OSPAR COMMISSION

Eutrophication Status of the OSPAR Maritime Area

Third Integrated Report on the Eutrophication Status of the OSPAR Maritime Area

Eutrophication Series

2017

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les Parties contractantes sont l'Allemagne, la Belgique, le Danemark, l'Espagne, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède, la Suisse et l'Union européenne.

Acknowledgements

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Contents

Executive Summary

Eutrophication is still a problem

The overall objective of the OSPAR Eutrophication Strategy is to achieve a healthy marine environment where no eutrophication occurs. To determine progress towards the objective, the OSPAR Common Procedure was applied by nine Contracting Parties for a third time in 2017, using data from 2006 to 2014. This application indicates that the strategic objective has not yet been achieved. Eutrophication is still a problem in 7% of the North-East Atlantic, mainly affecting coastal areas. The Greater North Sea had the largest problem area (approximately 98,000km^2) with respect to eutrophication, extending along the coast from Belgium to Danish and Swedish waters. Small problem areas (5 to 400 km^2) were found along the coast of France, Norway and the United Kingdom. In the Celtic Seas many small inshore and coastal areas were classified as problem areas (approximately 500 km^2). In the Bay of Biscay two problem areas (approximately 800 km^2) were identified.

Positive trends observed

Between applications of the Common Procedure in 2008 and 2017 the spatial extent of problem areas has decreased in Denmark, France, Germany, Ireland, Norway and the United Kingdom. For Belgium and the Netherlands it remained constant. For Sweden there was a small increase in the extent of problem areas, as a greater area was assessed in 2017 compared to previous applications. The total spatial extent of problem areas has decreased from nearly 169,000km^2 in 2003 to 119,000km^2 in 2008 and 100,000 km^2 in 2017. The extent of potential problem areas has decreased from 2008 to 2017 and some of these are former problem areas that are showing improvements. Eutrophication status improved mainly in offshore and outer coastal waters of the Greater North Sea, in particular in Danish waters and in the Skagerrak, while there were a few improvements in inner coastal and inshore waters.

Significant nutrient input reductions

Improvements in eutrophication status are largely dependent on reducing anthropogenic inputs of nitrogen and phosphorus into problem areas. Contracting Parties have made great efforts to reduce nutrient inputs since the 1980s. OSPAR initiatives, together with actions under EU Directives and the Gothenburg Protocol of UNECE Convention on Long-range Transport of Air Pollution (CLRTAP), have resulted in substantial reductions of up to 50% in some areas. Inputs of phosphorus to the Greater North Sea, the Celtic Seas, the Bay of Biscay and the Iberian Shelf have all reduced since 1990. However, the rate of decrease in phosphorus inputs to the Greater North Sea has slowed since 2003. Nitrogen inputs have also reduced, by up to 25% in the case of the Greater North Sea. Of particular note is that atmospheric nitrogen inputs have reduced by 30% since 1990.

Although Contracting Parties have substantially decreased nutrient inputs, this has not yet resulted in an improvement of the overall eutrophication status. The main reason is that improvements in eutrophication effects parameters (chlorophyll concentrations, abundance of phytoplankton indicator species, oxygen depletion) happen slowly as a result of time lags in the marine system.

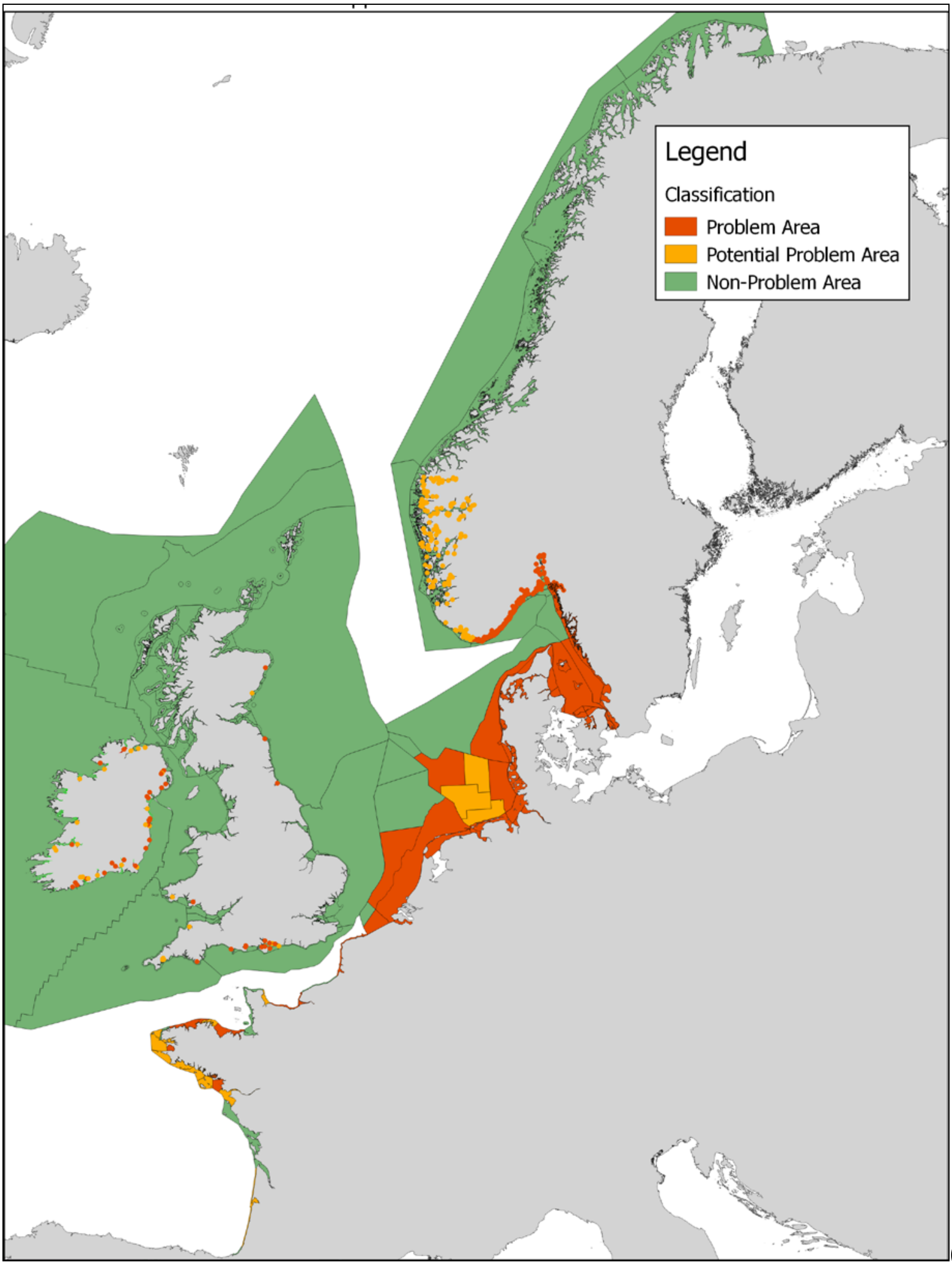
Further efforts are needed

Further effort is needed to reduce nutrient inputs in particular for nitrogen into the marine environment. Transboundary nutrient transport, both between Contracting Parties and from outside the OSPAR maritime area, remains a challenge, since nutrient reduction requirements are not only driven by the eutrophication status of Contracting Parties' own waters but also need to consider nutrients exported to the waters of other Contracting Parties. OSPAR's ecological modelling group ICG-EMO is working to improve quantification of transboundary nutrient fluxes. Some modelling studies estimate that nutrient input reductions beyond the current objective of the Eutrophication Strategy of a 50% reduction in anthropogenic loads in relation to input levels in 1985 will be needed to convert all problem areas into non-problem areas.

Experience gained in applying the Common Procedure

The Common Procedure has proved a good operational tool for the assessment of the eutrophication status and a useful instrument for addressing the requirements of the Marine Strategy Framework Directive (2008/56/EC).

A further application of the Common Procedure is necessary to follow up the effectiveness of reduction measures within OSPAR and under relevant EU regimes, for the eutrophication status of the North-East Atlantic. Contracting Parties have identified a number of issues concerning the Common Procedure that need to be addressed before its fourth application. Among them are: differences in assessment levels that result in contrasting classifications; the need to identify improvements in areas that have not yet achieved non-problem area status; remaining disparities between the Common Procedure and the Water Framework Directive; the need to make the fourth application less resource-intensive, and; technical issues relating to data analysis and emerging technologies such as automatic systems and remote sensing.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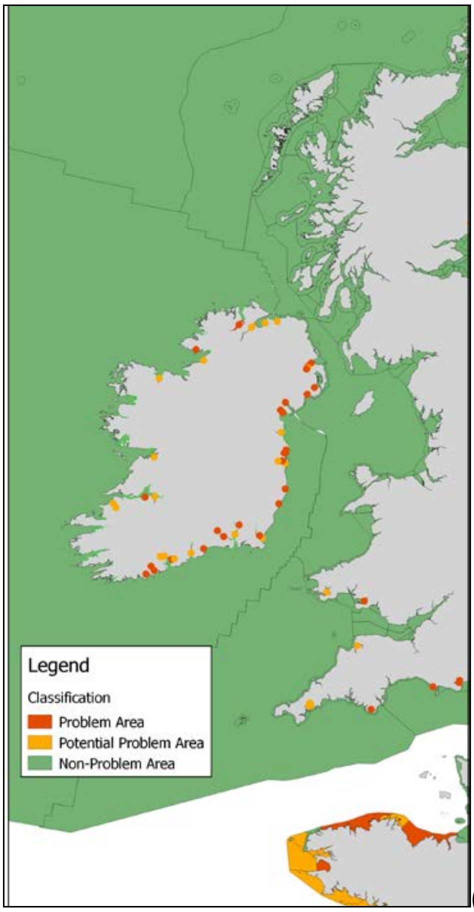

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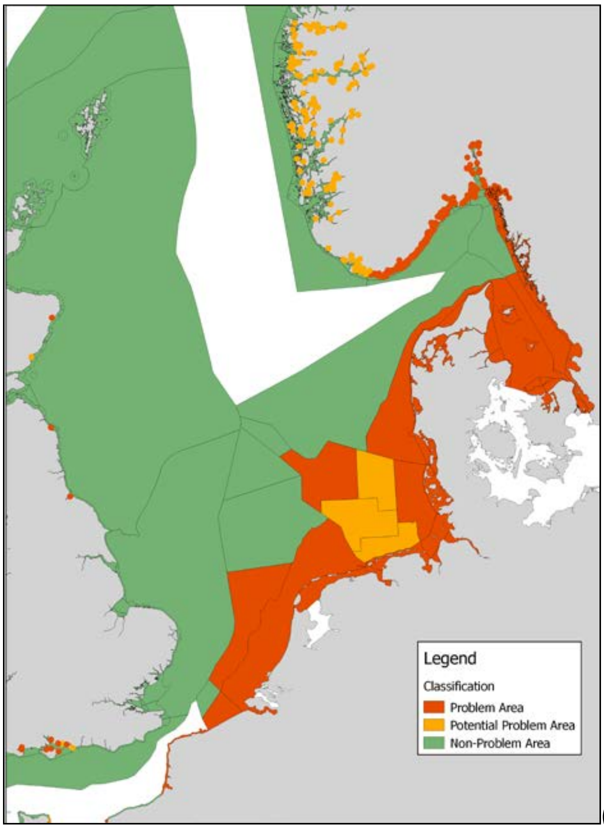

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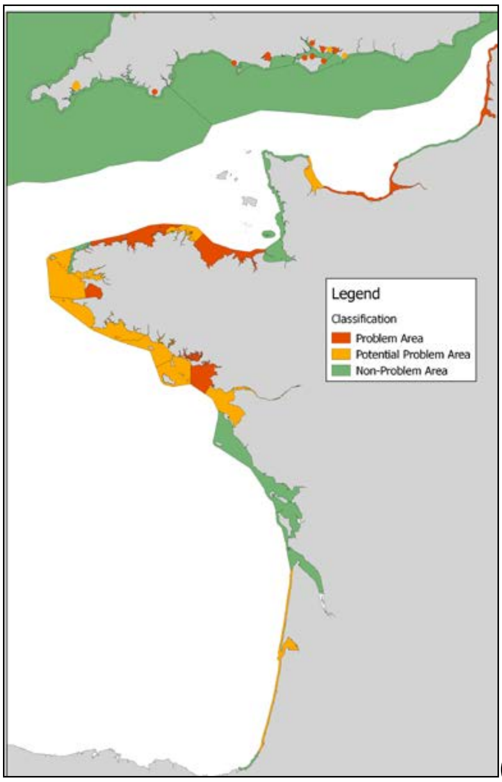

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***Figure 1**: Eutrophication status in areas assessed under the third application of the Common Procedure (2006–2014) in terms of problem areas, potential problem areas and non-problem areas: (a) whole area assessed, (b) Celtic Sea, (c) Greater North Sea, and (d) Bay of Biscay. For Ireland, Norway and the United Kingdom's inshore and coastal waters the locations of problem areas and potential problem areas are illustrated with circles, because these assessed areas are too small to be seen if their actual area extent is mapped*

Récapitulatif

Problème d'eutrophisation subsistant

L'objectif d'ensemble de la Stratégie eutrophisation OSPAR est de parvenir à un milieu marin sain exempt d'eutrophisation. Neuf Parties contractantes ont appliqué en 2017 pour la troisième fois la Procédure commune OSPAR, en se fondant sur des données de 2006 à 2014, afin de déterminer les progrès réalisés dans le sens de cet objectif. Cette application révèle que l'on n'est pas encore parvenu à cet objectif stratégique. L'eutrophisation présente encore un problème dans 7% de l'Atlantique du Nord-Est, affectant essentiellement les zones côtières. C'est dans la mer du Nord au sens large que se trouve la plus grande zone à problème d'eutrophisation (environ 98.000km^2), il s'agit de la bande côtière s'étendant des eaux belges aux eaux danoises et suédoises. De petites zones à problème (5 à 400 km^2) se trouvent le long des côtes de la France, de la Norvège et du Royaume Uni. De nombreuses petites zones côtières des mers celtiques, sont classées comme zones à problème (environ 500 km^2). On a identifié deux zones à problème dans le golfe de Gascogne (environ 800 km^2).

Tendances positives relevées

Au Danemark, en France, en Allemagne, en Irlande, en Norvège et au Royaume Uni, l'étendue des zones à problème a diminuée, entre les applications de la Procédure commune de 2008 et de 2017. Elle demeure inchangée dans le cas de la Belgique et des Pays-Bas. Dans le cas de la Suède on relève une légère augmentation de l'étendue des zones à problème car une plus grande zone a été évaluée en 2017 par rapport aux applications précédentes. La superficie totale des zones à problème a diminué, passant de presque 169.000 km^2 en 2003 à 119.000 km^2 en 2008 et 100.000 km^2 en 2017. L'étendue des zones à problème potentiel a diminué entre 2008 et 2017 car certaines d'entre elles sont d'anciennes zones à problème qui ont subi une amélioration. On a relevé une amélioration de l'état d'eutrophisation essentiellement dans les eaux du large et les eaux côtières externes de la mer du Nord au sens large, en particulier dans les eaux danoises et le Skagerrak, alors que les eaux côtières se sont peu améliorées.

Réductions significatives des apports en nutriments

L'amélioration de l'état d'eutrophisation dépend largement de la réduction des apports anthropiques d'azote et de phosphore dans les zones à problème. Depuis les années 1980, les Parties contractantes font de gros efforts afin de réduire les apports en nutriments. Les initiatives d'OSPAR, ainsi que les mesures prises dans le cadre des Directives de l'UE et du Protocole de Göteborg de la Convention de la CEE-NU sur la pollution atmosphérique transfrontière à longue distance (LRTAP), ont permis d'obtenir des réductions importantes, jusqu'à 50%, dans certaines zones. Les apports de phosphore dans la mer du Nord au sens large, les mers celtiques, le golfe de Gascogne et le plateau ibérique ont tous diminués depuis 1990. Le rythme de réduction des apports de phosphore dans la mer du Nord au sens large a cependant ralenti depuis 2003. Les apports d'azote ont également diminué, jusqu'à 25% dans le cas de la mer du Nord au sens large. La réduction de 30% des apports atmosphériques d'azote depuis 1990 présente un intérêt particulier.

Bien que les Parties contractantes soient parvenues à une réduction importante des apports en nutriments, l'état d'eutrophisation général ne s'est pas amélioré. Ceci est dû principalement au fait que l'amélioration des paramètres des effets de l'eutrophisation (teneurs en chlorophylle, abondance des espèces phytoplanctoniques indicatrices, appauvrissement en oxygène) est lente ce qui est dû au décalage dans le temps du système marin.

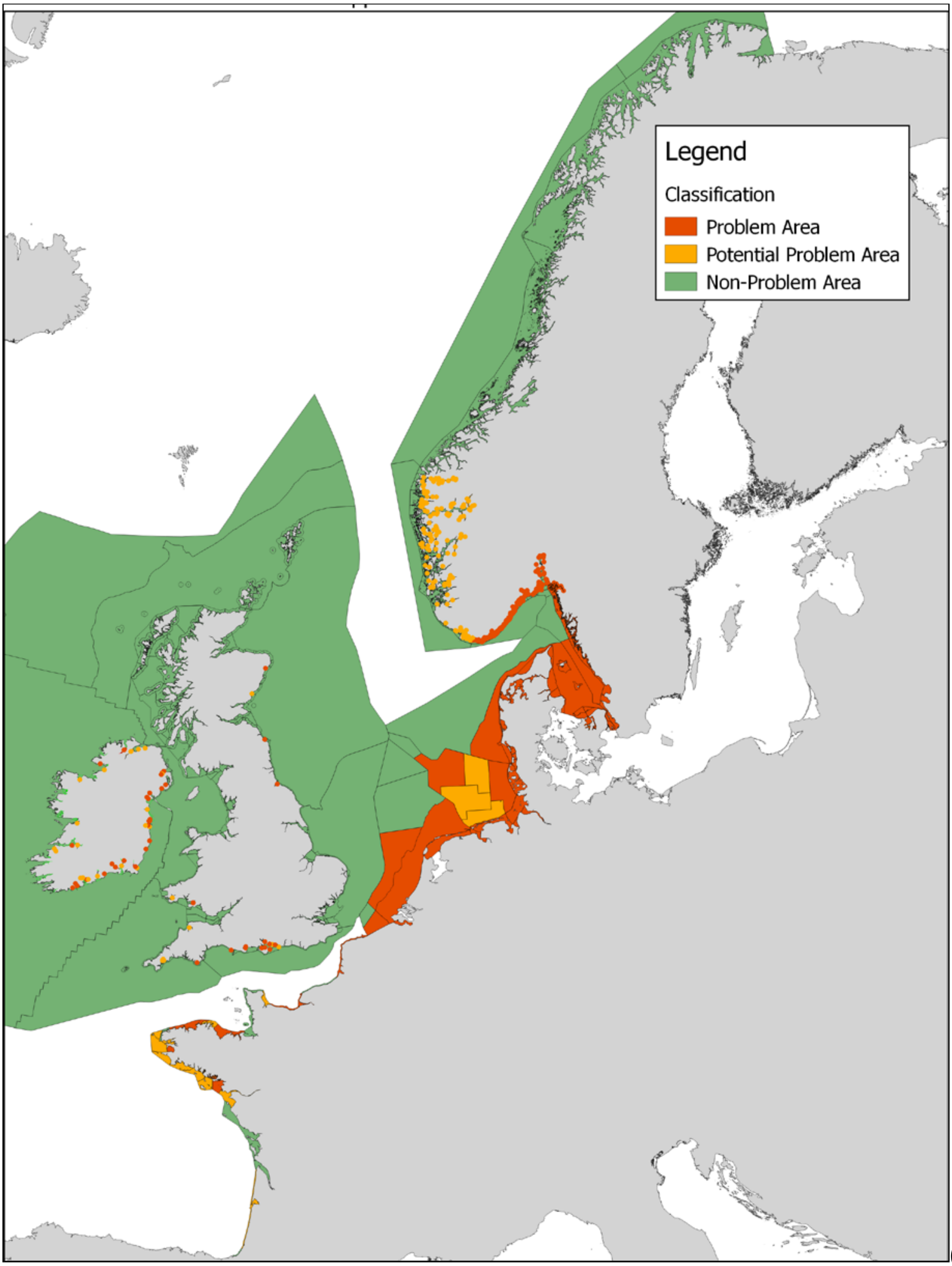
Efforts supplémentaires nécessaires

Il faudra faire des efforts supplémentaires pour réduire les apports en nutriments en particulier lorsqu'il s'agit de l'azote dans le milieu marin. Le transport transfrontière de nutriments, aussi bien entre Parties contractantes que provenant de l'extérieur de la zone maritime OSPAR, continue à présenter des problèmes car les exigences de la réduction des nutriments ne sont pas seulement conditionnées par l'état d'eutrophisation des eaux propres aux Parties contractantes mais elles doivent également considérer les nutriments exportés dans les eaux d'autres Parties contractantes. Les travaux du Groupe de modélisation écologique OSPAR (ICG-EMO) portent sur l'amélioration de la quantification des flux transfrontières de nutriments. Certaines études de modélisation estiment qu'il faudra parvenir à des réductions d'apports en nutriments allant au delà de l'objectif actuel de la Stratégie eutrophisation, soit une réduction de 50% des charges anthropiques par rapport aux niveaux d'apport de 1985, pour pouvoir convertir toutes les zones à problème en des zones sans problème.

Expérience acquise lors de l'application de la Procédure commune

La Procédure commune s'est avérée être un bon outil opérationnel pour l'évaluation de l'état d'eutrophisation et un instrument utile permettant d'aborder les exigences de la DCSMM (2008/56/CE).

Il y a lieu d'entreprendre une autre application de la Procédure commune afin de suivre l'efficacité des mesures de réduction au sein d'OSPAR et dans le cadre des programmes pertinents de l'UE, concernant l'état d'eutrophisation de l'Atlantique du Nord-Est. Les Parties contractantes ont identifié un certain nombre de questions concernant la Procédure commune qu'il y a lieu d'aborder avant sa quatrième application. Il s'agit notamment des différences que présentent les niveaux d'évaluation et qui donnent lieu à des classifications divergentes, de la nécessité de déterminer les améliorations à apporter aux zones qui n'ont pas encore été converties en zone sans problème, des disparités qui subsistent entre la Procédure commune et la Directive cadre sur l'eau, de la nécessité de réaliser une quatrième application exigeant moins de ressources et des questions d'ordre technique portant sur l'analyse des données et les technologies émergentes telles que les systèmes automatiques et la télédétection.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Non-Problem Area
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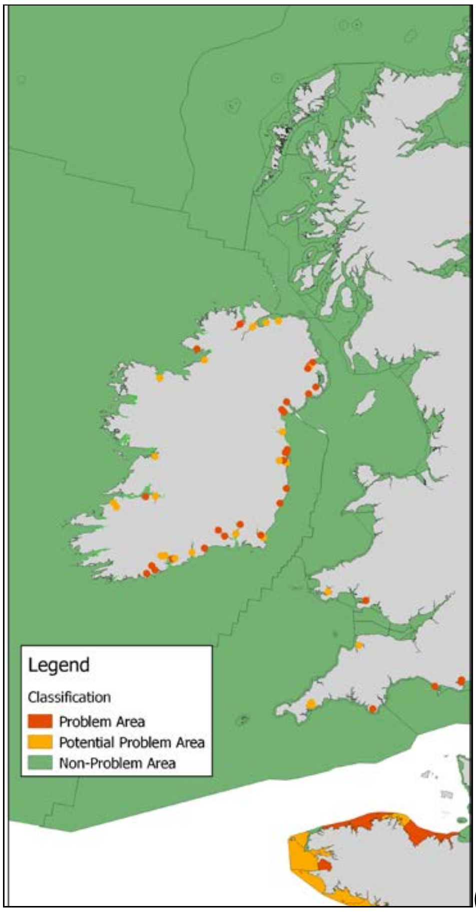

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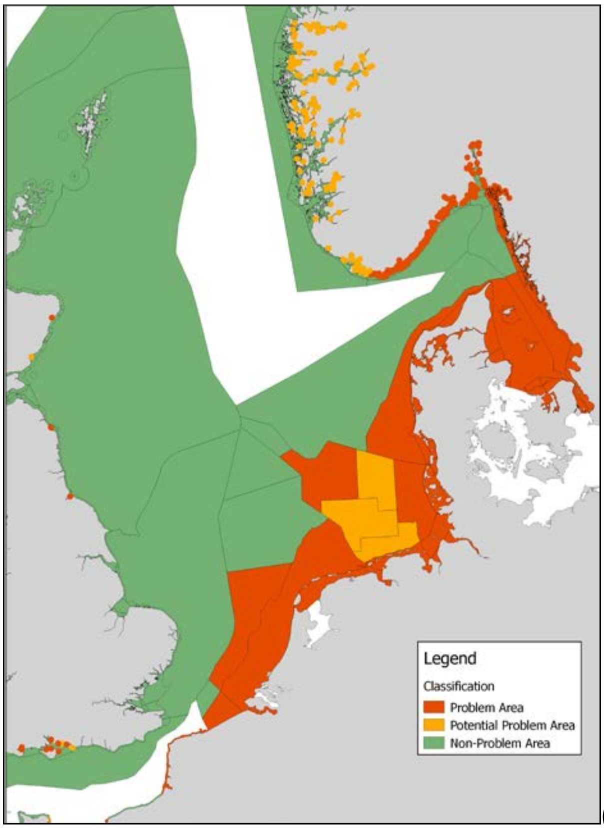

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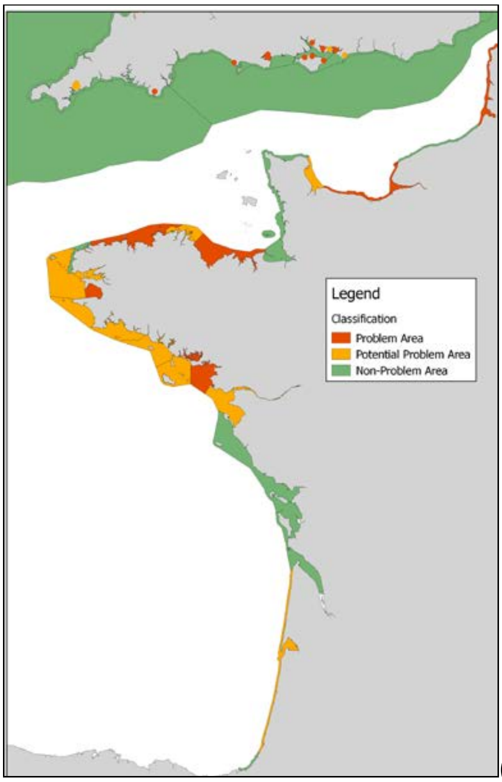

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Figure 2*: Etat d'eutrophisation dans les zones évaluées dans le cadre de la troisième application de la Procédure commune (2006–2014) à titre de zones à problème, de zones à problème potentiel et de zones sans problème: (a) ensemble de la zone évaluée, (b) mers celtiques, (c) mer du Nord au sens large, et (d) golfe de Gascogne. Dans le cas des eaux côtières de l'Irlande, de la Norvège et du Royaume Uni, l'emplacement des zones à problème et des zones à problème potentiel est indiqué par des cercles car elles ne sont pas assez étendues pour figurer clairement sur une carte*

1 Introduction

This report is the third in a series of periodic assessments of the eutrophication status of the OSPAR Maritime Area under the Common Procedure for the Identification of the eutrophication status of the OSPAR Maritime Area (the "Common Procedure") (OSPAR, 2013). It follows and builds on the results of the first and second applications of the Comprehensive Procedure (OSPAR, 2003a, 2008). The thematic assessment contributes to the OSPAR Intermediate Assessment 2017, which may be used by OSPAR Contracting Parties in support of the requirements of the European Union (EU) Marine Strategy Framework Directive (2008). The purpose of this report is:

- to assess the eutrophication status of the OSPAR Maritime Area and its Regions based on data for the period 2006–2014;
- to evaluate progress made towards achieving the objectives of the OSPAR Eutrophication Strategy;
- to consider the effectiveness of measures taken to combat eutrophication on the state of the marine environment, and;
- to identify priorities for future actions.

The following Contracting Parties conducted a third application of the Comprehensive Procedure: Belgium, Denmark, France, Germany, Ireland, the Netherlands, Norway, Sweden and the United Kingdom[1].

1.1 Eutrophication Strategy

OSPAR's North East Atlantic Environment Strategy (OSPAR, 2010) takes forward work related to the implementation of the Ecosystem Approach and the suite of five thematic strategies, to address the main threats that it has identified concerning issues within its competence. The aim of the OSPAR Eutrophication Strategy is to make every effort to combat eutrophication in the OSPAR Maritime Area in order to achieve and maintain, by 2020, a healthy marine environment where eutrophication does not occur.

[1] Spain and Portugal experienced delays in their delivery of reports under the Common Procedure. Iceland has previously carried out an assessment under the Screening Procedure of the Common Procedure and reported that there were no problem areas in its waters

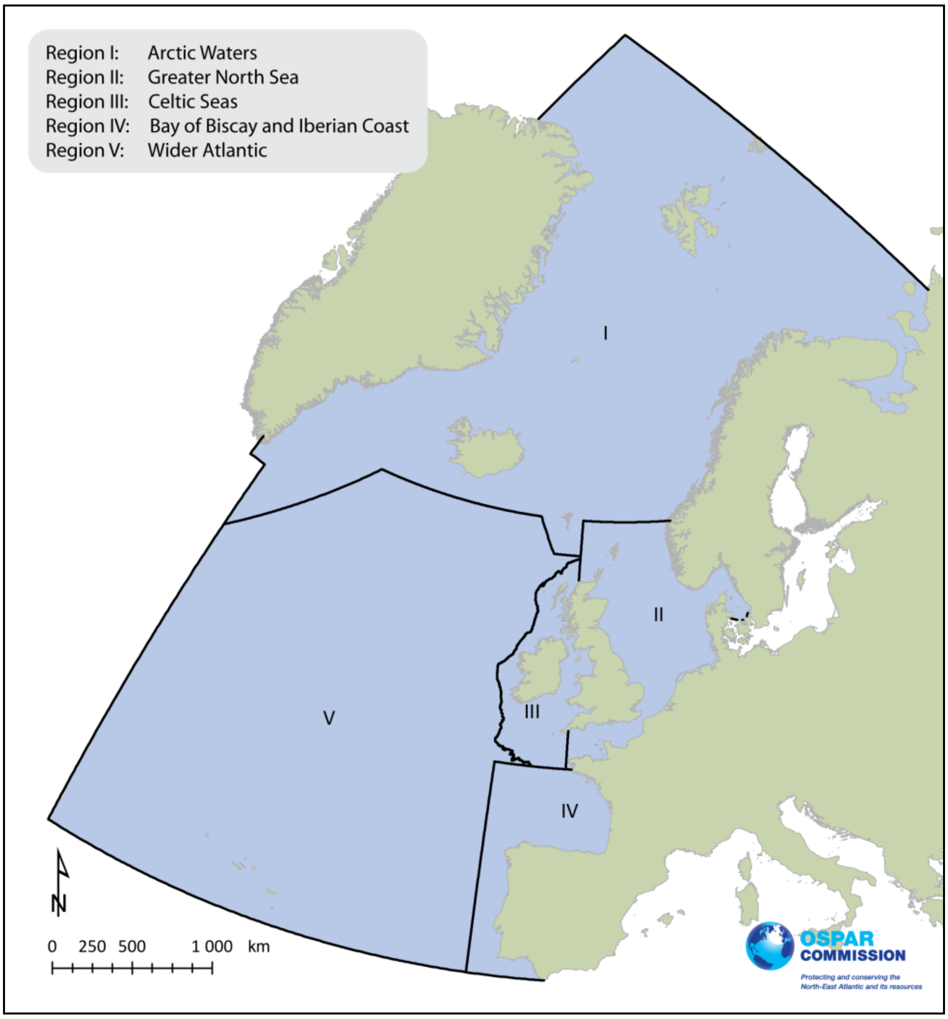


Figure 1.1 *OSPAR Maritime Area and its Regions*

The OSPAR Maritime Area covers most of the North-East Atlantic. It embraces open sea areas as well as inshore and coastal waters adjacent to densely populated catchments where pressures from human activities are particularly high. For assessment purposes, the OSPAR Maritime Area is divided into five Regions (Figure 1.1): Arctic (Region I), the Greater North Sea (Region II), the Celtic Seas (Region III), the Bay of Biscay and Iberian Coast (Region IV), and the Wider Atlantic (Region V).

Marine eutrophication is defined in the OSPAR Eutrophication Strategy as "the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients as described in the Common Procedure". This definition is similar to that adopted in European Community legislation relating to eutrophication. Primary production is often limited by the availability of light or nutrients. Nutrient enrichment may cause an increase in the growth of algae and higher forms of plant life but this depends on the availability of sufficient light and on the hydrodynamics of the water body. This in turn may lead to a range of undesirable disturbances in the marine ecosystem such as the oxygen depletion in bottom waters causing the death of fish and other species and significant shifts in the composition of the flora and fauna affecting habitats and biodiversity. A simplified schematic illustration of many of the issues associated with the eutrophication process is given in Figure 1.2.

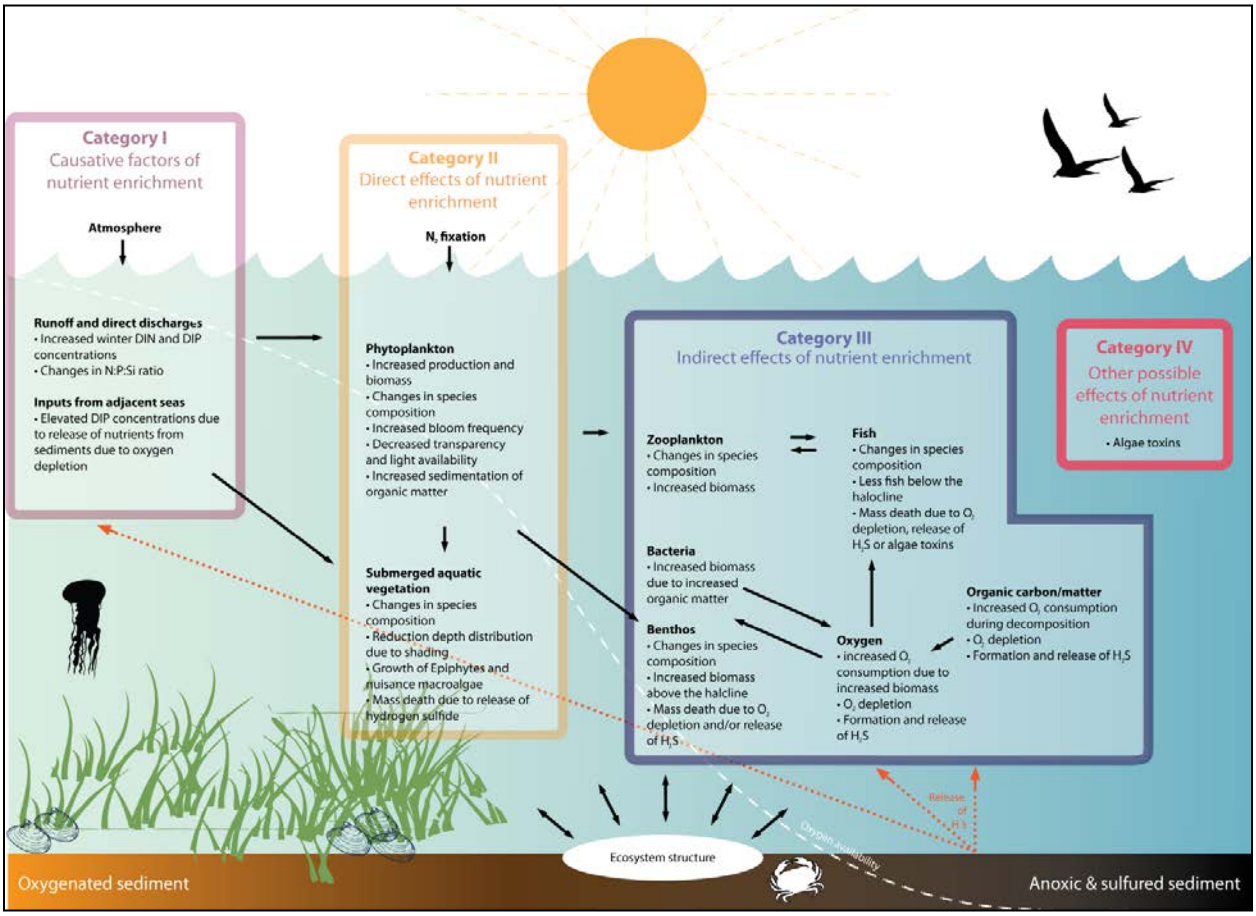


***Figure 1.2**: Simplified illustration of many of the issues associated with eutrophication. DIN is dissolved inorganic nitrogen and DIP is dissolved inorganic phosphorus. N:P:Si is the ratio between nitrogen, phosphorus and silicate (after Ferreira et. al, 2010)*

Human activities resulting in anthropogenic nutrient enrichment encompass inputs from point sources (e.g. sewage plants or industry) and from diffuse sources (e.g. agriculture, households not connected to sewerage, overflows, and atmospheric deposition). In combating human-induced eutrophication, the Eutrophication Strategy builds on long-standing work of OSPAR. This includes the commitment of Contracting Parties to achieve a substantial reduction at source, in the order of 50% compared to 1985, in inputs of phosphorus and nitrogen into areas where these inputs are likely, directly or indirectly, to cause pollution (PARCOM, 1998). These areas are defined as problem areas. To assist Contracting Parties in identifying these areas in a consistent way, OSPAR developed a common assessment framework: the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area (the "Common Procedure"). Under the Common Procedure waters are classified as problem areas, potential problem areas and non-problem areas with regard to eutrophication.

It is the responsibility of Contracting Parties to apply the Common Procedure to their parts of the OSPAR Maritime Area. The OSPAR Commission reviews the results of the national assessments. In cases in which the final classification results in problem areas with regard to eutrophication, the Eutrophication Strategy requires the OSPAR Commission and Contracting Parties, individually or jointly, to take measures to reduce or to eliminate the anthropogenic causes of eutrophication and to assess, based on implementation reporting, the effectiveness of those measures on the state of the marine ecosystem. In the case of potential problem areas with regard to eutrophication, preventive measures shall be taken in accordance with the precautionary principle and monitoring and research shall be urgently implemented to enable a full assessment of the eutrophication status of each area concerned after five years of its classification.

The Common Procedure is supported under the eutrophication-related part of the OSPAR Joint Assessment and Monitoring Programme (JAMP) (OSPAR, 2014a) by collective OSPAR monitoring. The Eutrophication Monitoring Programme (OSPAR, 2005) is supplemented by monitoring guidelines, as part of the OSPAR Coordinated Environmental Monitoring Programme (CEMP) (OSPAR, 2016). Monitoring and periodic assessments of temporal trends of waterborne and atmospheric inputs of nutrients to the OSPAR Maritime Area under the OSPAR Comprehensive Study of Riverine Inputs and Direct Discharges (RID) (OSPAR, 2014) and the OSPAR Comprehensive Atmospheric Monitoring Programme (CAMP) (OSPAR, 2015) also inform the assessment of the eutrophication status.

The implementation of the Eutrophication Strategy takes place within the framework of the obligations of Contracting Parties in this field in other fora. This includes, for example, the Urban Waste Water Treatment Directive (91/271/EEC) and the Nitrates Directive (91/676/EEC), which require Member States of the European Community and the European Economic Area to identify “sensitive areas” and nitrate “vulnerable zones”, respectively, as basis for the implementation of targeted measures to reduce nutrient inputs to these areas. Under the Water Framework Directive (2000/60/EC), an assessment framework closely linked to the conceptual approach of the Common Procedure has been set up to assess, classify and monitor the ecological quality of a water body in transitional and coastal waters. It requires the adoption of measures and programmes to achieve good ecological status of those waters. The Marine Strategy Framework Directive (2008/56/EC) requires EU Member States to take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest. This includes the goal to minimise human-induced eutrophication, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

1.2 OSPAR common indicators and the Intermediate Assessment 2017

OSPAR is developing a set of common indicators that will contribute to the Intermediate Assessment 2017 and may be used by Contracting Parties to support their assessment and reporting requirements under the EU Marine Strategy Framework Directive. In contrast to the Common Procedure assessments that are carried out by Contracting Parties for the waters under their jurisdiction, the common indicators are developed at regional scales. Eutrophication-related common indicators are being developed for nutrient inputs (both from rivers and the atmosphere), nutrient concentrations (in the sea), chlorophyll-a concentration (in the sea), *Phaeocystis* abundance (in the sea, in one part of the Maritime Area) and dissolved oxygen concentration (in waters near the seabed). The indicators focus on trends and contribute to assessing progress towards the objective of the Eutrophication Strategy. The common indicators may be used to support the assessment of progress towards the goal of the Marine Strategy Framework Directive as three indicators (nutrient concentrations, chlorophyll-a and dissolved oxygen) represent the primary criteria and one (*Phaeocystis*) represents a secondary criterion adopted in the 2017 revision of the European Commission Decision (EU, 2017).

2. The Common Procedure

Marine eutrophication is diagnosed through the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area. The Common Procedure comprises two procedural phases: an initial screening of selected marine areas and the application of a Comprehensive Procedure assessment.

The screening procedure identifies those areas of the OSPAR Maritime Area that are likely to be areas where eutrophication is not a problem. Those areas are classified as non-problem areas without further detailed assessment.

The Comprehensive Procedure is an iterative process that links qualitative harmonised assessment criteria in a cause-effect scheme to form a holistic assessment of the eutrophication status of a given area (see Figure 1 of the Common Procedure, OSPAR, 2013). Ten assessment parameters, in four categories, have been selected for harmonised application by Contracting Parties in the eutrophication assessment (Table 2.1). For each parameter, area-specific assessment levels are derived in relation to the relevant background conditions. The assessment level may deviate from background conditions to reflect natural variability. For concentrations, the assessment level is generally defined as a justified area-specific percentage deviation from background conditions not exceeding 50%. Parameters are selected and applied according to their relevance for the area concerned because they reflect the cause-effect relationships of the eutrophication process (step 1 of the Comprehensive Procedure).

For an initial classification of an area the observed levels or concentrations for each assessment parameter are scored and evaluated in relation to each other (step 2 of the Comprehensive Procedure). Areas showing levels or concentrations that exceed the assessment levels for each of the categories of assessment parameters are initially classified as problem area. Where none of the categories have elevated levels the area is initially classified as non-problem area. Section 5 of the Common Procedure provides a complete guide to the possible outcomes from scoring in the initial classification.

Following the initial classification, an overall appraisal can be made of all relevant information concerning the harmonised assessment parameters, their respective assessment levels and supporting environmental factors in the assessment framework, in order to achieve a final classification of the area concerned (step 3 of the Comprehensive Procedure). The purpose of this step in the assessment is to provide a sufficiently sound, transparent and verifiable account of the reasons for giving a particular status to an area.

In the assessment under the Comprehensive Procedure Contracting Parties are encouraged to take into account supporting environmental factors that may have a bearing on eutrophication processes and their assessment. The physicochemical and hydromorphological factors to be taken into account by Contracting Parties to determine the sensitivity of an area to eutrophication include: salinity gradients and regimes; depth; stratification and mixing characteristics; transboundary fluxes; upwelling; sedimentation; residence and retention time; mean water temperature; turbidity (expressed in terms of suspended matter), and; mean substrate composition (in terms of sediment types).

***Table 2.1**: OSPAR harmonised assessment criteria and associated elevated levels*

Assessment parameter		
Category I		*Degree of nutrient enrichment*
	1	Riverine inputs and direct discharges (area-specific)
		Elevated inputs and/or increased trends of total N and total P (compared with previous years)
	2	Nutrient concentrations (area-specific)
		Elevated level(s) of winter DIN and/or DIP
	3	N/P ratio (area-specific)
		Elevated winter N/P ratio (Redfield N/P = 16)
Category II		*Direct effects of nutrient enrichment (during growing season)*
	1	Chlorophyll-a concentration (area-specific)
		Elevated maximum, mean and/or 90 percentile level
	2	Phytoplankton indicator species (area-specific)
		Elevated levels of nuisance/toxic phytoplankton indicator species (and increased duration of blooms)
	3	Macrophytes including macroalgae (area-specific)
		Shift from long-lived to short-lived nuisance species (e.g. *Ulva*). Elevated levels (biomass or area covered) especially of opportunistic green macroalgae)
Category III		*Indirect effects of nutrient enrichment (during growing season)*
	1	Oxygen deficiency
		Decreased levels (< 2 mg l^{-1}: acute toxicity; 2–6 mg l^{-1}: deficiency) and lowered % oxygen saturation
	2	Zoobenthos and fish
		Kills (in relation to oxygen deficiency and/or toxic algae)
		Long-term area-specific changes in zoobenthos biomass and species composition
	3	Organic carbon/organic matter (area-specific)
		Elevated levels (in relation to III.1) (relevant in sedimentation areas)
Category IV		*Other possible effects of nutrient enrichment (during growing season)*
	1	*Algal toxins*
		Incidence of DSP/PSP mussel infection events (related to II.2)

3 Third Application of the Comprehensive Procedure

OSPAR Contracting Parties, carrying out the third application of the Common Procedure, have provided National Assessment Reports. Summaries of the national assessments are given in Annex 1 (links in Box 1, also provides links to full national reports). A compilation of the assessment results for each assessed area is presented at Annex 2. An overview is presented at Annex 3 to this report of the problem areas and potential problem areas identified in the first, second and third applications of the Comprehensive Procedure.

Contracting Parties reported different experiences in the application of harmonised assessment criteria and added voluntary assessment parameters in the area classification under the Comprehensive Procedure. This resulted sometimes in different classifications of adjacent sea areas. These experiences are summarised here to explain classification results and to indicate needs for further development of the assessment framework of the Common Procedure.

Box 1: National summaries

Navigator to summaries of national assessments at Annex 1 (click on country's initials)

BE	
DE	
DK	
FR	
IE	
NL	
NO	
SE	
UK	

3.1 Characterisation of assessed areas

The areas assessed in the 2016 national assessments (Figure 1) include those that had been identified as problem areas, potential problem areas or non-problem areas in the second integrated report on Eutrophication Status. Some of the areas assessed have also been designated as polluted waters with associated vulnerable zones under the Nitrates Directive (91/767/EEC) or as sensitive areas (eutrophic) under the Urban Waste Water Directive (91/276/EEC).

The water types assessed in the third application of the Comprehensive Procedure have been grouped into inshore waters (bays, estuaries, fjords, and the Wadden Sea), coastal waters and offshore waters (Table 3.1). This differentiation is mainly related to salinity, for example in the Greater North Sea: inshore waters <30, coastal waters 30-34.5 and offshore waters ≥34.5 (Figure 3.1), morphology (estuaries and fjords) and hydrodynamics (sedimentation, stratification) which may control the regional extent of eutrophication. This characterisation is not always fully reflected in the national assessments. For example, Belgium did not include estuaries and France and Norway included estuaries and fjords and coastal waters but not offshore waters. Inshore waters were addressed individually by Ireland and the United Kingdom, were grouped within hydrodynamic sections by France, and were grouped within regions by Norway. Many Contracting Parties used the 1 nautical mile (3 nautical miles in Scotland) boundary of the WFD for delineating assessment areas.

Observed salinity gradients in the North Sea reflect the different extents of freshwater discharges along the North Sea coasts and the Baltic outflow, both contributing to residual coastal currents. These gradients indicate the dispersion of nutrient discharges from rivers, which can affect the distribution of phytoplankton biomass, as shown by the chlorophyll-a gradients. Steep salinity gradients indicated fast mixing of river plumes, limiting eutrophication to inshore waters.

Offshore waters were only assessed by Belgium, Denmark, Germany, Ireland, the Netherlands, Sweden and the United Kingdom for a total of 27 differentiated areas. 95 coastal waters and 95 inshore waters were assessed (Table 3.1), reflecting the more significant near coastal eutrophication.

***Table 3.1**: Number of assessed areas per Contracting Party. Inshore, coastal and offshore waters are defined according to the OSPAR Common Procedure based on surface salinities (inshore <30, coastal 30-34.5 (34 in*

the Irish Sea), offshore >34.5). These definitions do not follow the WFD that defines coastal waters as waters within 1 nautical mile from the coast (3 nautical miles in Scotland)

Land	Offshore	Coastal	Inshore	Total
Belgium	1	1	0	2
Denmark	3	15	20	38
France		23	5	28
Germany	2	4	5	11
Ireland	7	13	71	84
Netherlands	3	1	3	7
Norway	0	6	9	15
Sweden	2	6	2	10
United Kingdom	8	7	756	15
TOTAL	27	95	871	210

The assessed areas have been defined differently by Contracting Parties, which makes a comparison difficult. For example, Denmark, Ireland and Norway defined distinct areas within some of their estuaries or fjord systems, while for example Germany, the Netherlands and Sweden used a salinity related approach to the determination of assessment areas. Furthermore, Contracting Parties have dealt differently with the assessment of coastal/inshore waters that are managed under the WFD. While some Contracting Parties have used the WFD water bodies (e.g. Denmark and the United Kingdom) as assessment areas, others have combined water body types (e.g. France, Germany and Sweden) or even larger areas (e.g. Belgium, Ireland (for offshore areas), and the Netherlands).

In some cases, Contracting Parties have made changes to their assessment areas between the second and third application of the Comprehensive Procedure by grouping areas or splitting up previous assessment areas into smaller units. Details can be found in the national reports, and at Annex 3. For those areas, comparison between the first, second and third application outcomes may be difficult. In comparison to the second Comprehensive Procedure most Contracting Parties have used a greater number of assessment areas (Denmark, Germany, Norway, Sweden and the United Kingdom), whereas some have used the same (Belgium, France and Netherlands) or fewer (Ireland) assessment areas in the third application of the Comprehensive Procedure.

3.2 Use of assessment parameters

The parameters used by Contracting Parties in the assessment have been compiled in Table 3.2. The OSPAR Eutrophication Monitoring Programme specifies different requirements for monitoring of non-problem areas and potential and problem areas. Contracting Parties applying the Comprehensive Procedure can select from the list of harmonised assessment criteria those parameters that are relevant for their waters. This should reflect the specific characteristics of the area assessed, for example, organic matter is only relevant in sedimentation areas and macrophytes may not be relevant in deeper waters.

In this application of the Comprehensive Procedure not all of the relevant harmonised assessment criteria have been applied by all Contracting Parties. For example, for winter nutrients and N/P ratios, one Contracting Party argued that the relationship between nutrients and eutrophication effects during growing season was too complex to take those parameters into account. Contracting Parties have assigned different importance to the parameters phytoplankton indicator species and algal toxins as indicators for eutrophication and this has led to differences in their use.

In several instances, the parameters have been measured, but the data were considered insufficient and not fit for the final assessment, causing modifications between the initial and final assessments (Table 3.2). Practical issues like time and resource constraints were also given as reasons for not including some parameters in the assessment, especially those that would require considerable monitoring effort, like kills in fish and long-term changes in zoobenthos.

In general, the parameters riverine inputs, inorganic winter nutrients, Chlorophyll-a, phytoplankton indicator species, macrophytes and oxygen concentrations were the parameters used most by Contracting Parties (Table 3.2). However, the use of parameters differed according to water type. Inorganic winter nutrients, chlorophyll-a and oxygen concentrations are the parameters that have been used most in estuaries, including fjords, and in coastal waters. Offshore, winter nutrients, N/P ratios and chlorophyll-a have been used most in the assessments (see Figure 3.7, 3.10, 3.11). Analyses of phytoplankton indicator species, macrophytes including macroalgae and long term changes in zoobenthos biomass and species composition were used less often, perhaps reflecting the requirements in specific assessment areas.

Contracting Parties may use additional voluntary parameters in the Comprehensive Procedure assessment (e.g. total nitrogen, total phosphorus, transboundary nutrient transports). Only two Contracting Parties made use of the additional parameters (Table 3.2).

Table 3.2*: Harmonised assessment criteria (shaded) and additional voluntary parameters (*) applied and reported by Contracting Parties in the third application of the Comprehensive Procedure*

Category	Parameter	BE	DE	DK	FR	IE	NO	NL	SE	UK
Cat. I	**Riverine inputs and direct discharges**	✓	✓	X	✓	✓	✓	✓	✓	✓
	Winter DIN and DIP concentrations	✓	✓	✓	X	✓	✓	✓	✓	DIN
	N/P ratio	✓	✓	X	X	✓	✓	✓	✓	✓
	*Total nitrogen, total phosphorus	X	✓	X	X	X	X	X	✓	X
	*Transboundary nutrient transport	✓	✓	X	✓	X	X	✓	X	X
	*Atmospheric nitrogen deposition	X	✓	X	X	X	X	X	✓	X
	*Silicate (and Si ratios)	X	✓	X	X	X	X	X	✓	X
Cat. II	**Chlorophyll-a**	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Phytoplankton indicator species	✓	✓	X	✓	✓	X	✓	✓	✓
	Macrophytes including macroalgae	X***	✓	✓	✓	✓	✓	X	✓	✓
Cat. III	**Oxygen deficiency and lowered % saturation**	✓	✓	X	✓	✓	X	✓	✓	✓
	Kills in fish and zoobenthos	✓	X	X	X	X	X	X	✓	✓
	Long-term changes in zoobenthos biomass and species composition[2]	X	✓	✓	X	X	✓	X	✓	✓
	Organic carbon	X	✓	X	X	✓	X	✓	✓	X
	*Secchi depth	X	✓	✓**	X	X	X	X	✓	X
Cat. IV	**Algal toxins**	X	✓	X	✓	✓	X	X	✓	X

*additional voluntary assessment parameters
✓parameter included in the assessment
X parameter not included in the assessment
**only in the offshore parts of Kattegat
*** monitoring of macrophytes is not relevant for the Belgian part of the North Sea

[2] Long-term changes in zoobenthos biomass and species composition are listed as a harmonised assessment criterion in the Common Procedure and subject to monitoring under the Eutrophication Monitoring Programme. So far, OSPAR has not developed requirements for harmonised application of the parameter.

3.2.1 Developments with assessment levels

Background values and assessment levels were mostly differentiated for inshore, coastal and offshore waters, (Annex 4) reflecting the decreasing influences of river discharges. Mixing gradients are reflected by the salinity gradients which are particularly extensive along the continental North Sea coasts due to shallow bathymetry or the spreading Baltic Sea outflow along the Kattegat, Skagerrak and Norwegian coast (Figure 3.1).

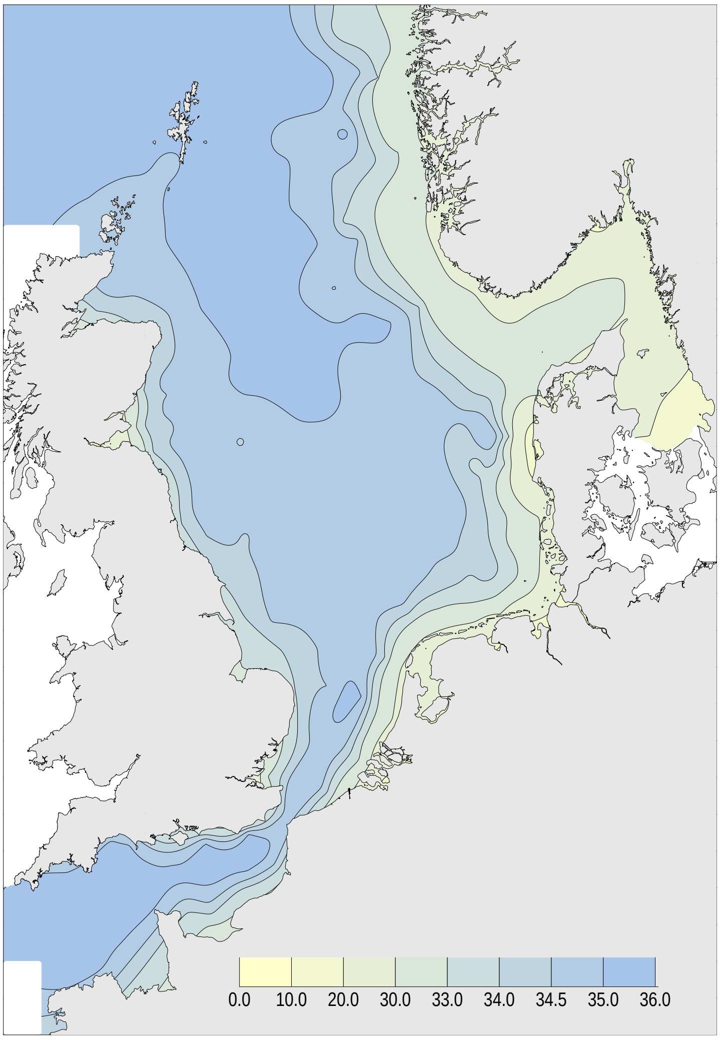


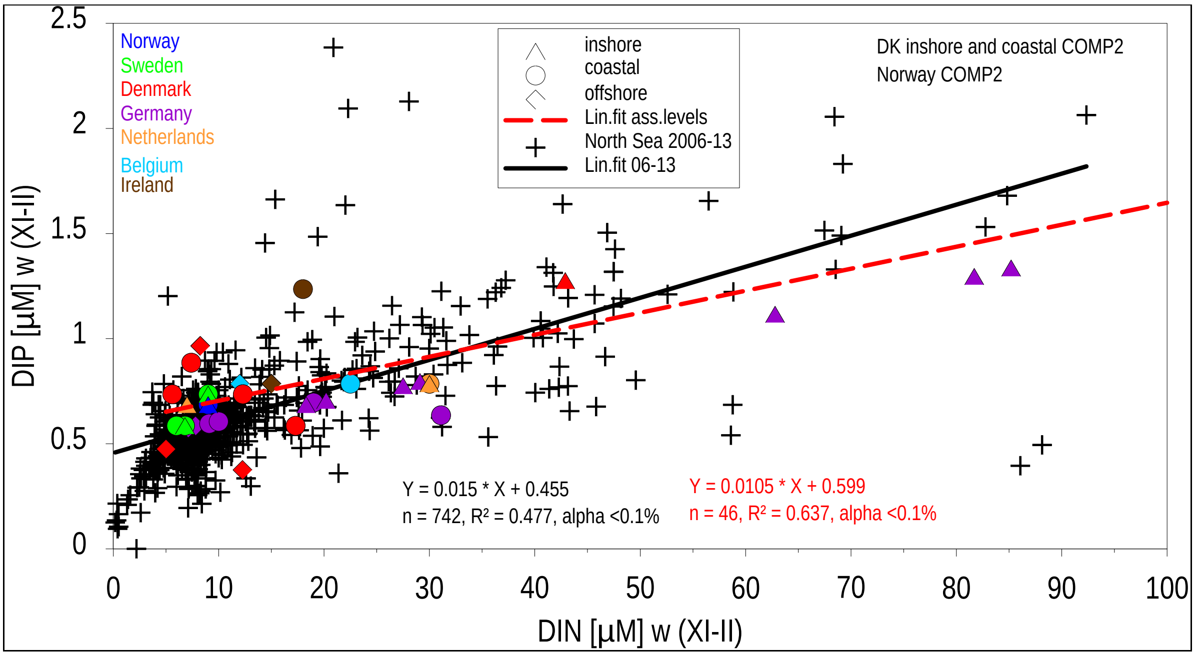
Figure 3.1: *Salinity at surface in the Greater North Sea in 2006 – 2013. Source: ICES-data*

The background levels used in the first application of the Comprehensive Procedure had mainly been based on expert judgement. In the second and third assessments a number of Contracting Parties reviewed their background levels based on recent knowledge and/or historical data. One driver for the review has been the need to have coherent assessment levels with the Water Framework Directive for transitional and coastal waters and the Marine Strategy Framework Directive for marine waters. The review of background levels has led to some changes of assessment levels used.

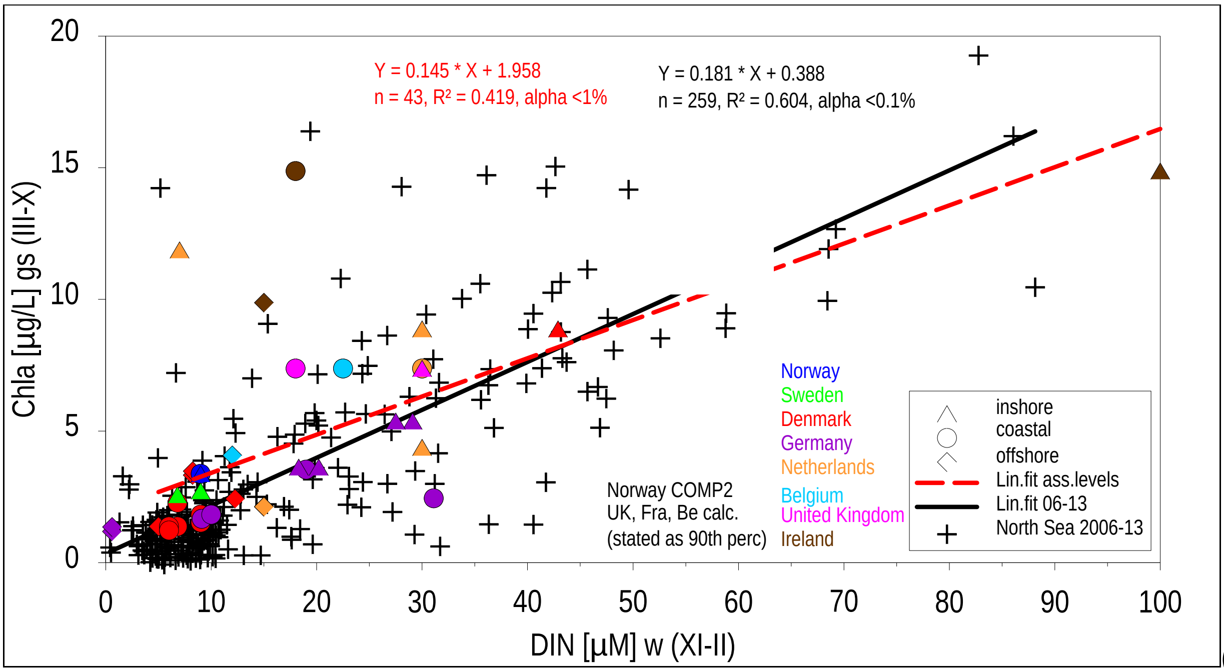
In the first application of the Comprehensive Procedure, assessment levels had been set at 50% deviation from background where natural variability needed to be taken into account. The 2013 revision of the

Common Procedure introduced a more flexible approach to setting assessment levels as justified area-specific % deviation from background which must not exceed 50%. In the current assessment, some Contracting Parties refined their assessment levels based on lower % deviation as a result of improved knowledge. For example, in German waters the acceptable deviation added to the background conditions was adjusted depending on the salinity and varied between 50% for coastal waters and 0% for marine end members, because it was assumed that the offshore areas are not affected by eutrophication. An overview of the assessment levels used by Contracting Parties in the third application of the Comprehensive Procedure for winter DIN, winter DIP, chlorophyll-a, oxygen and phytoplankton indicator species is given inAnnex 4.

To check whether assessment levels of Contracting Parties are consistent correlations between winter-DIN concentrations and winter-DIP concentrations as well as correlations between winter-DIN concentrations and chlorophyll-a (growing season) concentrations have been made. In general there is a good correlation between these parameters as is demonstrated when plotting the recent data, however, in particular in estuaries where nutrient concentrations or chlorophyll-a concentrations can reach very high values the relationship is weaker (Figure 3.2). In general, there was a good correlation between the assessment levels for winter-DIN and winter-DIP concentrations and winter-DIN concentrations and mean chlorophyll-a concentrations with only few outliers (Figure 3.2).



(a)



(b)

***Figure 3.2**: Correlations between (a) dissolved inorganic nitrogen concentrations (DIN) and dissolved inorganic phosphorus concentrations (DIP) for recent data 2006-2013 (black crosses) and (b) DIN and chlorophyll-a (Chla) for recent data 2006-2013 (black crosses), for assessment levels used by Contracting Parties. XI, November; II, February; black solid line, linear regression for recent data (black crosses); red dashed line, linear regression for the assessment levels (coloured circles); COMP2 = second application of the Common Procedure. For Belgium and the United Kingdom assessment levels for mean chlorophyll-a were calculated from 90th percentiles (divided by 2)*

3.2.2 Category I parameters: degree of nutrient enrichment

Most Contracting Parties assessed trends in riverine nutrient inputs, predominantly as loads (inputs) and sometimes also as concentrations. Germany assessed its riverine nitrogen inputs against a management target of 2.8mg l^{-1} total nitrogen at the limnic-marine border that is designed to allow for the achievement of non-problem area status. Only Germany and Sweden have considered atmospheric nitrogen inputs in detail. Germany has commissioned an EMEP study while Sweden has used its own model (MATCH).

The distribution of dissolved inorganic nitrogen (Figure 3.3) and dissolved inorganic phosphorus (Figure 3.4) concentrations show the well-established gradients from inshore waters to offshore waters, emphasising the importance of assessment in inshore and coastal waters (Table 3.1). Concentrations are highest for both nutrients along the continental coast, for dissolved inorganic phosphorus in the Irish Sea and for dissolved inorganic nitrogen along the northern part of the Bay of Biscay coast. The corresponding assessment levels used by Contracting Parties for winter nutrient concentrations (Figures 3.5 and 3.6 and Annex 4) reflect these gradients and some Contracting Parties use salinity normalised assessment levels to ensure a coherent approach. An exception is Denmark that applies the same assessment levels for coastal waters > 1 nautical mile and offshore waters. The Netherlands apply lower assessment levels for dissolved inorganic phosphorus in front of Lake Ijssel because the lake retains phosphorus and higher assessment levels further out in the Wadden Sea. There are differences between regions which depend on the characteristics of individual areas, but there are also larger changes in assessment levels at the national borders in the Greater North Sea that cannot be explained by the prevailing ecohydrodynamic conditions because the national boundaries are not aligned with the boundaries of ecohydrodynamic regions and there is a lack of harmonisation of assessment levels. These differences are pronounced at the border between the EEZs of Germany and the Netherlands and the border between Denmark and Germany. Generally, there is a decrease of assessment levels in the Greater North Sea from west to east. For Denmark, this is the case for dissolved inorganic phosphorus.

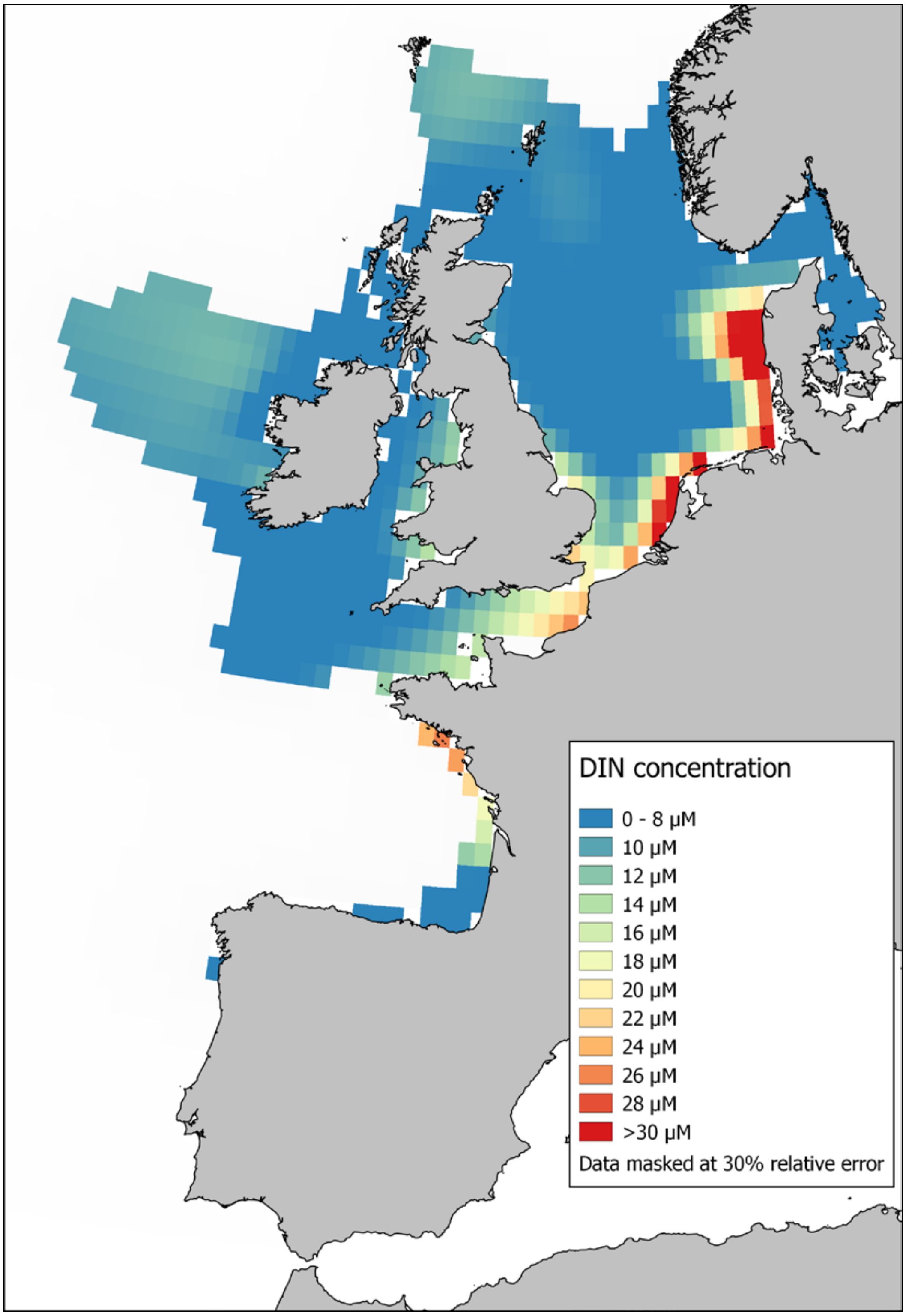


Figure 3.3*: Mean concentrations of DIN (µM) at the surface, winter (November-February) 2006-2013. White grid cells show areas with a lack of data (≥30% relative error). Data from ICES, gridded using the DIVA tool (after Ö. Bäck & M. Wenzer 2015, Troupin et al. 2015)*

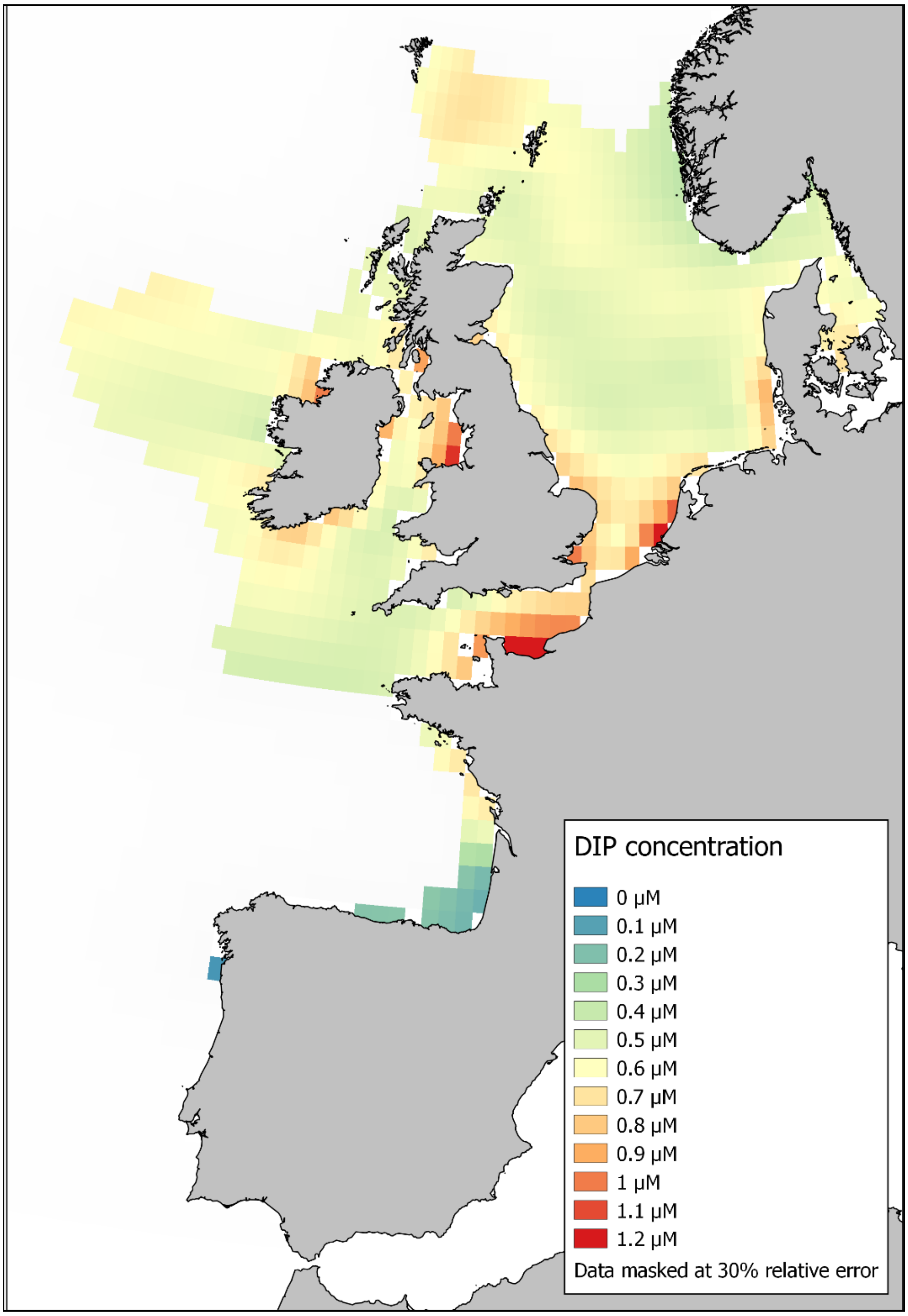


***Figure 3.4**: Mean phosphate concentrations (µM) at the surface, winter (November-February) 2006-2013. White grid cells show areas with a lack of data (≥30% relative error).Data from ICES, gridded using the DIVA tool (after Ö. Bäck & M. Wenzer 2015, Troupin et al. 2015)*

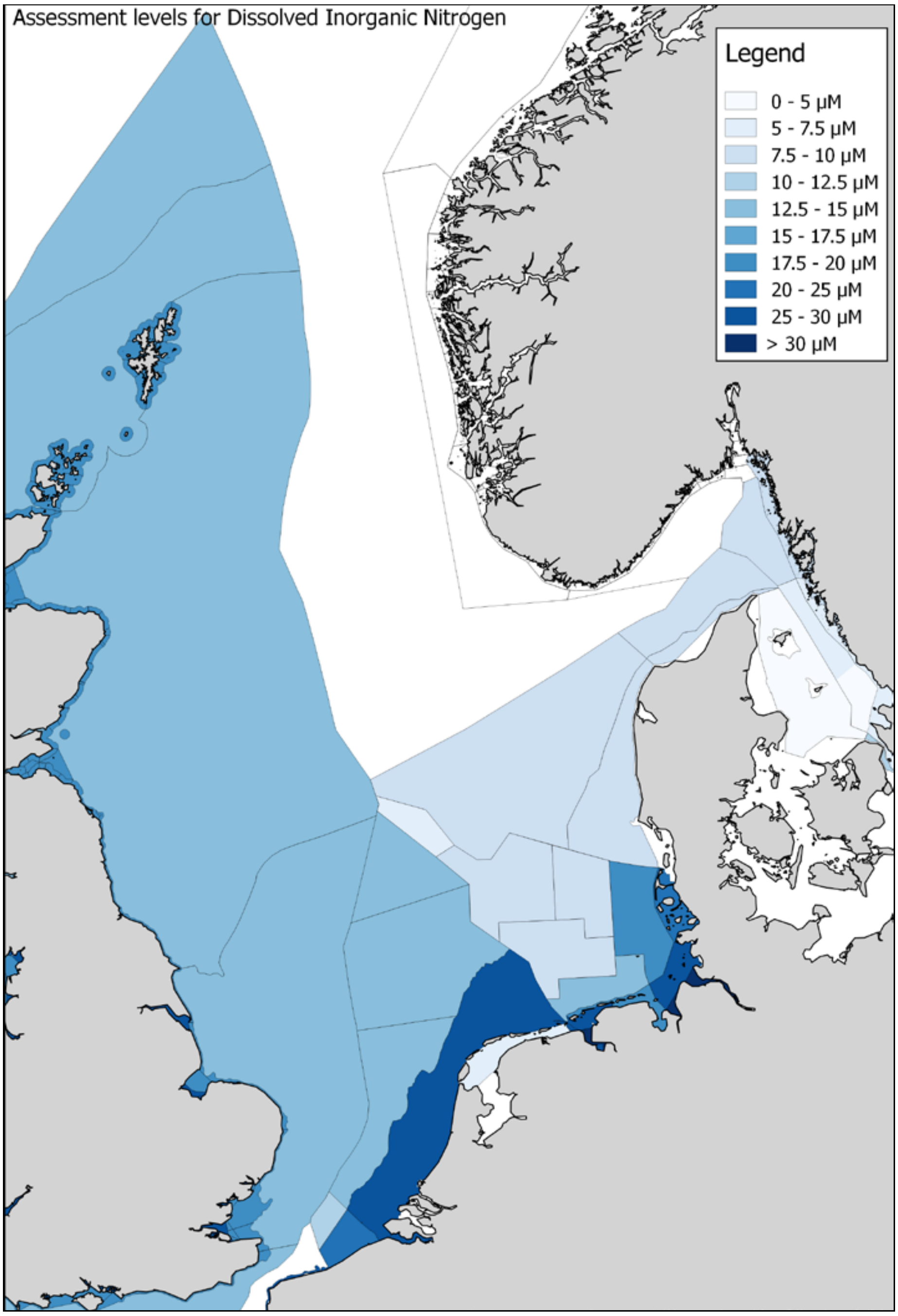


Figure 3.5*: Assessment levels for dissolved inorganic nitrogen per assessment area. The map focuses on the Greater North Sea since only in this region is eutrophication a wide-spread problem and assessment levels have been set also for offshore waters. White areas – dissolved inorganic nitrogen is not assessed*

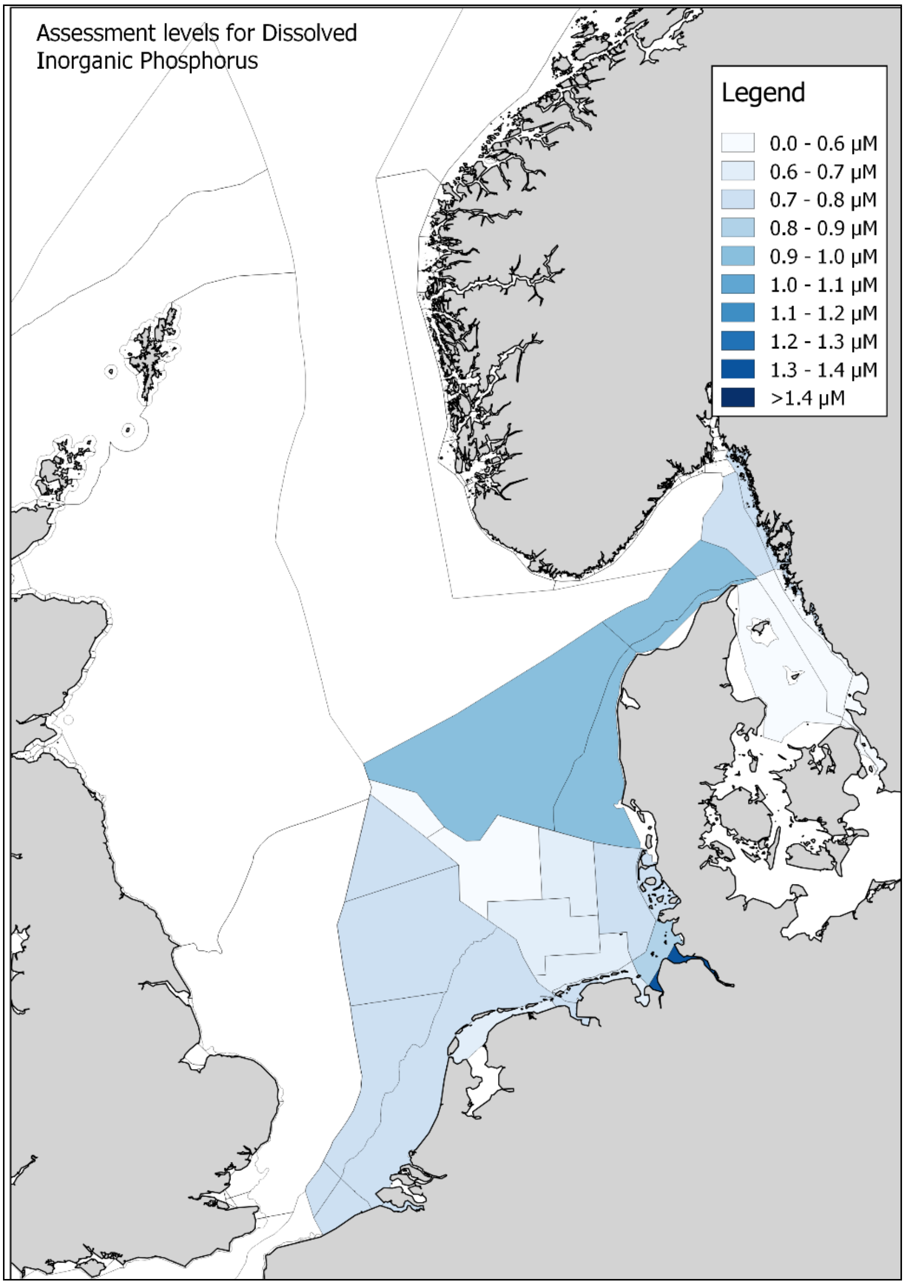


***Figure 3.6**: Assessment levels for dissolved inorganic phosphorus per assessment area. The map focuses on the Greater North Sea since only in this region is eutrophication a wide-spread problem and assessment levels have been set also for offshore waters. France and the United Kingdom do not assess phosphorus concentrations. White areas – dissolved inorganic phosphorus is not assessed*

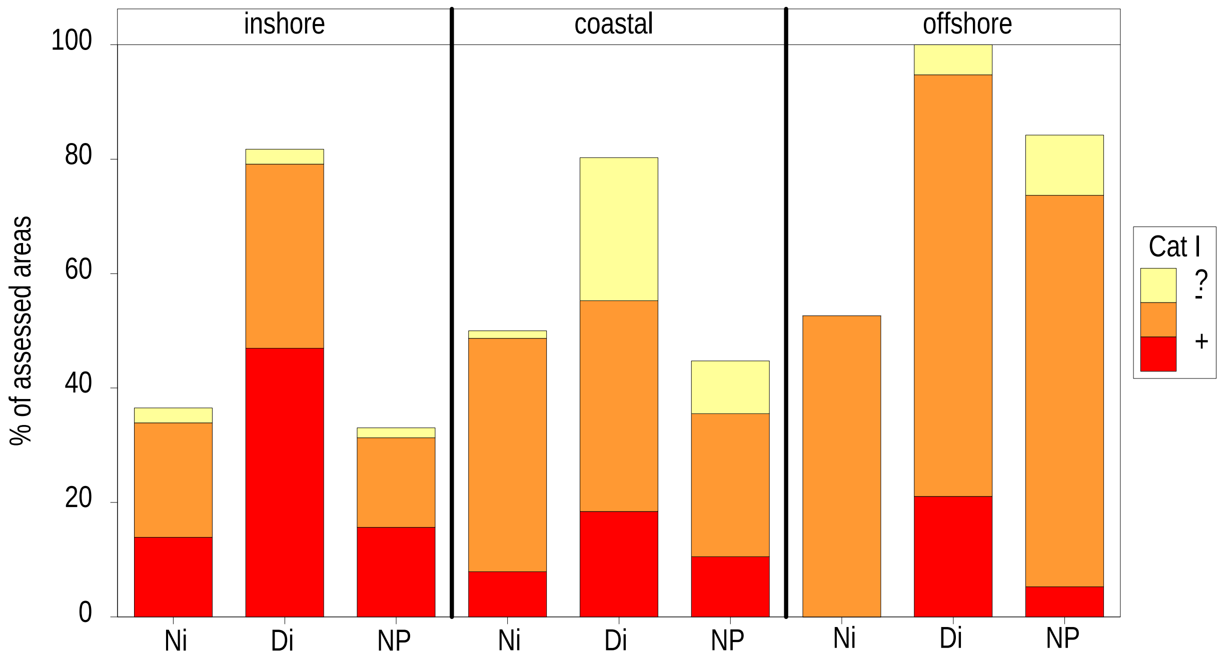


Figure 3.7*: Application of Category I parameters within the different water types as % of total numbers of assessment areas. Ni, nutrient inputs; Di, dissolved inorganic nitrogen and phosphorus; NP, N/P ratios; +, assessed as exceeding the assessment level; –, assessed as not exceeding the assessment level; ?, assessed but insufficient data to decide whether assessment levels are exceeded/not exceeded*

Inorganic nutrient concentrations were assessed within all offshore waters, but in coastal and inshore waters only in about 80% of the total assessment area (Figure 3.7). Nutrient discharges are most important for inshore and coastal waters, assessed in about 40% of the total assessment area, reflecting that some inshore waters do not receive significant freshwaters (fjords) and some coastal waters are not affected by local river discharges.

The assessment period for winter DIN and DIP varies dependant on the area specific conditions. Most Contracting Parties used the period November to February, but Belgium and Sweden used the period from December to February. Some Contracting Parties did not indicate the assessment period.

The voluntary parameters Total Nitrogen (TN) and Total Phosphorus (TP) were used by Germany, the Netherlands and Sweden.

3.2.3 Category II parameters: direct effects

Chlorophyll-a

The distribution of chlorophyll-a (an indicator for phytoplankton biomass) shows a similar distribution to the nutrient concentrations with higher concentrations inshore and in coastal waters and lower concentrations offshore, reflecting the influence of riverine nutrient discharges. The variation in inshore and coastal waters is high, reflecting the reaction of the phytoplankton to the weather-dependent inter-annual variation in riverine nutrient discharges. An example of a satellite image for 2011 is presented in Figure 3.8.

In the first application of the Comprehensive Procedure, Contracting Parties assessed mean and maximum concentrations of chlorophyll-a. Subsequently, a number of Contracting Parties observed difficulties in using maximum concentrations because of the high frequency of measurements needed to detect the maxima, and in light of requirements for coherence with the WFD, some Contracting Parties have used 90 percentile chlorophyll-a instead of, or in addition to, mean and maximum concentrations. The experience of

Contracting Parties shows that the 90 percentile is a suitable analytical tool, provided that monitoring is carried out with the necessary frequency to allow robust conclusions. A number of Contracting Parties used satellite data for chlorophyll-a in addition to in-situ measurements (Belgium and Denmark) or SmartBuoy data (the United Kingdom) to reduce the uncertainty of this parameter.

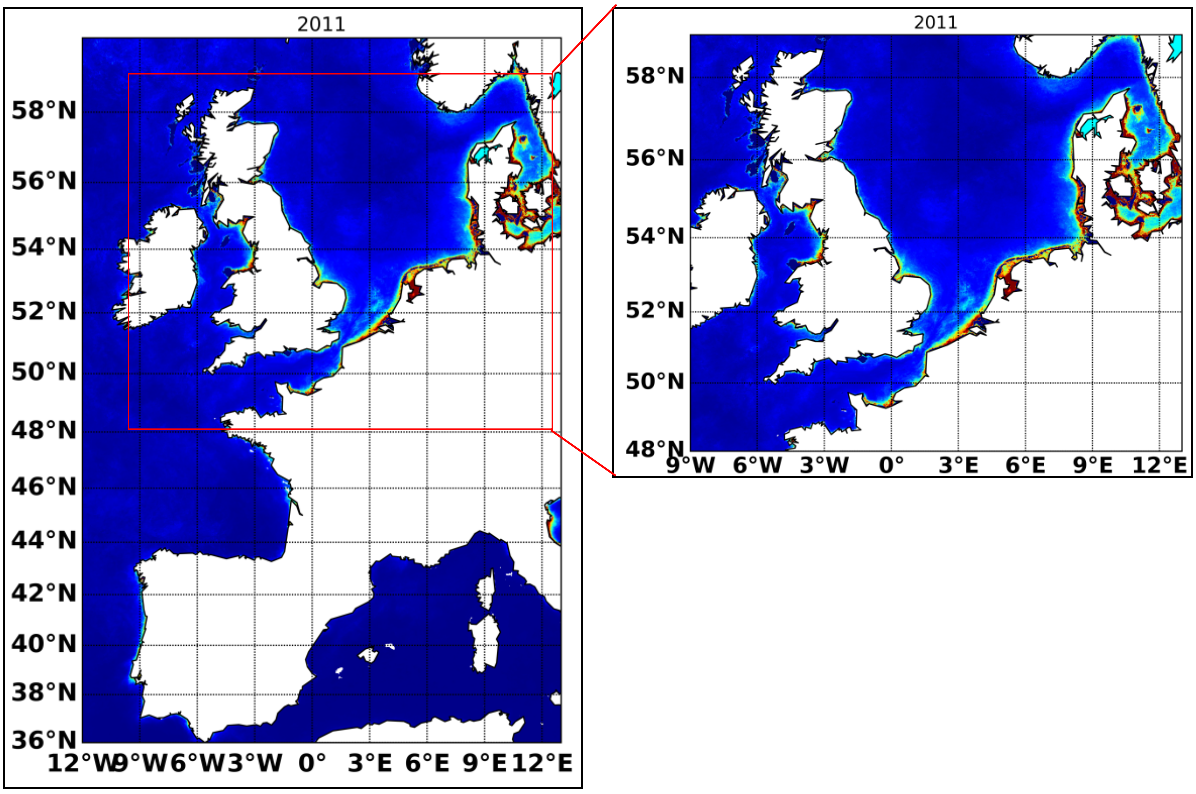


Figure 3.8: *Illustration of mean chlorophyll-a 90 percentile (µg l^{-1}) from March–September 2011. Seasonal means represent permanent smoothed chlorophyll-a gradients without any indication of elevated levels. Note, satellite data for inshore and coastal waters are often difficult to interpret and hence chlorophyll-a concentrations in these waters might not be adequately captured. The main areas of high chlorophyll-a concentrations are in the Greater North Sea (Region I) and Celtic Seas (Region II)*

The assessment levels used by Contracting Parties for 90 percentile chlorophyll-a concentrations are presented in Figure 3.9 and Annex 4. As is the case for nutrients these assessment levels reflect the gradient from inshore to offshore waters, with higher assessment levels close to the coast and lower levels offshore. Larger changes in assessment levels can be observed at the national borders and these cannot be explained by the prevailing ecohydrodynamic conditions and are due to a lack of harmonisation of assessment levels. These differences are in particular pronounced at the border between the EEZs of the Netherlands and the United Kingdom, of Germany and the Netherlands and the border between Denmark and Germany and Denmark and Sweden. Germany, the Netherlands (only for offshore) and Sweden have lower assessment levels inshore and offshore compared to Denmark and the United Kingdom.

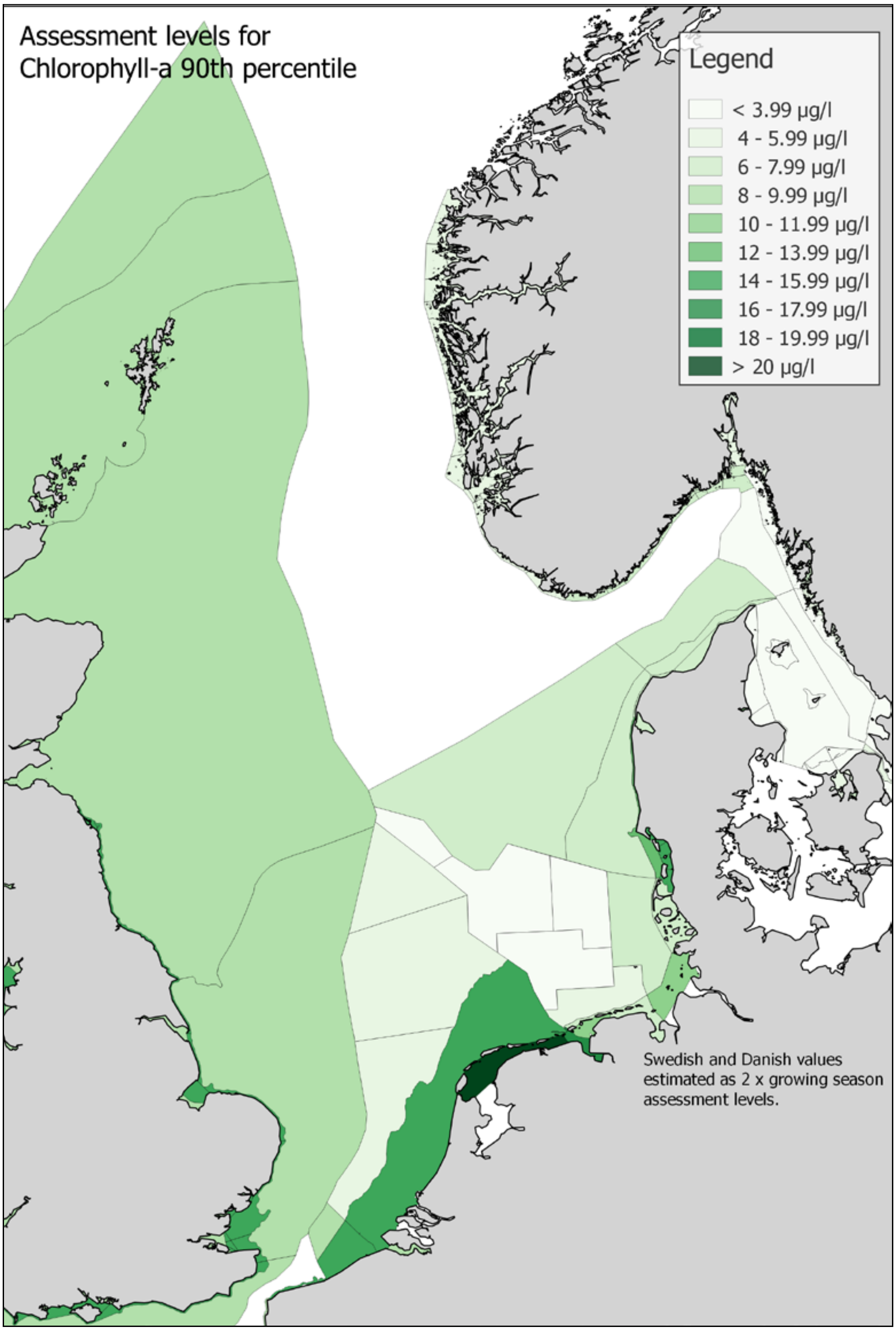


Figure 3.9*: Assessment levels for 90 percentile chlorophyll-a concentrations per assessment area. The map focuses on the Greater North Sea since only in this region is eutrophication a wide-spread problem and assessment levels have been set also for offshore waters. White areas – chlorophyll-a is not assessed*

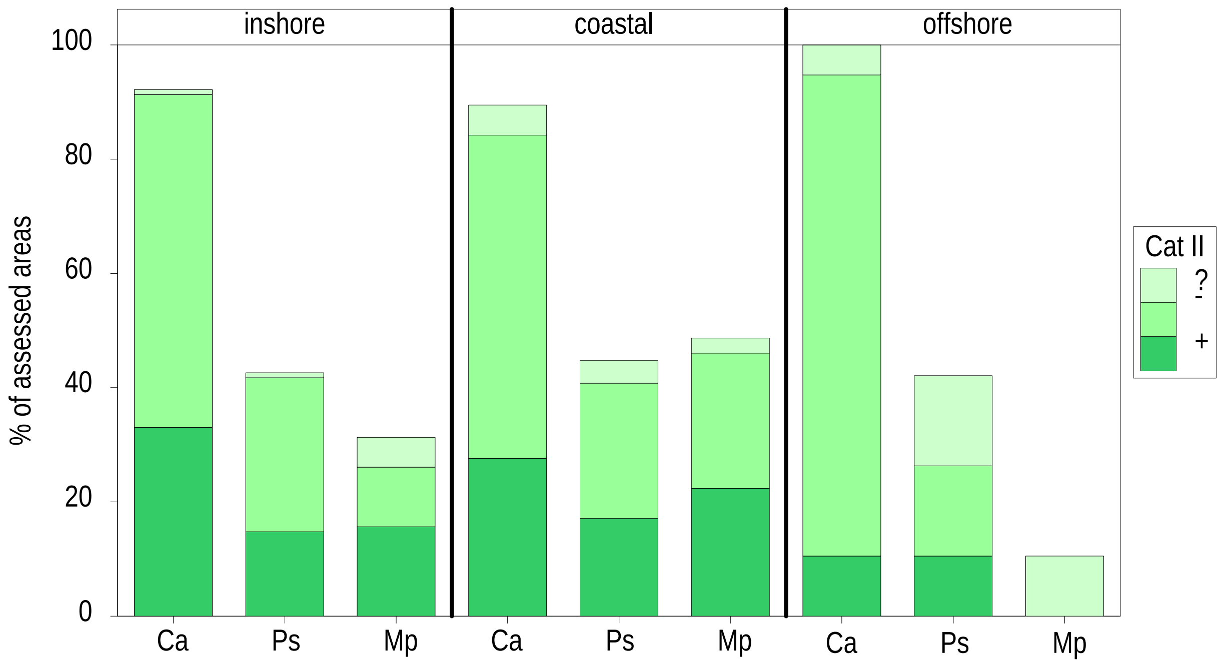


***Figure 3.10**: Application of Category II parameters within the different water types as % of total numbers of assessment areas. Ca, chlorophyll-a; Ps, phytoplankton indicator species; Mp, macrophytes; +, assessed as exceeding the assessment level; –, assessed as not exceeding the assessment level; ?, assessed but insufficient data to decide whether assessment levels are exceeded/not exceeded*

Chlorophyll-a has been assessed in 90% of inshore and coastal waters and all offshore waters (Figure 3.10).

Phytoplankton indicator species

The area-specific background concentrations and assessment levels for phytoplankton indicator species used by Contracting Parties are compiled in Annex 4.

A number of Contracting Parties measured *nuisance* phytoplankton species like the foam-forming species *Phaeocystis spp* or the dense surface algal blooms of *Noctiluca spp* as phytoplankton indicator species. The abundance of *Phaeocystis spp* had been developed as an OSPAR common indicator for the south-eastern North Sea.

Several Contracting Parties questioned the application of *toxic* phytoplankton species as indicators of the effects of eutrophication. Research has shown that, while there may be a link in specific waters, some Contracting Parties have found that the link to anthropogenic nutrient enrichment is insufficient to warrant continued use. In contrast to the use of single phytoplankton species, a more general approach involving the use of an index approach, pioneered for application in WFD assessments, is favoured by the United Kingdom. When used in the assessment phytoplankton indicator species were assessed in all waters (inshore, coastal and offshore) (Figure 3.10).

Macrophytes

The assessment of macrophytes, and in particular the shift from long-lived to short-lived nuisance species like *Ulva*, is relevant for coastal areas. The areal extent of macrophytes (brown and red macroalgae and sea grasses) reflects the depth distribution which is often controlled by prevailing light climate (and hence by the concentrations of suspended matter, including phytoplankton). However, many other factors also influence the extension of macrophytes, especially turbulence, shear stress and substrate. Additionally, the monitoring of patchy growing macrophytes is difficult. For these reasons, this parameter has not been applied by all

Contracting Parties. It has been most often applied in coastal waters followed by inshore waters and least often in offshore waters, where macrophyte stands might not occur because of greater depths (Figure 3.10). Most Contracting Parties have relied on the assessment of the biological quality element macrophytes as used for the second WFD cycle. Belgium and the Netherlands did not assess macrophytes.

3.2.4 Category III parameters: indirect effects

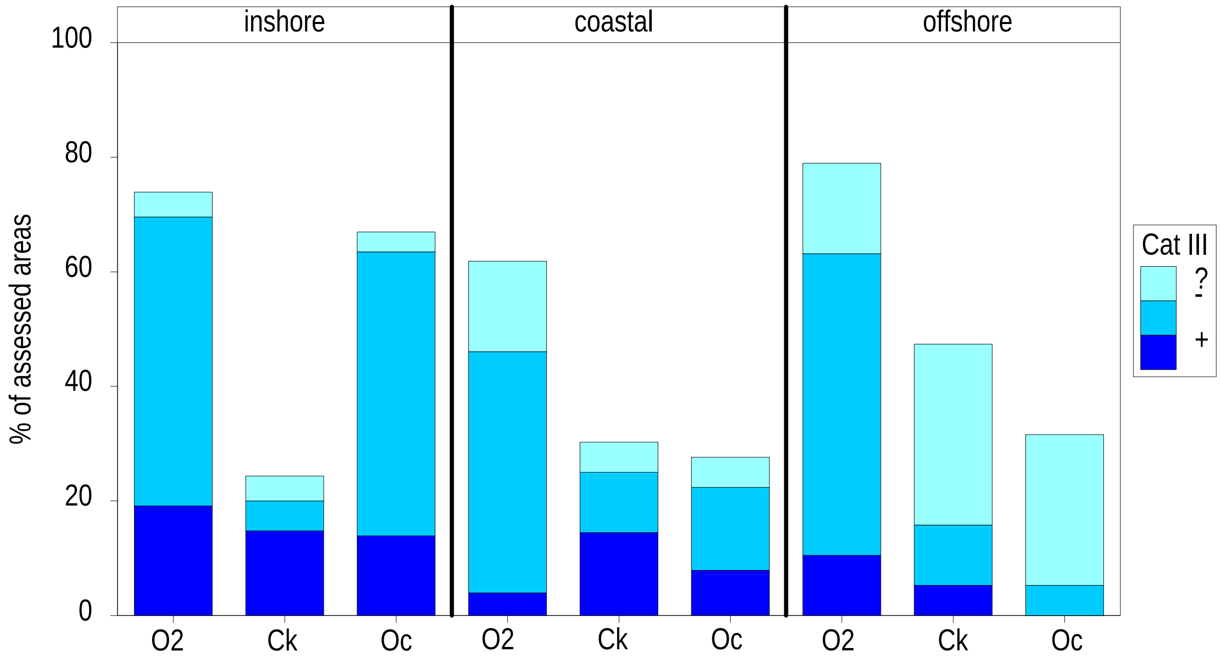


***Figure 3.11**: Application of Category III parameters within the different water types as % of total numbers of assessment areas. O2, oxygen concentrations; Ck, changes/kills in zoobenthos and fish kills; Oc, organic carbon/organic matter; +, assessed as exceeding the assessment level; –, assessed as not exceeding the assessment level; ?, assessed but insufficient data to decide whether assessment levels are exceeded/not exceeded*

Oxygen concentration near the bottom was assessed by most Contracting Parties, followed by organic matter analyses (Figure 3.11). Zoobenthos was only assessed in less than 30% of the inshore waters.

Oxygen

Oxygen depletion can be a natural process because organic matter, for example due to phytoplankton growth and other sources, is accumulated by sedimentation to bottom waters, especially below stable seasonal pycnoclines. However, enrichment of waters by nutrients that results in increased phytoplankton growth can lead to oxygen depletion and is, therefore, used as an indicator of the indirect effects of eutrophication. Oxygen deficiency was observed in some estuaries (13), bays and fjords (8), probably forced by high inputs of organic matter and long lasting stratification (fjords). Seasonal deficiency was only reported for some stratified coastal (1) or offshore areas (2) with long residence time of enclosed bottom waters (below the seasonal thermocline), exposed to long lasting supply of particulate organic matter by long-distance transports (e.g. in the south eastern North Sea), but had been reported for the shallow Wadden Sea (the Netherlands) and estuaries (Germany and Ireland) as well.

The current assessment levels for oxygen deficiency used by Contracting Parties range between 3-6 mg l^{-1} (see Annex 4).

Kills in fish and zoobenthos, and long-term changes in zoobenthos

Only Belgium, Sweden and the United Kingdom assessed kills in fish and zoobenthos but reported no kills. To assess changes in zoobenthos communities Contracting Parties applied different indices developed in relation to the Water Framework Directive in inshore and coastal waters. Germany assessed the biomass of benthic organisms in water > 1 nautical mile. Problems have mainly been observed in inshore and coastal waters (Figure 3.11), reflecting effects by elevated organic matter.

Organic carbon

Organic carbon is an important assessment parameter in sedimentation areas but has less often been analysed in coastal waters (about 30%, Figure 3.11). This could be a shortcoming, because anthropogenic impacts also include dissolved and particulate organic carbon which can significantly contribute to inshore eutrophication processes (e.g. by oxygen consumption during its decomposition). The organic river inputs can also affect coastal waters during high discharge rates or long residence times. Organic matter is a basic parameter for assessing eutrophication processes, linking nutrients, phytoplankton biomass, its conversion products, and oxygen consumption. MSFD Annex III mentions organic matter inputs as an important anthropogenic pressure to be considered when assessing marine waters under article 8.

3.2.5 Category IV parameters: other possible effects

Algal toxins

France, Ireland and Sweden have reported incidences of diarrhetic or paralytic shellfish poisoning (DSP/PSP) and mussel infection events in their waters, while Germany did not report any incidences. The other Contracting Parties have not assessed algal toxins because the link between nutrient enrichment, the incidence of toxic producing algae and the infection of bivalve shellfish is uncertain. While France and Ireland assessed algal toxins in the initial assessment, the parameter was not used for the final classification since it is not an appropriate indicator of eutrophication in Irish and French waters. Some Contracting Parties also mentioned that there was insufficient monitoring to assess this parameter.

Transboundary transports

Transboundary transport must be taken into account because national measures in some areas are not or only partly capable to improve the eutrophication status of the area under consideration. Therefore, Contracting Parties those waters are affected by transboundary transports (Belgium, France, Germany and the Netherlands) have addressed these in their national reports as an important source for nutrient inputs.

The United Kingdom carried out an evaluation of the risks of its nutrient enriched waters scoring “+--” to eutrophication problems elsewhere in the second application of the Common Procedure. The evaluation was not updated since the eutrophication status of the different United Kingdom areas has not changed since the last Common Procedure and the level of nutrient input was found to be decreasing. Belgium used the model MIRO&CO to undertake an assessment of transboundary nutrient transports in Belgium waters, including atmospheric deposition while the Netherlands used a model study from 2006. France reported the ICG-EMO results from 2009 while Germany reported new results that have been produced with the model ECOHAM in 2015. These results for the German waters show that the contribution of the German riverine input of total nitrogen quickly diminishes from coastal to offshore waters (Figure 3.12). In inner coastal waters the German contribution is 54% and it is reduced to 9% in outer coastal waters and to only 2% in offshore waters. At the same time, the contribution of the Netherlands (which contains contributions from Germany for the River Rhine) increases from 12% in inner coastal waters to 21% in outer coastal waters and the contribution of the United Kingdom increases from 6% in inner coastal waters to 13% in outer coastal waters. In offshore waters the main contribution comes from the open Atlantic Ocean.

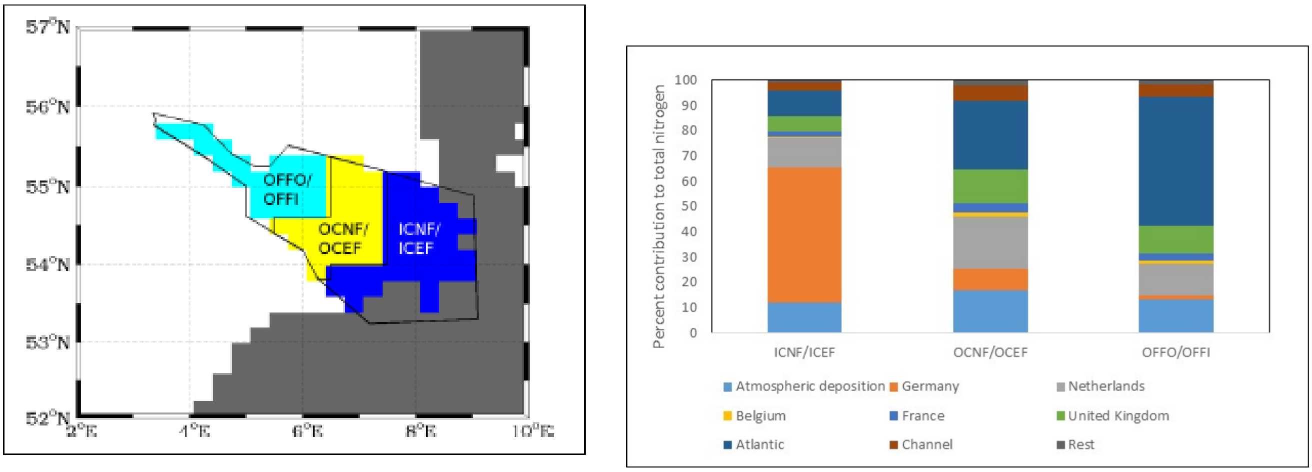


Figure 3.12*: Analysis of transboundary nutrient transport (TBNT) for German inner coastal (IC), outer coastal (OC) and offshore (OF) waters. Left: three model areas for which TBNT was analysed. Right: percent contributions to total nitrogen in the three areas. Source: Lenhart & Große 2017 (unpublished)*

3.2.6 Monitoring and Confidence

As indicated in the tabulated results of the national assessments at Annex 2, the monitoring of the parameters applied in the assessments was not always sufficient and lack of data weakened some assessments. In some cases the lack of data has led to a downgrading of the initial assessment (non-problem areas have been changed to potential problem areas or potential problem areas have been changed to problem areas, see section 3.3).

The revised Common Procedure of 2013 has in particular detailed procedures for confidence rating. In general, two different types of confidence rating have been distinguished: the confidence of the assessment against area-specific thresholds (e.g. using a method that assigns a variable confidence level to the claim that the combinations of assessment parameter and assessment area have been classified as either exceeded or remaining below the area-specific threshold); and the representativeness of data in space and time. The Common Procedure permits the use of both statistical and descriptive approaches but requires a thorough documentation of the approach used. Despite this concise specification of confidence rating, few Contracting Parties have followed this guidance in the third application of the Common Procedure. Information like data inventories, recent gradients or detailed time series, which would inform temporal and spatial coverage of the data used in the national assessments, were only reported by few Contracting Parties for the period 2006–2014.

The approach taken by Contracting Parties to demonstrate quality and representativeness of data differs. Belgium, Denmark and the Netherlands have not reported on confidence rating. The United Kingdom applied the methods described in the Common Procedure both for the assessment of the representativeness in space and time and against area-specific thresholds. Statistical confidence for the assessment against area-specific thresholds was also assessed and applied by Ireland and Norway. Sweden assessed the cumulative probability of the binomial distribution based on percentiles against area-specific thresholds while France trialled a bootstrap method that is also applied for Water Framework Directive assessments. Germany assessed the confidence of data in space and time using a simplified methodology but referred to a more elaborate assessment for chlorophyll-a, which has been published (Brockmann and Topcu 2014).

Results of confidence assessments of the data quality show that there is a need in many areas to improve the frequency and spatial coverage of monitoring with a focus on coherence in the monitoring of nutrient enrichment and related direct and indirect effects, and weather and hydrodynamic conditions. Some Contracting Parties have supplemented chlorophyll-a in-situ measurements with data from remote sensing, which can support observations of spatial and temporal distribution over large areas, despite limitations in the data due to cloud cover and changes in dominant phytoplankton species. A more harmonised and region-wide approach is desirable in this respect, making use of the high-quality products of the EU Copernicus programme. This will be trialled in the JMP EUNOSAT project (Joint Monitoring Programme Eutrophication of the North Sea with satellite data) that started in March 2017.

Some Contracting Parties indicated the necessity to perform “event monitoring” complementary to routine monitoring to monitor the cause-effect parameters in conjunction with each other, e.g. oxygen deficiency and kills in benthos underneath a surface algal bloom. However, this was mostly not realised due to restricted monitoring efforts. Germany reported that the Elbe flood in June 2014 flushed 21000 tons of nitrogen and 930 tons of phosphorus into the North Sea which was approximately 7 times more than the average nitrogen input in June and 13 times more than the average phosphorus input, indicating that capturing such events in monitoring is important.

Another aspect of the assessment confidence is whether adjacent areas, such as those connected by residual currents or with similar eco-hydrodynamic conditions, have similar assessment criteria and results. Such a consistency check was undertaken for this report based on the assessment results of individual parameters reported by Contracting Parties. For coastal waters, agreement was good, although based mainly on the assessment of chlorophyll-a concentrations supported by inorganic nutrient concentrations (Table 3.3). Comparison of some regions was hampered due to inconsistent sets of indicators being used. Results for adjacent offshore waters were also frequently inconsistent, probably due to nutrient and mixing gradients (e.g. between the Kattegat, the Skagerrak, as well as the wider North Sea) or due to local oxygen depletion at stratified deep locations (submerged Elbe palaeovalley). Differences in bottom substrate also limit the consistency of indicator choice: for example, soft-bottom macrofauna were assessed by Denmark and Sweden in Kattegat coastal waters, but not in the Skagerrak. In most continental coastal waters of the North Sea nutrient concentrations were assessed as being above the assessment levels. It should be noted that inconsistencies between assessments of adjacent areas might also arise due to the use of poorly--harmonised assessment levels for adjacent areas (sections 3.2.2 and 3.2.3. and Figures 3.5, 3.6, 3.9).

Table 3.3: *Assessment results of main parameters in adjacent coastal (salinity 30-34.5) and offshore (salinity >34.5) waters from the Kattegat/Skagerrak to the North Sea. +, assessed as exceeding the assessment level; –, assessed as not exceeding the assessment level; ?, assessed but insufficient data to decide whether assessment levels are exceeded/not exceeded; nr, parameter not relevant; na, parameter not assessed. *Abbreviations relate to the assessment areas as named by Contracting Parties (see Annex 2 or national reports)*

	Contracting Party, area*	**SE** Outer coastal waters of the west coast	**DK** Aalborg Bugt 222	**SE** Outer coastal waters of the west coast	**DK** Kystvande221	**NO** Semi-exposed coast	**DK** Vesterhavet 119	**DE** ICNF	**NL** Coastal area	**BE** Coastal waters	**UK** Southern North Sea	**FR** Zone 1
	Parameters	**Kattegat**		**Skagerrak**			**North Sea**					
Coastal waters	Final assessments	PA	PA	PA	PA	NPA	PA	PA	PA	PA	NPA	PA
	DIN/DIP concentrations	+	?	-	?	-	?	+	+	+	+	?
	N/P ratios	?	?	?	?	+	?	+	+	+	-	
	Chlorophyll-a	-	-	-	+	-	+	+	+	+	-	+

	Contracting Party, area*	SE Outer coastal waters of the west coast	DK Aalborg Bugt 222	SE Outer coastal waters of the west coast	DK Kystvande221	NO Semi-exposed coast	DK Vesterhavet 119	DE ICNF	NL Coastal area	BE Coastal waters	UK Southern North Sea	FR Zone 1
	Parameters	**Kattegat**		**Skagerrak**			**North Sea**					
	concentrations											
	Phytoplankton indicator species	+	?	+	?	na	?	+	+	+	?	+
	Macrophytes	-	+	-	?	-	?	nr	nr	nr		
	Oxygen deficiency	-	?	+	?		?	+	-	-	-	-
	Changes/kills in zoobenthos, fish	+	+	+	-	na	?	+	?	-	na	na
	Organic carbon / organic matter	+	?	+	?	na	?	?	na	?	na	na
	CP, area	**SE** Open sea	**DK** offshore parts	**SE** open sea	**DK** offshore parts	**NO** open exposed coast	**DK** The North Sea	**GE** OFFI	**NL** Oyster Grounds	**BE** Offshore area	**UK** Southern North Sea	**FR** Offshore
	Parameters	**Kattegat**		**Skagerrak**			**North Sea**					
Offshore waters	Final assessments	PA	PA	NP A	NPA	NPA	NPA	PA	NPA	NPA	NPA	PPA
	DIN/DIP concentrations	+	+	-	-	-	-	-	-	-	-	na
	N/P ratios	-	?	-	?	+	?	-	-	-	-	na
	Chlorophyll-a concentrations	-	-	-	-	-	-	-	-	-	-	na
	Phytoplankton indicator species	+	?	-	?	na	?	?	-	?	?	na
	Oxygen deficiency	+	?	-	?	na	?	+	-	-	-	na
	Changes/kills in zoobenthos, fish	+	-	-	?	-	?	?	?	-	na	na
	Organic carbon / organic matter	?	?	?	?	na	?	?	na	?	na	na

3.3 Procedure for area classification

The assessment process used by Contracting Parties has generally followed the guidance of the Common Procedure (sections 5 and 6 of agreement 2013-08), which entails:

a. the assignment of a score corresponding to the level of each assessment parameter which has been monitored;

b. an initial assessment based on a combination of these scores according to an agreed framework, and;

c. an overall final assessment of all relevant information relating to harmonised assessment criteria, their corresponding assessment levels and supporting environmental factors.

The results of the application of the assessment parameters and the initial and final classifications, using the reporting format of the Common Procedure are given in Annex 2. Contracting Parties have in general applied the assessment process according to the Comprehensive Procedure as described below.

Some Contracting Parties revised several of their initial area classifications using the final appraisal step and such changes in the final classification could affect up to 39% of the assessed area (Table 3.4). A common reason for this was that the initial assessment as 'problem area' was modified in the overall step to 'potential problem area' or 'non-problem area' due to the fact that there were only local eutrophication effects, or the effects occurred only once within the five-year assessment period. Often, elevated nutrient concentrations did not lead to eutrophication effects and oxygen depletion was characterised as a natural process, resulting in a final classification as "non-problem area". Changes from "non-problem area" status to "problem area status" or "potential problem area status" did also occur and were justified by insufficient data (e.g. low sampling effort for oxygen in offshore areas in German waters, lack of sampling of zoobenthos and organic matter in coastal waters). Detailed reasons for changes have been reported by Contracting Parties for each area concerned and are shown in Annex 2.

Table 3.4*: Summary of changes of the initial classification of the eutrophication status of areas in step 3 in the third application of the Comprehensive Procedure*

Contracting Party	Assessed areas	Number of changes of initial classifications in the overall area classification (step 3)						Δ
		PA to NPA	*PA to PPA*	*PPA to NPA*	*PPA to PA*	*NPA to PA*	*NPA to PPA*	%
Belgium	2							
Denmark	38							
France	28		11					39
Germany	11				1		3	36
Ireland	84	4	7	12	4	1	2	33
Netherlands	7					1		14
Norway	15		2	1				20
Sweden*	10							
United Kingdom	15**						0	0
# Total	(248)	4	21	13	5	2	6	23%

Note: NPA = non-problem area; PA = problem area; PPA = potential problem area, # missing, Δ = changes as % of national assessments, * only initial classification performed, **only marine waters (salinity >30) were considered in this table.

Despite guidance on the scoring of individual annual assessment results for the years 2006 to 2014 and their synthesis for an initial area classification provided in the Common Procedure (agreement 2013-8), a number of Contracting Parties based their scoring on calculated means for the entire assessment period. This hampers interpretation of scoring results for various parameters and consistency in the classifications achieved by Contracting Parties. In addition Contracting Parties with waters having common boundaries use different assessment levels to arrive at their classifications. An example of this is in the offshore southern North Sea where the Belgian offshore area, the United Kingdom southern North Sea area, the Netherlands Southern Bight, and German offshore waters all conjoin, and the classification ranges from 'problem area' to 'non-problem area'.

Contracting Parties had different approaches dealing with the lack of data in the assessment. Norway classified a number of Norwegian fjords as 'problem areas' based only on one parameter (macrophytes). In some cases direct effects parameters were scored to show no increasing trends or elevated levels or shifts/changes ("–") despite lack of data. In other cases, the assessment was based on the degree of confidence in the evidence of absence of undesirable disturbance.

3.4 Links with the Marine Strategy Framework Directive

The Marine Strategy Framework Directive 2008/56/EC (MSFD) (EU 2008) requires EU Member States to achieve or maintain good environmental status in the marine environment by the year 2020. Good environmental status relates to the various pressures acting on, and to the status of, the marine ecosystem and its components. Among the 11 descriptive objectives, the MSFD stipulates that "human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters". EU Member States shall, in respect of each marine region or sub-region, determine a set of characteristics for good environmental status on the basis of the qualitative descriptors listed in Annex I to the MSFD.

In support of the MSFD implementation, Commission Decision 2017/848/EU (EU, 2017) sets out criteria and methodological standards on good environmental status. The Commission Decision listed three criteria on nutrient enrichment and direct and indirect effects of nutrient enrichment, following the assessment framework of the Common Procedure. The eight indicators underpinning the criteria largely corresponded with the ten assessment parameters of the Common Procedure (OSPAR 2012). Six out of ten Member States that are OSPAR Contracting Parties used, or at least referred to, the Common Procedure for the definition of good environmental status for eutrophication in MSFD reporting in 2012. Many Member States related to the Quality Status Report 2010, including the second OSPAR integrated report (OSPAR 2008), as a common basis for reporting the state of eutrophication of their waters (Art. 8 MSFD) in 2012. The 2014 evaluation by the EU Commission of Member State's 2012 implementation reports on MSFD requirements for initial assessment, good environmental status and environmental targets (Art. 8, 9 and 10 MSFD) attested Member States in the field of eutrophication a relatively high degree of coherence in the North-East-Atlantic Region (with high coherence in North Sea and Celtic Sea and moderate coherence in the Bay of Biscay/Iberian Coast). Yet, the EU Commission's evaluation has identified room for improvements in relation to a more homogenous use of indicators, threshold values and Water Framework Directive standards EC 2014).

Overall, the EU Commission concluded in 2014 on serious shortcomings in the overall MSFD implementation (EU, 2014). As a result Commission Decision 2010/244/EU has been revised as 2017/848 (EU, 2017) with the aim to provide a) a more specific definition of each criterion, including threshold values to be used, b) detailed provisions on the elements to be covered by each criterion, c) methodological standards on assessment scales and how to derive the extent to which GES is achieved, and d) specifications and standardised methods for monitoring and assessment. The revision provides more details on linking the MSFD with existing standards at EU and regional level, including when and how to use the assessments coming from the WFD in coastal and territorial waters regarding eutrophication. The EU Commission and Member States are working on supporting guidance for the implementation of requirements of the revised Commission Decision, including the need to make assessments of the extent to which good environmental status has been achieved better comparable between EU marine regions.

Main methodological provisions of the revised Decision in the field of eutrophication requiring further consideration by OSPAR Contracting Parties that are EU Member States under the Common Procedure include:

- assessments under WFD shall be used for the assessments of each criterion in coastal waters (see section 3.5),
- regionally coherent quantitative expression of good environmental status in relation to eutrophication,
- regionally coherent threshold values for the individual criteria (i.e. OSPAR eutrophication common indicators),
- integration methods for the criteria that lead to an expression of the extent to which good environmental status is achieved which is comparable across EU marine regions.

Further consideration needs also to be given to the current dual approach to national eutrophication assessments based on the Common Procedure and regional indicator assessments. The individual eutrophication criteria/indicators are required to support assessments of the state of marine ecosystem components and should be consistent with the assessment of eutrophication status.

The revision and drafting of the guidance came too late to be taken into account in the present eutrophication assessment. The present assessment therefore follows the Common Procedure as updated in 2013, taking into account technical improvements such as on the refinement of assessment values. The need for further alignment of the Common Procedure with the revised Commission Decision is still to be taken forward in OSPAR.

3.5 Links with the Water Framework Directive

The Water Framework Directive (2000/60/EC) (WFD) has the objective to achieve, by 2015, at least good chemical and ecological status for transitional and coastal waters.

The guidance for eutrophication assessment in the context of European water policies ("EC eutrophication guidance", 2009), developed under the WFD, closely relates to the assessment framework of the Common Procedure. There are considerable synergies in the biological parameters used by the WFD and the assessment parameters of the Common Procedure (OSPAR, 2013). The intercalibration process under the WFD and the OSPAR assessment of coastal waters complement each other.

While for the classification of a 'non-problem area' or 'problem area', the Common Procedure relates to nutrient enrichment and eutrophication effects, the overall classification of the ecological status of a water body under the WFD takes into account all human pressures. However, with respect to a eutrophication assessment the EC eutrophication guidance allows focus on this specific pressure exclusively and in practice the biological quality elements assessed under the WFD represent the dominant pressure which is often eutrophication in the coastal waters of the OSPAR region. For the assessment of eutrophication problems, the boundary between a 'problem area' and a 'non-problem area' in the coastal region should align with the boundary between the 'good' and the 'moderate' ecological status under the WFD (Figure 3.13).

Under the WFD reference conditions and legally binding boundaries between classifications of high, good, moderate, poor and bad are developed in the intercalibration process, facilitated by the EU Commission. In the intercalibration process, national assessment systems are compared, and the process results in a number of type specific boundaries for high/good and good/moderate ecological status. The results of the intercalibration process have been used to some extent in the third application of the OSPAR Comprehensive Procedure, noting that the third intercalibration decision is currently being negotiated. The results of the OSPAR eutrophication assessment can therefore not be expected to be completely comparable with an assessment using the results of the intercalibration exercise. In future assessments of the eutrophication status, more harmonised assessment systems for the coastal waters will be available and built into the regional eutrophication assessment following the requirements for a consistent MSFD status assessment (see section 3.4). This is also a central requirement of the revised Commission Decision (EU, 2017) that prescribes the use of the assessment scales and threshold values for good status (good/moderate boundaries) of the WFD in coastal waters. The revised Commission Decision furthermore specifies that in coastal waters, the criteria shall be used in accordance with the requirements of the WFD to conclude on whether the water body is subject to eutrophication. Whether this means that the assessment of ecological status is sufficient to assess descriptor 5 of the MSFD needs to be clarified.

OSPAR Common Procedure	Further Application	Non-problem area		Problem area		
	Initial Application	Non-problem area	Potential problem area		Problem area	
Water Framework Directive		High	Good	Moderate	Poor	Bad
		OSPAR background condition and WFD reference conditions				

OSPAR Assessment Level (reflecting natural variability and (slight) disturbance (OSPAR background plus up to 50%))

Figure 3.13*: Relationship between the classification under the Common Procedure and the Water Framework Directive*

In the third application of the Common Procedure it can be observed that Contracting Parties make increasing use of the parameters (e.g. selected physical-chemical parameters and the biological quality elements macrophytes and macrozoobenthos) and good/moderate boundaries applied under the WFD. In consequence this has often lead to the use of the WFD assessments of the second WFD cycle whose time period diverges from the time period assessed in the third Common Procedure (e.g. 2009-2013/14 as compared to 2006–2014). Concerning the assessment areas in coastal waters most Contracting Parties have summarised the individual WFD water bodies to water body types or larger units (see also section 3.1). All Contracting Parties have applied the aggregation rules specified by the Common Procedure in coastal waters of the WFD.

4. Eutrophication status of the OSPAR Maritime Area and its Regions

4.1 Eutrophication status

This section summarises the results of the third application of the Comprehensive Procedure to identify the eutrophication status of the OSPAR Maritime Area on the basis of national assessments conducted by Contracting Parties.

The dominating nutrient source is river discharge, often resulting in problem areas in connected estuaries, fjords and bights, and areas affected by river plumes. Some areas are especially sensitive to eutrophication and respond with enhanced primary production in, for example, coastal currents with stable mixed layers or with accumulation of particulate organic material (e.g. in estuaries, fjords and in the Wadden Sea). One effect of these river-borne nutrient inputs is reflected by high chlorophyll concentrations along many coasts of the North Sea and in the stratified Norwegian coastal current (Figures 3.5, 3.6 and 3.9).

High nutrient inputs can result in direct and indirect eutrophication effects, which lead to problem area classification result under the Comprehensive Procedure. However, in some areas there is an uncoupling of higher nutrient inputs and their effects, due to light limitation by high turbidity or by vertical mixing resulting in a non-problem area classification.

Eutrophication cannot always be considered as a local problem, e.g. occurring at or near high nutrient inputs, because water masses from different regions of the OSPAR area interact with each other permanently, and nutrients are being transported from one place to another. These transboundary transports underline the importance of common efforts to tackle eutrophication problems.

***Table 4.1**: Surface area in the OSPAR Regions II, III and IV classified in terms of problem areas (PA), potential problem areas (PPA) and non-problem areas (NPA)*

Contracting party	Surface area (km^2)				All waters assessed?
	PA	PPA	NPA	Total area assessed	
Belgium	2203		1331	3534	yes
Denmark	32315		44191	76506	yes
France	4017	6065	5980	16062	no
Germany	23781	16774	2542	42261	yes
Ireland	171	114	390225	390510	yes
Netherlands	27677		34305	61982	yes
Norway	984	1600	93528	96112	no
Sweden	9384		4952	14336	yes
United Kingdom	213	108	735954	736275	yes
OSPAR total	**99909**	**24661**	**1313008**	**1437578**	**no**

Region I (Norwegian Sea and Barents Sea) is assessed as non-problem area. In Regions II, III and IV a large number of assessment areas in inshore and coastal waters (>100) are classified as problem areas, while only few but large offshore waters are classified as problem areas. In the previous integrated eutrophication reports the number of areas classified as problem areas, potential problem areas or non-problem area was reported, but due to the large differences in size for individual assessment areas (ranging from small individual fjords and estuaries to large coastal strips and even larger offshore areas) the number of assessment areas is not very informative. Table 4.1 gives the surface area of the waters that are assessed as problem area, potential problem area or non-problem area. Approximately 100,000 km^2 is classified as problem area and nearly 25,000 km^2 is classified as potential problem area. The surface area of non-problem areas only refers to the areas that were included in the assessments, based on an initial screening of eutrophication risks parts of Regions II, III and IV have not been included in the assessment. Some Contracting Parties have assessed all of their waters in the Comprehensive Procedure, while some have only assessed specific parts (Table 4.1).

The definition of coastal waters differs between Contracting Parties. Some Contracting Parties use the WFD definition of coastal water bodies, others describe a larger area, for example by including the Region of Freshwater Influence (ROFI) as coastal waters. Using the Contracting Parties' definition of inland and coastal waters, approximately 47% of the surface area of problem area is found in inland and coastal waters and 53% in offshore waters.

As Figure 4.1 shows, problem or potential problem areas are found in inshore waters and along the coasts of all Contracting Parties that have reported. The Greater North Sea (Region II) has the largest surface area classified as problem area (ca. 98,000 km^2) or potential problem area (ca. 19,000 km^2). Extensive areas are found along the coast from Belgium to Denmark in the North Sea and in Danish and Swedish waters in the Kattegat and Sound. Smaller areas classified as problem area or potential problem area in Region II are found along the coasts of France, Norway and the United Kingdom. In Region III (Celtic Seas) many small inland and coastal waters were classified as problem area (ca. 500 km^2) or potential problem area (ca. 2,100 km^2) on the French coast of Brittany and along the coasts of Ireland and the United Kingdom. In Region IV (Bay of Biscay and Iberian coast), only France carried out an assessment with two areas classified as problem area (ca. 800 km^2) and half of the areas classified as potential problem area (ca. 3,900 km^2).

The extent of problem, potential problem and non-problem areas identified for the OSPAR Maritime Area indicate the high pressure on the Greater North Sea and Celtic Seas in relation to eutrophication effects.

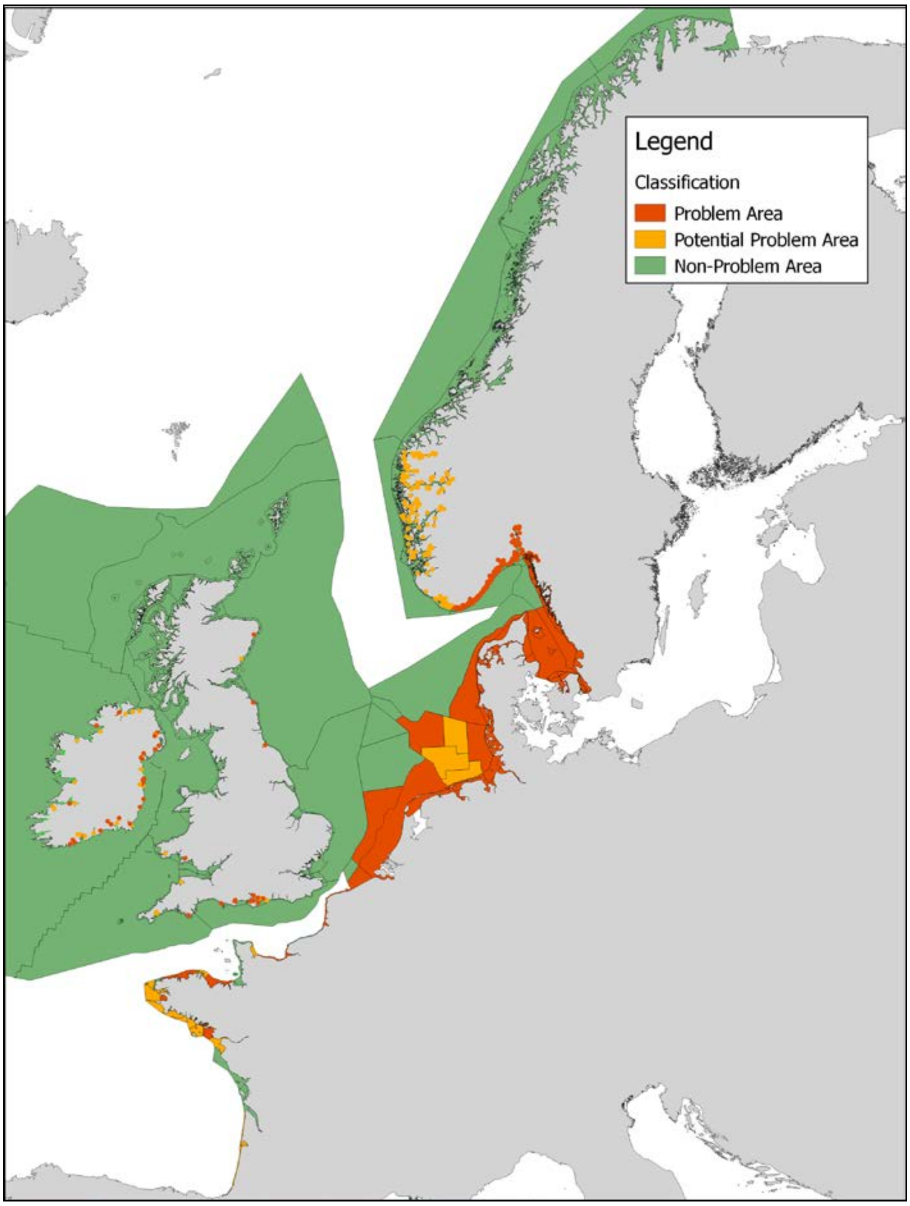


Figure 4.1: *Eutrophication status of the assessed OSPAR Maritime Area identified in the third application of the Comprehensive Procedure (2006–2014) in terms of problem areas, potential problem areas and non-problem areas. For Ireland, Norway and the United Kingdom's inshore and coastal waters the locations of problem areas and potential problem areas are illustrated with circles, because these assessed areas are too small to be seen if their actual area extent is mapped*

4.1.1 Greater North Sea

The Greater North Sea remains the Region in the North-East Atlantic with the largest extent of identified problem areas or potential problem areas (Figure 4.2, Table 4.2). Approximately 14% of the total surface area of 750,000 km^2 is classified as problem area, and 3% as potential problem area.

Reasons for that include high population densities as well as intensive agricultural activities in the watershed of the Greater North Sea, and related high nutrient inputs, mostly by the rivers discharging into the North Sea. Atmospheric nitrogen deposition can for certain areas be an important input pathway. A generalised compilation of riverine and atmospheric nitrogen inputs to the Greater North Sea based on data collected by OSPAR under its Riverine Inputs and Direct Discharges Programme (RID) and model calculations provided by the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmissions of Air Pollutants in Europe (EMEP) shows that the contribution of atmospheric nitrogen inputs to total inputs range from 25% to 39% in 1990–2004 in Region II (see Section 4.2.2).

In relation to the other OSPAR Regions or subregions, eutrophication effects in the Greater North Sea range over wider areas. The shallow character of the shelf sea and its hydrodynamics can increase eutrophication processes.

The largest extent of problem areas is found along the continental coast of the Greater North Sea. In the English Channel, problem areas in French coastal waters are mainly due to elevated nutrient concentrations and macroalgal blooms ("green tides") in the western part and elevated nutrient and chlorophyll levels in the eastern part. In the southern North Sea, elevated nutrient and phytoplankton concentrations, and in some cases indirect effects on macrophytes, benthic invertebrates or oxygen levels are the cause of problem areas in inland, coastal and sometimes also offshore waters in Belgium, Denmark, Germany and the Netherlands. Coastal areas of the Skagerrak and the entire area of Kattegat and Sound are classified as problem areas. Along the British coast, 13 problem areas and 5 potential problem areas are found.

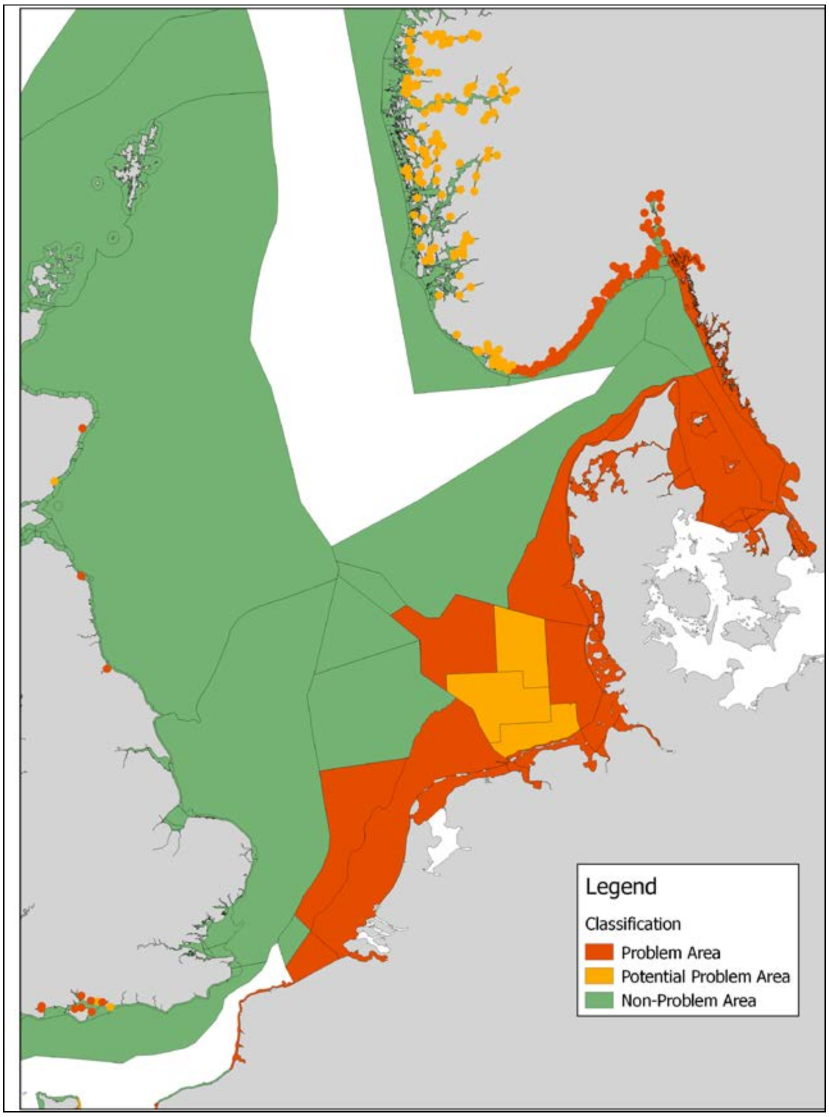


***Figure 4.2**: Eutrophication status of the Greater North Sea (Region II) identified in the third application of the Comprehensive Procedure (2006–2014) in terms of problem areas, potential problem areas and non-problem areas. For Norway and the United Kingdom's inshore and coastal waters the locations of problem areas and potential problem areas are illustrated with circles, because these assessed areas are too small to be seen if their actual area extent is mapped*

***Table 4.2**: Number of assessed areas and surface area in the Greater North Sea (Region II) classified in terms of problem areas (PA), potential problem areas (PPA) and non-problem areas (NPA). Note that some Contracting Parties have not assessed all waters, so the total surface area in the table is smaller than the total surface area of the Region*

Contracting Party	Number of areas		Total surface area (km^2)			All waters assessed?
	PA	PPA	PA	PPA	NPA	
Belgium	1	0	1331	0	2203	yes
Denmark	38	0	32315	0	44191	yes
France	8	4	3231	2566	1720	no
Germany	7	3	23781	16774	2542	yes
Netherlands	2	0	34305	0	27677	yes
Norway	188	141	984	1600	93528	no
Sweden	9	0	9384	0	4952	yes
United Kingdom	13	6	141	35	264919	yes
Total Region II	**268**	**154**	**104636**	**20975**	**441732**	**no**

4.1.2 Celtic Seas

In the Celtic Seas, eutrophication was observed along the coast of Ireland with 20 problem areas and 16 potential problem areas, based mainly on analyses of chlorophyll-a and oxygen (Figure 4.3, Table 4.3). Additionally, in Northern Ireland there were six problem areas and four potential problem areas. Along the south-west coasts of Wales and England, two areas were classified as problem area and two as potential problem area.

Anthropogenic induced eutrophication of the Celtic Sea is mainly restricted to inshore waters like bays, estuaries and fjords, where the identified potential problem area and problem area fall under the regime of the Water Framework Directive.

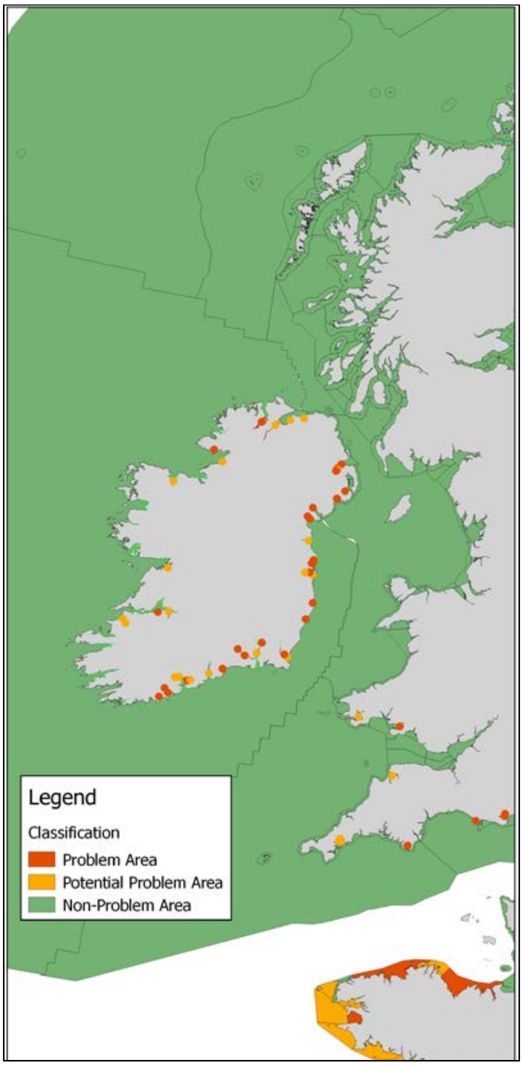


***Figure 4.3**: Eutrophication status of the Celtic Seas (Region III) identified in the third application of the Comprehensive Procedure (2006–2014) in terms of problem areas, potential problem areas and non-problem areas. For Ireland and the United Kingdom's inshore and coastal waters the locations of problem areas and potential problem areas are illustrated with circles, because these assessed areas are too small to be seen if their actual area extent is mapped*

***Table 4.3**: Number of assessed areas and surface area in the Celtic Seas (Region III) classified in terms of problem areas (PA), potential problem areas (PPA) and non-problem areas (NPA)*

Contracting Party	Number of areas		Total surface area (km^2)			All waters assessed?
	PA	PPA	PA	PPA	NPA	
Ireland	20	16	171	114	390225	no
United Kingdom	7	6	72	73	471035	yes
Total Region III	27	22	243	187	861260	**yes**

Note: some Contracting Parties have not assessed all waters, so the total surface area in the table is smaller than the total surface area of the Region

4.1.3 Bay of Biscay and Iberian Coast

The Bay of Biscay and the Iberian Coast are mostly less affected by eutrophication processes because the hydrographic conditions at the edge of the open ocean (e.g. fast dilution) inhibit the conversion of riverine nutrient discharges to extended phytoplankton blooms (Figure 4.4).

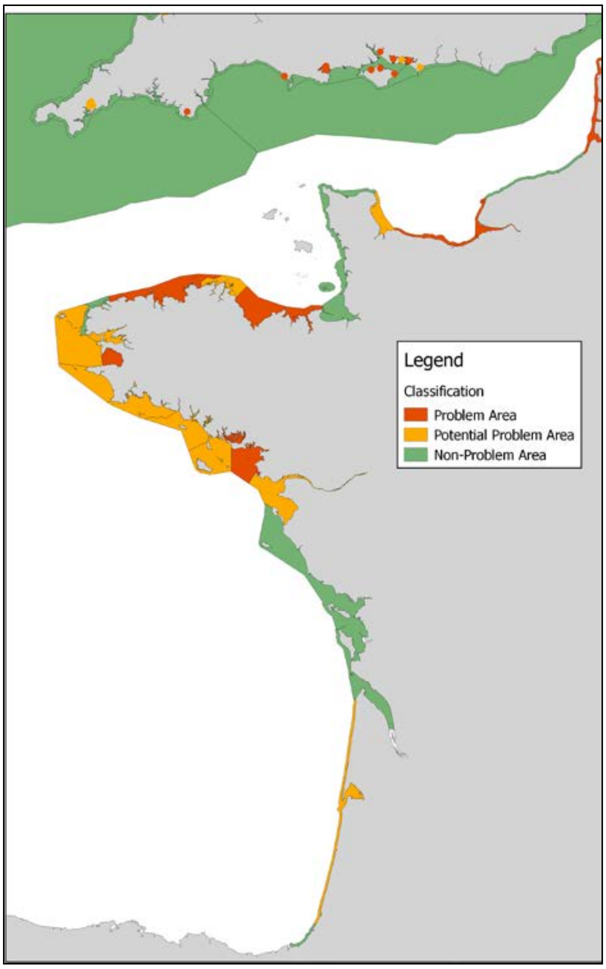


Figure 4.4: *Eutrophication status of the Bay of Biscay and the Iberian Coast (Region IV) identified in the third application of the Comprehensive Procedure (2006–2014) in terms of problem areas, potential problem areas and non-problem areas. In the United Kingdom's inshore and coastal waters the locations of problem areas and potential problem areas are illustrated with circles, because these assessed areas are too small to be seen if their actual area extent is mapped*

Along the French coast, the identified problem areas (Table 4.4) are related to elevated chlorophyll concentrations, phytoplankton indicator species or macroalgal blooms. The classification of potential problem areas is mainly related to the assessment of algal toxins for which the relationship with eutrophication is not demonstrated.

Table 4.4: *Number of assessed areas and surface area in the Bay of Biscay and Iberian Coast (Region IV) classified in terms of problem areas (PA), potential problem areas (PPA) and non-problem areas (NPA). Note that only one Contracting Parties has assessed its waters, so the total surface area in the table is smaller than the total surface area of the Region*

Contracting Party	Number of areas		Total surface area (km^2)			All waters assessed?
	PA	PPA	PA	PPA	NPA	
Total Region IV (France only)	2	6	786	4510	3249	no

4.2 Nutrient inputs

Contracting Parties have achieved substantial decreases in nutrient inputs to the OSPAR Maritime Area. However, in the Norwegian North Sea, Norwegian Sea and Barents Sea, inputs are again increasing substantially while several Contracting Parties have noticed possible changes in environmental conditions causing increases in (bioavailable) dissolved inorganic phosphorus inputs, even as total phosphorus inputs remain constant or decrease.

The OSPAR Maritime Area is the final recipient for inputs from the greater part of northern and western Europe (Figure 1). OSPAR Contracting Parties work together to collate information on nutrient inputs to the Maritime Area through the OSPAR RID Programme, with RID an acronym for Riverine Inputs and Direct Discharges. Contracting Parties follow common standards to measure at least 90% of the inputs from their territories. The remaining 10%, coming from small catchments along the coast between the larger monitored areas, is modelled in accordance with common guidance developed by the Contracting Parties. Data are maintained by the RID Data Centre, hosted by the Norwegian Institute for Bioeconomy, NIBIO. In addition to nutrients, the RID Guidelines require Contracting Parties to measure a limited suite of heavy metals and organic pollutants.

Riverine inputs are reported for each monitored watercourse and for the unmonitored (modelled sections). These data are then aggregated up to different scales, so inputs can be assessed at the individual river level, for a coastal region, from a country to a particular sea area or from a country as a whole. The RID programme does not include the requirement to measure transboundary inputs entering a coastal country from upstream, so riverine inputs reported for example from the Netherlands include inputs from the entire Rhine catchment.

In addition to inputs entering the OSPAR region via rivers, the RID programme requires Contracting Parties to report direct discharges to the sea. These come from human activities such as wastewater treatment, industry, aquaculture and storm water outlets. By summing riverine and direct discharge inputs, the total waterborne nutrient input to the OSPAR Maritime Area can be determined.

Atmospheric nitrogen inputs to the sea have been estimated based on measured deposition at a range of coastal sites, through the OSPAR CAMP (Comprehensive Atmospheric Monitoring Programme). Most CAMP monitoring stations are now included in the larger EMEP (European Monitoring and Evaluation Programme) under the UNECE Convention on Long-range Transport of Air Pollution (CLRTAP). CAMP and EMEP data are managed by the EMEP data centre at the Norwegian Institute for Atmospheric Research, NILU. EMEP also produce model estimates of atmospheric nitrogen deposition, based on nationally reported emissions data analysed using meteorological and atmospheric chemistry models. The EMEP model data have been used to estimate the atmospheric nitrogen input to the Greater North Sea.

Analysis of RID and atmospheric deposition data allows the nutrient input to the OSPAR Maritime Area from land-based sources to be assessed. Nutrient inputs from adjacent sea areas, such as the Baltic outflow, are not assessed by RID.

4.2.1 Spatial distribution of inputs

Analysis of RID data shows differences in the distribution of the major nitrogen and phosphorus sources (Figure 4.5, lower panels). The major nitrogen sources between 2006 and 2014 were the Rhine catchment, the German rivers and the rivers draining into the French Atlantic and English Channel coasts, followed then by the United Kingdom rivers draining into the southern North Sea and Norwegian sources in the Norwegian Sea. The Rhine catchment is also the major source of phosphorus, with the French Atlantic coast, German rivers and Norwegian Sea sources each about half the magnitude of the Rhine inputs. While the French and German inputs are associated with major rivers draining large catchments, the inputs to the Norwegian Sea appear to be dominated by discharges from point sources.

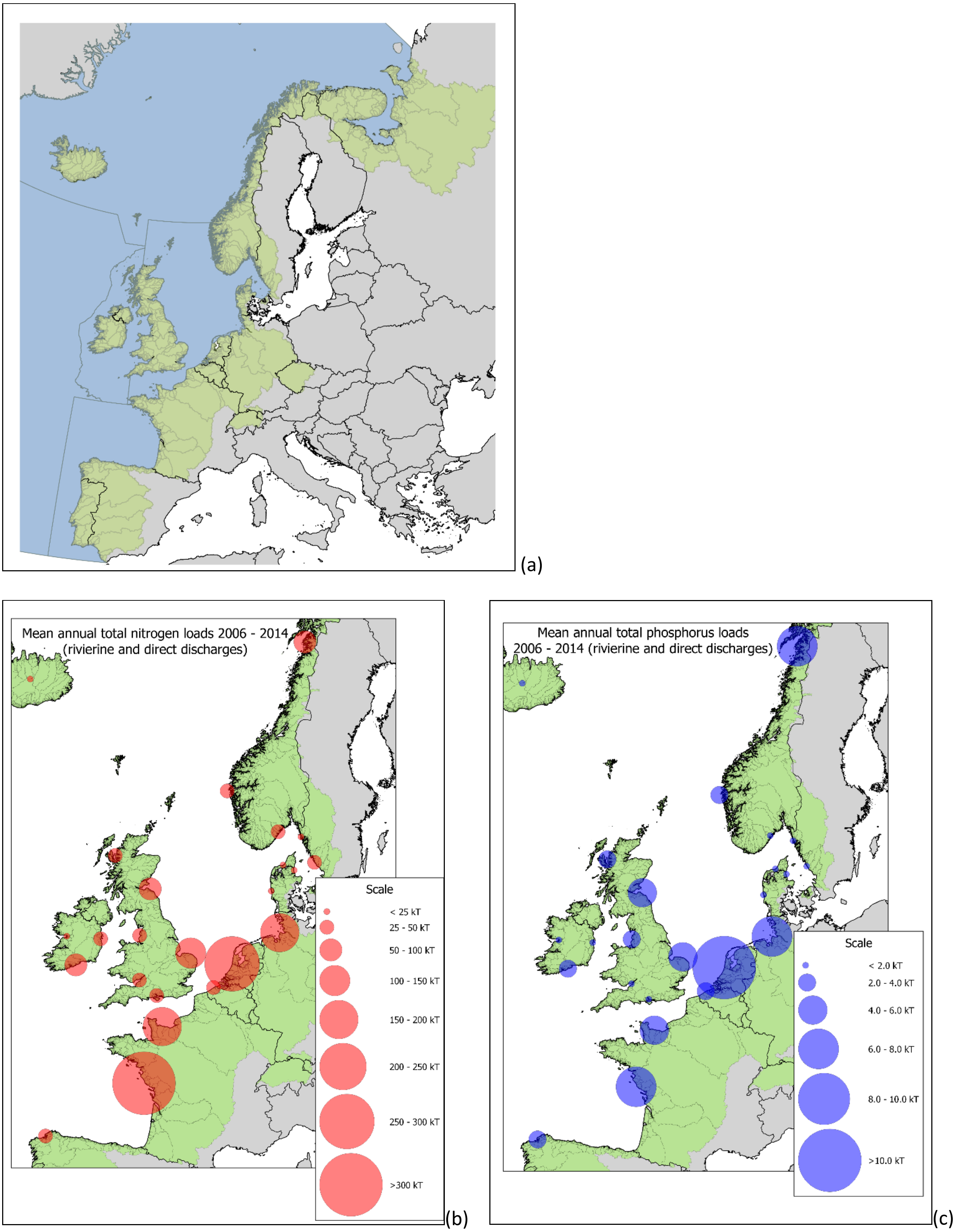


***Figure 4.5**: (a) Catchments discharging into the OSPAR Maritime Area (excluding Portugal) (Greenland excluded). Relative sizes of regional nitrogen (b) and phosphorus (c) inputs based on annual mean aggregated data reported to OSPAR RID 2006–2014*

4.2.2 Temporal changes

Contracting Parties have made great efforts to reduce nutrient inputs since the 1980s. These OSPAR initiatives have been supplemented and reinforced by EU directives and by commitments under the Gothenburg Protocol of CLRTAP, concerning atmospheric emissions. The results of these efforts can be seen in the development of nutrient inputs (Figure 4.6). Measures have been most successful in reducing the inputs of phosphorus to the Greater North Sea and to the Celtic Seas. In both of these regions, phosphorus inputs have roughly halved since 1990. Even phosphorus inputs to the Iberian Shelf and Bay of Biscay appear to have reduced significantly, although as data reporting from this region has been intermittent and a reasonable time series exists only after 1997, the change over the duration of the time series appears smaller.

Nitrogen inputs to the Greater North Sea vary from about 1400 to 2000 kilotonnes per year. Of this, approximately 500 kilotonnes come via the atmosphere (24–38% of the total). Particularly high inputs occurred in 1994, 1995 and 2002, associated with central European flood events (Engel, 1997; Förster, 2008). Since 2003, total nitrogen inputs to the Greater North Sea have remained fairly constant at around 1,500 kilotonnes. Total nitrogen inputs to the Greater North Sea appear to have decreased by about 500 kilotonnes over 24 years. Of this, approximately 150 kilotonnes is due to measures taken to reduce atmospheric nitrogen pollution.

Total phosphorus inputs to the Greater North Sea show a break point in the time series occurring after 2002. Prior to this, phosphorus inputs varied from 70 to 90 kilotonnes per year. Highest inputs occurred in 1995 and lowest during the years of 1996 and 2001. After 2002 phosphorus inputs of around 40 kilotonnes per year were regularly observed and did not return to the lowest levels observed previously. Annual phosphorus inputs have decreased by almost 50 kilotonnes since 1990 to just below 40 kilotonnes. While the rate of decrease in phosphorus inputs has reduced since 2003, there remains a significant downward trend in inputs to the North Sea, with inputs reducing by about 1½ kilotonnes per year (compared to decreases of more than 2 kilotonnes per year for the entire 1990–2015 time series).

Nutrient inputs to the Bay of Biscay and Iberian Coast are lower than those to the Greater North Sea and more variable. Total nitrogen inputs are around 300 kilotonnes per year after the year 2000, although during the year 2000 they exceeded 600 kilotonnes. This is most likely due to the extreme floods that occurred, in the autumn of 2000. The minimum observed nitrogen input in 2013 (a year when all countries reported data) was approximately 170 kilotonnes. Atmospheric deposition to the Bay of Biscay and Iberian Coast was not assessed.

Highest phosphorus inputs to the Bay of Biscay and Iberian Shelf occurred, as for total nitrogen, in the year 2000, and reached nearly 30 kilotonnes per year. Since 2004, inputs have been around 10 kilotonnes per year, although in the years when Portuguese data are available, this increases to about 12 kilotonnes.

Seen collectively, waterborne inputs of phosphorus to the Greater North Sea showed a significant reduction between 1990 and 2003. Inputs of nitrogen, both atmospheric and waterborne, have been more variable with weaker downward, but still significant, trends.

In the Greater North Sea the greater reduction in phosphorus compared to nitrogen inputs leads to an overall change in the molar nitrogen to phosphorus ratio in the inflowing freshwater from about 45:1 in 1990 to about 80:1 in 2014. A similar change has occurred in inputs to the Bay of Biscay and Iberian Coast, where the N:P ratio in fresh water inputs, aggregated across the entire region, has changed from around 40:1 to about 80:1.

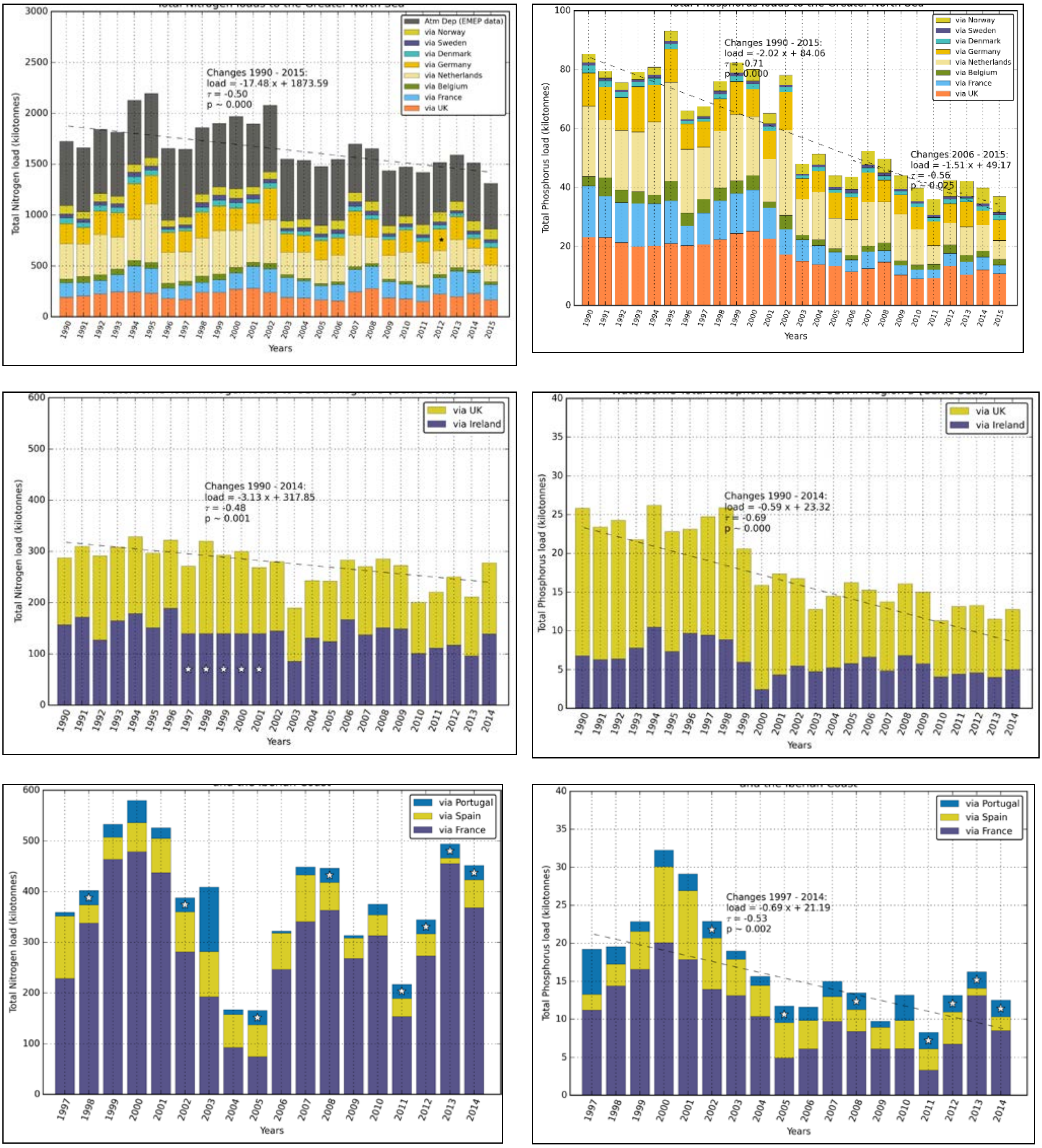


Figure 4.6: *Total nitrogen (left) and total phosphorus (right) inputs to the Greater North Sea (top), Celtic Seas (middle) and Bay of Biscay and Iberian Coast (lower), in kilotonnes.*, estimated mean values. Dashed line, statistically significant ($p<0.05$) trends*

4.2.3 Nominal concentrations

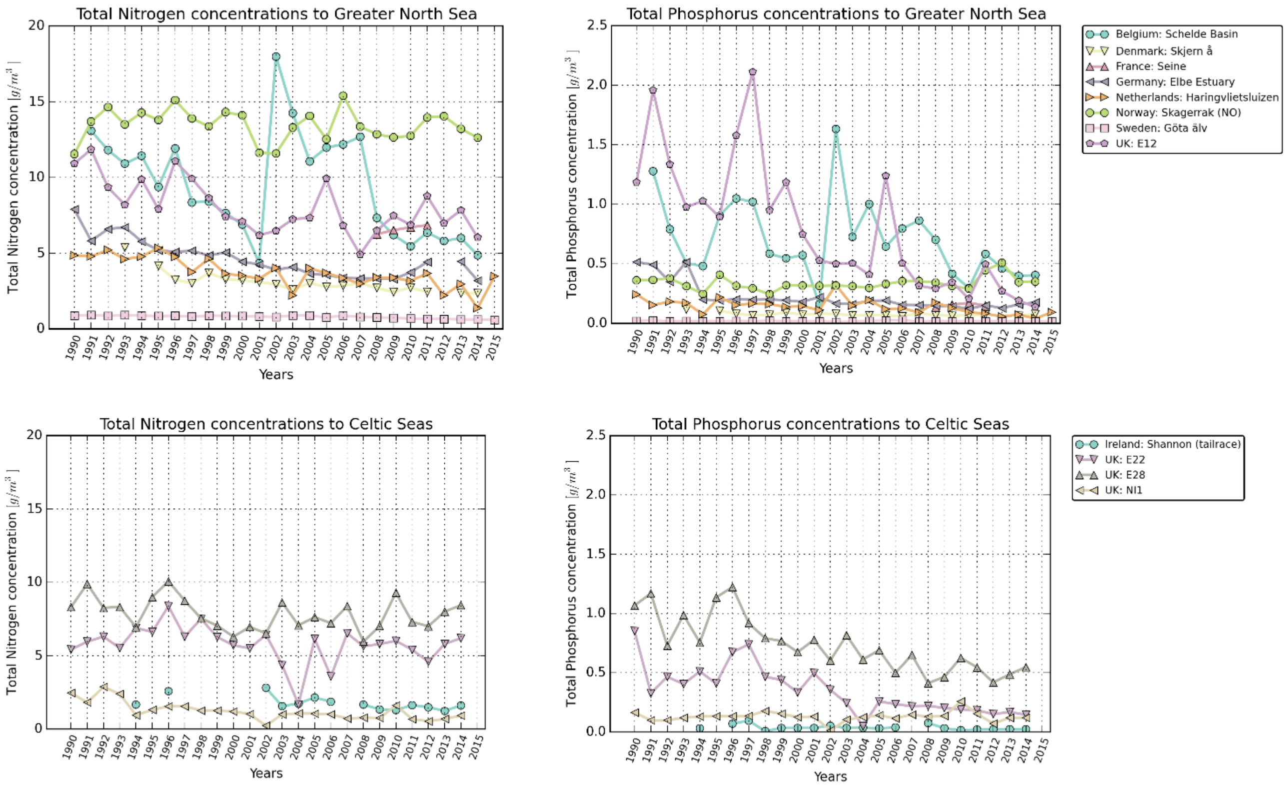
Germany uses a target, flow weighted concentration for total nitrogen of 2.8 mg l^{-1} (200 µM) in the major rivers (Box 3). To compare, a nominal annual concentration was calculated from the annual RID data, making use of reported annual flow data and the reported riverine inputs (Figure 4.6). This analysis is hampered by poor reporting of flow data to the RID database and the results could be considered ‘preliminary’.

Apparent average nutrient concentrations were calculated for major rivers draining into the Greater North Sea, The Celtic Sea and the Iberian Shelf/Bay of Biscay. To avoid problems associated with unevenly distributed sampling during each year, the ‘averages’ were calculated from the reported nutrient inputs and the reported annual discharges (Tables 6a and 9 respectively in the RID database). The United Kingdom reports inputs and flows from national reporting units. In this analysis they were chosen so as to be dominated by a single major riverine source. For discharges to the North Sea, the Thames catchment (the United Kingdom, E12) was used, while the Severn (E22), Mersey (E28) and Bann (NI1) catchments were selected. Norwegian RID data flows were also aggregated regionally. Skagerrak discharges were analysed, which would be expected to be dominated by the Glomma River.

With the exception of concentrations in the Norwegian river, apparently steady decreases in riverine concentrations have occurred since 1990 in all the studied North Sea rivers, for both nitrogen and phosphorus inputs. The smallest reduction occurred in the Göta River (Sweden) though this river also has the lowest apparent concentrations. The results from the Norwegian Skagerrak appear to be very high and need to be analysed further before conclusions are drawn.

Apparent nitrogen concentrations were initially lower in discharges to the Celtic Seas. However, there appear to be no changes in the concentrations in the Severn or Mersey. For total phosphorus, the apparent concentrations from the Mersey and Severn appear to have halved since the late 1990s, while levels in the Irish rivers have remained constant, and low.

Data coverage for specific rivers was too patchy for this analysis along the coast of the Bay of Biscay and Iberian Shelf.



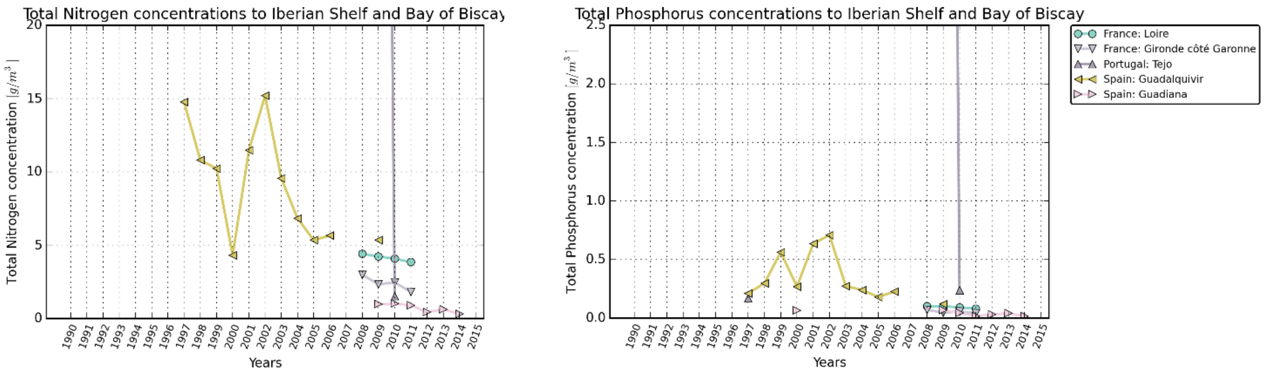


***Figure 4.7**: Apparent concentrations based on reported inputs and flows for total nitrogen (left) and total phosphorus (right) for the Greater North Sea (top), Celtic Seas (middle) and Iberian Shelf and Bay of Biscay (bottom)*

4.2.4 Atmospheric nutrient inputs and deposition

The calculations of nitrogen deposition to the OSPAR Maritime Area and calculations of sources apportionment for the deposition were performed in the Meteorological Synthesising Centre – West of EMEP located in the Norwegian Meteorological Institute (Bartnicki & Benedictow, 2017). The latest version of the EMEP MSC-W model (Simpson et al., 2012) was used for these calculations (Simpson et al., 2012).

4.2.4.1 Annual deposition to the OSPAR Maritime Area

Annual depositions of oxidised (NO_3^- and NO_2^-) and reduced nitrogen (NH_3 or NH_4^+) to all the OSPAR Maritime Area are presented in Figure 4.8 for the period 1995–2014. The main source for oxidised nitrogen deposition is fossil fuel combustion; the main source for reduced nitrogen deposition is agriculture.

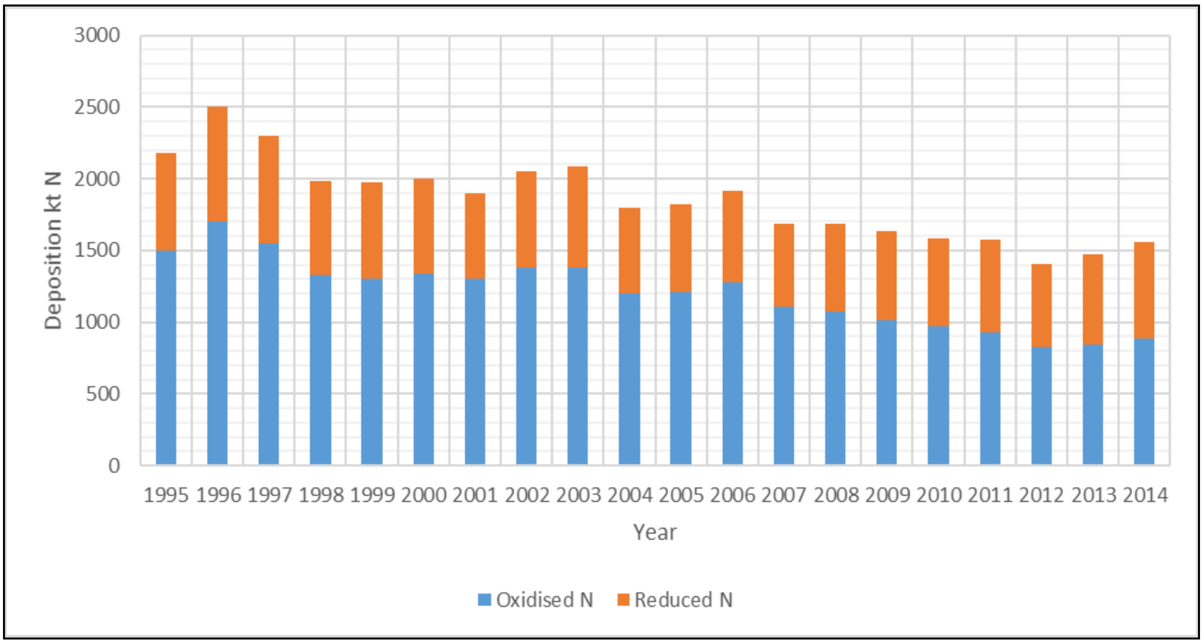


***Figure 4.8**: Annual deposition of oxidised and reduced nitrogen to all the OSPAR Maritime Area in the period 1995–2014*

For all the OSPAR Maritime Area inter-annual variation in calculated annual deposition is lower than for individual for Regions because of the much larger area for the deposition. Minima of the deposition occur in the year 2012 for oxidised, reduced and total nitrogen. Maxima of the deposition occur at the beginning of the period, in the year 1996 for all the kinds of deposition. Also for the OSPAR Maritime Area, all annual depositions are lower in 2014 than in 1995: 41%, 2% and 29% for oxidised, reduced and total nitrogen, respectively.

4.2.4.2 Weather-normalised deposition to Region II

Calculated annual depositions of nitrogen are dependent on both nitrogen emissions and meteorological conditions for the considered year. An efficient method to eliminate or at least largely reduce the effects of variable meteorological conditions is the normalisation of the depositions. This method has been used for several years in the EMEP calculations for HELCOM concerning nitrogen deposition to the Baltic Sea (Bartnicki et. al. 2016). The same method, based on source-receptor matrices for oxidised and reduced nitrogen was used for calculating normalised nitrogen deposition to individual OSPAR Regions and to all the OSPAR Maritime Area.

The normalised deposition of total (oxidised+reduced) nitrogen to OSPAR Region II is shown in Figure 4.9, together with actual annual deposition, minimum and maximum deposition.

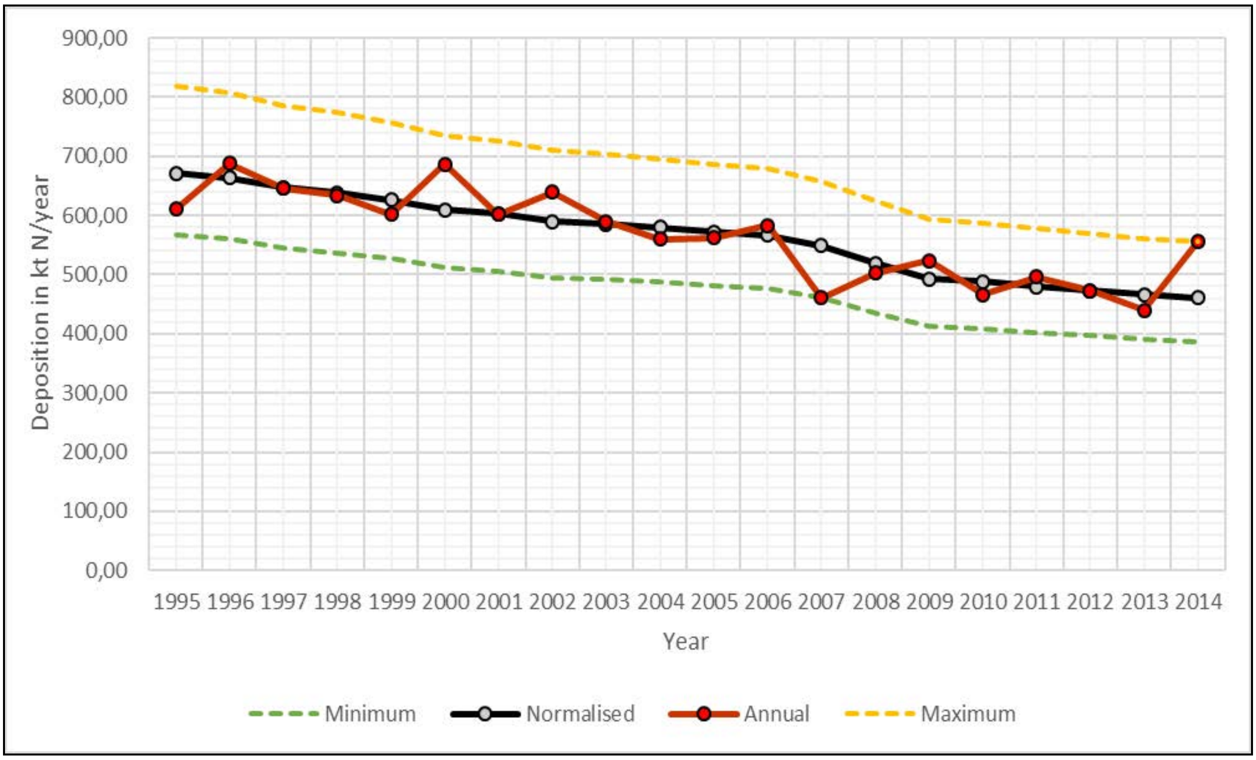


***Figure 4.9**: Normalised annual deposition of total (oxidised+reduced) nitrogen to OSPAR Region II for the period 1995–2014 and actual annual deposition, minimum deposition and maximum deposition for the same period*

For Region II computed normalised deposition was very smooth and monotonically decreasing. In 2014 normalised deposition of total nitrogen to Region II was 31% lower than in 1995. The range of meteorological uncertainty for the Region II was from -16% to 22%.

Concerning future atmospheric depositions to the OSPAR Maritime Area, they are mostly dependent on the future nitrogen emissions. In the revised Gothenburg Protocol the signatories have agreed to national reduction targets for NOx and NH_3 to be achieved from 2020 onwards, taking 2005 as the reference year. Following the Gothenburg Protocol, nitrogen oxides and ammonia emissions from 28 EU countries will be reduced by 42% and 6%, respectively in the year 2020 compared to reference year 2005. Following the EU

Directive (2016), nitrogen oxides and ammonia emissions from 28 EU countries will be reduced by 63% and 19%, respectively in the year 2020 compared to reference year 2005. In addition, there is an important regulation for ship emissions: Nitrogen Oxides (NOx) Emission Control Area (NECA) limiting NOx emissions from the ships via exhaust gases on the Baltic Sea and North Sea. The NECA applies to the new ships built after 2021. As the effect of NECA emissions from the ship traffic on the North Sea will be reduced 29% between 2014 and 2030. Taking the above regulations into account, further reductions in nitrogen depositions can be expected in the year 2020 and especially in 2030.

Comparison of the top ten contributors to atmospheric nitrogen deposition to OSPAR Region II for the period 2006–2014 is shown in Figure 4.10. There is a significant reduction in the United Kingdom contribution between the years 2006 and 2014, from 29% to 22%. On the increase side there is Germany from 12% to 19%, relative contribution from the remaining countries (countries not specified in the legend but labelled as 'REST' in Figure 4.10) and from ship traffic on the North Sea and on the Atlantic Ocean remains on the same level for the entire period 2006–2014.

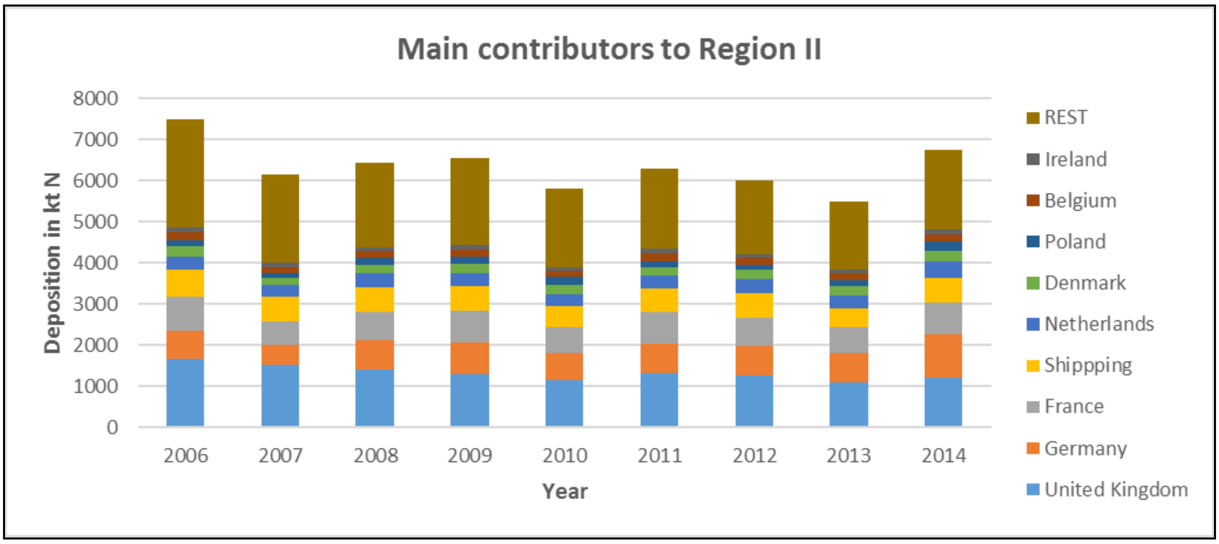


***Figure 4.10**: Comparison of main contributors to annual total nitrogen deposition to OSPAR Region II in the years 1995–2004 (kilotonnes, kt N) per year. REST = other countries not specified*

4.2.5 Highlights from national reports

The rivers of northern and western France are significant sources of nitrogen both locally but also to the southern North Sea. Nutrients from the River Seine largely impact the coast in the French part of the eastern English Channel before merging within the Channel jet to form up to 20% of the total nitrogen in the offshore part of the German Bight (EUC(2) 09/4/1-Add.1-E(L) part 46). Inputs from the Loire and other western French rivers affect both the Bay of Biscay before spreading into the English Channel where it contributes to more than 10% to the nitrogenous content of the phytoplankton entering the North Sea through the Straits of Dover (ECO-MARS3D, EMOSEM). No region in the French assessment was identified as having increasing nutrient inputs during the period 2006–2014 in which several had significant decreases.

From the United Kingdom, highest total inputs of dissolved inorganic nitrogen were to the northern North Sea, the southern North Sea, the Celtic Sea and the eastern Irish Sea. The lowest inputs were into the Atlantic region. The highest inputs of dissolved inorganic nitrogen to coastal waters were via rivers. The highest inputs of dissolved inorganic phosphorus to the northern North Sea and English Channel were from sewage sources, while the main inputs into the southern North Sea and the Atlantic were from both riverine and sewage sources. In the Irish Sea, industrial inputs were the main input in the early 1990s but as these have decreased, riverine inputs became dominant from the late 1990s onwards. Trend analyses (1990–2014) indicate that sewage and riverine inputs of phosphorus have decreased in all regions, except the Atlantic, while industrial inputs have decreased in the Celtic Sea and the Irish Sea.

Recent estimates from the caged fish farm industry to the north and west of Scotland suggest that they may be a significant source of nutrients into the north and west of Scotland where freshwater inputs are low. These nutrient inputs are mainly in the form of faecal and particulate organic matter deposited on the seabed. While they may not be available for immediate use by algae or higher forms of plant life they are likely to make an important contribution to biogeochemical cycling in the region.

Atmospheric discharges are also an important source of nitrogen (OSPAR, 2017). Nitrogen is emitted into the atmosphere by industry, transport (including shipping) and from agricultural practices. Agriculture accounted for 37–44% of atmospheric nitrogen deposited into the United Kingdom's waters.

For Belgian rivers, a clear decrease in nitrogen and phosphorus inputs occurred after 2001–2002 for both the coastal basin and the Scheldt River. This reduction is partly related to the measures for nutrient reduction policies implemented by the EU member states and partly due to the decrease in the Scheldt annual flow following the wet years of 2001 and 2002. Variability since 2005 in the annual input is related to changes in annual flow and result from diffuse sources – mainly fertiliser leaching from agricultural land. While no obvious decreasing trend in nutrient inputs over the last ten years can be observed, lower values are found for the assessment period 2006-2014. The average annual input of total nitrogen and total phosphorus for the period 2006-2014 is respectively 28.0 kilotonnes (kt) yr^{-1} and 2.0 kt yr^{-1} compared to 38.5 kt yr^{-1} and 2.7 kt yr^{-1} for the period 2001–2005.

The Netherlands reports significantly reducing nutrient inputs.

German discharges of nutrients to it EEZ are dominated by the Elbe and Weser, contributing 145 kt TN yr^{-1} and 6.6 kt TP yr^{-1}. Trends between 2006 and 2014 were mostly non-significant. While trends of river nutrient concentrations show decrease tendencies since 1980, these have stagnated for total phosphorus since about since 2000 and for total nitrogen since 2005.

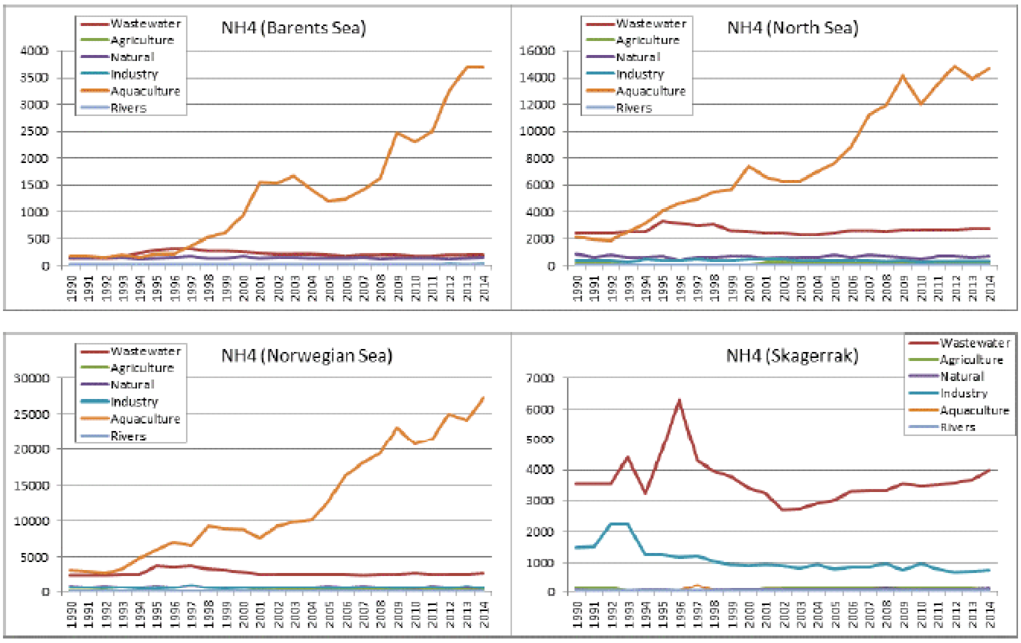
TN concentrations for the main Rivers Elbe, Weser, Ems and Eider and the mean concentrations weighted according to freshwater discharges showed decreasing linear trends since 1980. The concentrations can be compared with the management level of 2.8 mg l^{-1} (200 µM) that was set under the WFD for all German North Sea rivers under the assumption that this level will allow the achievement of good ecological status in coastal waters. The management level was reached in the River Elbe and weighted means approached this level. The concentrations within the Ems decreased as well but remained far above the management level. The same was true for the TN concentrations in the River Eider that stagnated at 250 µM.

Denmark did not report changes in nutrient inputs.

Sweden reported significant decreases in the flow normalised nitrogen inputs for 1990–2014 to all sea areas. Nitrogen inputs also decreased significantly during the assessment period 2006–2014, with the exception of the Sound (between Denmark and Sweden) where dissolved inorganic nitrogen inputs increased. Significant decreasing trends were also found for total phosphorus for all areas, but only for the long time series 1990–2014. Inorganic phosphorus inputs to the Skagerrak and Kattegat increased.

The atmospheric deposition of nitrogen to Skagerrak and Kattegat decreased significantly during the time periods 1990–2013 and 2000–2013 despite increases in maritime transport. The overall decrease is due to measures on land. Reduced nitrogen, which comes almost completely from agriculture, was 30% of the total input of atmospheric nitrogen. A significant decreasing trend for the reduced nitrogen was only found in Skagerrak. Atmospheric deposition of phosphorus was estimated as a constant value, as recent measurement and model data are lacking.

Norway reported that inputs to the Norwegian Sea and the Barents Sea coastal waters showed low but increasing anthropogenic inputs (Figure 4.11), particularly of NH4 (52% for the Norwegian Sea and 61% in the Barents Sea for the last 10 years), but also total phosphorous and total nitrogen, and nutrients (NO3, PO4). The NH4 inputs were mainly caused by the increasing aquaculture industry. In the Skagerrak, input trends showed an increase in the case of PO4, reduced for NH4 and no trend for NO3, tot N and tot P. In the southern North Sea a large increase in inputs were found for NH4 (43%), NO3, total nitrogen and phosphorous.



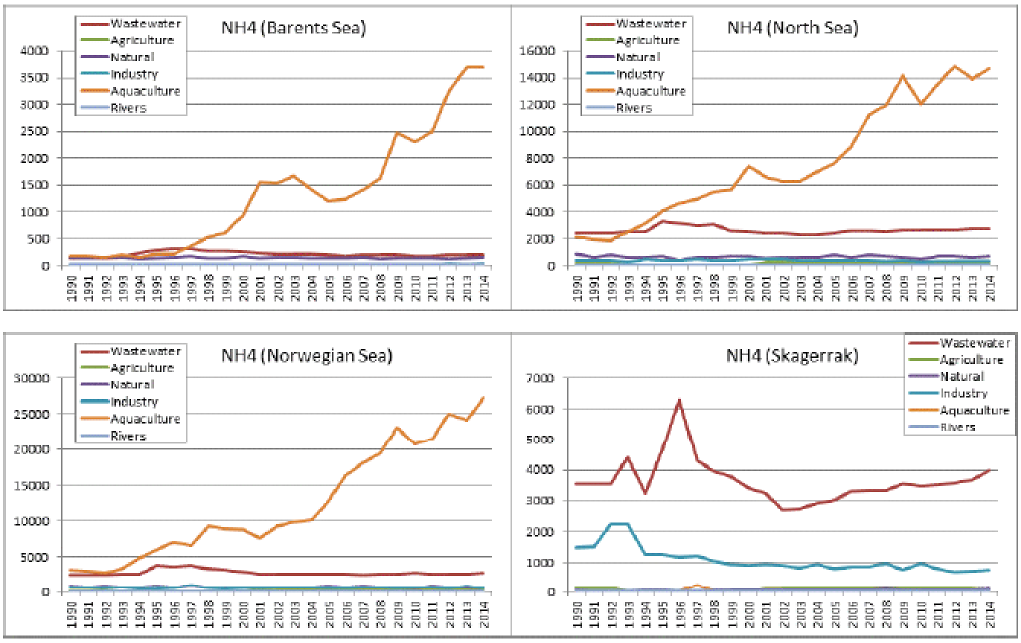


***Figure 4.11**: Increasing discharges from aquaculture are a significant source of nutrients in Norwegian waters (Norderhaug et al, 2016). Units are tonnes*

4.2.6 Transboundary nutrient transport

Transboundary nutrient transports are an important source of nutrient inputs that need to be taken into account when setting nutrient reduction targets. Essentially, this means that the nutrient reduction requirements of Contracting Parties are not only driven by the eutrophication status in their national waters but in addition should consider nutrients exported to the waters of other Contracting Parties. In order to quantify transboundary nutrient transports work has been ongoing in ICG-EMO to model this process. Marine ecosystem models provide information on the distribution of ecosystem parameters in space and time by calculating their biogeochemical dynamics and transport. The TBNT (Trans-Boundary Nutrient Transport) tool constitutes an extension allowing for the tracing of nutrients from specific sources, like rivers or atmospheric nitrogen deposition. This implies that all nutrient fluxes, both physical and biogeochemical, are related to the input from these selected sources. The result is a budget of the contribution from different input sources to the overall amount of the selected nutrient (e.g. TN or TP) within a certain region of the ecosystem. Therefore, this tool underpins the source oriented approach by OSPAR as it allows quantification of the contribution from selected sources to the overall nutrient cycle within one defined maritime area. During the OSPAR TBNT workshop in 2009 in Brussels an overview was provided on the percentage contributions from the different national river groups to total nitrogen in maritime areas and specific water bodies averaged over the relevant models (OSPAR, 2010) (Figure 4.12). Work to further develop those model tools is ongoing to support future conclusions on the eutrophication status in the OSPAR Maritime Area. Initial results were presented by ICG-EMO at HASEC 2017 for German waters (see Figure 3.12).

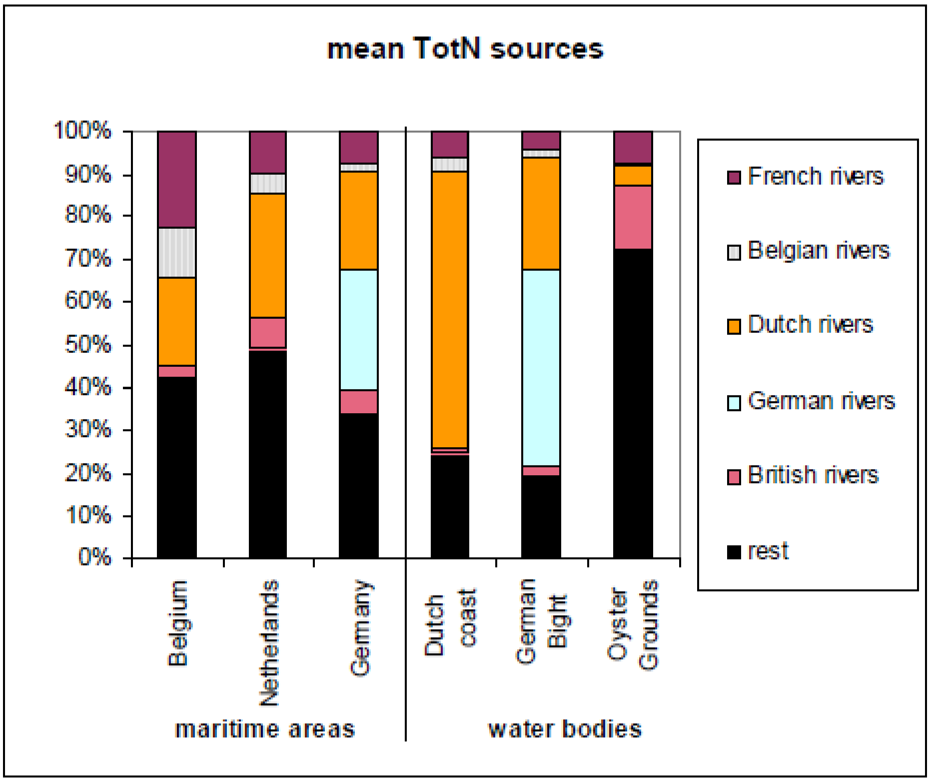


Figure 4.12*: The percentage contributions from the different national river groups to total nitrogen in maritime areas and specific water bodies averaged over the relevant models; because the category 'rest' is different for each model used in calculating the mean, the contribution of Atlantic Ocean, English Channel, atmospheric deposition and the 'rest' are taken together (OSPAR, 2010)*

4.3 Development since the first application of the Comprehensive Procedure

Nine Contracting Parties have applied the Comprehensive Procedure to assess the eutrophication status of their waters three times, in 2003, 2008 and now in 2017. A direct comparison of the assessment results for each assessment area, in those three applications, is not always straightforward as in some cases assessment areas have changed, areas were split or new areas have been added. In addition, assessment levels of the parameters have changed or the assessment parameters have been adapted.

Table 4.5 gives the percentage of the total surface area classified as non-problem area, potential problem area or problem area for each Contracting Party in the three Common Procedure assessments. Note that in some cases the total area that has been assessed by a Contracting Party differs between their three applications of the Common Procedure.

Table 4.5*: The assessment results of the three Common Procedure applications per Contracting Party, expressed as percentage of the total surface area that was assessed. COMP1 = first Common Procedure, COMP2 = second Common Procedure, COMP3 = third Common Procedure*

Contracting Party	Assessment	Total area assessed (km^2)	Non-problem area (%)	Potential problem area (%)	Problem area (%)
Belgium	COMP1	3534	0.00	37.66	62.34
	COMP2	3534	0.00	37.66	62.34
	COMP3	3534	37.66	0.00	62.34

Contracting Party	Assessment	Total area assessed (km^2)	Non-problem area (%)	Potential problem area (%)	Problem area (%)
Denmark	COMP1	76506	24.09	0.00	75.91
	COMP2	76506	21.79	27.32	50.90
	COMP3	76506	57.76	0.00	42.24
France	COMP1	16170	52.31	18.81	28.89
	COMP2	16062	32.30	28.00	39.70
	COMP3	16062	30.94	44.05	25.01
Germany	COMP1	42261	8.93	10.31	80.76
	COMP2	42261	0.00	21.99	78.01
	COMP3	42261	5.90	38.92	55.18
Ireland	COMP1	1128	83.09	0.71	16.20
	COMP2	1164	76.37	3.35	20.27
	COMP3	390510	99.93	0.03	0.04
Netherlands	COMP1	61982	12.99	0.00	87.01
	COMP2	61982	55.35	0.00	44.65
	COMP3	61982	55.35	0.00	44.65
Norway	COMP1	89445	96.41	2.18	1.41
	COMP2	14845	64.52	26.99	8.49
	COMP3	96112	97.31	1.66	1.02
Sweden	COMP1	13879	0.00	0.00	100.00
	COMP2	13879	35.68	0.00	64.32
	COMP3	14336	34.54	0.00	65.46
United Kingdom	COMP1	773676	99.97	0.01	0.03
	COMP2	773677	99.96	0.01	0.03
	COMP3	736275	99.95	0.02	0.03

The outcomes of the three applications of the Comprehensive Procedure were compared by looking at the surface area that has been classified as problem area or potential problem area (Table 4.5). Figure 4.13 gives the total surface area problem area or potential problem area per Contracting Party. The surface area of non-problem area is not presented, as the total area that each Contracting Party has assessed can be different between the various applications of the Comprehensive Procedure. Compared to the second application, the surface of problem areas has decreased in six cases (Denmark, France, Germany, Ireland, Norway and the United Kingdom), or remained constant (Belgium and the Netherlands). Only Sweden observed a small increase in problem areas. Compared to the first application, the extent of problem areas in this third application has decreased in nearly all cases.

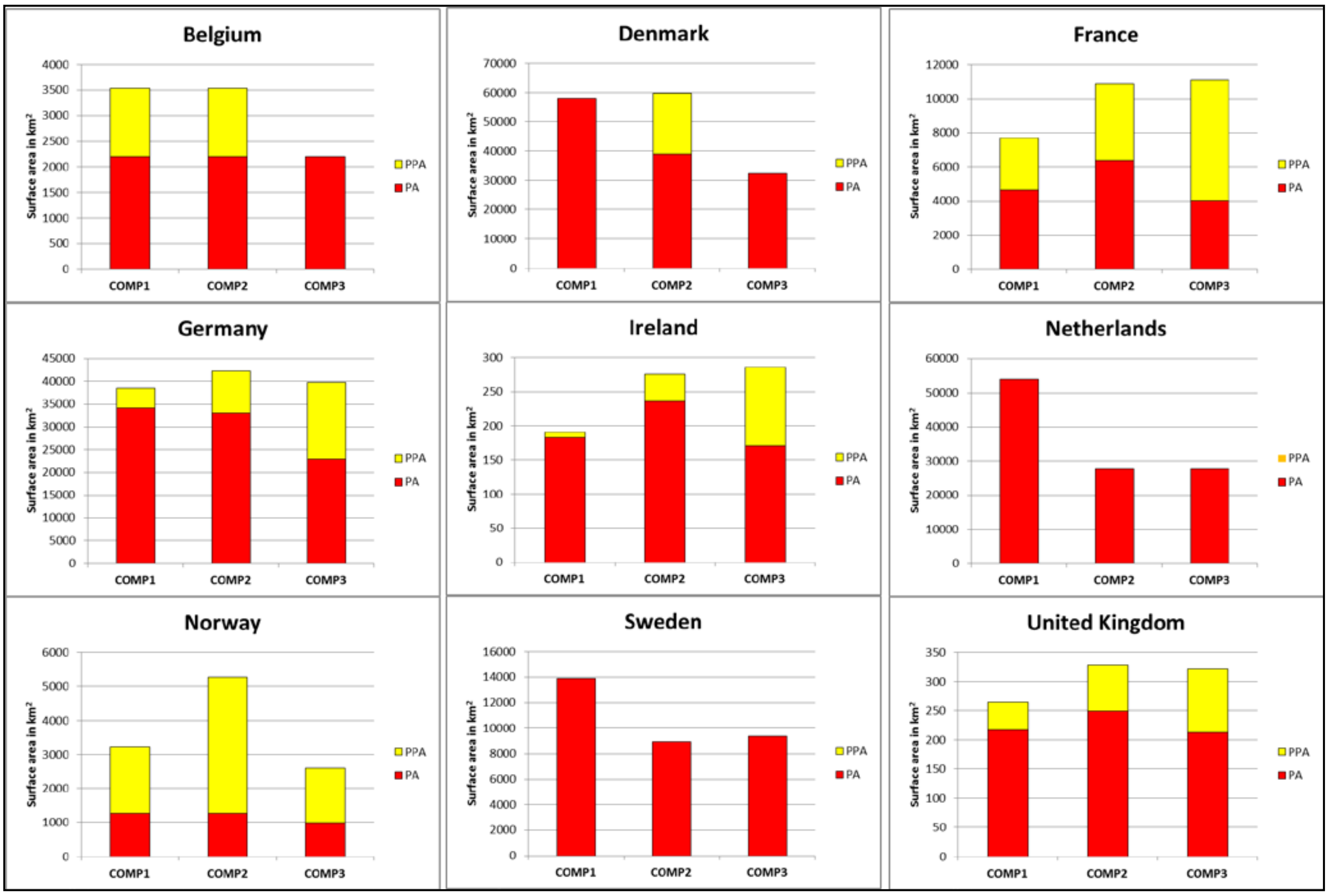


***Figure 4.13**: Surface area (km^2) of problem areas (PA) and potential problem areas (PPA) per Contracting Party in the three applications of the Comprehensive Procedure (first application: 1990-2001; second application: period 2001-2005; third application: period 2006–2014)*

For the entire OSPAR area that is covered by the nine Contracting Parties that have applied the Comprehensive Procedure three times, the total surface of problem areas has decreased from nearly 169,000 km^2 in the first application of the Comprehensive Procedure, to 119,000 km^2 in the second application and 100,000 km^2 in the third application (Figure 4.14). The extent of potential problem areas has increased from the first to the second application of the Comprehensive Procedure, and decreased from the second to the third applications.

Maps of the assessment results in the first and second applications are shown in Figures 4.15 and 4.16. The results of the third application are shown in Figure 1.

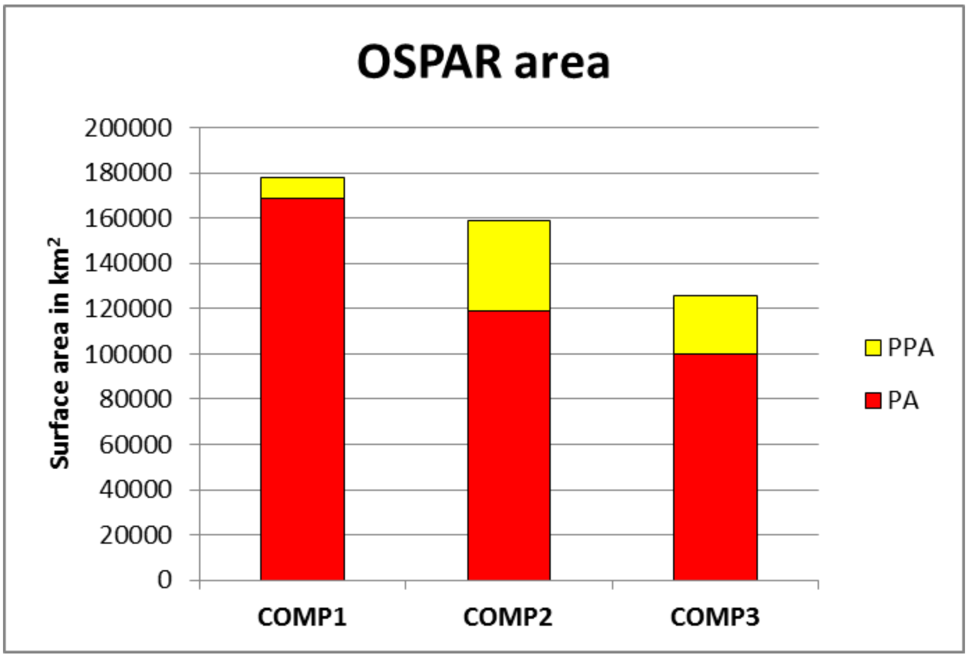
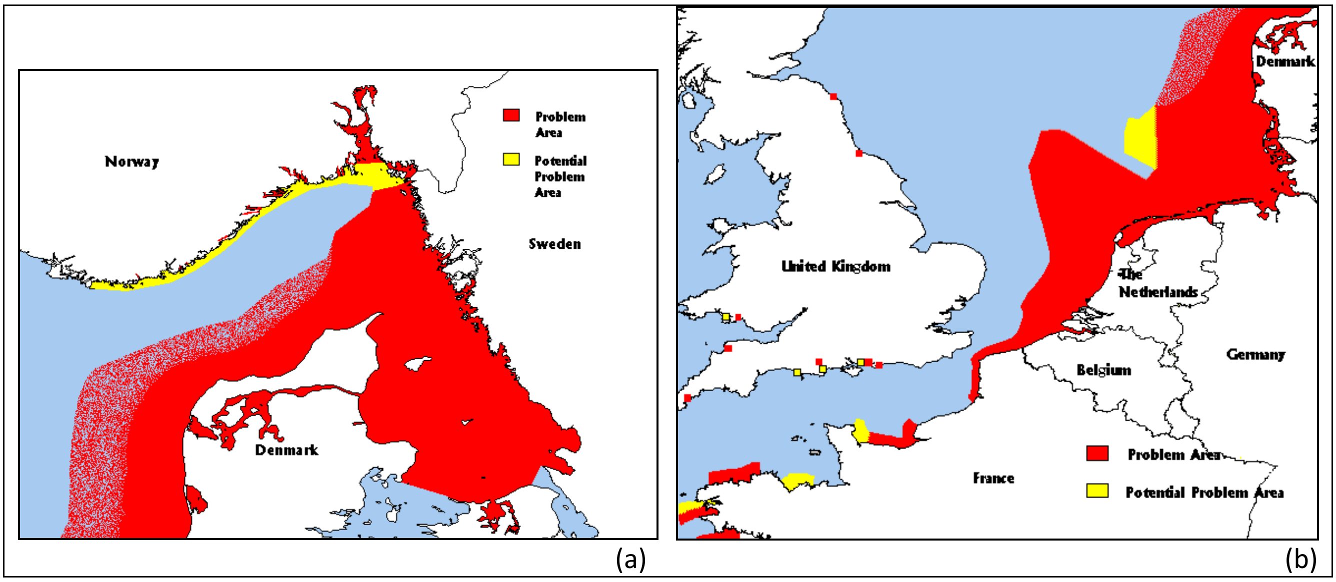
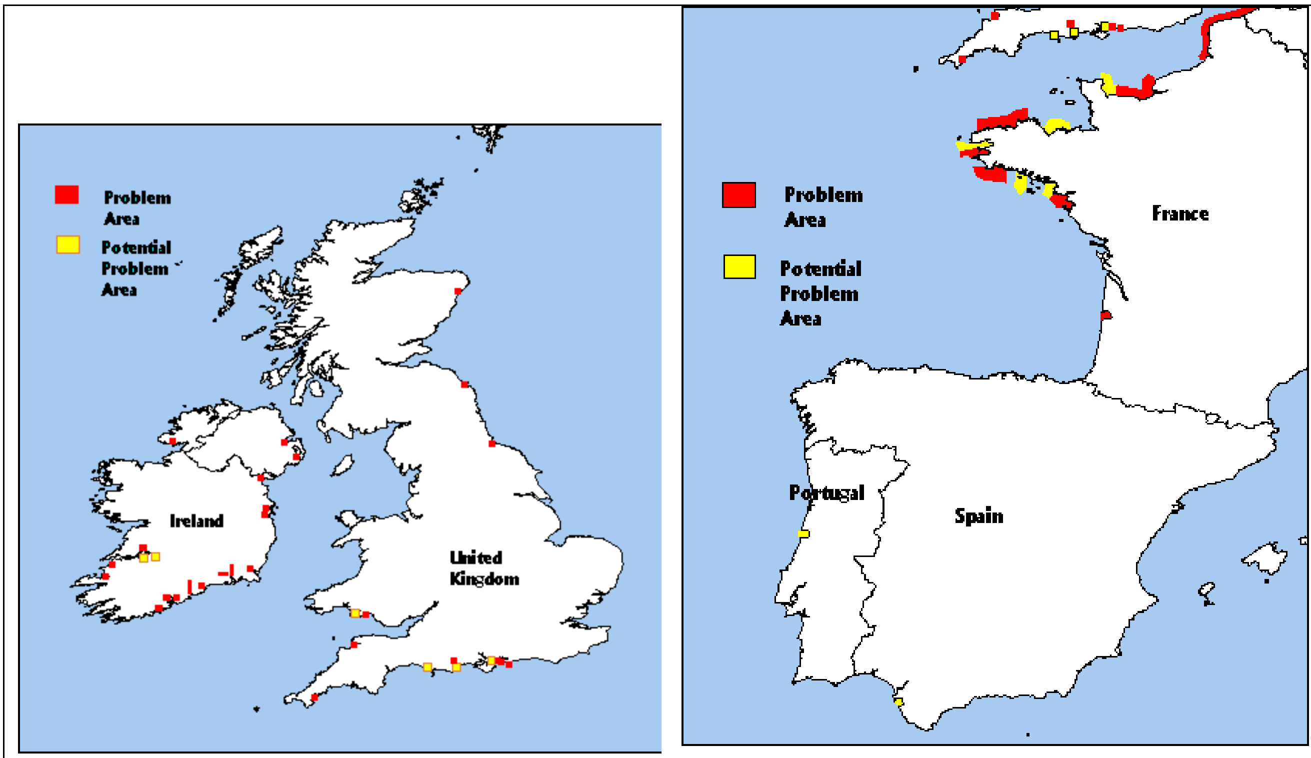


Figure 4.14: *Surface area (km²) of problem areas (PA) and potential problem areas (PPA) in the entire OSPAR area (with the exception of Portugal and Spain) in the three applications of the Comprehensive Procedure (first application: 1990-2001; second application: period 2001-2005; third application: period 2006–2014)*





(c) (d)

Figure 4.15*: Eutrophication status of the OSPAR Maritime Area identified in the first application of the Comprehensive Procedure, in terms of problem areas, potential problem areas and non-problem areas. (a) Kattegat, Skagerrak and eastern North Sea, (b) southern North Sea and English Channel, (c) coastal waters of Ireland and the United Kingdom, and (d) English Channel, Bay of Biscay and Iberian coastline*

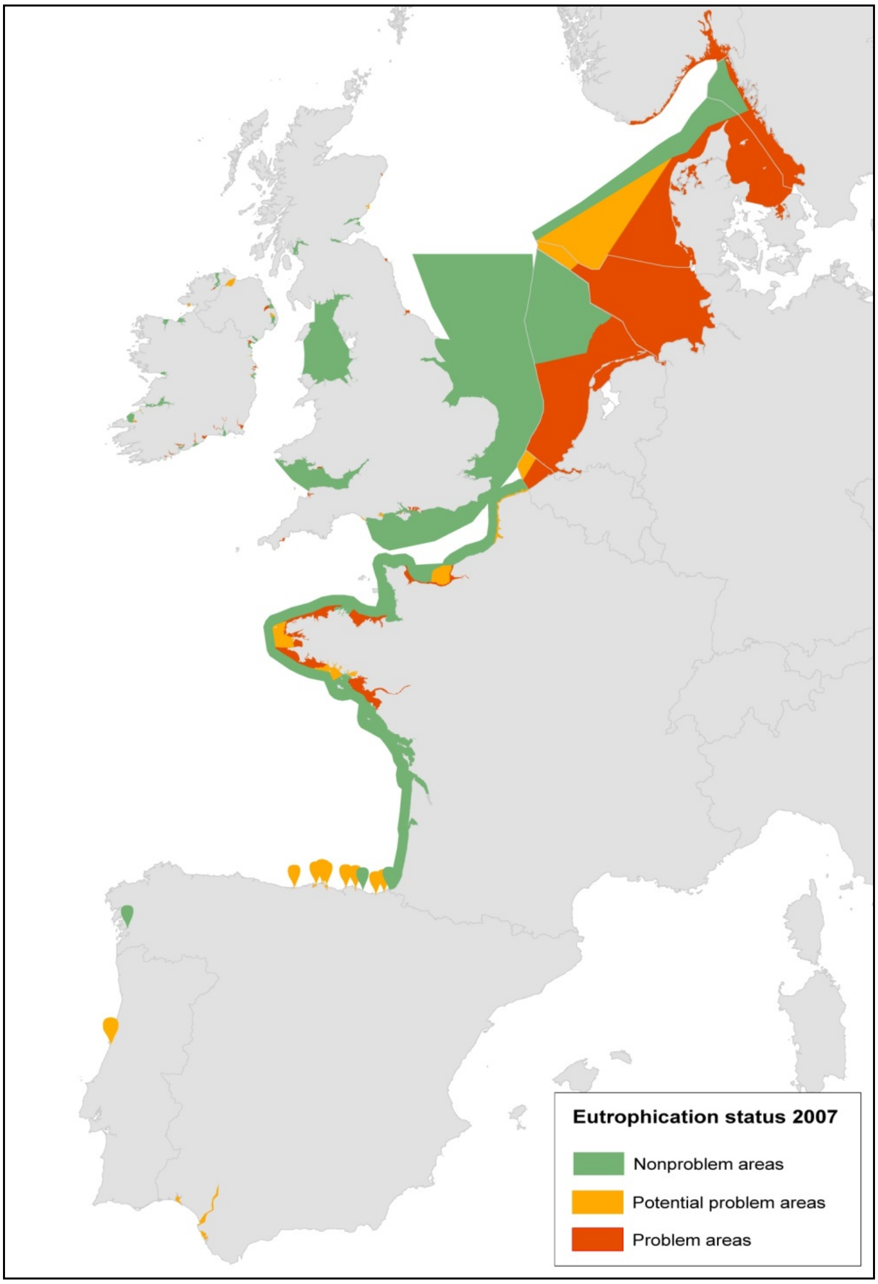


Figure 4.16: *Eutrophication status of the OSPAR Maritime Area identified in the second application of the Comprehensive Procedure, in terms of problem areas, potential problem areas and non-problem areas*

Changes in status mainly relate to improvements in the more offshore waters. Some of the changes in status are also due to improvements in monitoring or in the assessment methods.

Nevertheless, it is important to note that in the meantime some substantial improvements have been made in nutrient reduction, reflected in presented time series, but they did not cause an improvement of the overall eutrophication status of many assessment areas yet, for two main reasons:

- only improvements of eutrophication effects (reflected by direct/indirect effects parameters like chlorophyll concentrations, abundance of phytoplankton indicator species, oxygen depletion) will result in a better classification,
- the response of these parameters to nutrient reduction is slow due to annual maximum river discharges during phytoplankton spring blooms, high efficiency of nutrient recycling, and nutrient supply from transboundary fluxes as well as from sediments by remobilisation of trapped nutrients.

The eutrophication status in the Greater North Sea shows improvements, compared to previous applications of the Comprehensive Procedure. Some of the offshore and outer coastal areas show an improvement to non-problem area, in particular in the southern North Sea and the Skagerrak. Overall, the surface of problem area has decreased by approximately 40% since the first application of the Comprehensive Procedure, and by approximately 15% since the second application. In some other areas trends can be observed in parameters which indicate an improvement (decreasing nutrient concentrations, decreasing chlorophyll concentrations) but this is not yet visible in the overall assessment result.

North Sea offshore waters of Belgium, Denmark and Germany changed status from (potential) problem area to non-problem area. A high number of estuaries, fjords, coastal waters and parts of the offshore waters mainly along the continental coast, the Skagerrak and the Kattegat have still been classified as problem areas. These are either shallow areas with restricted mixing or stratified environments. These conditions keep the phytoplankton seasonally within the euphotic zone and allow an extended utilisation of supplied nutrients (for example in the Norwegian coastal current which is fed by the Baltic outflow). Reasons for the classification of these open waters as problem areas are elevated chlorophyll concentrations, the occurrence of phytoplankton indicator species and seasonal oxygen depletion in the bottom water of stratified areas. Fjords and estuaries are often classified as problem area due to restricted occurrence of macrophytes. The eutrophication status of Norwegian coastal waters of the Skagerrak has improved compared to the second Comprehensive Procedure, which is mainly due to assessment at the larger spatial scale of water types and because sugar kelp is no longer considered as principal eutrophication indicator.

As shown by some budget calculations, transboundary transports of nutrients and organic matter can be significant, if not dominating in some coastal areas and fjords. This prevents local reduction measures to show effects. Additionally, the share of atmospheric nitrogen inputs and the respective deposition can contribute to nitrogen budgets, especially along the main shipping lanes. Nitrogen inputs from shipping can level atmospheric deposition originating from surrounding countries. The significance of inputs via transboundary water and air transport underline the need for continued harmonised reduction measures as also required by EC legislation (for example Water Framework Directive (2000/60/EC), Nitrates Directive (91/676/EEC), Urban Waste Water Treatment Directive (91/271/EEC), National Emission Ceilings Directive (2001/81/EC).

4.4 Comparison of Comprehensive Procedure results with the common indicators for eutrophication

OSPAR agreed that the common indicator assessments would be used as the basis of the Intermediate Assessment 2017. The common indicators related to eutrophication describe nutrient inputs, and the concentrations of nutrients, chlorophyll, *Phaeocystis* and oxygen. The intermediate results of the assessments focus on trends in the Greater North Sea. For some indicators trend assessments were done for other regions as well, such as the Celtic Seas (chlorophyll-a, dissolved oxygen) and Bay of Biscay and Iberian coast (nutrient inputs).

The trends and gradients compiled for the common indicators allow comparisons with local gradients assessed by Contracting Parties within the national borders, and with the situation in the entire OSPAR maritime region.

With respect to the causative factors, the common indicator for nutrient inputs used data from national reporting under the RID programme and data from EMEP. Nitrogen inputs include both riverine and direct discharges and atmospheric deposition. For the Greater North Sea a reduction in phosphorus inputs between 1990 and 2003 was observed (approximately 50%) and to a lesser extent a reduction in nitrogen inputs (approximately 25%) since 1990. For the Bay of Biscay and Iberian Coast phosphorus inputs have decreased as well, but no trend in nitrogen inputs is discernible. The common indicator for nutrient concentrations is based on data from the ICES database supplemented with data from national databases. Winter concentrations of dissolved inorganic nitrogen (DIN) and phosphorus (DIP) decreased significantly since 1990 in the coastal areas of the southern North Sea and, for DIN, in the Kattegat, the Sound and the offshore areas of the Skagerrak. Since 2006, concentrations of DIN and DIP stayed mostly the same.

For the Greater North Sea, the national third Comprehensive Procedure reports also show decreases in phosphorus and nitrogen inputs since 1990, which is obvious as they are mainly based on the same datasets. For the reporting period of the third Comprehensive Procedure (2006–2014) some countries (Belgium) report that there are no significant trends in nutrient concentrations. TN and TP inputs reported by the Netherlands show a decrease. Norway reported increased phosphate inputs in the Skagerrak, but no trend for total-P inputs over the last ten years. Similarly, NH_4 inputs decreased but total-N inputs showed no trend. On the west coast of Norway, increased inputs of NH_4, total-N and total-P into the North Sea were reported by Norway. France only reported data for the period 2006-2011, showing significant decreasing trends in nitrogen inputs in some catchments and no trends in other areas.

For the Bay of Biscay and Iberian Coast, only the French third Comprehensive Procedure report is available. France reported an absence of significant trends in P and N inputs in nearly all catchments for the period 2006-2010. The common indicator for nutrient inputs had too many data lacks to establish trends.

The common indicator for chlorophyll used data from the ICES database, covering the North Sea, Skagerrak, Kattegat and Sound in the Greater North Sea and the Celtic Seas. The common indicator showed significant decreasing trends in chlorophyll concentrations in Skagerrak and Sound for the period 1990-2014. The United Kingdom reported significant increasing trends in chlorophyll-a in their part of the northern North Sea, which was not observed in the common indicator assessment (that covers a larger area). In some cases, decreasing trends in chlorophyll-a were reported in the third Comprehensive Procedure reports, either for the period 1990-2014 or for the period 2006–2014. This was the case for some assessment areas in the coastal waters (English Channel, France, southern North Sea, Germany and the Netherlands) and in the Kattegat and the Sound. The observed trends reported by Contracting Parties in parts of the southern North Sea were not reflected in the results of the common indicator chlorophyll-a, probably due to the large spatial scale of the assessment area used in the latter assessment.

Cell counts of the indicator species *Phaeocystis sp.* were reported by Belgium and the Netherlands. Concentrations of this species are generally above the assessment level and do not show a trend over time. The common indicator for *Phaeocystis* showed that highest concentrations of this indicator species are found in coastal waters along the Belgian-Dutch-German coast. No statistically significant trends were found for the period 1990-2014.

Oxygen deficiencies were not reported in the third Comprehensive Procedure reports, or were reported as being absent. The common indicator on dissolved oxygen concentrations showed that there is a downward trend in the Celtic Sea, and upward trends in the Kattegat, northern North Sea, and Bay of Biscay and Iberian Coast. For most areas with sufficient data, oxygen deficiency was not observed.

Overall, it can be concluded that the common indicator assessments of trends over time and at a relatively large spatial scale, have identified a few significant trends. This is most obvious for the decreases in nutrient inputs since 1990. Both the common indicator for nutrient concentrations and the third Comprehensive

Procedure reports show that the reduction in nutrient input and the concomitant decrease in nutrient concentrations mainly occurred in the period 1990–2006. During the 2006–2014 reporting period of the third Comprehensive Procedure no clear trends in nutrient inputs and concentrations were found. The national third Comprehensive Procedure reports show the assessment results obtained for smaller spatial scales than the common indicators, and in a few cases showed improvements in the classification of chlorophyll.

4.5 Quantifying the effectiveness of measures

OSPAR Contracting Parties have made significant efforts to reduce nutrient losses to the marine environment. As early as 1988 Contracting Parties agreed to reduce nutrient emissions to the Greater North Sea by 50% (PARCOM 88/2). This commitment was reinforced through PARCOM 89/2, which introduced a coordinated programme to reduce nutrient losses. Finally, PARCOM 92/4 introduced a range of measures aimed at agricultural practices that were causing excessive nutrient losses. Reporting on PARCOM 88/2 was suspended in 2006 in expectation of better, ecosystem-based nutrient reduction targets. Within the EU, Directives covering nitrates, wastewater treatment, and industrial emissions as well as bathing water and shellfish quality have built on the work of OSPAR. Atmospheric emissions have been limited through EU Directives but also more widely through work under the Gothenburg Protocol of the UNECE Convention on the Long-range Transport of Atmospheric Pollutants.

In general, quantifying the effects of lowering of nutrient inputs requires a rigorous analysis of indicators related to marine eutrophication. This type of analysis has only been made for some coastal areas, notably in Denmark. A wider analysis of changes in, for example, primary productivity, is not available, so this analysis describes the observed large scale changes before describing some of the local recovery analyses produced by Denmark, as a guide for future OSPAR analyses.

4.5.1 Nutrient input reductions and reductions in eutrophic areas

Joint efforts by OSPAR Contracting Parties have resulted in significant reductions in nutrient inputs to individual coastal waters (e.g. Figure 4.17) but also to the OSPAR Marine Regions as a whole (section 4.2.2). Rapid input reductions occurred particularly with the introduction of secondary, and in some areas tertiary, wastewater treatment, which in most countries occurred at the end on the 1980s and start of the 1990s. Statistically significant reductions have been achieved for nitrogen to the North Sea and Celtic Seas, and for phosphorus to all three OSPAR Regions: the Greater North Sea, the Celtic Seas and the Bay of Biscay and Iberian coast.

Over the same period, observed nutrient concentrations in coastal waters have decreased, although the complexity of processes at the basin scale and the uneven spatial distribution of monitoring stations make it difficult to directly link observed changes in nutrient concentrations to the input reductions. Despite these difficulties, since the first application of the Common Procedure (1990–2001), the extent of the OSPAR Maritime Area classified as either problem or potential problem area has decreased steadily by about 50 000 km^2 (see Figure 4.14).

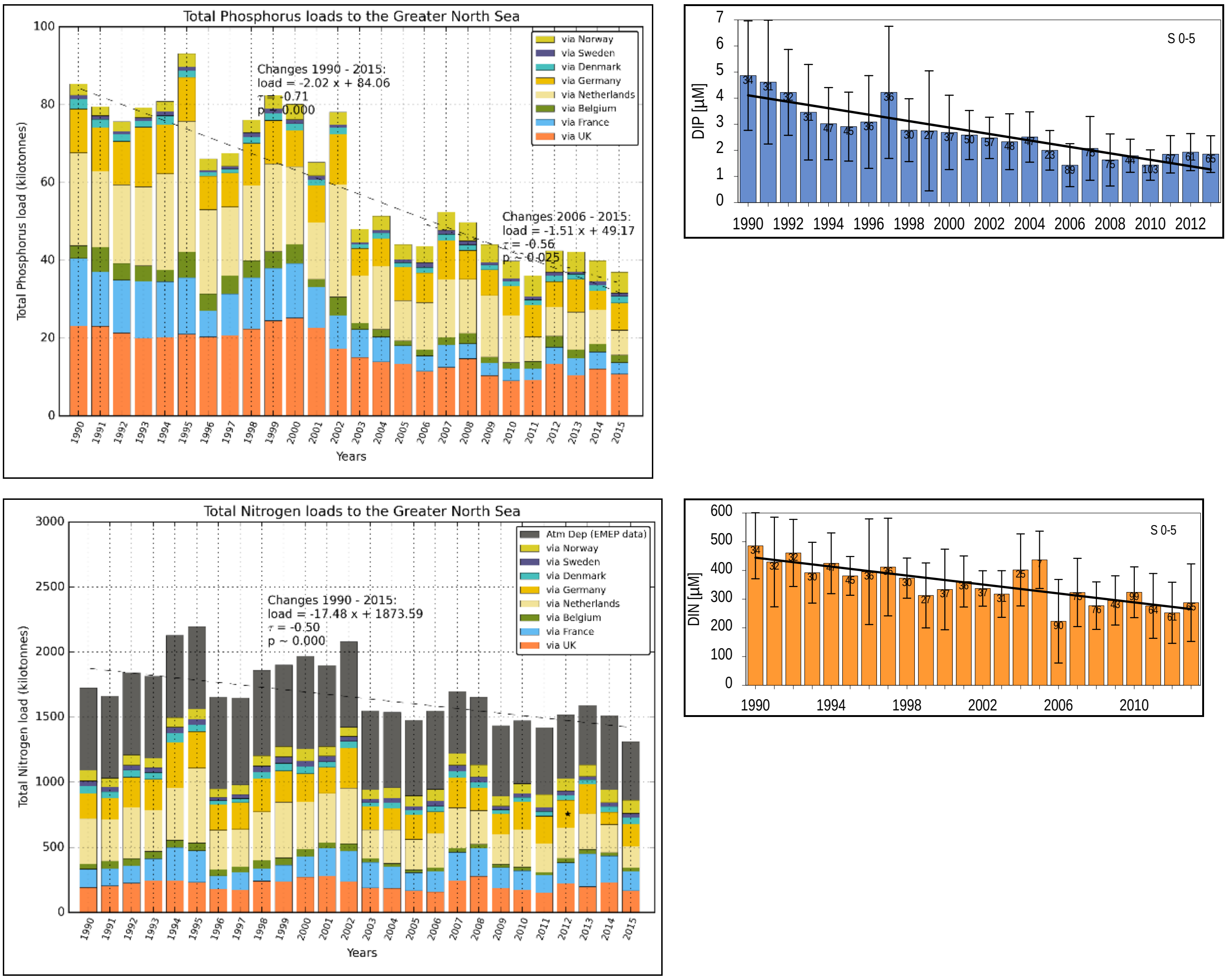


__Figure 4.17__: Dissolved inorganic phosphorus (upper) inputs (left) and concentrations (right) and -nitrogen (lower) inputs and concentrations in the coastal southern North Sea (salinity range of 0–5)

4.5.2 Importance of local analyses

Analyses on smaller scales, in coastal water bodies, show clear relationships between nutrient inputs, in-situ concentrations of nutrients and phytoplankton biomass (e.g. Carstensen and Henriksen, 2009). Well-documented examples exist where changes in local inputs led to reductions in primary production in the coastal water (e.g. Lyngsgaard et al, 2014).

The broad scale analysis presented above used trends to support a descriptive approach where the development of inputs, nutrient concentrations and eutrophication status were plotted over time. While this approach works well for quantifying changes where development is monotonic, such as in relatively sheltered waterbodies, this method struggles to document the effect of reduced nutrient inputs where the relationships are more complex. Looking at the effect on individual biological response variables is also problematic: Figure 4.18 shows the development of chlorophyll-a, a measure of phytoplankton biomass, in the coastal waters of the southern North Sea, in response to the reducing nutrient inputs and concentrations. At a 95% confidence level, there is no trend in the chlorophyll response, despite significant trends in the inputs and concentrations. Chlorophyll is a proxy for phytoplankton biomass and while biomass production is related to nutrient inputs, the total biomass is also a function of mortality, zooplankton grazing and transport processes. Thus it is not the perfect indicator for the effects of nutrients on algal growth. This has been shown perhaps most recently by Lyngsgaard et al (2017).

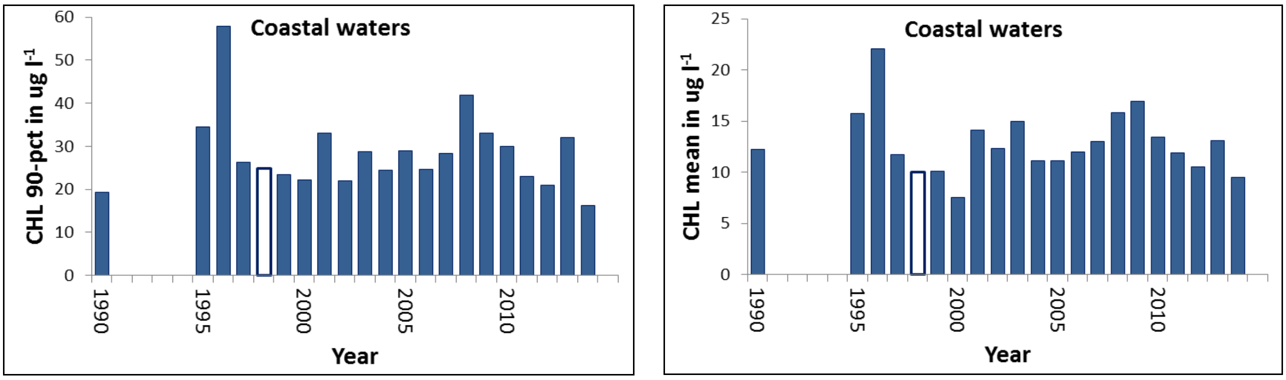
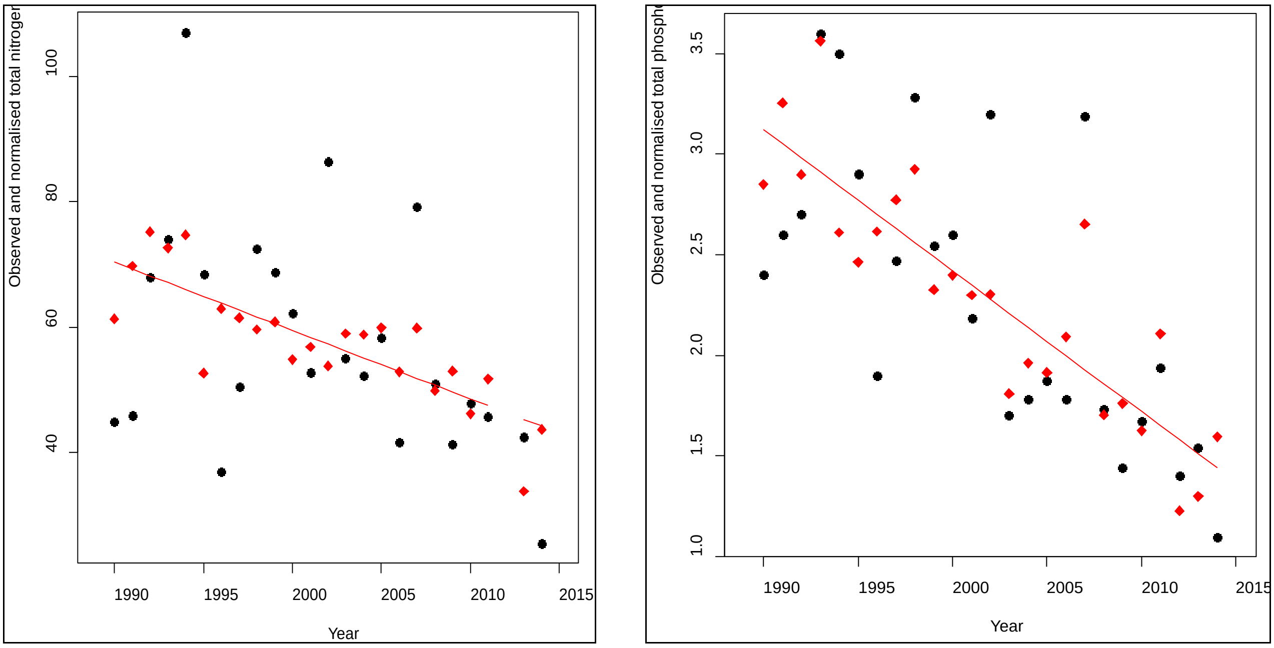


***Figure 4.18**: Development of chlorophyll-a concentrations in North Sea coastal waters, as 90 percentile (left) and growing season mean (right), from OSPAR chlorophyll-a indicator assessment for the Intermediate Assessment 2017*



Percentage change 1990 – 2014:
Normalised values: -28.73152
Modelled values: -37.12558
Mann-Kendall test for normalised values
Standard model
Tau = -0.6449275
Score = -178
var(Score) = 1625.333
2-sided p-value = 1.131531e-05
Theil-Sen's (MK) or seasonal/regional Kendall (SKT/RKT) slope= -1.06659

Percentage change 1990 – 2014:
Normalised values: -44.01632
Modelled values: -53.92275
Mann-Kendall test for normalised values
Standard model
Tau = -0.7
Score = -210
var(Score) = 1833.333
2-sided p-value = 1.054485e-06
Theil-Sen's (MK) or seasonal/regional Kendall (SKT/RKT) slope= -0.0690727

***Figure 4.19**: Observed (black) and flow-normalised (red) total nitrogen (left) and total phosphorus (right) inputs and percentage changes 1990 to 2014. Example from the Weser River*

Given that run-off governs the actual annual inputs, these are subject to random variability that complicate time series analyses. A better approach is to analyse the relationships between actual absolute inputs of nitrogen and/or phosphorus and to establish significant relationships to the biological response as far as possible. If this is combined with time series for flow-weighted (run-off standardised) inputs (Figure 4.19), more reliable statements can be made about the possible positive effects of nutrient inputs, which is highly desirable given the large cost associated with nutrient reduction. Such an analysis has been done before for some indicators, such as those presented in Lyngsgaard et al, 2014. In this study, both total annual and surface layer primary productivity were decreased with reductions in nitrogen input ($p < 0.003$) while 'deep' primary production (below about 8 metres) increased as a result of decreasing nitrogen inputs, which may be expected from an increase in water clarity. This study clearly shows the positive effect of nutrient reduction measures on eutrophication effects.

An alternative approach is to use a GLM (general linear model) with year, station and month as classes. Such an approach was developed by Carstensen and Henriksen (2009) to develop Water Framework Directive reference conditions and class boundaries to relate nutrient inputs to concentrations and then to chlorophyll-a concentrations. While they were able to derive empirical relations between the parameters, there were large local variations due to differences in offshore influence between estuaries and open coast sites. Thus, an in-depth analysis of the effect of measures needs to incorporate site specific information.

Box 2: Effectiveness of measures – in-situ mitigation

Contracting Parties use complementary efforts to remove nutrients from the water column.

Farmed mussels consume plankton, so subsequent mussel harvesting removes the nutrients from the marine environment. This is considered relatively cost-effective: based on results from a farm in the Danish Skivefjord, a hectare of mussels on longlines takes up 600–900 kg nitrogen and 30–40 kg phosphorus, at an estimated cost of about €14.8 per kilogramme nitrogen harvested (Petersen et al. 2014). However, limitations include the costs involved in handling mussel shells and the need to find a market for them.

Sweden is running a project using long-line marine farming techniques to produce sea squirts (Ciona intestinalis). Like mussels, sea squirts filter phytoplankton from the water column. A one hectare farm is expected to remove up to 15 tonnes nitrogen and 1.5 tonnes phosphorus each year, as well as producing 0.6 GWh of biogas through anaerobic digestion – double the amount that can be produced from a hectare of wheat on land. Digestate from the biogas is expected to be recycled as fertiliser (Svensson, 2015).

Risks associated with these methods that need to be addressed include: the effects of high concentrations of faecal pellets on the bottom fauna and denitrification processes in the sediment underneath a farm; the possible release of hazardous substance through mussel faeces (Gilek et al, 1997); possible reductions in zooplankton grazers where feeders prefer zooplankton to phytoplankton, and; possible concentrations of heavy metals in digestate-based fertilisers. Aquaculture as a mitigation measure involves the use of large areas in coastal regions, and requires supporting infrastructure such as nets, buoys and platforms. To be effective in nutrient removal and to survive rough conditions, such installations typically need to be in estuaries, fjords or other areas close the coastline. These areas are typically under significant exploitation pressure, resulting in potential conflicts with nature conservation, marine recreation and tourism.

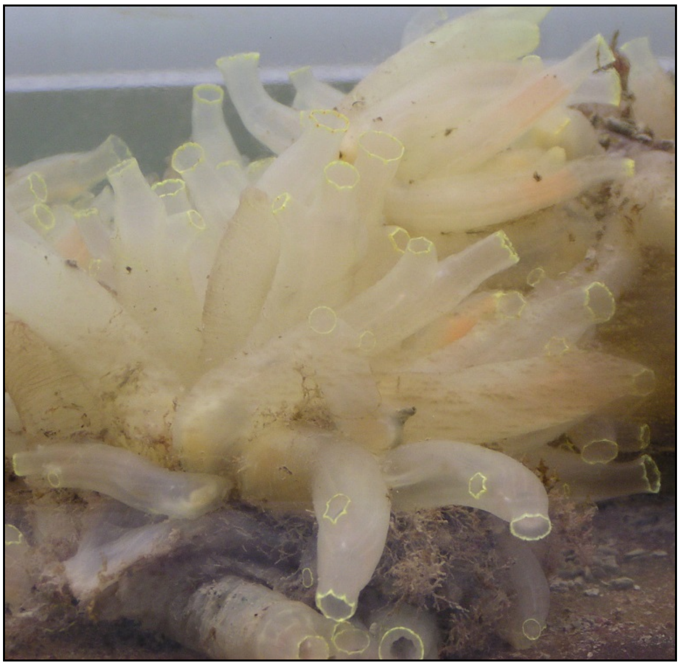


Figure B2.1: Sea squirts (Ciona intestinalis)

[image by perezoso, https://commons.wikimedia.org/wiki/File:Cionaintestinalis.jpg, under GFDL https://en.wikipedia.org/wiki/GNU_Free_Documentation_License and https://creativecommons.org/licenses/by-sa/3.0/)

Marine plant cultivation avoids the problem of high faecal inputs from filter feeders. The Seafarm project in Sweden has established a 0.5 hectare kelp farm that should remove around 41–84 kg nitrogen and 5.5–7.5 kg phosphorus per year (Pechsiri et al, 2016; Seghetta et al 2016). Holdt and Edwards (2014) suggest a cost for sugar kelp nitrogen removal of €10–38 per kilogramme nitrogen. Kelp digestate also meets strict Swedish criteria for cadmium content in fertilisers.

Restoration of reef habitats can also lead to improved sequestration of nutrients from the water column by providing substrate for perennial macroalgae as well as for filter feeders. In areas with restricted water exchange, the presence of macroalgal photosynthesis may potentially ameliorate the effects of seasonal hypoxia by producing oxygen in bottom waters. However, the approach is sensitive to changes in water clarity and to short-term anoxia that can convert the biomass of macroalgae from an oxygen source to a sink. This worsens the anoxic event and leads to further nutrient release both from the bottom sediment but also from the decaying macroalgae.

On soft bottoms nutrients can be taken from the water column and buried in the sediment via burrowing animals or through eelgrass roots. In Odense the uptake from restored eelgrass beds is estimated to be 663 tonnes nitrogen per year (http://www.balticdeal.eu/measure/restoration-of-eelgrass/).

Some Swedish North Sea fjords are separated by shallow sills, which restrict water exchange. This can cause complete anoxia in the deep water below the sill depth, with the further release of phosphorus from the bottom sediment producing an internal nutrient input. Pumping surface water to the bottom of the fjord introduces oxygen directly and promotes inflows of oxygenated water from outside the fjord. Phosphorus could again be bound to the bottom sediment, ammonium concentrations reduced and bottom fauna started to recolonise the fjord (Stigebrandt et al, 2014).

'End-of-pipe' mitigation methods are however less effective than improving nutrient management at source for example through more effective agricultural practices. Unlike conventional agricultural mitigation measures, in-situ marine mitigation techniques also fail to improve eutrophication in the associated freshwater ecosystems.

Box 3: Setting nitrogen reduction requirements in river catchments that lead to the achievement of good status with respect to eutrophication in coastal and marine waters

To manage eutrophication in coastal and marine waters Germany has set a management target of 2.8 mg l^{-1} total nitrogen for all individual German rivers (Elbe, Weser, Ems, Eider) entering the North Sea. This value is measured at the limnic-marine border. For the River Rhine that flows through Germany but enters the sea in the Netherlands, the management target is valid at the border between Germany and the Netherlands. The management target is laid down in the German Surface Water Ordinance and is hence legally-binding. If the target is reached, it is assumed that it will enable coastal waters to achieve "good ecological status" according to the WFD and marine waters to achieve "good status" with respect to eutrophication under the MSFD.

To make this target value operational for water managers and in particular to formulate nitrogen reduction requirements for upstream waters the catchment model MONERIS was applied, considering retention. On this basis nitrogen reduction requirements for the whole catchment have been set (Figure B3.1). These are used as a basis for planning measures in the respective WFD River Basins Management Plans. For example, at the limnic-marine border nutrient reduction requirements have been calculated considering freshwater discharge. They range between 30% for the Weser to 48% for the Ems.

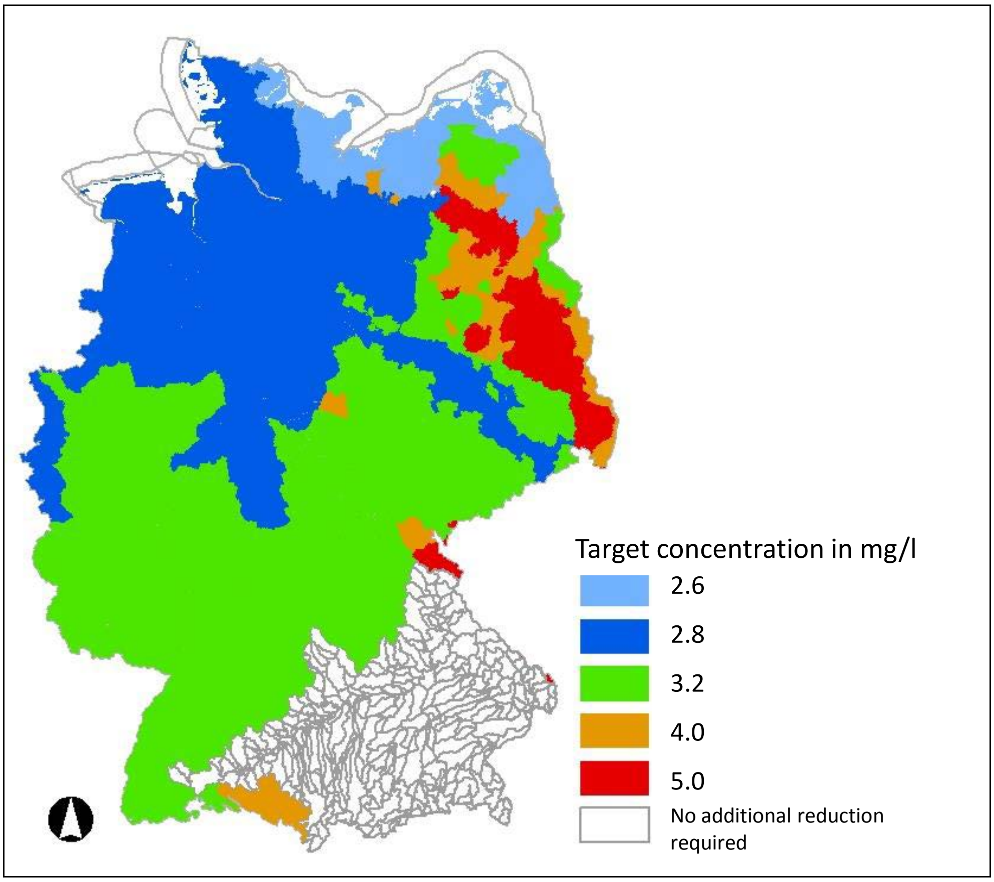


Figure B3.1: *Mean annual target concentration for total nitrogen in mg l^{-1} that is required in the catchments of German rivers to achieve good status with respect to eutrophication in coastal and marine waters of the North Sea and Baltic Sea. In white areas there is no need for a reduction (Danube catchment, for the Black Sea no reduction targets have been set so far). Source: LAWA, 2016*

5 Discussion

5.1 Analysis of national applications of the Comprehensive Procedure

The OSPAR Common Procedure (OSPAR, 2013) provides a framework for Contracting Parties to identify the eutrophication status of the OSPAR Maritime Area. The framework provides the flexibility to take account of differing sensitivity to eutrophication and the selection of relevant parameters in different areas. Following each application of the Common Procedure, the guidance has been developed to improve the degree of harmonisation. Guidance on statistical methods for trend analysis and for confidence rating were developed for this third application.

There are differences in how the nine Contracting Parties have reported the results of their application of the Common Procedure which means that comparing the assessment results is not always straightforward. An example of this is in how assessments carried out under the EU Water Framework Directive have been used, or not, in support of the overall assessment.

The Common Procedure provides guidance on determining assessment areas and, more generally, OSPAR has considered an overall nested approach to setting such areas. There are apparent discrepancies and a lack of clarity on how different Contracting Parties have applied the guidance in arriving at their sub-divisions. While this may reflect differences in the specific waters, sharing of information about the different rationales can form the basis for consideration of further harmonisation.

Most Contracting Parties applying the Comprehensive Procedure have used the Harmonised Assessment Criteria, including criteria (nutrient concentration, chlorophyll, and oxygen) being designated as Primary Criteria for assessment of MSFD Descriptor 5 on eutrophication. Table 3.2 shows which Contracting Party used which harmonised criteria. In carrying out their assessments some Contracting Parties did not use some of the criteria, e.g. nutrient inputs, nutrient concentration, phytoplankton indicator species or oxygen.

Most Contracting Parties have made use of the final step in the Comprehensive Procedure to provide an appraisal of all relevant information, including use of parameters included in the holistic checklist, to come to a final classification of status. Some Contracting Parties did not use this final step. Comparing the different approaches should lead to greater harmonisation and transparency.

There were differences in how Contracting Parties applied the technical guidance on temporal trends and confidence rating. Some Contracting Parties did not report confidence rating. It is becoming apparent that the availability of data from monitoring programmes can affect both the outcome and the quality of the assessments.

To ensure improved comparability between eutrophication assessments further work is needed to refine aspects of the Common Procedure and how it is applied. Lessons in relation to harmonisation can already be learnt from the development of the eutrophication Common Indicators as part of the OSPAR Intermediate Assessment 2017. The further work needs to develop improved clarity on assessment areas, the scope for harmonisation of assessment thresholds (considering experience), and technical guidance on statistical methods for trends and confidence rating. The mutually supporting links to WFD and MSFD requirements need some more coherent thinking.

5.2 Lessons learnt since the first application of the Comprehensive Procedure

In the first application of the Comprehensive Procedure (OSPAR 2003) several fjords, estuaries and coastal areas and some offshore areas were classified as problem areas. This classification was due to increased or significant riverine and/or transboundary nitrogen and phosphorus inputs, and elevated winter concentrations of dissolved inorganic nitrogen and phosphorus, and elevated winter nitrogen/phosphorus ratios. However, the assessment of the direct effects of nutrient enrichment, such as chlorophyll-a, nuisance/toxic phytoplankton eutrophication indicator species and nuisance macrophytes, was not undertaken consistently by Contracting Parties and in a number of cases, information on these direct effects was not available. With regard to assessment of the indirect or other possible effects of nutrient enrichment, the degree of oxygen deficiency was not used and assessed in a similar way by all Contracting Parties. Other indirect effects such as changes/kills in zoobenthos, fish kills, organic carbon and organic matter had not been extensively monitored in conjunction with the direct effect parameters or used to the same extent in this assessment.

In this first application, it became clear that the interpretation of the third step of the Comprehensive Procedure, “the appraisal of all relevant information concerning the harmonised assessment criteria and their respective assessment levels and the supporting environmental factors”, differed between Contracting Parties. It was concluded that this first application of the Comprehensive Procedure by Contracting Parties had therefore produced an assessment and area classification of the eutrophication status of OSPAR marine waters which was reasonably transparent but not totally harmonised. A need for improvements to the assessment and area classification tools and for a common understanding of the way they should be applied and interpreted was identified. This included issues like the derivation of background values for specific parameters, the nature of the classification process, and improved information on atmospheric inputs and the anthropogenic contribution in transboundary nutrient inputs.

The assessment showed deficiencies in the available monitoring data and their quality, particularly for the direct and indirect effect parameters, and a need in some areas to improve the frequency and spatial coverage of the nutrients and eutrophication effects monitoring.

In the second application of the Comprehensive Procedure (OSPAR 2008), it was concluded that eutrophication was still a problem in areas in the Greater North Sea (Region II) and in some small coastal embayments and estuaries within the Celtic Seas (Regions III) and the Bay of Biscay and Iberian Coast (Region IV). Some improvement compared to the first assessment could be observed in the Skagerrak and central North Sea. This was partly related to the emerging consensus that potentially toxic phytoplankton indicator species were not related to eutrophication. Some areas showed improving trends in individual assessment parameters but these trends were not visible in the overall area classification. The improvement of the eutrophication status was largely dependent on reduced anthropogenic inputs of nitrogen and phosphorus into affected areas. In the period 1985–2005, most Contracting Parties achieved reductions in discharges, emissions and losses of phosphorus by 50% compared to input levels in 1985. Modelling studies estimated that nutrient input reductions beyond the current objective of the Eutrophication Strategy of 50% in relation to input levels in 1985 will be needed to convert all problem areas into non-problem areas. Modelling tools were developed to calculate nutrient dynamics and their transport across boundaries, including the tracking of specific nutrients from specific rivers through the nutrient cycle to calculate the proportions of the nutrient budget in defined areas originating from specific rivers.

The second application showed a further refinement and harmonisation of the Comprehensive Procedure across OSPAR Contracting Parties. It was recognised that the Common Procedure closely relates to the eutrophication assessment in the context of EU water policies, such as the Water Framework Directive and the Marine Strategy Framework Directive.

In this third application of the Comprehensive Procedure, some trends already observed in the second Comprehensive Procedure have continued. While eutrophication is still a problem in areas in the Greater North Sea (Region II), the Celtic Seas (Regions III) and the Bay of Biscay and Iberian Coast (Region IV), slight improvements in eutrophication status have been observed, particularly in outer coastal and offshore waters. Assessment methods have again been adapted as a consequence of improved understanding of the relations between elevated nutrient inputs and direct and indirect effects. The decline of sugar kelp in the Skagerrak, which was seen as a sign of eutrophication in the second Comprehensive Procedure, is now no longer considered a primary indicator for eutrophication. Adaptations of the assessment areas, often aligning with the water bodies defined under the Water Framework Directive, has led to a further refinement of the spatial scale of assessments, and to a harmonisation of the results of the Comprehensive Procedure with the assessment under the Water Framework Directive.

5.2.1 Experience with the common indicators

The common indicator assessments are intended to be used as the basis of the OSPAR Intermediate Assessment 2017. Drafts of the common indicator assessments are being finalised, and describe nutrient inputs and the concentrations of nutrients, chlorophyll, *Phaeocystis* and oxygen. The intermediate results of the assessments with the common indicators focus on the Greater North Sea (Region II) and to some extent (nutrient inputs, oxygen concentrations) on OSPAR Regions III (Celtic Sea) and IV (Bay of Biscay and Iberian Coast).

The common indicators generally have been applied at a relatively large spatial scale that encompasses several assessment areas from various Contracting Parties. Consequently, the common indicators show trends that are in line with the results from the national applications of the Comprehensive Procedure, but do not yet reflect the changes in eutrophication status that have been observed for some assessment areas.

5.2.2 Experience of the Comprehensive Procedure

Following their third national applications of the Comprehensive Procedure, Contracting Parties discussed issues and questions they had encountered as summarised in Table 5.1. This information could be used to inform improvements to future applications of the Common Procedure.

Table 5.1*: Issues identified by Contracting Parties during their third national applications of the Comprehensive Procedure*

Description of issue
Application of Comprehensive Procedure & link with common indicators
Comprehensive Procedure requires data to be assessed per year and then summarised across the assessment period; risks assessment results being based on small datasets.
The Comprehensive Procedure is resource-intensive and its application is open to interpretation.
Some areas may not be achieving non-problem area status, but are improving due to management measures. Such improvements are not recognised in the Comprehensive Procedure.
Assessment levels for some parameters differ nationally, resulting in contrasting classification of eutrophication status of regional waters either side of national boundaries. Differential implementation of measures can result.
The relationship between national Comprehensive Procedure and the regionally-assessed common indicators for

Description of issue
eutrophication is unclear. Confidence rating has not been widely reported by Contracting Parties in their national applications of the Comprehensive Procedure. Not all Contracting Parties assess nutrient budgets and related parameters that enable other Contracting Parties to assess trans-boundary nutrient transport.
Harmonisation with EU Directives
Disparity between the Common Procedure of OSPAR and eutrophication assessments of European Directives, e.g. assessment of coastal waters under the WFD. Different definitions of ‘inshore’, ‘coastal’ and ‘offshore’ waters in the Common Procedure compared with the Water Framework Directive
Data and analytical processes
Incomplete datasets or inaccurately submitted data to ICES DOME. Possibility of auto-correlation in continuous high-frequency data e.g. from sensors on fixed moorings or ferry-boxes. Insufficient monitoring data for some areas. The contribution of the atmospheric nitrogen and phosphorus deposition cannot be quantified at the scale of the Greater North Sea.

5.2.3 Joint Monitoring Programme North Sea/Celtic Sea – Chlorophyll case study

The final judgement under the Comprehensive Procedure (eutrophication status) enables comparison between countries. Across national borders however, discontinuities appear. This is caused by differences in the analytical methods used for the determination of chlorophyll-a. In fact there is a relative big difference in the precision in which chlorophyll-a is measured.

Other sources of differences between countries are the sampling designs and choice of the natural background value and the yearly calculation of the concentration representing the growing season, i.e. mean value or 90% percentile.

Currently, monitoring is organised country by country, using in-situ measurements from ships and taking account of the eutrophication assessment areas. Since chlorophyll is a highly variable parameter, both spatially and temporally, the monitoring programs are relatively intensive i.e. approximately biweekly during the growing season (March-October). Countries with large marine areas (the United Kingdom) cannot support such intensity and measure part of their waters outside the growing season or measure locations randomised. The sampling method as such is comparable between countries. With regard to sampling techniques there is no barrier for joint monitoring based on ship surveys.

The same is true for chlorophyll data from remote sensing (RS) by satellites. Such techniques have a large advantage over dedicated ship surveys: enhanced temporal and spatial coverage. Satellites make snapshots of the whole North Sea with a daily or near daily coverage, using a 1km^2 grid. This would be impossible by using in-situ water sampling. Gaps due to cloud cover can be corrected using algorithms that interpolate in space and time. An additional advantage is that satellite data can be used to focus in-situ sampling campaigns. A comparison of RS and ship based monitoring in French coastal waters (WFD) shows that eutrophication assessment based on RS monitoring is reliable and makes the assessment of eutrophication much easier. Dutch analyses of historic time series (covering the whole North Sea) reveal that increased spatial and temporal coverage by remote sensing leads to more stable estimates: year-to-year variations and uncertainties in the region-wise characteristics are smaller compared to the in-situ monitoring.

These differences and issues listed above are being addressed by the project "**Joint Monitoring Programme of the EUtrophication of the NOrth-Sea with SATellite data (JMP EUNOSAT)**", which started in 2017.

It aims at coherent and cost effective good environmental status (GES) assessments for eutrophication in the Greater North Sea and to:

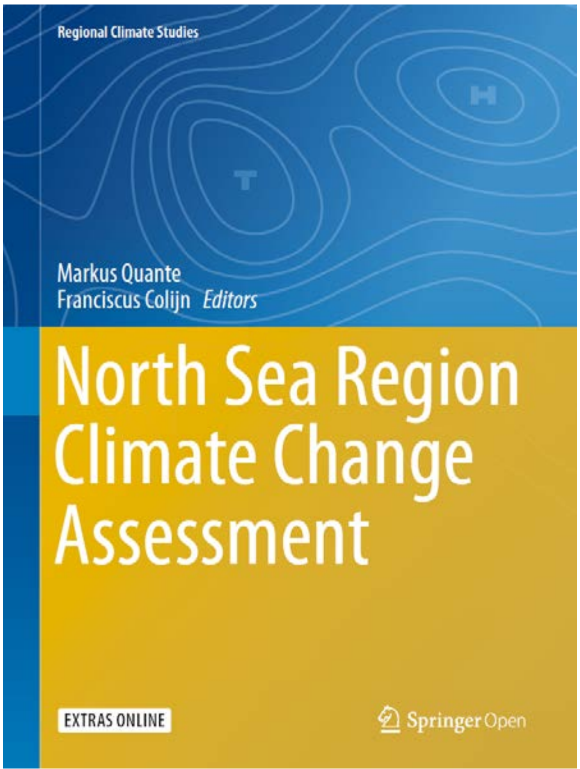
1. enhance coherence in GES determinations for chlorophyll across North Sea countries and between WFD and MSFD,
2. enhance coherence in eutrophication assessments based on chlorophyll, using satellite data,
3. organise North Sea wide operational collaboration.

5.3 Outlook – climate change

This description of the expected impacts of climate change is based almost entirely on the recent North Sea Region Climate Change Assessment (Quante and Colijn, 2016), the most complete description of the current knowledge on North Sea climate impacts presently available. For the references to the original studies, readers are referred to this assessment.

While there is reasonable consensus about the expected large-scale physical changes, there remain major uncertainties in understanding what they mean for the ecosystem response. Coupled catchment – ocean model studies based on realistic socio-economic scenarios of nutrient losses and emissions are completely lacking, while the difficulty in explaining the divergence of results coming from existing biogeochemical models indicates a need for more work with these tools before such a study would be worthwhile.

While climate change will affect the marine ecosystem in perhaps unforeseen ways, nutrient management on land remains fundamental to marine eutrophication management, even in a changing climate.



5.3.1 *The NOSCCA assessment*

Global climate change assessments produced regularly by the UN Intergovernmental Panel on Climate Change provide a broad scale description of the likely climate change and impacts resulting from a variety of possible emission scenarios. However, global analyses lack regional and national detail that decision-makers need. This has led to a number of regional climate assessments. The North Sea Region Climate Change Assessment started in 2010 and was published in 2016. This work has collated peer-reviewed research, conference proceedings and government reports concerning climate-related changes in the North Sea region. It identified areas of consensus, but also of uncertainty and knowledge gaps. The assessment has covered climate impacts on the atmospheric, terrestrial, hydrological and marine environments and included changes to the physical environment, ecosystem and societal responses across the entire Greater North Sea. The NOSCCA report is freely available.

5.3.1.1 Temperature

Changing air temperatures will lead to changes in heat budgets in the sea, but also to in changes to land use and run-off patterns. Changes in the land-sea temperature difference affect the intensity of sea breezes, which will affect the intensity of coastal mixing in the summer. Studies of the instrumental record over the past 200 years show clear increases in temperatures over land. In recent decades, the warming trend has been greater than that predicted by climate models, with the excess warming attributed to atmospheric changes, particularly in winter and spring. The number of frost days has decreased and the length of summer has increased.

Ensemble analyses, using a range of models suggest mean annual warming of between 1.7 and 3.2°C by 2100, depending upon the emissions scenario assumed. Strongest warming is expected to occur in eastern Scandinavia in winter (3–4°C increase) and in the south of the North Sea catchment in the summer (2–3°C). Winter atmospheric warming over the North Sea is not expected to exceed 2°C. The most extreme scenario, assuming a continued increase in emissions (RCP8.5) suggested a 4.5°C (summer) - 6.1°C (winter) increase across northern Europe. In terms of extremes, heat waves and warm spells are expected to increase most in the south, with smaller changes in northern Europe and little change in Scandinavia.

By 2100, greatest warming will occur in the surface water during summer months, when seasonal stratification reduces vertical mixing, with most warming seen in the southern parts. However, these results are not reproduced by all models. Many models indicate that summer stratification will start earlier and extend longer into the autumn, except in those models which emphasise winter warming: as winter water becomes the bottom water after the onset of stratification, warmer winter water results in smaller vertical temperature gradients than if the winter water warms less.

5.3.1.2 Wind stress and storminess

Increasing wind stress increases the energy available for mixing in the sea, but can also change nutrient uptake patterns on land due to, for example, changes in forest growth profiles resulting from storm damage. Longer calm periods, and the associated temperature increases in surface waters over the sea in late summer would be associated with increased hypoxia, as bottom water is not renewed by advection or vertical mixing. Studies looking at changes in mean wind speed appear to predict increases, which would shorten the stratification period but further studies showed that model resolution could influence this result.

5.3.1.3 Precipitation

Changes in precipitation affect land-use and run-off. In particular, storm events are associated with nutrient pulses to the coastal zone and corresponding algal bloom events. Atmospheric nitrogen deposition is also strongly linked to precipitation events. Intensified rainfall is expected in a warmer climate. Annual land precipitation has increased almost everywhere in the North Sea region since the 1950s (period 1951 – 2012) with the largest increases found in winter in Belgium, the Netherlands, western Norway and southern Sweden. Extreme precipitation events in winter and spring appear to increase in frequency, though there appears to be uncertainty connected to the period analysed and the statistical model used to generate the extremes.

The proportion of precipitation falling as snow and the length of the snow period is expected to decrease. A reduction in snow-melt will affect the distribution of the winter discharge maximum and therefore nutrient inputs.

5.3.2 Changes in the catchment

5.3.2.1 Changes in run-off patterns

Nutrient inputs to the North Sea come mainly via the region's rivers, and mainly during periods of high flow, such as during the spring flood. Changes in run-off patterns will influence eutrophication in the North Sea.

The Greater North Sea receives fresh water from a multitude of catchments extending from the relatively warm, maritime west to the northern Alps and the Norwegian mountains. Climate change is expected to affect precipitation in these regions differently both spatially and temporally. A change towards warmer winters is expected to reduce winter storage of water on land as snow, spreading the spring flood period across a longer period. In addition, glacial run-off is expected to increase both in duration and volume.

Analyses of the long time series available from the major rivers suggest an increase in winter flow, but no increase in summer. Records are however highly variable, and increased precipitation may be balanced to a certain degree by increased evaporation, resulting in only small changes in flow. Also, engineering changes in the catchment, for example coupled to urbanisation, canalisation and water extraction may change the nature of both peak and low flows.

Increasing turn-over of organic material in soils due to higher temperatures, coupled to increased rainfall, can result in increased nutrient losses if resource management does not keep pace with the changing climate. Studies connecting socio-economic and agricultural scenarios in the catchment to nutrient inputs at the coast are lacking.

5.3.3 Changes in the physical/chemical marine environment

Model predictions indicate an expected freshening of the North Sea, due to changes both in the regional hydrological cycle and in the North Atlantic.

Estimates of changing transport patterns are rare, due to the differences in model results. The studies presented however indicated a weakening of the inflow from the English Channel and an increase in input from the North Atlantic.

5.3.3.1 Acidification

Global ocean acidification as a result of enhanced atmospheric carbon dioxide levels has been identified as a major threat to ecosystem health – particularly for shell- and skeleton-building organisms. Regionally, ocean acidification is closely related to eutrophication as both affect dissolved inorganic carbon (DIC) and total alkalinity. With mild eutrophication and excess availability of oxygen, organic matter respiration releases DIC leading to lower pH. With a shortage of oxygen (which could be due to stratification, more intense eutrophication or within the bottom sediment) denitrification causes the conversion of nitrate to nitrogen gas and a relative release of alkalinity together with the DIC. Increasing alkalinity increases the CO_2 and pH buffering capacity of the sea and thus reduces the response to acidification. Measures to reduce eutrophication therefore increase vulnerability to acidification.

Temperature and salinity changes also impact on acidification: uptake of atmospheric CO_2 (and resulting acidification) is reduced at higher temperatures, but an increased partial pressure of CO_2 in the atmosphere or a decrease in salinity increases the net uptake of atmospheric CO_2.

5.3.3.2 Oxygen concentrations

The capacity of seawater (oxygen saturation) to hold oxygen is a function of temperature and salinity. At higher temperatures, and to a lesser degree higher salinities, seawater reaches saturation with a lower oxygen concentration. Therefore a smaller amount of oxygen is available for biogeochemical processes such as respiration, and the risk of hypoxia increases. Despite this, the direct effect of increased temperature is unlikely to have a significant impact on the incidence of hypoxia. Instead, secondary effects, such as stronger thermal stratification or reduced bottom water volume (due to a deeper thermocline) are likely to increase the incidence of hypoxic events. In coastal waters, stronger salinity stratification due to increased run-off may have a similar effect. Where tidal influence is limited, as in the Kattegat and Skagerrak, horizontal advection in the bottom water is important for replenishing oxygen levels. Blocking weather systems may reduce this horizontal advection, as happened in 2002, which led to severe seasonal hypoxia throughout the southern Kattegat and Belt Seas (Ærtebjerg et al, 2003). Increased organic carbon inputs from land, as well as marine eutrophication, increase oxygen consumption, as can sediment and organic matter resuspension as a result of bottom disturbances such as dredging and trawling.

Areas of the central North Sea vulnerable to hypoxia include the Oyster Grounds and areas off the Danish west coast. Model studies suggest that strengthening stratification around the Oyster Grounds, rather than direct temperature effects on oxygen solubility or increased respiration rates, explain the low oxygen concentrations recently observed. Figure 5.1 summarises the findings of five studies reviewed in the NOSCCA analysis. Climate effects on dissolved oxygen concentrations are uncertain (Figure 5.1).

Study	Storyline / Findings	Consequences on Oxygen	Impact
Lowe et al., 2009 Meire et al., 2013	Earlier onset and increased intensity of stratification	Lower ventilation	
Weston et al. 2008	General increase in water temperature	Reduce solubility of oxygen increased bacterial metabolism	
Gröger et al., 2013	Reduced winter nutrient import by Atlantic	Reduced NetPP by 30 % followed by reduced organic matter export	
Mathis et al. 2015	Higher increase in winter temperature vs. summer	Decrease in stratification/ ventilation Reduced solubility/increased metabol.	

Figure 5.1*: Summary and explanation of predictions of North Sea oxygen concentration as a result of climate change*

5.3.4 Biological response

Model estimates of long term changes in primary production are hampered by the lack of realistic scenarios of nutrient input from the catchment. In general however, net primary production is expected to decrease, due to reduced DIN inputs from the North Atlantic. The impact of local changes in stratification is less important. Decreases in net primary productivity were in the range 2–30%. Greatest decreases were predicted for the northern North Sea, while the south may even see an increase. Differences in model predictions may be due to problems in modelling temperature impacts on metabolic rates, or on cross shelf nutrient supply. Changes in DIN inputs from the North Atlantic were considered to be of greatest importance for the offshore North Sea, while freshwater nutrient inputs affected coastal waters. Analysis of biological data suggests that increased temperature and transparency have led to increased primary production in the southern North Sea, which has reached a peak. Future increases in primary productivity may however come further north.

Model predictions suggest an increase in dinoflagellates with a longer growing season and earlier spring bloom. This result does not appear to be supported however by reports of changes in phytoplankton community structure since the 1960s, where dinoflagellate abundance has decreased, even as species diversity increased. Increased stratification is thought to promote a shift from diatoms to coccolithophorids, which have increased in the North Sea.

Zooplankton studies indicate a shift towards smaller copepods at warmer temperatures, while time series from the Skagerrak also show an increase in jellyfish abundance. Studies of planktonic larvae also suggest that temperature increases are favouring benthic decapods against molluscs. These changes in benthic fauna need to be considered when understanding ecosystem response to eutrophication.

5.3.5 Summary

While there is reasonable consensus about the expected large scale physical changes, there remain major uncertainties in understanding what they mean for the ecosystem response. Coupled catchment – ocean model studies based on realistic socio-economic scenarios of nutrient losses and emissions are lacking, while the difficulty in explaining the divergence of results coming from existing biogeochemical models indicates a need for more work with these tools before such a study would be worthwhile.

While climate change will affect the marine ecosystem in perhaps unforeseen ways, nutrient management on land remains possible, even in a changing climate.

Box 4: Fisheries, habitat loss and eutrophication

Coastal habitats are exposed to a range of pressures from human activities: habitat and spawning ground loss occurs due to coastal construction; fishing pressure involves selective species removal while coastal waters are a recipient for nutrients and other pollutants.

The classical model of nutrient pollution states that increased nutrient inputs increase algal production including the increasing growth of filamentous algae. Increased algal growth increases turbidity, shading deeper living, perennial, habitat-forming species, such as *Fucus* spp. on hard bottoms and eelgrass on soft. When algae decay in the autumn, the resulting drop in oxygen levels harms fish and burrowing macrofauna, reducing oxygen penetration into bottom sediment.

While the classical model appears robust, recent studies show that declines in predatory fish cause symptoms similar to eutrophication. Loss of predatory fish such as cod allows mesopredators to flourish. Increases in mesopredators such as sprat or crabs increases pressure on grazers such as pelagic zooplankton or gastropods. These become less effective at grazing down phytoplankton or filamentous algae, which then grow unchecked (Figure B4.1).

In lake ecosystems, managing fish stocks is an established restoration technique. It is commonly applied when external nutrient inputs have been reduced without a corresponding decrease in algal biomass. In these cases, an excess of mesopredators maintains the lake in a stable, eutrophic state. In lakes, removal of roach and bream can turn a turbid, eutrophic lake into a clear, oligotrophic system. These results are not always sustainable over the long term, however (MISTRA EviEM, 2013) – possibly due to poor estimates of sustainable nutrient inputs, or due to poor understanding of the lake ecosystem.

The Swedish Agency for Marine and Water Management and the Swedish Research Council Formas recently funded a meta-analysis of algal response to North Atlantic ecosystem (Östman et al, 2016). It shows (Figure B4.2) that nutrient inputs and mesopredators were equally important factors increasing ephemeral macroalgae biomass – a typical eutrophication symptom. Mesograzers and piscivores were connected to biomass reductions.

These results indicate that to be effective and efficient, eutrophication management needs to be part of wider ecosystem management. Grazers such as amphipods have been affected by releases of hazardous substances, particularly organotins. Piscivores have been reduced through fishing, habitat loss and climate change. A holistic approach to marine management offers the most cost effective solution to both marine eutrophication and fisheries problems.

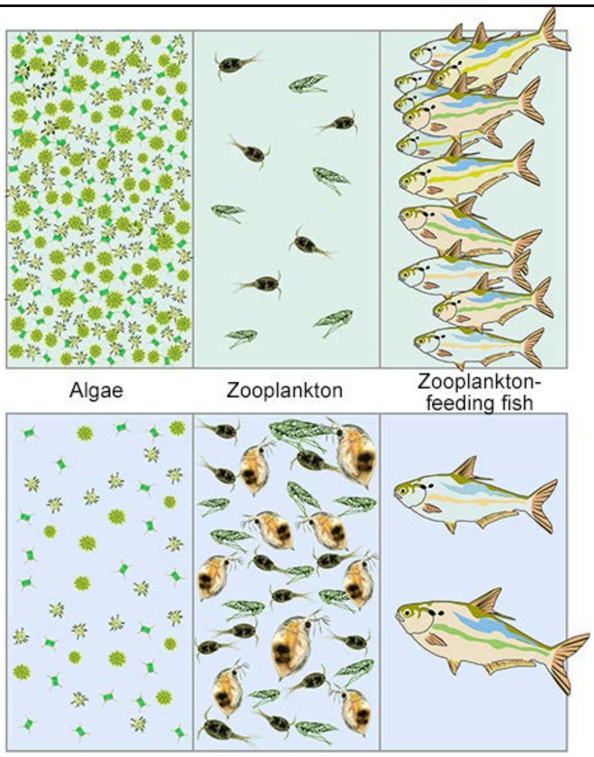


Figure B4.1*: A mesopredator dominated ecosystem (top) contrasted with a system with few mesopredators (bottom) (image from [http://www.eviem.se/en/projects/Can-removal-of-planktivorous-fish-improve-the-water-quality-of-eutrophic-lakes/.](http://www.eviem.se/en/projects/Can-removal-of-planktivorous-fish-improve-the-water-quality-of-eutrophic-lakes/) Anthony Thorpe, Lakes of Missouri Volunteer Program)*

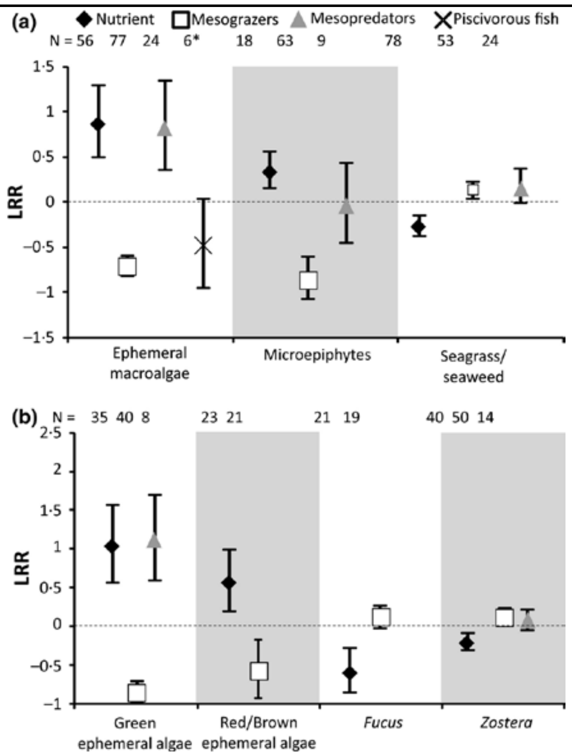


Figure B4.2*: Log response functions of drivers (nutrients, mesograzers, mesopredators and piscivores) on the production of various algal / plant types (from Östman et al, 2016)*

6 Conclusions and Recommendations

6.1 What is the eutrophication status?

Contracting Parties concluded on the status of their waters in terms of problem, potential problem and non-problem areas (Figure 1) through a third application of the Common Procedure. Of the assessed area, 91% has non-problem area status, 2% potential problem area status and 7% problem area status. In general many inshore waters, some coastal waters and a few larger scale offshore waters are still assessed as problem areas. Compared with the results from the second application of the Common Procedure there are more offshore areas are classified as non-problem. For example: the offshore area of Belgium has changed from potential problem area to non-problem area; the most offshore part of Germany's assessed area has changed from potential problem area to non-problem area, and; offshore waters of Denmark have changed from potential problem area to non-problem area (Figures 4.1 and 4.16).

Furthermore, some of the remaining problem areas show trends in a good direction with respect to minimising eutrophication, but these trends have not yet resulted in a change of classification.

6.2 What was the experience of Contracting Parties applying the Common Procedure?

The national reports provide an overview of how the Common Procedure has been applied by Belgium, Denmark, France, Germany, Ireland, the Netherlands, Norway, Sweden and the United Kingdom.

Following the second application, the Common Procedure was revised, taking account of Contracting Parties' experience and this has resulted in a more harmonised approach in the assessment process. Some differences still exist which may limit comparability of classification results to inform regionally coordinated measures to combat eutrophication and to assess their effectiveness. The experience of Contracting Parties in their third application of the Comprehensive Procedure indicates a need for continued development of assessment methods to support Contracting Parties that are EU Member States in implementing the Marine Strategy Framework Directive (Descriptor 5) taking account of the requirements of the revised Commission Decision (EU, 2017), the revised MSFD Annex III, and MSFD Article 8 Guidance. Further work is also required on how assessments, relating to eutrophication carried out for the Water Framework Directive (2000/60/EC) (WFD CIS Guidance 23; EC, 2009) are linked coherently to the Common Procedure.

6.3 What needs to be improved?

The Common Procedure has been applied successfully three times to the OSPAR Maritime Area. Each application has resulted in lessons learnt and in refinement of the assessment procedure to ensure greater coherence and harmonisation. This experience is described in section 5.2.2, including an identification of proposed improvements following the third application.

The issues identified for further work fall into three categories (Table 5.1):

- application of the Comprehensive Procedure and link with the OSPAR common indicators;
- harmonisation with EU Directives (including WFD and MSFD);
- data and analytical processes.

Ongoing research and development work in the field of marine eutrophication can be better used to inform developments in our monitoring and assessment methods. It is intended to draw on the outcome of the Joint Monitoring Programme for the North Sea and Celtic Sea (JMP, PP/ENV D2/SEA) and the JMP EUNOSAT (section 5.2.3) projects, which have been developed to support OSPAR and European Union activities.

It is considered that the process entailed in the Common Procedure needs to be made more efficient and consideration will be given to better automation of the assessment through improved use of digital tools.

6.4 What is the policy message?

The overall goal of the OSPAR Eutrophication Strategy is "to achieve and maintain a healthy marine environment where eutrophication does not occur". This objective has been partially achieved but eutrophication problems persist in a number of areas. A further application of the Comprehensive Procedure will be necessary to enable OSPAR to assess the effectiveness of nutrient reduction measures and whether the overall goal of the Eutrophication Strategy has been achieved by 2020.

The main result of the third application of the Comprehensive Procedure is that Contracting Parties concluded that several of their coastal areas (including fjords and estuaries) and some offshore areas are identified as problem areas or potential problem areas, while a number of offshore areas are classified as non-problem areas. Compared with the results of the previous applications of the Comprehensive Procedure some areas show improving trends in the assessment parameters.

Extensive nutrient reduction measures have been put in place to prevent eutrophication. It must also be noted that measures to reduce nutrient inputs from point as well as agricultural and other diffuse sources have in many cases been taken later than envisaged under OSPAR and/or relevant EU legislation. Under the relevant EU regimes measures are ongoing or in preparation and there will be further measures in place. There is a time lag that can be observed between putting measures in place and a positive response from the marine ecosystem which may take many years. However, nutrient reduction measures have been shown to produce immediate reductions in nutrient concentrations and the direct effects of eutrophication in some estuaries and coastal areas. There is, therefore, good science-based evidence that such measures are effective in combatting eutrophication. In other areas, there are improving trends where achieving non-problem area status may be foreseen given time. These experiences should be used to design and apply the most effective measures for the different problem areas as early as possible.

Further efforts are necessary to completely achieve the objective of the Eutrophication Strategy. Modelling studies estimate that reductions in nutrient inputs to problem areas larger than the agreed 50% nutrient reduction target will be needed to convert all remaining problem areas into non-problem areas.

The Common Procedure forms a good international operational tool for the assessment of the eutrophication status of the North-East Atlantic and a useful instrument for addressing the requirements of the Marine Strategy Framework Directive (2008/56/EC), but some aspects still need further development (list of key issues from 6.3, including assessment levels). The Comprehensive Procedure should be adapted, where necessary, to support Contracting Parties in meeting the requirements of the MSFD and taking account of the requirements of the revised Commission Decision (EU, 2017), the revised MSFD Annex III, and MSFD Article 8 Guidance. Further work is also required on synchronisation and harmonisation with the Water Framework Directive (2000/60/EC).

This third OSPAR Integrated Report on the Eutrophication Status of the OSPAR Maritime Area contributes to the OSPAR Intermediate Assessment 2017, which may inform Contracting Parties' update to the 'initial assessment' required under the Marine Strategy Framework Directive in 2018.

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Annex 1 Summaries of national assessments

The first application of the Comprehensive Procedure of the Common Procedure (OSPAR, 2003a) identified a considerable number of problem areas and potential problem areas with regard to eutrophication in the OSPAR Maritime Area. Five years on, Contracting Parties applied the Comprehensive Procedure (OSPAR, 2005a) for a second time for the period 2001–2005 to reassess the status of areas identified as problem or potential problem areas with regard to eutrophication, or non-problem area where there were grounds for concern that there had been a substantial increase in the anthropogenic nutrient input. The Comprehensive Procedure was applied by Contracting Parties for a third time in 2016, for the period 2006–2014.

In the following sections national summaries of the national assessments are given. The full national reports (Table A1.1) are available from https://www.ospar.org/work-areas/hasec/eutrophication/common-procedure, under "Third application of the Common Procedure national reports".

***Table A1.1**: National assessment reports*

Contracting Party		**National assessment reports**
1	Belgium	Report on the third application of the OSPAR Comprehensive Procedure to the Belgian marine waters
2	Denmark	Eutrophication in the Danish parts of the North Sea, Skagerrak and Kattegat 2006-2014. A literature-based status assessment
3	France	Third Application of the Comprehensive Procedure (COMP3) to determine eutrophication status of OSPAR marine waters. French national report
4	Germany	3rd Assessment of the eutrophication status of German coastal and marine waters 2006 – 2014 in the North Sea, according to the OSPAR Comprehensive Procedure
5	Ireland	National Eutrophication Assessment Report under the Common Procedure. Ireland
6	Netherlands	Report on the third application of the OSPAR Comprehensive Procedure to the Dutch marine waters
7	Norway	Eutrophication status for Norwegian waters. National report for the third application of OSPAR's Common Procedure
8	Sweden	Swedish National Report on Eutrophication Status in the Skagerrak, Kattegat and the Sound. OSPAR Assessment 2016
9	United Kingdom	Common Procedure for the identification of the eutrophication status of the UK maritime area.

1. Belgium

1.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

The Belgian coastal zone, the most sensitive part of the Belgian Continental Shelf (BCS) is still characterised as 'problem area'. Offshore, the area has been classified as 'non-problem area'. For the coastal waters, this assessment is in accordance with the second Comprehensive Procedure (2001-2005) in which elevated nutrient and chlorophyll-a concentrations were reported. In general, problems appear near the coast where riverine nutrient inputs have the strongest influence. The second Comprehensive Procedure classified the offshore area as 'potential problem area'. The current change of status of the offshore area is mainly due to an improved assessment of the direct effects in that area.

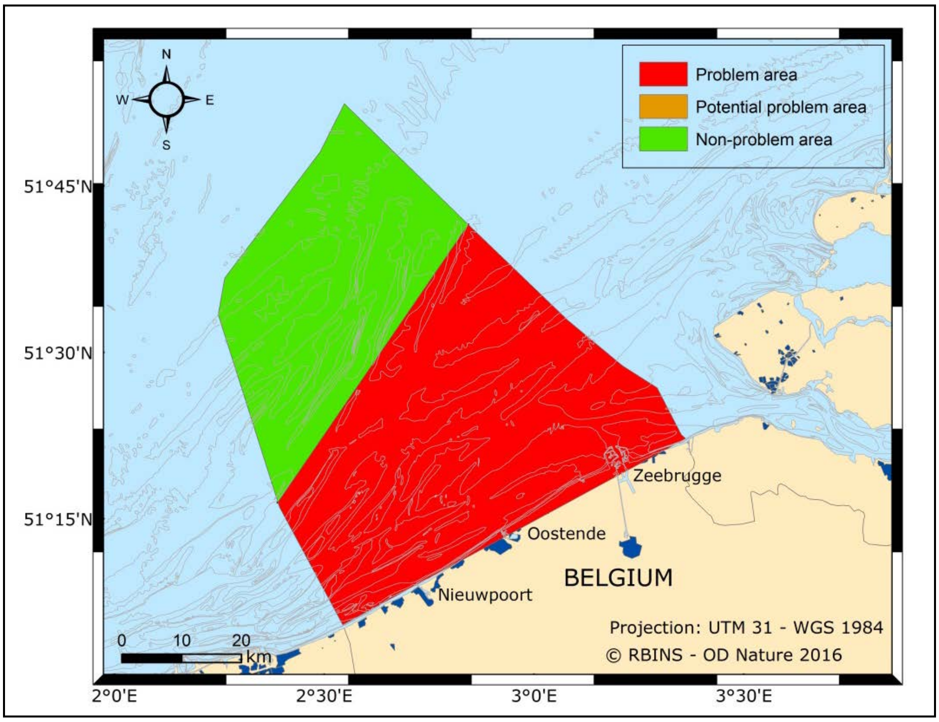

***Figure A1.1**: Classification of Belgian marine waters*

The reported riverine nutrient inputs consist in the Belgian contribution to the Scheldt nutrient inputs near the Belgian-Dutch border and in other small Belgian rivers and channels. After the wet years 2001 and 2002, a decrease in annual nutrient inputs could be noticed in Belgian rivers, followed by oscillations since 2005 mainly related to changes in water discharge. A lower mean annual input of total nitrogen and total phosphorus for the period 2006–2014 is reported compared to the previous reporting period. However, the winter nutrient concentrations in the BCS at salinity 33.5 remain high. The decreasing trend in DIN and DIP observed since the '90s halted and was followed by yearly oscillations during the last decade. Winter DIP shows oscillations slightly above the threshold. The DIN/DIP ratio stabilises around 32-33 without a significant trend over the whole period. In the offshore waters, winter DIN, DIP and DIN/DIP ratios do not show elevated levels.

The chlorophyll-a 90 percentile (CHL-P90) is elevated in the major part of the coastal waters, more or less corresponding to the area within a distance of 12 nautical miles from the coastline. The percentage surface of the BCP that shows elevated levels of CHL-P90 also features high interannual variabilities and does not reveal any significant trend. The 6-year averages, limited in time to 2011, show an increase that seems to be linked to hydrometeorological variability. The offshore waters do not show an elevated chlorophyll-a level on the classified satellite-observed CHL-P90 map calculated over 6 years.

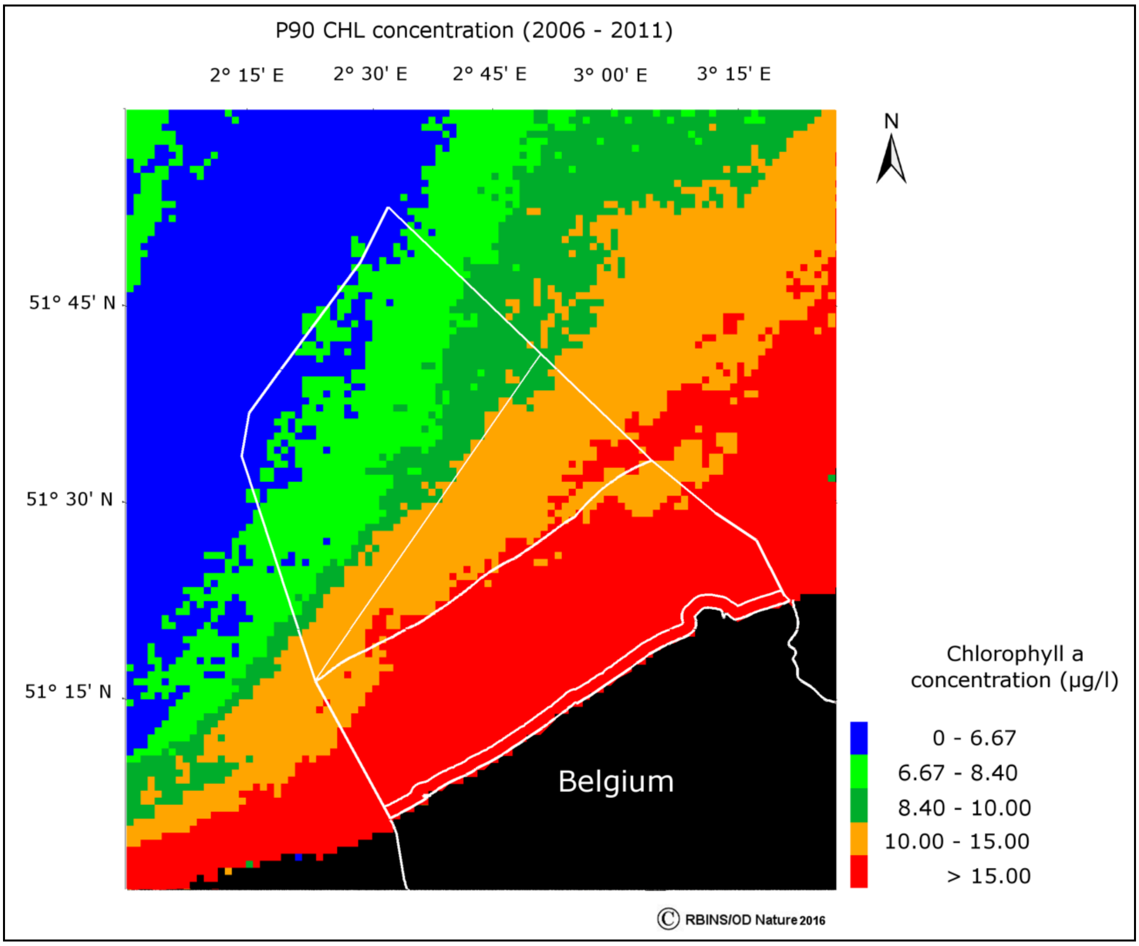

***Figure A1.2**: 2011 for the Belgian Continental Shelf (red: > 15 µg l^{-1})*

Generally no problems with oxygen deficiency occur in the BCS due to the prevailing hydrodynamic conditions ensuring continuous oxygen replenishment. No zoobenthos or fish kills have been observed.

Although nutrient inputs are lower than during the previous assessment period, the situation at sea has not significantly improved. A significant reduction in nutrients is needed to reach the status of non-problem area in the receiving coastal zone. The amount has been quantified by a large-scale modelling study (EMoSEM). Based on different nutrient reduction scenarios, it has been concluded that an in-depth change in the agro-food systems will be needed to reach any significant mitigation in coastal eutrophication. Due to the trans-boundary origin of nutrients in coastal basins, an international collaboration is likely to be needed to tackle the problem of national eutrophication in Belgium and adjacent countries.

1.2 Description of area

The Belgian part of the North Sea with a surface of about 3500 km2 shows water depths of less than 20 m near the coast increasing till 45 m offshore. The area is characterised by the presence of sandbanks, strong tidal currents (often more than 1m s^{-1}), wind driven currents and a high turbidity. The shallow waters combined with strong currents assure a continuously mixed water column. The water masses that impact this region originate from the English Channel and different rivers with, as most important contributors, the Scheldt and the Rhine-Meuse, and to a lesser extent the Seine. These water inputs also contribute to significant cross-border nutrient inputs in the Belgian waters, increasing the winter N concentrations and, hence, the N content of phytoplankton (mean 2000-2010 winter DIN contributions in the coastal area are 28% from the Scheldt, 17% from the Rhine-Meuse, 9% from the Seine, 27% from the Atlantic and 19% from the atmospheric deposition).

The coastal waters show a strong coastal-offshore gradient in salinity. In accordance with the OSPAR recommendation and the previous assessment, two subareas, the coastal and offshore zone, are defined in the BCP separated by the 34.5 isoline of salinity.

1.3 Assessment procedure

The current assessment is based on riverine total nitrogen and phosphorus inputs, winter DIN and DIP concentrations, N/P ratio and CHL-P90. The high temporal frequency of satellite-observed chlorophyll-a leads to more accurate estimates of the 90 percentile. Besides, oxygen measurements and a 3-year dataset of *Phaeocystis* abundance have been taken into account. The criteria regarding macrophytes, organic carbon/organic matter and algal toxins are not used. Changes/kills in zoobenthos and fish kills are evaluated based on general observational basis for occurrence of acute mortality. However, sufficient data regarding nutrient enrichment, measured at 10 monitoring stations distributed over the BCS, and phytoplankton biomass, consisting of validated, high frequency satellite-observed chlorophyll-a, are available for a reliable assessment of the eutrophication status in the BCS. Evaluation methods and thresholds of nutrients and chlorophyll-a applicable to the coastal area are in accordance with the targets defined within Water Framework Directive and Marine Strategy Framework Directive. Nutrient concentrations at salinity 33.5 are well correlated with satellite-born CHL-P90 along the coastal-offshore gradient. The surface of high chlorophyll-a areas can be estimated by remote sensing. The 6-years averaged evolution of the surface of these areas is considered to be an objective indicator of the eutrophication trend. The elevated levels for nutrients have been evaluated and redefined for DIN and N/P ratio based on a recent research project providing information on concentrations in pristine situation.

1.4 Improving future assessments

Future assessments will benefit further from the satellite-born chlorophyll-a products. With the new generation of satellites, an improvement of the spatial resolution is expected as well as continuous data collection. Undesirable species, like e.g. *Phaeocystis*, is defined as an additional target to be followed when the situation improves. Information on the presence of undesirable species would further complete future assessment. An improvement and alignment of the assessment methods for undesirable species used in the frame of OSPAR and Water Framework Directive is recommended.

2. Denmark

2.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

The overall conclusions from the third application of the Comprehensive Procedure are the same as those of the second application: all coastal waters as well as the open parts of the Kattegat are classified as Problem Areas, while most of the open parts of the North Sea and Skagerrak are Non-Problem Areas (Figure A2.1). A significant improvement compared to the first and second applications of the Comprehensive Procedure is documented for the open parts of the North Sea (Table A2.1). The extent of the Problem Area has decreased due to two factors. Firstly because of reduced nutrient inputs to the south-eastern North Sea, especially to the German Bight and secondly due to improvement in assessment methodology, i.e. the use of satellite-based observations for delineation of the boundary between the coastal Problem Area along the west coast of the Jutland peninsula and the Non-Problem Area in the offshore parts of the North Sea and Skagerrak.

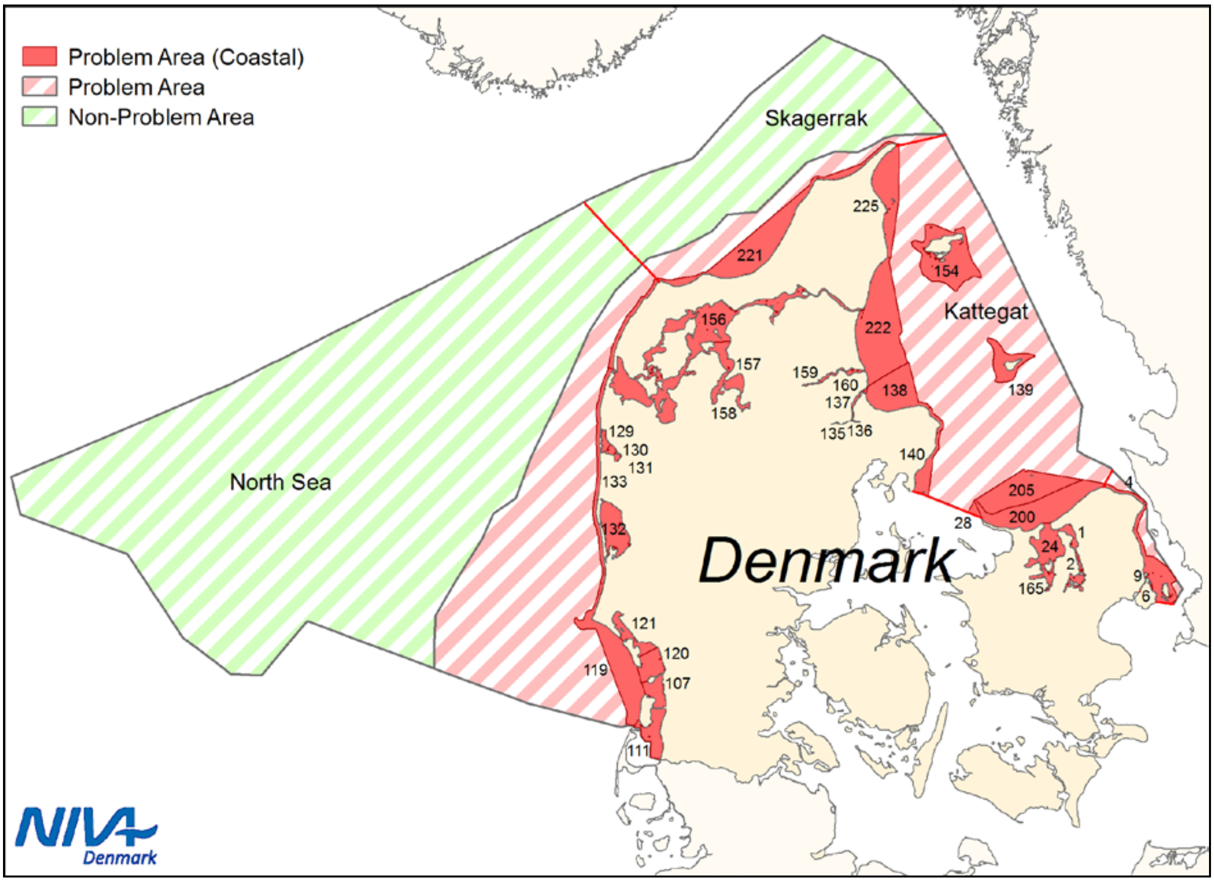

***Figure A2.1**: problem areas (red) and non-problem areas (green) in the Danish parts of the North Sea, Skagerrak, Kattegat and northern and central parts of the Sound (from Andersen et al. 2016). The hatched areas represent the offshore areas, while the filled areas represent the coastal areas. Each number represents a water body /assessment unit*

Table A2.1: *Estimated coverage of non-problem areas (NPA), potential problem areas (PPA) and problem areas (PA) in Danish parts of the North Sea, Skagerrak, Kattegat and northern and central parts of The Sound for the three assessment periods (first, second and third applications of the Comprehensive Procedure)*

Assessment period	NPA	PPA	PA	Total
First Common Procedure application	18,433	0	58,073	76,506
Second Common Procedure application	16,668	20,899	38,939	76,506
Third Common Procedure application	44,191	0	32,315	76,506

2.2 Description of area

The study area consists of the Danish parts of the North Sea, Skagerrak, Kattegat as well as the northern and central part of the Sound. The study area and its physical characteristics, including the salinity gradient from the highly saline waters of the North Sea to brackish in the Kattegat are in general very well understood and documented, as is its environmental status The water masses in the Danish parts of the North Sea and Skagerrak are largely of Atlantic origin, and the major sources in nutrient to these are direct and riverine inputs in the southern North Sea. The Kattegat is the transition zone between the North Sea/Skagerrak and the Baltic Sea and major sources of inputs of nutrient include to outflow from the Central Baltic Sea as well as direct (point sources and riverine inputs) and indirect inputs (atmospheric deposition) from both Denmark and Sweden. The assessment units for coastal waters are those of the 2014 Danish WFD Initial Assessment.

2.3 Assessment procedure

This Danish OSPAR Comprehensive Procedure assessment has been based on the 2014 Water Framework Directive Initial Assessment of ecological status in coastal waters, the 2012 Marine Strategy Framework Directive Initial Assessment of environmental status and a comprehensive analysis of satellite-based observation in order to separate coastal problem areas from offshore non-problem areas.

In the Danish Water Framework Directive Initial Assessment from 2015, ecological status in coastal waters has been assessed using the following intercalibrated indicators: Chlorophyll-a, depth limit of Eelgrass (*Zostera marina*), and DKI (Dansk KvalitetsIndeks) (Naturstyrelsen 2014). A multi-metric indicator-based assessment tool was not applied due to the limited number of both indicators and biological quality elements.

In the Danish Marine Strategy Framework Directive Initial Assessment from 2012, eutrophication status was assessed using multiple indicators (concentrations of nutrients, chlorophyll-a concentration, DKI, submerged aquatic vegetation (where relevant), oxygen concentration, etc.) in combination with the HEAT 2.0 tool Both WFD coastal waters and MSFD offshore waters were covered.

For the present study, the average chlorophyll-a concentrations in the Danish parts of the North Sea and Skagerrak were calculated for nearly 10 years of MERIS (MEdium Resolution Imaging Spectrometer) observations. The MERIS chl a concentration was corrected by comparison with in-situ observations. The results were then used to determine the extent of the problem area, defined as the area where the 10-year average chlorophyll-a concentration exceeds 3.5 $\mu g\ l^{-1}$. A composite map is shown in Figure A2.2.

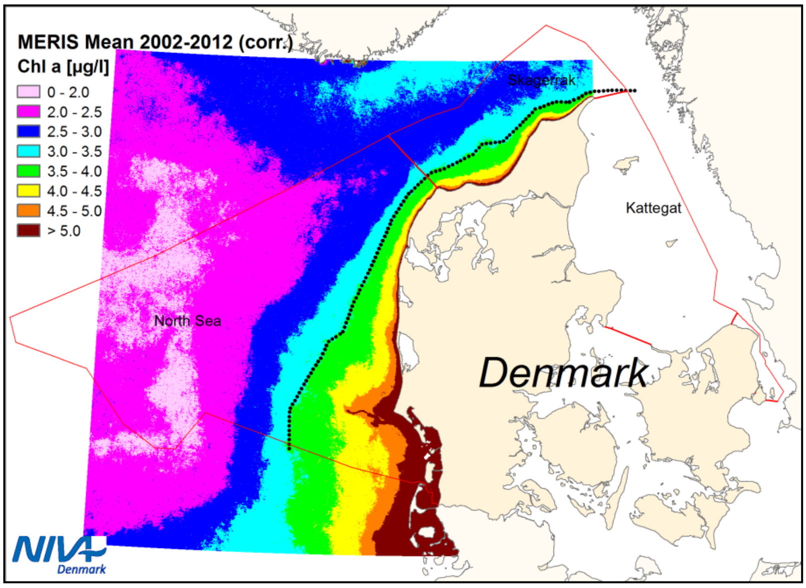

Figure A2.2: *EO-based segregation of problem areas and non-problem areas in the Danish parts of the North Sea and Skagerrak*

2.4. Improving future assessments

Two possibilities have been identified for improving future assessments of nutrient enrichment and eutrophication status in the Danish parts of the North Sea, Skagerrak and Kattegat are: (1) science-based monitoring of eutrophication-related indicators in offshore waters, where the station network and the sampling frequencies are determined by analyses of indicator-specific variations, and (2) assimilation of in-situ measured data into a 3D biogeochemical model, in order to bridge gaps in space and time..

3. France

3.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

Over the 28 French coastal areas assessed, only 8 are qualified as non-problem area, 10 as problem areas and 10 as potential-problem areas (Figure A3.1).

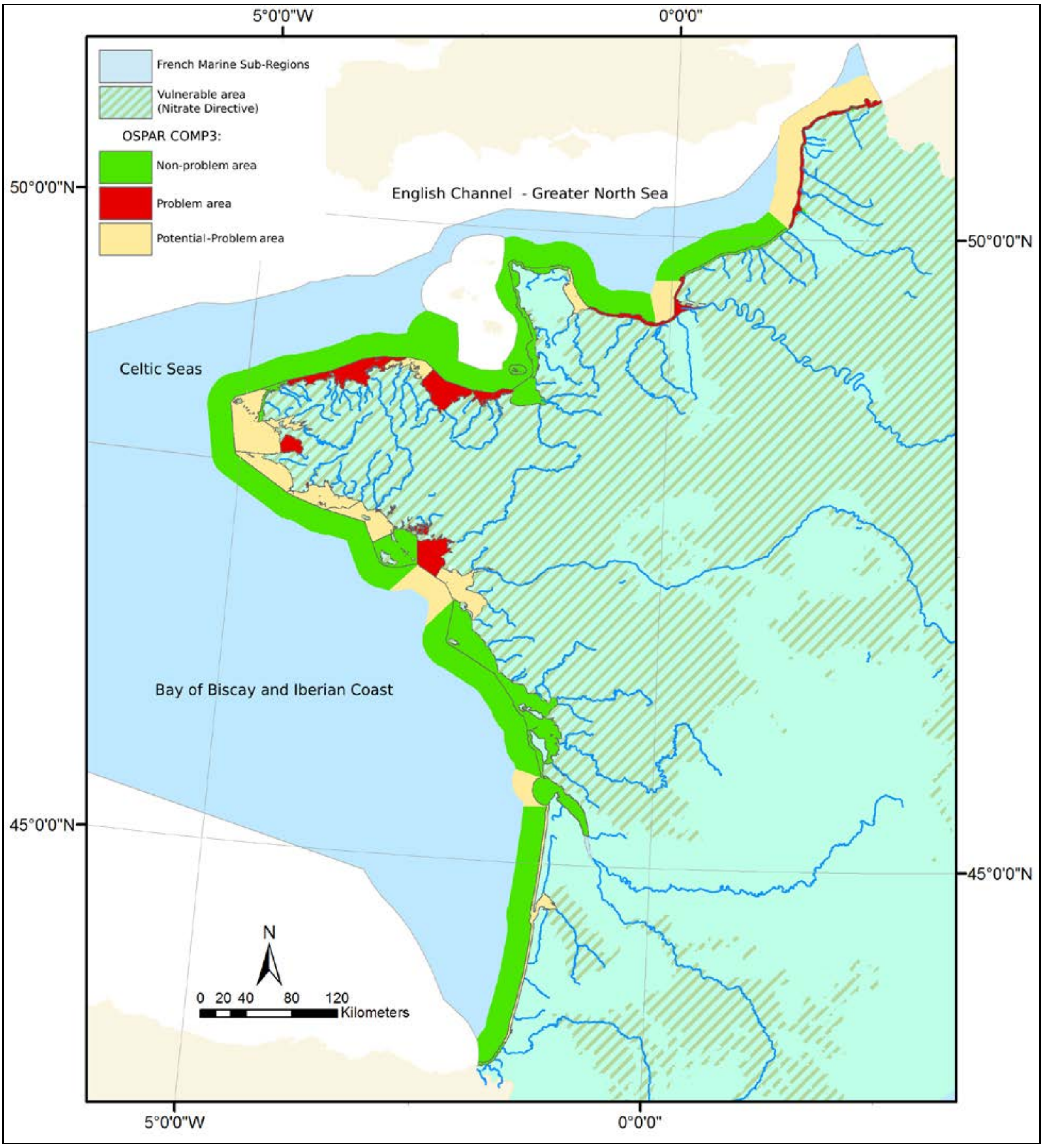

***Figure A3.1**: Classification of French waters*

From the 10 water masses qualified as problem areas, 8 are located in the English Channel (Region II) and 2 in the Atlantic (Region IV). In the English Channel, problems are mainly due to elevated levels of macrophytes (green tides) in the western part, and to high nutrient concentrations and high phytoplankton biomass and bloom occurrences in the eastern part. In the Atlantic, main problems occurred in the Gulf of Morbihan and in the Bay of Vilaine. Most of the potential problem areas are characterised by the occurrence of harmful algal blooms (without any other disturbance) which relation to eutrophication still needs to be demonstrated. No oxygen deficiency was reported.

Six non-problem areas were identified under the French first Comprehensive Procedure and were not re-assessed thereafter. The second French application of the Comprehensive Procedure highlighted 14 problem areas to be compared to the 10 identified for the third Comprehensive Procedure; it represents a slight improvement of the situation. Only two coastal areas turn from potential problem areas in the second Comprehensive Procedure to problems areas (the two northern ones, at the Belgium border) in the third Comprehensive Procedure; this is not due to a real degradation of the status but to a revision of the expert advice in order to propose a more coherent assessment at the boundary.

Globally, nitrogen inputs show significant decreasing trends or no trends (-3% to -5% per year according to the area) between 2006 and 2010; the chlorophyll-a concentration show also a significant decreasing trends in the majority of coastal areas (-2% to -4% per year according to the area); other assessment parameters show no global significant decreasing trends.

All environmental measures taken by France to reduce eutrophication effects in marine waters in the last decades (under Water Framework Directive, Nitrate Directive, Urban Waste Water Directive etc.) seems to give quiet good results, especially concerning observed decreasing trends in nitrogen and phosphorus anthropogenic inputs. These measures also aim to reduce atmospheric inputs of nitrogen.

3.2 Description of area

French marine waters are divided in three different DCSMM marine sub-regions: the English Channel Greater North Sea, the Bay of Biscay and Iberian Coast and the Celtic Sea. The English Channel part shows a highly mixed turbid water column (particularly in the eastern part) with strong tidal current (macrotidal regime) with a North East resultant that flushes its water to the southern bight of the Greater North Sea. The maximal depth is around 200m and the salinity varies around 35 in the western part to 34.5 in the eastern part, with increasing gradient from the coast to offshore. The hydrology of the Eastern English Channel is locally influenced by middle and small size estuaries. The Bay of Biscay marine waters are more stratified and less turbid with average depth at 1800m. The salinity varies from 34.5 to 35.5 out of areas of freshwater influence.

Atmospheric nitrogen input represents approximately 20% of the total nitrogen input in the French OSPAR areas between 1995 and 2008. 50% to 67% of this atmospheric N originate from agriculture activities (NHx) and contribute from 20% to 50% to the total N input at the sea.

Transboundary transportation of nutrients can be observed all along the French English Channel Coast to the offshore part of the German Bight and are mainly due to the Seine River.

3.3 Assessment procedure

In an attempt to better harmonised eutrophication, and more generally ecological, assessments results at the French national level but also at higher geographical scale, the reference conditions and assessment levels used for each harmonised assessment parameters were those from the Water Framework Directive. Then the OOAO method was applied at the category level (degree of nutrient enrichment, direct and indirect effects) and finally the scoring integration method was used to obtain an initial classification. Experts judgments were then required at the national and regional levels to review if this initial classification was pertinent to general knowledge for each areas. This results in an overall classification for 28 areas. These coastal OSPAR areas were obtained by locally aggregated Water Framework Directive water masses. The choice was made not to assess coastal areas already identified as non-problem areas with the 2001 Screening Procedure.

Water transparency, N/P ratio, Changes/kills in zoobenthos and fish kills and Organic carbon/organic matter criteria were not used to perform the procedure.

Data used to perform the French evaluation come from different sources. The nitrogen flow data come from the modelling results of the EMoSEM project; raw data of water discharge and water quality data come, respectively, from the HYDRO data bank (DREAL) and from regional Water Agencies. Data used to assess macrophytes come from the CEVA (Center for Study and Valorization of Algae). Data of nitrogen, chlorophyll-a, oxygen concentrations and phytoplankton related data in coastal areas come from the Ifremer Database Quadrige[2]. All these data are submitted to specific qualification and validation control processes.

3.4 Improving future assessments

Assessment of eutrophication status for offshore waters (> 1nm) is still a problem due to the lack of data in these areas. Some proposals are made to integrate additional data from satellite-derived products, modelling, ferry-boxes, buoys or instrumented stations.

Because of the time lag between management actions and environmental responses, efforts should be maintained as some coastal areas remains in problem or potential problems. In-situ conventional monitoring programs should benefit from the development and implementation of new technologies (high spatial and resolution products from coastal to offshore areas) in order to optimise assessment then environmental management.

4. Germany

4.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

In the third application of the OSPAR common procedure, 6% of Germany's national waters were assessed as non-problem areas, 39% as Potential Problem areas and 55% as problem areas. In comparison the second application assessed 0% of Germany's national waters as non-problem areas, 20% as potential problem areas and 80% as problem areas. Compared to the second application of the Comprehensive Procedure the eutrophication status seems to have improved only in the offshore area OFFO (the area was previously classified as a potential problem area). The transitional and coastal waters remain highly eutrophic and are characterised by elevated concentrations of nutrients and chlorophyll-a (including phytoplankton indicator species), reduced light climate and partly by seasonal oxygen depletion. Large areas in the inner and outer coastal waters were classified as potential problem areas due to missing data for macrozoobenthos, organic carbon and phytoplankton indicator species.

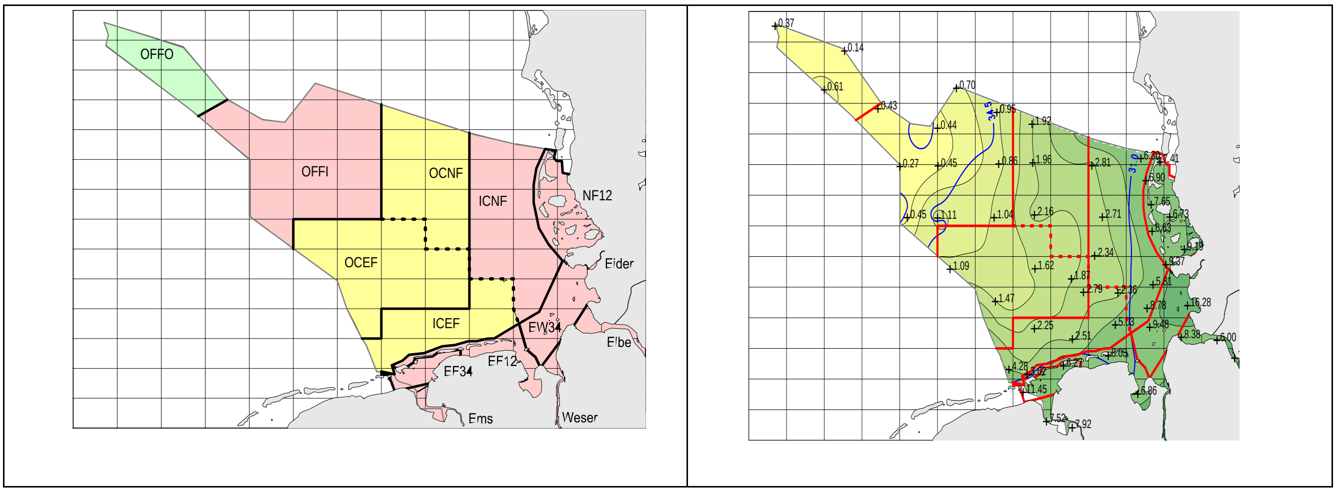

***Figure A4.1**: Left: Final classification of the German transitional, coastal and marine waters according to the third application of the Comprehensive Procedure, based on data from 2006–2014. Right: Chlorophyll-a concentrations [µg l^{-1}], growing season (March-October) 2006–2014, surface data*

Nutrient inputs stem from local rivers and the atmosphere, but mostly from trans-boundary nutrient transports. Riverine nutrient inputs and concentrations showed decreasing trends between 1980 and 2000/2005, followed by stagnations, indicating that further nutrient reduction measures are required. None of the main rivers (Elbe, Weser, Ems, Eider) achieved the target management level of 2.8 mg l^{-1} nitrogen that has been set in the national Surface Water Ordinance for TN at the limnic-marine border. Their discharge contributed 26% of total annual TN inputs to the German Exclusive Economic Zone (GEEZ). Atmospheric nitrogen deposition contributed between 14 to 20%, indicating that this remains an important source. The nutrient regime in the GEEZ was dominated by trans-boundary nutrient inputs, transported either counter-clockwise by the residual coastal current (31% of nitrogen inputs) or stemming from the mixing with Atlantic waters (28%). Hence good status with respect to eutrophication in the GEEZ cannot be achieved through national nutrient reduction efforts alone, but relies significantly on reduction efforts by "upstream" Contracting Parties.

4.2 Description of area

The GEEZ includes about 43.097 km2 with a mean water depth of 20 m. In the ancient Elbe valley the water depth can reach >40m. The GEEZ is characterised by a salinity gradient starting with salinities below 18 within the estuaries and reaching 34.5 in outer coastal waters. Estuaries and extended shallow tidal flats of the Wadden Sea, sheltered by a belt of islands, form a main part of the coastline, representing inshore waters that are also assessed under the Water Framework Directive. In consideration of the prevailing salinity gradient the GEEZ was divided into 13 subareas: 2 offshore areas (> 34.5), 2 outer (33-34.5) and 2 inner coastal waters (30-33), 4 Water Framework Directive inshore waters (18-30) and 3 main estuaries (<18). The ancient Elbe valley constitutes the border between the East Frisian (EF) and North Frisian (NF) waters. The inshore waters of the Water Framework Directive were summarised according to Water Framework Directive types (NEA 1/2 and NEA 3/4) into 4 assessment areas (EF34, EF12, EW34, EW12). Compared to the second application of the Comprehensive Procedure the coastal waters with salinities of 30-34.5 have been further subdivided into four areas (ICEF, OCEF, ICNF, OCNF), distinguishing inner and outer coastal waters, while the other assessment areas remained the same.

4.3 Assessment procedure

The assessment was performed according to the OSPAR guidance for the Comprehensive Procedure, considering the full set of mandatory and voluntary parameters (dissolved and total nutrients, nutrient ratios, chlorophyll-a, phytoplankton indicator species, macrophytes, macrozoobenthos, oxygen concentrations/saturation and organic carbon) for an initial assessment. The final assessment result was determined considering the variability of data and their confidence. Efforts have been undertaken to align the third Comprehensive Procedure with the assessment of “ecological status” under the Water Framework Directive for the waters <1 nautical mile. Water Framework Directive assessment levels have been applied and for the parameters macrophytes and macrozoobenthos Water Framework Directive assessment results based on the period 2009-2013/14 have been used. The assessment levels of total and dissolved nutrients have been revised since the second application and new assessment levels were used based on a harmonised approach for Water Framework Directive waters and waters beyond 1 nautical mile. For the subareas thresholds were calculated according to main seasonal salinities, based on linear mixing diagrams with marine endmembers for concentrations of total nitrogen.

4.4 Improving future assessments

Monitoring has not significantly improved since the second Comprehensive Procedure and is still insufficient especially for the biological parameters (macrozoobenthos, chlorophyll-a, phytoplankton indicator species) in inner and outer coastal waters. Efforts will be undertaken to make routine use of satellite data (Copernicus products) for the assessment of chlorophyll-a in the future. Furthermore, a routine procedure for the assessment of confidence should be further developed and applied. While it was tried to further align the Comprehensive Procedure assessment with the assessment of ecological status under the Water Framework Directive the degree of harmonisation is still not satisfactory. Germany is also striving for a stronger alignment with the eutrophication assessment method used in the Baltic Sea, with the ultimate aim to base the fourth Comprehensive Procedure on a semi-automated, quantitative and transparent assessment methodology.

5. Ireland

5.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

In the third application of the OSPAR common procedure, 24% of transitional and coastal waters assessed were identified as problem areas, 19% as potential problem areas and 57% as non-problem areas. This is an improvement from the second application where 41% were identified as problem areas and in increase from 51% in areas identified as non-problem. With increased monitoring under the Water Framework Directive, there has been an increase in the number of areas assessed using the common procedure so the percentage of areas as well as the actual number are indicated in Figure A5.1. As in the previous assessments, offshore waters do not show elevated nutrient concentrations.

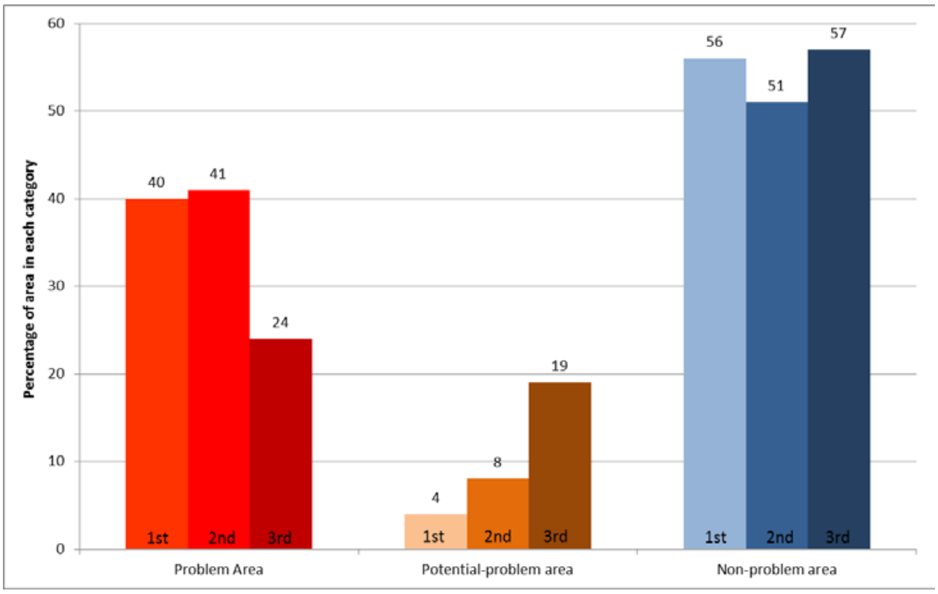

Figure A5.1*: Percentage of areas in each category with actual number of assessed areas marked on each bar*

The regions with the largest number of problem areas are located along the eastern and southeastern coasts. The majority of non-problem areas are located along the western and northwestern coasts. The occurrence of eutrophication is mainly restricted to inshore estuarine waters and rarely extends out to coastal areas.

The overall percentage of non-problem areas has remained largely stable between the three assessment periods. There has been a shift from problem area to potential problem areas with only 24% of areas still at problem areas status in the third assessment.

Data from the OSPAR riverine inputs programme has been used to assess the levels of inputs of N and P into the marine environment from 2006–2014. Trends analysis of total P, total N, MRP, TON and NH3 was undertaken and for all areas assessed there were no upward trends. Significant downward trends in total P were seen in 20% of areas. Significant declines in total N were seen in 40% of the areas assessed.

The largest number of problem areas is located inshore and predominantly along the eastern, south-eastern and southern coasts of Ireland. In general, this distribution reflects the greater impacts that arise from pressures associated with higher human population densities and more intense agricultural activities in these regions.

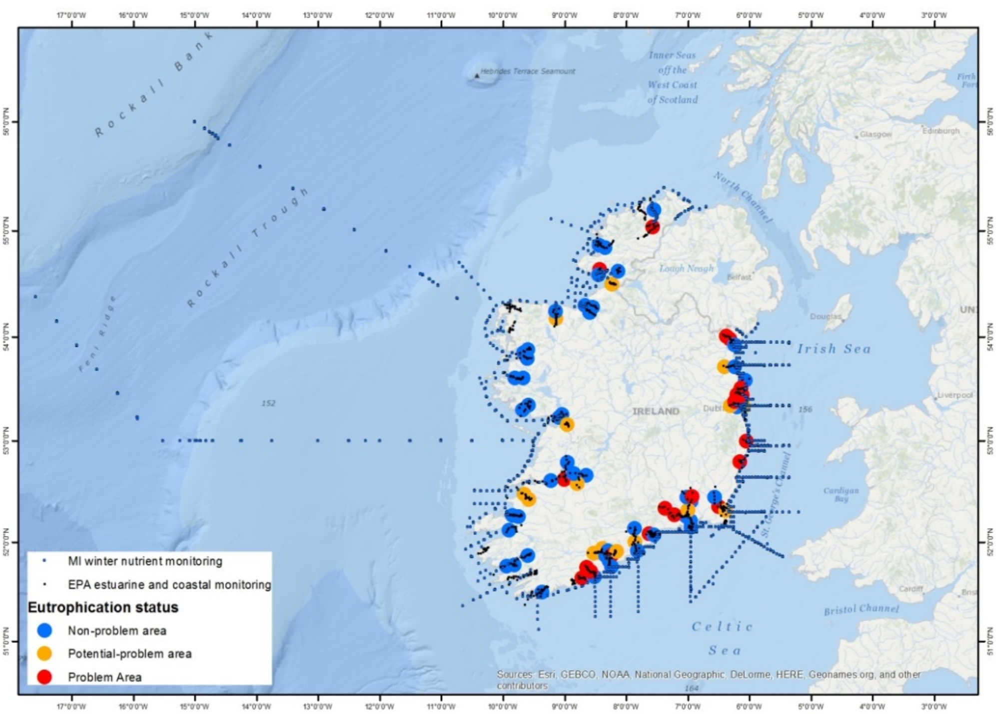

***Figure A5.2**: Environmental Protection Agency and Marine Institute monitoring for 2009–2014 used for the application of the Common Procedure*

5.2 Description of area

The boundaries of the estuarine and nearshore coastal waters included in this assessment are the Water Framework Directive, limits with the outer boundary generally being defined by salinity. The outer limit the offshore coastal water bodies was demarcated by the baseline plus 1 nautical mile seaward boundary of the Water Framework Directive. The outer boundary of the offshore waters was Ireland's Exclusive Economic Zone (EEZ) boundary. Atmospheric or transboundary inputs are not considered at this time.

5.3 Assessment procedure

The main source of data used in this assessment is derived from the Environmental Protection Agency's national estuarine and nearshore coastal waters monitoring programme and the Marine Institute's winter monitoring of coastal and offshore waters. Data from these programmes are used for fulfilling the monitoring requirements of various legislative obligations.

Ireland's application of the Common Procedure uses the trophic status assessment scheme (TSAS) in estuarine and nearshore waters to assess nutrient levels in summer and winter, chlorophyll-and oxygen. The use of N:P ratios was not applied to estuarine and nearshore coastal waters that are influenced by freshwater input. The abundance and composition of macroalgae from certain transitional areas is also used. No data for fish kills and changes to zoobenthos were used for this assessment.

5.4 Improving future assessments

- Better integration with Water Framework Directive and Marine Strategy Framework Directive monitoring programme including streamlining of common areas
- Include data for indirect effects not available for this assessment.

6. The Netherlands

6.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

Five out of seven sub-areas of the Dutch continental shelf (45% of the total area) are classified as a problem area in terms of eutrophication. The two non-problem areas are the most offshore parts of the Dutch continental shelf: the Oyster Grounds and the Dogger Bank. The problem areas are the estuaries of the Western Scheldt and the Ems-Dollard, the Wadden Sea, the coastal waters and the offshore waters in the Southern Bight. The problem areas are the parts of the Dutch continental shelf that are most strongly influenced by riverine discharges and transboundary nutrient transport.

Compared to the previous assessment (the second Comprehensive Procedure, 2001-2005), the status of all areas in the overall assessment results has remained the same. However, at the level of the individual criteria, some improvements have occurred: The Southern Bight offshore was classified as problem area due to elevated levels of chlorophyll-a and of the indicator phytoplankton species Phaeocystis in the second Comprehensive Procedure, but in the third Comprehensive Procedure only because of *Phaeocystis*. Coastal waters also show improvement for the criterion Chlorophyll-a. In the Wadden Sea and the Ems-Dollard estuary, oxygen deficiency was observed in the second Comprehensive Procedure, but this was no longer the case in the third Comprehensive Procedure.

A reduction of riverine phosphate and nitrogen inputs has occurred. Compared to the second Comprehensive Procedure, total-N inputs have decreased with approximately 15% and total-P inputs with approximately 30%. Compared to the first Comprehensive Procedure, the decreases were 30% and 50%, respectively.

Despite a reduction of riverine phosphate and nitrogen inputs since 1985, five out of the seven subareas of the Dutch continental shelf are still classified as a problem area. In the Coastal Waters, the Wadden Sea and the estuaries the winter DIN and DIP concentrations were still above elevated level. Chlorophyll-a has decreased and is now below elevated level in the Southern Bight offshore and in Coastal waters, but still above elevated levels in the Wadden Sea and the estuaries. The phytoplankton indicator species Phaeocystis is above elevated levels in all problem areas. It can be concluded that there are improvements in concentrations of assessment parameters, but these are not (yet) visible in the overall assessment.

6.2 Description of area

Wadden Sea: A shallow sea with tidal channels and intertidal flats, with a row of barrier islands forming the northern border. Annual mean salinity varies between 25 and 29. Depending on hydrodynamic conditions, sediments are silty, sandy or mixed. The Wadden Sea is influenced by water from the Dutch coast and freshwater discharges from Lake Ijssel (water from river Rhine).

Western Scheldt: The estuary of the river Scheldt, between the Dutch-Belgian border and the North Sea, with a few deep tidal channels and intertidal flats and marshes. The estuary has low phytoplankton production due to limited light penetration, is well mixed and has a tidal range is up to 6 meters. The annual mean salinity varies between 21 and 27.

Ems-Dollard estuary: The estuary of the river Ems between the Dutch-German border and the Wadden Sea, with extensive tidal mudflats and salt marshes. The estuary is characterised by high SPM levels and high turbidity. The annual mean salinity varies between 20 and 24.

Coastal Waters: The waters closest to the Dutch coast with salinity below 34.5. Water depth varies between 5 m near the coast to 30 m further offshore. The sediment consists mainly of fine sandy sediments. The area is well-mixed and strongly influenced by river discharges (Rhine and to a lesser extent from Meuse and Scheldt).

Southern Bight offshore, the southern part of the Dutch continental shelf is relatively shallow (30 m) and tidally mixed. The sediment is partly coarse and partly fine sands. The area is influenced by water from the Channel, and discharges from Belgian and Dutch rivers.

Oyster Grounds: form the middle part of the Dutch continental shelf. This area is deeper than the Southern Bight offshore (on average 45 m) and may be thermally stratified during summer. The sediment is a mixture of fine sand and silt. The Oyster Grounds are influenced by nutrient discharges from the United Kingdom and by Atlantic Ocean water.

Dogger Bank: the most northern part of the Dutch continental shelf, receives mainly waters from the northern boundary (Atlantic Ocean).

6.3 Assessment procedure

In the application of the third Comprehensive Procedure, a number of criteria were not used. For Direct effects, the criterion “Macrophytes including macroalgae” was not used as macrophytes are not relevant for assessment of eutrophication. For Indirect effects, only “Oxygen deficiency” was applied, but monitoring of events as oxygen deficiency and concomitant kills of zoobenthos is not always sufficient in frequency, as for the other criteria monitoring was insufficient. However, the sampling frequency for phytoplankton and relevant environmental factors is more than sufficient to meet the demands of OSPAR. In the third Comprehensive Procedure monitoring data were used that are also applied for other assessments, such as the Water Framework Directive. The assessment is based on data collected each year, by monthly or bi-weekly sampling of all relevant parameters at more than 20 monitoring stations.

6.4 Improving future assessments

For the phytoplankton indicator species Phaeocystis, the assessment level is based on maximum cell number. One of the quality elements in the Water Framework Directive is the frequency of blooms of Phaeocystis. It is recommended to align the assessment methods of the Comprehensive Procedure and Water Framework Directive for this indicator. It should also be checked if the assessment of both Chlorophyll-a and *Phaeocystis* has added value, in particular when the assessment of Chlorophyll-a is going to be improved by applying remote sensing data. The assessment level of the N/P ratio is 24. It would be better to have a range of values, but also in this case it should be evaluated if this criterion has added value in addition to DIN and DIP concentrations. The background levels of nutrients in some of the assessment areas may need a revision as well.

A standardised procedure for the assessment of confidence needs to be developed and applied.

7. Norway

7.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

Norwegian waters lie within OSPAR Region I (Norwegian Sea and Barents Sea) and Region II (Skagerrak and the North Sea). Regional environmental authorities have classified 96% of assessed water bodies in Region I as good or high status (Water Framework Directive). Thus, this region has been classified as non-problem area (Figure A7.1). In Region II, the comprehensive procedure was used on the level of water type within each ecoregion, so that every water body of the same type were classified equally. The water bodies classified were 1 – Open exposed coast, 2 – Semi-exposed coast, 3 – Sheltered coast/fjord, 4 and 5 – Freshwater affected and strongly freshwater affected water, and 6 – Fjords with naturally low oxygen levels. This resulted in 188, 141 and 351 problem, potential problem and non-problem water bodies, respectively (Figure A7.1). The final assessment of Region II classified all water bodies of water type open and semi-exposed waters as non-problem areas. Also sheltered coast/fjords in the North Sea were non-problem areas. In Skagerrak, sheltered coast/fjords were classified as problem areas, which was also the case for freshwater affected and strongly freshwater affected waters. All fjords with naturally low oxygen levels and freshwater affected and strongly freshwater affected waters in the North Sea were classified as potential problem areas because of lack of data. Offshore areas were classified as non-problem areas.

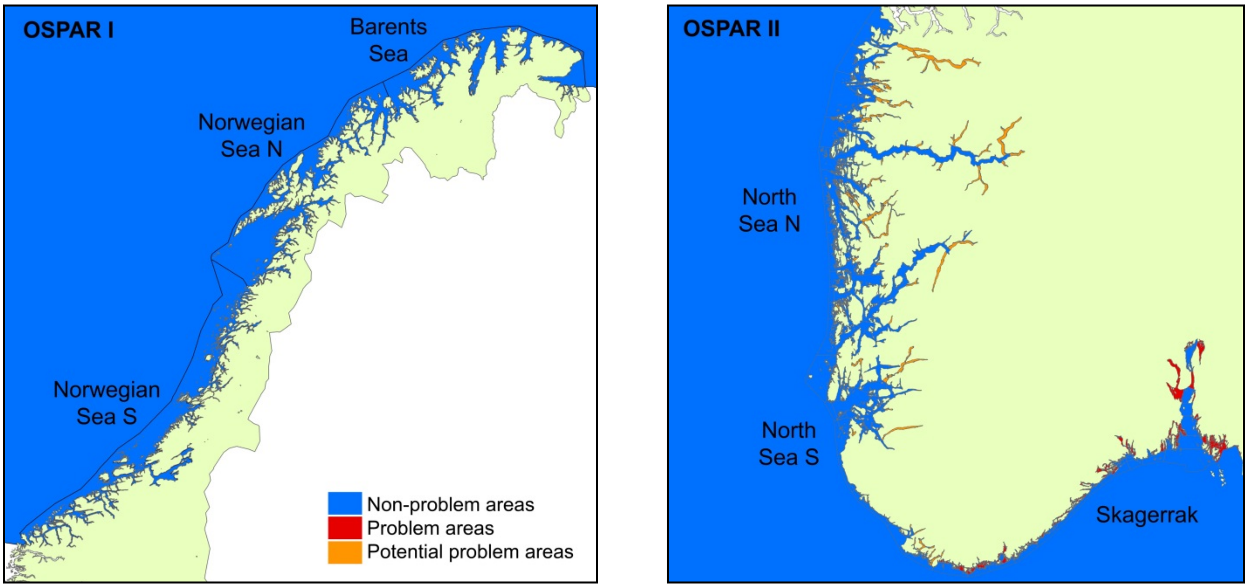

Figure A7.1*: Classification from screening in OSPAR Region I including the Norwegian Sea and Barents Sea (left) and final assessment in Region II including the North Sea N/S and Skagerrak (right). The final assessment was performed on water type level thus all water bodies of each water type are given the same status*

The Norwegian Skagerrak coast was classified according to the OSPAR Common Procedure in 2002 (the first Comprehensive Procedure) and 2007 (the second Comprehensive Procedure). The status has improved because of reduced inputs of nutrients, but also due to a change in use of assessment parameters. The second Comprehensive Procedure classified Skagerrak as a problem area due to a large-scale eutrophication-related decline of sugar kelp. Later, researchers have concluded that the decline is also affected by direct and indirect effects of global warming. Sugar kelp was thus not given principal importance as an eutrophication indicator in the third assessment, but was included in macroalgae indicator. In general, there has been a slight decline in nutrient inputs to the outer coast of Skagerrak the last decades, in particular attributed to reduced transboundary transfers from the south. Inner coasts of Skagerrak, however, are affected by increased climate-related run-off from land, which make it difficult to separate effects from these two factors. The other sea regions have experienced increased inputs of nutrients, where aquaculture is the main contributor. Other nutrient sources associated with regional run-off from land, however, has been relatively stable in these sea areas.

7.2 Description of area

The Norwegian coastal current flows northwards, from Skagerrak, through the North Sea and Norwegian Sea, towards the Barents Sea. Coastal water is a mix of Atlantic, Baltic, North Sea and fresh water from land with varying salinity, usually around 30 psu. Rivers transport nutrients and particles to the marine environment from anthropogenic activities including agriculture, industry, forestry and wastewater treatment. This transport is highly seasonal, with peeks during periods of snow melting and heavy rainfall. The fjords are typically described by a shallow sill and a stratified water column with brackish surface water. The deep water is stagnant for shorter or longer periods and deep water replacement may occur in intervals from months to several years, sometimes leading to hypoxic conditions. Offshore waters are dominated by Atlantic water with high salinity. The Norwegian part of Skagerrak and the North Sea covers areas of ca 0.5 mill km2 and are on average 250 m deep. The Norwegian Sea and Barents Sea covers 1.1 and 1.4 mill km2 with average depths of 1 600 and 230 m, respectively.

7.3 Assessment procedure

Since the second common procedure was applied in 2007; the Water Framework Directive has been implemented in Norwegian legislation. Water Framework Directive class boundaries were used to secure harmonised results to the national Water Framework Directive work as well as to neighbouring countries and Contracting Parties’ marine areas. Through the screening procedure, the whole of Region I was classified based on Water Framework Directive classifications.

Riverine inputs and monitoring data on nutrients, particles and biology from the Environmental Agency database were used to calculate status and trends in Region II. Where data was available, established Water Framework Directive class boundaries between moderate and good for classifying non-problem and problem areas were used. The assessment was performed on water type level within each Water Framework Directive Region in coastal areas to take into account high local variability in salinity and other parameters. Norway has not implemented class boundaries for offshore areas, therefore, expert judgement based on management plans for the North Sea and Skagerrak was used.

Norwegian waters cover vast areas and the monitoring network do not cover all water types in all regions throughout the entire monitoring period 1990-2014. To overcome the spatial and temporal shortcoming in the available data, the total dataset in the statistical modelling were used to predict winter situations at the depth of 2m, at the level of water type for each region. In this way it was possible to fill gaps where data were weak and to take advantage of data sampled in other seasons and depths. For trend assessments, Mixed Generalised Linear Models were used. Significant ($\alpha<0.05$) and increasing linear trends were identified. For status assessments average values and standard deviations for all water types in Region II were estimated, based on available winter (December-February) data from 2012–2015 and not deeper than 15m. Confidence was calculated as the risk of being above class boundary when classified below.

7.4 Improving future assessments

The monitoring frequency in time and space is scarce, particularly in Region I where nutrient inputs from aquaculture are increasing. Consequently, monitoring frequency, intensity and extent should be improved. Also, the coupling between the assessment parameters and their stressors should be more closely linked by a tighter spatial and temporal coordination in the monitoring programs.

8. Sweden

8.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

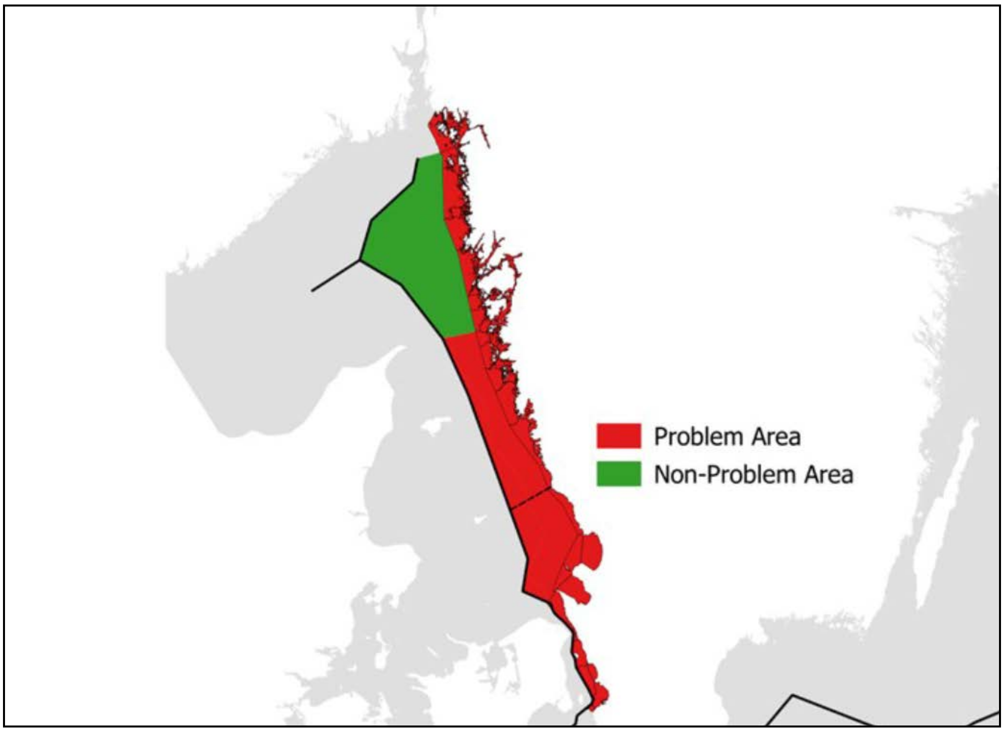

***Figure A8.1**: Swedish water assessed in the OSPAR Common Procedure 2016. Red: problem areas, Green: non-problem areas*

In the third Swedish application of the Comprehensive Procedure the open sea Skagerrak is classified as a non-problem area with regard to eutrophication. All other (nine) assessment units are problem areas. The distribution of problem areas and non-problem areas are the same as in the second Swedish application of the Comprehensive Procedure. In the first application of the Common Procedure all assessment units were classified as problem areas.

Concentrations of dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), total nitrogen (TN) and chlorophyll-a have decreased in most areas, although trends in DIP were not statistically significant (95% level). Concentrations of silicate, particulate organic carbon (POC) and total phosphorus (TP) had increased. Secchi depth (a measure of water clarity) increased in most areas. Oxygen deficiency remains a problem in the fjords and in the Kattegat open sea.

The observed improvements, while insufficient to achieve a change to non-problem status, may be attributed to reduced nutrient inputs. Inputs of TN and TP from land to the Skagerrak, Kattegat and Sound have decreased. Atmospheric nitrogen inputs to both the Skagerrak and Kattegat have also decreased.

8.2 Description of area

The Kattegat (including the Sound) and the Skagerrak have surface areas of about 24 500 and 32 300 km^2 and mean depths of 22 m and 210 m respectively. They constitute the outer part of the estuarine transition zone between the brackish Baltic Sea and the oceanic North Sea.

The Skagerrak is a fjord with a sill depth of 270 metres and a maximum depth of about 700 metres. It has an almost permanent cyclonic circulation and receives water from three different sources: Kattegat surface water enters from the south (Andersson and Rydberg, 1993), Atlantic water enters along the west side of the Norwegian Trench to form intermediate and deep water (Furnes et al 1993) while a mixture of North Sea waters enters from the west and south-west via the Jutland current. Low salinity water here indicates recirculation of Baltic water or high river discharges in the southern North Sea. The main river input is from the Glomma River (700 m^3 s^{-1}) which enters the sea just north of the Swedish / Norwegian border.

The Kattegat has two-layer stratification, with the halocline found at a depth of 15m. The deep water consists of Skagerrak water while the surface water is a mixture of entrained deep water and brackish water from the Baltic. The proximity of the halocline to the sea floor makes the southern and western Kattegat particularly susceptible to hypoxia. The main river input is from the Göta river (575 m^3 s^{-1}), just at the border between the Skagerrak and Kattegat. As the general circulation along the Swedish west coast is northward, most of the river water is mixed into Skagerrak coastal water north of the mouth. Coastal waters typically have a high salinity range, are stratified with a shallow halocline and are influenced by surface water. Tidal effects are minimal.

The Skagerrak is governed by trans-boundary transports from the North Sea of mainly nitrogen but also phosphorus. The Kattegat receives trans-boundary nutrients to its surface waters from the Baltic Sea through the Sound and Belt Sea, while the deep water receives nutrients from the Skagerrak.

8.3 Assessment procedure

The Common Procedure was applied to the Swedish Greater North Sea EEZ (HVMFS 2012:18). Coastal waters were defined as waters within one nautical mile of a line connecting the outermost archipelago (Skerries) off the coastline (NFS 2006:1), divided into 8 water types as per the Swedish implementation of the Water Framework Directive (Anon, 2000). The assessment used national and regional monitoring data and was based primarily on winter nutrient, chlorophyll-a and oxygen concentrations as well as macrophytes, phytoplankton and zoobenthos. National assessment levels were used according to HVMFS 2012:18 for the open sea and HVMFS 2013:19 for coastal waters. Trends were analysed for two time periods; 1993–2014 and 2006–2014. Results from the Water Framework Directive 2015 assessment were used for macrophytes and no new assessment was made. To consider the confidence rating of the assessment the cumulative probability of the binomial distribution which is based on percentiles were used (A6 in Annex 8 in OSPAR 2013).

There are differences between the three applications of the Comprehensive Procedure, both in assessment levels for some of the assessment units and parameters but also how data have been aggregated geographically. In the first and second applications, the assessment area was aggregated into only four units: Skagerrak and Kattegat open sea and Skagerrak and Kattegat coastal waters. In the present application, these four units have been divided into nine smaller units and been complemented with one (The Sound). The smaller size of the assessment units imply that the assessment, for especially coastal units, can better be related to the adjacent land area.

8.4 Improving future assessments

Future Comprehensive Procedure applications can be improved by improved nutrient budgets and also by the use of satellite-data for chlorophyll estimates. Increased knowledge will allow assessment levels to be further improved and interactions between apparent eutrophication symptoms and other environmental pressures, such as climate change, ocean acidification and fisheries, to be clarified.

9. United Kingdom

9.1 Outcome of the third Comprehensive Procedure, compared with the second Comprehensive Procedure

The third application of the OSPAR Common Procedure has resulted in 100% of the marine waters in the eight regional sea areas around the United Kingdom assessed as non-problem area. In the transitional and coastal waters around the United Kingdom, subject to the provisions of the Water Framework Directive (WFD), Urban Waste Water Treatment Directive (UWWTD) and Nitrates Directive, there are 21 problem areas (see map below) and 11 potential problem areas.

The problem areas and potential problem areas in transitional and coastal waters are found in OSPAR Region II (the Greater North Sea) on the north east and southern coasts of the United Kingdom and in OSPAR Region III (the Celtic Seas) on the south-west coasts of England and Wales and in Northern Ireland. These small areas are estuaries or harbours with restricted water circulation. The problem areas represent a small proportion of the total area of United Kingdom waters (0.03%) and of transitional and coastal waters (0.41%).

The number of problem areas has decreased (from 23 to 21) and the number of potential problem areas has increased (from six to 11). This results from the continued development of surveillance, monitoring and assessment being undertaken for transitional and coastal waters. It does not, necessarily, represent an increase in eutrophication problems. Some water bodies are showing signs of improvement from problem area to potential problem area.

Data from the OSPAR riverine inputs and direct discharges (RID) programme have been used to assess change in nutrient inputs. Nitrogen inputs (1990-2014) show decreasing trends in all the United Kingdom regional sea areas but the rate of decrease varies (0.2–2.8%) from area to area. The smallest decrease in nitrogen input is to the English Channel coast. Phosphorus inputs show decreasing trends in all regional sea areas.

Environmental measures taken to reduce nutrient pollution and eutrophication problems in the last decades (e.g. under the UWWT, Nitrates, Habitats and Birds Directives and covered by Water Framework Directive River Basin Management Plans) appear to be leading to beneficial change to the areas at risk in the marine environment. The full effect of these measures takes a long time to have the desired outcome due to time lags between taking measures and change in the large reservoirs of nitrogen that have built up in soils and ground-waters in previous decades.

9.2 Description of area

The United Kingdom maritime area contains estuaries, coastal waters and marine waters that have been divided for assessment using a nested approach: estuarine and coastal water bodies within 1 nautical mile of the baseline (containing the WFD water bodies), and within each regional sea into ‘coastal’ and ‘offshore’ based on salinity. The United Kingdom regional sea area boundaries are informed, in part, by their general physical characteristics based on whether they are well mixed, partly or seasonally stratified. These areas are well flushed. Many areas, particularly those around England, are naturally very turbid.

The main input contribution to the United Kingdom waters in both the Greater North Sea (OSPAR Region II) and the Celtic Seas (OSPAR Region III) is from land-based sources (mainly from agriculture and wastewater treatment plants) via rivers and the atmosphere. The significance of riverine and direct discharges varies within each regional sea area. The highest inputs are to the northern North Sea, the southern North Sea, the Celtic Sea and the eastern Irish Sea.

As part of the second Comprehensive Procedure, the United Kingdom carried out a risk assessment in relation to transboundary transport that could affect the United Kingdom waters or could impact on the waters of other Contracting Parties. The risk of impact was found to be minimal. As the eutrophication status of the different the United Kingdom areas assessed has not changed, and the level of nutrient input is decreasing, the minimal risk that either the United Kingdom waters are affected by transboundary transport or that other waters are affected, is further reduced.

9.3 Assessment procedure

The United Kingdom has applied the OSPAR Common Procedure, to the marine waters in its 8 regional sea areas. The objective was to assess eutrophication status on the basis of all available information and see if the non-problem area status of areas identified in successive Comprehensive Procedure applications as non-problem areas was still maintained. The United Kingdom has also taken account of recent assessments under the Water Framework Directive, the UWWTD and the Nitrates Directive concerning transitional and coastal waters.

In line with the Common Procedure approach for non-problem areas the principal information relates to winter nutrient concentrations as per the OSPAR CEMP Eutrophication Monitoring Programme. In addition, available information on nutrient inputs (RID), chlorophyll, and dissolved oxygen were used. Additional information has been used to support expert judgement, where needed, in order to reach the final classification of each area.

The parameters water transparency, N:P ratios, changes/kills in zoobenthos and fish, and organic carbon/organic matter have not been used in the United Kingdom assessment, in line with the Common Procedure as applied to non-problem areas. Use of harmonised assessment parameters, nutrients, chlorophyll, dissolved oxygen and other available information has delivered a robust assessment of status for the regional sea areas. Monitoring done for Water Framework Directive, UWWTD and Nitrate Directives in inshore waters includes nutrients, phytoplankton, macrophytes and macroalgae, and dissolved oxygen.

Data used for the third application of the Common Procedure come from different sources. Data on inputs come from the OSPAR RID programme. In-situ data on nutrients, chlorophyll-and oxygen were extracted from the ICES database, United Kingdom national databases (at BODC) and databases held by United Kingdom institutions. They include monitoring data (United Kingdom contribution to the OSPAR CEMP Eutrophication Monitoring Programme) and a variety of research programmes. The data used were rigorously quality assured and validated prior to use in the assessment. The data are, in general, of good representivity (in time and space) and there is generally good confidence in the assessments of the individual parameters against the area specific thresholds.

9.4 Improving future assessments

Although there have been improvements in the management of marine data, there is still room for improvement to the reporting and quality assurance of data and metadata. This would contribute greatly to improved efficiency in carrying out future assessments of eutrophication status in marine waters.

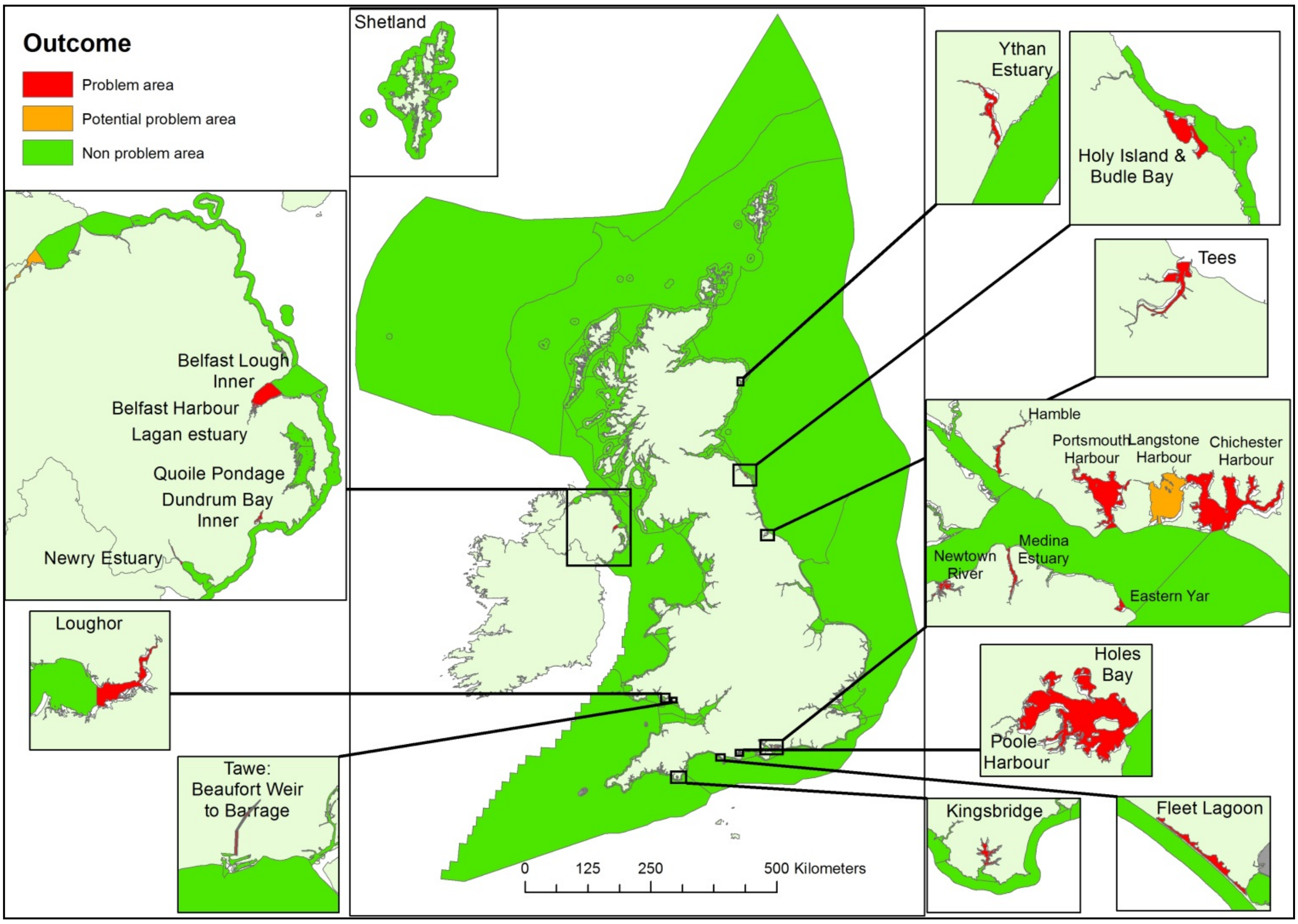

Figure A9.1: *Results from the third application of the Common Procedure. Insets show all water bodies assessed as problem areas (red). Non-problem areas are shown in green. Grey lines indicate boundaries for regional seas and Water Framework Directive water bodies*

Annex 2 Compilation of national assessment results

Reported by Contracting Parties in the format of the Common Procedure (Agreement 2013-08)

Key to the table

NI	Riverine inputs and direct discharges of total N and total P	Mp	Macrophytes including macroalgae
DI	Winter DIN and/or DIP concentrations	O_2	Oxygen deficiency
NP	Increased winter N/P ratio	Ck	Changes/kills in zoobenthos and fish kills
Ca	Maximum and mean chlorophyll-a concentration	Oc	Organic carbon/organic matter
Ps	Area-specific phytoplankton indicator species	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

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	Appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Belgium												
Coastal area	NI	-	Ca	+	O_2	-	At	?	Problem area	Problem area based on all assessment parameters, except for the indirect effects and riverine inputs.	Problem area	2006–2014
	DI	+	Ps	+	Ck	-						
	NP	+	Mp	nr	Oc	?						
Offshore area	NI	Nr	Ca	-	O_2	-	At	?	Non-Problem area	Non-Problem area based on all assessment parameters. Model results confirm the initial classification.	Non-Problem area	2006–2014
	DI	-	Ps	?	Ck	-						
	NP	-	Mp	nr	Oc	?						
Denmark												
The North Sea	NI	?	Ca	-	O_2	?	At	?	Non-Problem area	No increase in nutrient or Chl-a concentration.	Non-Problem area	2006-2012
	DI	-	Ps	?	Ck	?						
	NP	?	Mp	?	Oc	?						
Juvre dyb (107)	NI	?	Ca	?	O_2	?	At	?	Problem area	No assessment for this assessment unit in the assessment period.	Problem area	2006-2012
	DI	?	Ps	?	Ck	?						
	NP	?	Mp	?	Oc	?						
Listerdyb (111)	NI	?	Ca	+	O_2	?	At	?	Problem area	Increase in Chl-a concentration and impaired status of bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	?	Oc	?						
Vesterhavet (119)	NI	?	Ca	+	O_2	?	At	?	Problem area	Elevated Chl-a concentration.	Problem area	2006-2012
	DI	?	Ps	?	Ck	?						
	NP	?	Mp	?	Oc	?						
Knude Dyb (120)	NI	?	Ca	+	O_2	?	At	?	Problem area	Elevated in Chl-a concentration.	Problem area	2006-2012
	DI	?	Ps	?	Ck	?						

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/other possible effects				**Initial classification**	**Appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)**	**Final classification**	**Assessment period**
	NP	?	Mp	?	Oc	?						
Grådyb (121)	NI	?	Ca	+	O_2	?	At	?	Problem area	Elevated Chl-a concentration and impaired status of bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	?	Oc	?						
Nissum Yderfjord (129)	NI	?	Ca	+	O_2	?	At	?	Problem area	Elevated Chl-a concentration. Reduced depth limit and coverage of Eelgrass. Impaired status of bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	+	Oc	?						
Nissum Mellemfjord (130)	NI	?	Ca	+	O_2	?	At	?	Problem area	Elevated Chl-a concentration and impaired status of bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	?	Oc	?						
Ringkøbing Fjord (132)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated. Depth limit and coverage of Eelgrass reduced. Bottom fauna impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	+	Oc	?						
Vesterhavet (133)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated.	Problem area	2006-2012
	DI	?	Ps	?	Ck	?						
	NP	?	Mp	?	Oc	?						
Skagerrak, Offshore parts	NI	?	Ca	-	O_2	?	At	?	Non-problem area	No increase in nutrient - or Chl-a concentration.	Non-problem area	2006-2012
	DI	-	Ps	?	Ck	?						
	NP	?	Mp	?	Oc	?						
Skagerrak, Kystvande (221)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	?	Oc	?						
Kattegat, offshore parts	NI	?	Ca	-	O_2	?	At	?	Problem area	Nutrient concentration elevated. No deterioration of bottom fauna. Secchi depth is included as an indirect effect in the classification.	Problem area	2006-2012
	DI	+	Ps	?	Ck	-						
	NP	?	Mp	?	Oc	?						
Roskilde Fjord, ydre (1)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated. No reduction in Eelgrass depth limit or coverage. No deterioration in bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	-	Oc	?						
Roskilde Fjord, indre (2)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated. Depth limit and coverage of Eelgrass reduced. No deterioration of status of bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	+	Oc	?						

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/other possible effects				**Initial classification**	**Appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)**	**Final classification**	**Assessment period**
Kattefat, >20m (205)	NI	?	Ca	+	O_2	?	At	?	Problem area	Nutrient concentration elevated. No deterioration of bottom fauna.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	?	Oc	?						
Kattegat, <20m (200)	NI	?	Ca	-	O_2	?	At	?	Problem area	No increase in Chl-a concentration. Status of bottom fauna not deteriorated.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	?	Oc	?						
Isefjord, ydre (24)	NI	?	Ca	+	O_2	?	At	?	Problem area	Nutrient concentration elevated. No significant reduction in depth limit or abundance of Eelgrass. Status of bottom fauna impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	-	Oc	?						
Sejrø Bugt (28)	NI	?	Ca	-	O_2	?	At	?	Problem area	Nutrient concentration not elevated. Depth limit and abundance of Eelgrass reduced. Bottom fauna not dimpaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	+	Oc	?						
Randers Fjord, Grund Fjord (135)	NI	?	Ca	+	O_2	?	At	?	Problem area	Nutrient and Chl-a concentrations elevated. Depth limit and abundance of Eelgrass reduced. Status of bottom fauna not impaired.	Problem area	2006-2012
	DI	+	Ps	?	Ck	-						
	NP	?	Mp	+	Oc	?						
Randers Fjord, mellem del (136)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated. Bottom fauna impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	?	Oc	?						
Randers Fjord, ydre del (137)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated. Depth limit and abundance of Eelgrass as well as bottom fauna is impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	+	Oc	?						
Hevring Bugt (138)	NI	?	Ca	-	O_2	?	At	?	Problem area	Chl-a concentration not elevated. Depth limit and abundance of Eelgrass as well as bottom fauna is impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	+						
	NP	?	Mp	+	Oc	?						
Farvandet ved Anholt (139)	NI	?	Ca	+	O_2	?	At	?	Problem area	Chl-a concentrations elevated. Bottom fauna not impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	?	Oc	?						
Farvandet	NI	?	Ca	+	O_2	?	At	?	Problem	Chl-a concentrations elevated.	Problem	2006-2012

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/other possible effects				**Initial classification**	**Appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)**	**Final classification**	**Assessment period**
Djursland	DI	?	Ps	?	Ck	?			area		area	
Øst (140)	NP	?	Mp	?	Oc	?						
Farvandet	NI	?	Ca	-	O_2	?	At	?	Problem	Chl-a concentration not elevated. Depth limit and abundance of	Problem	2006-2012
ved Læsø	DI	?	Ps	?	Ck	+			area	Eelgrass as well as status of bottom fauna is impaired.	area	
(154)	NP	?	Mp	+	Oc	?						
Kattegat,	NI	?	Ca	-	O_2	?	At	?	Problem	Chl-a concentration not elevated. Depth limit and abundance of	Problem	2006-2012
Aalborg	DI	?	Ps	?	Ck	+			area	Eelgrass as well as status of bottom fauna is impaired.	area	
Bugt (222)	NP	?	Mp	+	Oc	?						
Kattegat,	NI	?	Ca	-	O_2	?	At	?	Problem	Chl-a concentration not elevated. Depth limit and abundance of	Problem	2006-2012
Ålbæk	DI	?	Ps	?	Ck	+			area	Eelgrass ras well as status of bottom fauna is impaired.	area	
Bugt (225)	NP	?	Mp	+	Oc	?						
Vestlige	NI	?	Ca	+	O_2	?	At	?	Problem	Chl-a concentration elevated. Depth limit and abundance of	Problem	2006-2012
Limfjord	DI	?	Ps	?	Ck	+			area	Eelgrass reduced. Status of bottom fauna is impaired.	area	
(156)	NP	?	Mp	+	Oc	?						
Centrale	NI	?	Ca	+	O_2	?	At	?	Problem	Chl-a concentration elevated. Depth limit and abundance of	Problem	2006-2012
og sydlige	DI	?	Ps	?	Ck	+			area	Eelgrass as well as status of bottom fauna is impaired.	area	
Limfjord (157)	NP	?	Mp	+	Oc	?						
Hjarbæk	NI	?	Ca	+	O_2	?	At	?	Problem	Chl-a concentration elevated. Depth limit and abundance of	Problem	2006-2012
Fjord	DI	?	Ps	?	Ck	?			area	Eelgrass reduced.	area	
(138)	NP	?	Mp	+	Oc	?						
Mariager	NI	?	Ca	?	O_2	?	At	?	Problem	Depth limit and abundance of Eelgrass reduced. Status of bottom	Problem	2006-2012
Inderfjord	DI	?	Ps	?	Ck	+			area	fauna is impaired.	area	
(159)	NP	?	Mp	+	Oc	?						
Mariager	NI	?	Ca	+	O_2	?	At	?	Problem	Chl-a concentration elevated. Depth limit and abundance of	Problem	2006-2012
Yderfjord	DI	?	Ps	?	Ck	+			area	Eelgrass reduced. Status of bottom fauna is impaired.	area	
(160)	NP	?	Mp	+	Oc	?						
Isefjord,	NI	?	Ca	+	O_2	?	At	?	Problem	Chl-a concentration elevated.	Problem	2006-2012
indre	DI	?	Ps	?	Ck	?			area		area	
(165)	NP	?	Mp	?	Oc	?						
The	NI	?	Ca	+	O_2	?	At	?	Problem	Nutrient and Chl-a concentrations elevated.	Problem	2006-2012
Sound,	DI	+	Ps	?	Ck	?			area		area	

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offshore parts	NP	?	Mp	?	Oc	?						
Øresundstragten (4)	NI	?	Ca	-	O_2	?	At	?	Problem area	Chl-a concentrations not elevated. Status of bottom fauna is not impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	-						
	NP	?	Mp	?	Oc	?						
Nordlige Øresund (6)	NI	?	Ca	-	O_2	?	At	?	Problem area	Chl-a concentrations not elevated. Depth limit of Eelgrass impaired.	Problem area	2006-2012
	DI	?	Ps	?	Ck	?						
	NP	?	Mp	+	Oc	?						
København Havn (9)	NI	?	Ca	?	O_2	?	At	?	Problem area	No assessment for this assessment unit in the assessment period.	Problem area	2006-2012
	DI	?	Ps	?	Ck	?						
	NP	?	Mp	?	Oc	?						
	DI		Ps		Ck							
	NP		Mp		Oc							
France												
Dunkirk and Calais (Zone 1)	NI	-	Ca	+	O_2	-	At	-	+		+	2006–2014 except for NI : 2006-2010
	DI	?	Ps	+	Ck							
	NP		Mp		Oc							
Boulogne Somme (Zone 2)	NI	-	Ca	+	O_2	?	At	-	+		+	–
	DI	+	Ps	+	Ck							
	NP		Mp		Oc							
Pays de Caux (Zone 3)	NI	-	Ca	-	O_2	-	At	-	-		-	–
	DI	?	Ps	-	Ck							
	NP		Mp		Oc							
Seine estuary and bay (Zone 4)	NI	-	Ca	+	O_2	-	At	+	+		+	–
	DI	+	Ps	+	Ck							
	NP		Mp	-	Oc							
Calvados (Zone 5)	NI	-	Ca	+	O_2	-	At	+	+		+	–
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
Baie des Veys and	NI	-	Ca	-	O_2	-	At	+	+	Slightly increasing macroalgae blooms since 2008 in only one limited area. Problem with algal toxins whose relationship with	?	–
	DI	-	Ps	-	Ck							

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St Vaast (Zone 6)	NP		Mp	+	Oc					eutrophication is not demonstrated.		
Cherbourg (Zone 7)	NI		Ca		O_2		At		-		-	_
	DI	-	Ps		Ck							
	NP		Mp	-	Oc							
West Cotentin (Zone 8)	NI	-	Ca		O_2		At		-		-	_
	DI	-	Ps		Ck							
	NP		Mp	-	Oc							
Mont St Michel Bay (Zone 9)	NI	-	Ca		O_2		At		-	Turbidity prevents major eutrophication phenomena despite the presence of nutrients.	-	_
	DI	?	Ps		Ck							
	NP		Mp	-	Oc							
Rance, Arguenon and Fresnaye (Zone 10)	NI	-	Ca	+	O_2	-	At	-	+		+	_
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
St Brieuc (Zone 11)	NI	-	Ca	-	O_2	?	At	-	+		+	_
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
Paimpol, Trieux, Jaudy (Zone 12)	NI	-	Ca	-	O_2	-	At	-	+	Macrophyte problem restricted in one limited area.	?	_
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
Lannion et Morlaix (Zone 13)	NI	-	Ca	-	O_2	-	At	+	+		+	_
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
Finistère abers (Zone 14)	NI		Ca	?	O_2	?	At	-	+	Problem with phytoplankton species in 2006 not after. Strong mixing area (no pb chloro and oxy). Macrophyte problem restricted in one limited area (an MET) with WFD EQR close to the good boundary.	?/-	_
	DI	?	Ps	+	Ck							
	NP		Mp	+	Oc							
Brest (Zone 16)	NI	-	Ca	+	O_2	?	At	+	+	Problem with phytoplankton species and chla in 2006 not after. Therefore, only problem with algal toxins whose relationship with	?	_
	DI	?	Ps	+	Ck							

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	NP		Mp	-	Oc					eutrophication is not demonstrated.		
Iroise (Zone 15)	NI		Ca	?	O_2	?	At	+	+	Only problem with algal toxins whose relationship with eutrophication is not demonstrated.	?	_
	DI	?	Ps	-	Ck							
	NP		Mp		Oc							
Douarnenez (Zone 17)	NI		Ca	-	O_2	?	At	+	+		+	_
	DI	-	Ps	+	Ck							
	NP		Mp	+	Oc							
Audierne (Zone 18)	NI		Ca	?	O_2	?	At	+	+	Only problem with algal toxins whose relationship with eutrophication is not demonstrated.	?	_
	DI	?	Ps	-	Ck							
	NP		Mp	-	Oc							
Concarneau, Aven, Belon (Zone 19)	NI	-	Ca	-	O_2	?	At	+	+	Macrophyte problem restricted in two limited area. Problem with algal toxins whose relationship with eutrophication is not demonstrated.	?	_
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
Lorient, Groix, Etel (Zone 20)	NI	-	Ca	+	O_2	-	At	+	+	Problem with chla in 2006 not after. Macrophyte problem restricted in two limited area. Problem with algal toxins whose relationship with eutrophication is not demonstrated.	?	_
	DI	?	Ps	+	Ck							
	NP		Mp	+	Oc							
Bay of Quiberon and Belle Ile (Zone 21)	NI		Ca	-	O_2	?	At	+	+	Only two years during the assessment period with phytoplankton species problems. Problem with algal toxins whose relationship with eutrophication is not demonstrated. Excellent water quality in regard of the WFD evaluation.	?/-	_
	DI	?	Ps	+	Ck							
	NP		Mp	-	Oc							
Gulf of Morbihan (Zone 22)	NI		Ca	?	O_2	?	At	-	+		+	_
	DI	?	Ps	-	Ck							
	NP		Mp	+	Oc							
Vilaine (Zone 23)	NI	-	Ca	+	O_2	?	At	+	+		+	_
	DI	?	Ps	+	Ck							
	NP		Mp	-	Oc							
Loire and Bourgneuf (Zone 24)	NI	-	Ca	+	O_2	+	At	-	+	Problem with oxygen in 2006 not after. Problem with chla in the first middle of the assessment period not after.	?	_
	DI	?	Ps	-	Ck							
	NP		Mp	-	Oc							
Vendée, pertuis et	NI	-	Ca				At		-	Non-problem area status confirmed but problem with algal toxins observed, not yet evaluated under the third Comprehensive	-	_
	DI	?	Ps									

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Marennes (Zone 25)	NP		Mp	-	Oc					Procedure.		
Gironde (Zone 26)	NI	-	Ca						-		-	_
	DI	?	Ps									
	NP		Mp	-								
Arcachon and Landes (Zone 27)	NI	-	Ca	-	O_2	?	At	+	+	Only problem with algal toxins whose relationship with eutrophication is not demonstrated and limited to the Bassin d'Arcachon.	?	_
	DI	?	Ps	-	Ck							
	NP		Mp		Oc							
Pays basque (Zone 28)	NI	-	Ca		O_2		At		-	Non-problem area status confirmed but problem with algal toxins observed, not yet evaluated with the third Comprehensive Procedure	-	_
Germany												
Estuaries	NI	+	Ca	nr	O_2	?	At		Problem area	OC	Problem area	2006 - 2014
	DI	+	Ps	nr	Ck	+						
	NP	+	Mp	?	Oc	+						
EW 34	NI		Ca	+	O_2	-	At	-	Problem area	Ca, Ps	Problem area	2006 - 2014
	DI	+	Ps	+	Ck	+						
	NP	+	Mp	+	Oc	+						
EF 34	NI		Ca	+	O_2	?	At	-	Problem area	Ca Ps,O_2	Problem area	2006 - 2014
	DI	+	Ps	+	Ck	+						
	NP	+	Mp	+	Oc	?						
NF 12	NI		Ca	+	O_2	-	At	-	Problem area	Ca	Problem area	2006 - 2014
	DI	+	Ps	-	Ck	+						
	NP	+	Mp	-	Oc	?						
EF 12	NI		Ca	+	O_2	-	At	-	Problem area	Ca Ps#,Oc	Problem area	2006 - 2014
	DI	+	Ps	-	Ck	-						
	NP	+	Mp	+	Oc	+						
ICNF	NI		Ca	+	O_2	+	At	-	Problem area	Ca Ps? Ck#,O_2	Problem area	2006 - 2014
	DI	+	Ps	+	Ck	+						
	NP	+	Mp	nr	Oc	?						
ICEF	NI		Ca	+*	O_2	-	At	-	Non-problem	Ck? Oc?	Potential Problem	2006 - 2014
	DI	+*	Ps	?	Ck	?						

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	NP	+	Mp	nr	Oc	?			area		area	
OCNF	NI		Ca	-	O_2	-	At	nyr	Non-problem area	Ck?,Oc?	Potential Problem area	2006 - 2014
	DI	-	Ps	?	Ck	?						
	NP	-	Mp	nr	Oc	?						
OCEF	NI		Ca	-	O_2	-	At	nyr	Non-problem area	Ck? Oc?	Potential Problem area	2006 - 2014
	DI	-	Ps	?	Ck	?						
	NP	+	Mp	nr	Oc	?						
OFFI	NI		Ca	-	O_2	+	At	nyr	Potential Problem area	O_2 min, Ck? Oc?	Problem area	2006 - 2014
	DI	-	Ps	?	Ck	?						
	NP	-	Mp	nr	Oc	?						
OFFO	NI		Ca	-	O_2	-	At	nyr	Non-problem area	Ck? Oc?	Non-problem area	2006 - 2014
	DI	-	Ps	?	Ck	?						
	NP	-	Mp	nr	Oc	?						

Area	**Category I** Degree of nutrient enrichment	**Category II** Direct effects	**Category III and IV** Indirect effects/other possible effects	**Initial classification**	**Appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)**	**Final classification**	**Assessment period**
Ireland							
(4) Boyne Estuary[2]	NI - DI + NP	Ca - Ps + Mp -	O_2 - Ck Oc + At	Problem area	Elevated winter nutrients, dissolved inorganic nitrogen and elevated phytoplankton bloom frequency. This latter indicator, in the absence of elevated biomass, is not sufficient to confirm a direct effect so the area is classed as a potential Problem area. In the last assessment this area was classified as a potential-Problem area due to the presence of opportunistic macroalgae, but levels of this indicator have decreased in the current assessment period. Decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^{4}).	Potential-Problem area	
(4) Boyne Estuary[2]	NI - DI - NP -	Ca - Ps - Mp	O_2 - Ck Oc - At	Problem area	Elevated winter nutrients, dissolved inorganic nitrogen and elevated phytoplankton bloom frequency. This latter indicator, in the absence of elevated biomass, is not sufficient to confirm a direct effect so the area is classed as a potential Problem area. In the last assessment this area was classified as a potential-Problem area due to the presence of opportunistic macroalgae, but levels of this indicator have decreased in the current assessment period. Decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^{4}).	Potential-Problem area	
(5) Boyne Estuary Plume Zone[3]	NI DI - NP -	Ca - Ps - Mp	O_2 - Ck Oc - At	Non-Problem area		Non-Problem area	
(6) Rogerstown[2]	NI DI + NP	Ca - Ps - Mp +	O_2 - Ck Oc - At	Problem area	Elevated levels of green opportunistic affecting seagrass beds in the inner part of estuary.	Problem area	
(7)Broadmeadow[2]	NI DI + NP	Ca + Ps + Mp	O_2 + Ck Oc + At	Problem area	Elevated levels of winter nitrogen and phosphorus and summer phosphorus. Elevated summer chlorophyll-and very high levels of dissolved oxygen supersaturation indicating excessive photosynthetic activity.	Problem area	
(8)	NI	Ca -	O_2 - At	Problem	Elevated levels of winter nitrogen and elevated levels of green	Problem area	

Malahide Bay[3]	DI	+	Ps	-	Ck				area	opportunistic macroalgae in summer. Elevated winter N:P ratio		
	NP	+	Mp	+	Oc	-						
(9) Northwestern Irish Sea (HA08)[3]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(10) Liffey Estuary Lower[1]	NI	-	Ca	-	O_2	-	At		Potential-Problem area	No direct or indirect effects arising and decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^4).	Non-Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	-						
(11) Liffey Estuary Upper[2]	NI	-	Ca	-	O_2	+	At		Problem area	Decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^4). Degree of nutrient enrichment has decreased in the current assessment. Depressed dissolved oxygen levels in upper estuary may be due to historically-enriched sediment.	Potential-Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	-						
(12) Tolka Estuary[2]	NI	-	Ca	-	O_2	-	At		Problem area	Elevated levels of winter nitrogen and phosphorus and in summer excessive levels of green opportunistic macroalgae.	Problem area	
	DI	+	Ps		Ck							
	NP		Mp	+	Oc	-						
(13) Dublin Bay[3]	NI		Ca	-	O_2	-	At		Potential-Problem area	Elevated levels of brown opportunistic algae (*Ectocarpus* sp.) are seasonally present and occasionally wash-up on shore in nuisance quantities. Change in benthic invertebrate community structure indicative of organic enrichment.	Potential-Problem area	
	DI	-	Ps		Ck							
	NP	-	Mp	?	Oc	-						
(14) Broad Lough[2]	NI		Ca	-	O_2	+	At		Problem area	Depressed dissolved oxygen levels in summer. Elevated winter nutrients	Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	-						
(15) Avoca Estuary[2]	NI	-	Ca	-	O_2	-	At		Potential-Problem area	Significant reduction in riverine inputs of total nitrogen (TN), total ammonia (NH^4) and total phosphorus (TP). Previously a Problem area	Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(16) Upper Slaney Estuary[1]	NI	-	Ca	-	O_2	-	At		Problem area	Decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^4), but excessive levels of nitrogen in summer and winter. No direct effects observed. Direct effects may be inhibited due to high flushing rate.	Non-Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc	-						
(17) Lower Slaney Estuary[2]	NI	-	Ca	+	O_2	-	At		Problem area	Excessive levels of winter and summer nitrogen and elevated levels of chlorophyll-and dissolved oxygen supersaturation. Lack of suitable substrate may inhibit opportunistic algal growth.	Problem area	
	DI	+	Ps	+	Ck							
	NP	+	Mp	-	Oc	+						
(18) Wexford Harbour[3]	NI		Ca	+	O_2	-	At		Problem area	Elevated winter N:P ratio, but no direct effects arising. Change in benthic invertebrate community structure indicative of organic enrichment. Low levels of DSP and *Dinophysis* sp. detected in this area.	Potential-Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc							

(19) Nore Estuary[1]	NI	-	Ca	-	O_2	-	At		Problem area	Elevated levels of winter and summer nitrogen and summer phosphorus. No direct or indirect effects arising. Decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^4).	Non-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	-						
(20) Upper Barrow Estuary[1]	NI	-	Ca	+	O_2	-	At		Problem area	Excessive levels of winter and summer nitrogen and direct and indirect effects arising but decrease in riverine inputs of total phosphorus (TP) and total ammonia (NH^4).	Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc	-						
(21) Barrow Nore Estuary Upper [1]	NI		Ca	-	O_2	-	At		Problem area	Excessive levels of winter and summer nitrogen but primary production likely to be limited by light availability.	Non-Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc	-						
(22) New Ross Port[1]	NI		Ca	-	O_2	-	At		Potential -Problem area	Excessive levels of winter and summer nitrogen but primary production likely to be limited by light availability. Change in benthic invertebrate community structure indicative of organic enrichment.	Potential-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	-						
(23) Upper Suir Estuary [1]	NI	+	Ca	+	O_2	-	At		Problem area	Increase in riverine inputs of total nitrogen (TN) (although not statistically significant) but decrease in total phosphorus (TP) and total ammonia (NH^4). Elevated levels of winter and summer nitrogen and summer chlorophyll.	Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc	+						
(24) Middle Suir Estuary[1]	NI	+	Ca	+	O_2	-	At		Problem area	Increase in riverine inputs of total nitrogen (TN) (although not statistically significant) but decrease in total phosphorus (TP) and total ammonia (NH^4). Elevated levels of winter and summer nitrogen and elevated summer chlorophyll-and dissolved oxygen supersaturation.	Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc	-						
(25) Lower Suir Estuary[2]	NI	+	Ca		O_2	-	At		Problem area	Elevated levels of winter and summer nitrogen but primary production likely to be limited by light availability.	Non-Problem area	
	DI	+	Ps		Ck							
	NP	+	Mp		Oc	-						
(26) Barrow Suir Nore Estuary[2]	NI		Ca	-	O_2	-	At		Potential -Problem area	Elevated winter nitrogen but no direct or indirect effects arising.	Non-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	-						
(27) Waterford Habour[3]	NI		Ca	-	O_2	-	At		Non-Problem area	Elevated N:P ratio, but no direct or indirect effects arising. DSP algal toxins and intermittent episodes of *Dinophysis* above assessment level but at levels considered not to be indicative of eutrophication.	Non-Problem area	
	DI	-	Ps		Ck							
	NP	-	Mp		Oc	-						
(28) Colligan Estuary[2]	NI		Ca	-	O_2	-	At		Problem area	Elevated winter nitrogen and elevated green opportunistic macroalgae in summer.	Problem area	
	DI	+	Ps		Ck							
	NP		Mp	+	Oc	-						
(29)	NI		Ca	-	O_2	-	At		Non-		Potential-	

Dungarvan Harbour[3]	DI	-	Ps		Ck				Problem area		Problem area	
	NP	-	Mp		Oc	-						
(30) Upper Blackwater Estuary[1]	NI	-	Ca	-	O_2	-	At		Potential -Problem area	Elevated winter and summer nitrogen but no direct or indirect effects arising. Direct effects may be inhibited due to high flushing rate. Notable decrease in riverine inputs of total nitrogen (TN), total ammonia (NH^4) and total phosphorus (TP).	Non-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	-						
(31) Lower Blackwater Estuary[2]	NI	-	Ca	+	O_2	-	At		Potential -Problem area	Direct effects present; elevated chlorophyll-and opportunistic green macroalgae.	Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp	-	Oc	-						
(32) Youghal Bay[3]	NI		Ca	-	O_2	-	At	-	Potential -Problem area	Elevated N:P ratio but no direct or indirect effects arising. Intermittent accumulations of green opportunistic algae, but levels not indicative of Problem area status.	Non-Problem area	
	DI	-	Ps		Ck							
	NP	+	Mp	-	Oc	-						
(33) Lee (Cork) Estuary Upper[1]	NI	+	Ca	-	O_2	+	At		Problem area	Increase in riverine inputs of total phosphorus but decrease in total nitrogen. Elevated winter nitrogen and depressed dissolved oxygen levels in summer which may be linked to historically enriched-sediments.	Potential-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	+						
(34) Lee (Cork) Estuary Lower[2]	NI	+	Ca	-	O_2	+	At		Problem area	Increase in riverine inputs of total phosphorus (although not statistically significant) but decrease in total nitrogen. Elevated winter nitrogen and depressed dissolved oxygen levels in summer which may be linked to historically enriched-sediments.	Potential-Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	-						
(35) Lough Mahon[2]	NI		Ca	-	O_2	-	At		Potential -Problem area	Elevated winter nitrogen but no direct or indirect effects arising. Opportunistic algal growth may be inhibited due to absence of suitable substrate.	Non-Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	-						
(36) Harper's Island[2]	NI		Ca	-	O_2	+	At		Potential -Problem area		Non-Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	-						
(37) Owenacurra Estuary[2]	NI		Ca	-	O_2	-	At	-	Potential -Problem area	Excessive winter nitrogen but no direct or indirect effects arising. PSP and DSP toxins detected sporadically and presence of *Alexandrium and Dinophysis* above respective assessment levels but no elevated trend detected.	Non-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	+						
(38) North Channel Great Island[2]	NI		Ca	-	O_2	+	At		Potential -Problem area	Elevated winter nitrogen and elevated summer dissolved oxygen supersaturation. PSP and DSP toxins detected sporadically and presence of *Alexandrium* and *Dinophysis* above respective assessment levels but no elevated trend detected.	Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	-						
(39) Glashaboy Estuary[2]	NI		Ca	-	O_2	-	At		Potential -Problem area	Excessive winter and summer nitrogen but no direct or indirect effects arising. High flushing rate may inhibit phytoplankton growth.	Non-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	+						

(40) Cork Harbour[3]	NI		Ca	-	O_2	-	At		Problem area	Elevated winter nitrogen and elevated phytoplankton bloom frequency. In the absence of elevated phytoplankton biomass, elevated bloom frequency on its own is not sufficient to indicate a direct effect. Classified as potential Problem area.	Potential-Problem area	
	DI	+	Ps	+	Ck							
	NP	+	Mp		Oc	-						
(41) Outer Cork Harbour[3]	NI		Ca	-	O_2	-	At		Problem area	Elevated winter nitrogen, winter N:P ratio and elevated phytoplankton bloom frequency. In the absence of elevated phytoplankton biomass, elevated bloom frequency on its own is not sufficient to indicate a direct effect. Elevated cover of green opportunistic algae on rocky shores requires further investigation and assessment. Classified as potential Problem area.	Potential-Problem area	
	DI	+	Ps	+	Ck							
	NP	+	Mp	?	Oc	-						
(42) Upper Bandon Estuary[1]	NI	-	Ca	+	O_2	+	At		Problem area	Elevated levels of winter nitrogen and elevated levels of chlorophyll, bloom frequency and DO supersaturation indicating excessive levels of photosynthesis. Elevated levels of organic enrichment in summer.	Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	+						
(43) Lower Bandon Estuary[2]	NI	-	Ca	+	O_2	+	At		Problem area	Elevated levels of winter nitrogen and elevated levels of chlorophyll, bloom frequency and DO supersaturation indicating excessive levels of photosynthesis. Elevated levels of organic enrichment in summer.	Problem area	
	DI	+	Ps	-	Ck							
	NP		Mp		Oc	+						
(44) Kinsale Harbour[3]	NI		Ca	+	O_2	-	At	-	Non-Problem area	Low levels ASP and DSP toxins present – no elevated trend detected.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(45) Argideen Estuary[2]	NI		Ca	+	O_2	+	At		Problem area	Elevated levels of winter and summer nitrogen. Excessive levels of green opportunistic macroalgae present in summer and elevated levels of chlorophyll-also present in summer. Elevated levels of organic enrichment in summer.	Problem area	
	DI	+	Ps		Ck							
	NP		Mp	+	Oc	+						
(46) Ilen Estuary[2]	NI		Ca	-	O_2	-	At		Potential -Problem area	Elevated phytoplankton bloom frequency, but in the absence of elevated biomass, insufficient to indicate a direct effect.	Non-Problem area	
	DI	+	Ps	+	Ck							
	NP		Mp		Oc	-						
(47) Inner Kenmare River[2]	NI		Ca	-	O_2	-	At		Non-Problem area	Elevated levels of organic enrichment.	Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(48) Kilmakilloge Harbour[2]	NI		Ca	-	O_2	-	At		Non-Problem area	Presence of DO undersaturation due to natural seasonal stratification and not anthropogenic nutrient enrichment.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(49) Outer Kenmare River[3]	NI		Ca	-	O_2	+	At		Non-Problem area	Presence of DO undersaturation due to natural seasonal stratification and not anthropogenic nutrient enrichment.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(50) Castlemain	NI		Ca	-	O_2	-	At		Non-Problem		Non-Problem area	
	DI	-	Ps		Ck							

e Harbour [2]	NP		Mp		Oc	-			area			
(51) Cromane[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(52) Lee (Kerry) Estuary [1]	NI		Ca	-	O_2	-	At		Potential-Problem area	Elevated winter phosphorus but no direct or indirect effects arising.	Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(53) Inner Tralee Bay[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP	-	Mp		Oc	-						
(54) Upper Feale Estuary [1]	NI		Ca	-	O_2	+	At		Potential Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	+						
(55) Cashen [2]	NI		Ca	-	O_2	-	At		Potential Problem area	Elevated organic enrichment: source unknown.	Potential Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	+						
(56) Deel Estuary[1]	NI	-	Ca	-	O_2	-	At		Problem area	Elevated summer phosphorus and summer BOD.	Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	+						
(57) Fergus Estuary [1]	NI	-	Ca	-	O_2	+	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(58) Maigue Estuary[1]	NI	-	Ca	-	O_2	+	At		Potential-Problem area	Elevated winter phosphorus and nitrogen but no direct or indirect effects arising.	Non-Problem area	
	DI	+	Ps		Ck							
	NP		Mp		Oc	-						
(59) Limerick Dock [1]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(60) Upper Shannon Estuary[1]	NI	-	Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(61) Lower Shannon Estuary[2]	NI	-	Ca	-	O_2	-	At	-	Non-Problem area	Low levels of DSP and *Dinophysis*; above assessment level but not considered at levels indicative of eutrophication.	Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(62) Kinvarra	NI		Ca	-	O_2	-	At		Potential -Problem	Some evidence that groundwater inputs of nutrients may be causing nutrient enrichment. Elevated phytoplankton bloom frequency.	Potential Problem area	
	DI	-	Ps	-	Ck							

Bay[3]	NP		Mp		Oc	+			area	Classed as potential Problem area because elevated bloom frequency on its own insufficient to indicate a direct effect and uncertainty about magnitude of groundwater inputs.		
(63) Corrib Estuary[2]	NI		Ca	-	O_2	-	At	-	Non-Problem area		Non-Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(64) Inner Galway Bay[3]	NI		Ca	-	O_2	-	At	-	Non-Problem area	Intermittent low levels of DSP, and *Dinophysis* above assessment level but not considered at levels indicative of eutrophication.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(65) Camus Bay[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(66) Kilkieran Bay[3]	NI		Ca	-	O_2	-	At		Non-Problem area	Change in benthic invertebrate community structure indicative of organic enrichment, but may be linked to collapse of large *Karenia mikimotoi* bloom in summer 2005. These blooms are known to originate offshore and are not thought to be linked to inshore nutrient enrichment.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(67) Erriff Estuary[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(68) Killary Harbour[3]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(69) Inner Clew Bay[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(70) Westport Bay[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp	-	Oc	-						
(71) Newport Bay[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(72) Moy Estuary[2]	NI		Ca	-	O_2	-	At		Potential Problem area	Elevated levels of green opportunistic macroalgae and phytoplankton bloom frequency.	Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp	+	Oc	-						
(73) Killala Bay[3]	NI		Ca	-	O_2	+	At	-	Potential Problem	Single elevated BOD measurement – insufficient to classify as potential Problem area.	Non-Problem area	
	DI	-	Ps		Ck							

	NP	-	Mp		Oc	-			area	AZP and low levels of DSP and *Dinophysis*.		
(74) Garavogue Estuary[2]	NI		Ca	-	O_2	-	At		Non-Problem area	Elevated phytoplankton bloom frequency, but insufficient on its own to indicate a direct effect in the absence of elevated biomass.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(75) Sligo Bay[3]	NI		Ca	-	O_2	-	At	-	Non-Problem area	Low levels of DSP, and *Dinophysis* above assessment level but not considered at levels indicative of eutrophication.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(76) Ballysadare Estuary[2]	NI		Ca	-	O_2	-	At		Non-Problem area	Elevated phytoplankton bloom frequency and DO supersaturation.	Potential Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(77) Erne Estuary[2]	NI	+	Ca	-	O_2	-	At		Potential Problem area	Elevated riverine inputs of total phosphorus (although not statistically significant) and elevated phytoplankton bloom frequency.	Potential Problem area	
	DI	-	Ps	-	Ck							
	NP		Mp		Oc	-						
(78) Inner Donegal Bay[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(79) Killybegs Harbour[3]	NI		Ca	-	O_2	+	At		Problem area	Depressed DO levels and elevated brown opportunistic algae in inner part of Harbour.	Problem area	
	DI	+	Ps		Ck							
	NP	-	Mp	+	Oc	-						
(80) McSwyne's Bay[3]	NI		Ca	-	O_2	+	At		Non-Problem area	Significant DO undersaturation in summer. Donegal Bay is an area of slack residual flow and water column stratification can occur close to the coast. Oxygen undersaturation in the bottom layer of this water body is likely to be due to the presence of seasonal water column stratification. Persistant and high levels of AZP, low levels of DSP toxins and low levels of *Dinophysis*.	Non-Problem area	
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc	-						
(81) Gweebarra Estuary[2]	NI		Ca	-	O_2	-	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP		Mp		Oc	-						
(82) Gweebarra Bay [3]	NI		Ca	-	O_2	+	At		Non-Problem area		Non-Problem area	
	DI	-	Ps		Ck							
	NP	-	Mp		Oc	-						
(83) Swilly Estuary[2]	NI		Ca	+	O_2	+	At		Problem area	Direct effects arising; excessive phytoplankton blooms may be linked to organic enrichment and elevated levels of dissolved organic matter (DOM).	Problem area	
	DI	-	Ps	+	Ck							
	NP		Mp		Oc	+						
(84) Lough	NI		Ca	-	O_2	-	At		Non-		Non-Problem	

Swilly[3]	DI NP	- -	Ps Mp	- 	Ck Oc	 -			Problem area		area	
The Netherlands												
Coastal Area	NI DI NP	? + +	Ca Ps Mp	+ + n.r	O_2 Ck Oc	- ? 	At	-	Problem area	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; O2 in 2009 (2008 missing); *Influenced by Rhine, and to lesser extent by Meuse and Scheldt.*	Problem area	2006–2014 comparison 2001-2005
Wadden Sea	NI DI NP	? + +	Ca Ps Mp	- + n.r.	O_2 Ck Oc	+ ? -	At	-	Problem area	Problem area in 2006–2014 based on all assessment parameters except oxygen; no change in overall status compared to previous years (2001-2005); averaged result is identical to 'per year' result, except for DIP in 2012, 2014; Ps in 2009; O2 in 2006, 2007, 2009 (2008 missing); *Influenced by coastal river (80%) and lake IJssel, through river Rhine.*	Problem area	2006–2014 comparison 2001-2005
Western Scheldt	NI DI NP	? + +	Ca Ps Mp	+ + n.r.	O_2 Ck Oc	+ ? 	At	-	Problem area	Problem area in 2006–2014 based on all assessment parameters except O2 (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; O2 in 2014; NB the station close to the Belgian border (Schaarvoddl) is problem area for O2. *Influenced by Scheldt.*	Problem area	2006–2014 comparison 2001-2005
Ems-Dollard	NI DI NP	? + +	Ca Ps Mp	- + n.r	O_2 Ck Oc	+ ? 	At	-	Problem area	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; O2 in 2007*. Influenced by Ems river and outlets of estuary*	Problem area	2006–2014 comparison 2001-2005
Southern Bight Offshore	NI DI NP	 - -	Ca Ps Mp	+ + n.r.	O_2 Ck Oc	- ? -	At	-	Problem area	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, the Netherlands and Belgium*	Problem area , trans-boundary transport	2006–2014 comparison 2001-2005
Oyster Grounds	NI DI	 -	Ca Ps	- -	O_2 Ck	- ?	At	-	Non-Problem	Non-Problem area; averaged result is identical to 'per year' result, except DIP in 2010, 2013. Change in overall status overall compared to	Non-problem area	2006–2014

	NP	-	Mp	n.r	Oc				area, based on toxic Ps	first assessment (1995-2000) due to change in toxic algae criterion. *Receiving waters from Atlantic Ocean and the United kingdom*		comparison on 2001-2005
Dogger Bank	NI		Ca	-	O_2	-	At	-	Non-Problem area	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 the United Kingdom*	Non-Problem area	2006–2014 comparison: ~2001-2005 ~1995-2000
	DI	-	Ps	-	Ck	?						
	NP	-	Mp	n.r.	Oc							
Norway												
N1	NI	+	Ca		O_2		At		Potential Problem area	Management plan (Skotte et al. 2011)	Non-problem area	
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							
N2	NI	+	Ca	-	O_2		At		Non-Problem area		Non-Problem area	1990-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							
N3	NI	+	Ca	-	O_2		At		Non-Problem area		Non-Problem area	1990 – 2014
	DI	+	Ps		Ck	-						
	NP	-	Mp	-	Oc							
N4 & N5	NI	+	Ca	+	O_2		At		Problem area	Expert judgement spatial coverage	Potential Problem area	1990 – 2014
	DI	+	Ps		Ck	-						
	NP	-	Mp		Oc							
N6	NI	+	Ca		O_2		At		Problem area	Expert judgement spatial coverage	Potential Problem area	1990 – 2014
	DI		Ps		Ck							
	NP		Mp		Oc							
M1	NI	+	Ca		O_2		At		Non-Problem area		Non-Problem area	1990 – 2014
	DI	-	Ps		Ck							
	NP	-	Mp	-	Oc							
M2	NI	+	Ca	-	O_2		At		Non-Problem area		Non-Problem area	1990 – 2014
	DI	-	Ps		Ck	-						
	NP	-	Mp		Oc							

M3	NI	+	Ca	-	O_2		At		Non-Problem area		Non-Problem area	1990 – 2014
	DI	+	Ps		Ck	-						
	NP	-	Mp		Oc							
M4 & N5	NI	+	Ca	+	O_2		At		Problem area	Expert judgement spatial coverage	Potential Problem area	1990 – 2014
	DI	+	Ps		Ck	-						
	NP	-	Mp		Oc							
M6	NI	+	Ca		O_2		At		Potential Problem area	Expert judgement spatial coverage	Potential Problem area	1990 – 2014
	DI		Ps		Ck							
	NP		Mp		Oc							
Sweden												
Skagerrak open sea	NI	-	Ca	-	O_2	-	At	?	Non-Problem area	The atmospheric deposition of total nitrogen to Skagerrak decreased significantly during the time periods 1990-2013 and 2000-2013. The nutrient inputs to Skagerrak from land had a significant decreasing trend for both total nitrogen and total phosphorus for the time period 1990-2014. There was also a significant decrease since 2006 for total nitrogen from land. Skagerrak is governed by trans-boundary transports from the North Sea of mainly nitrogen but also phosphorus. Mean concentrations of DIN were above the assessment level only twice during the assessment period and DIP were below during the whole period. Mean chlorophyll-a concentrations were at or below the reference value and was only once exceeding the assessment level. There were decreasing tendencies for DIN, DIP and chlorophyll-a but no significant trends. There were no problems with the oxygen situation in bottom waters or of the benthic fauna, oxygen concentrations and BQI were always above the assessment level.	Non-Problem area	1990 – 2014
	DI	-	Ps	-	Ck	-						
	NP	-	Mp	?	Oc	?						
Inner coastal	NI	-	Ca	+	O_2	-	At	+	Problem area	The nutrient input to Skagerrak from land decreased significantly for both total nitrogen and total phosphorus for the time period 1990-	Problem area	1990-2014
	DI	-	Ps	+	Ck	+						

waters of the west coast	NP	?	Mp	-	Oc	-				2014. There was also a significant decrease since 2006 for total nitrogen. Mean concentrations of DIN have improved recently and were during the assessment period generally below the assessment level. Concentrations of DIP were below the assessment level during the whole assessment period but without trends. Mean chlorophyll-a concentrations, on the other hand, were mainly elevated though the tendency was decreasing concentrations. Phytoplankton indicator species have been found above assessment levels every year during 2006–2014. There have been several occasions of DST (Diarrhetic Shellfish Toxin) infections in mussels during 2006–2014 and one occasion of PST (Paralystic Shellfish Toxin) infection in the area. There were no problems of the oxygen situation in bottom waters and oxygen concentrations were always above the assessment level. However, the BQI were below the assessment level for the Skagerrak coast. The Skagerrak inner coastal water is overall assessed as a problem area. Concentrations of nutrients are not the reason for the classification and the problems can thus have been caused by trans-boundary transport from adjacent areas.		
Fjords on the west	NI DI	- +	Ca Ps	- +	O_2 Ck	+ +	At	+	Problem area	The fjords on the west coast are governed by high DIN concentrations and only occasionally the DIN levels were below the assessment level.	Problem area	1990 – 2014

coast	NP	?	Mp	-	Oc	-				Concentrations of DIP were close to the assessment level but still mostly elevated. Trends for DIN and DIP were decreasing and the decrease was significant for DIN. Mean chlorophyll-a concentrations were not elevated and there was a significant decrease during the whole period. Phytoplankton indicator species have been found above the assessment levels every year during 2006 - 2014. There have been several occasions of DST (Diarrhetic Shellfish Toxin) infections in mussels during 2006–2014 and one occasion of PST (Paralystic Shellfish Toxin) infection in the area. Circulation of the deep water is restricted because of the natural characteristics of fjords which were also mirrored in the oxygen situation and benthic fauna. The bottom waters in the fjords suffer from anoxia and the lowest quartile of data had negative oxygen values meaning hydrogen sulphide. However, there is an increasing tendency during the later years. The BQI were mostly below the assessment level.		
Outer coastal	NI DI	- -	Ca Ps	- +	O_2 Ck	- +	At	?	Problem area	The nutrient inputs to Skagerrak from land have significant decreasing trends for both total nitrogen and total phosphor for the time period	Problem area	1990 – 2014

waters of Skagerrak	NP	?	Mp	-	Oc	+				1990-2014. There was also a significant decrease, since 2006, for total nitrogen. There was a net transport of nutrients from the coastal waters to the open sea. Mean concentrations of DIN have improved recently in the outer coastal waters in Skagerrak and were generally below the assessment level. DIP was never elevated and had also a significant decreasing trend since 1993. Chlorophyll-a was only elevated a few times during the assessment period and the macrophytes were in good status according to the WFD assessment. Phytoplankton indicator species have been found above the assessment levels every year during 2006–2014. Algal toxins in mussels are not monitored in this area. There were no problems with low oxygen concentrations but the BQI were below the assessment level and the benthic fauna was thus in bad condition. There was a significant increasing trend for POC for the long time period 1993–2014, for the short time period there was an increasing tendency. The Skagerrak outer coastal waters are overall assessed as problem area. Concentrations of nutrients are not the reason for the classification and the problems can thus have been caused by trans-boundary transport from adjacent areas.		
Kattegat open sea	NI DI	- +	Ca Ps	- +	O_2 Ck	+ +	At	?	Problem area	The atmospheric deposition of total nitrogen to Kattegat decreased significantly during the time periods 1990-2013 and 2000-2013. The	Problem area	1990 – 2014

	NP	-	Mp	?	Oc	?				nutrient input to Kattegat from land had a significant decreasing trend for both total nitrogen and total phosphorus for the time period 1990-2014. There was also a significant decrease since 2006 for total nitrogen. There is a net export of nutrients from the Swedish zone of Kattegat towards the coastal water and the western parts of Kattegat. There were decreasing trends for DIN in Kattegat during the time period 1993-2014, and the trend was significant in the northern parts. Concentrations of DIN were still generally elevated, especially in the southern parts of Kattegat while DIP was closer to the assessment level. However, no trends were observed for DIP. Chlorophyll-a was significantly decreasing and close to the reference value. The assessment level was only exceeded once during the assessment period. Phytoplankton indicator species have been found above Swedish assessment levels every year except 2012. Algal toxins in mussels are not monitored in this area. The oxygen concentrations, lowest quartile of data, in the deep water were always below the assessment level and the benthic fauna was also in bad condition.		
Inner coastal	NI DI	- -	Ca Ps	- +	O_2 Ck	- +	At	?	Problem area	The nutrient input to Kattegat from land had a significant decreasing trend for both total nitrogen and total phosphorus for the time period	Problem area	1990 – 2014

waters of the west coast	NP	?	Mp	-	Oc	+				1990–2014. There was also a significant decrease since 2006 for total nitrogen. Concentrations of DIN and DIP were not elevated during the assessment period. However, normalisation of DIN resulted in many negative DIN-values which make the assessment uncertain. Nitrogen in the inner coastal waters of Kattegat has a strong relationship with salinity and DIN is decreasing towards the sea. DIN and DIP decreased in the area but only significantly, 1993–2014, for DIN. Chlorophyll-a decreased during the whole period, however not significantly, and was only elevated once during the assessment period. The macrophytes were in good status according to the WFD assessment. Phytoplankton indicator species have been found above the Swedish assessment levels every year except 2012 and 2013. Algal toxins in mussels are not monitored in this area. There were no problems with oxygen deficiency but the BQI were below the assessment level and the benthic fauna was thus in bad condition. There was a significant increasing trend for POC for the long time period 1993–2014, for the short time period there was however an decreasing tendency.		
Outer coastal	NI DI	- +	Ca Ps	- +	O_2 Ck	- +	At	?	Problem area	The nutrient inputs to Kattegat from land have significantly decreased for both total nitrogen and total phosphorus for the time period	Problem area	1990 - 2014

waters of Kattegat	NP	?	Mp	-	Oc	+				1990–2014. There is also a significant decrease since 2006 for total nitrogen. There is a net transport of nutrients from the coastal waters to the open sea. Concentrations of DIN have improved during the later years and there was a significant downward trend for 1993–2014. Concentrations of DIP, on the other hand, were mainly elevated during the assessment period. Improvements were also seen in chlorophyll-a that was elevated only once during the assessment period and significantly decreased in 1993–2014. The macrophytes were in good status according to the WFD assessment. Phytoplankton indicator species have been found above the Swedish assessment levels every year except 2013. Algal toxins in mussels are not monitored in this area. There were no problems with oxygen deficiency in the area but the BQI were below the assessment level and the benthic fauna was thus in bad condition. There was a significant increasing trend for POC for the long time period there was however a decreasing tendency.		
Coastal waters of southern Halland and the northern Sound	NI DI NP	- + ?	Ca Ps Mp	- + -	O_2 Ck Oc	- + -	At	?	Problem area	The nutrient input to Kattegat from land had a significant decreasing trend for both total nitrogen and total phosphorus for the time period 1990–2014. There was also a significant decrease since 2006 for total nitrogen. This area has a net inflow of nutrients from Kattegat and the Sound. Only DIP were elevated during the assessment period and there were an increasing tendency for DIN while it was decreasing for DIP, no significant trends were however found. Chlorophyll-a was improved during the later years but without significant trends. The macrophytes were in good status according to the WFD assessment. Phytoplankton indicator species have been found above the Swedish assessment levels every year except 2012 and 2013. Algal toxins in mussels are not monitored in this area. There were no problems with oxygen deficiency but the BQI were below the assessment level and the benthic fauna was thus in bad condition. The oxygen situation has improved and significant positive trends were found in 2006–2014.	Problem area	1990 – 2014
Coastal waters of	NI DI	- +	Ca Ps	+ -	O_2 Ck	- -	At	?	Problem area	DIN, DIP and chlorophyll-a was elevated during the assessment period and especially DIN tended to increase. However, normalisation of DIN	Problem area	2006–2009(O_{2})

the Sound	NP	?	Mp	-	Oc	+				resulted in many negative DIN-values which make the assessment uncertain. Nitrogen in the inner coastal waters of the Sound has a strong relationship with salinity and DIN is decreasing towards the sea. Some of the monitoring stations in the Sound are situated in Lommabukten where very high DIN-values were measured. Chlorophyll-a decreased significantly since 2006 but, on the other, hand, the value in 2006 was the highest during the whole period. The macrophytes were in good status according to the WFD assessment. No phytoplankton indicator species have been observed above the Swedish assessment levels. Although not an OSPAR indicator, the potentially toxic diatom genus Pseudo-nitzschia (AST, Amnesic Shellfish Toxin) is reported here due to its toxicity. The genus has been observed above the Swedish assessment level 2008 and 2009 in this area. Data has however not been delivered to the data host since 2012. There were no problems with oxygen deficiency in the Sound and the BQI were mostly above the assessment level although the time series was short (2006 - 2009). There was a significant increasing trend for POC for the long time period		1993–2014 (POC)
Göta river – and Nordre river estuary	NI DI NP	- + ?	Ca Ps Mp	+ ? ?	O_2 Ck Oc	- ? ?	At	?	Problem area	Concentrations of DIN were elevated and even though there was a significant decreasing trend (1993 - 2014) concentrations are far from the assessment level. DIP, on the other hand, is mostly below the assessment level. Chlorophyll-a was elevated in the area but decreased significantly during 1993–2014. There are no phytoplankton data or data from algal toxins in mussels in this area. There were no problems with oxygen deficiency in the transitional river waters.	Problem area	1990 – 2014
United Kingdom												
Northern North Sea	NI DI	- -	Ca Ps	-	O_2 Ck	-	At		Non-Problem	• There is good evidence that the area is not nutrient enriched	Non-Problem area	2006–2014

– coastal	NP	-	Mp		Oc				area	(high confidence) based on nutrient data with good representivity. • There is evidence that there is no accelerated growth (high confidence) in the area based on chlorophyll data with good representivity. • The available evidence does not suggest any undesirable disturbance (high confidence) based on dissolved oxygen data with moderate representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing but there is a small increasing trend in chlorophyll.		
Northern North Sea – offshore	NI DI NP	- - -	Ca Ps Mp	+	O_2 Ck Oc	-	At	+	Non-problem area	• There is good evidence that the area is not nutrient enriched (high confidence) based on nutrient data with good representivity. • There is evidence that there is no accelerated growth (high confidence) in the area based on chlorophyll data with good representivity. • The available evidence does not suggest any undesirable disturbance (high confidence) based on dissolved oxygen data with moderate representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing but there is a small increasing trend in chlorophyll.	Non-problem area	2006–2014
Southern North Sea – coastal	NI DI NP	- + -	Ca Ps Mp	-	O2 Ck Oc	-	At		Non-problem area	• There is good evidence that the area is nutrient enriched (high confidence) based on nutrient data with good representivity. • There is evidence that there is no accelerated growth (high confidence) based on chlorophyll data with good representivity. • The available evidence does not suggest any undesirable disturbance (high confidence) based on dissolved oxygen data with low representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing and there is a decreasing trend in DIN.	Non-problem area	2006–2014
Southern North Sea	NI DI	- -	Ca Ps	-	O_2 Ck	-	At		Non-problem	• There is good evidence that the area is not nutrient enriched	Non-problem area	2006–2014

– offshore	NP	-	Mp		Oc				area	(high confidence) based on nutrient data with good representivity. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data with good representivity. • The available evidence does not suggest any undesirable disturbance (low confidence) based on limited dissolved oxygen data. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.		
English Channel – coastal	NI	-	Ca	?	O_2	?	At		Not Known	• There is evidence that the area is nutrient enriched (low confidence) based on limited nutrient data with moderate representivity. • There is evidence that there is no accelerated growth (low confidence) based on limited chlorophyll data with low representivity. • There is no evidence to assess undesirable disturbance. It is confirmed that the status of the area is not known due to lack of data. Nitrogen inputs to the area are decreasing (but not significant) and, based on previous non-problem area status, it is likely that the area is a non-problem area.	Not Known	2006–2014
	DI	?	Ps		Ck							
	NP	?	Mp		Oc							
English Channel – offshore	NI	-	Ca	-	O_2	?	At		Non-problem area	• There is evidence that the area is not nutrient enriched (medium confidence) based on nutrient data with moderate representivity. • There is evidence that there is no accelerated growth (high confidence) based on limited chlorophyll data with low representivity. • There is no evidence to assess undesirable disturbance. It is confirmed that this area remains a non-problem area (low confidence) based on the absence of nutrient enrichment and accelerated growth.	Non-problem area	2006–2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							
Celtic Sea – coastal	NI	-	Ca	?	O_2	?	At		Non-problem	• There is evidence that the area is nutrient enriched (low	Not known	2006–2014
	DI	+	Ps		Ck							

	NP	?	Mp		Oc				area	confidence) based on very limited nutrient data with moderate representivity. • There are no data to assess the presence of any accelerated growth nor any undesirable disturbance. • The area is adjacent to the Bristol Channel, known to be nutrient enriched but not experiencing accelerated growth or undesirable disturbance due to its high turbidity/very low light climate. It is confirmed that the status of the area is not known due to lack of data. Nutrient inputs to the area are decreasing and, based on previous non-problem area status, it is likely that the area is a non-problem area.		
Celtic Sea – offshore	NI	-	Ca	-	O_2	-	At		Non-problem area	• There is evidence that the area is not nutrient enriched (high confidence) based on available nutrient data of moderate representivity. Nutrient concentrations are decreasing. • There is evidence that there is no accelerated growth (high confidence) based on limited chlorophyll data of low - moderate representivity. • The available evidence does not suggest any undesirable disturbance (low confidence) based on limited dissolved oxygen data. It is confirmed that this area remains a non-problem area (medium confidence) based on the available evidence. Nutrient inputs to the area are decreasing and winter nutrient concentrations are decreasing.	Non-problem area	2006–2014
	DI	-	Ps		Ck							
	NP	?	Mp		Oc							
Irish Sea – coastal	NI	-	Ca	-	O_2	-	At		Non-problem area	• There is evidence that the area is not nutrient enriched (high confidence) based on nutrient data of good representivity. DIN concentrations are decreasing. • There is evidence that there is no accelerated growth (high confidence) based on chlorophyll data of good representivity. • The available evidence does not suggest any undesirable disturbance (high confidence) based on dissolved oxygen data of low representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs are decreasing.	Non-problem area	2006–2014
	DI	-	Ps	-	Ck							
	NP	-	Mp		Oc							
Irish Sea –	NI	-	Ca	-	O_2	?	At		Non-	• There is evidence that this area is not nutrient enriched (high	Non-problem	2006–

offshore	DI NP	- -	Ps Mp		Ck Oc				problem area	confidence) based on nutrient data of good representivity. DIN concentration is decreasing. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of good representivity. • There is no evidence to assess undesirable disturbance. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.	area	2014
Minches and Western Scotland – coastal	NI DI NP	- - -	Ca Ps MP	-	O_2 Ck Oc	?	At		Non-problem area	• There is no evidence that the area is nutrient enriched (high confidence) based on nutrient data of good representivity. • There is evidence that there is no accelerated growth (high confidence) based on chlorophyll data of good representivity. • The available evidence does not suggest any undesirable disturbance (moderate confidence) based on dissolved oxygen data of moderate representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs are decreasing.	Non-problem area	2006–2014
Minches and Western Scotland – offshore	NI DI NP	- - -	Ca Ps MP	-	O_2 Ck Oc	?	At		Non-problem area	• There is evidence that this area is not nutrient enriched (high confidence) based on nutrient data of good representivity. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of good representivity. • There is good evidence that there is no undesirable disturbance based on oxygen concentrations with moderate representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.	Non-problem area	2006–2014
Scottish Continenta l Shelf – coastal	NI DI NP	- - -	Ca Ps MP	-	O_2 Ck Oc	?	At		Non-problem area	• There is no evidence that the area is nutrient enriched (high confidence) based on nutrient data of moderate representivity. • There is evidence that there is no accelerated growth (high confidence) based on chlorophyll data of moderate representivity. • There are no data on undesirable disturbance. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs are decreasing.	Non-problem area	2006–2014
Scottish	NI	-	Ca	-	O_2	-	At		Non-	• There is evidence that this area is not nutrient enriched (high	Non-problem	2006–

Continental Shelf – offshore	DI NP	- -	Ps MP		Ck Oc				problem area	confidence) based on nutrient data of moderate representivity. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of moderate representivity. • There is good evidence that there is no undesirable disturbance (high confidence) based on oxygen concentrations with low representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.	area	2014
Atlantic and North-West Approaches – offshore	NI DI NP	-	Ca Ps MP	-	O_2 Ck Oc	-	At		Non-problem area	• There are no data on nutrient concentrations in this region. • There is good evidence that there is no accelerated growth (high confidence) based on chlorophyll data of moderate representivity. • There is evidence that there is no undesirable disturbance (high confidence) based on oxygen concentrations with low representivity. It is confirmed that this area remains a non-problem area (high confidence) based on the available evidence. Nutrient inputs to the area are decreasing.	Non-problem area	2006–2014

Annex 3 List of Problem and Potential Problem Areas

PA; problem area. PPA; potential problem area. NPA; non-problem area

Notes against Contracting Party names

(1) Denmark reported on 38 assessment areas; this list does not entirely match the list of 22 assessment areas from the second Comprehensive Procedure

(2) France reported on 28 assessment areas; this list does not entirely match the list of 24 assessment areas from the second Comprehensive Procedure

(3) No final report yet

(4) Ireland reported on 83 assessment areas; this list does not entirely match the list of assessment areas from the second Comprehensive Procedure

(5) Norway reported on a different list of assessment areas from that used in the second Comprehensive Procedure

(6) Sweden reported on a different list of assessment areas from that used in the second Comprehensive Procedure

Contracting Party and marine area	Classification in 2003	Classification in 2008	Classification in 2016
Belgium			
Coastal area	PA	PA	PA
Offshore area	PPA	PPA	NPA
Denmark (1)			
Kattegat			
Kattegat Coastal areas	PA		
Western coastal area:		PA	
Aalborg Bight			PA
Ålbæk Bight			PA
Djursland:		PA	
Djursland East			PA
Djursland North (Hevring Bight)			PA
Southern coastal:		PA	
>20 meters			PA
<20 meters			PA
Kattegat fjords and estuaries			
Limfjorden – eastern part		PA	
Limfjorden – central (/eastern) parts		PA	PA
Limfjorden – southern parts (Hjarbæk Fjord)		PA	PA
Limfjorden – western parts		PA	PA
Mariager Fjord:		PA	
Inner part			PA
Outer part			PA
Randers Fjord:		PA	
Inner part (Grund Fjord)			PA
Middle part			PA
Outer part			PA

Contracting Party and marine area	**Classification in 2003**	**Classification in 2008**	**Classification in 2016**
Sejerø Bight			PA
Isefjord:		PA	
Outer part			PA
Inner part			PA
Roskilde Fjord:		PA	
Outer part			PA
Inner part			PA
Kattegat Open areas	PA		PA
Northern part		PA	
Central part:		PA	PA
Anholt		PA	PA
Læsø			PA
Southern part		PA	
The Sound			
Open areas	PA		PA
Øresundstragten (Open area)	PA		PA
Northern part	PA		PA
Copenhagen Harbour	PA		
Skagerrak			
Skagerrak Coastal area	PA	PA	PA
Skagerrak Open area	PA	NPA	NPA
North Sea			
North Sea open waters	NPA	PA	NPA
North Sea Southern coastal waters:		PA	
North Sea, Southern Coastal waters (1nm)		PA	PA
Wadden Sea:	PA	PA	
Juvre Dyb	PA	PA	PA
Listerdyb	PA	PA	PA
Knude Dyb, tidal area	PA	PA	PA
Graa Dyb, tidal area	PA	PA	PA
North Sea Coastal area (1 nm)	PA	PA	PA
Ringkøbing Fjord		PA	PA
Nissum Fjord:		PA	
Nissum Outer Fjord			PA
Nissum Middle Fjord			PA
France (2)			
Dunkerque and Calais	PA	PPA	PA
Boulogne and Canche	PA	PPA	PA
Pays de Caux	PA	PPA	NPA
Estuary and Bay of Seine	PA	PA	PA
Calvados	PA	PA	PA
Bay des Veys and St Vaast	PPA	PPA	PPA
Cherbourg	NPA	NPA	NPA

Contracting Party and marine area	Classification in 2003	Classification in 2008	Classification in 2016
West Cotentin	NPA	NPA	NPA
Mont Saint Michel Bay	NPA	NPA	NPA
Rance	NPA	PA	PA
Arguenon and Fresnaye	PA	PA	
St Brieuc	PA	PA	PA
Paimpol, Trieux, Jaudy	PPA	PPA	PPA
Lannion	PA	PA	PA
Morlaix	PA	PA	
Abers finistériens	NPA	PA	NPA
Iroise (not identified in 2002)	NPA	PPA	PPA
Brest	PPA	PA	PPA
Douarnenez	PA	PA	PA
Audierne	NPA	PA	PPA
Concarneau	PA	PA	PPA
Aven, Belon (and Laïta)	NPA	PA	
Lorient	PPA	PPA	PPA
Etel (and Groix)	NPA	PPA	
Bay of Quiberon and Belle Ile			PPA
Golfe du Morbihan	NPA	PPA	PA
Vilaine	PPA	PA	PA
Loire and Bourgneuf	PA	PA	PPA
Vendée, Pertuis and Marennes	NPA	NPA	NPA
Grionde	NPA	NPA	NPA
Bassin d'Arcachon (Arcachon and Landes)	PA	NPA	PPA
Pays Basque	NPA	NPA	NPA
Germany (3)			
Estuaries (<28): Elbe, Weser, Ems	PA	PA	PA
Wadden Sea (15-33)	PA	PA	PA
Coastal Waters (25-34.5)	PA	PA	PPA PA
Offshore (>34.5)	PPA	PPA	PA NPA
Ireland (4)			
E16 Castletown Estuary	PA	PA	PA
Inner Dundalk Bay	NA	PA	PA
Boyne Estuary	NA	PPA	PPA
Rogerstown Estuary (Inner)	NA	PA	PA
Rogerstown Estuary (Outer)	NA	PA	PA
E12 Broadmeadow Estuary (Inner)	PA	PA	PA
E30 Liffey Estuary	PA	PPA	PPA
E39 Slaney Estuary (Upper)	PA	PA	NPA
E40 Slaney Estuary (Lower)	PA	PA	PA
South Wexford Harbour	NA	PA	NA
Wexford Harbour	NA	PA	PPA
Nore Estuary	NA	PA	NPA

Contracting Party and marine area	**Classification in 2003**	**Classification in 2008**	**Classification in 2016**
E3 Barrow Estuary	PA	PA	PA
E5 Suir Estuary (Upper)	PA	PA	PA
E18 Colligan River	PA	PA	PA
E19 Dungarvan Harbour	PA	PA	PPA
E8a Blackwater Estuary Upper	PA	PA	NPA
E8b Blackwater Estuary Lower	PA	PA	PA
E26a Lee Estuary/Lough Mahon	PA	PA	PPA
E26b Owennacurra Estuary/North Channel	PA	PA	NPA
E1a Upper Bandon Estuary	PA	PA	PA
E1b Lower Bandon Estuary	PA	PA	PA
Kinsale Harbour	NA	PA	NPA
Argideen Estuary	NA	PA	PA
E28a Upper Lee (Tralee) Estuary	PA	PA	NPA
E28b Lower Lee (Tralee) Estuary	PA	PPA	NPA
E15a Upper Feale Estuary	PA	NPA	NPA
E15b Cashen Feale Estuary	PA	PPA	PPA
E36 Maigue Estuary	PPA	NPA	NPA
E37 Deel Estuary	PPA	NPA	PA
E38 Fergus Estuary	PA	NPA	NPA
E24 Killybegs Harbour	PA	PA	PA
McSwyne’s Bay	NA	PPA	NPA
Upper Swilly Estuary	NA	PA	PA
Netherlands			
Dutch offshore Oyster Grounds	PA	NPA	NPA
Dogger Bank	NPA	NPA	NPA
Dutch offshore Southern waters	PA	PA	PA
Dutch coastal waters (salinity < 34.5)	PA	PA	PA
Dutch Wadden Sea	PA	PA	PA
Dutch Ems Dollard	PA	PA	PA
Dutch Western Scheldt	PA	PA	PA
Norway (5)			
A1 Iddefjorden	PA	PA	PA
A2 Hvaler/Singlefjord	PA	PA	PA
A3 Inner Oslofjord	PA	PA	PA/NPA
A4 Drammensfjord	PA	PA	PA
A5 Sandebukta etc.	PA	PA	PA
A6 Middle part of outer Oslofjord coastline	PA	PA	NPA
A7 Southern part of outer Oslofjord	PPA	PA	NPA
A8 Tønsbergfjord	PA	PA	PA
A9 Southern part of Tønsbergfjord	PPA	PA	NPA
A10 Sandefjordsfjord	PA	PA	PA
A11 Larviksfjord and Viksfjord	PPA	PA	NPA
A12-A13 Frierfjord/Grenlandsfjord	PA	PA	PA

Contracting Party and marine area	Classification in 2003	Classification in 2008	Classification in 2016
A14 Telemark	PPA	PA	PA/NPA
A15 Stølefjord/ Kragerøfjord	PPA	PA	PA
A16 Stølefjord/ Kragerøfjord	PA		PA
A17-A18 Søndeledfjord/ Sandnesfjord	PA	PA	PA
A19 Lyngør archipelago	PPA	PA	PA
A20 Tvedestrandsfjord	PA	PA	PA
A21 Flostadøysund	PPA	PA	PA
A22 Tromøysund	PPA	PA	PA
A23 Arendal fjord and Utnes	PA	PA	NPA
A24 Arendal fjord and Utnes	PPA		NPA
A25 Fevik coast	PPA	PA	PA
A26 Grosfjord, Vikkil and Bufjord	PPA	PA	PA/NPA
A27 Grosfjord, Vikkil and Bufjord	PPA	PA	PA/NPA
A28 Kaldvellfjord	PPA	PA	PA
A29 Lillesand outer	PPA	PA	NPA
A30 Skallefjord and Tingsakerfjord	PPA	PA	PA
A31-A32 Steindalsfjord, Isefjærfjord and Blindleia south	PA	PA	PA/NPA
A33 Steindalsfjord, Isefjærfjord and Blindleia south	PPA	PA	PA/NPA
A34 Kvåsefjord	PPA	PA	PA
A35-A36 Ålefjærfjord, Topdalsfjord and Kristiansandsfjord	PPA	PA	PA/NPA
A37-A38 Vågsbygd and Songvårdsfjord	PPA	PA	NPA
A39 Trysfjord	PA	PA	PA
A40 Harkmarksfjord	PPA	PA	PA
A41 Buøysund	PPA	PA	PA
A42 Skogsfjord	PPA	PA	PA
A43 Mannefjord	PPA	PA	PA
A44 Hillesund-Snigsfjord	PPA	PA	PA
Sweden (6)			
6. The Sound			PA
5. Southern Halland and the northern Sound coastal waters			PA
1s. Kattegat inner coastal waters			PA
Coastal Kattegat	PA	PA	
4. Kattegat Outer Coastal Waters			PA
Offshore Kattegat	PA	PA	PA
2. Skagerrak fjords			PA
1n. Skagerrak Inner Coastal Waters			PA
Coastal Skagerrak	PA	PA	
3. Skagerrak Outer Coastal Waters			PA
Offshore Skagerrak	PA	NPA	NPA
United Kingdom			
England and Wales			

Contracting Party and marine area	Classification in 2003	Classification in 2008	Classification in 2016
Chichester Harbour	PA	PA [a]	PA [a]
Eastern Yar (Solent)		PA [a]	PA [a]
Fal Lower estuary		PA [a]	PPA [b]
Fleet Lagoon (The Fleet)	PPA	PPA [a]	PA [a]
Hamble estuary		PA [a]	PA [a]
Holes Bay	PA	PA [a]	PA [a]
Holy Island & Budle Bay (Lindisfarne NNR)	PA	PA [a]	PA [a]
Kingsbridge			PA [c]
Langstone Harbour	PA	PA [a]	PPA [a, b]
Medina estuary (Solent)		PA [a]	PA [a]
Newtown River (Newtown Harbour)		PA [a]	PA [a]
Pagham Harbour	PA	PA [a]	PPA [a, b]
Poole Harbour	PPA	PPA [a]	PA [a]
Portsmouth Harbour	PA	PA [a]	PA [a]
Taw Estuary	PA	PA [a]	PPA [a, b]
Tees (Seal Sands)	PA	PA [a]	PA [a]
Truro, Tresillian and Fal Upper	PA	PA [a]	PPA [a, b]
Wales			
Burry Inlet Inner (Loughor Estuary)	PPA	PA [a]	PA [a]
Milford Haven Inner			PPA
Tawe – Beaufort Weir to Barrage	PA	PA [a]	PA [a]
Scotland			
South Esk estuary (Montrose basin)		PPA	PPA
Ythan Estuary	PA	PA	PA [a]
Northern Ireland			
Bann Estuary (HMWB) [d]			PPA
Belfast Harbour	PA		PA
Belfast Lough Inner	PA	PA	PA
Connswater (HMWB) [d]			PPA
Dundrum Bay Inner			PA
Foyle estuary and lough [d]		PPA	PPA
Lagan Estuary (HMWB)	PA	PA	PA
Newry Estuary (HMWB)			PA
Quoile Pondage (HMWB)		PA	PA
Roe Estuary [d]			PPA
Strangford Lough North		PPA	NPA

United kingdom footnotes

[a] Sensitive Areas (Urban Waste Water Treatment Directive) or Polluted Areas (Nitrates Directive)

[b] Designated previously but improving in response to management measures

[c] Not yet formally classified as problem area, but likely to be designated as a Polluted Water (Eutrophic) under the Nitrates Directive

[d] Final classification based on Water Framework Directive results and expert judgement

Contracting Party and marine area	Classification in 2003	Classification in 2008	Classification in 2016
Portugal			
Mondego Estuary	PPA	PPA	
Spain			
Basque region			
Butroe Estuary		PPA	
Oka Estuary		PPA	
Inurritza Estuary (unit of the Oria)		PPA	
Oiartzun Estuary		PPA	
Cantabria			
Oyambre Estuary		PPA	
Santander Bay		PPA	
Joyel Estuary and marshes		PPA	
Victoria Esturay and marshes		PPA	
Santoña Estuary and marshes		PPA	
Andalucia			
Tinto-Odiel Estuary		PPA	
Guadalquivir Estuary		PPA	
P. N. Bahía de Cádiz	PPA	PPA	

Annex 4 Assessment levels and parameters used by Contracting Parties

Area specific background concentrations of winter nutrients, growing season chlorophyll-a and dissolved oxygen can be found in Annex 6b of the OSPAR Common Procedure (OSPAR, 2013).

4.1 Assessment levels for winter DIN and winter DIP

Table A4.1: *Salinity-related assessment levels used by Contracting Parties for winter DIN and winter DIP (mostly November-February)*

OSPAR Region	Contracting Party	Salinity: normalisation value (and nominal range)	Winter DIN ($\mu mol\ l^{-1}$) Range of salinity-related assessment levels			Winter DIP ($\mu mol\ l^{-1}$) Range of salinity-related assessment levels			Remarks
			Offshore	Coast	Estuary	Offshore	Coast	Estuary	
II	Sweden/Kattegat	20	6/3.5 N/S	6.0-6.8	6.8	0.6	0.6	0.6	
II	Sweden/Skagerrak	27	9	9	9	0.75	0.75	0.75	
II	Sweden/Sound	20	---	6	---	---	0.6	---	
II	Norway[1]	20	---	9	9	---	0.7	0.7	
II	Denmark/North Sea open	(30–34.5)	8.25	5.3-5.9	---	0.98	0.6-0.9	---	
II	Denmark/Skagerrak	(30-34)	8.25	7.4	---	0.98	0.9	---	
II	Denmark/Kattegat	(20-30)	5	9.9-14.7	42.89	0.49	0.7-0.8	1.29	
II	Denmark/Wadden Sea	(27-34) 20-33	---	17.3	---	---	0.6	---	
II	Denmark/Sound	? 13.3-17.6	12.26	---	---	0.39	---	---	
II	Germany	1.0-34.8	7.1-7.8	9.1-29.1	62.5-85.2	0.60	0.61-0.81	1.13-1.38	
II	Netherlands	30	15	30	30	0.8	0.8	0.8	
II	Netherlands/Wadden Sea	30	---	7	---	0.7	---	---	
II	Belgium	33.5	12	22.5	---	0.8	0.8	---	
II	France[5]	33	---	29	---	---	---	---	
II	United Kingdom[3]	>34.5 (offshore) 30-34.5 (coastal)	15	18	30	---	---	---	
III	United Kingdom[3]	>34.5 (offshore) 30-34.5 (coastal)	15	18	30	---	---	---	Irish Sea offshore>34 Irish Sea coastal S30-34
III	Ireland[6]	>34.5, 1-17, 0	18	18	100	1.25	1.25	2	
IV	France[5]	33	---	29	---	---	---	---	

OSPAR Region	Contracting Party	Salinity: normalisation value (and nominal range)	Winter DIN (µmol l^{-1}) Range of salinity-related assessment levels			Winter DIP (µmol l^{-1}) Range of salinity-related assessment levels			Remarks
			Offshore	Coast	Estuary	Offshore	Coast	Estuary	
	Spain[4]	30 (0.5 - >35)	---	12-15	24-50	---	0.68-1.0	0.78-1.10	
	Portugal	---	--	---	66[2] (0-36)	---	---	---	

[1] Norway used summer mean concentrations for nutrients with the assessment levels from the Norwegian Classification System.
The values that are given here are the assessment levels for the nutrient winter mean concentrations of that same system. Recalculated from mg l^{-1}

[2] Portugal used the measured value of 1993

[3] The United Kingdom used the N/P ratio = 24 as assessment level (corresponds with 0.625, 0.83, 1.25 µmol l^{-1} DIP for offshore, coast and estuaries, respectively)
The United Kingdom did not use winter DIP as nitrogen is the limiting nutrient in United Kingdom waters

[4] Provisional values for Spain; a range needs to be established for all Spanish autonomous communities. Values for the coast are referred to 35 (average)

[5] France considered that the relationship between nutrient concentration and eutrophication is too complex to define a eutrophication criterion based on nutrient concentrations or nutrient ratios

[6] Applied as medians

from national Reports 2016, from second application of the Common Procedure , new areas; salinity 2006–2014

4.2 Assessment levels for chlorophyll-a during growing season (mostly March-October)

Table A4.2: *Assessment levels used by Contracting Parties for chlorophyll-a mean and maximum (max.) concentrations and the 90 percentile (90 per.)*

OSPAR Region	Contracting Party	Chlorophyll-a (µg l^{-1})									Remarks
		Offshore			Coast			Estuary			
		Mean	Max.	90 per.	Mean	Max.	90 per.	Mean	Max.	90 per.	
II	Sweden/Kattegat	1.5	---	---	1.50-2.80	---	---	2.7	---	---	
	Sweden/Skagerrak	1.8	---	---	1.7-2.1	---	---	3.6	---	---	
	Sweden/Sound	---	---	---	1.50	---	---	---	---	---	
	Norway	3.5	---	---	3.5	---	---	3.5	---	---	
	Denmark/North Sea open	3.45	---	---	6.85	---	---	8	---	---	estuaries = Fjords
	Denmark/Skagerrak	3.6	---	---	4	---	---	---	---	---	**DK: mean oder 90 perc?**
	Denmark/Kattegat	1.5	---	---	1.6, 1.9	---	---	2.1 - 9.0	---	---	7x1.6, 2x1.9
	Denmark/Wadden Sea	---	---	---	7.5	---	---	---	---	---	
	Denmark/Sound	2.55	---	---	1.65	---	---	---	---	---	
	Germany	1.3-1.5	---	2.6-3.0	1.8-5.5	---	3.59-11.0	---	---	---	
	Netherlands	2.25	---	4.5	7.5	---	15	4.5-9	---	9-18	
	Netherlands/Wadden Sea	---	---	---	12	---	24	---	---	---	
	Belgium	---	---	8.4	---	---	15	---	---	---	
	France	---	---	---	---	---	15	---	---	15	
	United Kingdom	---	---	10	---	---	15	---	---	15	
III	United Kingdom	---	---	10	---	---	15	---	---	15	
	Ireland[2]	10	---	20	15	---	30	15	---	30	
IV	France	---	---	---	---	---	10	---	---	10	
	Spain[1]	---	---	---	---	---	7-12	12	---	15	
	Portugal	---	---	---	---	---	---	7.4	56	15	

[1] Provisional values for Spain. A range still must be established for all Spanish autonomous communities. For estuaries, the value for mean chlorophyll is applied in Andalusia; the value for the 90 percentile is applied in Basque Country

[2] Applied as median. Assessment levels derived from chlorophyll data extracted using the hot methanol extraction method, assessment levels for chlorophyll data based on cold acetone extraction are 50% lower

4.3 Assessment levels for oxygen

***Table A4.3**: Assessment levels used by Contracting Parties for oxygen in bottom layer for stratified water or in surface layer mixed waters; 'nr' marks where oxygen concentration is not relevant for the assessment*

OSPAR Region	Contracting Party	Oxygen deficiency in concentration (mg l^{-1})	% saturation
II	Sweden/Kattegat	5/3 offshore/coast	
	Sweden/Skagerrak	5/3 offshore/coast	
	Norway	5*	---
	Denmark	---	---
	Germany	6	70%, 84%**
	Netherlands	6	---
	Belgium	6 (mean)	---
	France	3 (10 percentile)	---
	United Kingdom	<4-6 (Mean of the lowest quartile (lowest 25%)	50-75%
III	United Kingdom	<4-6 (Mean of the lowest quartile (lowest 25%)	50-75%
	Ireland	Assessed as % saturation Concentration mg l^{-1} equivalents for 5 percentile at 20° C are: 6.5 (tidal fresh waters) and 6.0 (full salinity waters)	5 percentile and 95 percentile: Tidal fresh waters: <70 or >130 Intermediate waters: <70 or >130 Full salinity waters: <80 or >120
IV	France	3 (10 percentile)	---
	Spain	6	80
	Portugal	8.4 (6mg l^{-1}, 10 percentile)	---

* recalculated from ml l^{-1}; ** applied additionally; *** (8.5–5 percentile) means that the average % saturation value is 8.5 for the lowest 5% of the observations

Second Common Procedure, third Common Procedure

Annual mean autumn bottom oxygen concentration from the lower quartile

4.4 Assessment level for area-specific phytoplankton indicator species, the third application of the Comprehensive Procedure

***Table A4.4**: Assessment levels for area-specific phytoplankton indicator species*

"N.D.A": No Data Available, "√": parameter assessed but no threshold values found

<table>
<tr><th colspan="2">Species</th><th>Belgium</th><th>Denmark</th><th>France</th><th>Germany</th><th>Ireland</th><th>Netherlands</th><th>Norway</th><th>Portugal</th><th>Spain</th><th>Sweden</th><th>United Kingdom</th></tr>
<tr><td rowspan="2">Nuisance species</td><td>Phaeocystis spp.</td><td>$>4.10^6$</td><td>-</td><td rowspan="12">Percentage of samples with at least one bloom defined by category and taxon size:
small: 250 000 cells l^{-1} (unicellulars < 20µm without chain)
large: 100 000 cells.l^{-1} (colonial species < 20µm + sp. > 20µm)
Elevated levels
> 40% of samples above reference abundances</td><td>$>10^6$ cells l^{-1}</td><td>-</td><td>$>10^7$ cells l^{-1} *</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^6$ cells l^{-1}</td><td rowspan="12">Phytoplankton assessment using new phytoplankton index approach based on:
90 percentile chlorophyll (March-October)
Elevated taxa counts (full year)
Count (%) of chlorophyll exceeding 10 µg l-1
Count (%) of individual taxa exceeding 250 000 cells l-1 (southern regions)
500 000 cells l-1 (northern regions)
Count (%) of total taxa exceeding 106 cells l-1 (southern regions) or 107 cells l-1 (northern regions)
Seasonal succession of functional groups (full year)
Diatoms and dinoflagellates</td></tr>
<tr><td>Noctiluca scintillans</td><td>-</td><td>-</td><td>$>10^4$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^4$ cells l^{-1}</td></tr>
<tr><td rowspan="10">Toxic species</td><td>Chrysochromulina polylepis</td><td>-</td><td>-</td><td>$>10^6$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^6$ cells l^{-1}</td></tr>
<tr><td>Karenia mikimotoi
syn. Gynodinium mikimotoi</td><td>-</td><td>-</td><td>$>10^4$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^5$ cells l^{-1}</td></tr>
<tr><td>Alexandrium spp.</td><td>-</td><td>-</td><td>$>10^2$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^2$ cells l^{-1}</td></tr>
<tr><td>Dinophysis spp.</td><td>-</td><td>-</td><td>$>10^2$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^2$ cells l^{-1}</td></tr>
<tr><td>Prorocentrum spp.</td><td>-</td><td>-</td><td>$>10^4$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>-</td></tr>
<tr><td>Pseudo-nitzschia spp.</td><td>-</td><td>-</td><td>$>10^6$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^6$ cells l^{-1}</td></tr>
<tr><td>Chattonella
spp.</td><td>-</td><td>-</td><td>$2x10^5$ cells l^{-1}*</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>-</td></tr>
<tr><td>Odentella sinensis</td><td>-</td><td>-</td><td>$>10^3$ cells l^{-1}</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>-</td></tr>
<tr><td>Verrucophora spp.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>N.D.A.</td><td>N.D.A.</td><td>$>10^6$ cells l^{-1}</td></tr>
</table>

*: This parameter is new in the Dutch assessment

Sweden bio-volume, not differentiated for species

United Kingdom, Thresholds vary geographically

Note: Not applied in United Kingdom waters, but used as additional evidence

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