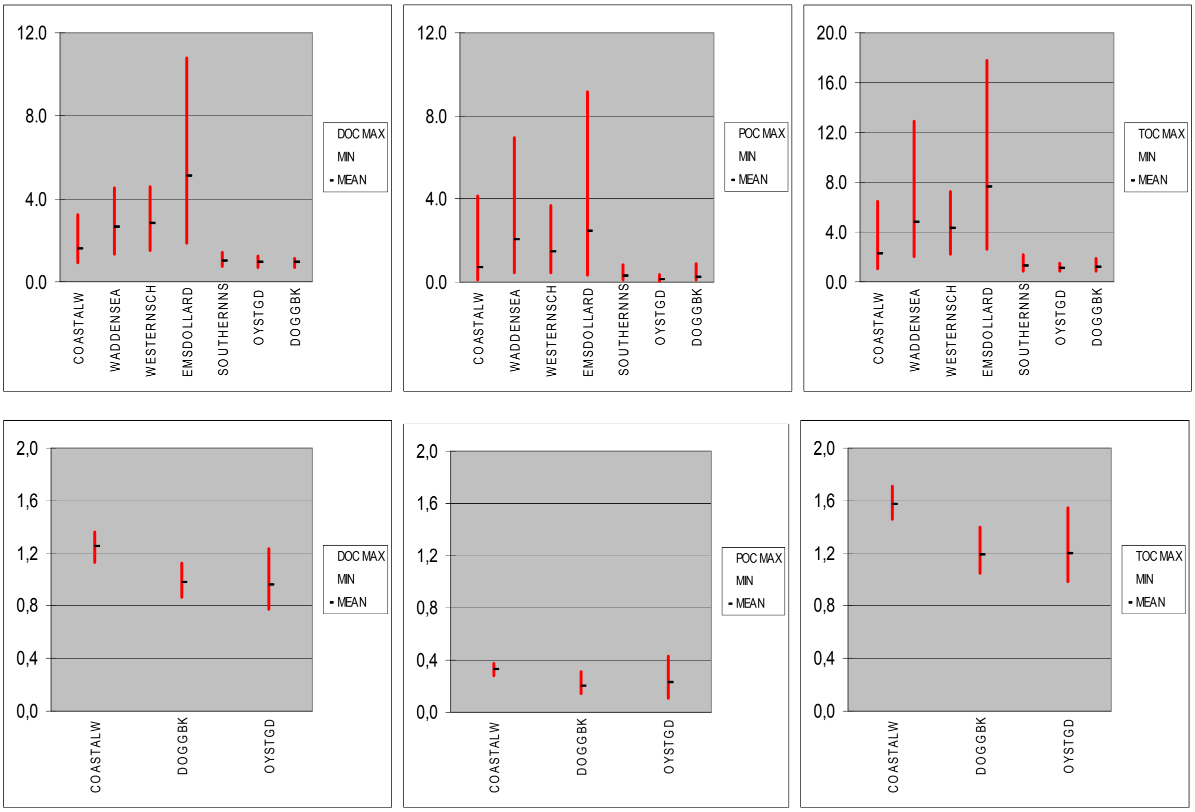


Fig. 3. Ranges of DOC, POC and TOC (mg/l) in the seven sub areas. The upper row at the surface and the lower row at the bottom, during stratification. The lower end of the range is the mean of the annual minimum values, the upper end is the mean of the annual maximum values and the mean is the mean of the annual means.

Category IV (other possible effects):

algal toxins (DSP/PSP mussel infection events): have not been assessed in the absence of monitoring data.

5.3 Consideration of supporting environmental factors and quality of data

5.4 Overall assessment

Fig. 4 presents the initial and the final classification. In the initial classification all criteria have been taken into account and all sub areas are classified as problem areas (see tables Ax.1 in Annexes 1-7). For the offshore areas Oyster Grounds and Dogger Bank this score is only due to the exceeding of the toxic phytoplankton indicator species *Alexandrium* spp., *Chrysochromulina* sp and *Dinophysis spp* of their assessment levels. Because of the uncertainty of a cause-effect relationship between nutrient availability and the elevated levels of these species, these areas are classified as non-problem areas in the final classification. In the Southern Bight offshore area also chlorophyll-a and the nuisance indicator species *Phaeocystis* reached bloom densities above the assessment level, which makes it a problem area. Fig. 5 shows the individual results for the criteria DIN/DIP, chlorophyll-*a*, the nuisance phytoplankton indicator species (i.e. *Phaeocystis*) and oxygen.

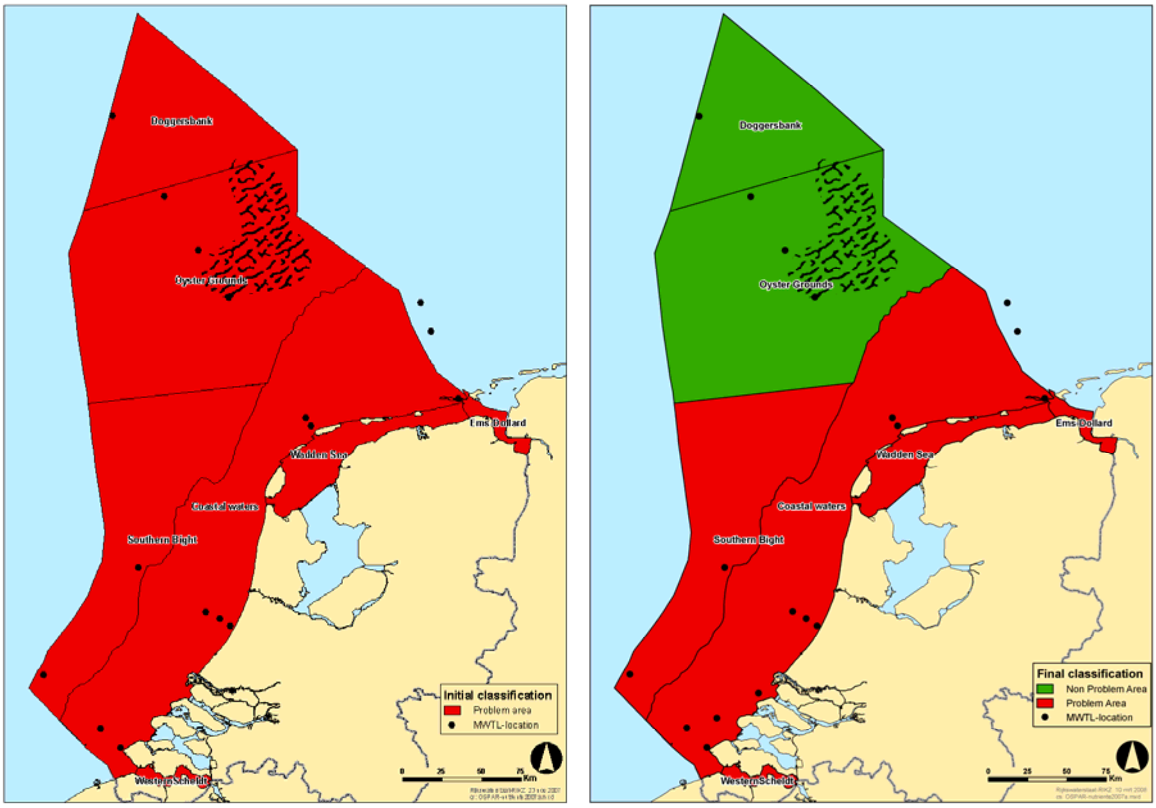
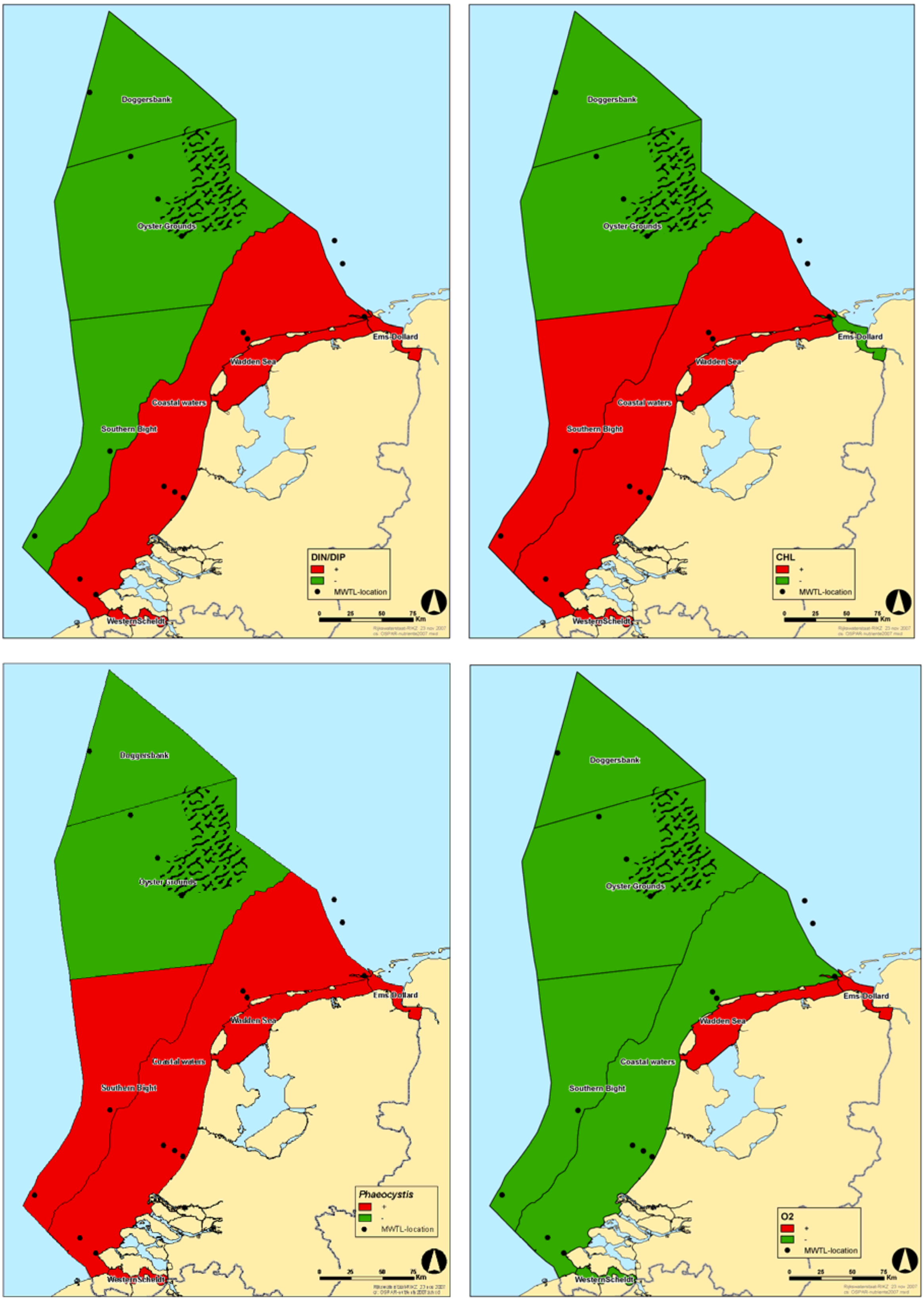


Fig. 4. Overall assessment results. Left: Initial classification: taking into account all criterion; Right: Final classification: Red: Problem Area; Green: Non-Problem Area. Black shading: Oyster Grounds proper.



Fig, 5. Assessment results per criterion. Upper row: DIN/DIP and Chlorophyll-a; lower row: Phytoplankton indicator species without the toxic species (so in fact: only with *Phaeocystis*) and Oxygen. Red: +; Green: --. Black shading: Oyster Grounds proper.

Table 6 Overview of the results of the OSPAR Comprehensive Procedure – The Netherlands

Key to the table

NI Riverine inputs and direct discharges of total nitrogen and total phosphorus
DI Winter DIN and/or DIP concentrations
NP Increased winter N/P ratio
Ca Maximum and mean chlorophyll *a* concentration
Ps Area-specific phytoplankton indicator species

Mp Macrophytes including macroalgae
O_2 Oxygen deficiency
Ck Changes/kills in zoobenthos and fish kills
Oc Organic carbon/organic matter
At Algal toxins (DSP/PSP mussel infection events)

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data to perform an assessment or the data available is not fit for the purpose
n.r. = Not relevant
Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated levels, shifts or changes.

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/ other possible effects				Initial classification	Overall appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Coastal area	NI	+	Ps	+	Ck	?			Problem area, 2001-2005	Problem area in 2001-2005 based on all assessment parameters; no change in status compared with previous years (<1995-2000); averaged result is identical to 'per year' result, except chl-a in 2005; *Influenced by Rhine, and to lesser extent by Meuse and Scheldt.*	PA	2001-2005 comparison: <1995-2000
	DI	+	Mp	n.r.	Oc	-						
	NP	+	Ca	+	O2	-	At	-				
Wadden Sea	NI	+	Ps	+	Ck	?			Problem area, 2001-2005	Problem area in 2001-2005 based on all assessment parameters; no change in status compared with previous years (<1995-2000); averaged result is identical to 'per year' result; *Influenced by coastal river (80%) and lake IJssel, through river Rhine.*	PA	2001-2005 comparison: <1995-2000
	DI	+	Mp	?.	Oc	-						
	NP	+	Ca	+	O2	+	At	-				
Western Scheldt	NI	+	Ps	+	Ck	?			Problem area, 2001-2005	Problem area in 2001-2005 based on all assessment parameters; no change in status compared with previous years (<1995-2000); averaged result is identical to 'per year' result, except O2 in 2002; *Influenced by Scheldt.*	PA	2001-2005 comparison: <1995-2000
	DI	+	Mp	?.	Oc	-						
	NP	+	Ca	+	O2	-	At	-				

Ems-Dollard	NI + Ps + Ck ? DI + Mp ? Oc - NP + Ca - O2 + At -	Problem area, 2001-2005	Problem area in 2001-2005 based on all assessment parameters; no change in status compared with previous years (<1995-2000); averaged result is identical to ‘per year’ result, except chl-a in 2001 and O2 in 2002 and 2004. *Influenced by Ems river and outlets of estuary*	PA	2001-2005 comparison: <1995-2000
Southern Bight offshore	NI Ps + Ck ? DI - Mp n.r. Oc - NP - Ca + O2 - At -	Problem area, 2001-2005	Problem area in 2001-2005, based on the assessment parameters chlorofyl-*a* and nuisance phytoplankton indicator species *Phaeocystis*; no change in status compared with previous years (<1995-2000); averaged result is identical to ‘per year’ result, except chl-a in 2005. *Influenced by waters flowing from the Channel, NL and Belgium*	PA **,** trans-boundary transport	2001-2005 comparison: <1995-2000
Oyster Grounds	NI Ps + Ck ? DI - Mp n.r. Oc - NP - Ca - O2 - At -	Problem area, 2001-2005, based on toxic Ps	Initially a problem area in 2001-2005, but only based on elevated levels of toxic phytoplankton indicator species. Because of the uncertainty of a cause-effect relationship between nutrient availability and the elevated levels of these toxic species this area is finally classified as a non-problem area; averaged result is identical to ‘per year’ result, except chl-a in 2003. Change in status compared with previous years (<1995-2000).*Receiving waters from Atlantic Ocean and UK*	NPA	2001-2005 comparison: <1995-2000
Dogger Bank	NI Ps + Ck ? DI - Mp n.r. Oc - NP - Ca - O2 - At -	Problem area, 2001-2005, based on toxic Ps	Initially a problem area in 2001-2005, but only based on elevated levels of toxic phytoplankton indicator species. Because of the uncertainty of a cause-effect relationship between nutrient availability and the elevated levels of these toxic species this area is finally classified as a non-problem area; averaged result is identical to ‘per year’ result. No change in status compared with previous years (<1995-2000, see OSPAR 2003: the so-called Dutch utmost northern offshore waters).*Receiving waters from mainly Atlantic Ocean, and to a minor extent from UK*	NPA	2001-2005 comparison: <1995-2000

General NOTE: riverine inputs in the Dutch coastal zone from Rhine, Scheldt, Meuse are influenced by upstream waters across border

5.5 Comparison with preceding assessment

Description of changes in quality status of the areas (tables, maps)

The results for all parameters are to a large extent comparable with the results of the previous period (1995-2000).

5.5 Voluntary parameters

5.6.1 Transboundary nutrient transport

In 2006 a model study has been carried out by WL | delft hydraulics (Blauw, et al., 2006). The model domain is the southern North Sea and comprises the whole Dutch continental shelf. The model used is their hydrodynamical 2D model, coupled to the Generic Ecological Model (GEM). Two different methods were used to calculate the contribution originating from the different countries and from the boundaries. The contributions are expressed in terms of percentage of the total. One method calculates the contribution in total nitrogen and phosphorus and the other calculates the fractions in the phytoplankton biomass. The differences are minor, and the conclusions drawn from both methods are the same. The results of the contribution in the total nitrogen and phosphorus are presented.

Nitrogen

In Tab. 6 the model estimates of the contribution of the different nitrogen sources in total nitrogen are given for the Dutch coastal waters (salinity < 34) and the Dutch Offshore area (sal >34). The values for NL Offshore are averages for the whole Dutch Offshore area, comprising the Southern Bight offshore, the Oyster Grounds and the Dogger Bank.

Table 7. Model estimates of the contribution in percentages of the different nitrogen sources in total nitrogen for two areas (NL Coastal refers to the area of the Dutch continental shelf with averaged salinity below 34 and Nl Offshore to the area above 34, AT = Atlantic boundary, CH = Channel boundary). Source: Blauw et al. (2006).

	UK	FR	BE	NL	GE	DK	AT	CH
NL Coastal	2	4	10	65	1	0	0	19
NL Offshore	13	7	2	14	0	0	21	42

In Fig. 6a can be seen that the Dogger Bank is receiving waters containing nitrogen from mainly the northern boundary of the model (Atlantic Ocean) with small contributions from UK, France and the southern border (Channel). The Oyster Grounds receive waters containing nitrogen from the Atlantic Ocean and UK in almost equal proportions, and minor contributions from the Channel, NL and France. In the Southern Bight offshore nitrogen mainly comes from the Channel, NL and Belgium (not shown).

Phosphate

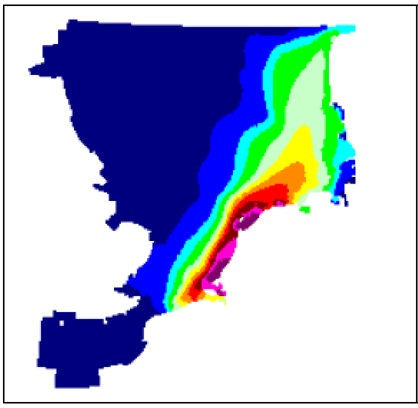
Tab. 7. gives the same information for P as Tab. 5 for N and from Fig. 6b the relative contribution of the different sources can be read, which are different from the nitrogen distribution. This is not only due to differences in processes involving N and P, like remineralisation of nitrogen and sediment processes for P, but also due to differences in N and P loads between different sources. In general it can be said that in comparison with the relative contributions to total nitrogen the relative contributions to total phosphorus are larger from both boundaries, while the riverine contributions are smaller.

Table 8. Model estimates of the contribution in percentages of the different phosphorus sources in total phosphorus for two areas (NL Coastal refers to the area of the continental shelf with averaged salinity below 34 and NL Offshore to the area above 34, AT = Atlantic boundary, CH = Channel boundary). Source: Blauw et al. (2006).

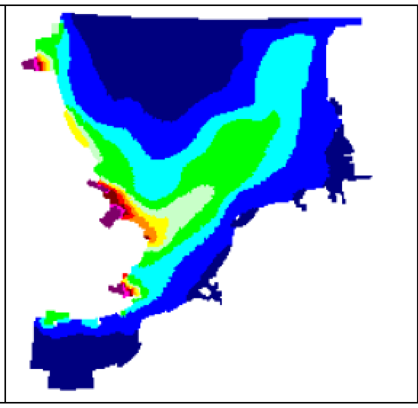
	UK	FR	BE	NL	GE	DK	AT	CH
NL Coastal	4	3	6	33	0	0	2	52
NL Offshore	8	3	1	3	0	0	43	43

5.6.2 Oxygen saturation percentage

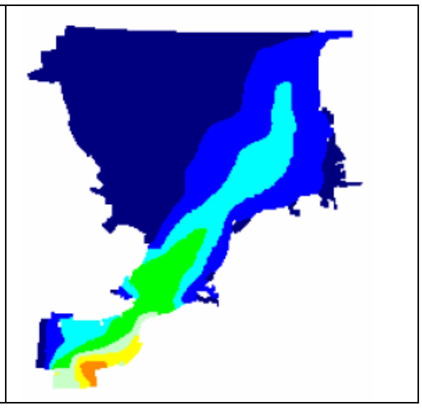
The assessment results for the oxygen saturation percentage, which takes into account salinity and temperature hardly differ from those based on the oxygen concentration alone, when we take 70% as the assessment level (Fig. 7). Small differences can be seen in the areas with variable salinities, i.e. the coastal waters and the estuaries.



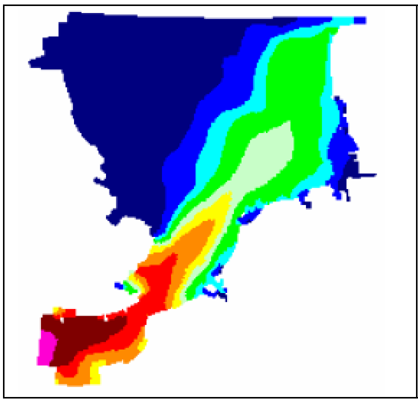
N: From the Netherlands



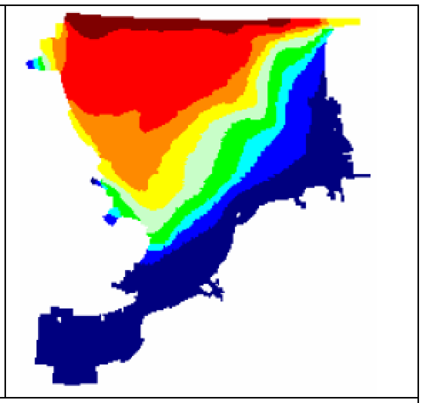
N: From UK



N: From France



N: From Southern Boundary



N: From northern boundary

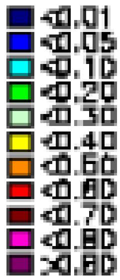
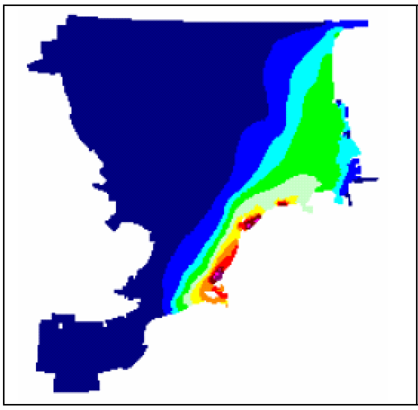
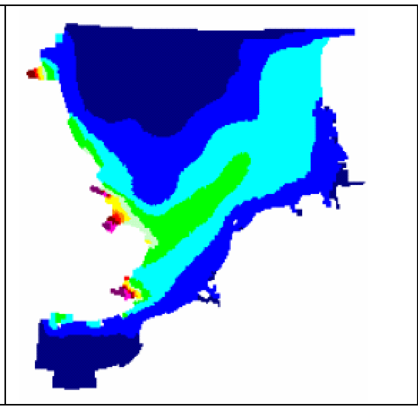


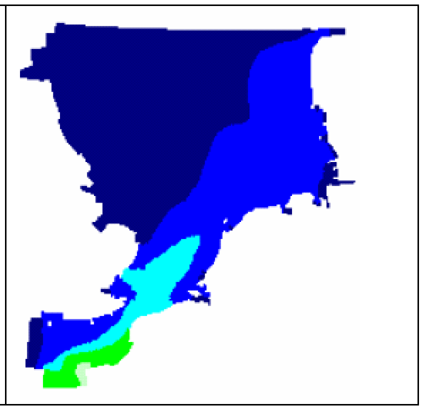
Fig. 6a. Model results, showing the contribution of the different nitrogen and phosphorus sources in total nitrogen and total phosphorus Source: Blauw et al. (2006).



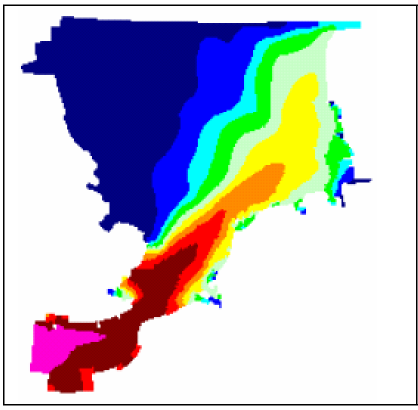
P: From the Netherlands



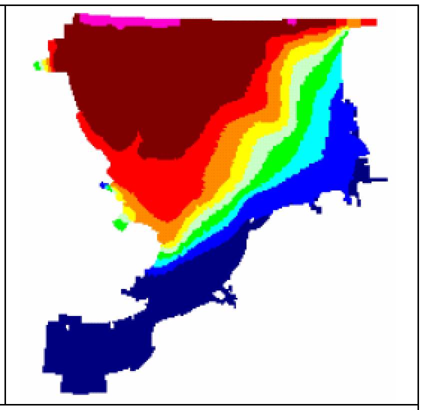
P: From UK



P: From France



P: From southern Boundary



P: From northern boundary

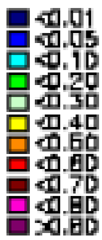
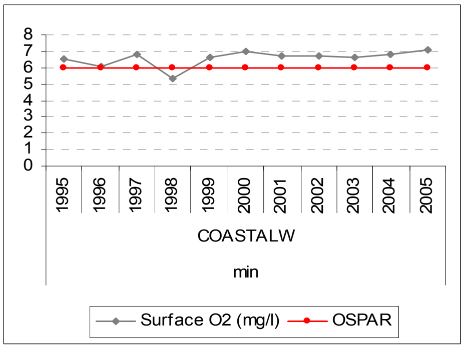
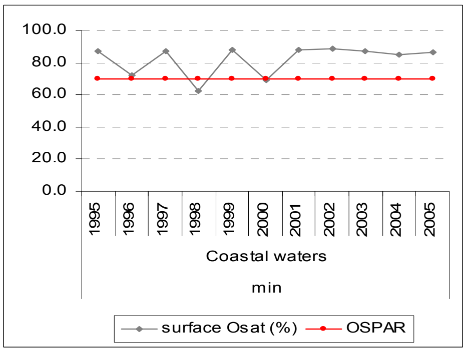
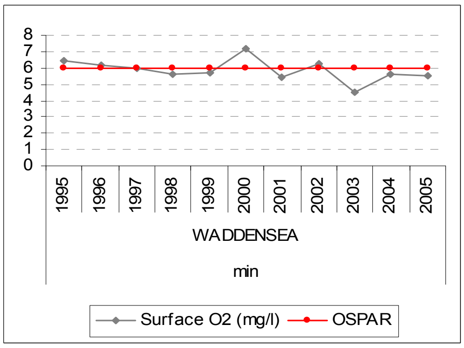


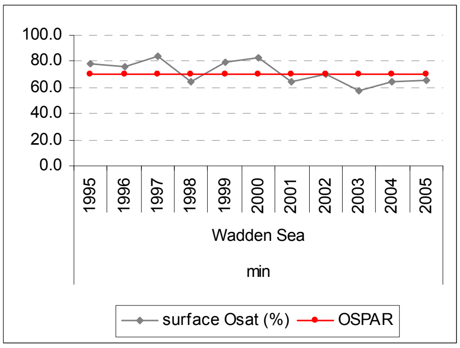
Fig. 6b. Model results, showing the contribution of the different nitrogen and phosphorus sources in total nitrogen and total phosphorus Source: Blauw et al. (2006).



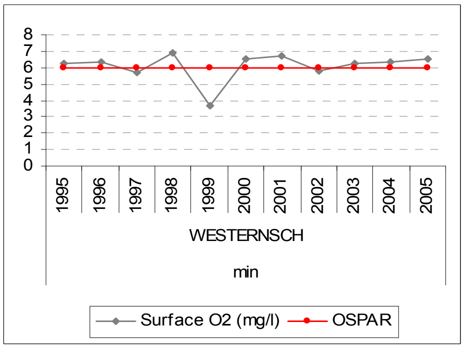


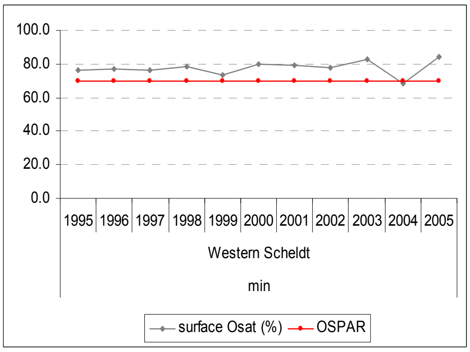
Coastal waters



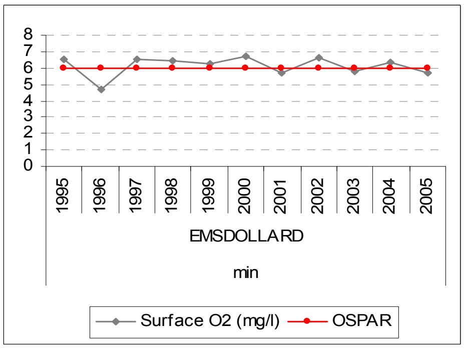


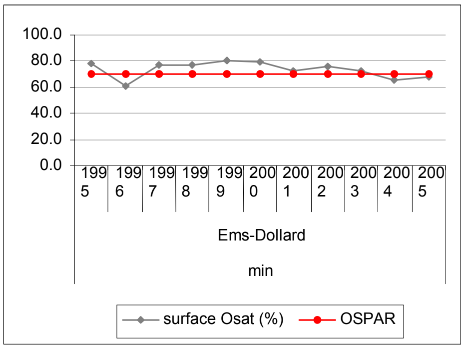
Wadden Sea



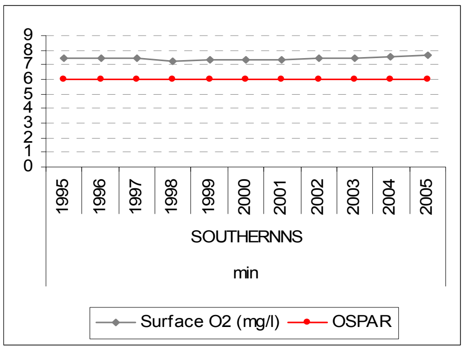


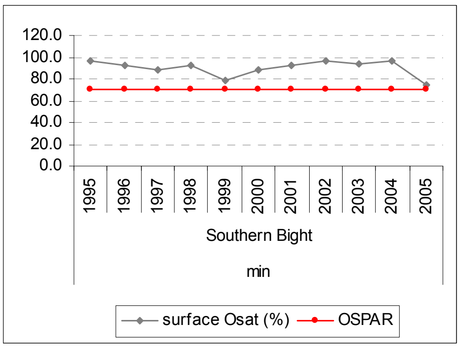
Western Scheldt





Ems-Dollard





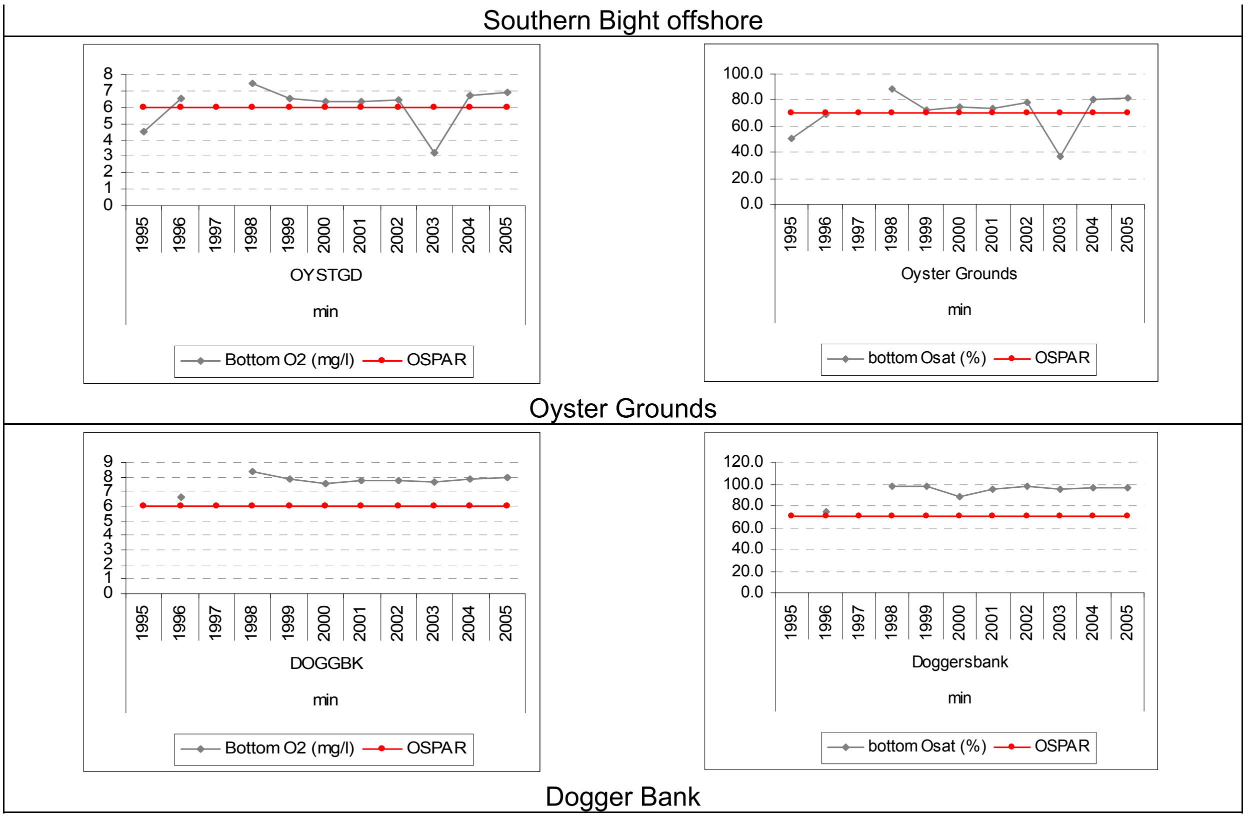


Fig. 7. Left: Oxygen concentration (mg/l) in surface (for well-mixed areas) or bottom layer (in stratified areas) and Right: oxygen saturation percentage (%) of the seven sub areas.

6. Comparison and/or links with European eutrophication related policies

6.1 WFD

The WFD is limited to the transitional waters, as Ems-Dollard and Western Scheldt and the coastal waters until 1 nautical-mile. The NL relevant subdivisions of the coastal waters are open euhaline, open polyhaline and sheltered polyhaline. The Dutch coastal zone until 1 sea-mile from the coast belongs partly to the open polyhaline coastal waters (the Holland coast) and partly to the open euhaline coastal waters (the Zeeland Coast and the Wadden Sea, north of the West-Frisian islands). The Wadden Sea is of the water type: sheltered polyhaline.

For the WFD the ecological quality objectives are leading, while the nutrients are supporting physico-chemical elements, as is the case within the OSPAR Comprehensive Procedure assessment. As known, the OSPAR eutrophication assessment comprises more parameters than the WFD ecological assessment. Chlorophyll-a and the frequency of blooms of the nuisance alga *Phaeocystis* in concentrations above the elevated level have been used in the assessment period as ecological quality parameters. The frequency of *Phaeocystis* blooms has been expressed as the number of months with $>10^6$ cells/l^{-1} as a percentage of all months in the assessment period. This takes into account the suggested longer duration of *Phaeocystis* blooms since the beginning of anthropogenic eutrophication (Cadée & Hegeman, 2002). When a bloom persists longer than one month it counts double or even more (see also Annex 9). Potentially toxic phytoplankton species are neither included in the assessment of the Dutch WFD coastal and transitional waters nor in the WFD assessments of the other countries around the North Sea, because of the uncertainty of a cause-effect relationship between nutrient availability and the occurrence and toxicity of these species (ICES, 2004; Van Duren, 2006).

In those Dutch geographical areas where both the OSPAR eutrophication assessment and the WFD ecological assessment is applicable, the over-all classification with regard to eutrophication in both assessments is consistent with each other.

6.2 Nitrates Directive

Following Article 3.5 of the Nitrates Directive 91/676/EEC, Member States shall be exempt from the obligation to designate specific vulnerable zones, if they establish and apply action programmes referred to in Article 5 throughout their national territory. The Netherlands apply article 3.5 of the Nitrates Directive – this means that the Netherlands have chosen to apply in their whole territory the stringent control measures related to vulnerable zones without having assessed whether all waters in their whole territory are indeed vulnerable with regard to eutrophication.

As a consequence, the Netherlands are implementing control measures in agriculture to reach the set quality standards for surface and groundwater by 2009.

6.3 Urban Waste Water Treatment Directive

Following Article 5.8 of the UWWT Directive, Member States do not have an obligation to identify sensitive areas (i.e. sensitive water bodies) if they implement, on their whole territory, more stringent treatment (Art. 5.2 and 5.3) or more stringent requirements for reduction of the overall load of total nitrogen and total phosphorus entering all urban waste water treatment plants (Art. 5.4). The Netherlands have chosen to apply the whole territory approach as referred to in article 5.8 of the Directive and already comply with the measure requirements of the UWWT Directive. When necessary and cost-effective, additional measures will be taken to reach ecological objectives.

7. Implementation of integrated set of EcoQOs for eutrophication

The Netherlands have implemented the integrated set of five eutrophication Ecological Quality Objectives (EcoQOs) according to the implementation plan described in EUC (1) 06/2/Info.1 Annex 3. Their implementation is carried out in this second application of the Comprehensive Procedure of Dutch North Sea waters and estuaries, as national contribution to produce the integrated report on eutrophication status to OSPAR 2008.

As can be seen in Table 5 (overall area classification) five of the seven assessed sub areas (Coastal waters with salinity < 34.5, Dutch Wadden Sea, Western Scheldt, Ems-Dollard and Offshore Southern Bight) are classified as problem areas, and the other two (Oyster Grounds and Dogger Bank) as non-problem areas, in terms of eutrophication. For these areas the overall Ecological Quality Objective that an area should have the status of a non-problem area for eutrophication is clearly not met. With respect to the sub-EcoQOs, there is an advantage of using this approach since it allows us to see in more detail the changes and / or trends in eutrophication status of a particular area over the assessed period of time (see Fig. 8). Therefore we conclude that the implementation of the integrated set of EcoQO's has been implemented in the Dutch marine and estuarine waters through the second application of the comp proc

With respect to the adequacy of monitoring of the integrated set of five eutrophication EcoQOs the following can be concluded (Tab. 8). The monitoring in all seven sub areas of the parameters of the EcoQOs: winter DIN and DIP, chlorophyll-*a*, and area-specific phytoplankton indicator species and their relevant accompanying environmental factors were judged to be sufficient. However, monitoring of oxygen deficiency events under dense surface algal blooms and concomitant kills in zoobenthos was not always sufficient in frequency. Event monitoring (of oxygen deficiency and kills) is something that is not covered strictly in the JAMP Eutrophication Monitoring programme. However, since we do have an accurate sampling frequency for phytoplankton in Dutch marine waters in conjunction with the regular airborne surveys (Bonn Agreement) and relevant environmental factors (light, wind, run off, temperature etc.) we are quite confident that the Dutch monitoring programme is more than sufficient to meet the demands of OSPAR.

Table 8. Overview of adequacy in temperal and spatial monitoring of assessment parameters, including the integrated set of five eutrophication **EcoQOs** (in **bold**). Key to the table:

NI	Riverine inputs and direct discharges of tot N and tot P	Mp	Macrophytes including macroalgae
DI	Winter DIN and/or DIP concentrations **(EcoQO)**	**O_2**	Degree of oxygen deficiency **(EcoQO)**
NP	Increased winter N/P ratio	**Ck**	Changes/kills in zoobenthos and fish kills **(EcoQO)**
Ca	Max and mean chlorophyll *a* concentration **(EcoQO)**	Oc	Organic carbon/organic matter
Ps	Area-specific phytoplankton indicator species **(EcoQO)**	At	Algal toxins (DSP/PSP mussel infection events)

+: Sufficient monitoring; -: insufficient monitoring.

CP: area classified as PA or PPA	**Frequency / Spatial Coverage Category I Degree of nutrient enrichment**		**Frequency / Spatial Coverage Category II Direct effects**		**Frequency / Spatial Coverage Category III and IV Indirect/other possible effects**			
Netherlands	NI	+ (all areas)	**Ca**	**+ (all areas)**	**O_2**	+/- **(offshore)**	At	**+/-some areas**
	DI	**+ (all areas)**	**Ps**	**+ (all areas)**	**Ck**	**+/- (offshore)**		
	NP	+ (all areas)	Mp	+ (in Wadden Sea)	Oc	- (sedimentat areas)		

8. Perspectives

8.1 Implemented and further planned measures

The Netherlands will proceed with implementing the OSPAR agreements (50% emission reduction at source of both N and P compared to 1985). An overview of the implemented and further planned measures is presented in the 2007 implementation report on PARCOM recommendation 89/4. As can be learned from the 2007 NL-implementation report on PARCOM Recommendation 88/2, in 2005 reduction at source compared to 1985 is 45% for nitrogen and 78% for phosphorus. At the moment, a riverine input reduction for P of around 50% has been achieved for the rivers entering the North Sea from the Netherlands, but not for nitrogen where the riverine input reduction compared to 1985 is 20-30%. In some of the sub areas, Oyster Grounds and Dogger Bank an increase in total phosphate concentrations has been observed. Further analysis is necessary to be able to explain this increment. Finally, there may be increased atmospheric nitrogen deposition in the North Sea. This would have an effect on both: coast and offshore waters.

8.2 Outlook

i. Expected trends

See section 8.1.

ii. Improvement of assessments

One of the quality elements in the WFD is the frequency of blooms of *Phaeocystis*. The frequency of *Phaeocystis* blooms has been expressed as the number of months with >10^6 cells/l as a percentage of all months in the assessment period. This indicator takes into account the suggested longer duration of *Phaeocystis* blooms since the beginning of anthropogenic eutrophication (Cadée & Hegeman, 2002), because a bloom that lasts more than one month will be counted twice or even more times, without the necessity for more frequent sampling. Therefore it is recommended to use this indicator in the Comprehensive Procedure instead of the maximum number of cells/l. See for a comparison of the OPSAR and the WFD method Annex 9).

The assessment level of the N/P ratio is 25. Better would be to have a range of assessment ratios. The normal ratio is N:P = 16:1. With a 50% elevation of the nitrogen concentration the ratio is 25 and with a 50% elevation of the phosphorous concentration it is around 10. So an assessment range of 10-25 would be the natural range.

9. Conclusions

Despite a reduction of phosphate (40 to 50 %) and nitrogen (20 to 30 %) in **riverine inputs** and a reduction of 45% (N) and 78% (P) **at Dutch source** since 1985, five out of the seven sub areas of the

Dutch continental shelf are still classified as a problem area in terms of eutrophication. Two offshore areas in the northern part, namely Oyster Grounds and Dogger Bank, are considered to be non-problem areas.

In the Coastal waters and in the estuaries the **winter DIN and DIP** concentrations were above elevated level, but in some areas, in particular in the Wadden Sea, a reduction could be observed in the last few years. In all offshore waters DIN and DIP concentrations are below the assessment levels.

Although the trend for **chlorophyll** starts to decrease in coastal and estuarine waters, the concentrations remained above the elevated level, in all areas except for the Ems-Dollard estuary, where the primary production is limited by light availability. Also in the offshore Southern Bight chlorophyll concentrations are too high, although the nutrient concentrations are below the assessment level. In the other offshore waters, Oyster Grounds and Dogger Bank, however, both chlorophyll and nutrient concentrations are below the assessment levels.

Overall it can be concluded that there are trends in the good direction in concentrations of assessment parameters, but they are not (yet) visible in overall assessment. Fig. 8 gives an overview of the trends per assessment parameters.

	DIN	DIP	Chl	O2
Coastal W	~ decrease	~ decrease	~ decrease	~ increase
Wad Sea	~ decrease	~ decrease	~ decrease	~ decrease
W Scheldt	~ decrease	~ decrease	~ decrease	~ increase
E-Dollard	~ decrease	~ decrease	no trend	no trend
South Bight offsh	~ decrease	no trend	~ decrease	~ increase
Oyster G	no trend	no trend	? no trend	no trend
Doggersb	no trend	no trend	~ decrease	~ increase

Fig. 8. Overview of trends per assessment parameter. Green indicates in the right direction and red in the wrong direction.

Phytoplankton indicator species can be divided in nuisance and potential toxic phytoplankton species. They were in all sub areas above the assessment levels, resulting in the initial classification as problem area. *Phaeocystis,* known as a nuisance phytoplankton indicator species in Dutch marine waters, showed a clear decreasing gradient from near shore to offshore, with concentrations above the assessment level in the estuaries, the Coastal waters and in the offshore Southern Bight. Concentrations of *Phaeocystis* were below the assessment level in the offshore areas, Oyster Grounds and Dogger Bank. This gradient coincides with the degree of nutrient enrichment (winter DIN and DIP) and the direct effects (chlorophyll). This is not clear for toxic phytoplankton indicator species that are already toxic at low concentrations and that showed elevated levels only in the Oyster Grounds and Dogger Bank areas during stratification. A recent analysis of data from the Dutch monitoring programme did not find a relation between riverine nutrient inputs and the associated winter concentrations on the one hand and harmful algae on the other (Van Duren, 2006). Granelli (1987) emphasized that certain toxic dinoflagellate species do show a relation with increased fluxes of nitrate under conditions of thermal stratification, such as occurring in the northern offshore areas of the Dutch part of the North Sea, the Oyster Grounds and Dogger Bank. Because of the uncertainty in cause-effect relation between nutrients and potential toxic phytoplankton indicator species the areas where only these species are above the assessment levels have been classified in the final classification as non-problem areas.

During the EUC 2005 meeting (EUC 05/13/1, Annex 9) it has been formulated: "*The ICES technical evaluation (ICES, 2004) emphasized that the links between toxic species and manageable human activities may be limited, even more so than chlorophyll a. ICES advised caution in using "harmful algal blooms" as indicators of eutrophication, since such species do not always have a relevance to eutrophication. However, ICES confirmed that there is growing evidence that there is a relationship for some areas for some toxic phytoplankton species with nutrient enrichment and elevated N/P ratios*". OSPAR (2005c) concluded: *"There is evidence that certain nuisance species blooms are reliable, area-specific indicators of increased nutrient loading and changed N/P ratios in some areas. With respect to toxic species,* *becoming toxic at low levels, the relationship with nutrient enrichment is less clear. There is some evidence, however, that there may be a relationship with nutrient enrichment and elevated N/P ratios, e.g. for the elevated levels of* Chrysochromulina polylepis *and* Kerenia mikimotoi *in Skagerrak and, for the latter species, also in the sedimentation area Oyster Grounds and in the Frisian Front area during stratification. In this respect it is very important to perform the required monitoring on the area-specific phytoplankton indicator species in conjunction with environmental physical and biological factors as prescribed in the Comprehensive Procedure, the Eutrophication Monitoring Programme and its adherent guidelines".* More research on these relations is necessary to justify a correct classification of the eutrophication status of marine waters, through cause-effect ecophysiological studies.

In two of the estuaries and in one of the offshore areas from time to time **oxygen** concentrations reach values lower the assessment level of 6 mg/l. In the Wadden Sea and in the Ems-Dollard in most years of the assessment period there is a short period with concentrations just below the assessment level. On the Oyster Grounds the situation is different. In most years the oxygen concentrations stay above the assessment level and only in 2003 the oxygen concentrations were below 6 mg/l for a longer period during summer.

10. References

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Website: http://en.wikipedia.org/wiki/Oxygen_saturation

11. Annexes 1-7

Annex 1 Coastal waters
Annex 2 Wadden Sea
Annex 3 Western Scheldt
Annex 4 Ems-Dollard
Annex 5 Southern Bight offshore
Annex 6 Oyster Grounds
Annex 7 Dogger Bank
Annex 8 Results of airborne surveys
Annex 9 Comparison of two *Phaeocystis* classification tools.

Annex 1 Coastal waters

Results of the OSPAR Comprehensive Procedure – NL -Coastal waters

1. Area: Coastal waters (see Fig. 1).

2. Description of the area

In the Dutch coastal waters (<34.5) mixing of nutrient-rich river water from Scheldt, Meuse and Rhine occurs gradually and over long distances, predominantly in a northward direction. The depth is between 0 and 30 meters.

3. Assessment

Tab. A1.1. Results of the assessment of the Coastal waters (see for assessment levels Tab. A1.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall Score
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total nitrogen and total phosphorus	overall trend: −		−
	Winter DIN and/or DIP concentrations	+ in 2001-2005	+++++	+
	Winter N/P ratio (Redfield N/P = 16)	+ in 2001-2003,2005; - in 2004	+++−+	+
Direct Effects (II)	Mean chlorophyll *a* concentration	- in 2001-2003; - in 2004-2005	+++−−	+
	Area-specific phytoplankton indicator species	+ in 2001-2005	+++++	+
	Macrophytes including macroalgae	- in 2001-2005	n.r.	−
Indirect Effects (III)	Oxygen deficiency	- in 2001-2005	−−−−−	−
	Changes/kills in zoobenthos and fish kills	- in 2001-2005	?	
	Organic carbon/organic matter	- in 2001-2005		
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	−−−−	−

Key to the Score

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

− = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

n.r.= Not relevant

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. To assess the level of elevation in nutrient levels over the years the concentrations were normalized to a salinity of 30 (OSPAR. Ref. No. 2020-20 appendix 4). In general the winter **DIN** concentrations were about a factor of 2 above elevated levels until 2000 and since then the concentrations are reduced to a factor 1.5 above the assessment level. For **DIP** the difference between the measured concentration and the elevated level has been decreased gradually from a factor 1.5 in 2000 to almost 0 in 2002. After 2002 the difference between measurement and elevated level has increased again to a factor 1.5. **Chlorophyll** concentrations were variable if compared from year to year and although they are still above elevated level in the period 2001-2005 the overall picture shows a slight trend from 2002 on. Some of the area-specific phytoplankton **indicator species**, including *Phaeocystis*, are above the elevated bloom levels. **Oxygen** causes no problem in this shallow well-mixed area.

Based on the assessment criteria the Coastal waters are still classified as a problem area.

In Figs A1.1 and A1.2 the river loads data until 2002 (source: IfM, Hamburg) are given. The TotN loads have been decreased, but still above the 50% of the 1985 loads. Since 1999 the TotP loads were less than 50% of the 1985 loads.

Annex 1 Coastal waters

Tables and Figures

Tab. A1.2. Background and assessment levels for the Coastal Waters.

	Background	Assessment level
DIN (µmol/l)	20	30
DIP (µmol/l)	0.6	0.8
Chl-a mean (µg/l)	5	7.5
Chl-a 90-perc (µg/l)	10	15
Oxygen, min. (mg/l)		6

Tab. A1.3. MWTL stations used for the assessment of the Coastal waters.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Coastal waters	GOERE6	x	x	x	x
	NOORDWK10	x	x	x	x
	NOORDWK2	x	x	x	x
	NOORDWK20	x	x	x	x
	ROTTMPT3	x	x		x
	ROTTMPT50	x	x		x
	ROTTMPT70	x	x		x
	SCHOUWN10	x	x		x
	TERSLG10	x	x	x	x
	TERSLG4	x	x	x	x
	WALCRN2	x	x	x	x
	WALCRN20	x	x	x	x

Tab. A1.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Dutch Coastal waters. In red: Cell numbers exceeding assessment level value.

Coastal waters	Alexandrium spp.	Chrysochromulina sp.	Dinophysis spp.	Karenia mikimotoi	Noctiluca scintillans	Phaeocystis sp.
	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
1995	469	0	872	3956	1169	47218000
1996	201	194231	135	0	612	41482100
1997	4000	898321	1000	3000	1699	139339000
1998	0	763052	1120	320	1440	118600000
1999	0	1E+07	3001	1004	1004	55735600
2000	500	1515150	500	106	7000	16818200
2001	102	2763160	4190	0	1000	30000000
2002	97	6060610	5573	0	1000	16515200
2003	3000	7575760	2000	0	1000	42424200
2004	0	3181820	2786	0	1278	18939400
2005	612	5757580	3913	0	2034	134722000

Annex 1 Coastal waters

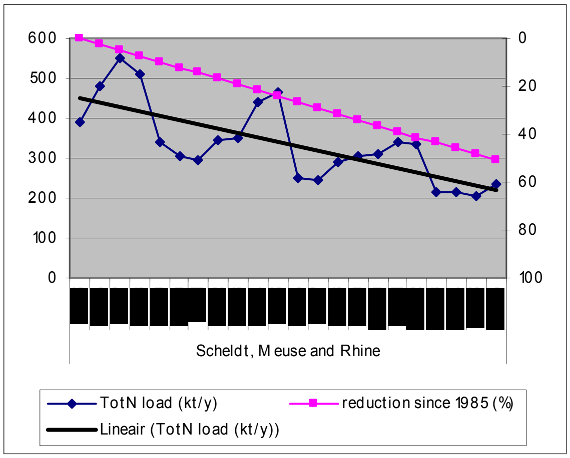


Fig. A1.1. TotN (kt/y) load from the rivers Rhine, Meuse and Scheldt into the Dutch coastal waters.

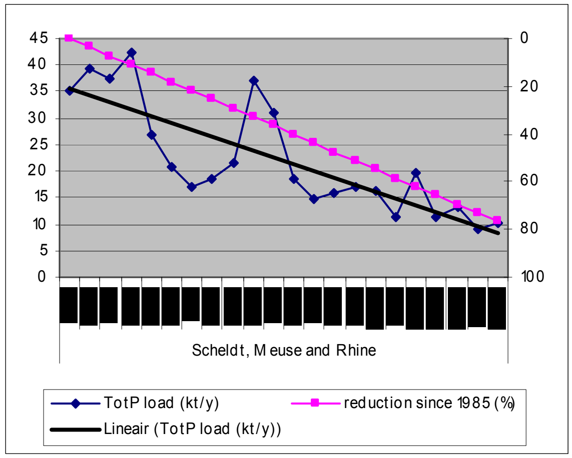


Fig. A1.2. TotP (kt/y) load from the rivers Rhine, Meuse and Scheldt into the Dutch coastal waters.

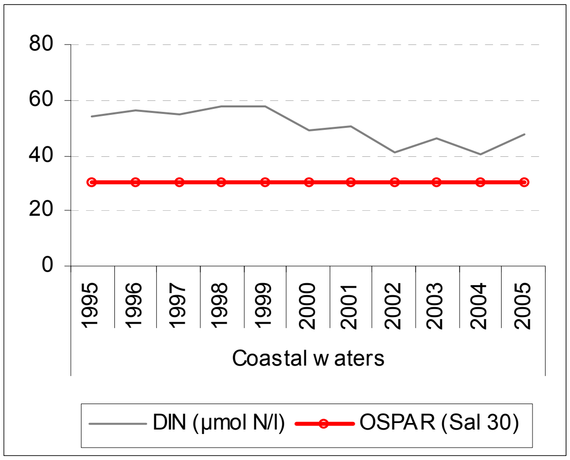


Fig. A1.3. Winter mean concentration of DIN (µmol/l) in the Dutch coastal waters, normalized to salinity 30 (see main text).

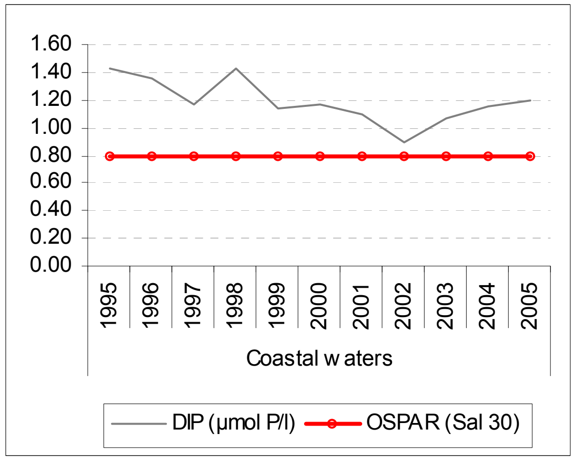


Fig. A1.4. Winter mean concentration of DIP (µmol/l) in the Dutch coastal waters, normalized to salinity 30.

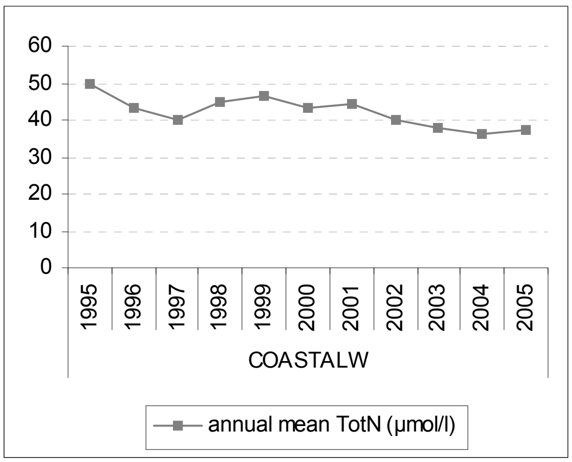


Fig. A1.5. Annual mean concentration of TotN (µmol/l) in the Dutch coastal waters. NOT corrected for salinity! No assessment level.

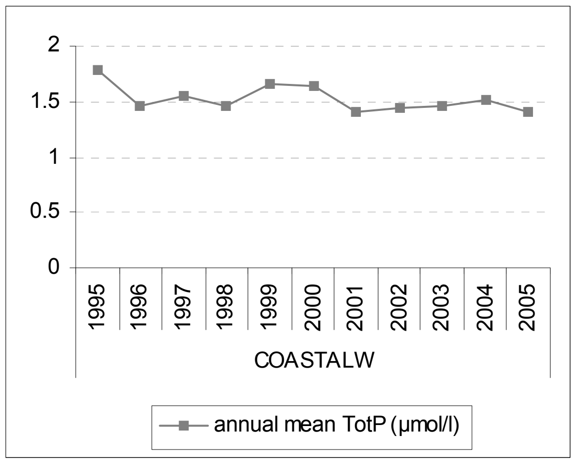


Fig. A1.6. Annual mean concentration of TotP (µmol/l) in the Dutch coastal waters. NOT corrected for salinity! No assessment level.

Annex 1 Coastal waters

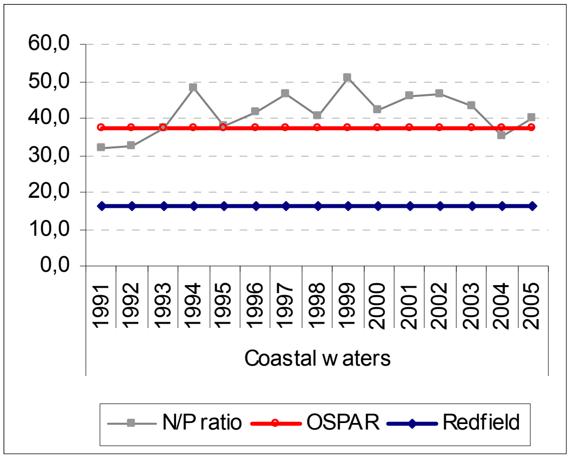


Fig. A1.7. N/P ratio in the Dutch coastal waters calculated with the winter mean concentrations of DIN and DIP.

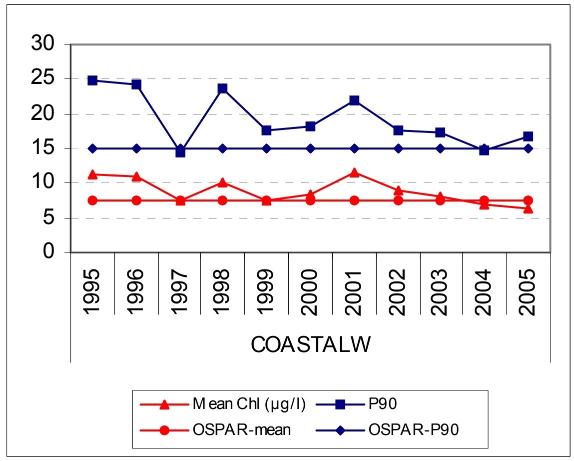


Fig. A1.8. Summer (March-Sept) mean and summer 90-percentile concentration of Chlorophyll-*a* (µg/l) in the Dutch coastal waters. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values

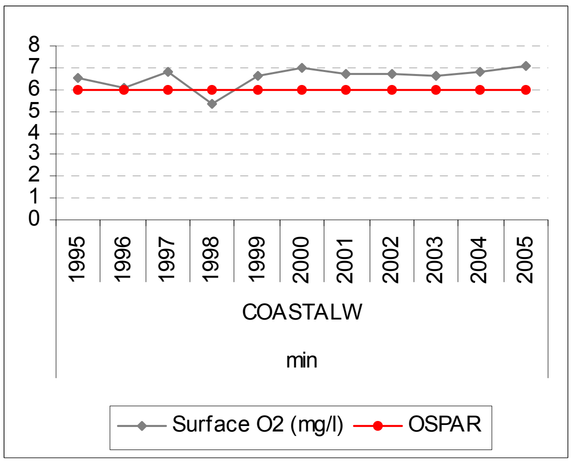


Fig. A1.9. Annual minimal concentration of surface oxygen (mg/l) in the well-mixed Dutch coastal waters.

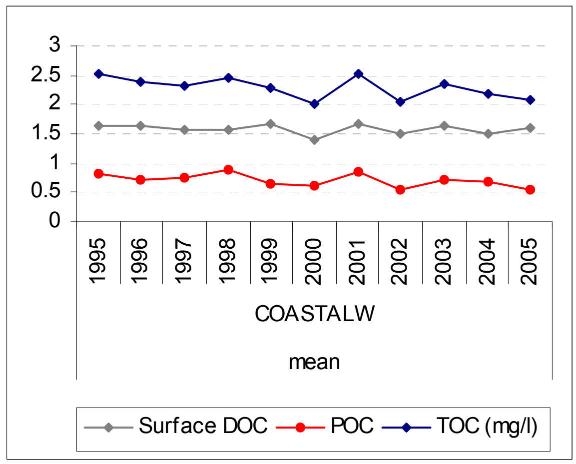


Fig A1.10. Annual mean concentrations of organic carbon (mg/l) in the Dutch coastal waters; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level.

Annex 1 Coastal waters

Annex 2 Wadden Sea

Results of the OSPAR Comprehensive Procedure – NL –Wadden Sea

1. Area Wadden Sea (see Fig. 1).

2. Description of the area

The Wadden Sea is a coastal sea and there are many interactions with the North Sea and the mainland. The main elements of the Wadden Sea system are the barrier islands, the tidal inlets, the ebb-tidal deltas, the tidal channels, the tidal flats and the salt marsh. The Wadden Sea is an important nursery area for North Sea fish, shellfish and some species of marine mammals. The quality of water, sediment and marine habitats of the Wadden Sea is, to an important degree, affected by the North Sea and activities in the catchment areas of the debouching rivers and the Lake IJssel in the western part.

3. Assessment

Tab. A2.1. Results of the assessment of the Wadden Sea (see for assessment levels Tab. A2.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall score
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total nitrogen and total phosphorus	overall trend: −		−
	Winter DIN concentrations and winter DIP concentrations	+ in 2001- 2005	+++++	+
	Winter N/P ratio (Redfield N/P = 16)	+ in 2001 - 2005	+++++	+
Direct Effects (II)	Mean chlorophyll *a* concentration	+ in 2001- 2005	+++++	+
	Area-specific phytoplankton indicator species	+ in 2001- 2005	+++++	+
	Macrophytes including macroalgae	- in 2001-2005	?	
Indirect Effects (III)	Oxygen deficiency	+ in 2001, 2003-2005; - in 2002	+−+++	+
	Changes/kills in zoobenthos and fish kills	- in 2001-2005	?	
	Organic carbon/organic matter	- in 2001-2005		
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	−−−−	−

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. In contrast to the 1995-2001 assessment the concentrations were not normalized to a salinity of 20 (OSPAR. Ref. No. 2020-20 appendix 4) for for reasons described in the main text. In general in the period 2001-2003 the **winter nutrient** concentrations are a factor of 10 and 2 above preliminary elevated levels for DIN and DIP, respectively. In the past two years a decreasing trend can be observed in both DIN and DIP concentrations. **Chlorophyll** concentrations are variable if compared from year to year and above the elevated level without a clear trend. Some of the area-specific phytoplankton **indicator species**, including *Phaeocystis*, are above the elevated bloom levels. The minimal **oxygen** concentrations are below the assessment level in four of the five years at several stations for a short period, with minimal values between 4.5 and 5.9 mg/l.

On the basis of the assessment criteria the Wadden Sea is classified as a problem area. The used background values for the winter concentrations of DIN and DIP are still preliminary. However, even when we use the annual mean background for TotN and TotP of 13 µmol/l and 0.8 µmol/l respectively Van Raaphorst et al, 2000 estimated, the Wadden Sea will be classified as problem area[1].

In Figs A2.1 and A2.2 the river loads data until 2002 (source: IfM, Hamburg) are given. The TotN loads have been decreased, but still above the 50% of the 1985 loads. Since 1998 the TotP loads were less than 50% of the 1985 loads.

6. References

Van Raaphorst, W., V.N. de Jonge, D. Dijkhuizen and B. Frederiks. 2000. Natural Background Wadden Sea. RIKZ report. Ministry of Transport, Public Works and Water Management = Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, National Institute for Coastal and Marine Management = Rijksinstituut voor Kust en Zee (RWS, RIKZ). 52 pp.

1 Van Raaphorst et al (2000) estimated the winter TotN:DIN and TotP:DIP on 1.4. This factor and the annual mean values for TotN and TotP give estimated reference values for Din and DIP: 14 and 0.85 µmol/l, resulting in elevated values of: 21 and 1.3 µmol/l, respectively; both considerable higher tan the preliminary values.

Tables and Figures

Tab. A2.2. Background and assessment levels for the Wadden Sea.

	Background	Assessment level
DIN (µmol/l)	6.5	7
DIP (µmol/l)	0.5	0.7
Chl-a mean (µg/l)	8	12
Chl-a 90-perc (µg/l)	16	24
Oxygen, min. (mg/l)		6

Tab. A2.3. MWTL stations used for the assessment of the Wadden Sea.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Wadden Sea	BLAUWSOT				x
	DANTZGND				x
	DANTZGT	x	x	x	x
	DOOVBOT				x
	DOOVBWT	x	x		x
	MARSDND	x	x	x	x
	VLIESM	x	x		x
	ZOUTKPLG				x
	ZOUTKPLZGT	x	x		x
	ZUIDOLWOT	x	x	x	x

Tab. A2.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Wadden Sea.

Wadden Sea	Alexandrium spp.	Chrysochromulina sp.	Dinophysis spp.	Karenia mikimotoi	Noctiluca scintillans	Phaeocystis sp.
	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
1995	0	274941	400	1600	1200	74206100
1996	0	0	2000	2000	600	69993500
1997	0	388463	0	0	2008	31805400
1998	0	0	100	0	2600	78029800
1999	5000	25435	100	1004	1004	24468500
2000	0	2121210	1000	0	6000	29939200
2001	0	2307690	502	0	2284	39899000
2002	0	1515150	1000	0	2000	53030300
2003	0	9090910	197	0	1000	33030300
2004	0	3636360	72	0	1333	92222200
2005	0	1666670	1000	0	435	65277800

Annex 2 Wadden Sea

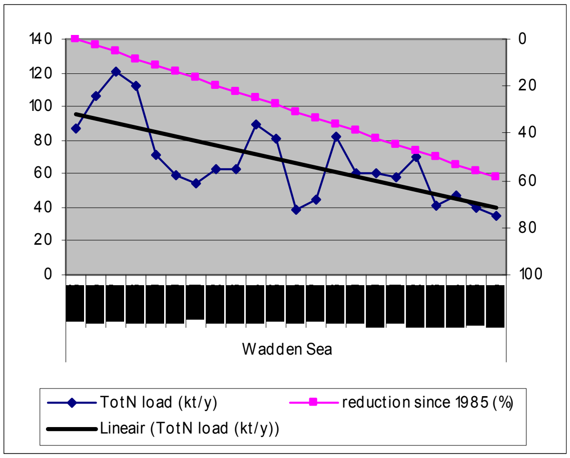


Fig. A2.1. TotN load (kt/y) from Lake IJssel into the western Wadden Sea.

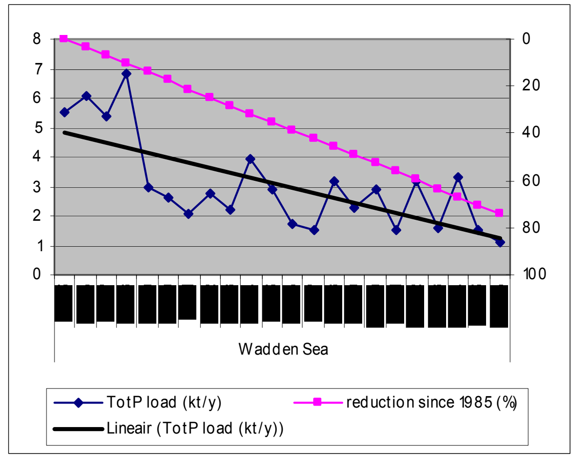


Fig. A2.2. TotP load (kt/y) from the Lake IJssel into the western Wadden Sea.

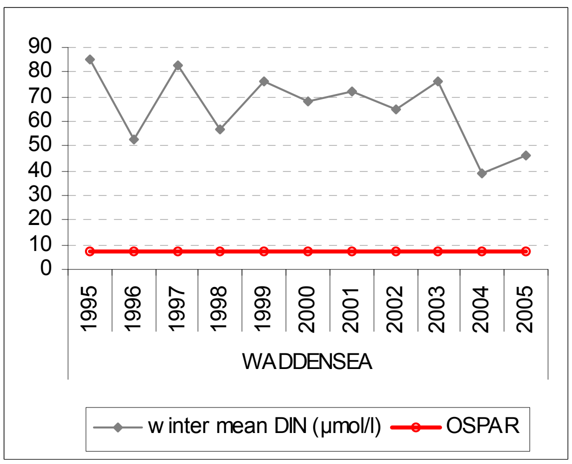


Fig. A2.3. Winter mean concentration of DIN (µmol/l) in the Wadden Sea. Preliminary assessment level.

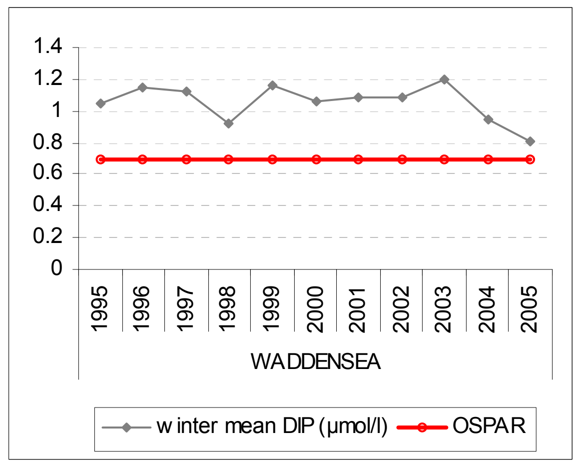


Fig. A2.4. Annual mean concentration of DIP (µmol/l) in the Wadden Sea. Preliminary assessment level.

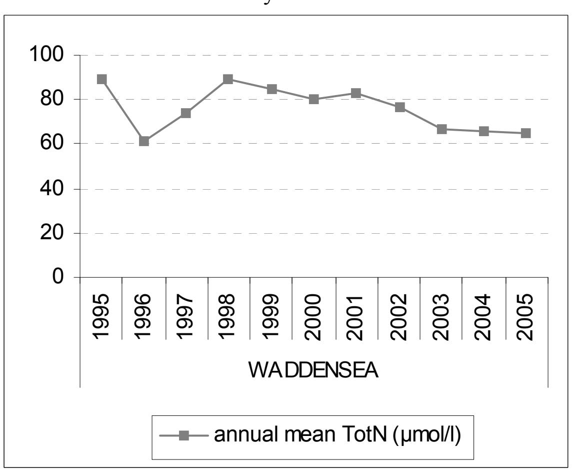


Fig. A2.5. Annual mean concentration of TotN (µmol/l) in the Wadden Sea. No assessment level.

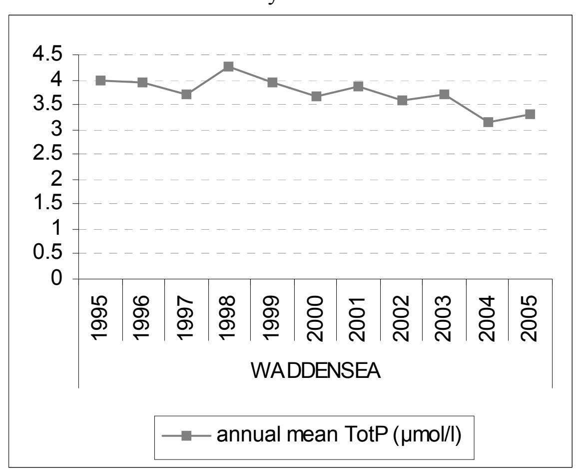


Fig. A2.6. Annual mean concentration of TotP (µmol/l) in the Wadden Sea. No assessment level.

Annex 2 Wadden Sea

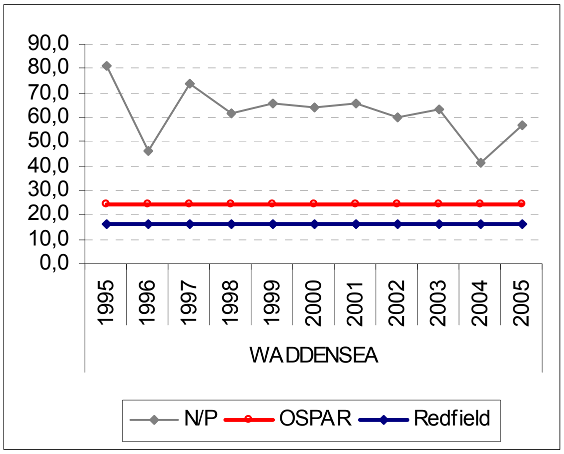


Fig. A2.7. N/P ratio in the Wadden Sea calculated with the winter mean concentrations of DIN and DIP.

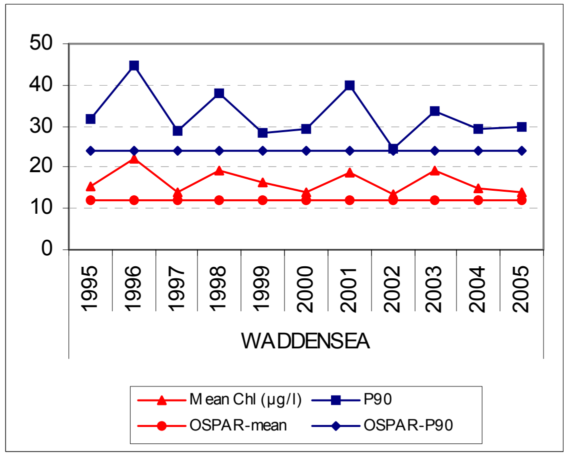


Fig. A2.8. Summer (March-Sept) mean summer 90-percentile concentration of chlorophyll-*a* (µgl/l) in the Wadden Sea. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values.

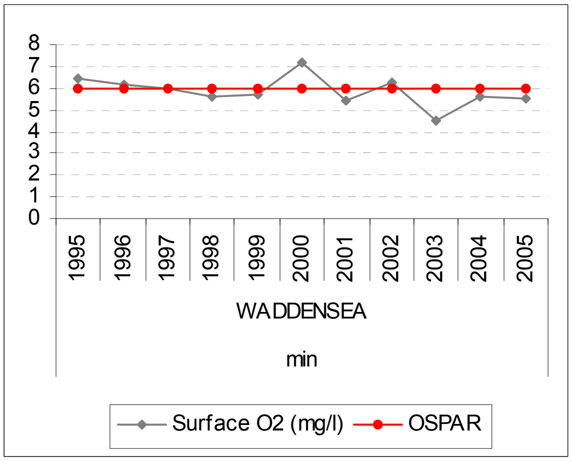


Fig. A2.9. Annual minimal oxygen concentration (mg/l) in the well-mixed Dutch Wadden Sea.

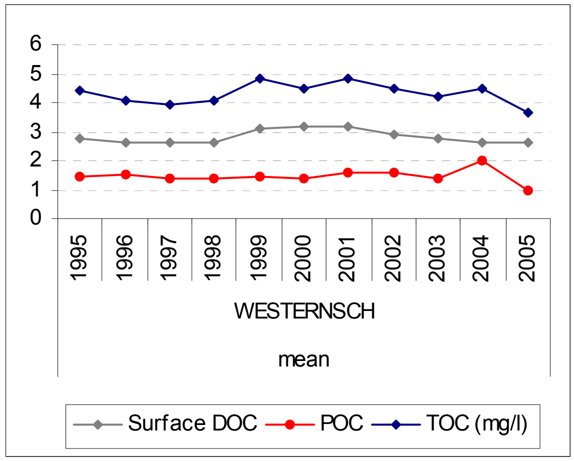


Fig. A2.10. Annual mean concentrations of organic carbon (mg/l) in the Wadden sea; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level.

Annex 3 Western Scheldt

Annex 3 Western Scheldt

Results of the OSPAR Comprehensive Procedure – NL –Western Scheldt

1. Area: Western Scheldt (see Fig. 1).

2. Description of the area

The Western Scheldt is the estuary situated between the Dutch-Belgian border and the North Sea and forms an important shipping route to Antwerp Harbor. The drainage basin is composed of catchments of numerous small streams, feeding larger tributaries such as rivers Leie, Dender and Rupel. It covers one of the most populated and industrialized areas of the Europe. The estuary is a typical heterotrophic ecosystem, where primary production is low due to limited light penetration. The estuary is well mixed and the tidal range is up to 6 meters.

3. Assessment

Tab. A3.1. Results of the assessment of the Western Scheldt (see for assessment levels Tab. A3.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall score
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total nitrogen and total phosphorus	overall trend: −		−
	Winter DIN and/or DIP concentrations	+ in 2001-2005	+++++	+
	Winter N/P ratio (Redfield N/P = 16)	+ in 2001 - 2005	+++++	+
Direct Effects (II)	Mean chlorophyll *a* concentration	+ in 2001- 2003; - in 2004, 2005	+++++	+
	Area-specific phytoplankton indicator species	+ in 2001- 2003; - in 2004, 2005	+++++	+
	Macrophytes including macroalgae	- in 2001-2005	?	
Indirect Effects (III)	Oxygen deficiency	- in 2001-2005	−+−−−	−
	Changes/kills in zoobenthos and fish kills	- in 2001-2005	?	
	Organic carbon/organic matter	- in 2001-2005		
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	−−−−−	−

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. In contrast to the 1995-2000 assessment the concentrations were not normalized to a salinity of 20 (OSPAR. Ref. No. 2020-20 appendix 4) for reasons described in the main text. In 2001 the **winter nutrient** concentrations were a factor of 6 and 4 above the (still preliminary) elevated levels for DIP and DIN, respectively. From 2002 on a slight trend can be observed in DIN concentrations. In the period 2001-2005 no clear trend can be observed in the DIP concentrations. **Chlorophyll** mean and 90-percentile concentrations are variable if compared from year to year and above elevated level and the overall picture shows no clear trend in contrast to the period 1995-2000, when a clear decreasing trend could be seen. Some of the area-specific phytoplankton **indicator species**, including *Phaeocystis*, are above the elevated bloom levels. The minimal **oxygen** concentration is below the assessment level in the summer of 2004 in one of the stations, but for a short time with a value only slightly below the assessment level.

Both nutrient concentrations and chlorophyll concentrations are well above the preliminary elevated levels, which makes the Western Scheldt estuary a problem area together with the high numbers of some of the phytoplankton indicator species.

In Figs A3.1 and A3.2 the river loads data until 2002 (source: IfM, Hamburg) are given. The TotN loads have been decreased, but are still far above the 50% of the 1985 loads. Since 1998 the TotP loads were less than 50% of the 1985 loads.

Tables and Figures

Tab. A3.2. Background and assessment levels for the Western Scheldt.

	Background	Assessment level
DIN (µmol/l)	20	30
DIP (µmol/l)	0.6	0.8
Chl-a mean (µg/l)	3	4.5
Chl-a 90-perc (µg/l)	6	9
Oxygen, min. (mg/l)		6

Tab A3.3. MWTL stations used for the assessment of the Western Scheldt.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Western Scheldt	APPZK2				x
	HANSWGL	x	x	x	x
	LAMSWDBI59				x
	SCHAARVODDL	x	x	x	
	TERNZBI20	x	x		x
	VLISSGBISSVH	x	x	x	x
	WIELGN				x

Tab. A3.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Western Scheldt.

Western Scheldt	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
	Alexandrium spp.	**Chrysochromulina sp.**	**Dinophysis spp.**	**Karenia mikimotoi**	**Noctiluca scintillans**	**Phaeocystis sp.**
1995	0	0	0	714	883	7620060
1996	0	72837	121	0	400	26571600
1997	0	152610	0	201	144	34133900
1998	0	169953	0	0	1010	2962030
1999	530	50870	0	0	393	20144600
2000	0	168919	0	0	5000	2828280
2001	0	769231	0	0	4000	4797980
2002	0	1.8E+07	0	0	1000	1739130
2003	0	3030300	0	0	1000	10909100
2004	0	4545450	0	0	0	24155400
2005	0	2777780	0	0	769	4895100

Annex 3 Western Scheldt

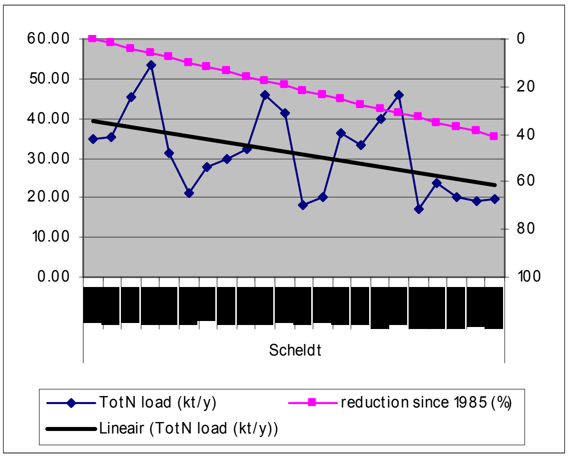


Fig. A3.1. TotN load (kt/y) from the river Scheldt into the Scheldt estuary.

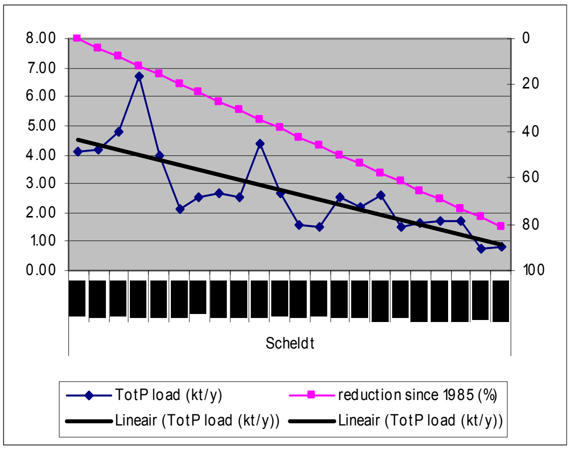


Fig. A3.2. TotP load (kt/y) from the river Scheldt into the Scheldt estuary.

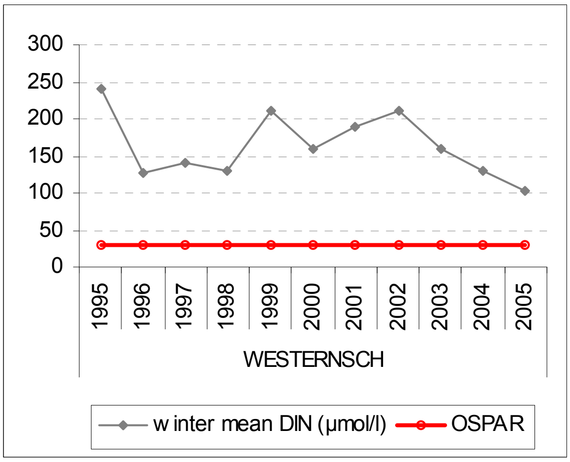


Fig. A3.3. Winter mean concentration of DIN (µmol/l) in the Western Scheldt estuary. Preliminary assessment level.

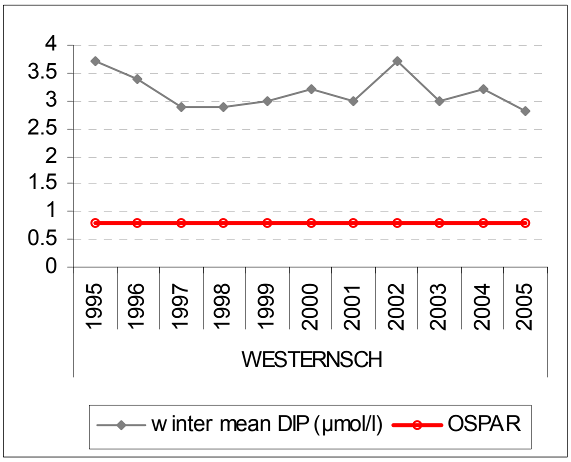


Fig. A3.4. Winter mean concentration of DIP (µmol/l) in the

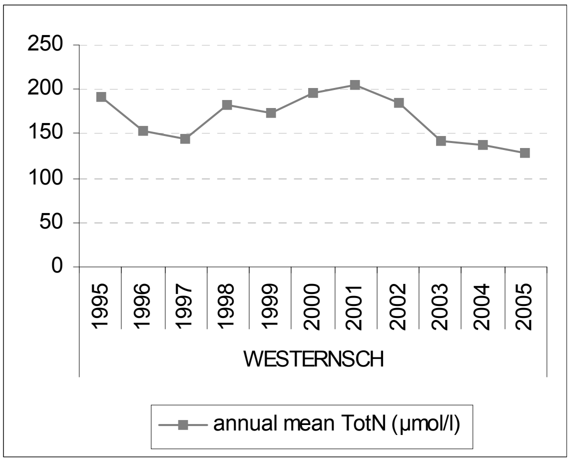
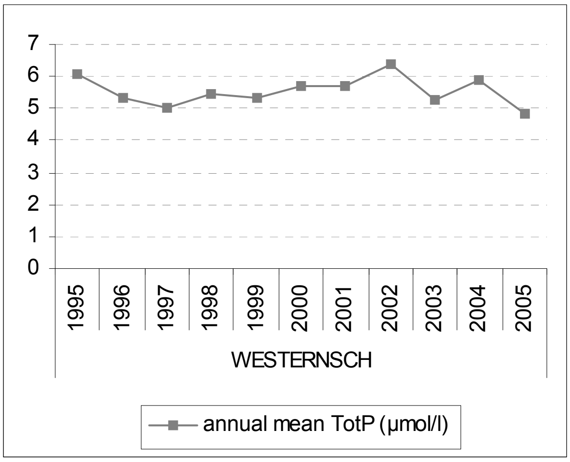


Fig. A3.5. Annual mean concentration of TotN (µmol/l) in the Western Scheldt estuary. No assessment level.



Western Scheldt estuary. Preliminary assessment level.

Fig. A3.6. Annual mean concentration of TotP (µmol/l) in the Western Scheldt estuary. No assessment level.

Annex 3 Western Scheldt

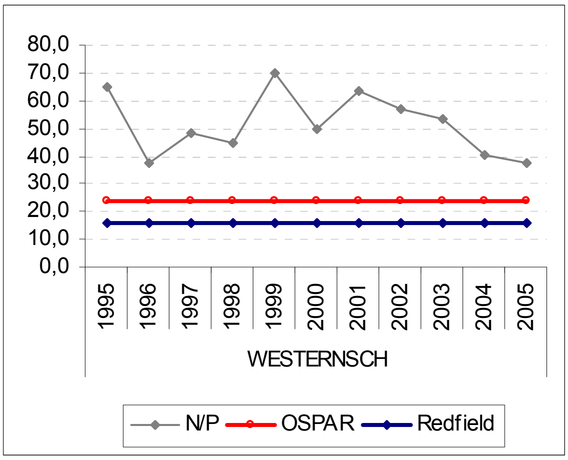


Fig. A3.7. N/P ratio in the Western Scheldt estuary, calculated with the winter mean concentrations of DIN and DIP.

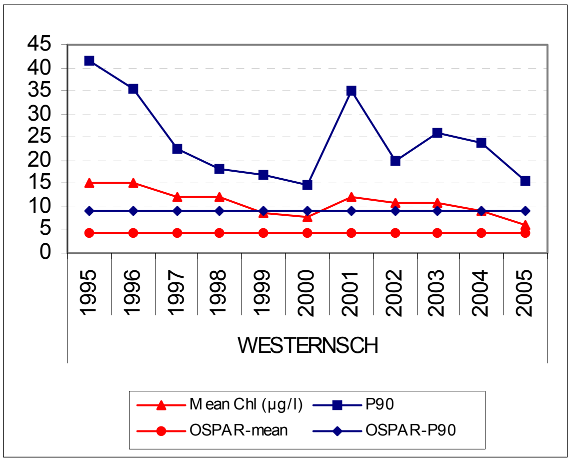


Fig. A3.8. Summer (March-Sept) mean summer 90-percentile concentration of chlorophyll-*a* (µgl/l) in the Western Scheldt. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values.

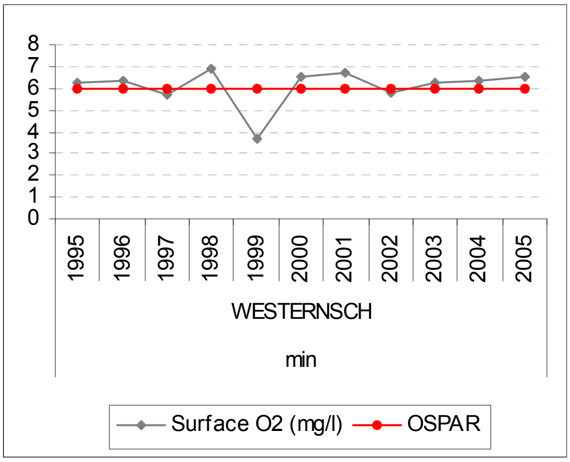


Fig. A3.9. Annual minimal oxygen concentration (mg/l) in the well-mixed Western Scheldt estuary.

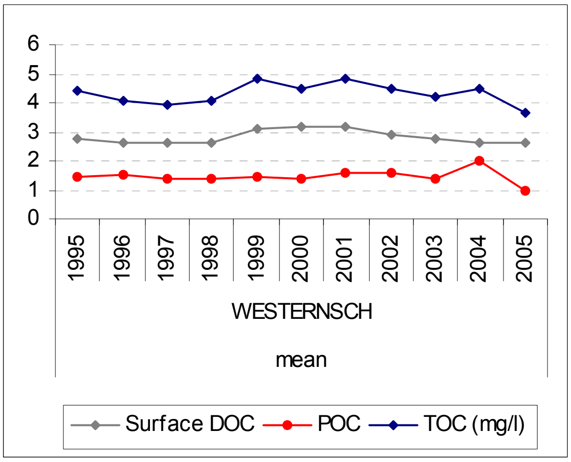


Fig. A3.10. Annual mean concentrations of organic carbon (mg/l) in the Western Scheldt; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level. No assessment level.

Annex 3 Western Scheldt

Annex 4 Ems-Dollard

– of the OSPAR Comprehensive Procedure – NL –Ems-Dollard

1. **Area:** Ems-Dollard (see Fig. 1).

2. **Description of the area**

Ems-Dollard estuary The Ems-Dollard is an estuary situated between the Dutch-German border and the Wadden Sea. The area consists of extensive tidal mudflats and salt marshes. The quality of water, sediment and marine habitats is, to an important degree, affected by activities in the catchment area of the Ems River and by outlets along the Dutch part of the estuary.

3. **Assessment**

Tab. A4.1. Results of the assessment of the Ems-Dollard (see for assessment levels Tab. A4.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall Score
	Riverine inputs and direct discharges of total nitrogen and total phosphorus	overall trend: −		−
	Winter DIN and/or DIP concentrations	− in 2001-2005	—————	+
Direct Effects (II)	Winter N/P ratio (Redfield N/P = 16)	+ in 2001 - 2005	+++++	+
	Mean chlorophyll *a* concentration	+ in 2001- 2005	+————	−
	Area-specific phytoplankton indicator species	+ in 2001- 2003; - in 2004, 2005	+++++	+
Indirect Effects (III)	Macrophytes including macroalgae	- in 2001-2005	?.	
	Oxygen deficiency	+ in 2001, 2003, 2005;- in 2002,2004	+−+−+	+
	Changes/kills in zoobenthos and fish kills	- in 2001-2005	?	
Other Possible Effects (IV)	Organic carbon/organic matter	- in 2001-2005		
Degree of Nutrient Enrichment (I)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	————	−

Key to the Score

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. In contrast to the 2003 assessment the concentrations were not normalized to a standard salinity (OSPAR. Ref. No. 2002-20 appendix 4) for reasons described in the main text. In general in the period 2001-2005 the **winter nutrient** concentrations are a factor of almost 7 and 2 above elevated levels for DIN and DIP, respectively. In the past three years a decreasing trend can be observed in DIN, while it looks like the DIP concentrations are increasing. Chlorophyll mean and 90-percentile concentrations are variable if compared from year to year and below the elevated level, which is comparable with the period from 1995-2001. The cause of the low **chlorophyll** concentrations in this extremely eutrophic estuary can be found in the limited light availability. Some of the area-specific phytoplankton **indicator species**, including *Phaeocystis*, are above the elevated bloom levels. The minimal **oxygen** concentrations are just below the assessment level in three of the five years, with values between 5.7 and 5.9 for short periods only (1 –3 weeks).

Although the chlorophyll concentrations are below the elevated levels, the Ems-Dollard estuary is classified as a problem area because of the high nutrients concentrations and some of the phytoplankton indicator species. The background levels for DIN and DIP are still preliminary.

In Figs A4.1 and A4.2 the river loads data until 2002 (source: IfM, Hamburg) are given. The TotN loads have been decreased, but still far above the 50% of the 1985 loads. In 2002 the TotP loads were still slightly more than 50% of the 1985 loads.

Annex 4 Ems-Dollard

Tables and Figures

Tab. A4.2. Background and assessment levels for the Ems-Dollard.

	Background	Assessment level
DIN (µmol/l)	20	30
DIP (µmol/l)	0.6	0.8
Chl-a mean (µg/l)	6	9
Chl-a 90-perc (µg/l)	12	18
Oxygen, min. (mg/l)		6

Tab. A4.3. MWTL stations used for the assessment of the Ems-Dollard.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Ems-Dollard	BOCHTVWTM				x
	BOCHTVWTND				x
	BOCHTVWTZD				x
	GROOTGND	x	x	x	x
	HUIBGOT	x	x	x	x

Tab. A4.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Ems-Dollard.

Ems-Dollard	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
	Alexandrium spp.	Chrysochromulina sp.	Dinophysis spp.	Karenia mikimotoi	Noctiluca scintillans	Phaeocystis sp.
1995	100	0	240	0	686	53402500
1996	0	0	300	1000	714	9332470
1997	259	457831	436	922	2685	10606400
1998	0	43381	0	0	114	22484600
1999	0	178046	571	0	717	16990600
2000	500	909091	1000	0	2000	3939390
2001	0	452489	198	0	561	14646500
2002	0	606061	97	0	500	4848490
2003	77	606061	68	0	276	1925680
2004	0	833333	52	0	1538	36944400
2005	0	4166670	1000	0	267	47430800

Annex 4 Ems-Dollard

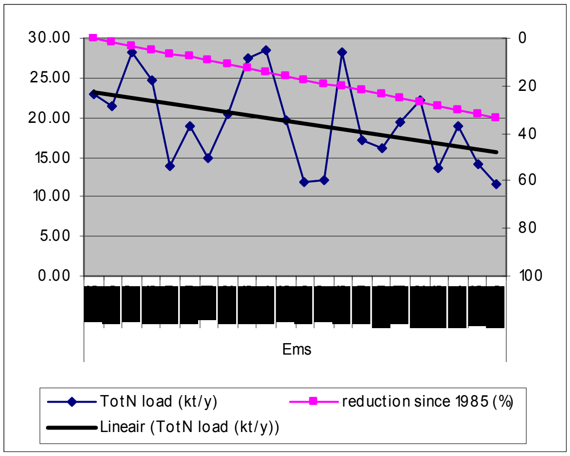


Fig. A4.1. TotN (kt/y) load from the river Ems into the Ems-Dollard estuary.

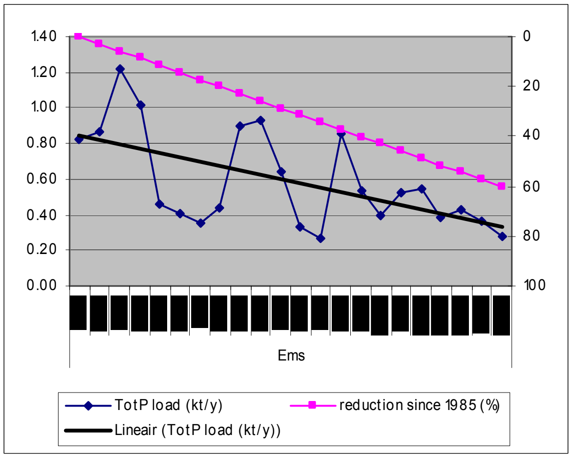


Fig. A4.2. TotP (kt/y) load from the river Ems into the Ems-Dollard estuary.

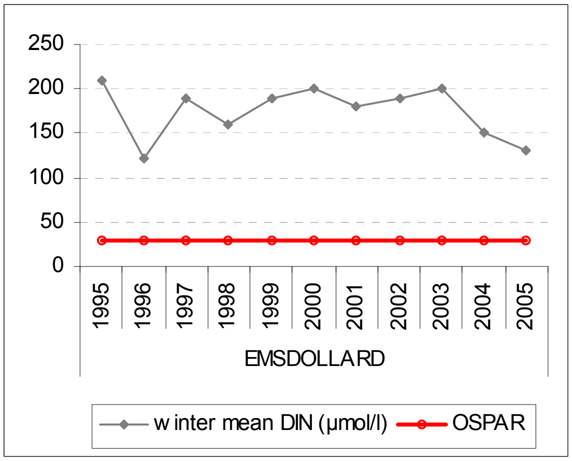


Fig. A4.3. Winter mean concentration of DIN (µmol/l) in the Ems-Dollard estuary. Preliminary assessment level.

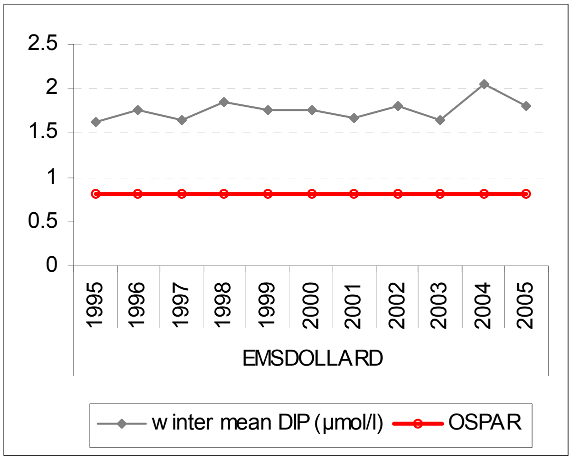


Fig. A4.4. Winter mean concentration of DIP (µmol/l) in the Ems-Dollard estuary. Preliminary assessment level.

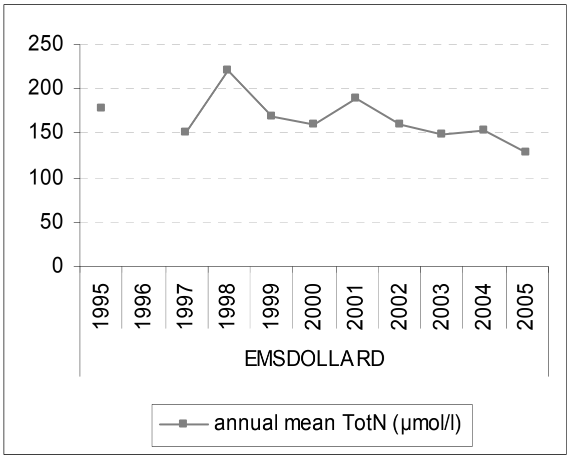


Fig. A4.5. Annual mean concentration of TotN (µmol/l) in the Ems-Dollard estuary. No assessment level.

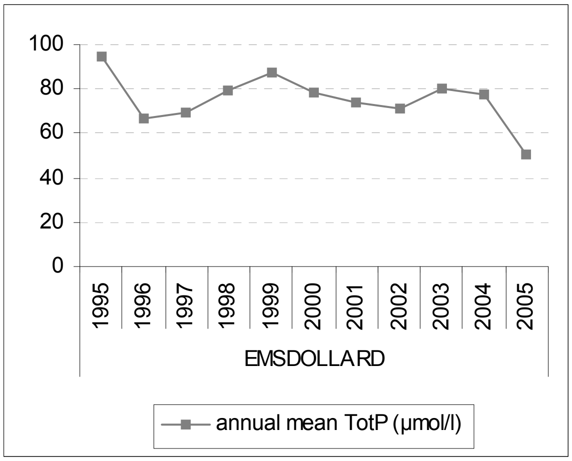


Fig. A4.6. Annual mean concentration of TotP (µmol/l) in the Ems-Dollard estuary. No assessment level.

Annex 4 Ems-Dollard

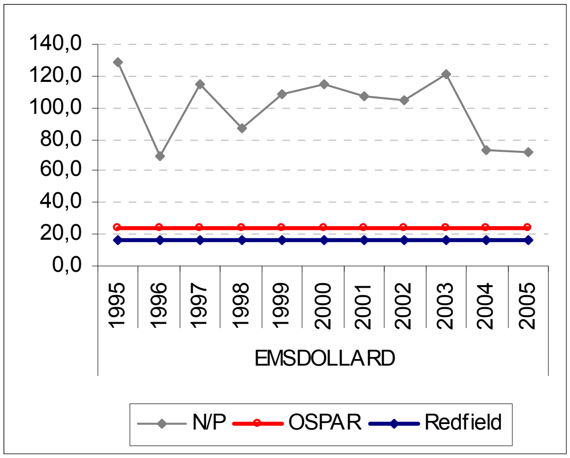


Fig. A4.7. N/P ratio in the Ems-Dollard estuary calculated with the winter mean concentrations of DIN and DIP.

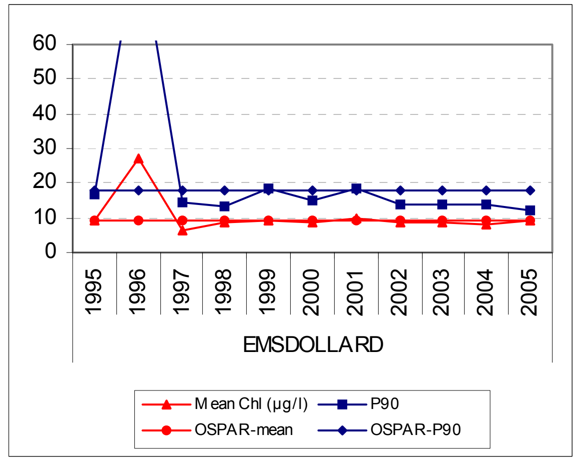


Fig. A4.8. Summer (March-Sept) mean summer 90-percentile concentration of chlorophyll-*a* (µgl/l) in the Ems-Dollard. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values.

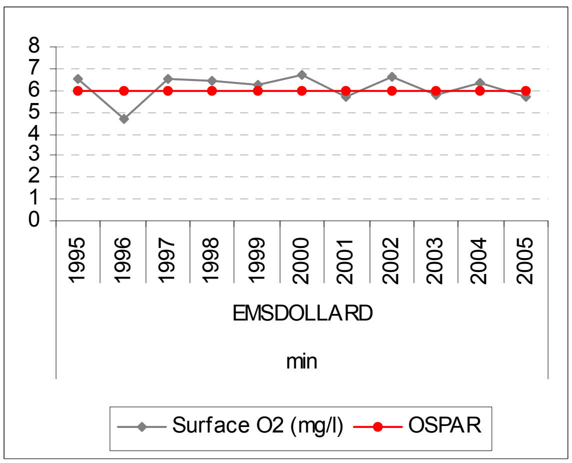


Fig. A4.9. Annual minimal oxygen concentration (mg/l) in the well-mixed Ems-Dollard estuary.

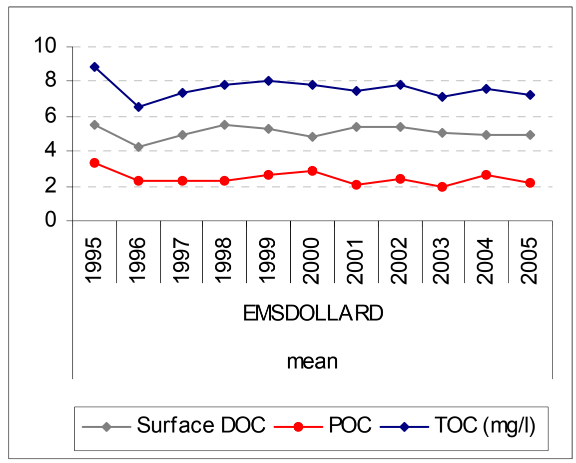


Fig. A4.10. Annual mean concentrations of organic carbon (mg/l) in the Ems-Dollard; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level.

Annex 4 Ems-Dollard

Annex 5 Southern Bight offshore

Results of the OSPAR Comprehensive Procedure – NL –Southern Bight offshore

1. Area: Southern Bight offshore (see Fig. 1).

2. Description of the area

The Southern Bight offshore (salinity >34.5) covers a part of the Frisian Front and Oyster Grounds. This area is well mixed from surface to bottom throughout the year. The depth is around 30 m.

3. Assessment

Tab. A5.1. Results of the assessment of the Southern Bight offshore (see for assessment levels Tab. A5.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall score
Direct Effects (II)	Riverine inputs and direct discharges of total nitrogen and total phosphorus			
	Winter DIN and/or DIP concentrations	+ in 2001-2005	–––––	–
	Winter N/P ratio (Redfield N/P = 16)	+ in 2001 - 2005	–––––	–
Indirect Effects (III)	Mean chlorophyll *a* concentration	+ in 2001-2004, -2005;	++++–	+
	Area-specific phytoplankton indicator species	+ in 2001- 2005	+++++	+
	Macrophytes including macroalgae	- in 2001-2005	n.r.	
Other Possible Effects (IV)	Oxygen deficiency	- in 2001-2005	–––––	–
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter	- in 2001-2005		
Degree of Nutrient Enrichment (I)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	––––	–

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

n.r.= Not relevant

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. In general, **winter nutrient** concentrations are below the elevated level, and also below the background values, without clear trend. The question is whether it is correct to use the elevated level as criterion in the offshore areas. **Chlorophyll** mean and 90-percentile concentrations were above the elevated level during all years of the assessment period (2001-2005) in contrast to the years 1995-2000, with elevated chlorophyll concentrations below the elevated level in 4 of the 6 years. Some of the area-specific phytoplankton **indicator species**, including the nuisance phytoplankton indicator species *Phaeocystis*, are above the elevated bloom levels. **Oxygen** causes no problem in this shallow well-mixed area.

Although the nutrients are below the elevated levels, this southern part of the offshore area of the Dutch continental shelf is classified as a problem area because of the chlorophyll concentrations and some of the phytoplankton indicator species.

As there is no direct relation between riverine input in the Dutch coastal waters and nutrients in the offshore waters, RID input data were not included in the assessment.

Tables and Figures

Tab. A5.2. Background and assessment levels for the Southern Bight offshore.

	Background	Assessment level
DIN (µmol/l)	10	15
DIP (µmol/l)	0.6	0.8
Chl-a mean (µg/l)	1.5	2.25
Chl-a 90-perc (µg/l)	3	4.5
Oxygen, min. (mg/l)		6

Tab. A5.3. MWTL stations used for the assessment of the Southern Bight offshore.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Southern Bight offshore	NOORDWK70	x	x	x	x
	WALCRN70	x	x	x	x

Tab. A5.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Southern Bight offshore.

Southern Bight offshore	Alexandrium spp.	Chrysochromulina sp.	Dinophysis spp.	Karenia mikimotoi	Noctiluca scintillans	Phaeocystis sp.
	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
1995	141	91071	11058	4322	120	8646620
1996	454	0	143	0	142	14193100
1997	100	52961	160	300	100	11989600
1998	0	915663	100	114	331	11116100
1999	100	305221	392	100	120	12540500
2000	141	1363640	48	0	6000	489865
2001	92	2222220	181	0	367	18846200
2002	77	628281	149	0	114	5422050
2003	0	1508120	90	0	36	18233200
2004	0	2831610	131	27	0	31884500
2005	162	2112080	298	0	74	17009100

Annex 5 Southern Bight offshore

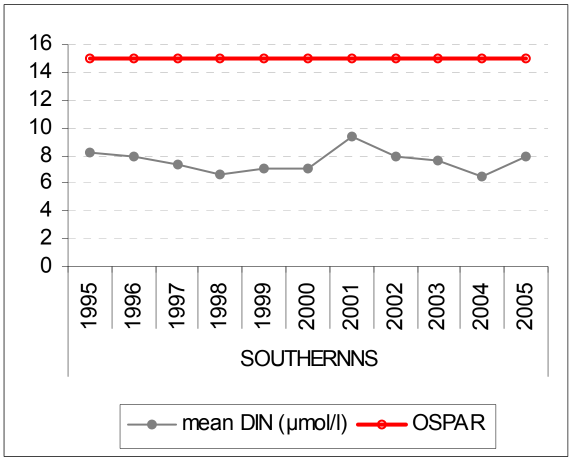


Fig. A5.1. Winter mean concentration of DIN (µmol/l) in the Southern Bight offshore.

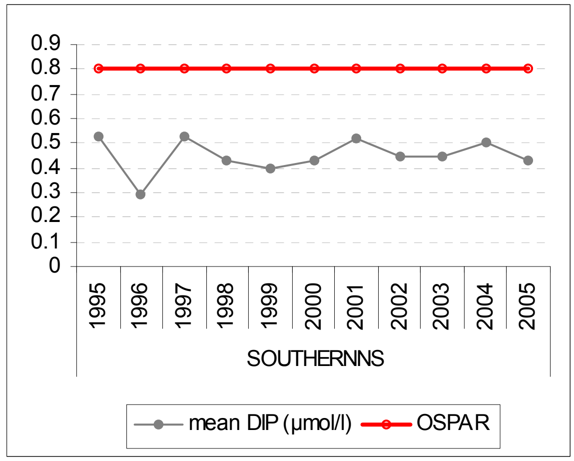


Fig. A5.2. Annual mean concentration of DIP (µmol/l) in the Southern Bight offshore.

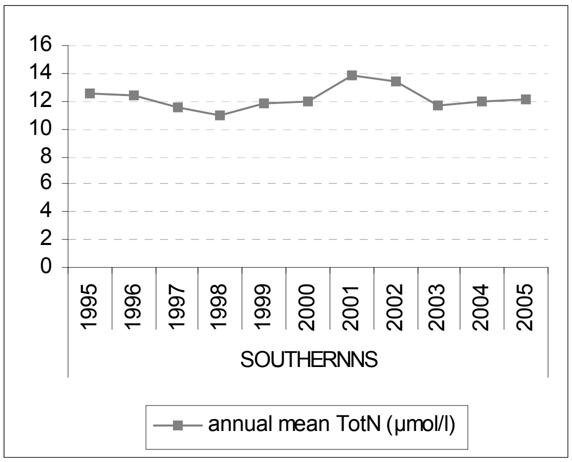


Fig. A5.3. Annual mean concentration of TotN (µmol/l) in the Southern Bight offshore. No assessment level.

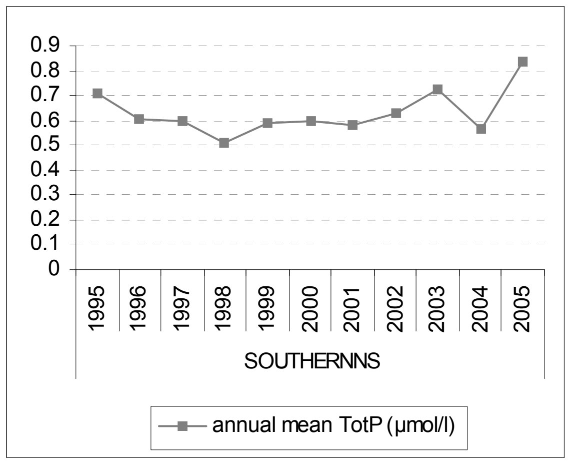


Fig. A5.4. Annual mean concentration of TotP (µmol/l) in the Southern Bight offshore. No assessment level.

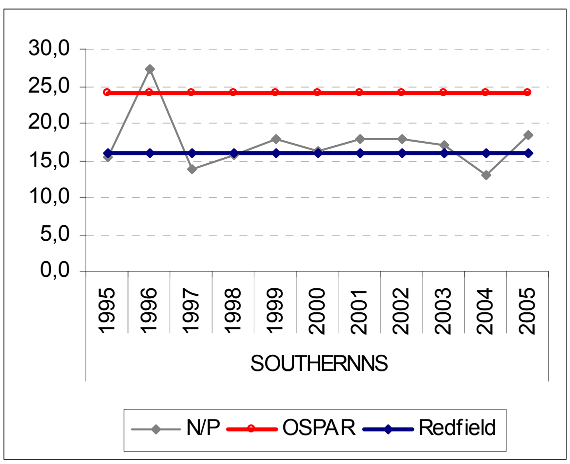


Fig. A5.5. N/P ratio in the Southern Bight offshore calculated with the winter mean concentrations of DIN and DIP.

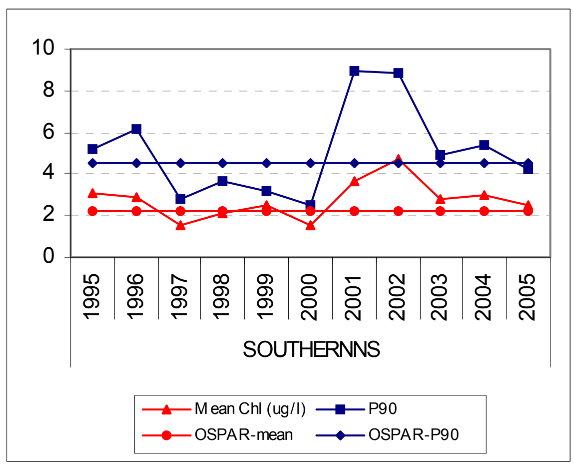


Fig. A5.6. Summer (March-Sept) mean summer 90-percentile concentration of chlorophyll-*a* (µgl/l) in the Southern Bight offshore. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values.

Annex 5 Southern Bight offshore

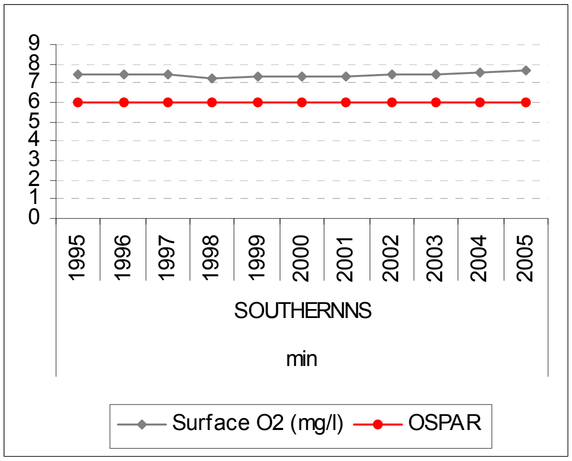


Fig. A5.7. Annual minimal oxygen concentration (mg/l) in the well-mixed Southern Bight offshore.

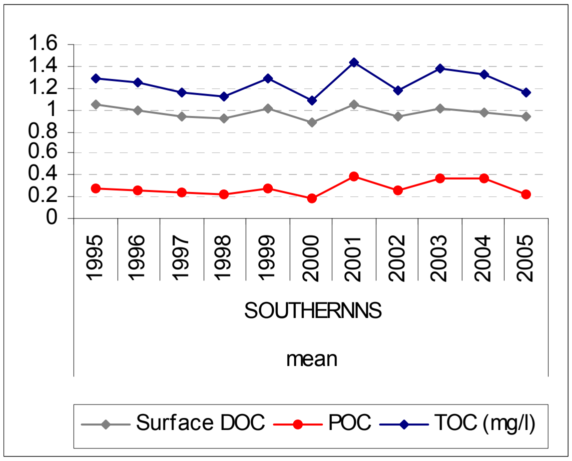


Fig. A5.8. Annual mean concentrations of organic carbon (mg/l) in the Southern Bight offshore; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level.

Annex 5 Southern Bight offshore

Annex 6 Oyster Grounds

Results of the OSPAR Comprehensive Procedure – NL –Oyster Grounds

1. Area: Oyster Grounds (see Fig. 1).

Description of the area

The Oyster Grounds is part of the offshore area (salinity >34.5) of the Dutch Continental shelf. This area is situated between the Southern Bight offshore and the Dogger Bank. In contrast with the shallower parts of the North Sea, which are well mixed from surface to bottom throughout the year, the Oyster Grounds (45 m depth) become stratified during some of the summers. During this period sedimentation takes place from the upper layer to the bottom. Forced by the circulation pattern this area receives its water from different adjacent marine areas, mainly from the Channel and coastal areas of the UK.

3. Assessment

Tab. A6.1. Results of the assessment of the Oyster Grounds (see for assessment levels Tab. A6.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall score
	Riverine inputs and direct discharges of total nitrogen and total phosphorus			
	Winter DIN and/or DIP concentrations	+ in 2001-2005	–––––	–
Direct Effects (II)	Winter N/P ratio (Redfield N/P = 16)	+ in 2001 - 2005	–––––	–
	Mean chlorophyll *a* concentration	- in 2001--2005	–––––	–
	Area-specific phytoplankton indicator species; only toxic species show elevation	+ in 2001- 2005	+++++	+
Indirect Effects (III)	Macrophytes including macroalgae	- in 2001-2005	n.r.	
	Oxygen deficiency	- in 2001-2002, 2004-2005; + in 2003	––+––	–
	Changes/kills in zoobenthos and fish kills		?.	
Other Possible Effects (IV)	Organic carbon/organic matter	- in 2001-2005		
Degree of Nutrient Enrichment (I)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	––––	–

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

n.r.= Not relevant

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. In general, winter nutrient concentrations are below the elevated level, and also below the background values, without clear trend. The question is whether it is correct to use the elevated level as criterion in the offshore areas. **Chlorophyll** mean and 90-percentile concentrations were below the elevated level and show a decreasing trend in the period 1995-2000 and no clear trend in the assessment period (2001-2005). Some of the area-specific toxic phytoplankton **indicator species**, however, are above the elevated bloom levels, both in the surface samples as well as in the samples taken at the thermocline. Differences between the periods 1995-2000 and 2001-2005 are insignificant. The nuisance phytoplankton indicator species *Phaeocystis* remains below the elevated level during the whole period. The minimum **oxygen** concentrations are in the right range of values in four of the five years. In 2003 the concentrations on two stations (Terschelling 100 and 135) reached values below 6 mg/l during around 10 weeks (from the end of July until half September) with a minimum value of 3.26 mg/l. At the third station (Terschelling 175) the oxygen concentrations always remained above the assessment level.

Although the nutrients and the chlorophyll concentrations are below the elevated levels, this stratified middle part of the offshore area of the Dutch continental shelf is initially classified as a problem area because some of the phytoplankton indicator species are blooming in too large numbers. In the final assessment, however, it is considered a non-problem area, because of the uncertainty of a cause-effect relationship between nutrient availability and the occurrence and toxicity of these species.

As there is no direct relation between riverine input in the Dutch coastal waters and nutrients in the offshore waters, RID input data were not included in the assessment.

Annex 6 Oyster Grounds

Tables and Figures

Tab. A6.2. Background and assessment levels for the Oyster Grounds.

	Background	Assessment level
DIN (µmol/l)	10	15
DIP (µmol/l)	0.6	0.8
Chl-a mean (µg/l)	1.5	2.25
Chl-a 90-perc (µg/l)	3	4.5
Oxygen, min. (mg/l)		6

Tab. A6.3. MWTL stations used for the assessment of the Oyster Grounds.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Oyster Grounds	TERSLG100	x	x	x	x
	TERSLG135	x	x	x	x
	TERSLG175	x	x	x	x

Tab. A6.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Oyster Grounds.

Oyster Grounds	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
	Alexandrium spp.	Chrysochromulina sp.	Dinophysis spp.	Karenia mikimotoi	Noctiluca scintillans	Phaeocystis sp.
1995	247	3347880	375	996	0	512749
1996	1798	1626690	6225	46781	0	3738960
1997	775	1505290	366	346	114	267068
1998	416	1092550	666	311	115	558415
1999	0	2525010	171	264	0	485579
2000	194	3939390	500	612	120	606061
2001	324	3415730	9533	1438	37	199847
2002	251	1674060	583	781	201	403277
2003	336	1855450	6080	3532	41	1166970
2004	327	1579550	139	82	161	1509710
2005	3525	1750380	353	1763	64	1106520

Annex 6 Oyster Grounds

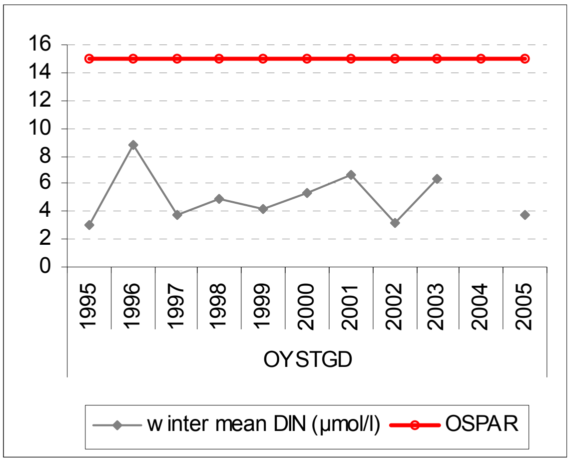


Fig. A6.1. Winter mean concentration of DIN (µmol/l) on the Oystergrounds.

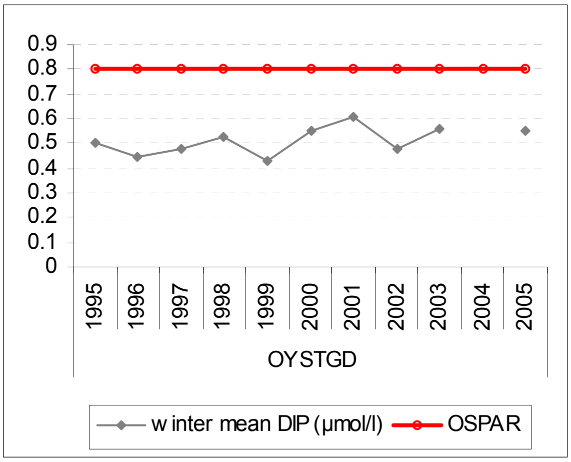


Fig. A6.2. Annual mean concentration of DIP (µmol/l) on the Oystergrounds.

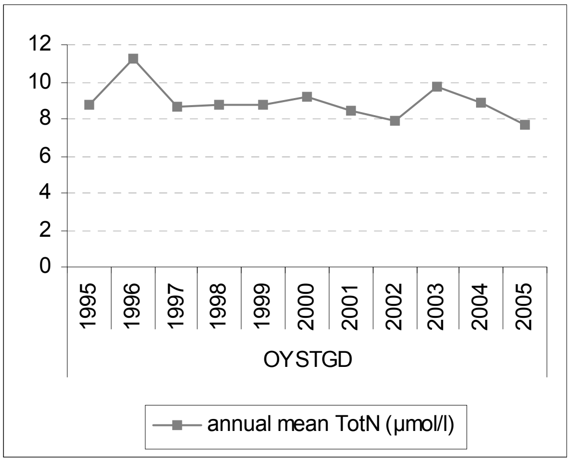


Fig. A6.3. Annual mean concentration of TotN (µmol/l) on the Oystergrounds. No assessment level.

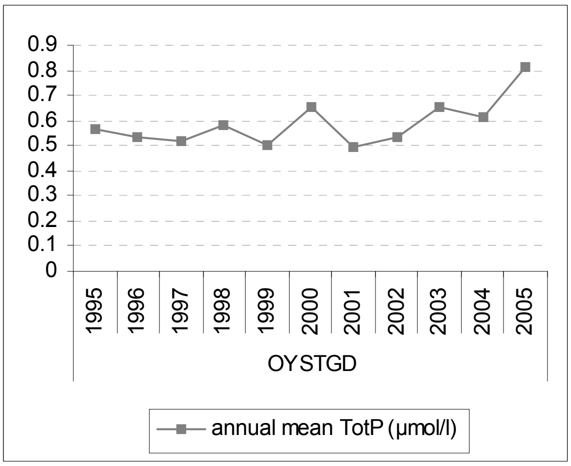


Fig. A6.4. Annual mean concentration of TotP (µmol/l) on the Oystergrounds. No assessment level.

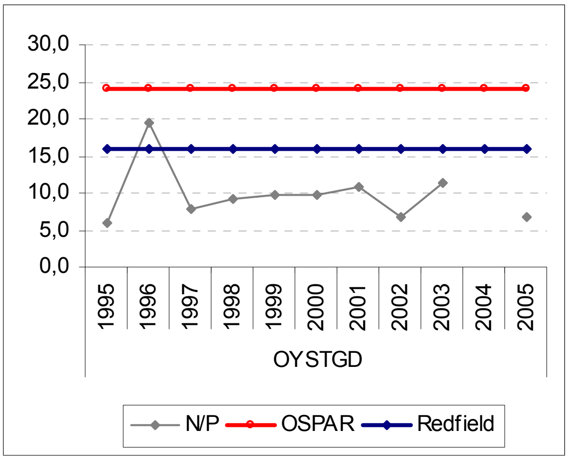


Fig. A6.5. N/P ratio on the Oystergrounds calculated with the winter mean concentrations of DIN and DIP.

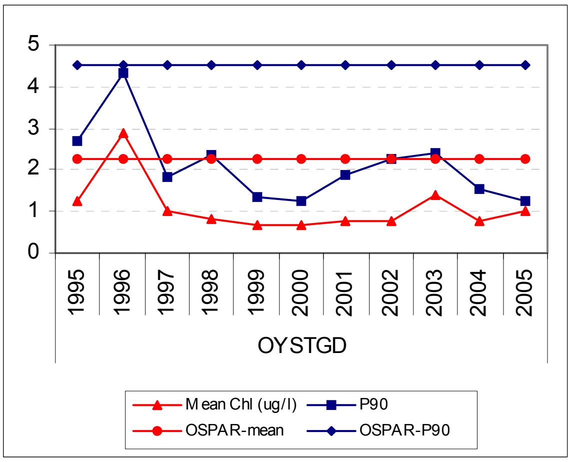


Fig. A6.6. Summer (March-Sept) mean summer 90-percentile concentration of chlorophyll-*a* (µgl/l) on the Oystergrounds. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values.

Annex 6 Oyster Grounds

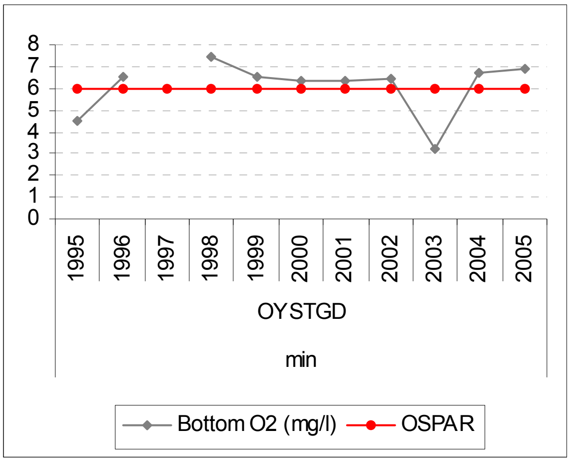


Fig. A6.7. Annual minimal oxygen concentration (mg/l) in the bottom layer on the Oystergrounds.

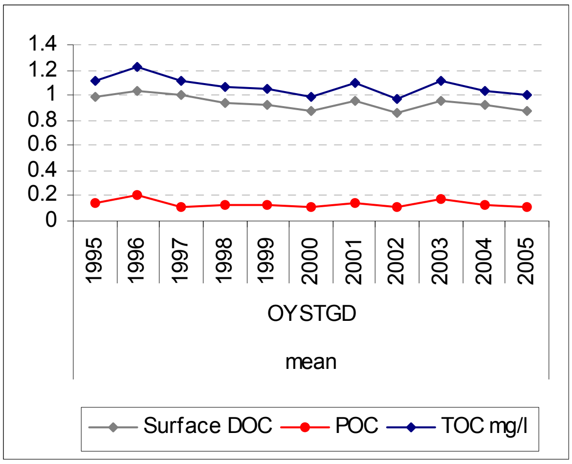


Fig. A6.8. Annual mean concentrations of organic carbon (mg/l) on the Oystergrounds; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level.

Annex 6 Oyster Grounds

Annex 7 Dogger Bank

Results of the OSPAR Comprehensive Procedure – NL – Dogger Bank

1. Area: Dogger Bank (see Fig. 1).

2. Description of the area

The Dogger Bank is the utmost part of the offshore area (salinity >34.5) of the Dutch continental shelf. With a depth of around 18 m this area is well mixed during most of the year, with a short stratified period in summer, Forced by the circulation pattern this area receives its water from different adjacent marine areas, mainly from the Channel and coastal areas of the UK.

3. Assessment

Tab. A7.1. Results of the assessment of the Dogger Bank (see for assessment levels Tab. A7.2).

Degree of Nutrient Enrichment (I)	Assessment Parameters	Description of Results	Annual Score (+ - ?)	Overall score
	Riverine inputs and direct discharges of total nitrogen and total phosphorus			
	Winter DIN and/or DIP concentrations	+ in 2001-2005	–––––	–
Direct Effects (II)	Winter N/P ratio (Redfield N/P = 16)	+ in 2001 - 2005	–––––	–
	Mean chlorophyll *a* concentration	- in 2001-2002, 2004-2005; + in 2003	–––––	–
	Area-specific phytoplankton indicator species: only toxic species show elevation	+ in 2001- 2005	+++++	+
Indirect Effects (III)	Macrophytes including macroalgae	- in 2001-2005	n.r.	
	Oxygen deficiency	- in 2001-2002, 2004-2005; + in 2003	–––––	–
	Changes/kills in zoobenthos and fish kills		?.	
Other Possible Effects (IV)	Organic carbon/organic matter	- in 2001-2005		
Degree of Nutrient Enrichment (I)	Algal toxins (DSP/PSP mussel infection events)	- in 2001-2005	––––	–

Key to the Score

+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters

- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters

? = Not enough data to perform an assessment or the data available is not fit for the purpose

n.r.= Not relevant

5. Discussion

The figures show time series of the causal factors (winter nutrients, category I) and direct effects (category II) in terms of chlorophyll concentrations. In general, winter nutrient concentrations are below the elevated level, and also below the background values, without clear trend. The question is whether it is correct to use the elevated level as criterion in the offshore areas. **Chlorophyll** mean and 90-percentile concentrations were below the elevated level and show a decreasing trend. Some of the area-specific toxic phytoplankton **indicator species**, however, are above the elevated bloom levels. The nuisance phytoplankton indicator species *Phaeocystis* remains below the elevated level during the whole period. **Oxygen** causes no problem in this shallow well-mixed area.

Although the nutrients and the chlorophyll concentrations are below the elevated levels, this utmost northern offshore part of the Dutch continental shelf is initially classified as a problem area because some of the phytoplankton indicator species are blooming in too large numbers. In the final assessment, however, it is considered a non-problem area, because of the uncertainty of a cause-effect relationship between nutrient availability and the occurrence and toxicity of these species.

As there is no direct relation between riverine input in the Dutch coastal waters and nutrients in the offshore waters, RID input data were not included in the assessment.

Annex 7 Dogger Bank

Tables and Figures

Tab. A7.2. Background and assessment levels for the Dogger Bank.

	Background	Assessment level
DIN (µmol/l)	10	15
DIP (µmol/l)	0.6	0.8
Chl-a mean (µg/l)	1.5	2.25
Chl-a 90-perc (µg/l)	3	4.5
Oxygen, min. (mg/l)		6

Tab. A7.3. MWTL station used for the assessment of the Dogger Bank.

Area	Station	Chl-a	Org. C, O2	Phytopl	Nutrients
Dogger Bank	TERSLG235	x	x	x	x

Tab. A7.4. Annual maximal numbers of cells/l of the specific phytoplankton species in the Dogger Bank..

Dogger Bank	1.E+02	1.E+06	1.E+02	1.E+05	1.E+04	1.E+07
	Alexandrium spp.	Chrysochromulina sp.	Dinophysis spp.	Karenia mikimotoi	Noctiluca	Phaeocystis sp.
1995	176	0	307	278884	0	168598
1996	408	1311060	1743	17260	0	3666120
1997	119	704089	185	0	0	946878
1998	314	1311060	348	3420	0	4710110
1999	118	4151700	194	1240	0	599690
2000	247	1570250	179	140	0	2660630
2001	202	1064300	413	399	0	3362640
2002	280	1082570	217	822	0	2098830
2003	65	2739650	1886	89	0	3025660
2004	296	7246380	30	162	0	1283360
2005	1028	1348000	128	163	0	3063940

Annex 7 Dogger Bank

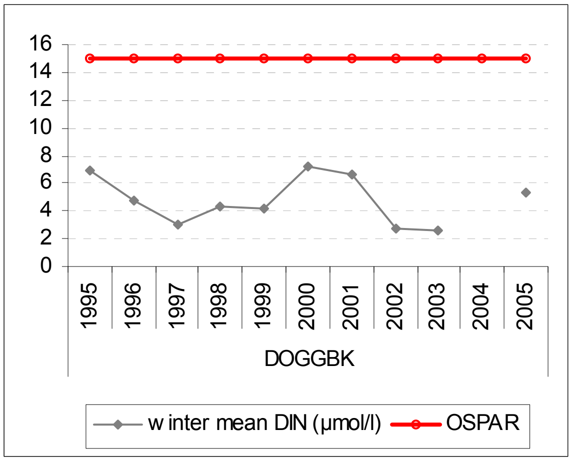


Fig. A7.1. Winter mean concentration of DIN (µmol/l) on the Dogger Bank.

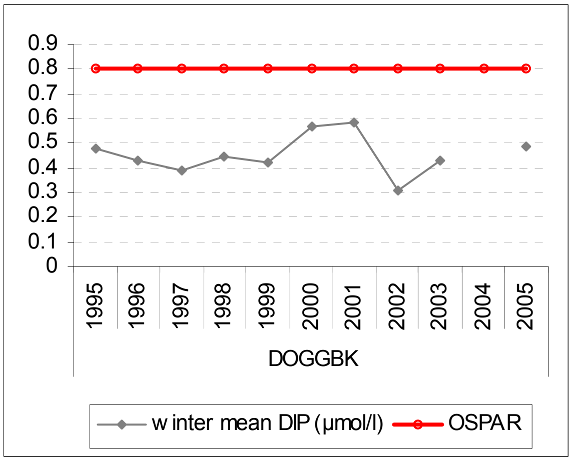


Fig. A7.2. Annual mean concentration of TotN (µmol/l) on the Dogger Bank.

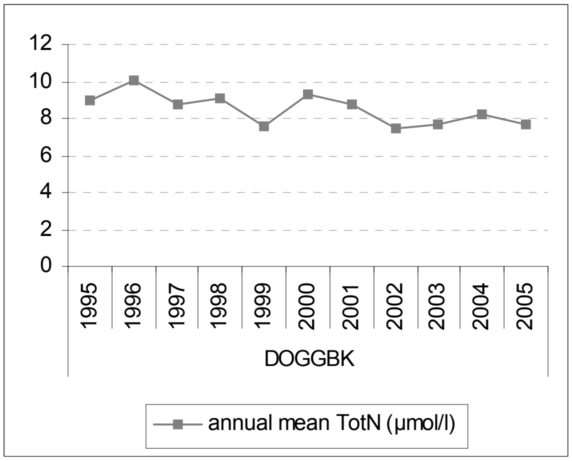


Fig. A7.3. Annual mean concentration of TotN (µmol/l) on the Dogger Bank. No assessment level.

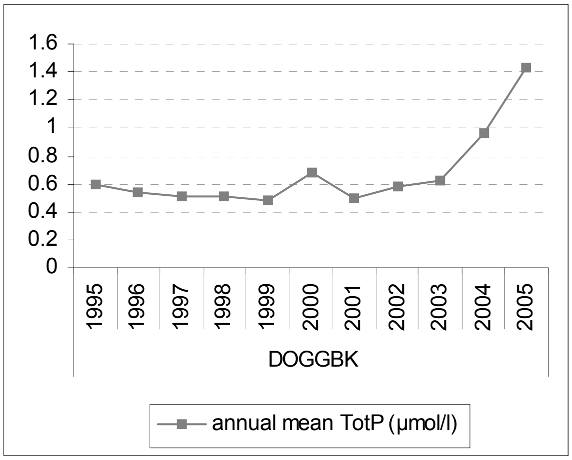


Fig. A7.4. Annual mean concentration of TotP (µmol/l) on the Dogger Bank. No assessment level.

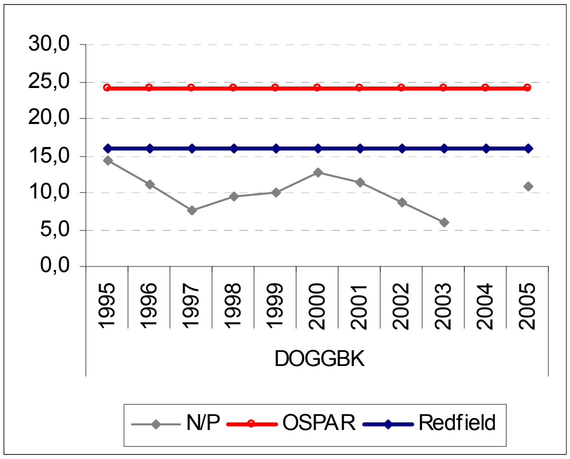


Fig. A7.5. N/P ratio on the Dogger Bank calculated with the winter mean concentrations of DIN and DIP.

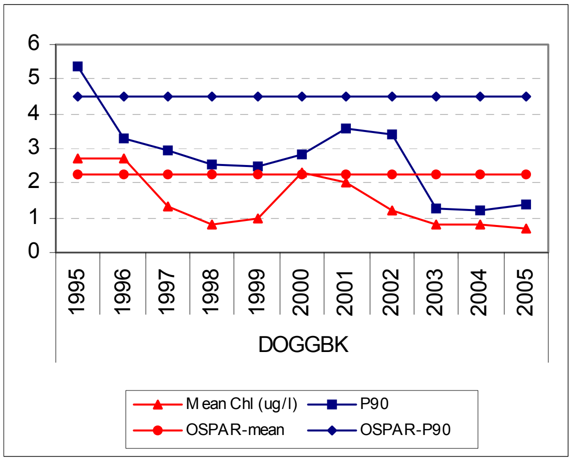


Fig. A7.6. Summer (March-Sept) mean summer 90-percentile concentration of chlorophyll-*a* (µgl/l) on the Dogger Bank. OSPAR-mean: OSPAR assessment level for mean values; OSPAR-P90: idem for 90-percentile values.

Annex 7 Dogger Bank

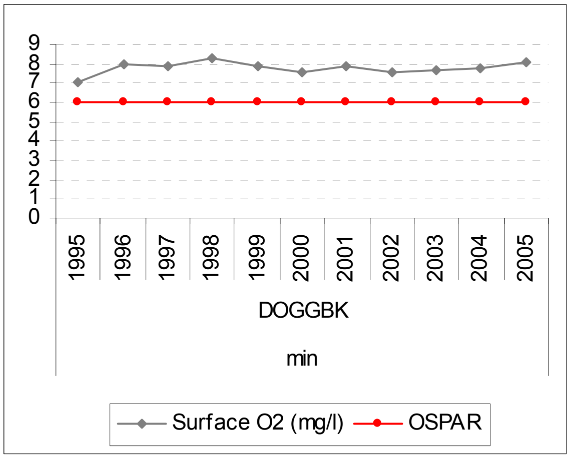


Fig. A7.7. Annual minimal oxygen concentration (mg/l) in the surface layer on the Dogger Bank.

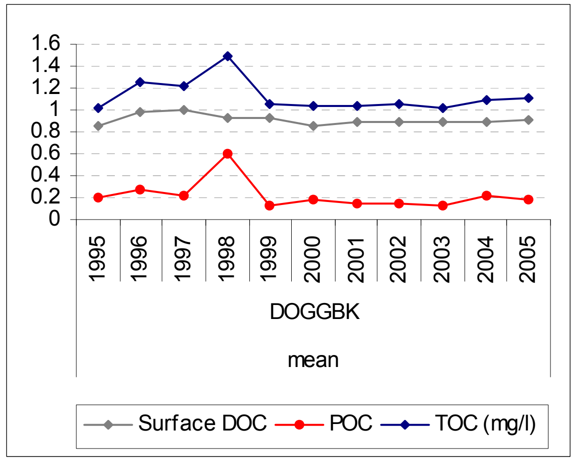


Fig. A7.8. Annual mean concentrations of organic carbon (mg/l) on the Dogger Bank; TOC = total, POC = particulate and DOC = dissolved organic carbon. No assessment level

Annex 7 Dogger Bank

Annex 8
Results of air-borne surveys

Annex 8 Results of airborne surveys

Fig. A8.1: shows results from “event monitoring” using airborne surveillance remote sensing (in the context of the Bonn Agreement), and sea-truth sampling in the observed surface algal blooms (for surface area coverage larger than 5 km^2. Most of these surface orange coloured algal blooms are from *Noctiluca scintillans* that form dense surface layers during the algal growing season during calm, sunny weather conditions in Dutch marine Coastal waters (sal. >34.5). When these layers persist for more than 2-3 days O_2 concentrations below the surface algal blooms may reach values lower 6 mg/l.

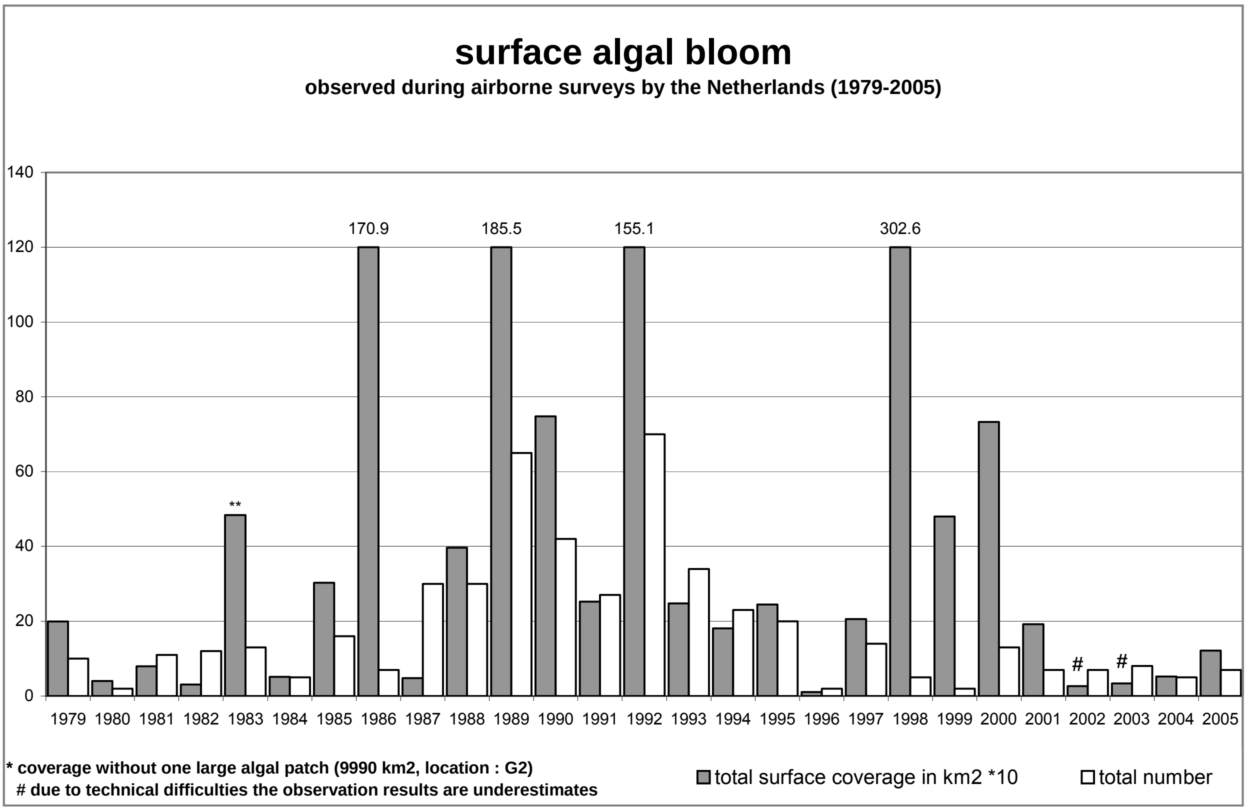


Fig A8.1. The total surface in 10 km^2, covered with algal blooms which are observed with airborne surveys, together with the number of algal blooms.

Annex 8
Results of air-borne surveys

Annex 9
Comparison of two Phaeocystis classification tools

Annex 9. Comparison of two *Phaeocystis* classification tools

In OSPAR the assessment of the indicator species *Phaeocystis* is based on the maximum number of cells/l with as assessment level 10^7 cells/l. The basis of the value is the assumption that a normal bloom has 10^6 cells/l and that an extreme bloom has at least 10^7 cells/l.

In WFD the bloom frequency has taken as criterion for the assessment of *Phaeocystis*. The basic assumption is that one or two months a year with blooms of at least 10^6 cells/l is considered to be normal. The percentages of months with *Phaeocystis* blooms in one year has been taken as indicator. So one month with a *Phaeocystis* bloom is 1/12 ∗100% =8.3% and two months with a bloom is 2/12 ∗100% = 16.7%, etc. The following assessment levels has been used:

Phaeocystis	high	good	moderate	poor	bad
Frequency (%)					
		10	17	35	80

The advantage of the bloom frequency as indicator in comparison to the maximal number of cells is that the duration of a bloom is indirect included in this indicator, because a bloom that exists more than one months is counted twice or maybe even three times, resulting in a lower Ecological Quality Ratio..

In the example below the results for *Phaeocystis* for the station Noordwijk 2 are given according to the OSPAR method and to the WFD method. Red means for OSPAR: problem area and for WFD: moderate, poor or bad. Green means: for OSPAR: no problem area and for WFD: high or good. When the results according to both methods are identical this is indicated by OK (and green), otherwise by X (and red).

The left table gives the annual results and the right one the results averaged over a period of five years. For OSPAR an area is a problem area over the whole period if it is a problem area in three or more years, otherwise it is a non-problem area. For WFD: the average frequency over a period of five years is the mean value of the annual frequencies.

Dutch coastal zone, station Noordwijk 2 per year

	OSPAR max nr cells/l	WFD:Freq. Jan-Dec(%)	Comparison
1991	1.24E+08	16.7	X
1992	6476190	25.0	X
1993	2676860	8.3	OK
1994	31271200	16.7	X
1995	47218000	16.7	X
1996	26571600	25.0	OK
1997	1.39E+08	33.3	OK
1998	1.19E+08	25.0	OK
1999	96565200	25.0	OK
2000	1969701	8.3	OK
2001	57441700	25.0	OK
2002	87719	0.0	OK
2003	46969650	25.0	OK
2004	7222220	8.3	OK
2005	5555560	25.0	X
2006	259000	0.0	OK

Dutch coastal zone, station Noordwijk 2 per period of 5 years

from	to	OSPAR Assessment	WFD Freq. (%)	Comparison
1991	1995	+	16.7	X
1992	1996	+	18.3	OK
1993	1997	+	20.0	OK
1994	1998	+	23.3	OK
1995	1999	+	25.0	OK
1996	2000	+	23.3	OK
1997	2001	+	23.3	OK
1998	2002	+	16.7	X
1999	2003	+	16.7	X
2000	2004	-	13.3	OK
2001	2005	-	16.7	OK
2002	2006	-	11.7	OK

The advantage of the WFD method is that the duration of blooms is taken into account to some extent.

Annex 9
Comparison of two Phaeocystis classification tools

Annex 10
Comparison of the assessment of the phytoplankton status according to OSPAR and WFD

Annex 10. Comparison of the assessment of the phytoplankton status according to OSPAR and WFD

In Table 1 the differences between OSPAR and the WFD are given.

Table 1. Definitions according to OSPAR and WFD

	OSPAR	**WFD**
Target areas	**marine waters:** whole Dutch Continental Shelf, divided into: Coastal waters (Sal. <34.5) Three offshore areas (Sal. >34.5) **estuarine waters:** Wadden Sea Westerscheldt Ems-Dollard	**marine waters:** Coastal waters within 1 nautical mile from the coast, divided into: Zeeland coast Northern Delta Coast Holland coast Wadden Coast Ems-Dollard Coast **estuarine waters:** Wadden Sea Westerscheldt Ems-Dollard
Data	Data of all stations in an area have been used over the period March to September (incl).	Data of only one station per area have been used over the period March to September (incl).
Chlorophyll-a	**Criterion:** mean and 90-percentile **Calculation:** calculated as mean value and 90-percentile of all samples in all relevant months in all stations in the target area. **Threshold:** area-specific.	**Criterion:** 90-percentile **Calculation:** In general more samples have been taken during the summer months. To avoid overrepresentation of months with more than one sample, monthly means have been calculated per station/area. From these monthly means the 90-percentile value has been calculated. **Threshold:** area-specific.
Phaeocystis	**Criterion:** The number of cells/l. **Threshold:** 10^7 cells/l: boundary between no problem and problem area.	**Criterion:** The frequency of extreme blooms per year. An extreme bloom has been defined as a concentration above 10^7 cells/l. **Threshold:** 2 months/year: boundary between good and moderate.
Other criteria	Nutrients, other indicator species, Oxygen.	None; nutrients are used as supporting quality elements.
Final judgement	Minimal score (“*one out all out*”)	The minimal value of the chlorophyll score and the mean value of the chlorophyll and *Phaeocystis* scores.

With respect to the target areas the following comparisons can be made:

1. OSPAR coastal waters with the combined score of the WFD coastal areas: Zeeland coast, Northern Delta Coast, Holland coast, Wadden Coast and Ems-Dollard Coast.
2. Wadden Sea
3. Ems-Dollard and
4. Westerscheldt.

In Table 2 the assessment by WFD (left column) and by OSPAR (right column) is given. The WFD scores are expressed in Ecological Quality Ratios with the following colour code: blue = high (EQR 0.8 –1); green = good (EQR 0.6 - 0.8); yellow = moderate (EQR 0.4 –0.6); orange = poor (EQR 0.2 –0,4);

Annex 10
Comparison of the assessment of the phytoplankton status according to OSPAR and WFD

and red = bad (EQR 0 –0.2). OSPAR distinguishes non-problem areas (green) and problem areas (red). In the middle column the “translation” of the WFD colours into the OSPAR colours is given.

Table 2. Assesment by WFD and OSPAR. The numbers in the WFD column are the calculated EQR’s.

	WFD mean over 2001-2005		**WFD in OSPAR colours**		**OSPAR mean over 2001-2005**
Phaeocystis score					
ED coast	0.58				
Wadden coast	0.51				
Holland coast	0.69				
N Delta coast	0.61				
Zeeland coast	0.71				
Wadden Sea	0.50				
Ems-Dollard	0.93		*		
Westerscheldt	0.66				
Chlorophyll-a score					
ED coast	0.78				
Wadden coast	0.67				
Holland coast	0.65				
N Delta coast	0.50				
Zeeland coast	0.49				
Wadden Sea	0.50				
Ems-Dollard	0.78		*		
Westerscheldt	0.61				
Final score**					
ED coast	0.68				
Wadden coast	0.58				
Holland coast	0.63			~	
N Delta coast	0.50				
Zeeland coast	0.49		0.58		
Wadden Sea	0.47			~	
Ems-Dollard	0.78		*	≠*	
Westerscheldt	0.58		***	~	

*Ems-Dollard: The Ems-Dollard scores by OSPAR and by KRW can not be compared, but because the assessed areas are not identical. In OSPAR the Ems-Dollard comprises the whole estuary, while in the WFD it comprises only the inner part.
**The final score for WFD is the lowest value of on the one hand the mean of the *Phaeocystis* and chlorophyll score and on the other hand the chlorophyll score. OSPAR uses the principle “one out, all out”. In this comparison only the chlorophyll concentrations and the *Phaeocystis* occurrence have been taken into account.
***Westerscheldt: At first sight it looks strange that the final score in the Westerscheldt is red, while *Phaeocystis* and chlorophyll both score green. This can be explained by how the *Phaeocystis* and chlorophyll scores are combined, with a final score for each year that never can exceed the chlorophyll score.

In conclusion: The WFD scores (expressed as Ecological Quality Ratio’s) of the different parts of the Dutch coastal zone are not identical: the Holland coast, Northern Delta Coast and Zeeland coast score better than the Wadden Coast and the Ems-Dollard coast, but the final assessments of all Dutch coastal water bodies together according to WFD with a mean EQR score = 0.58 correspond well with the assessment of the

Annex 10
Comparison of the assessment of the phytoplankton status according to OSPAR and WFD

coastal waters by OSPAR. The same is true for the Wadden Sea and the Westerscheldt. The differences for the Ems-Dollard estuary can be explained by the differences in the area assessed by WFD and OSPAR.