Common Procedure for the Identification of the Eutrophication Status of the UK Maritime Area

UK National Report

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1 Summary

1. Outcome of COMP3, compared to COMP2

The third application of the OSPAR Common Procedure has resulted in 100% of the marine waters in the 8 regional sea areas around the UK assessed as Non Problem Area. In the transitional and coastal waters around the UK, 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 UK 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 UK 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 6 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 UK regional sea areas but the rate of decrease varies from area to area. The smallest decrease in nitrogen input is to the 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 WFD 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.

2. Description of the area

The UK 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 baseline, and within each regional sea into ‘coastal’ and ‘offshore’ based on salinity. The UK 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 UK 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 eastern Irish Sea and the Celtic Sea.

As part of COMP2, the UK carried out a risk assessment in relation to transboundary transport that could affect UK 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 UK areas assessed has not changed, and the level of nutrient input is decreasing, the minimal risk that either UK waters are affected by transboundary transport or that other waters are affected, is further reduced.

3. Assessment Procedure

The UK 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 COMP applications as Non Problem Areas was still maintained. The UK has also taken account of recent assessments under the Water Framework Directive, the UWWTD and the Nitrates Directive concerning transitional and coastal waters.

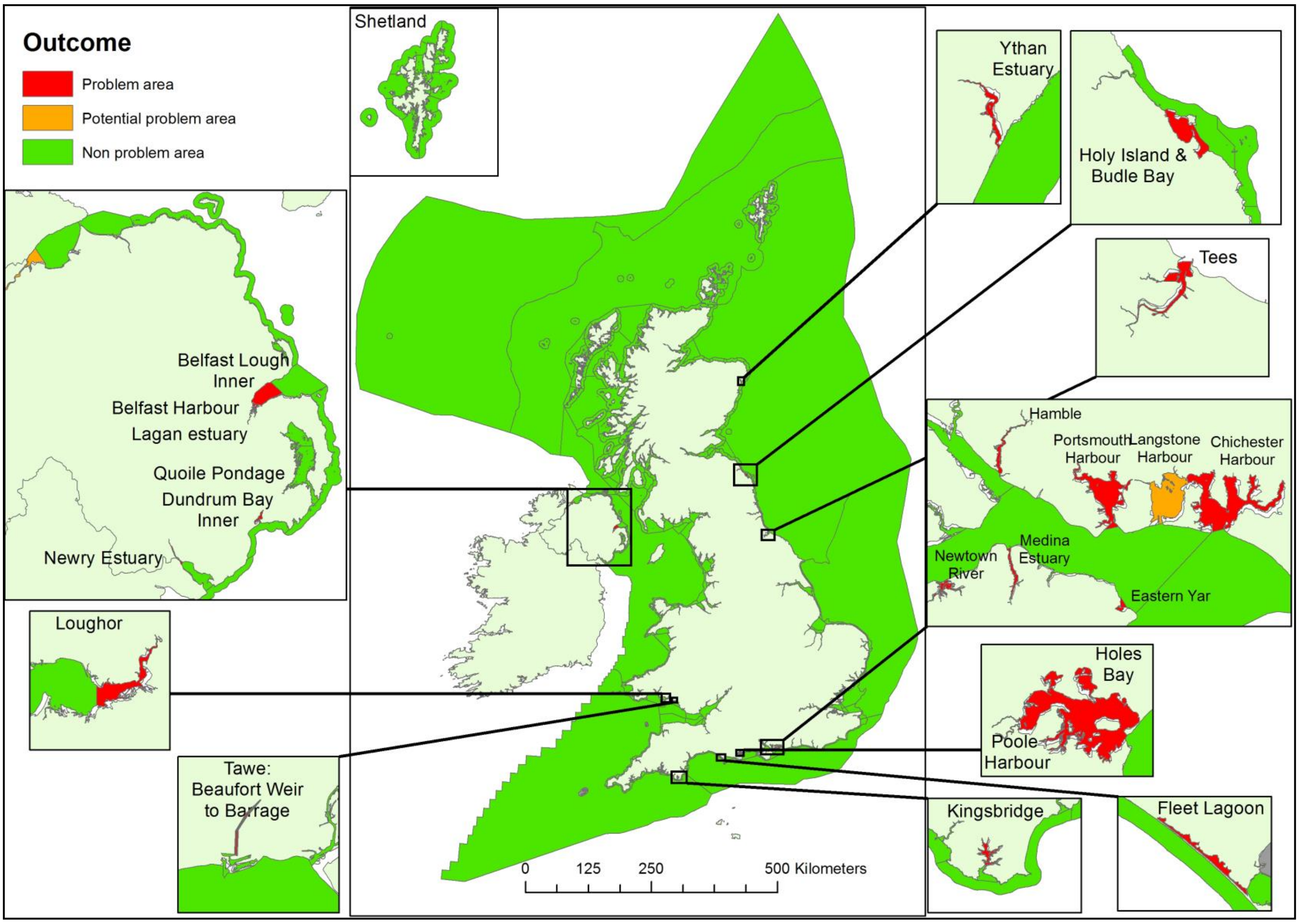
In line with the Common Procedure approach for Non Problem Areas the principal information relates to winter nutrient concentrations as per the OSPAR CEMP Eutrophication Monitoring Programme. In addition, we have used available information on nutrient inputs (RID), chlorophyll, and dissolved oxygen. 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 UK 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 WFD, UWWTD and Nitrate Directives in inshore waters includes nutrients, phytoplankton, macrophytes and macroalgae, and dissolved oxygen.

Data used for the 3rd application of the Common Procedure come from different sources. Data on inputs come from the OSPAR RID programme and *in situ* data on nutrients, chlorophyll and oxygen were extracted from the ICES database, UK national databases (at BODC) and databases held by UK institutions. The data in these databases derive from monitoring (UK contribution to the OSPAR CEMP Eutrophication Monitoring Programme), and a variety of research programmes. The data used have been subject to rigorous quality assurance and validation procedures prior to use in the assessment. The data are, in general, of good representivity (time and space) and there is generally good confidence in the assessments of the individual parameters against the area specific thresholds.

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.



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 WFD water bodies.

2 Introduction

This report presents the results of the third application of the Common Procedure to OSPAR maritime waters under the jurisdiction of the United Kingdom.

The first and second applications of the Common Procedure identified marine waters (salinity >30) around the UK as being Non Problem Areas with respect to eutrophication. Some Non Problem Areas considered to be particular areas of ongoing interest have been subject to monitoring beyond the requirements of the OSPAR Eutrophication Monitoring Programme for Non Problem Areas. A number of small estuaries, loughs and harbours in transitional and coastal waters were identified as Problem Areas with respect to eutrophication, or at risk due to factors such as restricted circulation.

Given the Non Problem Area status of the UK marine waters identified assessed by two successive applications of the Common Procedure, the third application has sought, on the basis of all available information, to confirm Non Problem Area status. We have used information on the relevant harmonised assessment criteria, to the extent possible, and used the formats and approach of the Comprehensive Procedure for a consistent and comparable presentation of the assessment.

The third application of the Common Procedure has taken account of assessments of transitional and coastal waters completed for the purposes of the Water Framework Directive (WFD, EU 2000), Urban Waste Water Treatment Directive (UWWTD, EC 1991a) and Nitrates Directive (ND, EC 1991b) to identify their eutrophication status and to support the application of the Screening Procedure to marine waters.

3 Description of the assessed area

The overall area and marine sub-areas assessed for the period 2006-2014 are shown in Figure 1. The marine sub-areas are the eight ‘regional seas’ assessed for Charting Progress 2 (CP2, Defra 2010) and used in the second UK application of the Common Procedure (Foden et al 2011). In each regional sea, assessments were structured using a nested approach for transitional, coastal and offshore waters:

- Within 1 nm (3 nm in Scotland), the transitional and coastal water bodies monitored and assessed under the WFD
- Beyond 1 nm, subdivisions of the regional sea into ‘coastal’ and ‘offshore’ salinity regimes (as below) within national jurisdictional boundary:

Coastal:	Irish Sea – salinity range	30 to <34.0
	All other areas – salinity range	30 to <34.5
Offshore:	Irish Sea – salinity range	≥ 34.0
	All other areas – salinity range	≥34.5

WFD classifications of biological and supporting parameter elements were used to identify the problem area status of transitional (estuarine) and coastal waters. Assessments were carried out for coastal and offshore waters of all regional seas, except Region 8 which remains an obvious Non Problem Area.

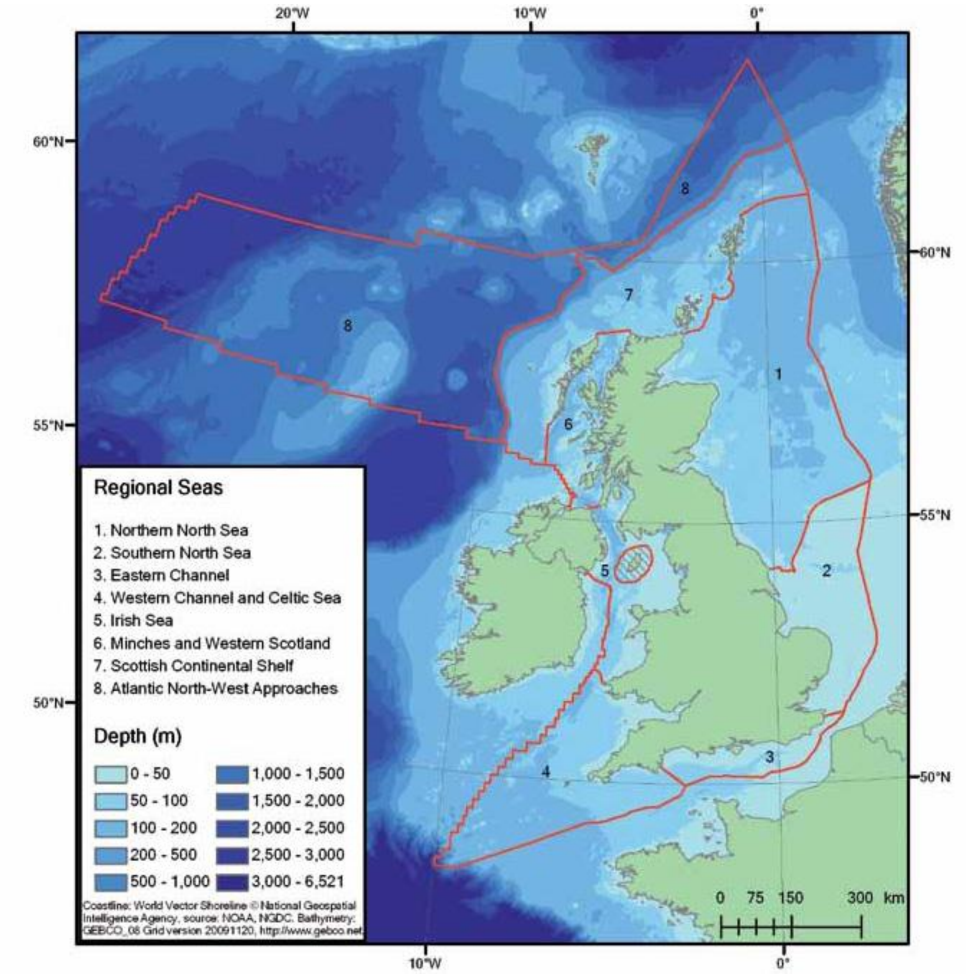


Figure 1: The regional seas (Defra 2010) assessed using the third application of the Common Procedure.

4 Methods and data

We have used readily available data on the set of Harmonised Assessment Criteria (Table 1), both from monitoring programmes and other sources to inform our assessment of continued Non Problem Area status. The thresholds used for assessment are the same as those used in the second application (Table 1). Methods used for collection and/or analysis of samples and data are given in Annex 1.

Table 1: Assessment parameters and description of thresholds for the third application of the OSPAR Common Procedure for UK marine areas (for details see Annex 1).

Assessment Parameters	Description
Category I. Degree of nutrient enrichment (causative factors);	
1. Riverine inputs and direct discharges (area specific)	Annual inputs for each year assessed for direct receiving area. Analysed for trend over longest time series available. **An increasing trend scores +.**
2. Nutrient concentrations (area specific) **Elevated level(s) of winter DIN and/or DIP**	The winter period defined as November - February inclusive. Thresholds for nutrients from the second application of the COMP were used. For example, North Sea: Winter DIN thresholds – relative to salinity/area. Coastal – salinity 30-34.5. Reference value + 50 % = threshold of **18 µM** Offshore –salinity 34.5. Reference value + 50 % = threshold of **15 µM** P was assessed as part of the N/P ratio (see assessment parameter 3, below).
3. N/P ratio (area specific) **Elevated winter N/P ratio (Redfield N/P = 16)**	Significant deviation (>50%) from Redfield ratio based on annual winter average nutrient concentrations. Reference value + 50 % threshold for N:P = **24:1** **Note: Not applied in UK waters, but only used as additional evidence.**

Category II. Direct effects of nutrient enrichment;	
1. Chlorophyll concentration (area specific) **Elevated percentile**	90^{th} percentile for period March – October (reflects WFD European Intercalibration approach). Thresholds: Coastal – **15 µg l^{-1}** Offshore – **10 µg l^{-1}**
2. Phytoplankton indicators (area specific) **Elevated levels of phytoplankton species (and**	Phytoplankton assessment using new phytoplankton index approach based on: • 90^{th} %ile chlorophyll (March-October) • Elevated taxa counts (full year) ○ Count (%) of chlorophyll exceeding 10 µg l^{-1} ○ Count (%) of individual taxa exceeding

increased duration of blooms)	▪ 250 000 cells l^{-1} (southern regions) ▪ 500 000 cells l^{-1} (northern regions) ○ Count (%) of total taxa exceeding 10^6 cells l^{-1} (southern regions) or 10^7 cells l^{-1} (northern regions) • Seasonal succession of functional groups (full year) ○ Diatoms and dinoflagellates Thresholds vary geographically. Note: Not applied in UK waters, but used as additional evidence.
3. Macrophytes including macroalgae (area specific)	Shift from long-lived to short-lived opportunistic species (e.g. *Ulva*) were assessed under the WFD using macroalgal tools which include composition, macroalgal cover, abundance and disturbance-sensitive taxa. Thresholds were developed by the UK Technical Advisory Group (TAG).

Category III. Indirect effects of nutrient enrichment (during growing season);	
1.Oxygen deficiency **Decreased levels (< 4-6 mg l^{-1}) and lowered % oxygen saturation**	The assessment levels that are used are concentrations measured below **4 – 6 mg l^{-1}** (**50 -75 % oxygen saturation**) to judge whether oxygen is scored as an undesired oxygen deficiency level for each area • Assessed for the summer stratified period, 1 July to 31 October • Mean of the lowest quartile (lowest 25%) of the data
2. Zoobenthos and fish **Long term area-specific changes in biomass and species composition of zoobenthos and fish**	Assessed under the WFD, as required. The outcome of these assessments is included in overall assessments to assess indirect effects of nutrient enrichment. Zoobenthos in coastal and transitional waters were assessed an infaunal quality index (IQI) which considers abundance, diversity and presence and/or absence of pollution-tolerant and disturbance-sensitive taxa. The three components are: the AZTI Marine Biotic Index (AMBI), Simpson's Evenness (1-'), and the number of taxa (S). Fish were assessed using the transitional fish classification index (TFCI) which considers composition, abundance, and the presence and/or absence of disturbance-sensitive taxa. The TFCI consists of ten components which include measures of species diversity and composition, species abundance, nursery function, and trophic integrity
3. Organic Carbon/Organic Matter	Not applied in UK waters unless a sedimentation area is identified and data are available.

4.1 Inventory of available data for marine areas and sub-areas

Anthropogenic inputs of dissolved nutrients into coastal waters via rivers and point sources (notably sewage and industrial discharges) are monitored under the Riverine Inputs and Direct Discharges (RID) programme for reporting to OSPAR. RID data from 1990 to 2014 were obtained from the MERMAN database (see Section 4.4). Loads of total dissolved nitrogen (N) and phosphorus (P) were calculated for each of the regional seas shown in Figure 1. Loads of N and P are given as total loads (e.g. Baxter et al. 2011) and separately for riverine, industrial and sewage sources.

Other parameters are monitored under the Clean and Safe Seas Monitoring Programme (CSEMP), which implements the OSPAR Co-ordinated Environmental Monitoring Programme for Eutrophication. UK marine waters are Non Problem Areas, so monitoring is largely limited to winter nutrient concentrations. The first application of the Common Procedure identified areas of particular continuing interest that required ongoing monitoring in the southern North Sea and the Irish Sea. These areas have been sampled for all relevant harmonised assessment criteria, and in several cases have undergone intense surveillance using *in-situ* sampling equipment (SmartBuoys, Figure 2) or specific surveys.

Monitoring under CSEMP is carried out by Cefas, the Environment Agency (EA), Marine Scotland Science, the Scottish Environment Protection Agency (SEPA), Agri-Food and Biosciences Institute (AFBI), the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland and Natural Resources Wales (NRW). Guidance is provided by the European Commission (EC-DG 2005, EC 2009) and the OSPAR harmonised assessment criteria (see Foden et al. 2011). Data for assessments are also obtained from research carried out in support of European Directives and through national/international research programmes. The number of samples in each assessment area was lower for areas further offshore compared with areas closer to the coast.

Various monitoring platforms are used, for discrete sampling (such as routine ship surveys or other field-based human sampling) or continuous sampling (such as moorings). Other sources of data, such as the Continuous Plankton Recorder (CPR, SAHFOS), FerryBoxes, gliders, and earth observations, have not contributed directly to the assessment but may inform expert judgement where that has been applied.

Variables monitored by monitoring platforms include physical parameters (such as temperature, suspended particulate material and light availability), chemical parameters (dissolved inorganic nutrients, such as dissolved inorganic nitrogen, DIN, dissolved total oxidised nitrogen, TOxN, dissolved inorganic phosphorus, DIP; dissolved oxygen) and biological parameters (such as phytoplankton chlorophyll and macrophytes). SmartBuoy moorings provide fixed point observations derived from a range of instruments (sensors and samplers) at one or more depths, measuring at high frequency (Mills et al. 2003, Kröger et al. 2009). Bottom landers carry a similar instrument payload at or just above the seabed. Figure 2b shows the locations of the SmartBuoys and benthic landers deployed at various times since 2002.

Details of sampling and analysis carried out by various platforms follow standard oceanographic procedures and guidelines and are described in a number of scientific publications (e.g. Greenwood et al 2010, Capuzzo et al 2013, Smith et al 2014).

Data for nutrient, chlorophyll and dissolved oxygen (DO) concentrations and all supporting metadata (e.g. latitude, longitude, water column depth, sample depth, temperature, salinity) for coastal and offshore (marine) waters were extracted from the ICES database and from national and institutional databases for the period from 1990 to 2014. Data on DO concentrations, temperature and salinity were also used to calculate oxygen percentage saturation per assessment region. High frequency data from SmartBuoys and benthic landers were used to calculate weekly (seven-day) averages per parameter (see Heffernan et al 2010), and included with the final data set for our analyses. Data collected for assessments in coastal and transitional waters under the WFD, UWWTD and ND are held in institutional databases. These data were assessed separately for the purposes of these Directives, and were not included in the data set for coastal and offshore waters (salinity >30).

Annex 2 summarises the sources of available marine data and the number of samples per assessment region.

Marine data were filtered by salinity, to assign to coastal or offshore waters, and by season for nutrients (winter, November to February), chlorophyll (growing season, 1 March to 31 October) and DO (stratified season, 1 July to 31 October). DO data was filtered by depth (within 10 m of the seabed, where water column depth was <500 m). Winter nutrient data were normalised to salinity 32 for coastal waters and 34.5 (34 in the Irish Sea) for offshore waters (OSPAR 2005), and analyses of DIN and TOxN concentrations were done using both normalised and non-normalised data. Mean winter values were assigned to the year relevant to the phytoplankton growing season. For example, nutrient data for November and December of 2009 and January and February of 2010 were reported as 2010 winter nutrients.

Data were included in assessments only where five or more data points (n = number of data points) were available. For DO, the number of data points within 10 m of the seabed was used, and not the number of data points in the lowest quartile of the data.

Confidence in Assessments

Confidence of assessment against area-specific thresholds

Confidence ratings of individual assessment parameters against area-specific thresholds were calculated for nutrients and dissolved oxygen using the approach described in the Common Procedure (Annex 8, Section A5, OSPAR 2013b). For winter nutrients, we assess the confidence that the mean value of the data is *above* the assessment threshold. However, for dissolved oxygen concentrations, we assess the confidence that the mean value of the lowest quartile of the data is *below* the assessment threshold.

Confidence ratings for 90th percentiles of growing season chlorophyll concentrations were calculated using the approach described in Section A6 of the Common Procedure (OSPAR 2005).

Representativeness in space and time

The representativeness of the available data in space and time during the assessment period (2006-2014) was calculated by following an approach similar to that described in the guidance (Annex 8, Sections B1 and B2, OSPAR 2013b; see Annex 1). The overall representativeness in space and time is taken as the lowest score in either space or time (Section B3, OSPAR 2013b).

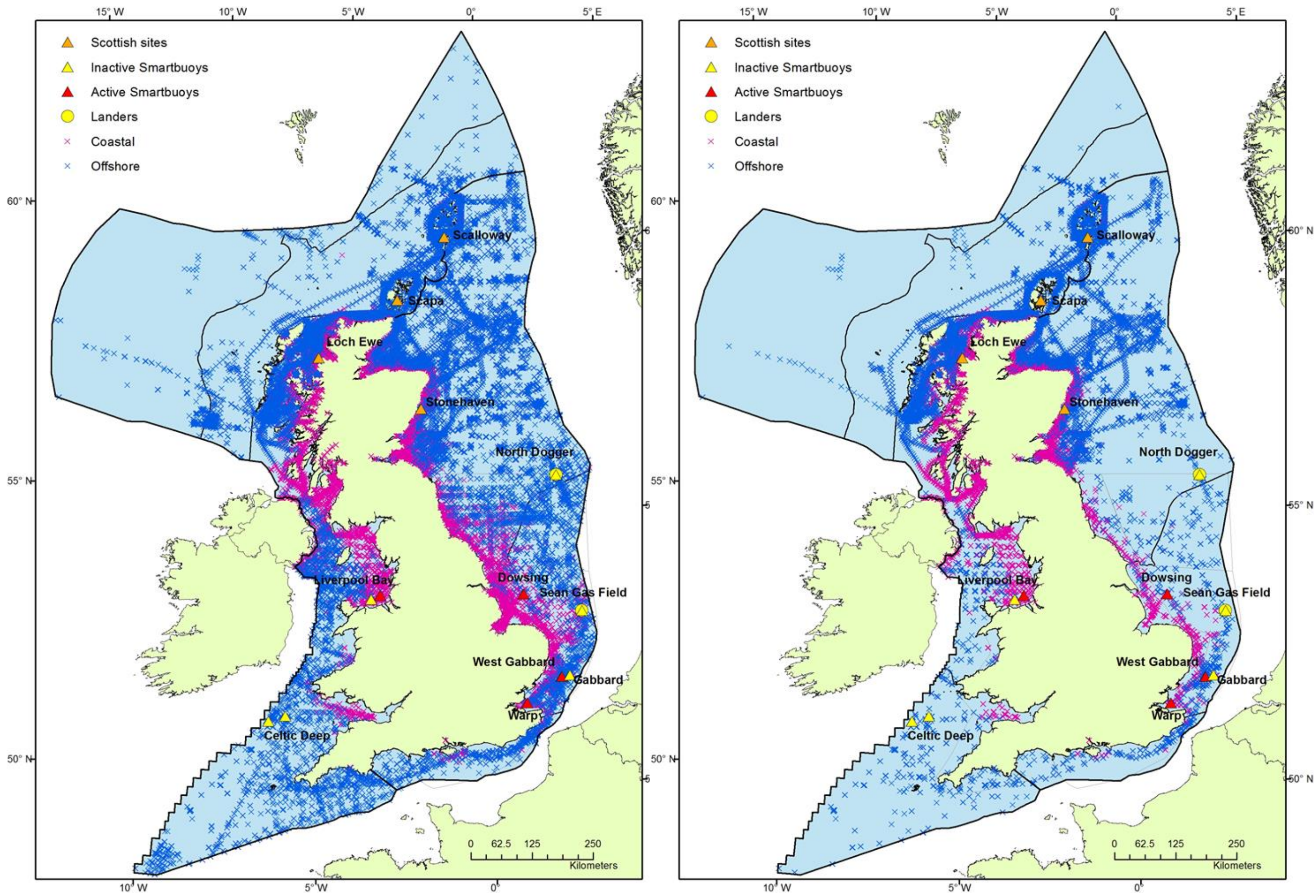


Figure 2: Locations of data obtained from different datasets for UK assessment areas. (a) All available data (1990-2014) after filters were applied for salinity (>30), season (winter nutrients, growing season chlorophyll, stratified season dissolved oxygen), and depth (dissolved oxygen); (b) All available data for the assessment period, 2006-2014, filtered as described in (a). X = sampling locations at coastal (red) and offshore (blue) sites. The regional seas are indicated by black lines. Areas assessed during the second application of the Common Procedure in England and Wales are also shown (grey lines). Locations of Cefas SmartBuoy moorings and benthic landers, and Scottish coastal monitoring sites. Active moorings in the southern North Sea (West Gabbard, the Warp, Dowsing) and Liverpool Bay are indicated by red triangles; other moorings and landers are currently inactive. Scottish monitoring sites are indicated by orange triangles.

4.2 Calculation and quality of time series

Nutrient Inputs

Nutrient input data were plotted as time series, and analysed for trends since 1990. The trends in each time series were summarised by the estimated yearly percentage change in loadings between 1990 and 2014. Trends over time were assessed for significance using Mann-Kendall non-parametric tests for trend analysis (Mann 1945; Kendall 1975). Where p-values are less than 0.05, it is assumed that there is a significant trend. Where p-values are greater than 0.05, a trend cannot be detected statistically.

Nutrients, chlorophyll and DO

For the period 1990 to 2014, mean winter nutrients, 90th percentiles for growing season chlorophyll, and means of the lowest quartile of the near-bed DO were plotted per year and analysed for trends in the data. For plotting trends in the data, both the ordinary least squares (OLS) and weighted least squares (WLS) regressions (see http://statsmodels.sourceforge.net/) were calculated. The 95% confidence intervals are shown for the means or, for chlorophyll, 90th percentiles. The width of the 95% confidence intervals was used as weight to calculate the WLS line. Trends over time were assessed using the Mann-Kendall non-parametric test for trend analysis (Mann, 1945; Kendall, 1975). The R library emon was used for this purpose (Barry and Maxwell 2015). Where p-values are less than 0.05, it is assumed that there is a significant trend. Where p-values are greater than 0.05, a trend cannot be detected statistically. The analyses were carried out using annual means of the filtered data per season per year or, for chlorophyll, the 90th percentiles of these data. For nutrients, the non-normalised winter means were used.

4.3 Methods for consideration of environmental factors in the assessments

The assessment areas used have been selected using biogeographic, ecological and eco-hydrodynamic characteristics (Tett et al. 2007) to allow the ready consideration of different environmental factors that might affect the response of the ecosystem to anthropogenic nutrient enrichment. This approach has been further refined through recent modelling studies, which were able to better define these regions, and extended to the whole of the UK shelf (see Annex 3).

A number of modelling studies carried out to assess the transport and fate of nutrients and to quantify nutrient transport in the North Sea have demonstrated the extent to which riverine nutrient sources contribute to marine nutrient levels in the simulated ecosystem (Annex 3). The contributions get progressively smaller with distance away from the sources, as waters are transported with the ambient residual circulation and as the influence of other sources, such as oceanic waters, increases.

4.4 Meta-data and reporting of monitoring data to national and ICES databases

Overview of the data and reporting streams

Quality controlled discrete data are uploaded to local databases. At present, data collected under the WFD, the UWWTD and ND are held locally. All other quality controlled discrete monitoring data are uploaded to the national database, MERMAN (Marine Environment Monitoring and Assessment) Database, held at the British Oceanographic Data Centre (BODC). These data are uploaded annually to the ICES DOME database and other (OSPAR, EMODnet) international environmental databases. Quality controlled data from oceanographic surveys are uploaded to the National Oceanographic Database (NODB) held at BODC, or to the ICES oceanographic database (OCEAN). NODB data are uploaded annually to ICES OCEAN. Quality controlled continuous data from SmartBuoys are uploaded to BODC as part of MEDIN (Marine Environmental Data and Information Network). These data are not uploaded to ICES. Other continuous data (e.g. from FerryBoxes, CTD profiles and gliders) are generally held locally.

5 Eutrophication assessment

The 2006 - 2014 assessment process for regional sea areas follows the requirements of the Common Procedure Guidance (OSPAR 2013a, b) for previously identified Non Problem Areas; that is, on the basis of all available information, to confirm Non Problem Status. All results are given in Annexes 4 to 16.

Assessments of transitional and coastal waters through application of the requirements of the Water Framework Directive (WFD, EU 2000), Urban Waste Water Treatment Directive (UWWTD, EC 1991a) and Nitrates Directive (ND, EC 1991b) are described in Annex 7. The outcome of these assessments is included here.

We have used the formats of the Comprehensive Procedure (OSPAR 2013b) to present the assessment information in a compatible and coherent manner and to allow ready comparison with previous assessments. However, scoring was only carried out on available data as per the Screening Procedure guidance. The score '?' is therefore not used in the overall assessment. Detailed results for each assessment area are given in Annexes 8 to 15.

5.1 Data analyses and presentation

<u>Trends in Nutrient Inputs</u>

The highest total inputs of dissolved inorganic nitrogen (see Annex 4) were to the northern North Sea (Region 1), the southern North Sea (Region 2), the Celtic Sea (Region 4) and the eastern Irish Sea (Region 5). Lowest loads were into the Atlantic region (Regions 6 and 7).

The highest inputs of dissolved inorganic nitrogen to coastal waters were via rivers. Flow-corrected data show that highest loads were into the southern North Sea (Figure 3) and the English Channel (Region 3). The significance of sewage and industrial inputs varies within each regional sea.

The highest inputs of dissolved inorganic phosphorus to coastal waters also varied by regional sea. Main inputs into 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 loads were the main input in the early 1990s but as these decreased riverine loads provided the dominant inputs from the late 1990s onwards. Analyses of trends (1990 to 2014) indicate that sewage and riverine inputs of phosphorus have decreased in all regions, except the Atlantic, while industrial inputs have decreased in the Irish Sea and the Celtic Sea.

Analysis of trends in riverine flow-corrected loads (1990 to 2014, Table 3) indicate that total inputs of dissolved inorganic nitrogen decreased significantly by 0.8 to 2.8 % per year in all regions apart from the English Channel. Total inputs of phosphorus decreased significantly by 2 to 6.1 % per year in all regions except the northern North Sea. Apart from nitrogen in the northern North Sea, all trends were linear (Figure 3) despite the high inter-annual variability in the data.

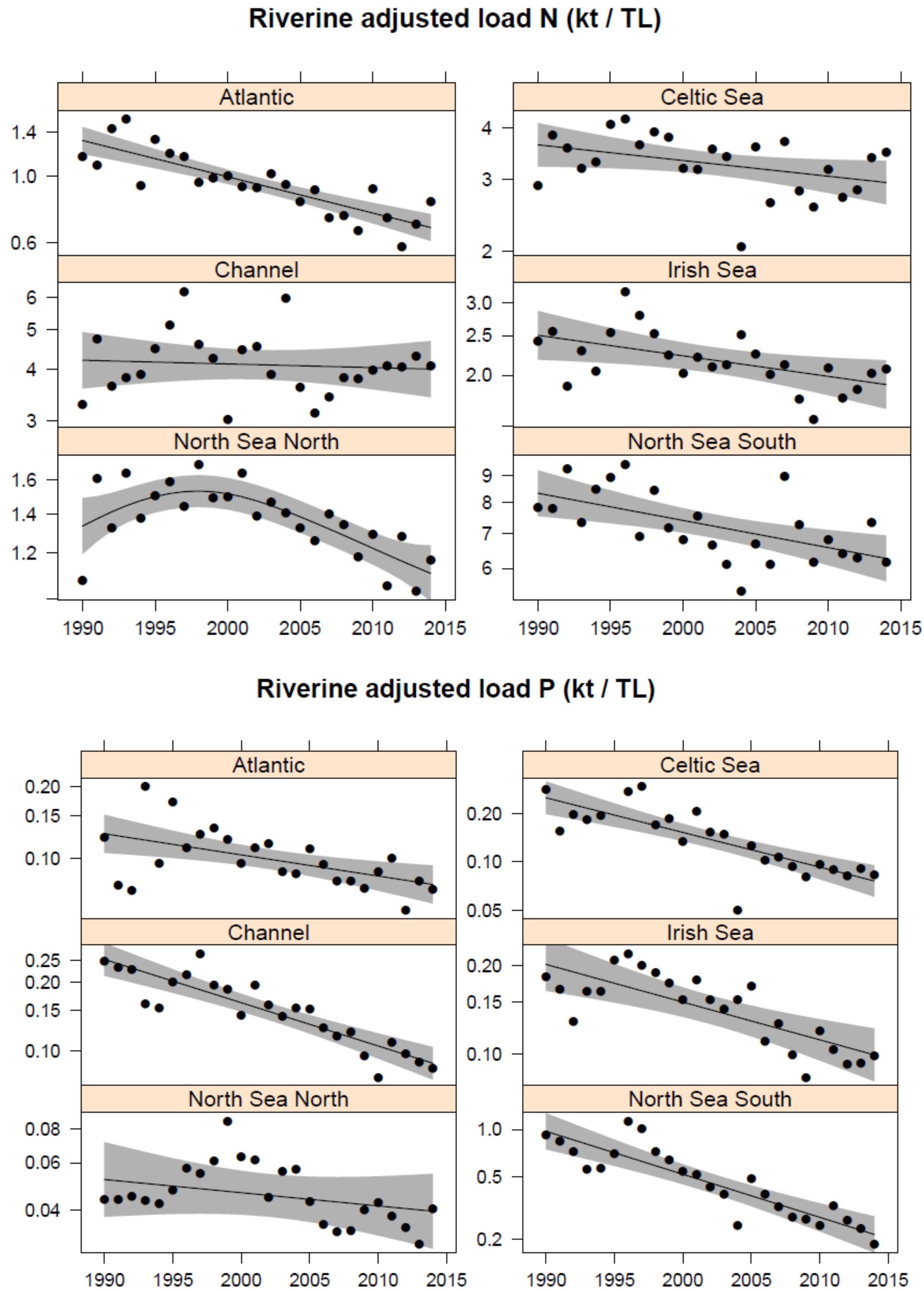


Figure 3: Trends in total riverine loads of N and P (Kt Tl^{-1}) corrected for river flow rates. Inputs were given in Kt y^{-1} and flow rates in Ml s^{-1}. Note changes in scale on each plot.

Table 3: Estimated percentage annual change in riverine loadings of dissolved inorganic nitrogen and phosphorus over the 25-year period (1990 to 2014). Negative numbers indicate downward trends; positive numbers indicate upward trends. Numbers shown in bold indicate that the change is significant at the 5% level. Riverine loads are shown with and without corrections for flow rates.

	N		P	
	unadjusted	flow adjusted	unadjusted	flow adjusted
Atlantic	**-2.6**	**-2.8**	**-1.8**	**-2.0**
Celtic Sea	0.2	**-0.9**	**-3.9**	**-4.9**
Channel	1.3	-0.2	**-2.5**	**-4.3**
Irish Sea	-0.4	**-1.1**	**-2.1**	**-2.9**
North Sea North	**-1.1**	**-0.8**	-1.3	-1.1
North Sea South	0.7	**-1.2**	**-4.2**	**-6.1**

Trends in assessment parameters

Nutrient concentrations

Time series (1990 - 2014) of the mean concentrations of winter DIN in the coastal and offshore waters of the regional seas were plotted (see Annex 5, Figure A5.1) and analysed for trends over the 25-year time period.

Mean winter DIN concentrations (Annex 5) were lowest in Regions 1, 6 and 7 (generally <15 µM) and highest in Region 2 (southern North Sea, up to 50 µM), Region 4 (Western Channel and Celtic Seas, up to 36 µM) and Region 5 (Irish Sea, up to 23 µM). These concentrations are likely to reflect the nutrient loads to each region from land and the ocean. Analyses of trends (Table 4) indicate significant decreases in winter DIN concentrations in coastal water in Regions 2 and 5, and in offshore waters in Region 4.

Mean winter TOxN values were also calculated (Annex 5, Figure A5.2), because the dataset included more TOxN values than DIN values (see Annex 1). Where data were available for both parameters, linear regressions indicate a close relationship between DIN and TOxN in almost all regions, suggesting that TOxN may be used as a proxy for DIN in most marine waters. This is particularly valuable in regions where moorings such as SmartBuoys provide continuous time series of TOxN data but not DIN. Analyses of trends indicate a significant decrease (Table 4) in TOxN concentrations in coastal water in Region 5, and in offshore waters in Regions 5 and 7. No other significant trends were observed.

Chlorophyll concentrations

Analyses of trends (Annex 5) indicate significant increases in chlorophyll concentrations in coastal and offshore waters in Region 1 (Table 4). No other significant trends in chlorophyll concentrations were observed (Table 4).

Time series of high frequency data from moorings (SmartBuoys) in Regions 2, 4 and 5 (for example see Annex 6) show the temporal variability in assessment parameters. These data have been included with the survey-based data in our analyses (see methods used, in Section 4.1).

Oxygen deficiency

Time series of available data on near-bed dissolved oxygen (DO) concentrations (Annex 5, Figure A5.4) indicate that oxygen concentrations in all regional seas were generally above 6 mg l^{-1}. Very few data were available. Analyses of trends, where sufficient data were available, indicate increases in DO concentrations in offshore water in Regions 1, 6 and 7 (Table 4). Decreasing trends were observed in coastal and offshore waters of Region 2. None of the observed DO trends were significant.

Table 4: Summary of the trends obtained by applying the Mann-Kendall analyses (1990-2014) to annually averaged filtered data per parameter per region. ↘ = decreasing trend, ↗ = increasing trend, - = no trend. nan = no data. Symbols shown in bold indicate that the trend is statistically significant at the 95% level (α=0.05). Shading indicates significant increasing trends. All the results of the Mann-Kendall trend test are shown in Annex 5.

Region		**Winter DIN**		**Winter TOxN**		**Growing season Chl**		**Dissolved Oxygen**	
		Coast	Offshore	Coast	Offshore	Coast	Offshore	Coast	Offshore
1	N North Sea	↗	↗	↗	↗	**↗**	**↗**	-	↗
2	S North Sea	**↘**	↘	↘	↗	↘	↘	↘	↘
3	English Channel	↘	↘	↘	↗	nan	↘	nan	nan
4	W Channel & Celtic Sea	↘	**↘**	↘	↘	-	↘	nan	-
5	Irish Sea	**↘**	↘	**↘**	**↘**	↘	↘	-	-
6	Minches & W Scotland	↘	↗	↗	↗	↗	↗	-	↗
7	Scottish Continental shelf	↗	↘	↗	**↘**	↘	↗	nan	↗
8	Atlantic NW Approaches	nan	nan	nan	nan	nan	↗	nan	-

5.2 Parameter-related assessment based on background concentrations/levels and assessment levels

Overall results for parameters in each of the regional seas are shown in Figures 4 to 6. Results are shown for coastal and offshore waters in the same plot. This nested approach has been used to ensure assessments are carried out at the right scale.

<u>Category I: degree of nutrient enrichment</u>

For *in situ* nutrient concentrations, results are shown for mean winter DIN (µM), and mean winter TOxN (Figure 4). For DIN and TOxN, results are shown for non-normalised and normalised means (left and right, respectively, Figure 4). In the previous application of the COMP, normalised means were used (see Foden et al. 2011). The normalised nutrient concentrations have therefore been used in assessments for this application of the COMP.

Normalised data showed that mean winter DIN and TOxN in Regions 2, 3 and 4 exceeded the assessment threshold in coastal waters (18 µM). These results indicate nutrient enrichment in the coastal waters in these regions. In coastal waters in all other Regions and in offshore water in all Regions, the mean winter DIN and TOxN concentrations were below the assessment thresholds. Mean winter DIN and TOxN values therefore indicate no nutrient enrichment in offshore waters in Regions 2, 3 and 4, or in any waters in Regions 1, 5, 6 and 7.

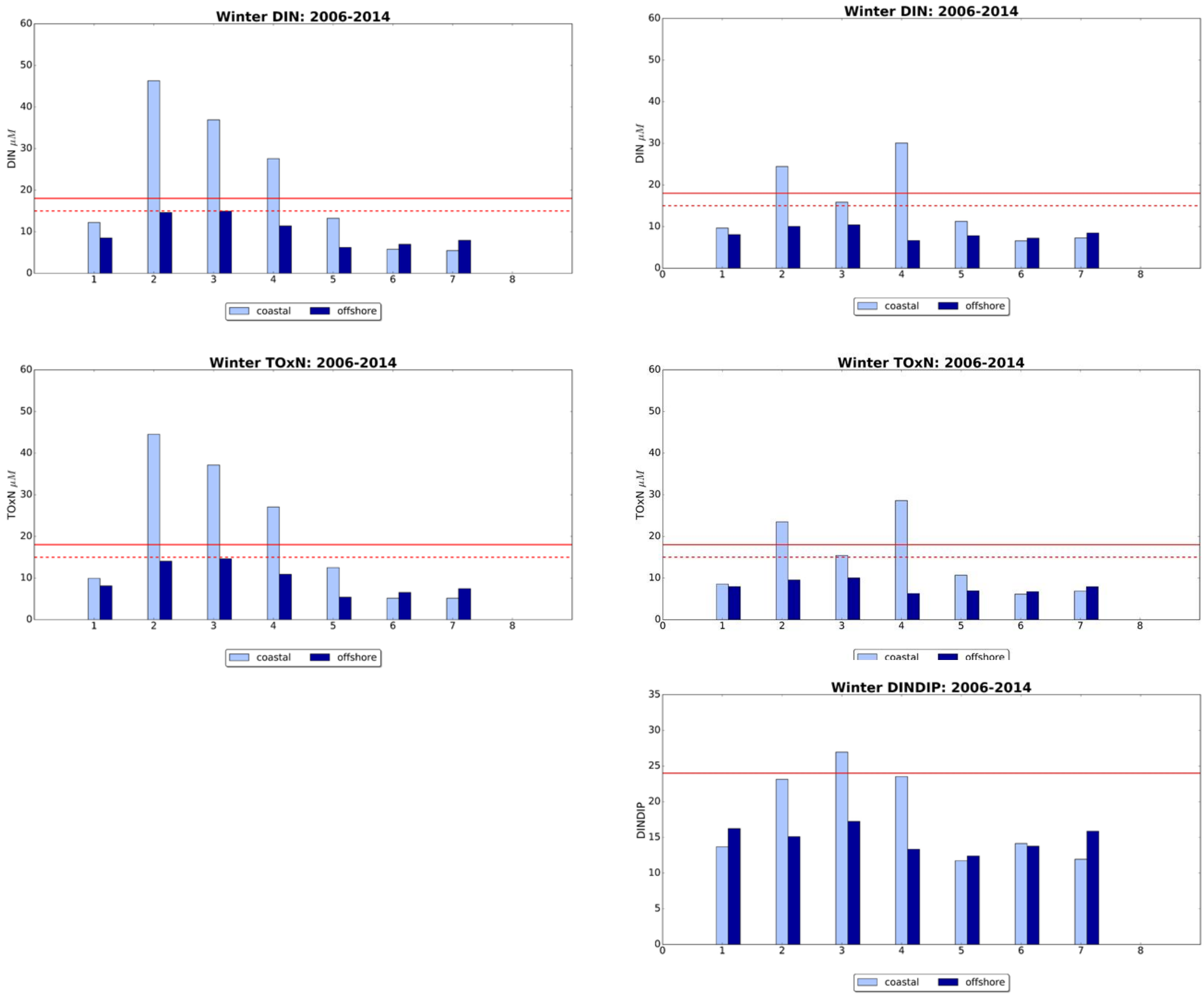


Figure 4: Category I: degree of nutrient enrichment – normalised mean winter concentrations of DIN and TOxN (left column) and non-normalised means (right column), and DIN:DIP ratios. Results are shown per assessment Region 1 to 8 (see legend in Figure 1), for coastal and offshore waters, using data from all depths sampled. Thresholds for assessments are shown (DIN and TOxN: coastal = 18 µM, solid line; offshore =15 µM, dashed line. DIN:DIP threshold = 24). Results are only shown where 5 or more data points were available.

<u>Category II: direct effects</u>

Growing season 90th percentiles for chlorophyll (Figure 5) did not exceed the assessment thresholds in coastal or offshore waters in any of the assessment regions. This suggests that nutrient enrichment did not have direct effects on the phytoplankton biomass in these regions. Light availability is considered to be a significant limiting factor in the southern North Sea (Region 2).

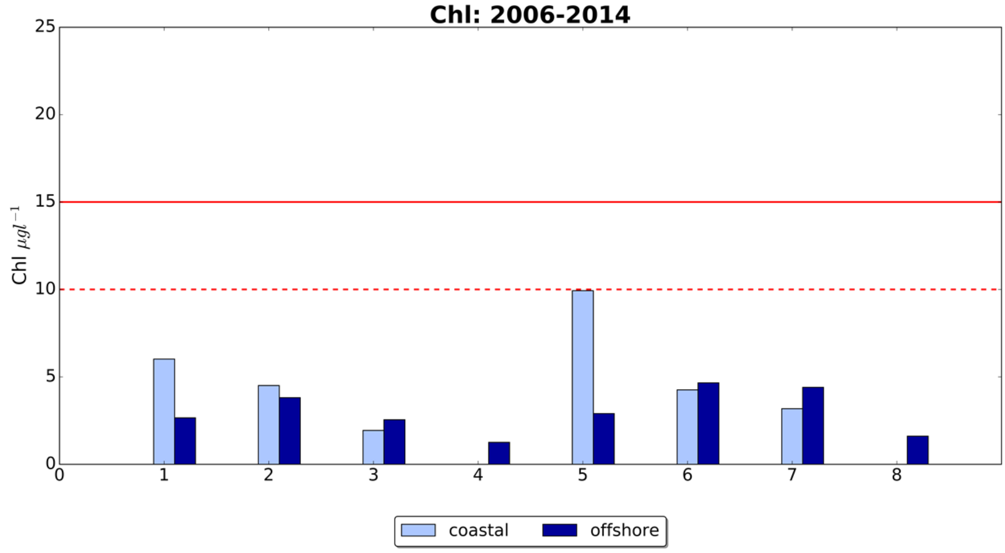


Figure 5: Category II: direct effects of nutrient enrichment - growing season 90th percentiles for chlorophyll per assessment Region 1 to 8 (see legend in Figure 1). Results are shown for coastal and offshore water, using data from all depths. Assessment thresholds are shown for coastal (15 µg l^{-1}, solid line) and offshore (10 µg l^{-1}, dashed line) water. Results are only shown where 5 or more data points were available.

Category III: indirect effects

Results are shown as the mean of the lowest 25% of the data (lowest quartile) for near-bed dissolved oxygen (DO), as concentrations and as percentage saturation (Figure 6). For DO, analyses were done using data from within 10 m of the seabed.

Limited data were available for DO in most regions. In coastal and offshore waters in all regions with available data, mean DO values (as concentrations and percentage saturation) were at or above the assessment threshold (6 mg l^{-1}).

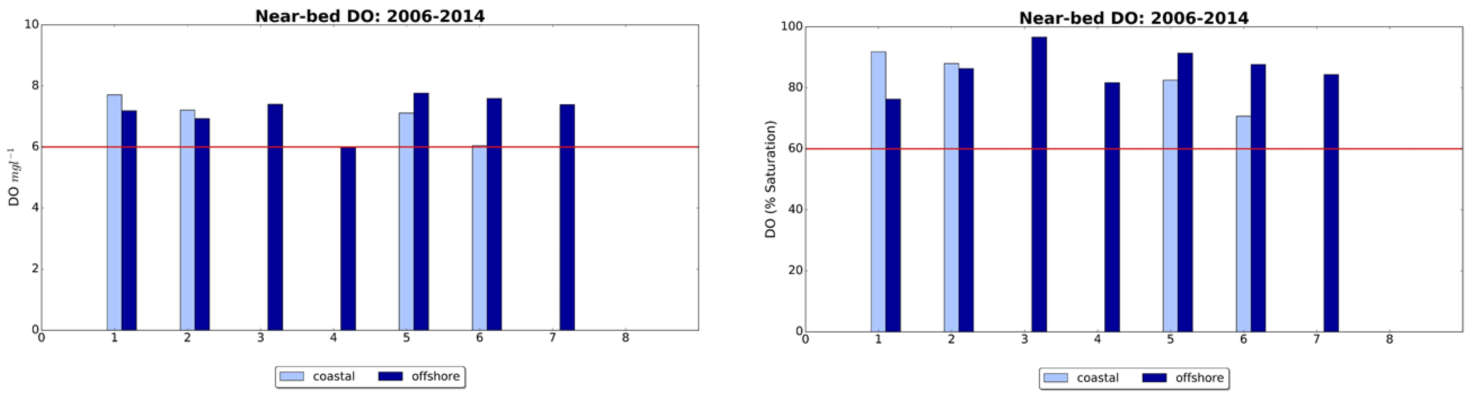


Figure 6: Category III: indirect effects of nutrient enrichment - mean of the lowest quartile of near-bed DO during the stratified season (July to October) per assessment Region 1 to 8 (see legend in Figure 1). Results are shown for all coastal and offshore water, using near-bed data (10 m from the bed). Assessment thresholds are shown for oxygen concentrations (6 mg l^{-1}) and percentage saturation (60% used here; range = 50-75%). Results are only shown where 5 or more data points were available.

5.3 Confidence in Assessments

A robust assessment of whether an area remains in Non Problem Area status depends on the confidence that can be assigned to the assessments of the individual parameters which together contribute to assigning status. We have assessed the confidence with which we can determine whether each parameter is below or, for dissolved oxygen, above the agreed assessment threshold based on available data. A high figure suggests we are confidently below, or above, the assessment threshold.

<u>Confidence levels</u>

Nutrients and chlorophyll

In Regions 1, 5, 6 and 7, confidence in assessments of nutrient and chlorophyll parameters was high (98-100%, Tables 5 and 6) in all marine waters. In Region 8 confidence in chlorophyll assessments was high (Table 6).

In coastal water in Regions 2, 3 and 4, confidence levels in winter nutrient concentrations being *below* the assessment threshold were low (0%, Table 5), due to nutrient enrichment (e.g. Region 2, Figure 3) and/or the small number of data points available (Region 3: n = 10). In offshore waters in these regions, confidence levels in winter nutrient concentrations were high (60-100%, Table 6); in Region 2, confidence levels were higher for TOxN (100%) than DIN (60%) due to data from SmartBuoy moorings (see Section 4.1).

In coastal water in Regions 2, 3 and 4, confidence levels in chlorophyll 90th percentiles being *below* the assessment threshold were high in Region 2 (100%, Table 5) and low in Region 3 (46.9%, Table 5), where few data (n=6) were available. In Region 4, no data were available for assessment of confidence. In offshore waters in Regions 2, 3 and 4, confidence levels in chlorophyll 90th percentiles were high (>86%, Table 6).

*Table 5: **Coastal areas** - confidence levels (%, 2006-2014) for assessing whether mean winter nutrients (DIN, TOxN, DIN:DIP) and growing season 90th percentiles for chlorophyll were below the assessment threshold, and dissolved oxygen (DO) concentrations were above the threshold. For DIN and TOxN, confidence levels are given for normalised means. n = number of available data points. DIN and TOxN = µM, chlorophyll = µg l^{-1}. For DO (mg l^{-1}) the mean value in the lowest quartile of the data was used. X = no data. Shading indicates where confidence levels were <50 %. Region 8 (Atlantic North-West Approaches) is an offshore region, and a Non Problem Area. N/A = not applicable.*

Assessment region	DIN		TOxN		DIN:DIP		Chlorophyll		DO	
	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*
1. N North sea	100	*982*	100	*1392*	100	*790*	100	*660*	100	*29*
2. S North Sea	0	*301*	0	*427*	94.84	*301*	100	*460*	99.78	*37*
3. English Channel	0	*10*	0	*10*	4.57	*10*	46.86	*6*	x	*x*
4. W Channel & Celtic Sea	0	*32*	0	*34*	76.82	*32*	x	*x*	x	*x*
5. Irish Sea	100	*611*	100	*734*	100	*533*	100	*952*	99.69	*27*
6. Minches & W Scotland	100	*558*	100	*761*	100	*464*	100	*580*	52.89	*29*
7. Scottish Cont Shelf	100	*166*	100	*252*	100	*121*	97.75	*36*	x	*x*
8. Atl NW Approaches	N/A		N/A		N/A		N/A		x	*x*

*Table 6: **Offshore areas-** confidence levels (%, 2006-2014) for assessing whether mean winter nutrients and growing season 90th percentiles for chlorophyll were below the assessment threshold and DO concentrations were above the threshold. For DIN and TOxN, confidence levels are given for normalised means. n = number of available data points. DIN and TOxN = µM, chlorophyll = µg l^{-1}. For DO (mg l^{-1}) the mean value in the lowest quartile of the data was used. X = insufficient or no data. Shading indicates where confidence levels were <50 %. Brackets ( ) = insufficient data to be statistically significant.*

Assessment region	DIN		TOxN		DIN:DIP		Chlorophyll		DO	
	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*
1. N North sea	100	*1291*	100	*2200*	100	*1268*	100	*827*	100	*166*
2. S North Sea	59.89	*431*	99.99	*609*	100	*431*	100	*555*	99.46	*33*
3. English Channel	67.99	*115*	98.5	*120*	100	*114*	86.49	*19*	x	*(1)*
4. W Channel & Celtic Sea	100	*186*	100	*200*	100	*185*	100	*98*	42.45	*15*
5. Irish Sea	100	*106*	100	*133*	100	*102*	99.94	*70*	x	*(1)*
6. Minches & W Scotland	100	*720*	100	*1135*	100	*708*	100	*236*	100	*32*
7. Scottish Cont Shelf	100	*530*	100	*947*	100	*488*	100	*585*	100	*65*
8. Atl NW Approaches	x		x		x		100	*111*	97.1	*8*

Dissolved oxygen concentrations

In coastal waters in Regions 1, 2, 5 and 6, confidence levels in concentrations of near-bed dissolved oxygen (DO) being *above* the assessment threshold in coastal waters were high (53-100%, Table 5).

In offshore waters in Regions 1, 2, 6, 7 and 8, confidence levels in near-bed DO being *above* the assessment threshold were high (97-100%, Table 6). In Regions 3 and 5 offshore, insufficient data were available. In Region 4 offshore, confidence levels were low (43%, Table 6) due to low sample numbers (n=14, mostly from 2014).

In summary, confidence levels in parameters being below/above the assessment threshold, as required, were lowest in coastal waters in Regions 3 and 4, largely due to insufficient data.

Representivity of data in time and space

Spatial and temporal representivity (2006-2014) was lowest for dissolved oxygen data (DO, 4.17 – 46.30%, Table 7), with the highest DO scores (39.6-46.3%) observed in Regions 1 and 6. These scores should provide the final score for representivity. However, DO is not routinely monitored in NPAs. Scores for nutrient and chlorophyll monitoring (Table 7) are consistently higher than for DO.

Excluding DO, overall scores for representivity of the data in time and space were best (>70%) in Regions 1, 2, 5 and 6, and worst (<20%, Table 7) in Regions 3 and 4. The overall score was 59% in Region 7, and 30% in Region 8 which is offshore.

In Regions 1, 2 and 5, representivity of TOxN data was generally higher in time than in space (Annex 16). These results are likely to reflect the risk-based monitoring carried out in these regions, especially in Regions 2 and 5. DIN is not measured routinely in these regions, giving slightly different results for representivity in time and space (Annex 16). In Regions 1 and 2, representivity of chlorophyll was also higher in time than in space (Annex 16), reflecting the risk-based monitoring in Region 2, and good data coverage in Region 1. In Region 5, chlorophyll representivity was highest in space (by longitude, Annex 16, Table A16.3) as a result of the comprehensive sampling in Scottish coastal waters during the assessment period (see Annex 12).

In Regions 3 and 4, representivity of nutrient and chlorophyll data was generally lower in time than in space, with chlorophyll giving the lowest score as well as a low score overall (Annex 16).

Representivity of nutrient data was lowest in time in Regions 6, and in space (latitude) in Region 7 (Annex 16). Representivity of chlorophyll data was lowest in space (latitude) in both regions.

Table 7. Spatial and temporal representativeness of available data (as a %) for DIN, TOxN, chlorophyll and DO in each of the assessment regions (for details, see Annex 16). Shading indicates highest overall scores, excluding DO. Note: these analyses use all data in an assessment region, and do not consider coastal and offshore waters separately.

Assessment region	DIN	TOxN	Chlorophyll	DO	Overall representativenes, excluding DO
1	80.30	80.30	71.23	39.63	71.23
2	72.54	83.30	70.41	25.77	70.41
3	39.75	35.82	19.21	4.17	19.21
4	38.78	61.35	12.52	8.33	12.52
5	88.56	88.83	72.81	10.81	72.81
6	91.47	94.68	78.41	46.30	78.41
7	62.96	62.96	59.04	7.66	59.04
8	x	x	30.29	1.57	30.29

5.4 Overall assessment

All Regional Sea assessment areas are confirmed as having Non Problem Area status (Table 9), based on all available data. Of the 750 transitional and coastal water bodies assessed for WFD (and UWWTD and ND), 21 Problem Areas have been identified within Regional Seas 1, 3, 4, and 5 (Table 8, Annex 7). These Problem Areas represent a small proportion (0.03%) of the total area of UK waters overall, and a small proportion of the area of these Regional Seas (Region 1, 0.02%; Region 3, 0.42%; Region 4, 0.02%; Region 5, 0.15%). The Problem Areas also represent a small proportion of the area of WFD water bodies overall (0.41%), and a small proportion of the area of WFD water bodies in each Regional Sea (Region 1, 0.56%; Region 3, 4.40%; Region 4, 0.28%; Region 5, 0.61%).

The overall assessment results are shown in Figure 7.

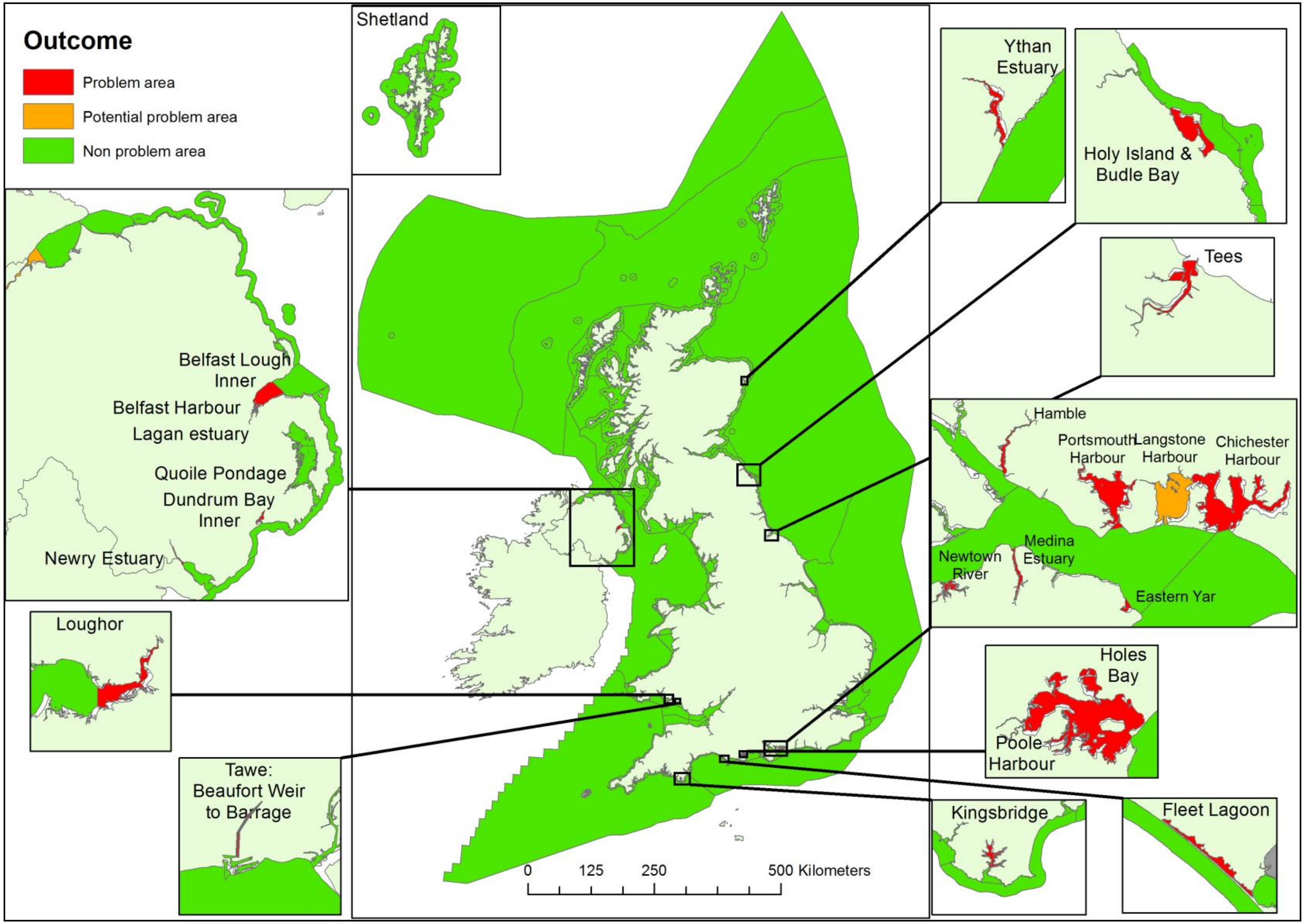


Figure 7: Results from the third application of the Common Procedure using data from 2006-2014. Insets show all water bodies assessed as Problem Areas (red). Insets include Potential Problem Areas (PPAs) which may be present; other PPAs are too small to be visible on the overall map. Non Problem Areas are shown in green. Grey lines indicate boundaries for regional seas and WFD water bodies.

Table 8: Overall classification results for water bodies assessed as Problem Areas (PAs) or Potential Problem Areas (PPAs) associated with designations under the Nitrates Directive or the Urban Waste Water Treatment Directive. NPA = Non Problem Area. HMWB = heavily modified water body.

Country	Assessment Area	OSPAR 2002	OSPAR 2008	OSPAR 2016
England	Chichester Harbour	PA	PA [1]	PA [1]
	Eastern Yar (Solent)		PA [1]	PA [1]
	Fal Lower estuary		PA [1]	PPA [2]
	Fleet Lagoon (The Fleet)	PPA	PPA [1]	PA [1]
	Hamble Estuary		PA [1]	PA [1]
	Holes Bay	PA	PA [1]	PA [1]
	Holy Island & Budle Bay (Lindisfarne NNR)	PA	PA [1]	PA [1]
	Kingsbridge			PA [3]
	Langstone Harbour	PA	PA [1]	PPA[1, 2]
	Medina estuary (Solent)		PA [1]	PA [1]
	Newtown River (Newtown Harbour)		PA [1]	PA [1]
	Pagham Harbour	PA	PA [1]	PPA[1, 2]
	Poole Harbour	PPA	PPA [1]	PA [1]
	Portsmouth Harbour	PA	PA [1]	PA [1]
	Taw Estuary	PA	PA [1]	PPA[1, 2]
	Tees (Seal Sands)	PA	PA [1]	PA [1]
	Truro, Tresillian, Fal Upper	PA	PA [1]	PPA [1, 2]
Wales	Burry Inlet Inner (Loughor estuary)	PPA	PA [1]	PA [1]
	Milford Haven Inner			PPA
	Tawe - Beaufort Weir to Barrage	PA	PA [1]	PA [1]
Scot-land	South Esk estuary (Montrose basin)		PPA	PPA
	Ythan estuary	PA	PA	PA [1]
Northern Ireland	Bann Estuary (HMWB) [4]			PPA
	Belfast Harbour	PA		PA
	Belfast Lough Inner	PA	PA	PA
	Connswater (HMWB) [4]			PPA
	Dundrum Bay Inner			PA
	Foyle estuary and Lough [4]		PPA	PPA
	Lagan Estuary (HMWB)	PA	PA	PA
	Newry Estuary (HMWB)			PA
	Quoile Pondage (HMWB)		PA	PA
	Roe Estuary [4]			PPA
	Strangford Lough North		PPA	NPA

[1] Sensitive Areas (Urban Waste Water Treatment Directive) or Polluted Areas (Nitrates Directive).
[2] Designated previously but improving in response to management measures.
[3] Not yet formally classified as a PA, but likely to be designated as a Polluted Water (Eutophic) under the Nitrates Directive.
[4] Final classification based on WFD results and expert judgement.

Table 9: UK Results of the OSPAR Common Procedure Assessment 2016. PA = Problem Area, NPA = Non Problem Area. Only + and – are used in the assessment as we have used all available data. No weight is assigned to '?' assessments

Key to the table

NI Riverine inputs and direct discharges of total N and total P
DI Winter DIN and/or DIP concentrations
NP Increased winter N/P ratio
Ca 90th percentile, maximum and mean chlorophyll *a* concentration
Ps Area-specific phytoplankton indicator species
Mp Macrophytes including macroalgae
O_2 Oxygen deficiency
Ck Changes/kills in zoobenthos and fish kills
Oc Organic carbon/organic matter
At Algal toxins (DSP/PSP mussel infection events)

\+ = Increased trends, elevated levels, shifts or changes in the respective assessment parameters
\- = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters
? = Not enough data were available for assessments. These data were not required or used to confirm Non Problem Status
Note: Categories I, II and/or III/IV are scored '+' in cases where one or more of its respective assessment parameters is showing an increased trend, elevated levels, shifts or changes.

Area	**Category I** Degree of nutrient enrichment		**Category II** Direct effects		**Category III and IV** Indirect effects/ other possible effects				Initial classification	Overall appraisal of all relevant information (concerning the harmonised assessment parameters, their respective assessment levels and the supporting environmental factors)	Final classification	Assessment period
Northern North Sea - coastal	NI	-	Ca	-	O_2	-	At		NPA	• 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.	NPA	2006-2014
	DI	-	Ps		Ck							
	NP	-	Mp		Oc							

Northern North Sea - offshore	NI DI NP	- - -	Ca Ps Mp	-	O_2 Ck Oc	-	At		NPA	• 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.	NPA	2006-2014
Southern North Sea - coastal	NI DI NP	- + -	Ca Ps Mp	-	O_2 Ck Oc	-	At		NPA	• 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.	NPA	2006-2014
Southern North Sea - offshore	NI DI NP	- - -	Ca Ps Mp	-	O_2 Ck Oc	-	At		NPA	• There is good evidence that the area is not nutrient enriched (high confidence) based on nutrient data with good representivity. • There is good evidence that there is no	NPA	2006-2014

										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 DI NP	- ? ?	Ca Ps Mp	?	O_2 Ck Oc	?	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 NPA status, it is likely that the area is a Non Problem Area.	Not Known	2006-2014
English Channel - offshore	NI DI NP	- - -	Ca Ps Mp	-	O_2 Ck Oc	?	At		NPA	• 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.	NPA	2006-2014

Celtic Sea - coastal	NI DI NP	- + ?	Ca Ps Mp	?	O_2 Ck Oc	?	At		NPA	• There is evidence that the area is nutrient enriched (low 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 NPA status, it is likely that the area is a Non Problem Area.	Not known	2006-2014
Celtic Sea - offshore	NI DI NP	- - ?	Ca Ps Mp	-	O_2 Ck Oc	-	At		NPA	• 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.	NPA	2006-2014

Irish Sea - coastal	NI DI NP	- - -	Ca Ps Mp	- -	O_2 Ck Oc	-	At		NPA	• 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.	NPA	2006-2014
Irish Sea - offshore	NI DI NP	- - -	Ca Ps Mp	-	O_2 Ck Oc	?	At		NPA	• There is evidence that this area is not nutrient enriched (high 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.	NPA	2006-2014
Minches and Western Scotland - coastal	NI DI NP	- - -	Ca Ps MP	-	O_2 Ck Oc	?	At		NPA	• 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.	NPA	2006-2014

									• 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.		
Minches and Western Scotland - offshore	NI	-	Ca	-	O_2	?	At	NPA	• 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.	NPA	2006-2014
	DI	-	Ps	Ck							
	NP	-	MP		Oc						
Scottish Continental Shelf - coastal	NI	-	Ca	-	O_2	?	At	NPA	• 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.	NPA	2006-2014
	DI	-	Ps		Ck						
	NP	-	MP		Oc						

Scottish Continental Shelf - offshore	NI DI NP	- - -	Ca Ps MP	-	O_2 Ck Oc	-	At	NPA	• There is evidence that this area is not nutrient enriched (high 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.	NPA	2006-2014
Atlantic and North-West Approaches - offshore	NI DI NP	-	Ca Ps MP	-	O_2 Ck Oc	-	At	NPA	• 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.	NPA	2006-2014

5.5 Comparison with preceding assessment

Transitional and coastal water bodies classified under the WFD were considered to have a status equivalent to OSPAR Problem Area for eutrophication in 21 water bodies, and a status equivalent to Potential Problem Area in 11 water bodies. Compared with the second application of the Common Procedure, these classifications indicate a decrease in the number of Problem Areas, and an increase in the number of Potential Problem Areas. This is partly due to management measures and/or improved monitoring of transitional and coastal water bodies, particularly since 2007. Where changes have been due to management measures, water bodies previously identified as Problem Areas have been identified as Potential Problem Areas.

Marine waters in the eight regional seas were classified as Non Problem Areas. The first and second applications of the Common Procedure also identified marine waters as Non Problem Areas. The second application (OSPAR 2008, see Foden et al. 2011; Defra 2010) showed that coastal waters included five areas that had previously been assessed as 'areas of ongoing concern' (East England, East Anglia, Liverpool Bay, the Solent and the Clyde), and had been subject to enhanced monitoring and investigative research. These areas were shown to be nutrient enriched and in some there was evidence of accelerated growth, but there was no evidence for undesirable disturbance, and the trend in nutrient loading indicated that the risk was not increasing. The risk continues to reduce as nutrient inputs decline.

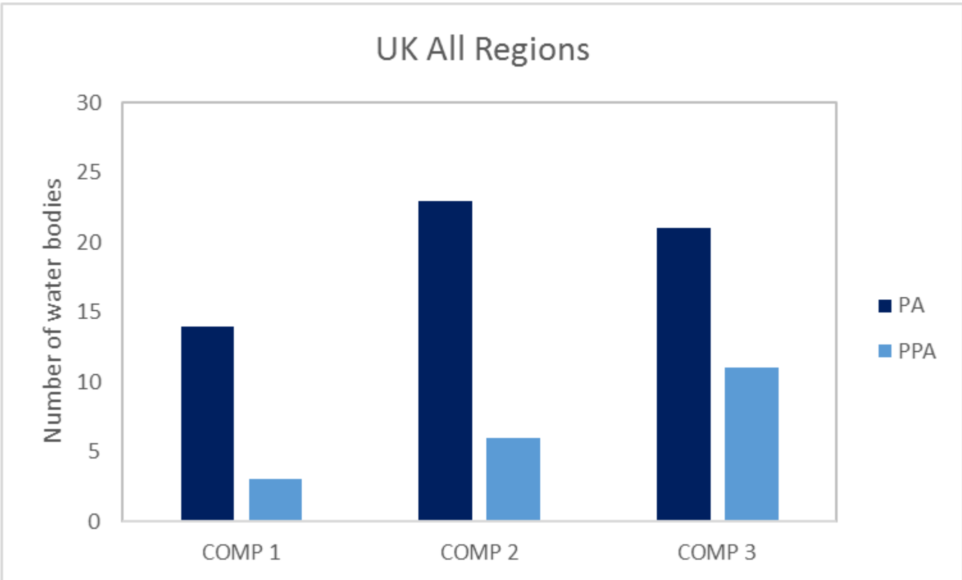


Figure 8: The total number of WFD water bodies in the UK classified as Problem Areas (PAs) and Potential Problem Areas (PPAs) during the three applications of the Comprehensive Procedure. COMP 1 = 1995-2001, COMP 2 = 2001-2005 and COMP 3 = 2006-2014.

6 Link to the results of the common indicators applicable to the sub-region wherein the CP waters are assessed.

[As a minimum Contracting Parties should comment on the trends of the common indicators

This section will be written when the common indicator assessments are finalised]

7 Perspectives

i. Expected trends taking account of observed trends related to Climate Change and Ocean Acidification
Expected trends (on the basis of measures being implemented, possible linkages between eutrophication and climate change etc.), confidence in prediction of the future state; supporting evidence
ii. Improvement of assessments
Comments for improvement of assessments, especially in relation to the WFD and, OPTIONAL, the Draft Marine Strategy Directive, on the application of additional parameters, and processes
iii. Improvement of monitoring
Including relevant outcomes from the Joint Monitoring Programme North Sea/ Celtic Sea (JMP NS/CS) project on integrated and optimised monitoring using a variety of platforms, such as satellite data for chlorophyll monitoring.

7.1 Expected trends - related to Climate Change and Ocean Acidification

Climate Change is likely to impact all parameters used for assessing eutrophication. Recent studies of DO, for example, have shown that concentrations are affected by warming of bottom water, particularly in regions where the water column stratifies in summer. In the North Sea, studies based on moorings (Greenwood et al. 2010) and spatial surveys (Queste et al. 2013) have attributed low summer DO concentrations near the sea bed to water temperature as well as processes such as decomposition of organic material. Using historical data (1900 to 2010), Queste et al. (2013) showed that trends of increasing near-bed hypoxia after 1990 were associated with trends in increased temperature.

Forecasting the likely impacts of climate change on nutrient enrichment and the subsequent risks and impacts of undesirable disturbance to the balance of organisms and water quality is complex and challenging. There is often no simple dose-response relationship between nutrient enrichment, primary production and undesirable disturbance. System attributes ‘filter’ responses to changes in nutrient loading – for example, the underwater light climate, horizontal exchange, tidal mixing, grazing and biogeochemical processes (Cloern 2001, de Jonge & Elliott 2001). Some eutrophication assessment parameters such as accelerated algal growth, changes in the phytoplankton community and near-bed oxygen depletion can also be the result of climate variability and the two causes are difficult to separate (McQuatters-Gollop et al. 2009).

Further work would be required to predict the consequences of known changes in the climate and ocean acidification at the decadal scale necessary. It is necessary to understand such changes as input to decisions about measures to minimise eutrophication either already in in place (see section 7.2) or considered necessary in future.

7.2 Measures taken to reduce the inputs of Nutrients from UK Problem Areas and Potential problem areas

The main existing measures to reduce nutrient inputs are taken through:

River basin management plans (RBMPs) developed under the Water Framework Directive (2000/60/EC)

These include measures to achieve the objectives for specific water bodies, particularly where nitrogen thresholds set under the WFD have resulted in the classification of 'moderate status' and an additional assessment of the biological quality indicates that measures to tackle eutrophication are necessary. The particular river basin districts concerned are indicated in the RBMPs and associated documents. The particular types of measure which have been included in the RBMPs are as follows:

- Reduced use of fertilisers, better fertiliser and manure management and farm management practices to reduce nutrient run-off, eg through the Nitrates Directive (91/676/EEC) and the WFD. There are also more general measures to tackle diffuse agricultural pollution including codes of good agricultural practice, agri-environment schemes and Catchment Sensitive Farming (CSF).
- In Scotland specific legislative measures have been introduced, by the Water Environment (Controlled Activities)(Scotland) Regulations, to implement WFD and which contain general binding rules to mitigate diffuse pollution.
- Measures are in place across the UK to work with farmers to secure good practice and improve environmental protection measures, including the Rural Development Programmes in England, Wales, Scotland and Northern Ireland. The above programmes which contribute to reducing nitrates from entering rivers and coastal areas are contributing to a significant reduction of diffuse pollution from agriculture.
- Some of the measures proposed in the RBMPs are voluntary. However, these have been developed following extensive consultation through the draft RBMPs, the liaison panels and location specific workshops, and are considered to be deliverable and achievable within the next cycle and will complement the suite of basic measures that are in place.
- Reduced nutrient inputs arising from sewage treatment works (STWs), eg through application of the EC Urban Waste Water Treatment (UWWT) Directive (91/271/EEC), the creation of 'UWWT Directive Sensitive Areas' and the implementation of STW nutrient reduction measures for the Habitats Directive (92/43/EEC).

The organisations responsible for these WFD-related measures are: in England, Defra; in Wales, the Welsh Government for western Wales, and for the river Severn and the river Dee joint responsibility between England and Wales; in Scotland, the Scottish Government; and in Northern Ireland, the Department of Agriculture, Environment and Rural Affairs (DAERA).

The RBMPs are reviewed at the end of each 6-year cycle as outlined in the WFD and a programme of measures is agreed to meet the objectives outlined in the plan. National environment agencies are currently updating the WFD RBMPs referred to above.

In England, the Countryside Stewardship (previously New Environmental Land Management Scheme, NELMS) from 2016, under the Rural Development Programme, will be an important future mechanism for reducing diffuse agricultural water pollution. In Northern Ireland, a new agri-environment scheme for the Northern Ireland Rural Development Programme 2014-2020 will run from 2016 to 2020.

Reduced emissions to the atmosphere

- Emissions of nutrients to the atmosphere are reduced through the setting of appropriate emission limits through the Industrial Emissions Directive (2010/75/EU) which sets emission limits for nitrogen in line with the best available abatement technologies. This measure is also aimed at reducing any possible contribution to trans-boundary impacts of nutrients to the waters of other countries.
- Emissions of nitrogen oxides and ammonia are reduced though implementation of the National Emissions Ceiling Directive (2001/81/EC) which sets emission ceilings on forms of nitrogen. This measure is also aimed at reducing any possible contribution to transboundary impacts of nutrients to the waters of other countries.

The control of Nitrogen Oxides (NOx) emissions from ships through the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 (as amended)

This measure, which requires engines installed on a ship to meet the specified NOx emission standard, is primarily designed to improve air quality. It will also contribute to the reduction of NOx inputs to both UK waters and the waters of other countries. The organisation responsible for implementation of these regulations is the Department for Transport.

Timescales for recovery

The timescales for recovery once measures are in place can be lengthy – a few decades - particularly when macroalgal growth is the issue. Many designated waters have measures under both Urban Waste Water Treatment Directive (UWWTD) and the Nitrates Directive which bear down on sewage effluent and agricultural nitrogen pressures. In no cases do we expect swift recovery. Some of the areas have contributions from groundwater feeding river flow where it will take decades for nitrate levels to reduce in response to measures. We have seen reductions in nutrient loadings at sites designated under UWWTD, as expected, and in some areas there is evidence that river nitrogen loadings may be falling. Evidence of biological improvements seems to be potentially apparent in certain estuaries, but it is too early to be clear on trends and whether they will be sustained.

7.2.1. Areas designated as Nitrate Vulnerable Zones under the Nitrates Directive

NVZs were originally designated in 1996 and covered approximately 8% of England's land area. Additional NVZs have been designated subsequently and brought the total coverage in England to just under 58% of the land area. However, NVZs which drain into waters affected by eutrophication make up about 5% of England.

In Scotland, four NVZs were designated in 2002, comprising 14% of the land area. In 2015, the extent of these NVZs was reduced. Two new NVZs are to be designated in 2016 (see http://www.gov.scot/Topics/farmingrural/Agriculture/Environment/NVZintro); one will become part of a previous designation. The total coverage of the five NVZs in 2016 will constitute approximately 11% of the total land area.

In Northern Ireland, seven small Nitrate Vulnerable Zones (NVZs) were designated in 1999 and 2003. Following a consultation undertaken in July 2004, Article 3.5 of the Nitrates

Directive was adopted which established Northern Ireland as an area to which an action programme should be applied (the ‘total territory’ approach). The Protection of Water against Agricultural Nitrate Pollution Regulations (Northern Ireland) 2004 came into operation in October 2004 establishing the ‘total territory’ approach.

The last review undertaken by the Welsh Government in 2012 resulted in the designation of 2.4% of the land area of Wales as a NVZ and introduced a strengthened range of measures in the Nitrates Action Programme that farms located within NVZs must comply with.

Programmes of measures and regulations were brought in to reduce losses of nutrients from agricultural land and protect or improve water quality. In addition, Member States were required to carry out effectiveness monitoring of the action plans.

7.2.2. Waters Designated as Sensitive under the Urban Wastewater Treatment Directive

The Urban Waste Water Treatment Directive (UWWTD) sets requirements for the collection, treatment and discharge of urban wastewater and establishes timetables for the achievement of these standards according to the sensitivity of the waters. The Directive requires that sewage being discharged to Sensitive Areas should be subjected to tertiary treatment to standards given in the Directive.

In England, there are 12 Sensitive Areas (Eutrophic) that are saline waters, 10 of which are also Polluted Waters (Eutrophic) with NVZs around them. In Langstone Harbour and the Fal there are signs of improvement but it is too soon to say whether this will be sustained. In Northern Ireland, improvements in the ecology of the waters in Belfast Lough have already been noticed since the installation of nitrogen removal at four wastewater treatment plants discharging into the Lough. There are 2 saline sensitive areas designated in Wales which have recently seen significant investment in sewerage infrastructure and ongoing monitoring is designed to identify an improvement to the ecology of these waters.

7.3 Improvements in assessment

Inconsistencies in reporting streams for marine data provided many challenges in compiling a data set (Section 4.1; Annex 2) for this application of the Common Procedure. The best available data set was considered essential to build confidence in the assessments (Section 4.1). Improved consistency in reporting streams and in data (and metadata) reported would contribute greatly to improved efficiency in carrying out future assessments of eutrophication status in marine waters.

There is general consensus that the impacts of climate change on nutrient enrichment and eutrophication are likely to be complex, and that a holistic ecosystem-based approach is required in order to improve our understanding of the cycling of nutrients in the water column and the coupling between water column and seabed processes (e.g. Statham 2012, Painting et al. 2013a, b). Such an approach requires ongoing research and monitoring, and the use of simulation models (see Painting et al. 2013a, Salihoglu et al. 2013) for examining fluxes and inter-annual variability in these fluxes. Studies to date have shown that improvements are needed in field measurements and models (e.g. Kelly-Gerryn et al. 2001, van der Molen et al. 2013), and on boundary conditions used in these models (eg., Lenhart et al. 2010).

Improvements in monitoring

The UK keeps its monitoring programmes, including the eutrophication monitoring programme, under review to ensure ongoing effectiveness and value for money. There are likely to be changes in the way data is collected using more remote technologies such as ocean colour via satellite observation, the adoption of modern *in situ* sensors and new sampling platforms. Modelling is likely to become a significant tool used in monitoring together with improvements in information technology for the collection, assessment and reporting of data.

8 Conclusions

This report presents the outcome of the third application of the Common Procedure to waters in the OSPAR maritime area under the jurisdiction of the United Kingdom. The purpose was to assess the continuing Non Problem status of UK marine waters and to take account of prior assessments in transitional and coastal waters carried out for the WFD, UWWTD and ND. This provides a comprehensive picture of marine eutrophication status in the UK.

The overall assessment is that marine waters in the regional seas were Non Problem Areas. This overall status is the same as found in both the first and second Common Procedure assessments. The status of 750 transitional and coastal water bodies (WFD water bodies) showed that 21 water bodies were Problem Areas, and 11 were Potential Problem Areas. Confidence in the transitional and coastal water assessment outcomes was good but confidence levels for assessments of marine waters varied depending on the data available.

Trends in inputs of nutrients showed that that total inputs of DIN (1990 to 2014) decreased significantly by 0.8 to 2.8 % per year in all regional seas apart from the English Channel, where inputs decreased but were not significant, and that total inputs of DIP decreased significantly by 2 to 6.1 % per year in all regions except the northern North Sea, where inputs decreased but were not significant. These decreases in input were reflected in decreasing concentrations in some, but not all, regional seas coastal areas especially where the inputs are high. In regions to the north of the UK, there were small but significant increases in parameter concentrations which may indicate changing oceanographic conditions.

The representativeness of the data has been rigorously assessed for this application of the Common Procedure and is good. Monitoring and surveillance reflects both the Non Problem Status of the regional sea areas and, for some regional seas where there is ongoing interest, sentinel monitoring that provides more than the minimum requirement.

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.

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Acronyms

AFBI:	The Agri-Food and Biosciences Institute
BODC:	British Oceanographic Data Centre
Cefas:	Centre for Environment, Fisheries and Aquaculture Science
CEMP:	Coordinated Environmental Monitoring Programme
CCW:	Countryside Council for Wales
DAERA:	Department of Agriculture, Environment and Rural Affairs (Northern Ireland). Previously DOE NI.
DIN:	Dissolved Inorganic Nitrogen (nitrate + nitrite + ammonium)
DIP:	Dissolved Inorganic Phosphorus
DOE NI:	Department of Environment Northern Ireland
EA:	Environment Agency
ICES:	International Council for Exploration of the Sea
MERMAN:	Marine Environment Monitoring and Assessment National Database
MSFD:	Marine Strategy Framework Directive
MSS:	Marine Scotland Science
NODB:	National Oceanographic Database
NRW:	Natural Resources Wales (Previously EA Wales, CCW and Forestry Commission)
OSPAR:	Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
SEPA:	Scottish Environment Protection Agency
TOxN:	Total Oxidised Nitrogen (nitrate + nitrite)
WFD:	Water Framework Directive

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