Report on the third application of the

OSPAR Comprehensive Procedure to the Dutch marine waters

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OSPAR Comprehensive Procedure to the Dutch marine waters

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Main text

1. Summary

This report contains the third application of the OSPAR Comprehensive Procedure to assess the eutrophication status of the Dutch marine waters for the nine-year period 2006-2014. A comparison with previous years addressed in the second (2001-2005) application of the Comprehensive Procedure for Dutch North Sea waters and estuaries has been made.

Despite a reduction of phosphate and nitrogen in riverine inputs and emission reductions at source of (N) and (P) in the Netherlands during the past decades, five out of seven subareas of the Dutch continental shelf are classified as a problem area in terms of eutrophication.

In the Coastal Waters, the Wadden Sea, the Western Scheldt and the Ems Dollard estuary, winter DIN and DIP concentrations were above elevated level. In the 2001-2005 assessment period in some areas, in particular in the Wadden Sea, a reduction could be observed in the whole assessment period. This is, not the case in the recent assessment. Only in the Wadden Sea winter DIP concentrations decrease to very close to and even below the assessment level in the years between 2011 and 2014.

The decreasing tendency for chlorophyll in the Coastal Waters and the Wadden Sea of which the beginning was hinted at in the earlier assessment periods is continuing. In the Western Scheldt estuary, however, the chlorophyll concentrations were highly variable with peaks as high as in 1995.

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 still based on the direct effects of eutrophication, expressed in concentrations above assessment levels of the nuisance phytoplankton indicator species *Phaeocystis* sp. This is probably caused by transboundary transport of water 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. For the nuisance phytoplankton indicator species, *Phaeocystis* the spatial gradient in concentrations in the Dutch southern part of the North Sea tracks the spatial gradient in the nutrient concentrations.

2. Introduction

This third report on the Eutrophication status of the Dutch marine waters in the period 2006-2014 is based on the OSPAR Common Procedure (COMP) as defined in the OSPAR agreement No. 2013-8, and on the guidance and examples on form and content of national reports (Annex 5 of the HASEC Summary Report 2015).

OSPAR agreement No. 2013-8 (OSPAR, 2013) is an update of 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), which are used for the first (1996-2000) and the second (2006-2014) applications of the COMP. The results of the assessment of the Dutch marine waters described in this report for the period of 2006-2014 are compared to the results with the two earlier applications of the Comprehensive Procedure (OSPAR 2002; Baretta-Bekker et al., 2008).

New in OSPAR agreement No. 2013-8 in comparison to No. 2005-3 are confidence ratings and trend assessments. Parts of the text of the second Dutch assessment report, e.g. the descriptions of the areas, have been copied into this report, sometimes with small textual adaptations.

3. Description of the assessed area

The Dutch continental shelf (Figure 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 subareas, of which the eutrophication status has been assessed separately (see Figure 1). The subareas 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 Subareas

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 from 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 annual mean salinity varies between 25 and 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 annual mean salinity varies between 21 and 27.

Ems-Dollard estuary The Ems-Dollard is a turbid 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 annual mean salinity varies between 20 and 24.

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 subareas:

Southern Bight offshore, the southern part of the Dutch continental shelf is not very deep (30 m) and tidally mixed. The sediment is partly coarse and partly fine sands. The total amount of nitrogen and phosphate originates from the waters flowing from the Channel, The Netherlands 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 maybe thermally stratified during summer. The sediment is a mixture of fine sand and silt. The Oyster Grounds receive waters from United Kingdom and from the Atlantic Ocean in almost equal proportions, with minor contributions from the Channel, The Netherlands and France.

Dogger Bank, the utmost part of the Dutch continental shelf receives mainly waters from the northern boundary (Atlantic Ocean) with small contribution from United Kingdom France and the southern border (Channel).

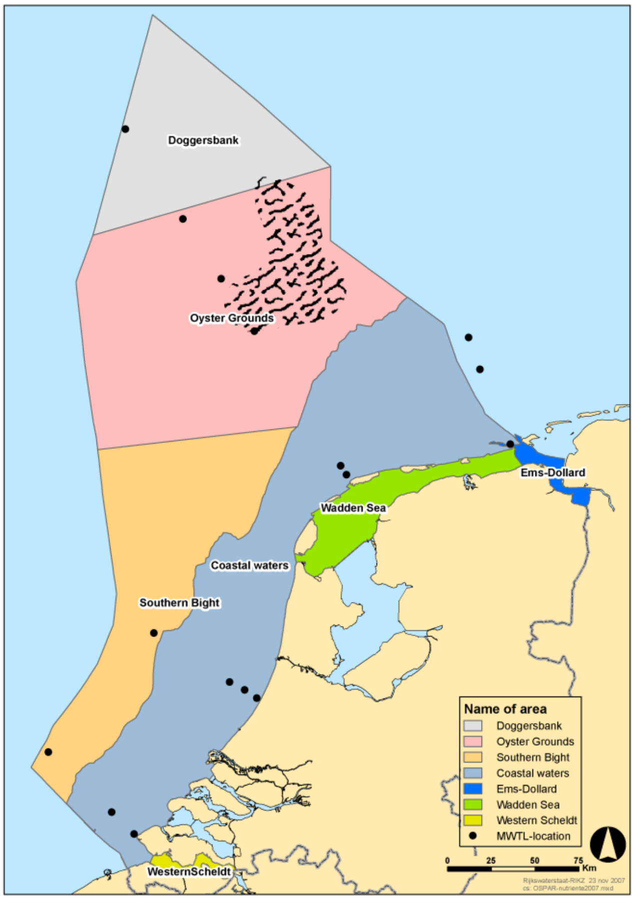


Figure 1. The Dutch continental shelf with the seven subareas: Coastal Waters (the border of the Coastal Waters is the decadal average 34.5 isohaline), Wadden Sea, Western Scheldt, Ems-Dollard estuary, and Offshore waters (salinity > 34.5) divided into: Southern Bight offshore, Oyster Grounds and Dogger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

4 Methods and data

In Table 1 the parameters of the holistic checklist are given with their dimension, 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 holds 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 Table 1) winter silicate, the annual mean concentrations of total nitrogen (TotN) and total phosphorus (TotP) are given, as well as the oxygen saturation.

In this assessment period, winter has been defined as described in the COMP (OSPAR agreement No. 2013-8) as the months November and December of year 0, and January and February, of year 1. In the Assessment 2001-2006 winter did not include the month November, which is also the case in the WFD.

For details on the measuring period of the year and frequency, see Table 1. In Table 2 the data availability has been given and in Figure 1 the Dutch subareas and the monitoring stations, which lie mainly on transects perpendicular to the coast.

With respect to the adequacy of monitoring of the integrated set of the parameters of the Comprehensive Procedure the following can be concluded (Table 3): The monitoring in all seven subareas of the parameters 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 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 3. 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	O2	Degree of oxygen deficiency
NP	Increased winter N/P ratio	Ck	Changes/kills in zoobenthos and fish kills
Ca	Max and mean chlorophyll a concentration	Oc	Organic carbon/organic matter
Ps	Area-specific phytoplankton indicator species	At	Algal toxins (DSP/PSP mussel infection events

+: Sufficient monitoring; -: insufficient monitoring

CP: area classified as PA or PPA	**Freq / Spatial Coverage Category I Degree of nutrient enrichment**		**Freq / Spatial Coverage Category II Direct effects**		**Freq / Spatial Coverage Category III and IV Indirect/other possible effects**		**Freq / Spatial Coverage Category II Direct 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	**n.r.**	Oc	**-** (sedim. areas)		

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**							
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		**C**	**Wa**	**We**	**ED**	**S**	**O**	**D**
						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	0.60 .8
	N/P ratio	Winter: XII-I-II;	Mean N/mean P	Surface: -1m	mol/mol	Redfield N/P = 16 Elevated levels >25							
II. Direct Effects	Chlorophyll <u>a</u> concentration	Growing season III- IX (incl) 2 x per month	Mean	Surface: -1m; at half depth; near bottom	μg/l	Background Elevated level	5 7.5	8 12	3 4.5	6 9	1.5 2.25	1.5 2.25	1.5 2.25
			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*	Whole year 1 à 2x per month	Maximum number of cells/l	Surface: -1m; at half depth; near bottom	Cells/l	Elevated bloom level > 10^7 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 subareas

Table 2. The subareas 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.

Area	Stations	Chl-a µg/l	Org C mg/l	O2 mg/l	Phyto cells/l	N and P µmol/l
Coastal Waters	GOERE2 (from 2007)					
	GOERE6	+	+	+	+	+
	NOORDWK10	+	+	+	+	+
	NOORDWK2	+	+	+	+	+
	NOORDWK20	+	+	+	+	+
	ROTTMPT3	+	+	+		+
	ROTTMPT50	+	+	+		+
	ROTTMPT70	+	+	+		+
	SCHOUWN10	+	+	+		+
	TERSLG10	+	+	+	+	+
	TERSLG4	+	+	+	+	+
	BOOMKDP (from 2007)					
	WALCRN2	+	+	+	+	+
	WALCRN20	+	+	+	+	+
Wadden Sea	BLAUWSOT					+
	DANTZGT	+	+	+	+	+
	DOOVBOT					+
	DOOVBWT	+	+	+		+
	MARSDND	+	+	+	+	+
	VLIESM	+	+	+		+
	ZOUTKPLG					+
	ZOUTKPLZGT	+	+	+		+
	ZUIDOLWOT	+	+	+	+	+
Western Scheldt	HANSWGL	+	+	+	+	+
	LAMSWDBI59					+
	SCHAARVODD				+	
	TERNZBI20	+	+	+		+
	VLISSGBISSVH	+	+	+	+	+
	WIELGN					+
	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. For most parameters data are available from 1985, but only data from 1995-2014 have been presented. The assessment period (2006-2014) is compared with the assessment period 2001-2005.

The time series of the nutrients, chlorophyll-a and organic carbon (total, particulate and dissolved) consist of mean values of the assessed parameters. The time series of oxygen consist of the annual minimum values of the concentrations. For some of the parameters the values have been averaged over the whole year and for other parameters over a number of months, see Table 1. The nutrients and chlorophyll-a 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. As the conclusions based on oxygen concentrations are identical to those based on saturation percentages (see 5.5.3), only the oxygen concentrations have been presented in the assessment.

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

Area-specific 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. For the third Dutch application of the Comprehensive Procedure (COMP) only the nuisance alga species *Phaeocystis* sp. has been used. In 2005 at the EUC During the EUC 2005 meeting (EUC 05/13/1, Annex 9) it has been decided to skip the toxic algae as indicator species: "*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.

The duration of a *Phaeocystis* sp. 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 8).

The nutrient loads entering the Dutch marine waters have been extracted from the RID database by Bert Bellert (RWS, NL) and presented in OSPAR (2000 – 2015; 2005b).

An estimate has been made of the total atmospheric deposition into the Dutch part of the North Sea, based on the EMEP programme (Bartnicki & Fagerli, 2006) in a OSPAR summary report (OSPAR, 2007), but there is no update.

Transboundary nutrient transport estimate have been extracted from a model study, carried out in 2006 by WL | delft hydraulics (Blauw et al., 2006), see further 5.6.1.

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. In the Coastal Waters along the continental coast haline stratification can occur in calm periods with high freshwater discharges, with freshwater kept close to the coast by the Coriolus effect.

5. Eutrophication assessment

5.1 Assessment period

The assessment period is the period of 2006-2014 (inclusive). As comparison the results of the period 2001-2005 have been used. The assessments for each of the subareas are given in Annexes 1-7.

As for the former assessments the results of winter DIN and winter DIP in the Coastal Waters are normalized to a salinity of 30. In the Wadden Sea, the Western Scheldt and the Ems-Dollard, however, no correction for salinity has been applied, in contrast to the first assessment. The reason for this is that in these areas 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

Total riverine input Table 3 and Figure 2 give the total riverine input via the Rivers Rhine and Meuse. On behalf of NL COMP3 application they have been recalculated using the NL-Load module (2015), analytical data and flow data. Direct input from industrial and municipal sources is negligible.

Table 3. Riverine inputs from Rhine, Meuse and Lake Ijssel as well of total nitrogen (TotN) and total phosphorus (TotP) in kT y^{-1} into Dutch marine waters between 1995 and 2014.

	TotN	TotP
1995	522	33
1996	280	19
1997	266	15
1998	336	16
1999	332	17
2000	334	17
2001	338	11
2002	391	21
2003	237	11
2004	246	15

2005	225	9
2006	238	10
2007	280	12
2008	264	13
2009	211	10
2010	265	10
2011	210	6
2012	228	7
2013	270	9
2014	190	7

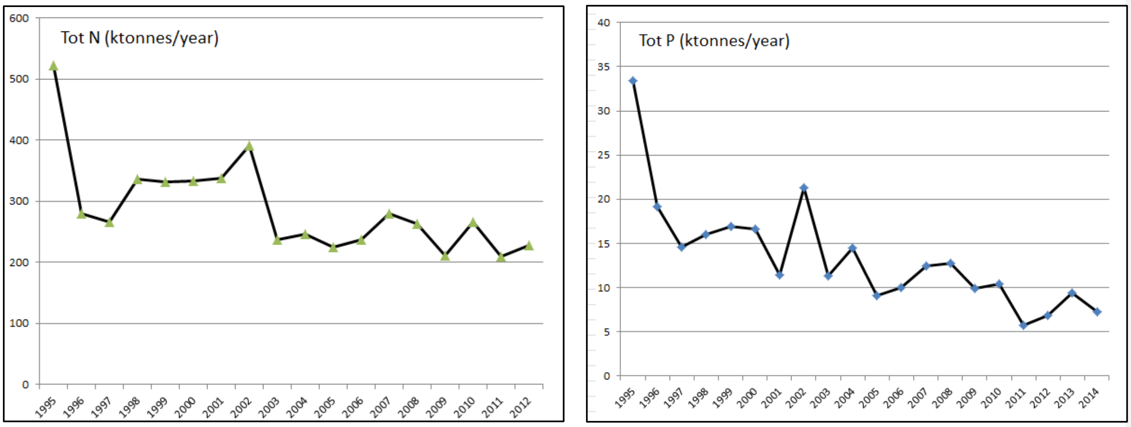


Figure 2. Riverine inputs of total nitrogen and total phosphorus in kT/y of all Dutch rivers (Rhine and Meuse) into Dutch marine waters between 1995 and 2014

Atmospheric deposition After the publication of the summary report on atmospheric deposition (OSPAR, 2007) with data on atmospheric deposition in the Greater North Sea for the period 2001-2004, originating from the EMEP programme no update has appeared. The data comprise observations as well as model output. Bartnicki and Fagerli (2006) estimated from these data 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 originated from atmospheric deposition. New data of nitrogen deposition up to 2013 are available in the CAMP reports (OSPAR, 2015), showing a decreasing trend.

winter DIN and DIP (Figure 3 and 4) In the estuaries and the Coastal Waters the measured winter (November, December, January and February) mean concentrations of DIN are above the assessment level, while the winter DIN concentrations are below the assessment level in the three offshore subareas. The winter DIP in the Coastal Waters and in the offshore areas show extreme outliers in two years of the assessment period. The extremes do not occur in the four areas simultaneously or all in the same years. The cause of these outliers is unknown. The slight decreasing tendencies that where visible in the estuaries and the Coastal Waters during the five years of the second assessment (2001-2005) can't be seen clearly in the recent assessment, except a decreasing tendency for winter DIP in the Wadden Sea to below the assessment level of 0.7 µmol/l. In the offshore subareas there is no clear tremdemcy either in DIN or in DIP, as there was in the earlier periods.

Annual TotN and TotP (Figure 5 and 6) In the Coastal Waters no trend for annual mean Tot N is visible and annual mean TotP increases. The tendencies for TotN and TotP in the Wadden Sea and the estuaries differ from those in the offshore areas. In the near-shore areas the trend is more or less decreasing, while the offshore areas show increasing trends for TotN and to a lesser extent also in Tot P.

winter N/P ratio (Figure 7) For the offshore subareas the winter DIN/winter DIP ratio is far below the Redfield value (16), but for all other subareas it is above these levels, implying a **relative** excess of winter DIP in offshore areas and of winter DIN in the near-shore areas.

Category II (direct effects):

Chlorophyll-a The mean and the 90-percentile concentrations of chlorophyll in the growing season (March to September, incl.) have their 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 almost all cases except for one year. NB This rule of thumb is valid for the Dutch measurements and monitoring programme, but is not necessarily generally true.

In the Wadden Sea and Western Scheldt the annual mean concentrations remain above the elevated level, and in the Coastal Waters a clear decreasing tendency to below the assessment level in 7 out of the 9 years of the assessment period is seen. Also in the Wadden Sea a slight tendency is visible, but this is not the case for the Western Scheldt. In the Ems Dollard the chl-a concentrations are below the assessment level, possibly due to the high turbidity in that area.

The chlorophyll-a concentrations in the offshore area Southern Bight are lower than in the second period (2001-2005), but still above the assessment level in 5 out of the 9 years.

In the Oyster Grounds and Dogger Bank the chl-a concentrations are well below the assessment level without any clear tendency.

Area-specific phytoplankton indicator species On the Dutch continental shelf and in the estuaries only one indicator species has been assessed:

Phaeocystis sp. This nuisance alga has an assessment level of 10^7 cells/l and appears in the Coastal Waters and in the Wadden Sea (in 8 out of 9 years), but also in the Southern Bight (in 5 out of 9 years). In the transitional waters Ems-Dollard and Western Scheldt it is present in seven, respectively six years, while it does not appear in the Oyster Grounds and only in one year Dogger Bank.

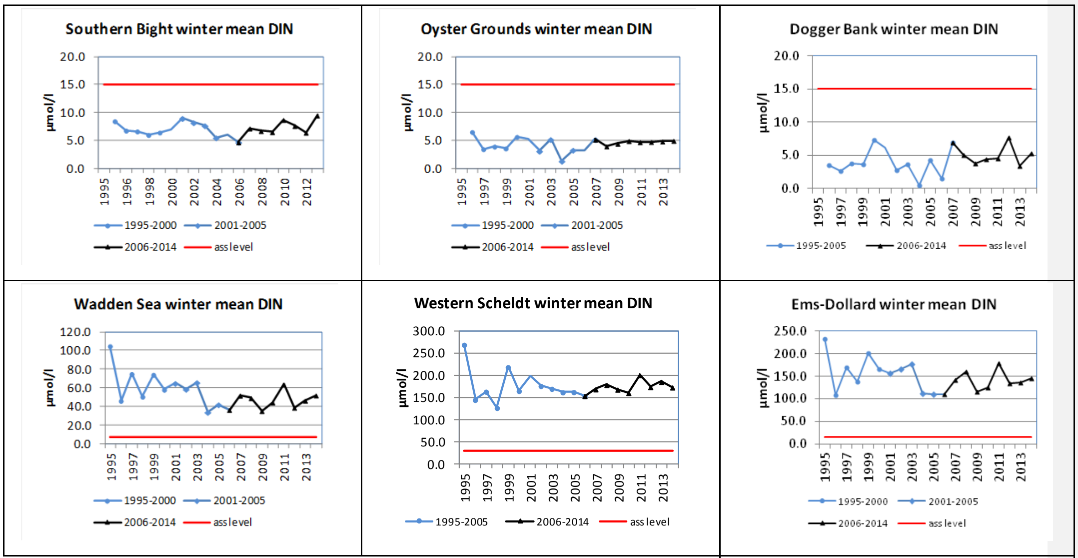
Although there is no detectable temporal trend, there is a clear spatial gradient for Phaeocystis, with blooms close to the coast in almost all years and the lack of extreme blooms in the offshore waters. This spatial gradient coincides with the spatial gradient in nutrients. In the more turbid estuaries it blooms occasionally.

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, minimum O_2 concentration (Figure 9) In this assessment period there is a very low O_2 concentration in the Coastal Waters in 2009, while there are no measurements in 2008. In the Wadden Sea the situation improved considerably, resulting in 5 out of 9 values above the assessment level of 6 mg/l. When the station close to the Belgian border, Schaar van Ouden Doel, in the Western Scheldt is included the oxygen concentration remains below the assessment level during the whole assessment period, but the trend is positive. Excluding this station, hence in the rest of the estuary Western Scheldt, in the Ems-Dollard and in the offshore areas the oxygen concentrations are always above 6 mg/l.

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



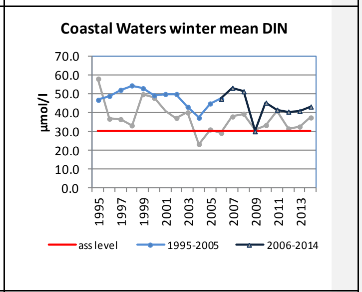
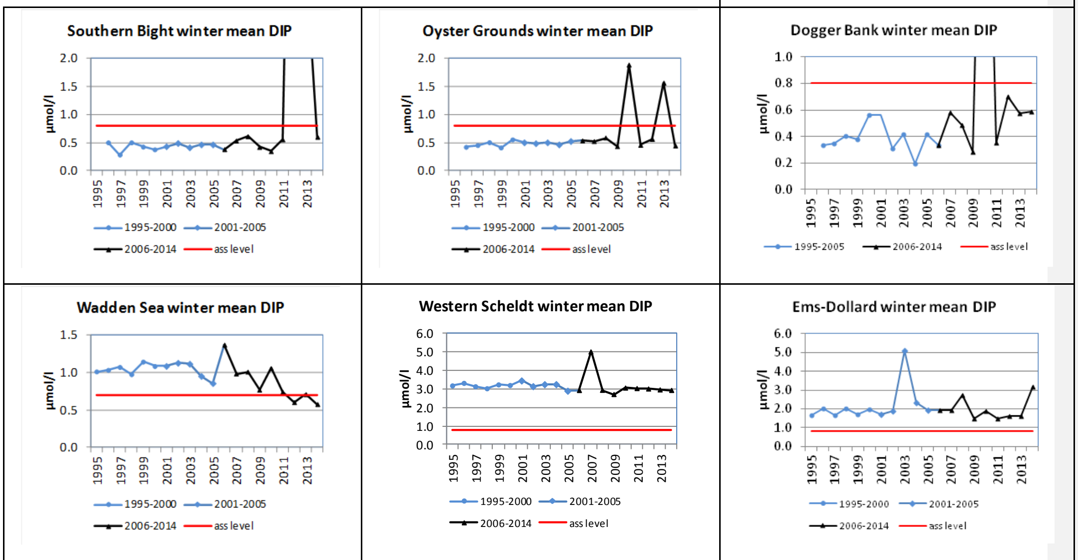


Figure 3 Concentrations of winter DIN (µmol/l) in the seven Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters with concentrations normalized to salinity 30. The grey line are the measurements.



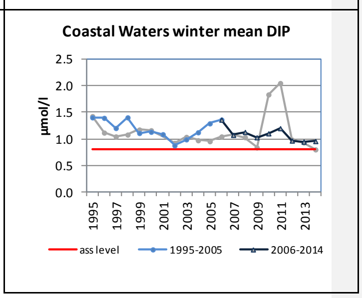
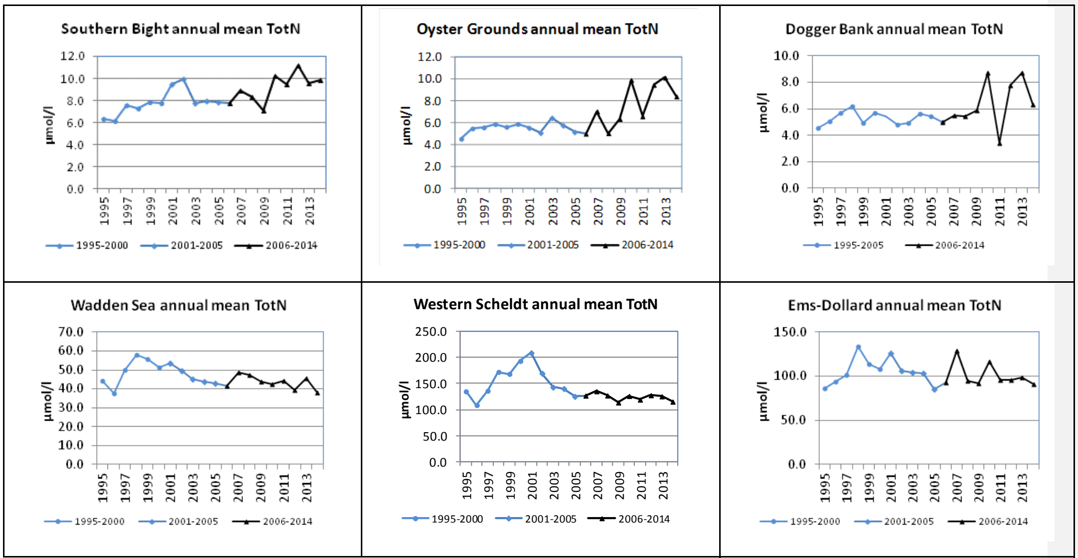


Figure 4 Concentrations of winter DIP (µmol/l) in the seven Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters with concentrations normalized to salinity 30. The grey line are the measurements.



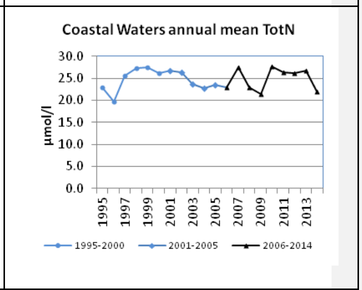
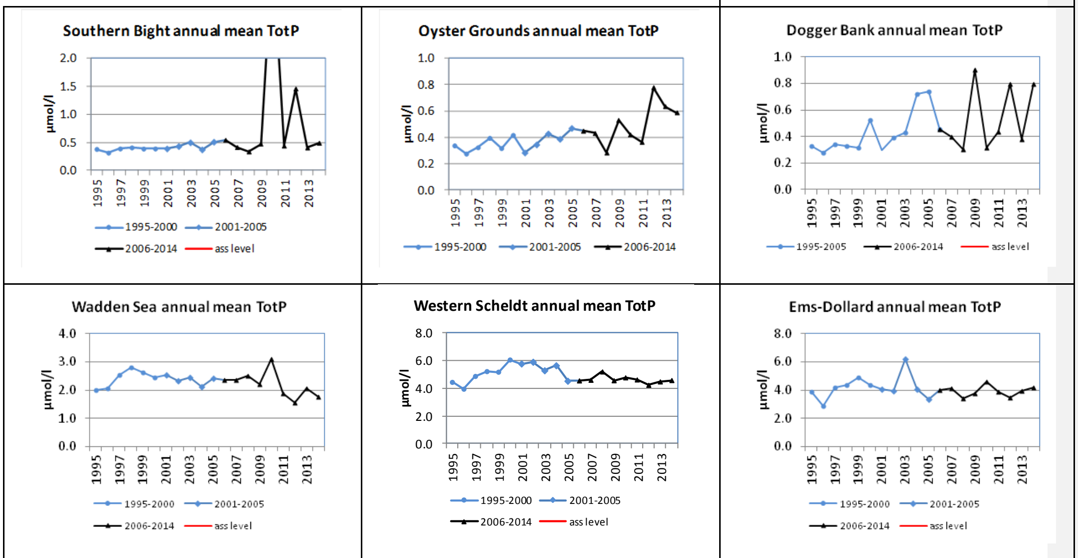


Figure 5 Concentrations of annual mean TotN (µmol/l) in the seven Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters.



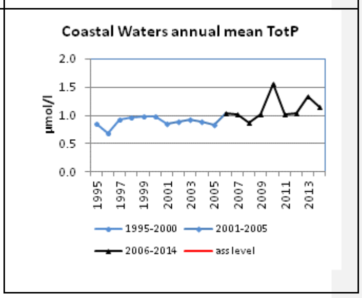
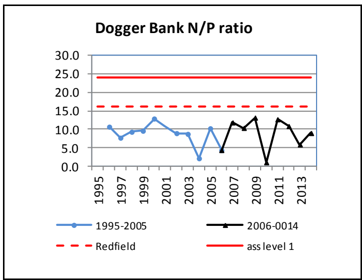
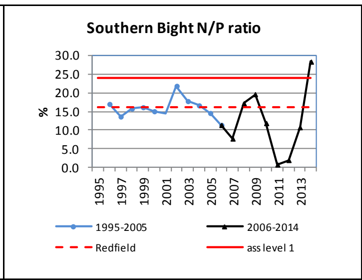
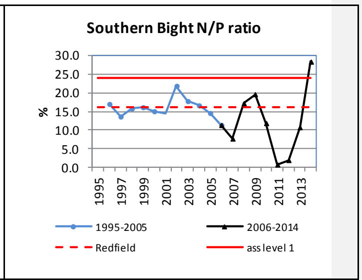
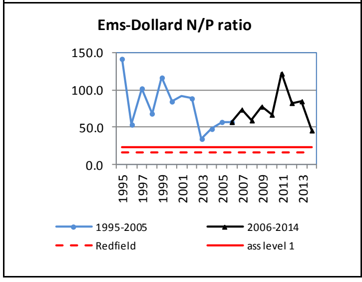


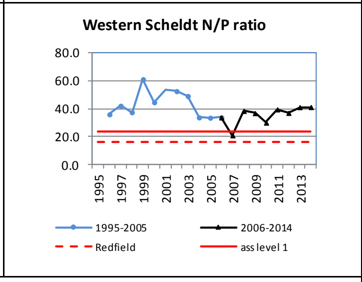
Figure 6 Concentrations of annual mean TotP (µmol/l) in the seven Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters.











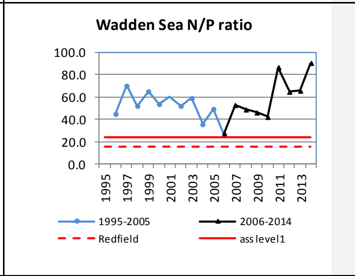
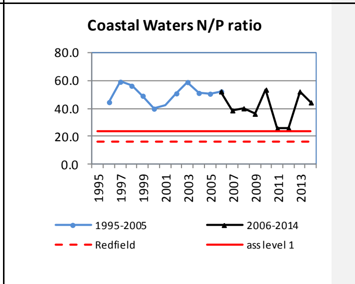
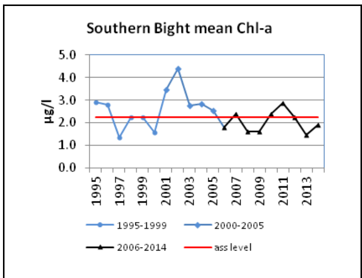
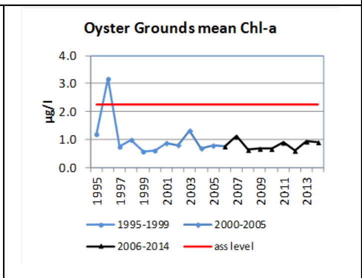
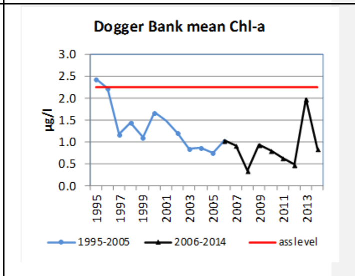


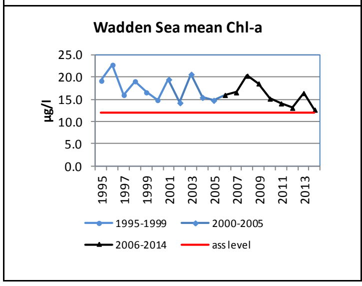
Figure 7 Concentrations of winter N/P ratio (-) in the seven Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters.

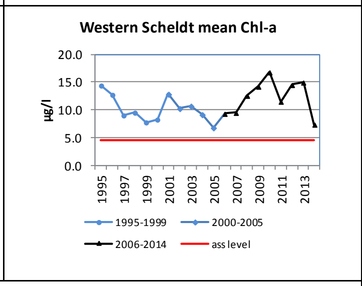












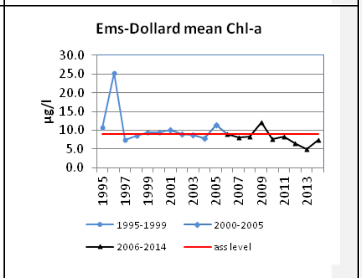
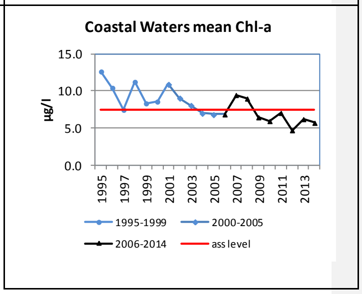


Figure 8 Concentrations of growing season chlorophyll-a (µg/l) in the seven Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters.



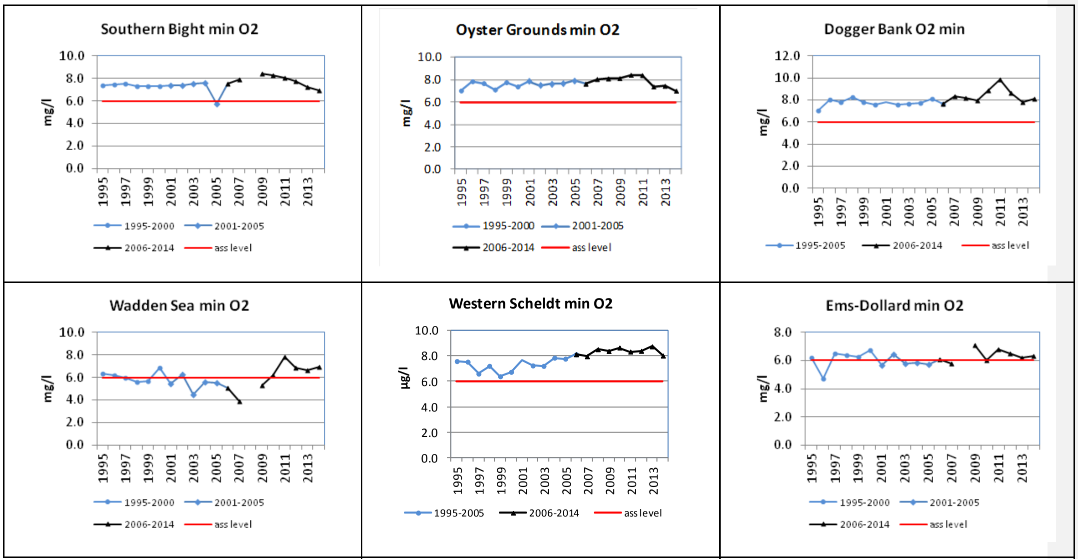
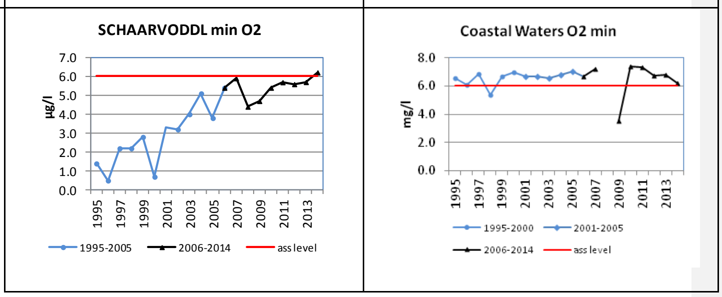


Figure 9 Concentrations of annual minimum O2 (mgl/l) in the Dutch OSPAR areas. Upper row: the offshore areas; Middle row: the Wadden Sea and the estuaries; and lower row: Coastal Waters. NB Western Scheldt is without station Schaar van Ouden Doel, which is shown separately.



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 Figure 3 shows the ranges for DOC, POC and TOC in the surface layer in all subareas 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.

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 and comparison with the previous assessment

Table 6 and Figure 10 presents the classification of the whole area over the assessment period 2006-2014. Figure 10 is identical to the classification in the previous period. In the 2001-2005 classification the offshore areas Oyster Grounds and Dogger Bank were non-problem areas, while all other subareas were classified as problem areas. This has not changed in the final assessment, but in 2001-2005 the Southern Bight offshore area was a problem area, because chlorophyll-a and the nuisance indicator species *Phaeocystis* reached bloom densities above the assessment level, while in the final assessment the Southern Bight offshore area is a problem area, based on the number of cells/l of *Phaeocystis* only. The Coastal Waters, Wadden Sea, Western Scheldt, and Ems-Dollard were problem areas due to the exceeding of almost all criteria in these areas. In the final period, however, the oxygen situation has improved in Wadden Sea and Ems-Dollard, and the oxygen concentrations are now above the assessment period in all subareas. In Figure 11 the individual results for the criteria DIN/DIP, chlorophyll-a, the nuisance phytoplankton indicator species (i.e. *Phaeocystis*) and oxygen in both periods are showed.

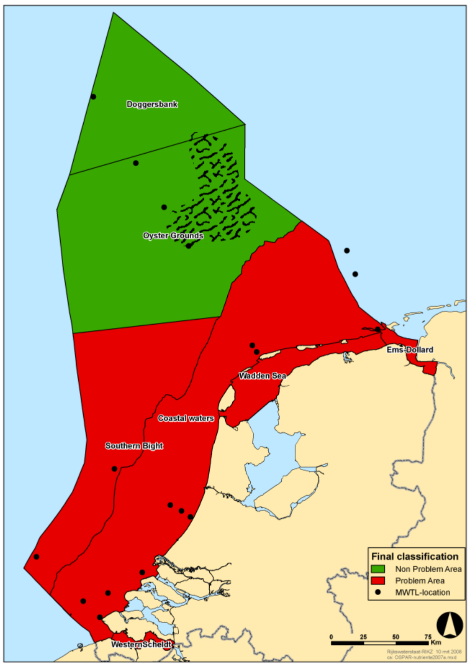
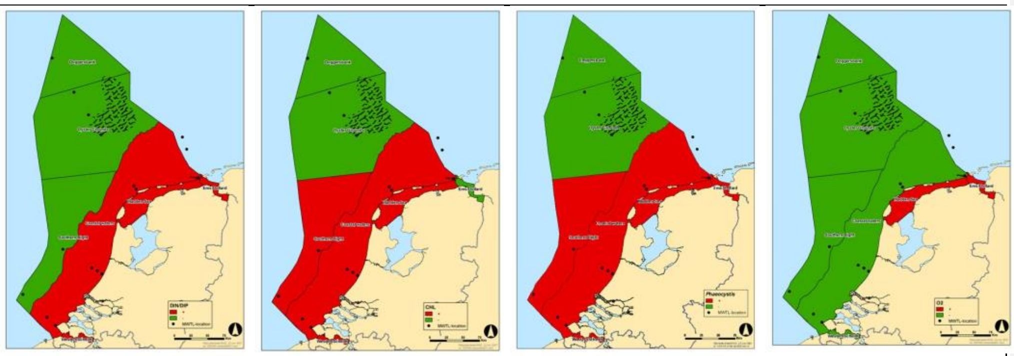
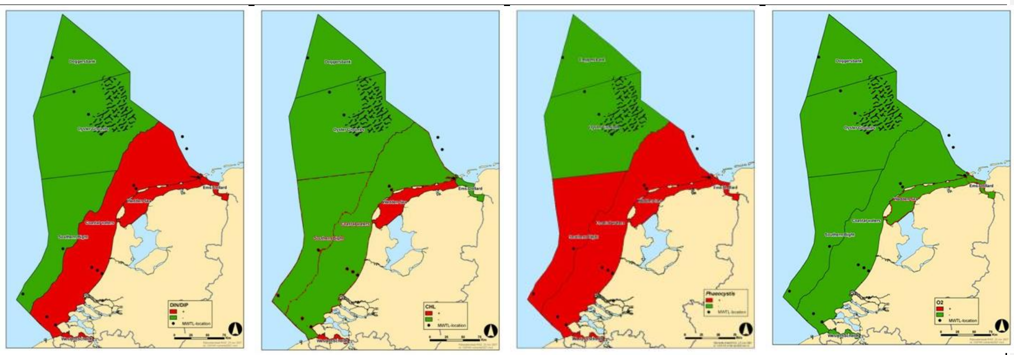


Figure 10. Overall assessment results: Classification at the end of the assessment period 2006-2014, which is identical to the classification over the previous period 2001-2005. Red: Problem Area; Green: Non-Problem Area. Black shading: Oyster Grounds proper.



DIN DIP	Chlorophyll-a	*Phaeocystis* sp.	Oxygen

2000 - 2005



DIN DIP	Chlorophyll-a	*Phaeocystis* sp.	Oxygen

2006 - 2014

Figure 11. Final classification results per criterion: DIN/DIP, chlorophyll-a, *Phaeocystis* sp. and oxygen of the previous assessment period (2001-2005; upper rows) and of the recent assessment period (2006-2014; lower rows). Red: Problem Area; Green: Non-Problem Area. Black shading: Oyster Grounds proper. NB The O_2 results for the Western Scheldt are based on the observations in that area without the observations of the station close to the Belgian border (Schaarvoddl).

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, 2006-2014	Problem area in 2006-2014 based on nutrients and *Phaeocystis*; no change in overall status compared to previous years (2001-2005); averaged result is identical to ‘per year’ result, except Chl + in 2007,2008; Ps in 2006; O_2 in 2009 (2008 missing); *Influenced by Rhine, and to lesser extent by Meuse and Scheldt.*	PA	2006-2014 comparison 2001-2005
	DI	+	Mp	n.r.	Oc							
	NP	+	Ca	+	O2	-	At	-				
Wadden Sea	NI	?	Ps	+	Ck	?			Problem area, 2006-2014	Problem area in 2006-2014 based on all assessment parameters except oxygen; no change in overall	PA	2006-2014 comparison
	DI	+	Mp	n.r	Oc							

	NP	+	Ca	+	O2	-	At	-		status compared to previous years (2001-2005); averaged result is identical to 'per year' result, except for DIP in 2012, 2014; Ps in 2009; O_2 in 2006, 2007, 2009 (2008 missing); *Influenced by coastal river (80%) and lake IJssel, through river Rhine.*		2001-2005
Western Scheldt	NI	?	Ps	+	Ck	?			Problem area, 2006-2014	Problem area in 2006-2014 based on all assessment parameters except O_2 (without station at Belgian border); no change in overall status compared to previous years (2001-2005); averaged result is identical to 'per year' result, except for Ps in 2006, 2009, 2012 except Ps in 2006,2009, 2012; O_2 in 2014; NB the station close to the Belgian border (Schaarvoddl) is PA for O_2 *Influenced by Scheldt.*	PA	2006-2014 comparison 2001-2005
	DI	+	Mp	n.r	Oc							
	NP	+	Ca	+	O2	+	At	-				
Ems-Dollard	NI	?	Ps	+	Ck	?			Problem area, 2006-2014	Problem area in 2006-2014 based on all assessment parameters, except chl; no change in overall status compared to previous years (2001-2005); averaged result is identical to 'per year' result, except chl in 2009; Ps in 2009, 2012; O_2 in 2007. *Influenced by Ems river and outlets of estuary*	PA	2006-2014 comparison 2001-2005
	DI	+	Mp	n.r	Oc							
	NP	+	Ca	-	O2	+	At	-				
Southern Bight offshore	NI		Ps	+	Ck	?			Non-Problem area, 2006-2014	Problem area in 2006-2014, only based on the assessment parameter *Phaeocystis*; no change in overall status compared to previous years (2001-2005); averaged result is identical to 'per year' result, except DIP in 2012,2013; chl-a in 2007, 2010, 2011; Ps in 2006, 2007, 2010, 2013. *Influenced by waters flowing from the Channel, NL and Belgium*	PA **,** trans-boundary transport	2006-2014 comparison 2001-2005
	DI	-	Mp	n.r.	Oc	-						
	NP	-	Ca	+	O2	-	At	-				
Oyster Grounds	NI		Ps	-	Ck	?			Non-Problem area, 2006-2014, based on toxic Ps	Non-problem area; averaged result is identical to 'per year' result, except DIP in 2010, 2013. Change in overall status overall compared to first assessment (1995-2000) due to change in toxic algae criterion. *Receiving waters from Atlantic Ocean and UK*	NPA	2006-2014 comparison 2001-2005
	DI	-	Mp	n.r.	Oc							
	NP	-	Ca	-	O2	-	At	-				

Dogger Bank	NI		Ps	-	Ck	?			Non-Problem area, 2006-2014, based on	Non-problem area; averaged result is identical to 'per year' result, except for DIN in 2010 and *Phaeocystis* in 2006. No change in overall status compared to previous years (2001-2005, see OSPAR 2003: the so-called Dutch outer northern offshore waters). *Receiving waters from mainly Atlantic Ocean, and to a minor extent from UK*	NPA	2006-2014 comparison: ~2001-2005 ~1995-2000
	DI	-	Mp	n.r.	Oc							
	NP	-	Ca	-	O2	-	At	-				

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

5.5 Voluntary parameters

5.5.1 Transboundary nutrient transport

In 2006 a model study has been carried out by WL | delft hydraulics (Blauw, et al., 2006). Assuming that the transport pattern has not changed since 2006, the same model result have been used as in the earlier assessment report (Baretta-Bekker et al., 2008). 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.

Transboundary nutrient transport of Nitrogen In Table 7 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 Figure 12a 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, The Netherlands and France. In the Southern Bight offshore nitrogen mainly comes from the Channel, The Netherlands and Belgium (not shown).

Transboundary nutrient transport of Phosphate Table 8 gives the same information for P as Table 7 for N and from Figure 12b 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

5.5.2 Silicate

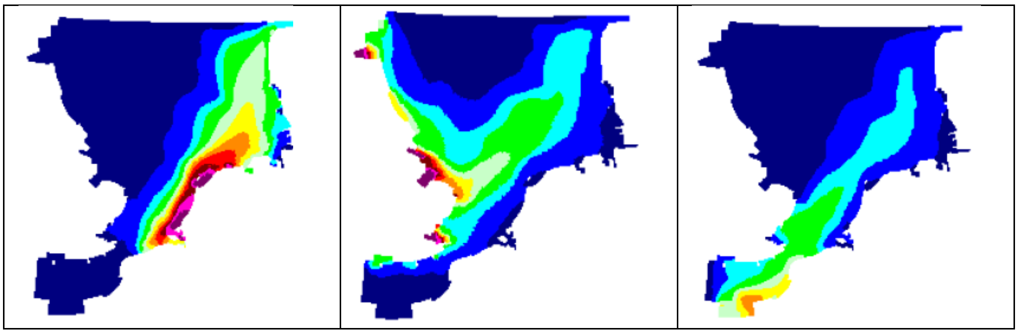
For this report also the winter SiO_2 concentrations have been taken into account. In all subareas the concentrations are very variable from year to year. The ranges of concentrations differ considerably between the subareas (Table 9). The lowest concentrations are found in the Coastal Waters, followed by the three offshore areas. The Wadden Sea has higher concentrations and the two estuaries have the highest values. For each subarea the ranges are much the same as in the previous periods.

Table 9. Ranges of the winter mean SiO_2 concentrations in the seven areas.

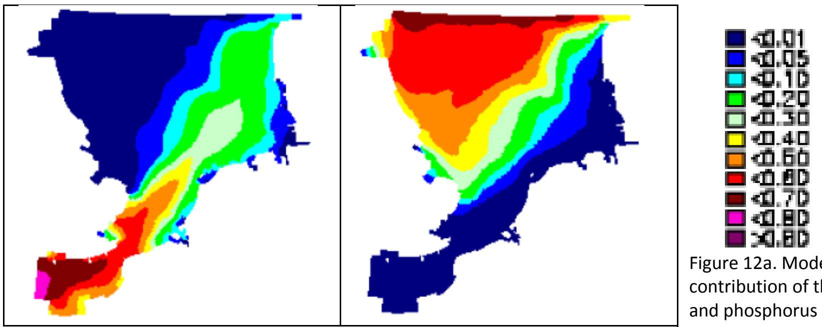
winter SiO_2 (µmol/l)	**CW**	**WS**	**Wsc**	**ED**	**SB**	**OG**	**DB**
min	0.4	10.9	65.9	72.3	1.1	3.1	0.4
mean	0.5	26.8	91.0	81.8	1.7	3.8	2.1
max	0.6	35.9	112.7	95.9	2.5	4.4	3.5

5.5.3 *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. Small differences can be seen in the areas with variable salinities, i.e. the Coastal Waters and the estuaries.

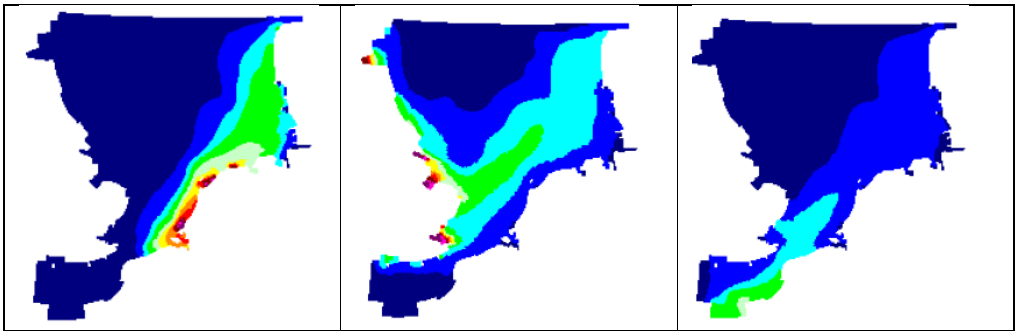


N: From the Netherlands | N: From UK | N: From France

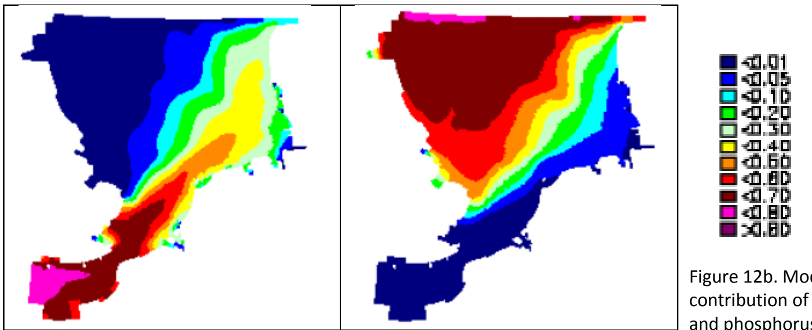


N: From Southern Boundary | N: From northern boundary

Figure 12a. 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

Figure 12b. Model results, showing the contribution of the different nitrogen and phosphorus sources in total nitrogen and total phosphorus Source: Blauw et al. (2006).

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

6.1 WFD

The WFD is limited to the transitional waters, such as Ems-Dollard and Western Scheldt and the Coastal Waters out to 1 nautical-mile. The relevant subdivisions of the Dutch Coastal Waters are open euhaline, open polyhaline and sheltered polyhaline. The Dutch coastal zone to 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 .

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. Suggestions for 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 24. It would be better to have a range of values. The Redfield ratio is N:P = 16:1. With a 50% elevation of the nitrogen concentration the ratio is 24 and with a 50% elevation of the phosphorus concentration it is around 10.7. So an assessment range of 10.7-24 would be the range of the elevated values.

9. Conclusions

Despite a reduction of phosphate and nitrogen in **riverine inputs** and a reduction **at Dutch sources** since 1985, five out of the seven subareas 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 the Wadden Sea there is a decreasing tendency of winter DIP to values close to and even below the assessment level in the last years. In all offshore waters winter DIN and DIP concentrations are below the assessment levels.

The decreasing tendency for **chlorophyll** in the Coastal Waters, that started in the second assessments period, reaches values below the level of 7.5 mg/l in the last 6 years. In the Wadden Sea the chlorophyll values came close to the assessment level of 12 mg/l. In the offshore Southern Bight chlorophyll concentrations are below the assessment level of 2.25 mg/l in 6 out of 9 years.

In the other offshore waters, Oyster Grounds and Dogger Bank, however, both chlorophyll and nutrient concentrations are below the assessment levels without discernible trend.

In most years of the previous assessment period (2001-2005) minimum **oxygen** concentrations in the Wadden Sea were below 6 mg/l, but from 2010 on the mimimum oxygen concentrations were above the assessment level.

Phytoplankton indicator species The area-specific indicator phytoplankton species in the Dutch estuarine and marine waters is Phaeocystis sp., known as a nuisance species. It 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 gradients in nutrient enrichment (winter DIN and DIP) and the direct effects (chlorophyll concentrations).

It can be concluded that there are improvements in concentrations of assessment parameters, but they are not (yet) visible in the overall assessment.

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11. Annexes 1-9:

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	Comparison of two Phaeocystis classification tools.
Annex 9	Comparison of the assessment of the phytoplankton status according to OSPAR and WFD

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, with the residual transport predominantly in a northward direction. The depth is between 0 and 30 meters.

3 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. 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		n.r.	
	Winter DIN and/or DIP concentrations	all +	**+++++++++**	**+**
	Winter N/P ratio (Redfield N/P = 16)	all +	**+++++++++**	+
Direct Effects (II)	Mean chlorophyll a concentration 90-p chlorophyll a concentration	all **−**, decreasing trend	**−++−−−−−−**	**−**
	Area-specific phytoplankton indicator species	all +, but **−** in 2006	**−++++++++**	+
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency -concentration	all −, but **+** in 2009, 2008 missing	**−− +−−−−−**	−
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)			

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), direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency).

To assess the level of elevation in **winter nutrient** levels over the years the concentration of DIN were normalized to a salinity of 30 (OSPAR, 2013, Annex-6a). A slight decrease can be noticed in the winter DIN and DIP concentrations during the most recent years, but they are still a factor of 30% and 20% above elevated levels respectively.

The **N/P** ratio remains above the assessment level.

The mean **chlorophyll** concentrations over the growing season were variable from year to year and below the elevated level from 2009 on.

The area-specific indicator species, the nuisance alga ***Phaeocystis*** sp. is above the elevated bloom levels in all years except in 2006.

Generally **oxygen** causes no problem in general in this shallow area, which most of the time is well-mixed. However, from time to time in calm periods, haline[1] stratification can occur by freshwater inflow from the rivers. During such a haline stratification, oxygen deficiency may occur. In the surface layer oxygen is below the assessment value in 2010 in the surface layer. Oxygen data for 2008 and 2009 are missing.

Based on the assessment criteria the Dutch Coastal Waters are still classified as a problem area, due to the nutrients and the maximum cell numbers of *Phaeocystis* sp above the assessment levels.

[1] Haline stratification is caused by salinity differences

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	GOERE2[2]	x	x	x	x
	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
	BOOMKDP[3]	x	x	x	x
	WALCRN2	x	x	x	x
	WALCRN20	x	x	x	x

[2] Since 2007

Table. A1.4. Annual maximal numbers of cells/l of *Phaeocystis* sp. in the Dutch Coastal Waters.
In red: Cell numbers exceeding assessment level value of 1.E+07. The assessment period of 2006-2014 is marked.

Coastal Waters	
1995	47218000
1996	41482100
1997	139339000
1998	118600000
1999	55735600
2000	16818200
2001	30000000
2002	16515200
2003	42424200
2004	18939400
2005	134722000
2006	2729530
2007	42067300
2008	87254900
2009	18703700
2010	48125000
2011	42666700
2012	15641026
2013	46620047
2014	134090909

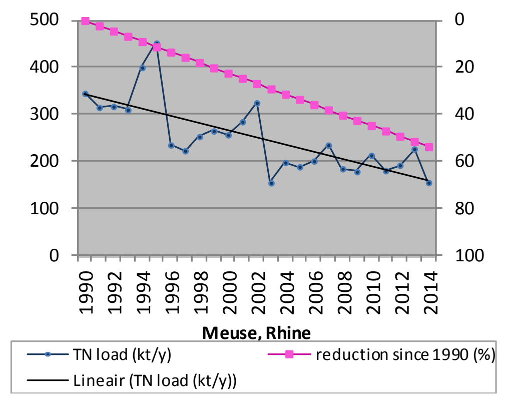

Fig. A1.1. TotN (kt/y) load from the rivers Rhine and Meuse into the Dutch Coastal Waters from 1990 - 2014.

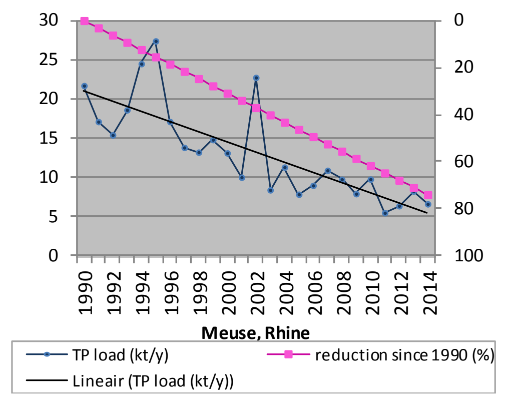

Fig. A1.2. TotP (kt/y) load from the rivers Rhine and Meuse into the Dutch Coastal Waters from 1990 - 2014.

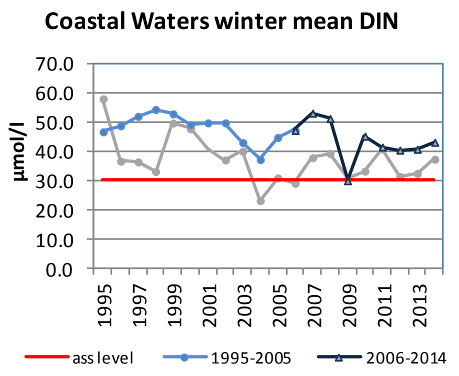

Fig. A1.1. Winter mean concentration of DIN (µmol/l) in the Dutch Coastal Waters, normalized to salinity 30. The grey line are the non-normalized concentrations.

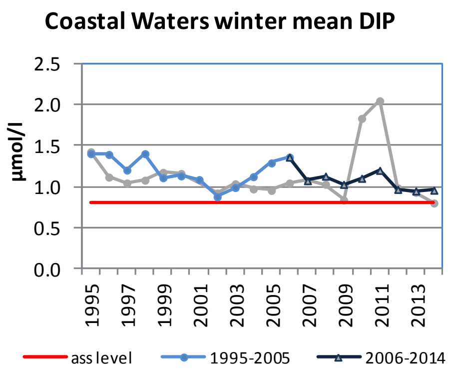

Fig. A1.2. Winter mean concentration of DIP (µmol/l)) in the Dutch Coastal Waters, normalized to salinity 30 (min extreme value). The grey line are the non-normalized concentrations

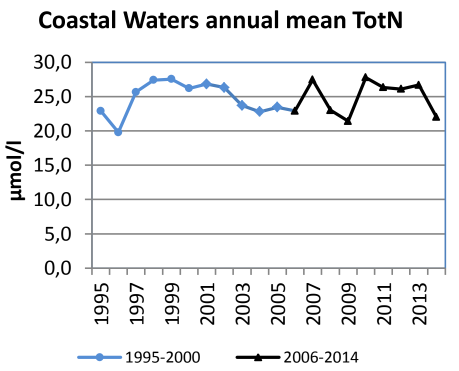

Fig. A1.3. Annual mean concentration of TotN (µmol/l)) in the Dutch Coastal Waters. No assessment level.

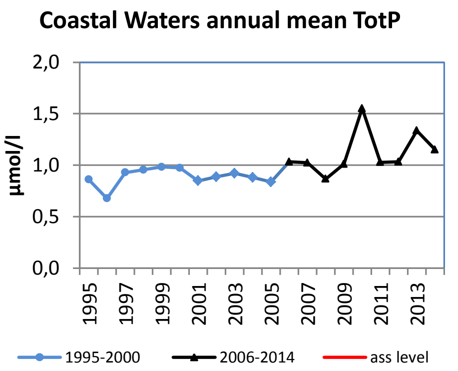

Fig. A1.4. Annual mean concentration of TotP (µmol/l) in the Dutch Coastal Waters. No assessment level.

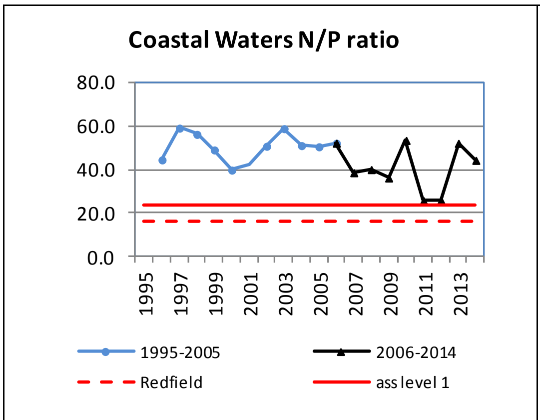

Fig. A1.5. N/P ratio in the Dutch Coastal Waters calculated with the winter mean concentrations of DIN and DIP

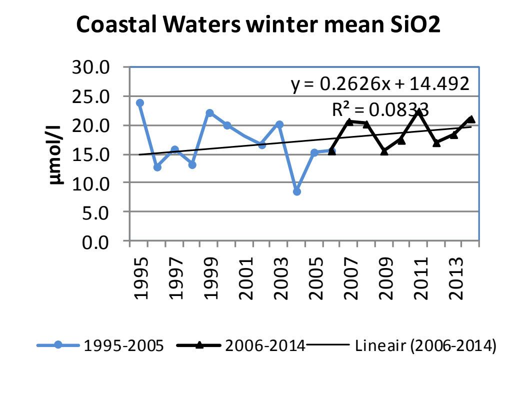

Fig. A1.6. Winter mean concentration of SiO_2 (µmol/l)) in the Dutch Coastal Waters.

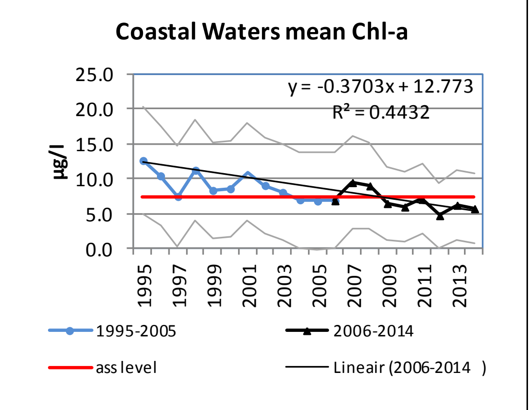

Fig. A1.7 Growing-season (March-Sept) mean concentration of Chlorophyll-a (µg/l) with standard deviation (grey lines) in the Dutch Coastal Waters.

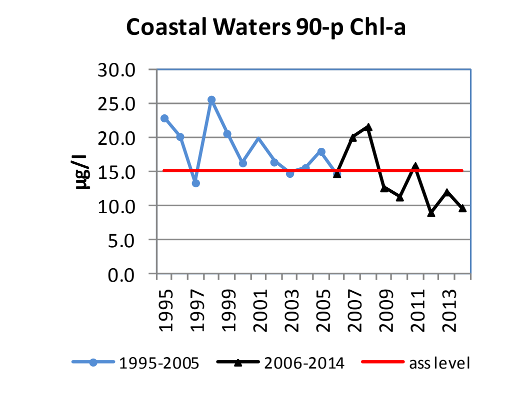

Fig. A1.8. Growing-season (March-Sept) 90-percentile concentration of Chlorophyll-a (µg/l) in the Dutch Coastal Waters.

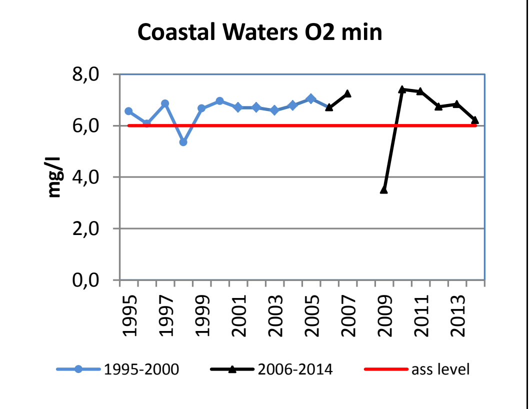

Fig. A1.9. Annual minimum concentration of oxygen (mg/l) in the surface layer of the Dutch Coastal Waters.

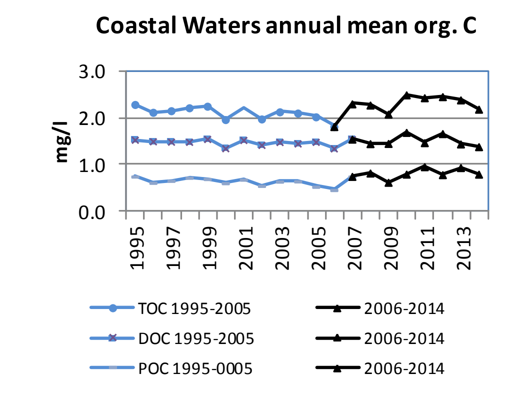

Fig A1.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface of the Dutch Coastal area.

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 Dutch 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 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. 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			
	Winter DIN and/or DIP concentrations	N all + P all +, but – in 2012, 2014	N+++++++++ P++++++–+–	**+** +
	Winter N/P ratio (Redfield N/P = 16)	all +	+++++++++	+
Direct Effects (II)	Mean chlorophyll a concentration	all +	+++++++++	+
	Area-specific phytoplankton indicator species, *Phaeocystis*	all +, but – in 2009	+++–+++++	**+**
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency	all –, but + in 2006, 2007, 2009; 2008 is missing	++ +–––––	–
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)			

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, direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency). The concentrations were not normalized to a standard salinity for the reason given in the main text.

In the assessment period 2006-2014 the **winter nutrient** concentrations of DIN are lower In comparison with the earlier periods, but still far above the assessment level. For DIP the situation is different. From a concentration of 1.5 times the assessment level, the concentrations decreased in 2012 to below the assessment level.

The **N/P** ratio in winter is increasing, mainly by a decrease of winter DIP.

The mean **chlorophyll** concentrations over the growing season are still very variable from year to year and above the elevated level but a slight decreasing tendency can be seen.

The maximum number of cells of the nuisance alga ***Phaeocystis***, is above the elevated bloom level in all years except in 2009.

The minimum **oxygen** concentrations are below the assessment level in the first years (2008 is missing) with minimum values between 3.9 and 5.3 mg/l at several stations for a short period. From 2010, however, the concentrations are above the assessment level and show a tendency in the right direction.

On the basis of the assessment criteria the Wadden Sea is classified as a problem area. The background values and assessment levels used now are quite low. Even when we use the annual mean background for TotN and TotP of 13 µmol/l and 0.8 µmol/l respectively, which Van Raaphorst et al. (2000) estimated, the Wadden Sea would still be classified as problem area[3].

3 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 considerably higher than the values used now.

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 *Phaeocystis* sp. in the Dutch Wadden Sea.
In red: Cell numbers exceeding assessment level value of 1.E+07. The different assessment periods are marked.

Wadden Sea	
1995	74206100
1996	69993500
1997	31805400
1998	78029800
1999	24468500
2000	29939200
2001	39899000
2002	53030300
2003	33030300
2004	92222200
2005	65277800
2006	18858600
2007	69697000
2008	21836200
2009	6334840
2010	16000000
2011	28266700
2012	17288135
2013	17333333
2014	40596909

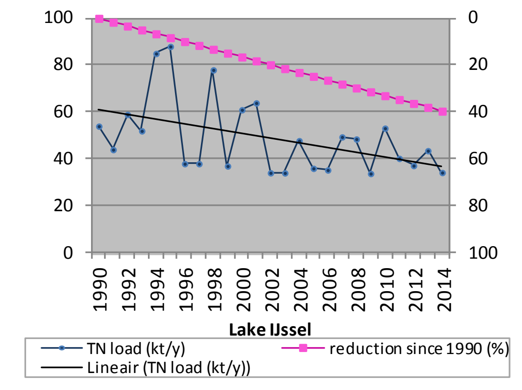

Fig. A2.1. TotN load (kt/y) from Lake IJssel into the western Wadden Sea until 2014.

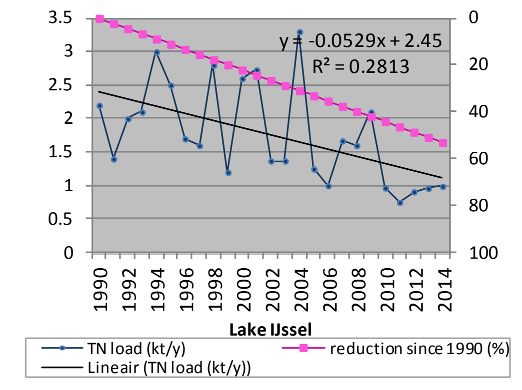

Fig. A2.2. TotP load (kt/y) from Lake IJssel into the western Wadden Sea until 2014. To be checked

Opmerking [hbb1]: These data have to be checked with Bert Bellert, because the graph is different from the graph in the second COMP, and different from the loads used in ICG-EMO

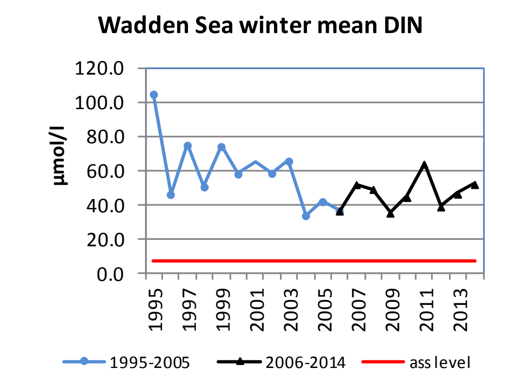

Fig. A2.1. Winter mean concentration of DIN (µmol/l) in the Dutch Wadden Sea.

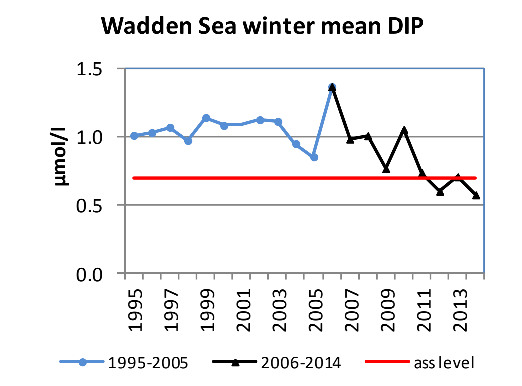

Fig. A2.2. Winter mean concentration of DIP (µmol/l)) in the Dutch Wadden Sea.

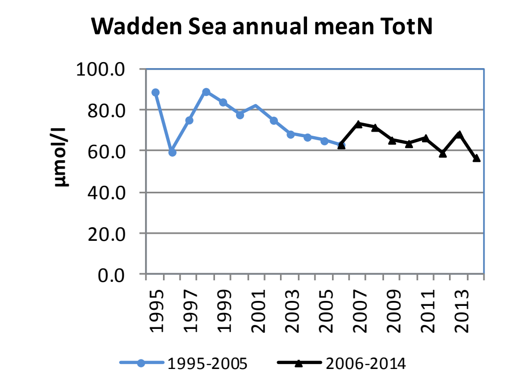

Fig. A2.3. Annual mean concentration of TotN (µmol/l)) in the Dutch Wadden Sea. No assessment level.

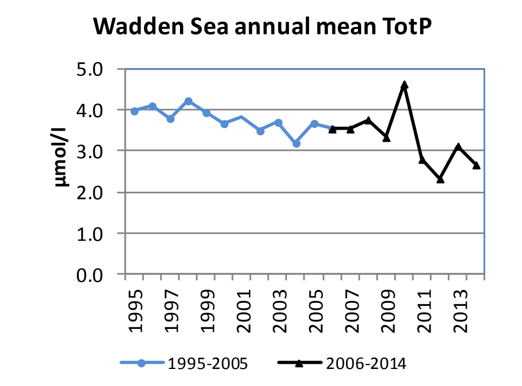

Fig. A2.4. Annual mean concentration of TotP (µmol/l) in the Dutch Wadden Sea. No assessment level.

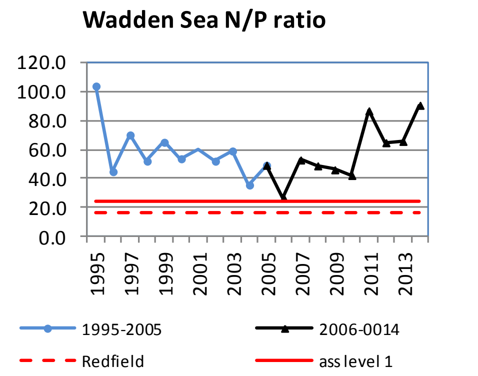

Fig. A2.5. N/P ratio in the Dutch Wadden Sea calculated with the winter mean concentrations of DIN and DIP.

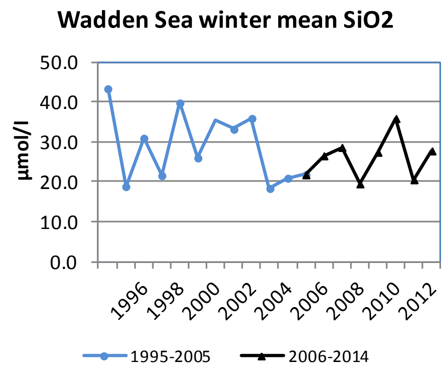

Fig A2.6. Winter mean concentration of SiO2 (µmol/l)) in the Dutch Wadden Sea.

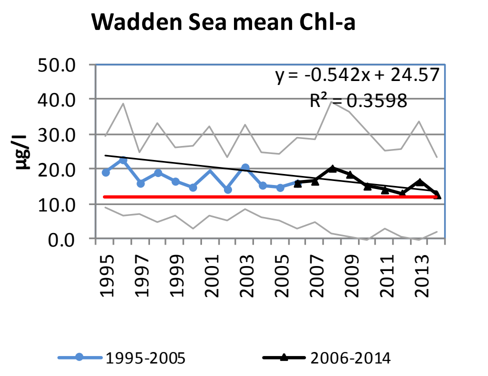

Fig. A2.7 Growing-season (March-Sept) mean concentration of Chlorophyll-a (µg/l) with standard deviation (grey lines) in the Dutch Wadden Sea and the OSPAR assessment level with trendline, equation and R^2.

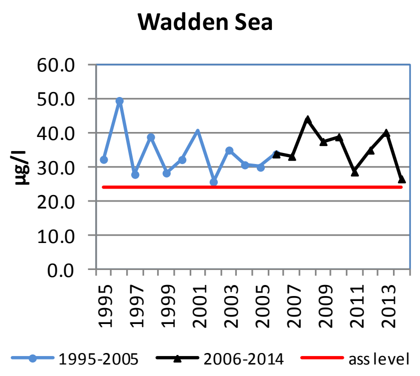

Fig. A2.8. Growing-season (March-Sept) 90-percentile concentration of Chlorophyll-a (µg/l) in the Dutch Wadden Sea and the OSPAR assessment level with trendline, equation and R^2.

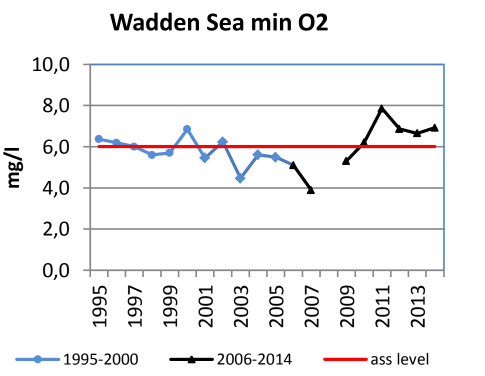

Fig. A2.9. Annual minimum concentration of oxygen (mg/l) in the surface layer of the Dutch Wadden Sea.

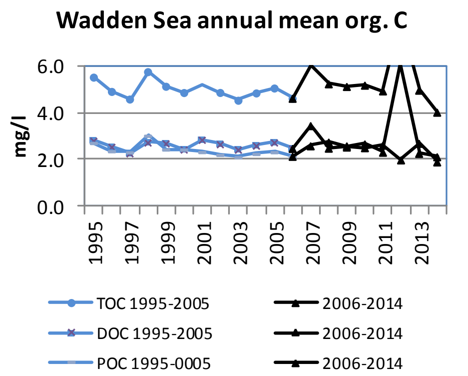

Fig. A2.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface of the Dutch Wadden Sea.

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 densely populated and highly industrialized areas of 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 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. Assessment

Tab. A3.1. Results of the assessment of the Coastal Waters (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			
	Winter DIN and/or DIP concentrations	all +	+++++++++	+
	Winter N/P ratio (Redfield N/P = 16)	all –	–––––––––	–
Direct Effects (II)	Mean chlorophyll a concentration		+++++++++	+
	Area-specific phytoplankton indicator species, *Phaeocystis*	all + but, – in 2006, 2009, 2012	–++–++–++	+
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency	all + but, – in 2014	++++++++–	+
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)			

Key to the Score, see next page.
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),direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency). The concentrations were not normalized to a standard salinity for the reason given in the main text.

In the assessment period, 2006-2014, the **winter nutrient** concentrations were a factor of 5 and 4 above the (still preliminary) elevated levels for DIP and DIN, respectively, without a clear trend. Winter DIN is not lower than in the earlier periods, while the DIP concentrations are slightly lower.

N/P ratios show a slight increasing tendency above the assessment level in the whole period.

Chlorophyll mean and 90-percentile concentrations are variable, above the assessment levels and in general higher than in the earlier periods.

The maximum number of cells of the area-specific nuisance alga ***Phaeocystis*** sp. is above the elevated bloom levels in all years except for 2006, 2009 and 2012.

Without the station close to the Belgian border (Schaar van Ouden Doel) the minimum **oxygen** concentrations are above the assessment level of 6 mg/l in all years of the assessment period 2006-2014. In Schaar van Ouden Doel, however, the concentrations are < 6 mg/l, but with a clear increasing trend culminating in 2014 with an annual minimum oxygen concentration of 6.2 mg/l.

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 the nuisance alga *Phaeocystis*.

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
Oxygen saturation percentage (%)		

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

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

Tab. A3.4. Annual maximal numbers of cells/l of *Phaeocystis* sp. in the Western Scheldt.
In red: Cell numbers exceeding assessment level value of 1.E+07. The different assessment periods are marked.

Western Scheldt	
1995	7620060
1996	26571600
1997	34133900
1998	2962030
1999	20144600
2000	2828280
2001	4797980
2002	1739130
2003	10909100
2004	24155400
2005	4895100
2006	275710
2007	23557700
2008	36298100
2009	10000000
2010	36666700
2011	34000000
2012	3936803
2013	56892655
2014	28666667

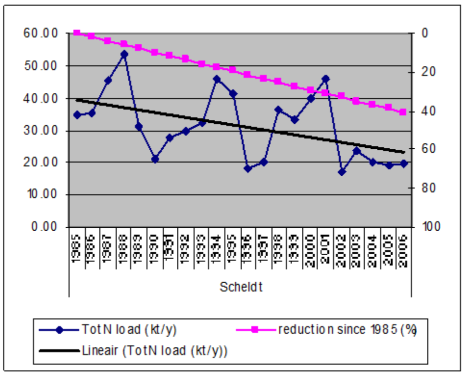

Fig. A3.1. TotN (kt/y) load from the rivers Rhine, Meuse and Scheldt into the Western Scheldt until 2006. To be extended.

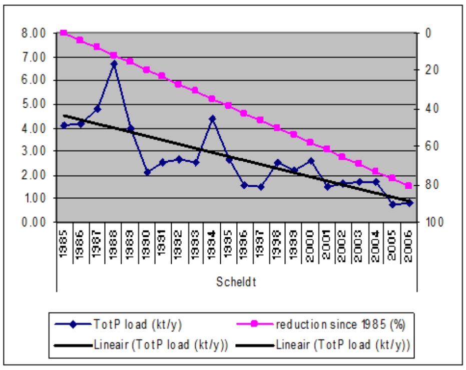

Fig. A3.2. TotP (kt/y) load from the rivers Rhine, Meuse and Scheldt into the Western Scheldt until 2006. To be extended.

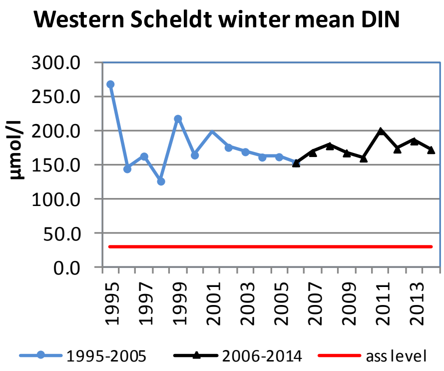

Fig. A3.1. Winter mean concentration of DIN (µmol/l) on the Western Scheldt.

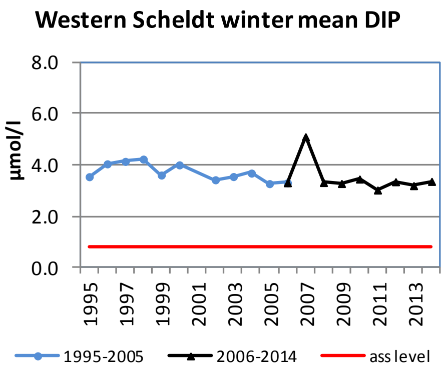

Fig. A3.2. Winter mean concentration of DIP (µmol/l)) on the Western Scheldt.

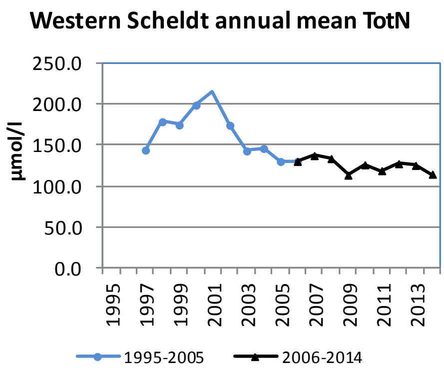

Fig. A3.3. Annual mean concentration of TotN (µmol/l)) on the Western Scheldt. No assessment level.

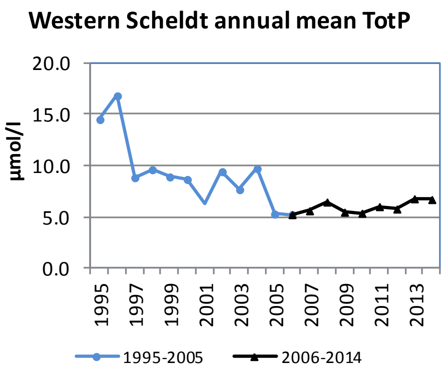

Fig. A3.4. Annual mean concentration of TotP (µmol/l) on the Western Scheldt. No assessment level.

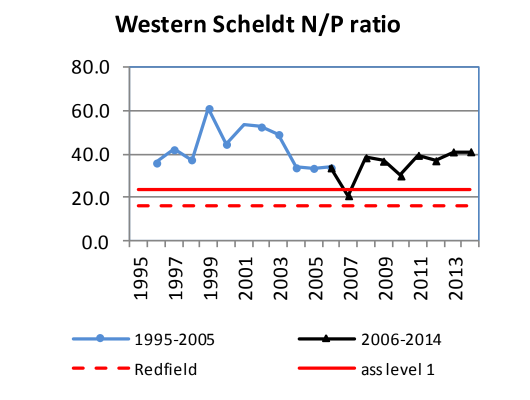

Fig. A3.5. N/P ratio on the Western Scheldt calculated with the winter mean concentrations of DIN and DIP.

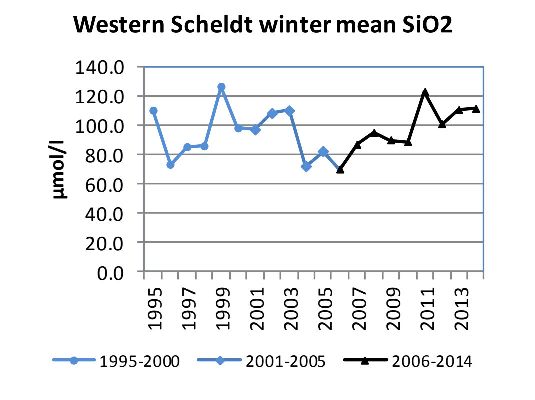

Fig A3.6. Winter mean concentration of SiO_2 (µmol/l)) on the Western Scheldt.

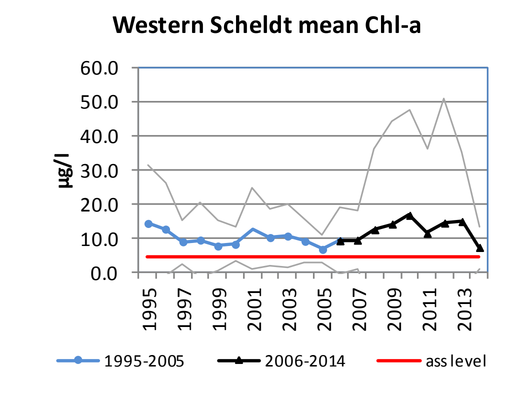

Fig. A3.7 Growing-season (March-Sept) mean of chlorophyll-a (µg/l) with standard deviation (grey lines) on the Western Scheldt and the OSPAR assessment level with trendline, equation and R^2.

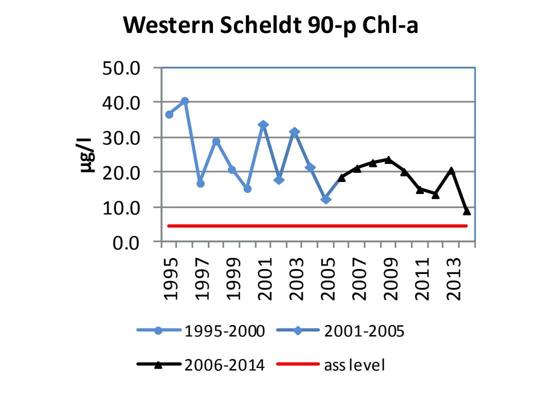

Fig. A3.8. Growing-season (March-Sept) 90-perc. concentration of chlorophyll-a (µg/l) on the Western Scheldt and the OSPAR assessment level with trendline, equation and R^2.

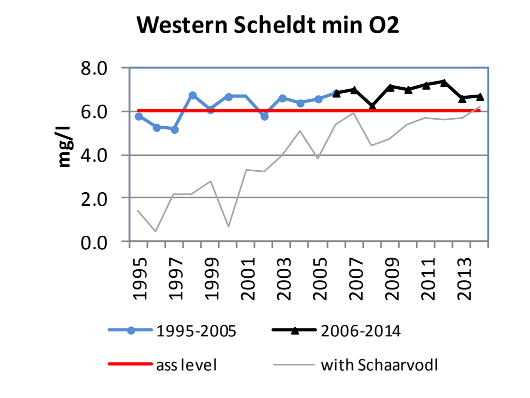

Fig. A3.9. Annual minimum concentration of oxygen (mg/l) in the surface layer of the Western Scheldt. The grey line is with station Schaar van Ouden Doel.

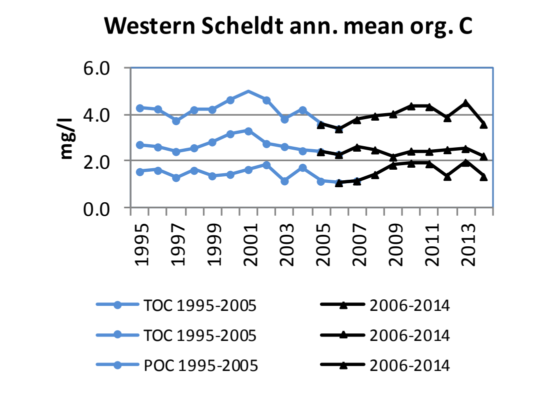

Fig. A3.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface of the Western Scheldt.

Annex 4 Ems-Dollard

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

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

2. Description of the area

The Ems-Dollard is an estuary situated between the Dutch-German border and the Wadden Sea. The area comprises extensive tidal (mud)flats 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 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. Assessment

Tab. A4.1. Results of the assessment of the Coastal Waters (see for assessment levels Tab. A4.2).

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			
	Winter DIN and/or DIP concentrations		+++++++++	+
	Winter N/P ratio (Redfield N/P = 16)		+++++++++	+
Direct Effects (II)	Mean chlorophyll a concentration	all –, but + in 2009	–––+–––––	–
	Area-specific phytoplankton indicator species	all +, but – in 2009, 2012	+++–++–++	+
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency	all –, but + in 2007	–+ ––––––	–
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)			

Key to the Score, see next page

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) direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency). The concentrations are not normalized to a standard salinity for the reason given in the main text.

In the assessment period 2006-2014 the **winter nutrient** concentrations were a factor of almost 5 and 1.5 above the elevated levels for DIN and DIP, respectively. The slight decreasing tendency in winter DIN from 2003-2005 on has not been extended during the recent assessment period. Instead an increasing tendency can be observed. In the winter DIP concentrations no clear tendency is observed.

The shift in winter nutrient concentrates, described above, results in an increasing tendency above the elevated level of the **N/P** ratio.

Chlorophyll mean and 90-percentile concentrations are variable and always below the elevated level except for the year 2009, which is comparable with the situation in the earlier periods since 1997. The cause of the low chlorophyll concentrations in this extremely eutrophic estuary can be found in the limited light availability.

The maximum number of cells of the area-specific nuisance alga ***Phaeocystis*** is above the elevated bloom level of 10^7 cells/l in all years of the assessment period, except for 2009 and 2012.

The minimum **oxygen** concentration is just below the assessment level only in one year (2007) and in two years (2006 and 2010: 6.00 mg/l) just above the assessment level, with values of 5.79, 6.07 and 6.00 mg/l respectively, 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 nutrient concentrations and the phytoplankton indicator species *Phaeocystis*.

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
Oxygen, saturation percentage		

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 *Phaeocystis* sp. in the Ems-Dollard.
In red: Cell numbers exceeding assessment level value of 1.E+07. The different assessment periods are marked.

Ems-Dollard	
1995	53402500
1996	9332470
1997	10606400
1998	22484600
1999	16990600
2000	3939390
2001	14646500
2002	4848490
2003	1925680
2004	36944400
2005	47430800
2006	20595500
2007	29032300
2008	21290300
2009	8188590
2010	20512800
2011	17600000
2012	3728813
2013	42400000
2014	26666666

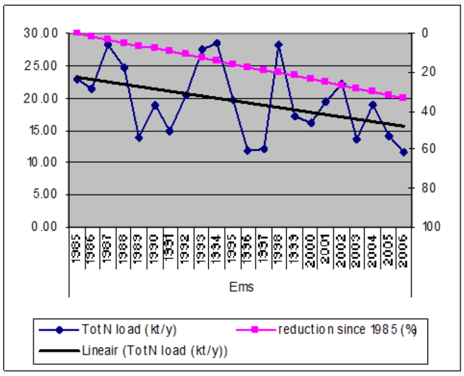

Fig. A4.2. TotN (kt/y) load from the river EMS into the Ems-Dollard until 2006. To be extended.

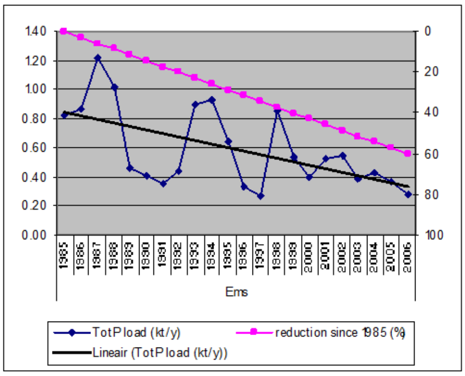

Fig. A4.2. TotP (kt/y) load from the river Ems into the Ems-Dollard until 2006. To be extended

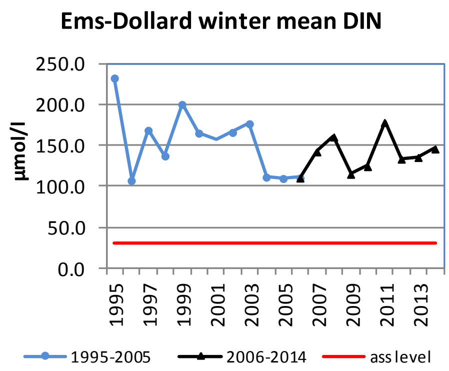

Fig. A4.1. Winter mean concentration of DIN (µmol/l) on the Ems-Dollard.

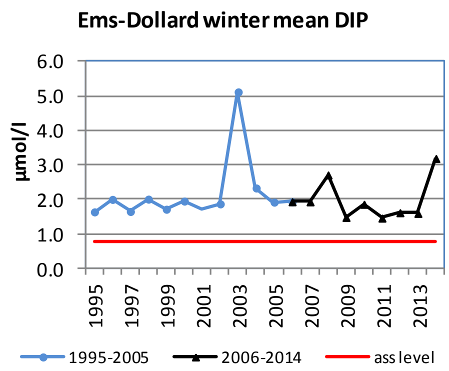

Fig. A4.2. Winter mean concentration of DIP (µmol/l)) on the Ems-Dollard.

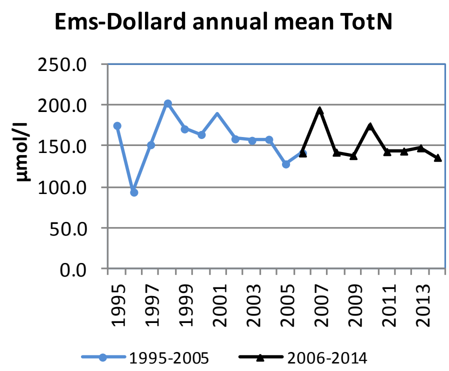

Fig. A4.3. Annual mean concentration of TotN (µmol/l)) on the Ems-Dollard. No assessment level.

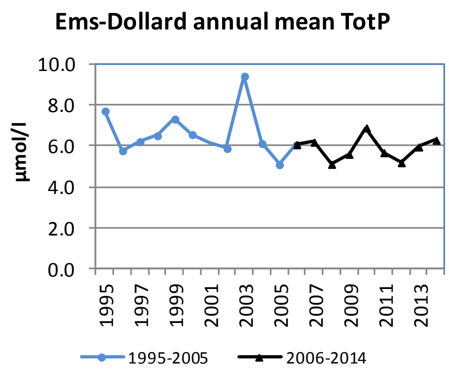

Fig. A4.4. Annual mean concentration of TotP (µmol/l) on the Ems-Dollard. No assessment level.

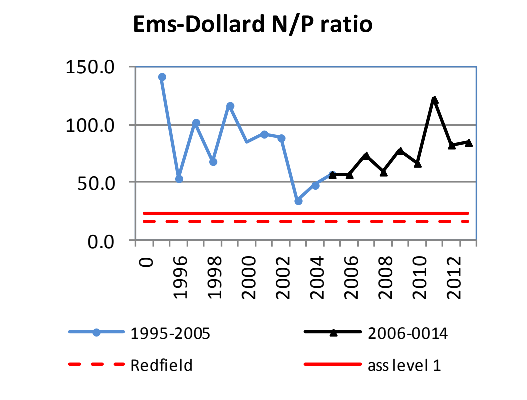

Fig. A4.5. N/P ratio on the Ems-Dollard calculated with the winter mean concentrations of DIN and DIP.

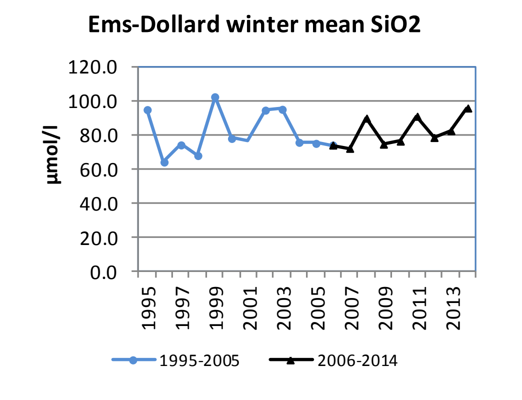

Fig A4.6. Winter mean concentration of SiO_2 (µmol/l)) on the Ems-Dollard.

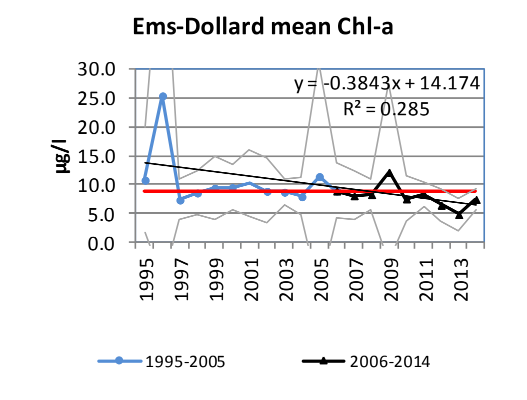

Fig. A4.7 Growing-season (March-Sept) mean concentration of Chlorophyll-a (µg/l) with standard deviation (grey lines) and the OSPAR assessment level in the Ems-Dollard with trendline, equation and R^2 over the assessment period.

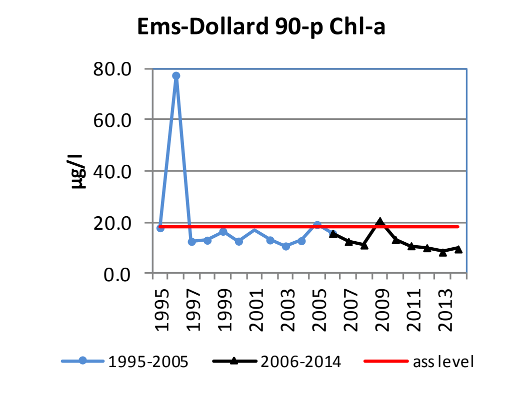

Fig. A4.8. Growing-season (March-Sept) mean and 90-percentile concentration of Chlorophyll-a (µg/l) and the OSPAR assessment level in the Ems-Dollard with trendline, equation and R^2 over the assessment period..

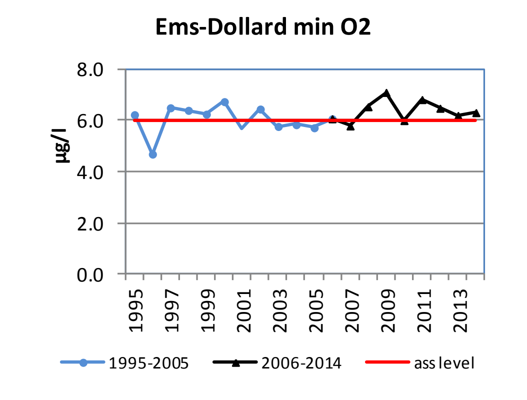

Fig. A4.9. Annual minimum concentration of oxygen (mg/l) in the surface layer of the Ems-Dollard.

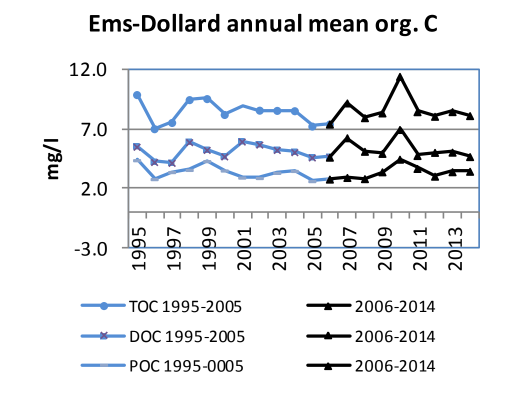

Fig A4.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface of the Ems-Dollard.

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 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. Assessment

Tab. A5.1. Results of the assessment of the Coastal Waters (see for assessment levels Tab. A5.2).

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		n.r.	
	Winter DIN and/or DIP concentrations	N all − P all −, but + in 2012 and 2013	N−−−−−−−−− P−−−−−−++−	− −
	Winter N/P ratio (Redfield N/P = 16)		−−−−−−−−−	-
Direct Effects (II)	Mean chlorophyll a concentration	all −, but + in 2007, 2010 2011	−+−−++−−−	−
	Area-specific phytoplankton indicator species, *Phaeocystis*	all +, but −in 2006, 2007, 2010, 2013	−−++−++−+	+
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency	all −, 2008 missing	−− −−−−−−	−
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)		?	

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), direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency).

In general, **winter nutrient** concentrations are below the elevated level, and also below the background values, without a clear tendency. The question is whether the background concentrations and the elevated levels in the offshore areas of the North Sea have been well chosen. The winter DIN concentrations show rather an increasing tendency from 2006 on in contrast to the two earlier periods (1995-2000 and 2001-2005). In winter 2012 and 2013 the winter DIP concentrations show extremely high peaks with values of ~11 µmol/l (winter 2012) and 4 µmol/l (winter 2013)[4].

The **N/P** ratio is below the assessment level and in some years even below the Redfield ratio, due to the high winter DIP concentrations.

Chlorophyll mean and 90-percentile concentrations were above the elevated level in three years of the nine years of the assessment period (2006-2014). This is no better than in the first assessment period (1995-2000) with in all years concentrations above the assessment level, but better than in the second period (2001-2005) with all years above the assessment level.

The maximum number of cells of the nuisance phytoplankton indicator species ***Phaeocystis*** is in five of the nine years above the assessment level. This is slightly better than in the two previous periods.

Oxygen causes no problem in this shallow generally well-mixed area during the assessment period.

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

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

[4] See comments on high peaks of winter DIP concentrations in the main text.

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
Oxygen, saturation percentage		

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 *Phaeocystis* sp. in the Southern Bight offshore.
In red: Cell numbers exceeding assessment level value of 1.E+07. The different assessment periods are marked.

Southern Bight offshore	
1995	8646620
1996	14193100
1997	11989600
1998	11116100
1999	12540500
2000	489865
2001	18846200
2002	5422050
2003	18233200
2004	31884500
2005	17009100
2006	635728
2007	9686500
2008	12116200
2009	12187900
2010	8944210
2011	20080100
2012	33552967
2013	7644970
2014	11251526

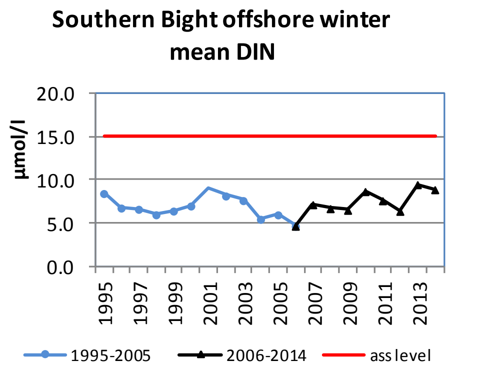

Fig. A5.1. Winter mean concentration of DIN (µmol/l) on the Southern Bight - offshore.

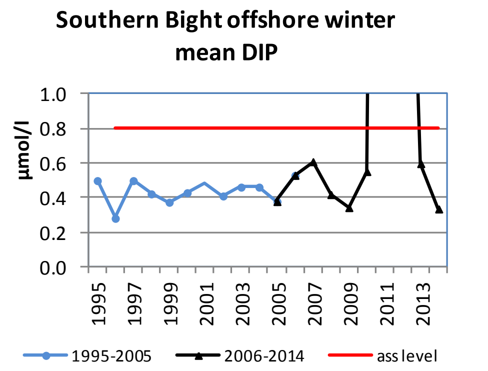

Fig. A5.2. Winter mean concentration of DIP (µmol/l)) on the Southern Bight - offshore.

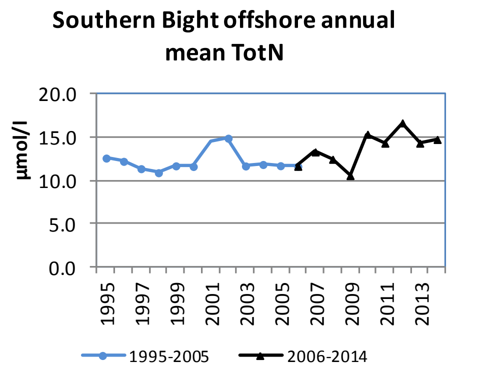

Fig. A5.3. Annual mean concentration of TotN (µmol/l)) on the Southern Bight - offshore. No assessment level.

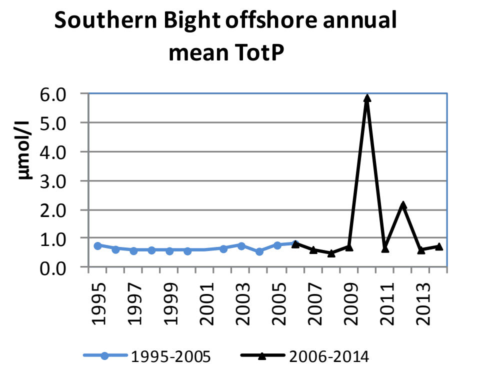

Fig. A5.4. Annual mean concentration of TotP (µmol/l) on the Southern Bight - offshore. No assessment level.

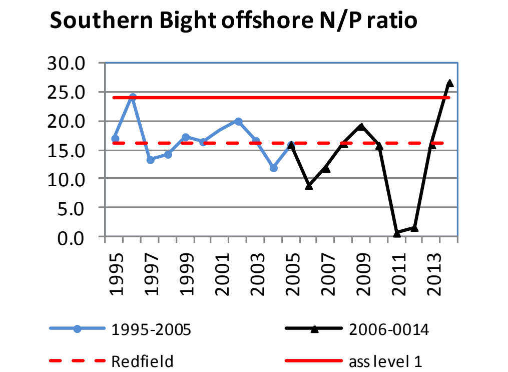

Fig. A5.5. N/P ratio in the Southern Bight - offshore calculated with the winter mean concentrations of DIN and DIP.

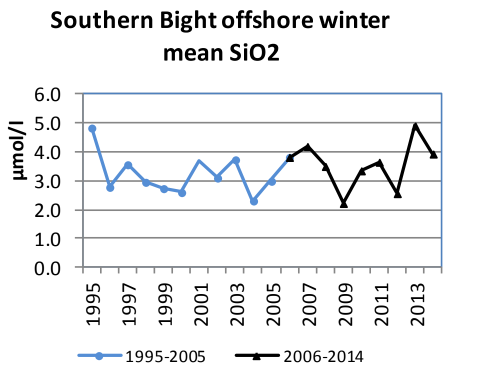

Fig A5.6. Winter mean concentration of SiO4 (µmol/l)) in the Southern Bight - offshore.

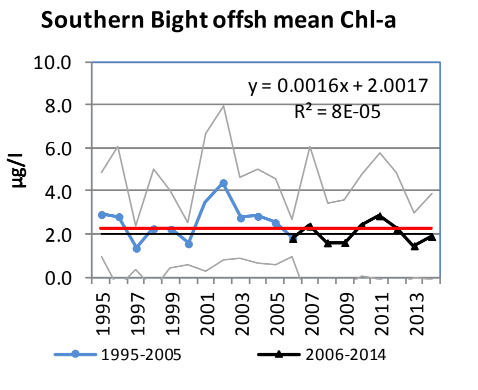

Fig. A5.7 Growing-season (March-Sept) mean concentration of Chlorophyll-a (µg/l) with standard deviation (grey lines) in the Southern Bight - offshore and the OSPAR assessment level with trendline, equation and R^2.

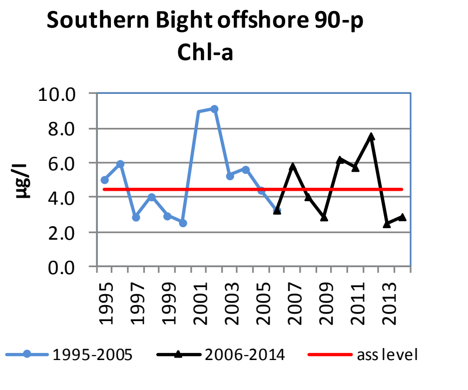

Fig. A5.8. Growing-season (March-Sept) 90-percentile concentration of Chlorophyll-a (µg/l) in the Southern Bight - offshore and the OSPAR assessment level with trendline, equation and R^2.

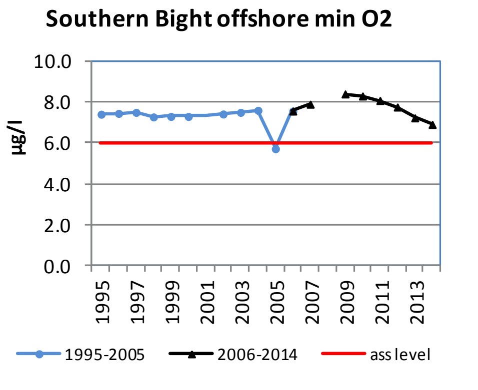

Fig. A5.9. Annual minimum concentration of oxygen (mg/l) in the surface layer of the Southern Bight - offshore.

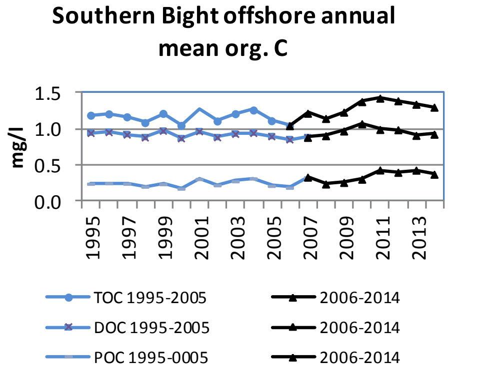

Fig. A5.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface of the Southern Bight – offshore.

Annex 6 Oyster Grounds

Results of the OSPAR Comprehensive Procedure – NL - Oyster Grounds

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

2. 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 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 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. Assessment

Tab. A6.1. Results of the assessment of the Coastal Waters (see for assessment levels Tab. A6.2).

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		n.r.	
	Winter DIN and/or DIP concentrations	N all – P all –, but + in 2010 and 2013	N--------- P----+--+-	– –
	Winter N/P ratio (Redfield N/P = 16)*		---------	–
Direct Effects (II)	Mean chlorophyll a concentration	all –	---------	–
	Area-specific phytoplankton indicator species *Phaeocystis*	all –	---------	–
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency	all –	---------	–
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)		?	

* N/P ratio: – indicates: within the two assessment levels around the Redfield ratio

Key to the Score, see next page

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), direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency).

In general, winter **nutrient** concentrations are below the elevated level, and also below the background values, without a clear tendency. The question is whether the background concentrations and the elevated levels in the offshore areas of the North Sea have been well chosen. The winter DIN concentrations in the assessment period (2006-2014) are rather constant, around 5 µmol/l, higher than in the two earlier assessment periods (1995-2005). Winter DIP has two extreme peaks, one in 2010 (1.9 µmol/l) and one in 2013 (1.6 µmol/l)[5].

The **N/P** ratio is below the assessment level and even below the Redfield, indicating a relative excess of phosphorus.

Chlorophyll mean and 90-percentile growing-season concentrations were below the elevated level and show no clear tendency in the assessment period. The concentrations are in the same range as in the second assessment period and slightly lower than in the first period.

The nuisance phytoplankton indicator species ***Phaeocystis*** remains, as in the earlier periods, below the elevated level during the whole period (1995-2005).

The minimum **oxygen** concentrations in the surface layer are in all years above the assessment level.

This northern offshore part of the Dutch continental shelf initially was classified as a problem area based on high numbers of specific phytoplankton species, which originally were used as indicator species. Because of the uncertainty of a cause-effect relationship between nutrient availability and the occurrence and toxicity of these species, it has been decided to use only the nuisance alga *Phaeocystis* sp. as indicator species, which makes the Oyster Grounds area a non-problem area.

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

[5] See comments on high peaks of winter DIP concentrations in the main text.

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
Oxygen, saturation percentage (%)		

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 *Phaeocystis* sp. on the Oyster Grounds.
In red: Cell numbers exceeding assessment level value of 1.E+07. The different assessment periods are marked.

Oyster Grounds	
1995	512749
1996	3738960
1997	267068
1998	558415
1999	485579
2000	606061
2001	199847
2002	403277
2003	1166970
2004	1509710
2005	1106520
2006	7184480
2007	1095950
2008	748013
2009	670768
2010	3887970
2011	304147
2012	2688192
2013	7073418
2014	1026302

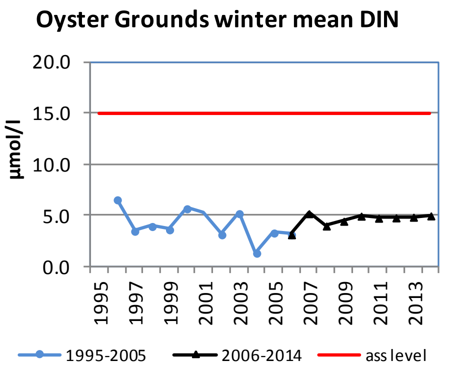

Fig. A6.1. Winter mean concentration of DIN (µmol/l) on the Oyster Grounds.

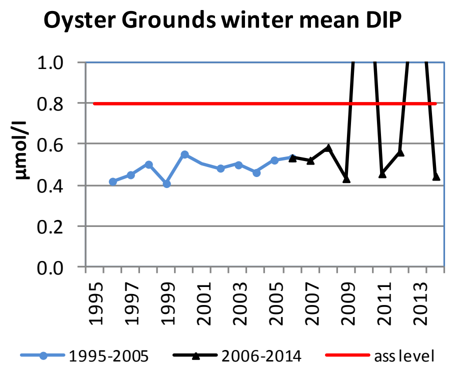

Fig. A6.2. Winter mean concentration of DIP (µmol/l)) on the Oyster Grounds.

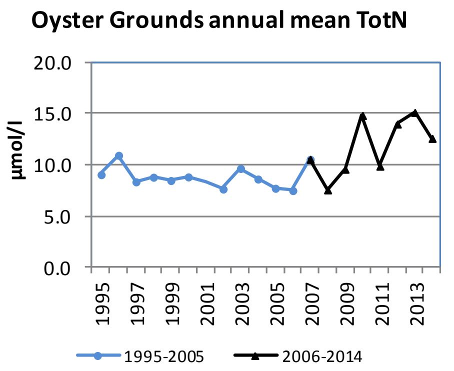

Fig. A6.3. Annual mean concentration of TotN (µmol/l)) on the Oyster Grounds. No assessment level.

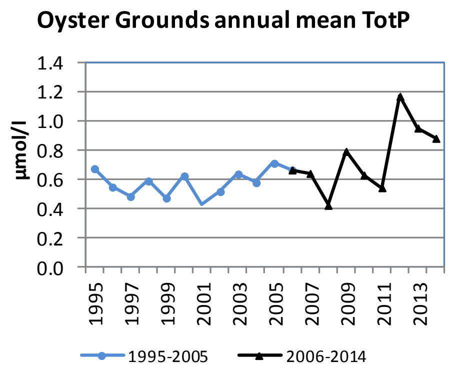

Fig. A6.4. Annual mean concentration of TotP (µmol/l) on the Oyster Grounds. No assessment level.

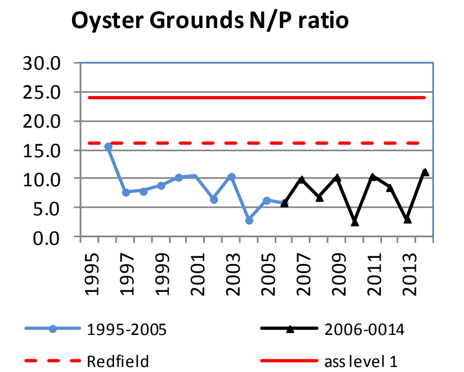

Fig. A6.5. N/P ratio on the Oyster Grounds calculated with the winter mean concentrations of DIN and DIP.

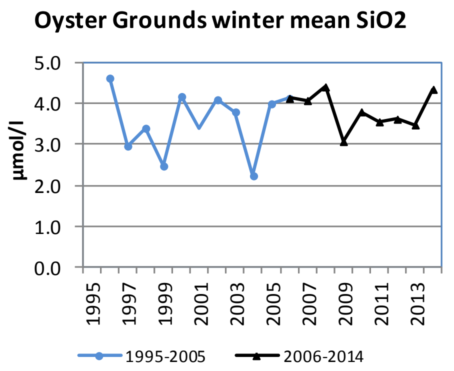

Fig A6.6. Winter mean concentration of SiO_2 (µmol/l)) on the Oyster Grounds

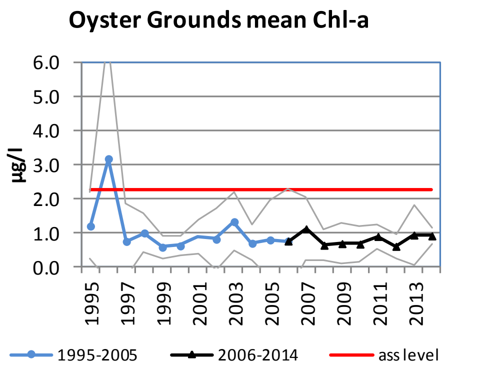

Fig. A6.7 Growing-season (March-Sept) mean a concentration of Chlorophyll-a (µg/l) with standard deviation (grey lines) on the Oyster Grounds and the OSPAR assessment level with trendline, equation and R^2.

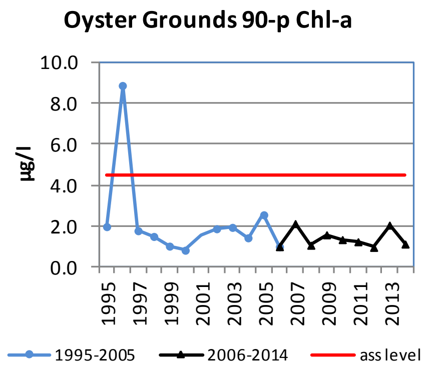

Fig. A6.8. Growing-season (March-Sept) 90-percentile concentration of Chlorophyll-a (µg/l) on the Oyster Grounds and the OSPAR assessment level with trendline, equation and R^2.

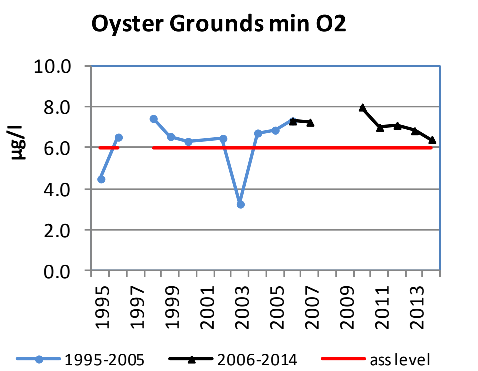

Fig. A6.9. Annual minimum concentration of oxygen (mg/l) in the bottom layer of the Oyster Grounds.

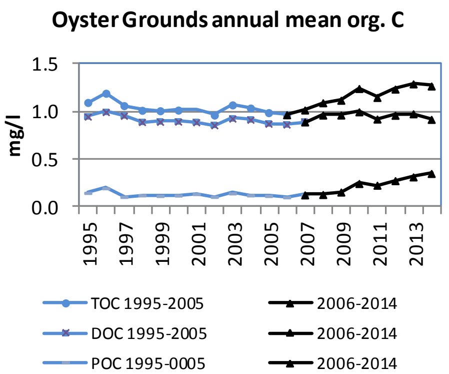

Fig. A6.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface layer of the Oyster Grounds.

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 outer part of the offshore area (salinity >34.5) of the Dutch continental shelf. With a minimum depth of around 18 m this area is well mixed during most of the year, with sometimes a short stratified period in summer. Driven 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 The monitoring design in relation to spatial and temporal variability of assessment parameters in the area

The Dutch monitoring programme is sufficient to meet the demands of OSPAR , see Table 3 of the main text.

4. Assessment

Tab. A7.1. Results of the assessment of the Coastal Waters (see for assessment levels Tab. A7.2).

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		n.r.	
	Winter DIN and/or DIP concentrations	N all – P all –, but+ in 2010	N––––––––– P––––+––––	– –
	Winter N/P ratio (Redfield N/P = 16)	all –	–––––––––	–
Direct Effects (II)	Mean chlorophyll a concentration		–––––––––	–
	Area-specific phytoplankton indicator species (*Phaeocystis)*	all –, but + in 2006	+––––––––	–
	Macrophytes including macroalgae		n.r.	
Indirect Effects (III)	Oxygen deficiency	all –	––––––––	–
	Changes/kills in zoobenthos and fish kills		?	
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)		?	

***** N/P ratio: – indicates: within the two assessment levels around the Redfield ratio

Key to the Score, see next page

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), direct effects (category II) in terms of chlorophyll concentrations and indirect effects (category III, oxygen deficiency).

In general, **winter nutrient** concentrations are below the elevated level, and even below the background values, with the exception of winter DIP in 2010. The question is whether the background concentrations and the elevated levels in the offshore areas of the North Sea have been well chosen. In 2010 the dissolved phosphorus winter concentration was extremely high (~4 µmol/l)[6].

The **N/P** ratio is below Redfield, indicating a relative excess of phosphorus.

Chlorophyll mean and 90-percentile concentrations were below the elevated level and the decreasing tendency of the two earlier periods (1995-2005) continues during this assessment period (2006-2014).

The nuisance phytoplankton indicator species ***Phaeocystis*** is above the elevated level in 2006, but remains below the elevated level during the rest of the assessment period.

Oxygen causes no problem in this shallow, well-mixed area.

This most northern offshore part of the Dutch continental shelf initially was classified as a problem area based on high numbers of specific phytoplankton species, which originally were indicated as indicator species. Because of the uncertainty of a cause-effect relationship between nutrient availability and the occurrence and toxicity of these species, it has been decided to use only the nuisance alga *Phaeocystis* sp. as indicator species, which makes the Dogger Bank area a non-problem area.

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.

[6] See comments on high peaks of winter DIP concentrations in the main text.

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, minimum (mg/l)		6
Oxygen saturation percentage, minimum. (%)		

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 *Phaeocystis* sp. on the Dogger Bank. In red: Cell numbers exceeding assessment level value of 1.E+07. The different assessment periods are marked.

Coastal Waters	
1995	168598
1996	3666120
1997	946878
1998	4710110
1999	599690
2000	2660630
2001	3362640
2002	2098830
2003	3025660
2004	1283360
2005	3063940
2006	12170200
2007	1917090
2008	2825250
2009	850110
2010	83333
2011	820994
2012	2561728
2013	559610
2014	682907

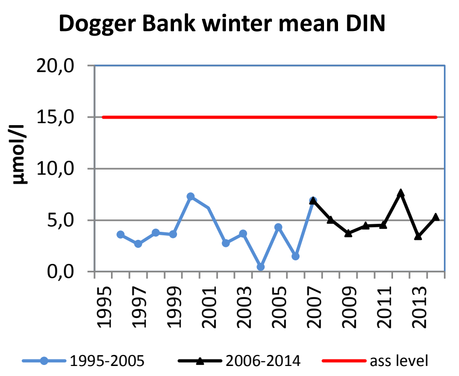

Fig. A7.1. Winter mean concentration of DIN (µmol/l) on the Dogger Bank.

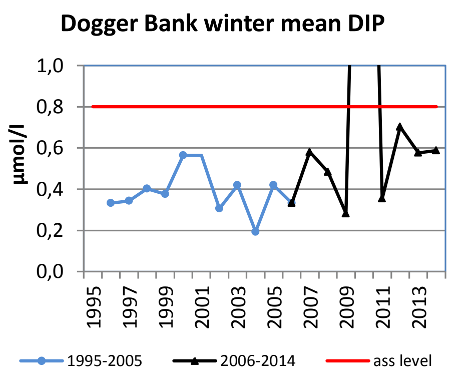

Fig. A7.2. Winter mean concentration of DIP (µmol/l)) on the Dogger Bank.

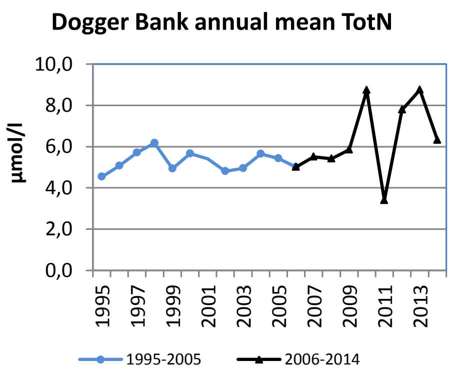

Fig. A7.3. Annual mean concentration of TotN (µmol/l)) on the Dogger Bank. No assessment level.

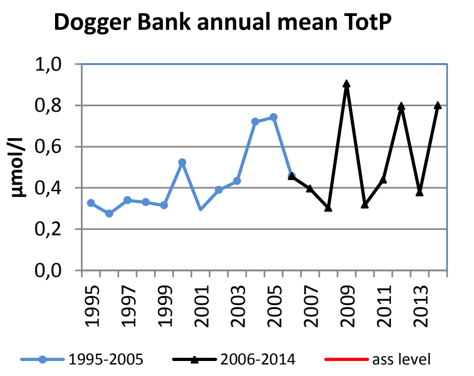

Fig. A7.4. Annual mean concentration of TotP (µmol/l) on the Dogger Bank. No assessment level.

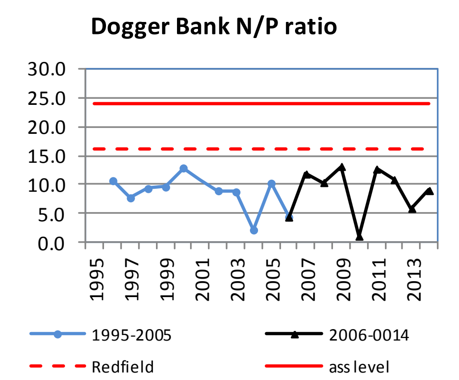

Fig. A7.5. N/P ratio on the Dogger Bank calculated with the winter mean concentrations of DIN and DIP.

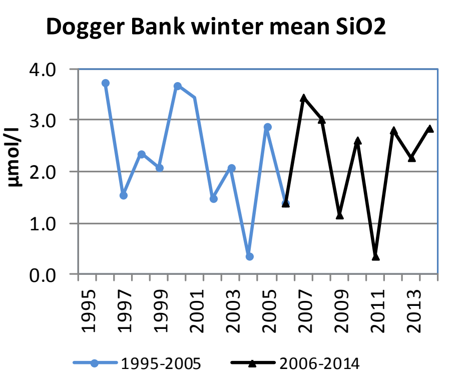

Fig A7.6. Winter mean concentration of SiO_2 (µmol/l)) on the Dogger Bank.

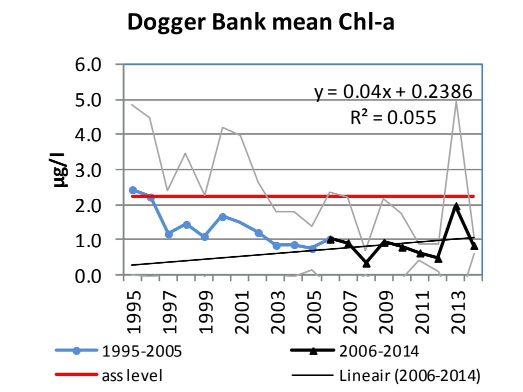

Fig. A7.8. Growing-season (March-Sept) mean concentration of Chlorophyll-a (µg/l) with standard deviation (grey lines) on the Dogger Bank and the OSPAR assessment level with trendline, equation and R^2.

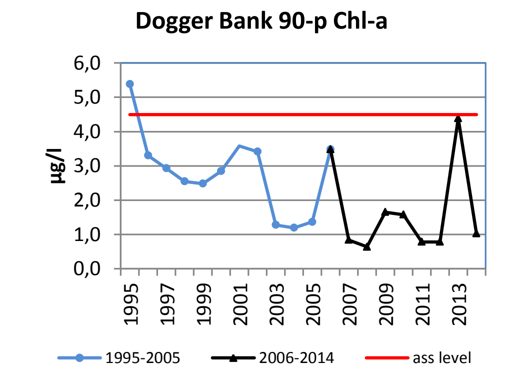

Fig. A7.8. Growing-season (March-Sept) 90-percentile concentration of Chlorophyll-a (µg/l) on the Dogger Bank and the OSPAR assessment level with trendline, equation and R^2.

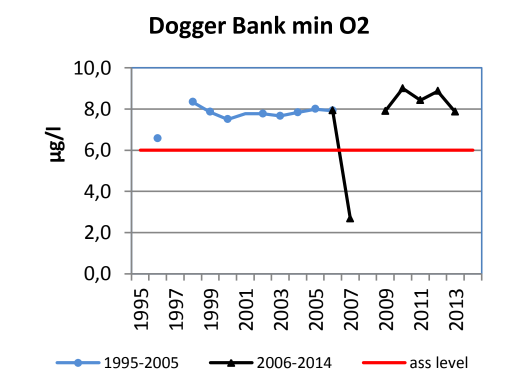

Fig. A7.9. Annual minimum concentration of oxygen (mg/l) in the bottom layer of the Dogger Bank.

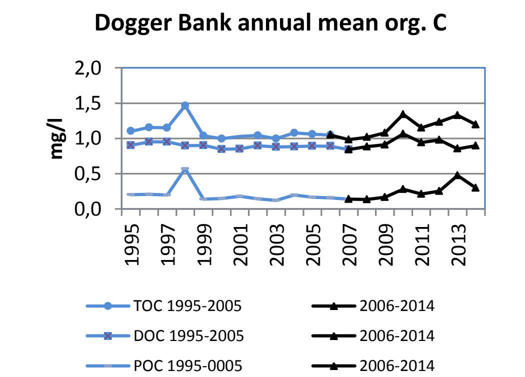

Fig. A7.10. Annual mean concentrations of total (TOC), dissolved (DOC) and particulate (POC) organic carbon (mg/l) in the surface layer of the Dogger Bank.

Annex 8 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 month 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 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); 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.