OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

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

(Reference number: 2013-8)[1]

Preface

This document defines a common procedure for the identification of the eutrophication status of the OSPAR maritime area (the "Common Procedure"). The Common Procedure is an integral part of the OSPAR North-East Atlantic Environment Strategy with regard to Eutrophication[2]. Action with respect to measures required following the identification of the eutrophication status of the maritime area are specified within this OSPAR Strategy.

This guidance for the application of the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area ("the Common Procedure") is updated in 2013. It describes all relevant existing arrangements with a view to the third application of, and the assessment report on, any new application by Contracting Parties of the updated 'screening procedure' and the application of the Comprehensive Procedure in 2016-2017. OSPAR also encourages use of it in other (maritime) areas and forums. The guidance includes experience gained by the Contracting Parties from the first and second applications of the Comprehensive Procedure in 2002 and 2008-09, considerations of synergies with the eutrophication assessment activity in the European Union, proposals on further developed harmonised assessment criteria and their assessment levels, elements of OSPAR agreement 2002-20, and more detailed arrangements developed to address confidence rating and trend assessment. This document supersedes OSPAR agreements, reference numbers 1997-11, 2002-20 and 2005-3.

The OSPAR Common Procedure was also brought to the attention of the relevant EU-level group of the MSFD Common Implementation Strategy (see OSPAR, 2012).

The procedures specified in this document are without prejudice to existing and future legal requirements, including European Union legislation where appropriate.

1 Supersedes agreements 1997-11 and 2002-20. Source: EUC 2005 Summary Record – EUC 05/13/1, Annex 5 as amended and endorsed by OSPAR 2005 Summary Record – OSPAR 05/21/1, §§ 6.2-6.5 and Annex 6. Updated 2013 and 2014

2 OSPAR Agreement 2010-03 – further referred to as the 'Eutrophication Strategy'.

Contents

1. Introduction and context

1.1 The OSPAR Commission's strategic objective, updated by Ministers in 2010, with regard to eutrophication is to combat eutrophication in the OSPAR maritime area with the ultimate aim to achieve and maintain a healthy marine environment where anthropogenic eutrophication does not occur. This should be achieved progressively by 2020, *inter alia*, by achieving that human-induced eutrophication is minimised, especially the adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters and by achieving and maintaining, by 2020, that all parts of the OSPAR maritime area have the status of non-problem area. The need for measures, the assessment of their effectiveness and, accordingly, the need for any further targeted OSPAR activities (measures, programmes, monitoring etc.) to achieve the goal set for 2020 require assessment and monitoring of the eutrophication status of OSPAR Convention waters. To this end OSPAR adopted, in 1997, the Common Procedure as a common framework for Contracting Parties to assess and to classify, in two phases[3], the eutrophication status of the OSPAR maritime area. This procedure (COMP) has been applied twice (see Box 1) and is now made ready for its third application.

Box 1 – **Development and application of the OSPAR COMP**

- OSPAR's 1998 Strategy to Combat Eutrophication was informed by more than a decade of work on eutrophication, with much information derived from the commitments of the North Sea Conferences. The OSPAR Common Procedure, officially established in 1997, pre-dates the Strategy (1998) and the first integral OSPAR Quality Status Report (2000). The results of its application covering data from the years 1990-2001 were published in 2003 in an OSPAR integrated report. This first application of the Common Procedure was preceded by a so-called screening procedure based on certain selected criteria and related indicators for a broad brush assessment of the eutrophication status. The subsequent applications of the Comprehensive Procedure focussed on areas identified under the screening procedure and areas already known to be problematic due to eutrophication. To guide the Contracting Parties in the application of the Comprehensive Procedure, common harmonised assessment criteria, their assessment levels and the area classification were formally agreed by OSPAR 2002.
- The second application of the Common Procedure took place in the period 2007-2008 (OSPAR 2008 integrated eutrophication assessment report), covering assessment periods of 2001 up to and including 2005 and previous years, and was geared towards including an updated eutrophication assessment into the Quality Status Report 2010, for which several reports provided substantiating information[4]. Contracting Parties had also examined the relationship between the OSPAR COMP and ecological status assessment requirements under existing or new EU legislation, like the Nitrates Directive and the Water Framework Directive[5]. (see Box 2)
- The pilot application of the integrated set of North Sea Ecological Quality Objectives for eutrophication[6] has been useful, also for communication purposes, and Contracting Parties will build on knowledge and experience gained in future work. The definition of the overall desired state with respect to eutrophication is to obtain non-problem area status as assessed under the Common procedure.

Box 2 – **OSPAR COMP and EU: Water Framework Directive and Marine Strategy Framework Directive**

- Parts of the OSPAR maritime area are also covered by the requirements of the EU Water Framework Directive. A 2009 document ("Policy Summary of Guidance document No. 23 on Eutrophication Assessment in the context of European Water Policies") describes the relationship between the assessment features of the relevant EU instruments in relation to those of regional sea conventions such as OSPAR[7]. Further information on the relation is described in Section 9.

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[3] The first phase was the 'screening procedure', enabling elimination of (obvious non-problem) areas where the second phase, the 'comprehensive procedure' would not have to be applied. A revised version of the screening procedure, originally intended to be applied as a 'one-off', is now included again in this revised COMP.

[4] See http://qsr2010.ospar.org/en/ch04.html and Section 4 under http://qsr2010.ospar.org/en/qsr_assessments.html

[5] Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (the "Water Framework Directive" or "WFD").

[6] http://qsr2010.ospar.org/media/assessments/EcoQO/EcoQO_05_Eliminate_eutrophication.pdf

[7] Document accessible at:

https://circabc.europa.eu/sd/d/75bf8789-716e-4d8f-8a9f-cb58bd009b38/PolicySummaryGuidDocNo23_Final2009.pdf

- The adoption of the EU Marine Strategy Framework Directive[8] frames eutrophication as a possible feature of marine environmental quality, and the objective of 'good environmental status' is, with respect to eutrophication, described as '*human-induced eutrophication is minimised, especially adverse effects thereof, such as the loss in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters*'. In 2012, OSPAR has documented how Contracting Parties can use the procedures and features of OSPAR's work on eutrophication for the MSFD implementation in OSPAR's MSFD Advice Manual and Background document on Good environmental status - Descriptor 5: Eutrophication (a living document)[9]. It states that the OSPAR Common Procedure for the identification of the eutrophication status of the OSPAR maritime area provides a good framework for assessing eutrophication and should be used as the basis for determining characteristics, targets and indicators for GES descriptor 5 in the North East Atlantic Ocean. The harmonised assessment parameters of the Common Procedure are suitable, and comparable with those of other frameworks, to act as area-specific indicators in relation to the descriptor 5 criteria. The indicators most used for monitoring and assessment are winter nutrients (DIN/DIP, N/P ratio), chlorophyll *a*, nuisance phytoplankton indicator species, macrophytes (e.g. opportunistic macroalgae and seagrass) and oxygen. Additional indicators such as total nitrogen/phosphorus, carbon, zooplankton and primary production could be considered, subject to demonstrating their added value. Assessment of biological elements such as phytoplankton indicator species, macrophytes and possibly zooplankton and primary production could provide links to GES descriptors 1 (biodiversity) and 4 (food chain).
- In order to move towards 'good environmental status' (MSFD) cq. non-problem area status (COMP) for existing eutrophication problem areas, reduction of human-induced nutrient enrichment is critical to minimising eutrophication effects. It is therefore considered likely that pressure-related targets seem to be essential for achieving GES descriptor 5 where there are problem areas, and providing a causative link to the relevant sources / source categories of the nutrients to underpin effective policy measures.

1.2 The data and information to be used in the application of the Common Procedure is broad ranging and will aim to capture the (sub-)regional and local characteristics of the maritime area and the possible eutrophication phenomena therein. Especially Contracting Parties with large marine waters might see a need to focus on problematic areas with regard to eutrophication and not to monitor and assess their whole waters with the same intensity. A risk-based approach, such as the screening procedure, could be an appropriate tool. This has been introduced into this COMP from the beginning. The Commission Decision 2010/477/EU – supplementing the MSFD Art. 9 – allows according to Part A (§ 4) that in a number of cases, and in particular taking into account the relation between information needs and the geographical scope of the marine waters concerned, it can be appropriate to apply as a first step some selected criteria and related indicators for an overall screening of the environmental state at a broader scale and only then identify instances and specific areas where, having regard to the importance of impacts and threats in view of the environmental characteristics and/or human pressures, a finer assessment is necessary, involving all relevant indicators related to criteria. Contracting Parties which have in the past used the screening procedure in the first application of the Common Procedure are invited to consider a repetition, taking account of the revised 'screening procedure' section as updated below.

1.3 Contracting Parties continuously endeavour to enhance the coherence of their implementation of the OSPAR Strategy and of the relevant EU legal instruments such as the WFD and the MSFD. Where possible they take steps to ensure the coherence of assessment criteria and procedures across the different parts of the maritime area. Areas of the COMP where this is particularly relevant include:

a. the WFD-typology which is considered in Section 3 (characterisation of the OSPAR Convention area) and to some degree in the overall classification in the Comprehensive Procedure (see reporting format, Annex 1);

b. the extension of parameters (e.g. composition and abundance of phytoplankton, and macrophyto- and macrozoobenthos) for the assessment procedure (step 1);

c. the scoring leading to an initial area classification (step 2), including also indications of trends in the assessment parameters;

d. the classification procedure, considering the level of confidence and precision; and,

e. the provision and sharing of relevant data.

[8] Directive 2008/56/EC of the European Parliament and the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (the "Marine Strategy Framework Directive" or "MSFD")

[9] http://www.ospar.org/documents/dbase/publications/p00582_advice_document_d5_eutrophication.pdf

2. Outline of the Common Procedure

2.1 It is the purpose of the Common Procedure to provide a means of establishing eutrophication status on a common basis. It aims at characterising maritime areas with regard to their eutrophication status as:

a. problem areas if there is evidence of an undesirable disturbance to the marine ecosystem due to anthropogenic enrichment by nutrients;

b. potential problem areas if there are reasonable grounds for concern that the anthropogenic contribution of nutrients may be causing or may lead in time to an undesirable disturbance to the marine ecosystem due to elevated levels, trends and/or fluxes in such nutrients;

c. non-problem areas if there are no grounds for concern that anthropogenic enrichment by nutrients has disturbed or may in the future disturb the marine ecosystem.

2.2 It comprises two phases: an initial “broad brush” screening of selected maritime areas and an iterative comprehensive eutrophication assessment of those maritime areas which, by screening, have not been identified as obvious non-problem areas with regard to eutrophication.

2.3 The assessment and classification is supplemented by common monitoring and reporting arrangements to attain harmonised information on the eutrophication status of maritime areas.

a. The Screening Procedure

2.4 In the light of experience through the two applications of the Common Procedure (see Box 1), in expectation of the assessment and monitoring requirements for the implementation of the MSFD and considering the possibility of developing a risk based approach as outlined in the Commission Decision 2010/477/EU, Contracting Parties consider that there may be scope for further use of the Screening Procedure or a modification thereof. The Screening Procedure was originally set up as a ‘broadbrush’ one-off process to identify areas that were obvious non-problem areas and where there was no requirement to carry out a harmonized assessment using the iterative Comprehensive Procedure, including trends. The details of the Screening Procedure are set out below.

2.5 The Screening Procedure is now a process of screening selected maritime waters in order to identify those areas which are either likely to be obvious non-problem areas with regard to eutrophication or have been identified in successive comprehensive procedure assessments as non-problem areas and any relevant pressures are assessed as unlikely to increase.

2.6 It was for the Contracting Parties to select areas for assessment and to decide on their size. Yet, the size of the selected area was critical for the assessment result. Features which should be taken into account for the selection were the area’s hydrodynamic characteristics and proximity to nutrient sources.

2.7 In the screening procedure, Contracting Parties are invited to obtain readily available information to the extent possible for the following types of information, *inter alia*:

a. demographic/hydrodynamic/physical information
- demographic data: population and waste water treatment;
- agriculture and industry;
- hydrodynamic/physical features (for example fronts, upwelling, turbidity, flushing rates, residence times, water transport and currents);

b. optical observations
- relevant optical observations made by ship, aircraft or satellite (for example the presence of, or evidence to the contrary of, algal blooms or fish kills) together with any information available from in situ mobile- and fixed platforms such as ferryboxes (monitoring tools on board of ships of opportunities, like ferries) and moorings, respectively;

c. nutrient-related information
- mandatory nutrient monitoring data held by ICES, and data such as nutrient concentrations from international research cruises. ICES data are useful for screening large areas, but in coastal areas, fjords and small estuaries other data may be more appropriate (although such data may not be easily available);
- input data (for example, atmospheric inputs, riverine inputs or direct discharges);
- nutrient budgets (including the total nutrient component and the anthropogenic nutrient component);
- information from monitoring carried out under European Directives (including the WFD and MSFD (from 2014).

b. The Comprehensive Procedure

2.8 The Comprehensive Procedure is to be applied to those areas not identified as non-problem areas in the Screening Procedure, including local areas located in wider non-problem areas, for their refined assessment and subsequent classification as non-problem, potential problem or problem areas with regard to eutrophication. It follows that the Comprehensive Procedure should be applied to any areas, including local areas, to which the Screening Procedure was not applied because they were not obvious non-problem areas.

2.9 The Comprehensive Procedure should be applied as soon as possible following the Screening Procedure in order to allow for immediate arrangements for appropriate monitoring activities and action programmes, namely with regard to potential problem and problem areas. The assessment may be applied as many times as necessary. Its repetition is of particular importance for areas classified as potential problem or problem areas in order to identify any changes in their eutrophication status (cf. § 4.2 of the Eutrophication Strategy).

2.10 The Comprehensive Procedure consists of a set of qualitative cause-effect related assessment criteria which are linked to form a holistic assessment and area classification with respect to the eutrophication status of a given maritime area. The holistic approach is reflected in the selection and application of such common assessment parameters which reflect, once inter-linked, the main cause/effect relationships in the eutrophication process. These cause/effect linkages form the essence of the classification process as illustrated by a generic conceptual framework for all categories of surface waters (Figure 1).

2.11 Contracting Parties should divide their waters in the OSPAR maritime area into suitable assessment units based on the relevant physical features. This process of characterisation could be undertaken in accordance with the Annex II to the Water Framework Directive. Guidance on this typology is given in Section 3.

2.12 Assessment and area classification in the Comprehensive Procedure is a three-step approach based on common methodologies, guidance on which is given in this document.

2.13 In a first step, assessment criteria and their corresponding area-specific assessment levels are set and applied for a given area based on a common methodology. The scores resulting from this application are reported in an agreed format (see Annex 1).

2.14 In a second step, the scores attained in the first step are integrated to give an initial classification for the given area.

2.15 In the third step, an overall assessment of all relevant information relating to harmonised assessment criteria, their corresponding assessment levels and supporting environmental factors is made to give the final area classification.

2.16 The Contracting Parties are required to report in a harmonised way on the assessment and classification process, including the requirements set out in Section 6, for the parts of the OSPAR maritime areas under their jurisdiction. This allows an integrated eutrophication assessment of the entire Convention area as basis for the development of targeted measures and programmes.

2.17 It follows that marine areas shall be monitored with regard to eutrophication in compliance with common minimum monitoring requirements as agreed, for the OSPAR Convention area, in the Eutrophication Monitoring Programme[10]. The risk of misinterpretation of the causes of direct and indirect effects should be reduced when all categories (nutrient enrichment, direct effect and indirect effects) as well as supporting environmental factors are monitored and assessed in coherence/together (see further Section 7). Contracting Parties shall document the relative confidence of their assessment findings as described in Section 8.

[10] The Eutrophication Monitoring Programme (reference number: 2005-4 (as updated in 2013)) supersedes the Nutrient Monitoring Programme adopted by OSPAR 1995 (Reference number 1995-5).

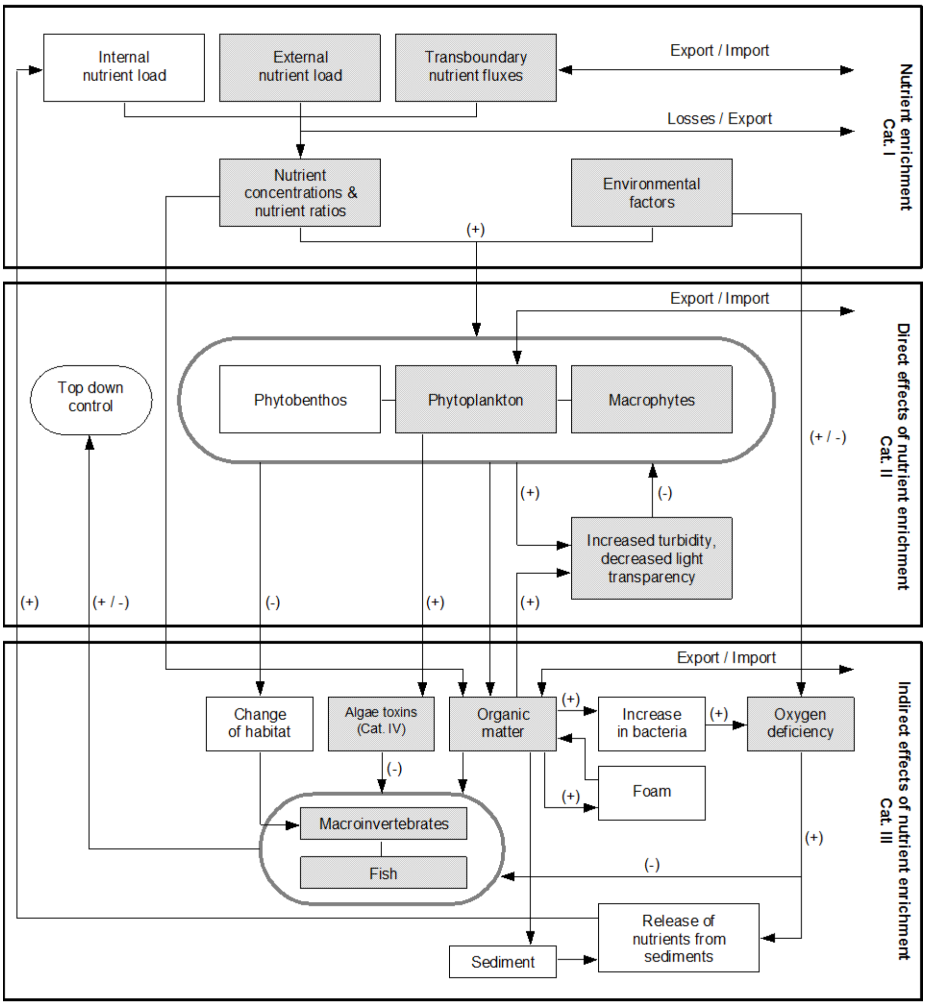

Figure 1 Generic conceptual framework to assess eutrophication in all categories of surface waters illustrating the main cause/effect linkages

Note: Shaded boxes indicate components relevant for the Comprehensive Procedure.
'+' indicate enhancement; '-' indicate reduction;

Cat. I = Category I. Degree of nutrient enrichment (causative factors);
Cat. II = Category II. Direct effects of nutrient enrichment;
Cat. III = Category III. Indirect effects of nutrient enrichment;
Cat. IV = Category IV. Other possible effects of nutrient enrichment.

3. Characterisation of the OSPAR Convention area

3.1 In order to enable area-specific reference conditions to be established, there might be a need for Contracting Parties to carry out an analysis of the relevant characteristics ("typology") for their parts of the OSPAR maritime area. Relating thereto, further relevant information can be found in the Quality Status Reports for the North Sea and the whole OSPAR maritime area (North Sea QSR 1993, QSR 2000 and QSR 2010).

3.2 For transitional (e.g. estuarine) and coastal waters falling under the regime of the Water Framework Directive, the respective typology could be used also for the application of the Comprehensive Procedure. When carrying out the characterisation, Contracting Parties should focus on the overall purpose of the Comprehensive Procedure to identify the eutrophication status of various parts of the OSPAR maritime area.

3.3 If Contracting Parties see a need to (further) divide their waters outside the area of jurisdiction of the Water Framework Directive, the following factors could assist in the characterisation (see also Figure 1 and Annex 2):

a. salinity gradients and regimes;

b. depth;

c. mixing characteristics (such as fronts, stratification);

d. transboundary fluxes;

e. upwelling;

f. sedimentation;

g. residence time/retention time;

h. mean water temperature (water temperature range);

i. turbidity (expressed in terms of suspended matter);

j. mean substrate composition (in terms of sediment types);

k. typology of offshore waters (cf. Annex 3).

3.4 The geographic scale of areas for eutrophication assessment should be chosen to balance hydrodynamic and ecosystem considerations with considerations such as efficiency, monitoring design to assess direct and indirect effects of nutrient enrichment in the sea and links with nutrient inputs and sources. Areas chosen too small may not be efficient for monitoring and assessment purposes, and areas chosen too large may disguise local problems. The consideration of salinity regimes from the rivers to offshore helps identifying and quantifying cause-effect relationships and determining assessment scales. The size of geographic assessment scales is expected to increase from smaller inshore waters to bigger offshore areas.

3.5 For comparison of eutrophication results across Contracting Parties it is recommended to group assessment areas into estuaries/inshore waters (small scale), inner coastal waters and outer coastal waters (medium scale) and offshore waters (large scale), based on salinity ranges, residence time and effects. Table 1 provides a general guiding example for geographic assessment scales, noting that national conditions (e.g. salinity ranges) and assessment purposes (screening, comprehensive assessment) may differ, requiring adjustment of the scaling factors. For example, the salinity of the whole Kattegat is less than 30 and requires a different salinity range for distinguishing inshore, coastal and offshore waters. Another example is the screening of homogenous water bodies in the UK which allow larger scales (e.g. combining inner and outer coastal waters).

Table 1 Guiding example for determining assessment scales

Areas	Salinity	Residence time
Estuaries	0.5-18	Days
Inshore waters	< 30	Days
Inner Coastal Waters	30-32	Weeks
Outer Coastal Waters	32-34.5	Weeks
Offshore waters	>34.5 or 35	Months

4. Assessment procedure (step 1)

4.1 To allow for a harmonised assessment of the eutrophication status of maritime waters throughout the Convention area, the Comprehensive Procedure developed a conceptual framework consisting of harmonised assessment criteria/parameters which are linked to form a holistic assessment.

4.2 The aim of step 1 is to select and apply parameters which are relevant for the area concerned because they reflect the cause/effect relationships of the eutrophication process (Table 2). These linkages are illustrated in Figure 1.

4.3 The results of the assessment of each of the parameters in Table 2 are reported in a harmonised way in the score table of the reporting format (in Annex 1, Section 3).

a. Setting and selecting of area-specific assessment parameters

4.4 The basic assessment parameters for the assessment of eutrophication of maritime waters are laid down for the OSPAR maritime area in the Eutrophication Monitoring Programme[11]. They are to be applied throughout the whole maritime area.

4.5 Building on this, the following four categories of qualitative assessment criteria for application in the Comprehensive Procedure are agreed:

Category I	Causative factors: nutrient enrichment, taking into account environmental supporting factors;
Category II	Direct effects of nutrient enrichment;
Category III	Indirect effects of nutrient enrichment;
Category IV	Other possible effects of nutrient enrichment.

4.6 For each category, specified assessment criteria and associated biological and chemical parameters are agreed. They are reproduced in the checklist in Annex 2.

4.7 Areas have been differentiated according to their salinity into offshore, coastal and estuarine waters. Further ecosystem characteristics, including environmental supporting factors are mainly taken into account in steps 2 and 3 of the Comprehensive Procedure when integrating the assessment results and classifying maritime areas with regard to their eutrophication status.

4.8 Area differences with respect e.g. to demographic and hydrodynamic conditions and differences in data availability are likely to influence the selection of assessment parameters and their assessment levels for the use in the eutrophication assessment. The levels against which assessment is made may be area-specific. When setting assessment levels, supporting environmental factors as listed under the causative factors (Category I assessment parameters), and the characteristics distinguishing various types of areas (cf. Section 3), should be taken into account.

4.9 Using synergies with the Water Framework Directive, maritime areas may need further characterisation under the Comprehensive Procedure according to the WFD-typology. The similarities and synergies of OSPAR Comprehensive Procedure assessment levels and the Water Framework Directive are set out in Figure 2 (cf. Section 9).

4.10 While allowing for area specifications, the methodology used for applying assessment parameters is based on the common approach.

4.11 This requires that for a number of *qualitative* assessment criteria/parameters corresponding *quantitative* assessment levels are set on the basis of common methodologies.

4.12 For the OSPAR maritime area, parameters were selected for this purpose on the basis of common denominators found in wide-ranged qualitative and quantitative information provided by the Contracting Parties (Annex 2). This information is derived from the previous use of those qualitative assessment parameters which are set out in the initial Common Procedure guidance.

4.13 Based on this experience, a set of assessment parameters was selected for the development of assessment levels relating to nutrient enrichment, direct/indirect and other effects of nutrient enrichment. These parameters form the basis for the later classification of maritime areas with regard to eutrophication. These assessment parameters and related elevated levels are outlined in Table 2.

4.14 Additional parameters (e.g. from the checklist in Annex 2) may be applied where necessary to support the assessment process, to harmonise the Comprehensive Procedure with the Water Framework Directive and/or the Marine Strategy Framework Directive, and to increase our current understanding. Where used, the Contracting Parties should describe, in their national reports on the application of the Comprehensive Procedure, their use with a view to their future harmonisation. Assessments can take account of information supplied from monitoring, research and modelling.

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[11] These are for nutrient enrichment: NH_4-N, NO_2-N, NO_3-N, PO_4-P, SiO_4-Si, salinity and temperature; for direct and indirect effects: phytoplankton chlorophyll *a*, phytoplankton indicator species and species composition, macrophytes, O_2 concentration (including % saturation) and benthic communities and groups of indicator species.

Table 2 Harmonised assessment parameters and related elevated levels.

Note: Parameters found at levels above the assessment level are considered as "elevated levels" and entail scoring of the relevant parameter category as (+) (cf. 'score' table at Annex 1). For concentrations, the "assessment level" is defined as a justified area-specific % deviation from background not exceeding 50%.

Assessment parameters		
Category I	**Degree of nutrient enrichment**	
	1	**Riverine inputs and direct discharges**[12] **(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: acute toxicity; 2 - 6 mg/l: 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)

b. Defining and applying the area-specific assessment parameters and their assessment levels

4.15 For each parameter listed in Table 2 an assessment level has been developed, based on levels of increased concentrations and trends as well as on shifts, changes or occurrence. For nutrient inputs, for example, insight is needed into both, increased concentrations and an examination of trends. For concentrations, for example, "assessment levels" are defined, in general terms, as a certain percentage above an area-specific background concentration, reflecting natural variability and allowing a 'slight disturbance' as is also the case for assessment under the Water Framework Directive. The "background concentration" is defined, in general, as salinity-related and/or specific to a particular area, and which has been derived from data relating to a particular (usually offshore) area or from historic data.

[12] Principles of the Comprehensive Study on Riverine Inputs and Direct Discharges (RID) (reference number: 1998-5, as amended).

c. Trends assessment

4.16 Temporal trend assessments of individual indicators at national and regional level could usefully supplement eutrophication status assessments within the Common Procedure. Trend assessment is of particular interest because environmental changes have been sometimes unusual in the past few decades with consequences on the environment in general, including impacts on the eutrophication process, on living resources and fishing management. Time-series are of importance to studies on the biological influence of anthropogenic effects and climatic changes, both in themselves and in providing a baseline and/or reference conditions for future investigations. They put short assessment periods into long-term perspective. As part of the Common Procedure, temporal trend assessment should allow monitoring whether or not key environmental parameters of a problem area or a potential problem area regarding its eutrophication status are moving in the right direction, indicating that measures taken to combat eutrophication are taking effect. Methods for trend assessment should be considered for river discharges, nutrient concentrations in receiving waters and phytoplankton biomass (chlorophyll *a*), which together could demonstrate the effectiveness of nutrient reduction. Riverine discharges are assessed through established methods under OSPAR's working group on inputs to the marine environment (INPUT) (see JAMP guidance on input trend assessment and the adjustment of loads, OSPAR agreement 2003-9). For the other physico-chemical and biological parameters and due to the complexity and diversity of statistical tools, a routine procedure (TTAinterfaceTrendAnalysis package) for temporal trend detection have been developed using the R programming software to perform non- parametric trend test analysis (Kendall test family) through an interactive graphical user interface (GUI), easy to handle for non-statistician users. The GUI guides the user through 5 successive panels which represent the successive steps of the data analysis. The routine trend assessment package is composed of consecutive smaller programmes which interact with each other as a function of their rule (data preparation, descriptive statistics, statistical test …) either automatically or according to the user's choice through a user-friendly interface (See Annex 4).

4.17 In order to allow for natural variability, and in the absence of more specific information, the assessment level was defined as the concentration 50% above the salinity-related and/or area-specific background concentration in the first application of the Comprehensive Procedure (OSPAR 2003). This applied to winter DIN and DIP concentrations, winter N/P-ratio and maximum and mean chlorophyll *a* concentrations. In the light of experience, further applications of the Comprehensive Procedure should be based on assessment levels defined as a justified area-specific % deviation from background not exceeding 50%.

4.18 Parameters which are found at levels above the assessment levels are at "elevated levels" for the purpose of the Common Procedure. For the initial assessment in step 2 of the Comprehensive Procedure, elevated levels entail scoring of the relevant parameter category as (+) (cf. 'score' table at Annex 1).

(I) Category I - Degree of nutrient enrichment (causative factors)

(1) Nutrient inputs

(a) Riverine inputs and direct discharges of total N and total P

4.19 Data on riverine and direct inputs are available from 1990 onwards, using the information provided by Contracting Parties and the data from the Comprehensive Study on Riverine Inputs and Direct Discharges (RID).

4.20The assessment procedures should:

a. consider the pattern of change in inputs and flows over the maximum period possible;

b. where possible, consider seasonal variations;

c. take into account the level of the (yearly) riverine discharge ("wet" and "dry" years) related to the respective riverine N- and P-inputs;

d. compare, if possible, current loads of total N and P (riverine and direct inputs) with the relevant background loads or reference conditions. In the absence of background loads, compare current loads of total N and P (riverine inputs and direct discharges) with those from previous years. Furthermore, existing trends of these total N and P loads (years need to be defined) should be considered and included in the assessment. In respect of establishing whether there is a trend in inputs, any change of more than 5% over a ten-year period should be considered as a trend. In respect of the analysis of trends, flow adjustment of riverine inputs should be made.

(b) Other parameters for nutrient input not listed in Table 2

4.21 The pressures causing eutrophication may originate a long way from a region being affected. There may be the situation where the nutrient pressures on affected regions may be originating from adjacent areas (see also paragraph 5.6 and Annex 5). Therefore, the overall assessment of nutrient inputs also needs to consider transboundary and atmospheric inputs as listed in the following paragraphs.

4.22 Assessment levels could be applied for target setting in combination with transboundary transport (TBT) connecting sources and effects. It has been acknowledged for a number of years that some marine areas (like the sedimentation areas: the Oyster Ground area in the Dutch offshore part of the North Sea, the German Bight and Skagerrak) are affected or likely to be affected not only by direct and riverine inputs, but also by nutrient fluxes from adjacent (maritime) areas. This occurs through transboundary nutrient inputs and related effects (nutrient inputs via transport of nutrient enriched water masses from one maritime area to another).

4.23 The further harmonisation of the assessment of transboundary inputs to specific sea areas should be strengthened in order to help to quantify and determine the significance of the anthropogenic and non-anthropogenic components. One way could be to divide the sea area into boxes, based on their inherent physical characteristics (temperature, salinity, flushing times) and to calculate their internal nutrient and water budgets, taking into account nutrient inputs via all significant pathways and sources and the transboundary fluxes between them. This work should include further development of scientifically accepted modelling tools directed towards spatial and temporal integration of nutrient fluxes.

(c) Atmospheric deposition of nitrogen

4.24 Atmospheric nitrogen inputs may have a material influence on nitrogen concentrations in marine waters. From the first application of the Comprehensive Procedure it became obvious that atmospheric nitrogen input plays a major role for some regions (in particular in those coastal regions where riverine inputs are small). In the current eutrophication assessment according to the Comprehensive Procedure atmospheric nitrogen is not adequately covered. Information (maps, tables etc.) on emissions and deposition of oxidised and reduced nitrogen in the OSPAR Convention area with a special emphasis on the North Sea (subdivided into 13 subregions) are presented in the EMEP report "Atmospheric Nitrogen in the OSPAR Convention Area in the Period 1990-2001" (EMEP 2004). This report is derived from results of the UNECE Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP) under the Convention on Long-Range Transboundary Air Pollution (LRTAP). These results and/or results from a possible update should be taken into account during the next application of the Comprehensive Procedure. Some more recent deposition calculation data are included in the OSPAR 2009 report on trends in atmospheric concentrations and deposition of nitrogen and selected hazardous substances to the OSPAR maritime area[13].

(2) Winter nutrient (DIN and/or DIP, and Si) concentrations

4.25 Widely used in comparable assessments are total dissolved inorganic nitrogen compounds (NO_3 + NO_2 + NH_4 (DIN)) and ortho-P (DIP) for winter time (when algal activity is lowest). Silicate (SiO_4) is monitored, but not widely used in assessments and is therefore not incorporated in Table 2.

(a) Overall guidance for salinity gradient riverine influenced waters

4.26The widely used uniform assessment procedure with respect to yearly trends and elevated concentrations of DIN and DIP in winter, and silicate in salinity-gradient (riverine influenced) waters is as follows (see examples in Annex 6a):

a. Mixing diagrams and salinity-specific background concentrations:
In marine coastal waters with salinity gradients yearly trends in winter nutrient concentrations are assessed by plotting the winter nutrient concentrations of each year in relation to the respective measured salinity values ("mixing diagrams"). In winter, defined as period when algal activity is lowest, DIN and DIP (but also silicate) show a conservative behaviour and, therefore, a good linear relationship with salinity (decreasing concentration with increasing salinity from coast to offshore);

b. Trends and increased concentrations compared with salinity-specific background concentrations:
In order to compensate for differences in salinity at the various locations and during the various years, nutrient concentrations are normalised for salinity. This is done by calculating the winter nutrient concentration at a given salinity (e.g. 30) from the mixing diagram of a particular year. The salinity normalised nutrient concentration (with 95% confidence interval) is plotted in relation to the respective year in order to establish trends in the winter nutrient concentrations and the assessment level (compared with background concentration).

4.27 To conclude, in undertaking, and reporting on, their assessments, Contracting Parties should use and report comprehensive data on winter DIN and winter DIP concentrations, and silicate, and associated salinity (report on lowest and highest values with associated salinity from the mixing diagram: see Annex 6a). Contracting Parties should consider winter nutrient concentrations, normalised for salinity.

[13] Available at http://qsr2010.ospar.org/media/assessments/P00447_Trend_atmospheric_inputs.pdf

(b) Areas without salinity gradients

4.28 In areas where there is no relationship between salinity and winter nutrient concentrations, nutrient levels can be simply assessed by calculating mean values for the winter period and compared to area-specific background concentrations.

4.29 When reporting on winter DIN and DIP, and on silicate for the various areas under investigation, the relevant mean salinity regime shall be reported.

4.30 The following assessment procedure is used for identifying elevated levels (see Annex 6b):

a. (salinity-related and/or area-specific) background concentrations and

b. assessment levels based on a justified area-specific % deviation from background not exceeding 50%.

4.31 From the monitoring data available in the ICES database, the following proposal is made for DIN in other waters not listed in Annex 6b: 10 μmol/l as background concentration; and an assessment level of 15 μmol/l.

4.32 From the monitoring data available in the ICES database, the following proposal is made for DIP in other waters not listed in Annex 6b: 0.6 μmol/l as background concentration; and an assessment level of 0.8 μmol/l.

4.33 As an overall conclusion, winter DIN and DIP concentrations are, and can be, assessed in a harmonised way for the central North Sea and its coastal waters, the Irish Sea, the Atlantic Sea, the Channel, the Wadden Sea, the Kattegat and the Skagerrak. Salinity-related and/or area-specific background concentrations and related assessment levels are used to assess the state of DIN and DIP nutrient enrichment. The assessment level for DIN and DIP should be based on a justified area-specific % deviation from background not exceeding 50%.

(3) Winter N/P, N/Si and P/Si ratios

4.34 Increased winter nutrient ratios, and in particular, increased N/P ratios (compared to Redfield ratio = 16), when coupled with absolute excess of nitrate, may cause shifts in species composition, from diatoms to flagellates, some of which are toxic. Since such increased N/P ratios increase the risk of nuisance and toxic algal species, increased winter N/P ratios are used in the common assessment (Table 2). Assessment levels of winter N/P ratio (24; i.e. 50% above Redfield ratio) should be used. Increased ratios of N/Si and P/Si may in addition be considered, with assessment levels at 2 for N/Si and 0,125 for P/Si, because silicate is less influenced by anthropogenic activities. These assessment levels are valid for offshore waters (salinity >34.5). For other areas assessment levels have to be defined according to the respective salinity.

4.35 Naturally increased N/P ratios are observed in some coastal/estuarine areas; consequently, the use of the Redfield N/P ratios may not be appropriate in such circumstances.

(4) Total nitrogen and phosphorus

4.36 Total nitrogen (TN), total phosphorus (TP) and organic carbon/organic matter are useful assessment parameters in addition to the winter DIN and DIP since they include all phases of the elements N and P and bridge as all-season-values the time-gap between winter and algal growing season and can be used to explain long-term nutrient enrichment in certain areas, caused by transboundary transport. TN and TP can be helpful to deduce reference conditions throughout estuarine and coastal waters because for rivers TN and TP are mostly present. TN and TP are, besides of riverine inputs, presently not included in the Eutrophication Monitoring Programme, but organic matter (total organic carbon and particulate organic carbon) is included for problem areas.

(II) Category II - Direct effects of nutrient enrichment

(1) Chlorophyll *a* concentration

4.37 There is a large fluctuation in chlorophyll *a* (chl. *a*) concentrations between years and seasons as well as spatial differences (in general, higher in nutrient enriched coastal waters, at frontal systems, and in (offshore) stratified waters compared to unstratified offshore waters). The latter difference often reflects the difference in nutrient enrichment levels (higher in coastal and stratified waters compared with unstratified offshore waters). This direct effect parameter of nutrient enrichment is furthermore highly influenced by other environmental factors (such as light availability, phytoplankton species composition and their physiological state (type of growth-limitation), and the variable grazing pressure). Nevertheless, this parameter is considered to be a useful direct effect assessment parameter of nutrient enrichment, and therefore listed in Table 2. It is predicted that chl. *a* concentrations will become reduced following the implementation of the agreed measures to achieve the 50 % N and P reduction targets (OSPAR 2001).

4.38 Environmental data such as phytoplankton chl. *a* exhibits periodicity and episodic change and, as a result, tends to be asymmetrically distributed with few high values (outliers or spikes) and many low values. While the mean (and maximum) chl. *a* values was previously recommended as assessment tools, an alternative approach is to employ box-whisker plots and derive 90th percentile values. The 90th percentile value is then compared with the respective 90th percentile threshold value derived from appropriate reference conditions. Such an approach eliminates outliers, increases confidence in the assessment and also has the advantage of bringing the OSPAR assessment into alignment with the approach adopted in freshwater under the Water Framework Directive. Generally speaking the 90 percentile level is approximately two times the mean.

4.39 Maximum and mean chl. *a* concentrations during the growing season have become available over the last decade. According to the Eutrophication Monitoring Programme and the JAMP Eutrophication Monitoring Guidelines[14], chl. *a* concentration is measured and expressed as µg chl.*a*/l, or sometimes calculated from Particulate Phytoplankton Carbon (40 µg PPC/l equals 1 µg chl.*a*/l). Contracting Parties should be conscious that significant differences may be attributable to different analytical methodologies for chlorophyll.

4.40 In determining the maximum and mean chlorophyll *a* levels in estuaries, chlorophyll *a* concentrations should be averaged over the estuarine salinity range during the growing season.

4.41 The assessment level for chlorophyll *a* is based on a justified area-specific % deviation from background not exceeding 50%. Examples for identifying elevated levels are at Annex 6b.

4.42 Assuming that eutrophication effects have their origin mostly in the elevated nutrient discharges, for the German Bight linear correlations between TN and chlorophyll *a* were performed during the growing season. Since TN is correlated with salinity as well, based on natural background concentrations on TN, assessment levels for chlorophyll *a* can be calculated (see Annex 6c). This approach could be tested and applied for/to other areas.

4.43 For estuaries, the full expression of chl. *a* during the growing season can be restricted by light limiting factors, e.g. in high turbidity areas. Contracting Parties should, therefore, take this possibility into account when undertaking their assessment for chlorophyll *a*, and make provision for the measurement of the variation in light regimes concurrent with chl. *a* in the relevant circumstances.

(2) Phytoplankton indicator species

4.44 Two types of area-specific phytoplankton indicator species can be distinguished: nuisance species, forming dense "blooms", and toxic species, already toxic at low concentration. Nuisance species (*Phaeocystis*, *Noctiluca)* and potentially toxic (e.g. dinoflagellates) species (e.g. *Chrysochromulina polylepis*, *Gymnodinium mikimotoi*, *Alexandrium* spp., *Dinophysis* spp., *Prorocentrum* spp.) are direct effect assessment parameters. The nuisance species show increased "bloom" levels (cell concentrations) and increased duration of "blooms" compared with previous years. General and physiological information of the various relevant indicator/assessment species is given in Annex 7a. Examples of levels considered as elevated levels and their effects are at Annex 7b. The list of species provided in the Annexes is not exhaustive. It should be noted that there is scientific uncertainty in the use of toxic phytoplankton species as indicators of direct eutrophication effects.

4.45 Shifts in species composition from diatoms to flagellates (some of which are toxic) could indicate eutrophication. The composition of phytoplankton should be compared with area-specific reference conditions and could for example be expressed by the ratio of diatoms to flagellates.

(3) Macrophytes including macroalgae

4.46 Shifts in species (from long-lived species like eel-grass to nuisance short-lived species like *Ulva, Enteromorpha*) form an important area-specific indicator/assessment parameter in shallow waters, estuaries and embayments. In some of these areas, specific assessment levels (reduced depth distribution, and increased area coverage with nuisance species) are mentioned.

(III) Category III - Indirect effects of nutrient enrichment

(1) Oxygen deficiency

4.47 The degree of oxygen deficiency is widely used as an indirect assessment parameter for nutrient enrichment. Oxygen deficiency, induced by decaying algal blooms and long-term nutrients and associated organic matter enrichment, is observed in areas, especially in those that are susceptible to eutrophication effects, e.g. sedimentation

[14] JAMP Eutrophication Monitoring Guidelines, reference numbers: 1997-2 to 1997-6, Benthos and chlorophyll *a* monitoring guidelines updated by HASEC 2012 as Agreements 2012-11 and 2012-12; Nutrients and oxygen updated by HASEC 2013 as Agreements 2013-04 and 2013-05.

areas, areas with long residence time, but also in (shallow) waters covered with surface algal "blooms" of increased abundance and biomass of nuisance algal species.

4.48 Assessment levels of the various degrees of oxygen deficiency show ranges for the various areas in the North Sea: <2 mg/l: acute toxic (ca. 75 % deficiency); 4 - 5 mg/l (ca. 50 % deficiency) and <5 - 6 mg/l: deficient. Oxygen concentrations above 6 mg/l are considered to cause no problems. The assessment levels that are now used are ranging from 4-6 mg/l to judge whether oxygen is scored as an undesired oxygen deficiency level for that particular area (scored as '+' in reporting format Annex 1). Attention needs to be given to scale and occurrence of oxygen deficiency by sufficient monitoring with respect to spatial and temporal aspects.

4.49 The assessment of oxygen should include also reporting of % saturation, water temperature and salinity in order to ensure comparability of assessments and presentation of results within the OSPAR maritime area. For example, dissolved oxygen criteria (% saturation) could be used in respect to both, deoxygenation and supersaturation (based on 5^{th} percentile and 95^{th} percentile compliance), with values established for tidal freshwaters, intermediate waters and full salinity waters.

(2) Changes/kills in zoobenthos

4.50 This parameter is indirectly related to nutrient enrichment. A distinction can be made between acute toxicity kills directly related to oxygen deficiency and/or toxic blooms, and long-term changes in zoobenthos species composition as a result of long-term increased eutrophication. However, the latter can also be caused by other factors like fisheries which may have an overriding effect compared with eutrophication effects.

4.51 The assessment guidance for "kills in zoobenthos" in relation to eutrophication is a "yes-or-no" assessment parameter (occurrence scored with '+', non-occurrence with '-') and should be based on supporting information on the occurrence of nuisance and/or toxic phytoplankton species and oxygen levels. Assessment guidance for "long-term changes in zoobenthos species composition and biomass" is still lacking.

(3) Fish kills

4.52 This parameter is a "yes-or-no" assessment parameter (occurrence scored with '+', non-occurrence with '-') and should be based on supporting information on the occurrence of toxic phytoplankton species and oxygen levels.

(4) Organic carbon/organic matter

4.53 Organic carbon/organic matter are not widely used in the assessment up to now. However, this parameter can be an integrating eutrophication indicator. It can serve as a food source for heterotrophic flagellates. Especially in sedimentation areas (like e.g. German Bight, Oyster Ground and Skagerrak) particulate organic matter can be accumulated causing undesirable disturbance. Additional effects in coastal areas are the modification of the light regime and formation of particulate organic matter, a product of enhanced sedimentation through flocculation. It is recommended to include this parameter into the eutrophication assessment, where relevant (e.g. sedimentation areas).

(IV) Category IV - Other possible effects of nutrient enrichment

Algal toxins

4.54 DSP/PSP mussel infection events are a relevant assessment parameter in relation to potential toxic algal species in areas where cultivated or wild shellfish stocks are harvested for human consumption. This parameter is a "yes-or-no" assessment parameter (occurrence of DSP/PSP mussel infection events scored with '+', non-occurrence with '-') and should be based on coherent monitoring on phytoplankton eutrophication indicator species (nuisance and/or toxic) (Category II.2).

5. Integration of categorised assessment parameters for initial area classification (step 2)

5.1 The assessment parameters are strongly interlinked along a cause/effect scheme from nutrient enrichment (Category I), to direct effects (Category II, e.g. chlorophyll *a*, phytoplankton nuisance and toxic indicator species) and indirect effects (Category III, e.g. oxygen deficiency and changes/kills in zoobenthos). Therefore, to reduce the risk of misinterpretation of these cause/effects, all categories (nutrient enrichment, direct effects and indirect effects) should be assessed together.

5.2 The scores for each of the parameters in Table 2 which result from the assessment procedure are reported in a common format (Annex 1, Section 4). This table is the departing point for the second step in the classification process.

5.3 The scores attained from the application of the assessment parameters are integrated in a table with the criteria categories (Table 2) and the area classes for an initial area classification (cf. Table 3 for guidance).

5.4 The initial classification shall be as follows:

a. areas showing an increased degree of nutrient enrichment accompanied by direct and/or indirect/ other possible effects are regarded as **‘problem areas’**;

b. areas may show direct effects and/or indirect or other possible effects, when there is no evident increased nutrient enrichment, for example, as a result of transboundary transport of (toxic) algae and/or organic matter arising from adjacent/remote areas. These areas could be classified as **‘problem areas’**;

c. areas with an increased degree of nutrient enrichment where:

   (i) either there is firm, scientifically based evidence of the absence of (direct, indirect, or other possible) eutrophication effects – these are classified initially as ‘**non-problem areas’**, although the increased degree of nutrient enrichment in these areas may contribute to eutrophication problems elsewhere;

   (ii) or there is not enough data to perform an assessment or where the data available is not fit for the purpose – these are classified initially as **‘potential problem areas’**;

d. areas without nutrient enrichment and related (in)direct/ other possible effects are considered to be **‘non-problem areas’**.

5.5 When weighing data derived from the assessment process, the quality of the underlying monitoring should be taken into account. It follows from Table 3 that it may be appropriate to initially classify an area as potential problem area if the area shows an increased degree of nutrient enrichment (Category I) but where data on direct, indirect/other possible effects are not sufficient to enable an assessment or are not fit for this purpose (as indicated by ‘?’ in Table 3). In such a situation section 4.2(b) of the OSPAR Eutrophication Strategy applies. It requires urgent implementation of monitoring and research in order to enable a full assessment of the eutrophication status of the area concerned within five years of its classification as potential problem area with regard to eutrophication. In addition, it calls for preventive measures to be taken in accordance with the precautionary principle.

5.6 It should be pointed out that, despite large anthropogenic nutrient inputs and high nutrient concentrations, an area may exhibit few if any direct and/or indirect effects. However, Contracting Parties should take into account the risk that nutrient inputs may be transferred to adjacent areas where they can cause detrimental environmental effects and Contracting Parties should recognise that they may contribute significantly to so-called “transboundary affected” problem areas and potential problem areas with regard to eutrophication outside their national jurisdiction.

5.7 In the case of areas with an increased degree of nutrient enrichment, initially classified as “non-problem areas” (cf. § 5.4 c(i)), the status is conditional on the provision of an appraisal in Step 3, explaining why there are reasonable grounds for considering that there will continue to be an absence of (direct, indirect or other possible) eutrophication effects, in spite of the presence of enhanced levels of nutrients. This should include an assessment that they may not lead in time to undesirable disturbance to the marine environment. These areas may retain their status as non-problem areas with respect to eutrophication, but will need to be re-examined at the next assessment under the Comprehensive Procedure. For these areas the monitoring requirements for potential problem areas apply (cf. Section 7).

Table 3 Examples of the integration of cause-effect related categorised assessment parameters
(see Table 2 for an initial classification)

	Category I	Category II	Categories III and IV	Initial Classification
	Degree of nutrient enrichment Nutrient inputs Winter DIN and DIP Winter N/P ratio	Direct effects Chlorophyll *a* Phytoplankton indicator species Macrophytes	Indirect effects/other possible effects Oxygen deficiency Changes/kills in zoobenthos, fish kills Organic carbon/matter Algal toxins	
a	+	+	+	problem area
	+	+	-	problem area
	+	-	+	problem area
b	-	+	+	problem area[15]
	-	+	-	problem area[15]
	-	-	+	problem area[15]
c	+	-	-	non-problem area[16]
	+	?	?	Potential problem area
	+	?	-	Potential problem area
	+	-	?	Potential problem area
d	-	-	-	non-problem area

(+) = Increased trends, elevated levels, shifts or changes in the respective assessment parameters in Table 2

(-) = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters in Table 2

? = 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 level, shift or change.

[15] For example, caused by transboundary transport of (toxic) algae and/or organic matter arising from adjacent/remote areas.

[16] The increased degree of nutrient enrichment in these areas may contribute to eutrophication problems elsewhere.

6. Overall area classification (step 3)

6.1 Following the steps 1 and 2 classification, in a third step, an appraisal of all relevant information (concerning the harmonised assessment criteria, their respective assessment levels and the supporting environmental factors) should be made in order to provide a sufficiently sound and transparent account of the reasons for giving a particular status to an area (cf. also Figure 1).

6.2 This step 3 appraisal should be carried out in the light of (i) the definitions relating to the three different types of areas with regard to eutrophication (see Section 2), (ii) the harmonised assessment parameters and related elevated levels (see Table 2), (iii) the scoring for each of these assessment parameters and (iv) their integration in accordance with Table 3.

6.3 Contracting Parties should present the results of the appraisal for each area to OSPAR as:

a. a statement that it does not see a need to assess additional local/regional supporting environmental factors and that the result of the application of steps 1 and 2 for an area, in accordance with the Comprehensive Procedure, is transparent and verifiable and reliable enough for giving a particular eutrophication status to that area;

b. a transparent and verifiable assessment of all relevant information, including additional local/regional factors not addressed in the steps 1 and 2.

6.4 OSPAR should review and assess the results of the initial classification following steps 1 and 2 and of the step 3 appraisal. Contracting Parties should take the outcome of this assessment into account when identifying the eutrophication status of their parts of the maritime area.

6.5 The Contracting Parties need to report in a harmonised transparent way on the overall classification consisting of the steps outlined above including the initial classification, the appraisal of all relevant information (that is, the harmonised assessment parameters and their respective assessment levels and the supporting environmental factors), and the subsequent final classification made by the Contracting Parties for their waters that are subject to the Comprehensive Procedure (see sections 5 and 6 of the reporting format, Annex 1).

6.6 Where, as a result of this classification process,

a. one Contracting Party thinks that it must classify part of the maritime area under its jurisdiction as a problem area with respect to eutrophication, having taken account of what it considers to be significant transboundary inputs into that area deriving, directly or indirectly, from nutrients discharged or emitted from or through the territory/marine waters of another Contracting Party (or Contracting Parties), and;

b. that other Contracting Party is not (or those other Contracting Parties are not) in a situation to accept such a classification, then the Comprehensive Procedure should not be regarded as completed in respect of that area.

The OSPAR Commission will then use its best efforts to clarify the position so that the Comprehensive Procedure can be completed.

6.7 In such a situation, an initial step could be to convene a meeting of experts from the Contracting Parties involved and from as many other Contracting Parties as possible, under the chairmanship of the Chairman of the Commission or a person appointed by him/her. The aim of such a meeting should be to produce a report to the OSPAR Commission reviewing and evaluating all the scientific evidence relevant to the eutrophication status of the area in question. In particular, the report should seek to establish to the extent possible:

a. the most likely origins of the various inputs of nutrients to the area;

b. the robustness of any evidence that nutrients discharged or emitted from the territory of the Contracting Party or Contracting Parties (alleged to be the source) are making a significant contribution to eutrophication in the area;

c. whether there is a need to change the classification of the area in question as a problem area;

d. the possibilities for, and the expected results of, measures to reduce inputs of nutrients to the area.

6.8 In the light of this report, the OSPAR Commission should then decide what further steps are desirable to resolve the situation. This may include the commissioning of further scientific studies to be jointly conducted and funded by the parties concerned. In the meantime, the area should be described in reports of the outcome of the Common Procedure as “problem area (transboundary affected) subject to resolution of assessment differences”. This review process should be completed within two years after that classification. Any extension of that period should be agreed upon by the OSPAR Commission.

7. Monitoring and data requirements

7.1 In order to be consistent in the harmonised holistic assessment and area classification, it is also necessary to follow the requirements of the relevant parts of the OSPAR monitoring programmes. This includes:

a. the OSPAR Eutrophication Monitoring Programme, with (mandatory) information being reported annually to ICES as part of the Coordinated Environmental Monitoring Programme (CEMP);

b. JAMP Eutrophication Monitoring Guidelines relating to nutrients, oxygen, chlorophyll *a*, phytoplankton indicator species, and benthos[17] and quality assurance procedures;

c. the Comprehensive Study of Riverine Inputs and Direct Discharges (RID)[18].

7.2 Area-specific aspects and the level of confidence in the assessment parameter levels should be adequately addressed by applying sufficient monitoring in space and time. There is for some assessment parameters in some areas a need to improve the monitoring frequency and area coverage in order to meet the area-specific requirements and the required level of confidence.

7.3 However, to ensure a complete assessment, full use should also be made of information arising from sources and programmes other than those mentioned above, subject to it satisfying the relevant needs in terms of quality assurance.

7.4 The Eutrophication Monitoring Programme defines the minimum requirements for monitoring and reporting. For areas, including local areas located in wider non-problem areas, identified as problem or potential problem areas, a sufficient frequency and spatial coverage of all the parameters in the programme should be monitored and reported each year. For the areas identified as non-problem areas, results relating to the monitoring of the assessment parameters listed in Category I should be reported once in 3 years.

7.5 In general, attention needs to be paid to a sufficient eutrophication monitoring under consideration of scale and occurrence of eutrophication related effects (e.g. phytoplankton blooms, mass occurrence of macroalgae, oxygen deficiency, fish kills). Therefore, spatial and temporal aspects of eutrophication have to be addressed adequately. Particular attention is drawn to the need of updated guidance on the frequency and spatial coverage of monitoring in the Eutrophication Monitoring Programme.

7.6 In the light of the agreed common assessment parameters and the experiences gained by the Contracting Parties in the first and second applications of the Comprehensive Procedure, OSPAR has re-examined its eutrophication monitoring programme[19] and adjusted it so that it is in line with the data requirements for future applications of the Comprehensive Procedure.

8. Confidence rating

8.1 In general, confidence rating of the individual assessment parameters will be applied to indicate the reliability of the monitoring data. Confidence of assessment against area-specific thresholds as well as of representativeness of monitoring stations in space and time will be assessed.

Confidence of assessment against area-specific thresholds

Confidence of the assessment against area-specific thresholds (score – or + in the assessment table, see Annex 1) is assigned using either a quantitative (e.g. for the parameters nutrients, chlorophyll *a*) or a descriptive approach (e.g. for the parameters macrophytes and macrozoobenthos) and is reported in the column "confidence rating" of the assessment table (see Annex 1). For the quantitative approach a method is proposed 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. This statistical method is further elaborated in Annex 8.

[17] OSPAR reference numbers: 1997-2 (updated 2013-04), 1997-3 (updated 2013-05), 2012-11, 1997-5 (under review) and 2012-12 respectively.

[18] OSPAR reference number: 1998-5.

[19] OSPAR reference number: 2005-04 (as updated in 2013)

Representativeness in space and time

To document the representativeness in space and time of their existing monitoring array Contracting Parties can use, if appropriate for their waters, a gridded approach. The approach requires an iterative procedure on the basis of subdividing space (e.g. stations along transects) and time (assessment period under consideration) in grid elements and assigning a score to the monitoring density in grid elements in relation to the gradients evident in that space/time. The method is further described in Annex 8. The procedure is not suitable for highly dynamic environments (where instead of transects of fixed stations e.g. high-frequency sampling from automated buoys might be employed) nor for marine areas where water masses are highly discontinuous and cannot be applied to monitoring strategies that are relying on novel observation tools. In case the proposed method is not suitable for certain assessment areas it should be explicitly described how the monitoring design addresses the particular typology and main hydrographical dynamics in the area, so as to provide evidence on the representativeness of monitoring in space and time.

The representativeness in space and time shall be documented in the reporting format (see Annex 1, section 3).

8.2 On the level of parameter groups, categories and the overall assessment there will be no confidence rating.

8.3 There will be no confidence rating of background concentrations and associated assessment levels but Contracting Parties will provide a transparent documentation that addresses the following details:

- Detailed account of the method applied to define the background concentrations of all individual assessment parameters (e.g. (i) transfer from undisturbed sites; (ii) historical data; (iii) combination of (i) and (ii) with modelling; (iv) calculation by modelling of undisturbed conditions; (v) expert judgement);
- Detailed account of the method to define assessment levels from background concentrations for those parameters (e.g. indicate whether knowledge on effects or significant correlations between assessment parameters were used or expert judgement).

9. Comparisons with the Water Framework Directive

9.1 There are similarities between the approach of the Water Framework Directive (WFD) and the Comprehensive Procedure:

- pressures: The WFD seeks to assess ecological status resulting from a wide variety of human pressures in coastal and transitional waters including the important pressure due to nutrient input. The Comprehensive Procedure seeks identification of where eutrophication problems exist. Each approach seeks to identify measures necessary to achieve good status (WFD) or non-problem area status;

- geographical area: both the Common Procedure and the Water Framework Directive include transitional and coastal waters. The WFD assessment area there is entirely included in the COMP assessment area. Seawards, the Comprehensive Procedure has a much broader geographical coverage (North-East Atlantic);

- parameters: Similar parameters are addressed in both assessment approaches, each covers phytoplankton, chlorophyll concentration, nutrients and dissolved oxygen. The way the parameters are used is different allowing an assessment of the quality and functioning of the aquatic ecosystem (WFD) or eutrophication status (Comprehensive Procedure). Parameters to assess change in the different biological quality elements (e.g., benthic invertebrates and macroalgae) have been further elaborated in the WFD to assess the ecological quality of these elements;

- classification: the boundary between good/moderate ecological status (WFD) should be comparable to the boundary between non problem/problem area status (Comprehensive Procedure). This is illustrated in Figure 2. The WFD provides for 5 classes, whereas the Comprehensive Procedure prescribes two final classes.

These similarities between the WFD and COMP allow the application of the two procedures to the same data.

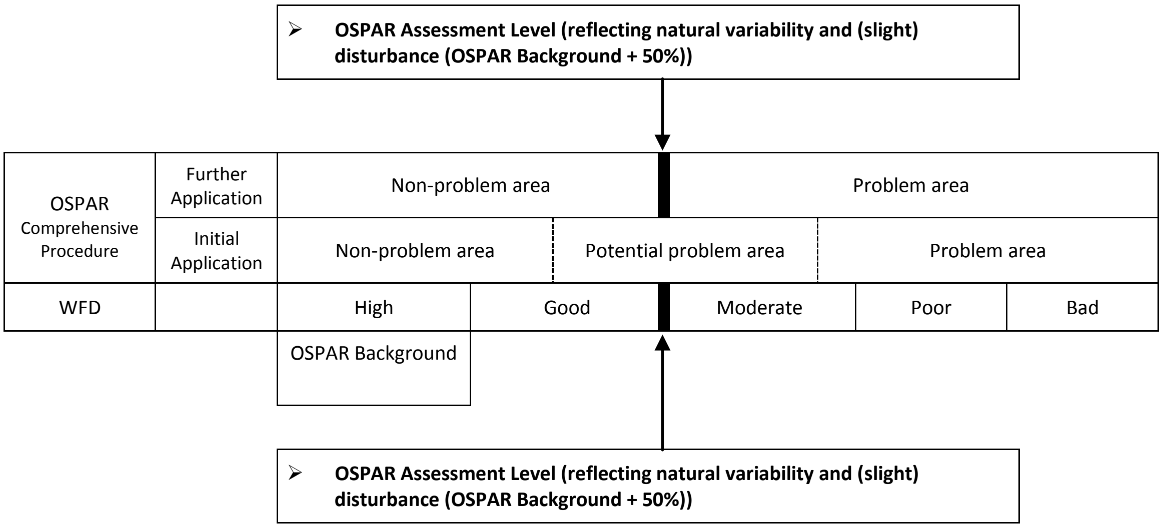


Figure 2 Relationship between the classification under the Comprehensive Procedure and the Water Framework Directive

Note: Assessment levels are based on a justified area-specific % deviation from background not exceeding 50%.

10. Arrangements for reporting

10.1 In describing the results of the overall area classification in a harmonised way, both the assessment of each of the parameters of the Categories I, II, III and IV (Table 2), as well as the resulting initial classification (Table 3) as non-problem, potential problem and problem areas should be reported by Contracting Parties.

10.2 To ensure harmonised reporting, a reporting format has been developed which is to be used by Contracting Parties (Annex 1). The format requests Contracting Parties to provide information of the assessed area relating to its salinity regime or other environmental characteristics including physics, hydrodynamics, weather/climate conditions etc. which are needed for the characterisation of the areas falling under the Comprehensive Procedure (cf. Section 3 and "typology" under the Water Framework Directive); a score table with the results of the application of each of the assessment parameters of Table 2; and information on the overall classification. Contracting Parties may provide more detailed information on the assessment process and the underlying data and assumptions used, including possible joint reports on adjacent areas.

10.3 The assessment period to be reported will be continuous with the previous assessment report. The most recent data to be included should cover the year N-2 where N is the year of the national assessment report. Further guidance will be provided separately on the features of the national reports.

10.4 The information reported by Contracting Parties is the basis for OSPAR to undertake an overall assessment of the eutrophication status of all parts of the OSPAR maritime area. On the basis of the resulting integrated report, OSPAR decides on the follow-up and its time frame: whether targeted measures need to be adopted, the Comprehensive Procedure to be applied again or the guidance thereon to be reviewed.

11. Reflecting science developments in the Common Procedure

11.1 There is a need to ensure that the Common Procedure agreement is kept up to date and reflects relevant agreements in science and in the light of experience through its application. Contracting Parties should bring forward new issues that they consider relevant and need to be reflected in the agreement and also when reporting in their national reports take account of developments in other sectors that have an impact on their results. Current (as of June 2013) issues considered important to take into account in reporting are:

- Temperature change (climate change)
- Acidification (increase in ambient CO_2).

11.2 Issues that require further development which were highlighted by Contracting Parties include:

- atmospheric input of phosphorus: for the future assessment atmospheric phosphorus inputs should be considered in view of their potential significance (cf. in HELCOM for the Baltic Sea).

Annex 1

Reporting format on the results of the OSPAR Comprehensive Procedure

1. Area

Name and map (geographical location: longitude, latitude)

2. Description of the area

Including environmental information

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

This section should include information on how the monitoring design addresses the particular typology and main hydrographical dynamics in the Area, so as to provide evidence of representativeness of monitoring.

4. Assessment[20]

Category	Assessment Parameters	Description of Results	Score (+ - ?)	Confidence rating
Degree of Nutrient Enrichment (I)	Riverine inputs and direct discharges of total N and total P			
	Winter DIN and/or DIP concentrations			
	Winter N/P ratio (Redfield N/P = 16)			
Direct Effects (II)	Maximum and mean chlorophyll *a* concentration			
	Area-specific phytoplankton indicator species			
	Macrophytes including macroalgae			
Indirect Effects (III)	Oxygen deficiency			
	Changes/kills in zoobenthos and fish kills			
	Organic carbon/organic matter			
Other Possible Effects (IV)	Algal toxins (DSP/PSP mussel infection events)			

Key to the Score

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

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

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

(Reporting format continued on next page)

[20] Make score visible for each year, as was done in the second application of the Procedure.

Reporting format on the results of the OSPAR Comprehensive Procedure (*continued*)

5. Overall Classification

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 Maximum and mean chlorophyll *a* concentration

Ps Area-specific phytoplankton indicator species

Mp Macrophytes including macroalgae

O_2 Oxygen deficiency

Ck Changes/kills in zoobenthos and fish kills

Oc Organic carbon/organic matter

At Algal toxins (DSP/PSP mussel infection events)

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

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

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

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
	NI		Ca		O_2		At					
	DI		Ps		Ck							
	NP		Mp		Oc							
	NI		Ca		O_2		At					
	DI		Ps		Ck							
	NP		Mp		Oc							
	NI		Ca		O_2		At					
	DI		Ps		Ck							
	NP		Mp		Oc							

6. Discussion

Explanation of classification results

7. Other information

Provide where possible consideration of the outlook for the future and the need for further action in order to achieve by 2010 a healthy marine environment where eutrophication does not occur.

Annex 2

Checklist for a holistic assessment

All areas <u>not</u> being identified as non-problem areas with regard to eutrophication through the Screening Procedure are subject to the Comprehensive Procedure which comprises a checklist of qualitative parameters for a holistic assessment:

The qualitative assessment parameters are as follows:

a. Category I the causative factors:

the degree of nutrient enrichment

- with regard to inorganic/organic nitrogen
- with regard to inorganic/organic phosphorus
- with regard to silicate

taking account of:

- sources (differentiating between anthropogenic and natural sources)
- increased/upward trends in concentration
- elevated concentrations
- increased N/P, N/Si, P/Si ratios
- fluxes and nutrient cycles (including across boundary fluxes, recycling within environmental compartments and riverine, direct and atmospheric inputs)

b. the supporting environmental factors, including:

- light availability (irradiance, turbidity, suspended load)
- hydrodynamic conditions (stratification, flushing, retention time, upwelling, salinity, gradients, deposition)
- climatic/weather conditions (wind, temperature)
- zooplankton grazing (which may be influenced by other anthropogenic activities);

c. Category II. the direct effects of nutrient enrichment:

i. phytoplankton:

- increased biomass (e.g. chlorophyll a, organic carbon and cell numbers)
- increased frequency and duration of blooms
- increased annual primary production
- shifts in species composition (e.g. from diatoms to flagellates, some of which are nuisance or toxic species)

ii. macrophytes, including macroalgae:

- increased biomass
- shifts in species composition (from long-lived species to short-lived species, some of which are nuisance species)
- reduced depth distribution

iii. microphytobenthos:

- increased biomass and primary production

d. Category III. the indirect effects of nutrient enrichment:

i. organic carbon/organic matter:

- increased dissolved/particulate organic carbon concentrations
- occurrence of foam and/or slime
- increased concentration of organic carbon in sediments (due to increased sedimentation rate)

ii. oxygen:

- decreased concentrations and saturation percentage
- increased frequency of low oxygen concentrations
- increased consumption rate
- occurrence of anoxic zones at the sediment surface ("black spots")

iii. zoobenthos and fish:

- mortalities resulting from low oxygen concentrations

iv. benthic community structure:

- changes in abundance
- changes in species composition
- changes in biomass

v. ecosystem structure:

- structural changes

e. Category IV. other possible effects of nutrient enrichment:

i. algal toxins (still under investigation - the recent increase in toxic events may be linked to eutrophication).

The significance of different factors potentially used in a typology of offshore waters in relation to the biotic parameters used in the Comprehensive Procedure

Characteristic	Optical properties	Density	Stratification	Phytoplankton	Phytobenthos
Salinity	Yes*	Yes	Yes	Yes (salinity preference)	Yes
Depth	Yes*	No	Yes*		Yes
Mean water temperature (range)	Yes*	Yes	Yes	Yes (preference, physiology)	Yes (preference, physiology)
Turbidity	Yes	No	No	No	Yes
Mean substratum composition	Yes*	No	No	Yes	Yes
Mixing characteristics	Yes*	Yes	Yes	Yes* (turbulence)	Yes
Residence time/retention time	No	No	No	Yes (biomass accumulation)	No

* signifies an indirect relationship

Annex 4

Technical Annex on trend assessment

How to download and use the TTAinterfaceTrendAnalysis package:

The **TTAinterfaceTrendAnalysis** package (Devreker & Lefebvre, *under review*) needs the basic R console to be installed and launched. It was written with R version 2.14 and is compatible with the most recent version. R software (at least v2.14) comes with basic packages and a command console which can be downloaded from the CRAN website http://cran.r-project.org/.

The **TTAinterfaceTrendAnalysis** package was created with the Tcl/Tk toolkit included in the tcltk package which is a part of the standard R installation for Windows, Linux and Unix platforms. For Mac OS X compatibility it is necessary to install an X Windows version of Tcl/Tk (http://cran.r-project.org/bin/macosx/tools/).

Once R is installed, the package is available on the CRAN mirror (an internet connection is obviously needed). Open the R console and click on "Install package(s)" in the 'Packages' menu of the console (step 1), select your mirror (your country), and follow the instructions to find the **TTAinterfaceTrendAnalysis** package. It will automatically install all the package that the **TTAinterfaceTrendAnalysis** package depend on.

When everything is installed, click on 'Packages/Load package…' in the 'Packages' menu of the console and select TTAinterfaceTrendAnalysis from the list (step 2). A small panel appears inviting you to start the interface. The first step need to be done only once to install the package, skip it and go directly to step **2** every time you need to load the interface. The GUI can be directly re-launched using the start panel.

A user guide is available in the folder where the user installed R (example: C:\Program Files\R\R-2.14.1\library\TTAinterfaceTrendAnalysis\help).
This user guide and some step-by-step helps are also available directly from the GUI.

Reference

Devreker D., Lefebvre A. TTAinterfaceTrendAnalysis: A R GUI for Temporal Trend Analysis and diagnostics. Under review.

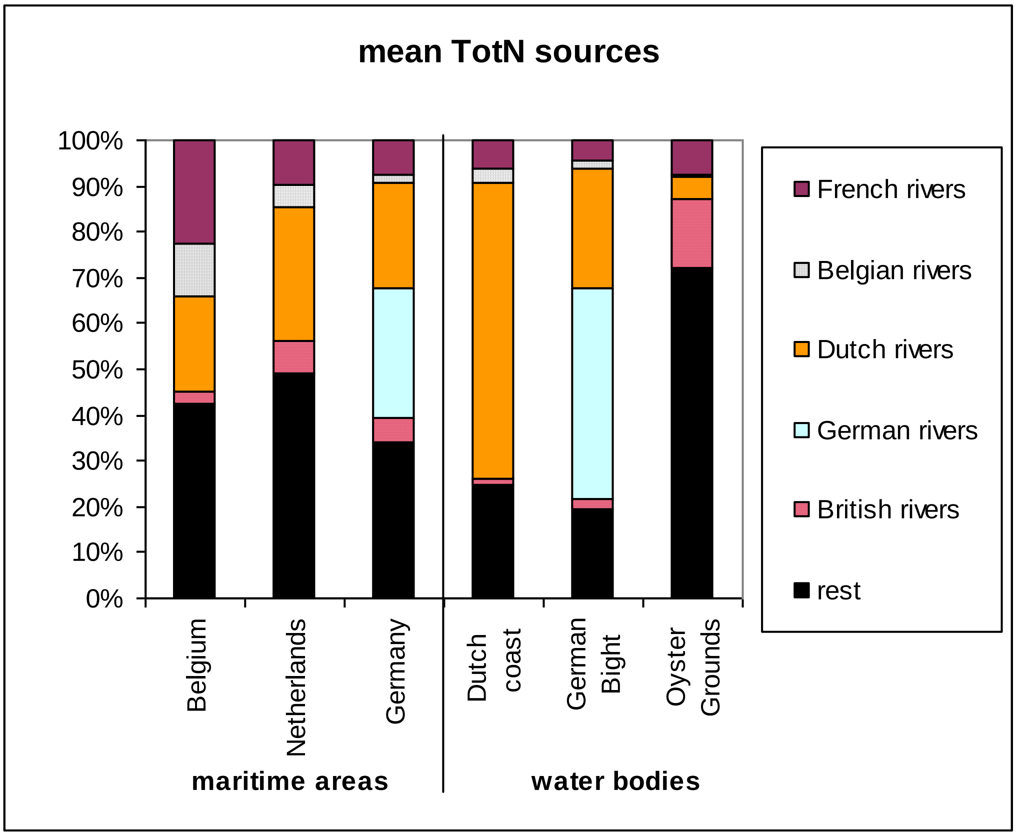
Annex 5

Transboundary nutrient inputs

In addressing nutrient inputs, Contracting Parties can refer to the results of transboundary nutrient transport modelling work undertaken under OSPAR by the Intersessional Correspondence Group on Eutrophication Modelling, as reported, finalised and periodically published.

An example is the figure below reported to the OSPAR 2010 meeting (document OSPAR 10/6/2-Add.1).

Figure: 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, Channel, atmospheric deposition and the 'rest' are taken together.



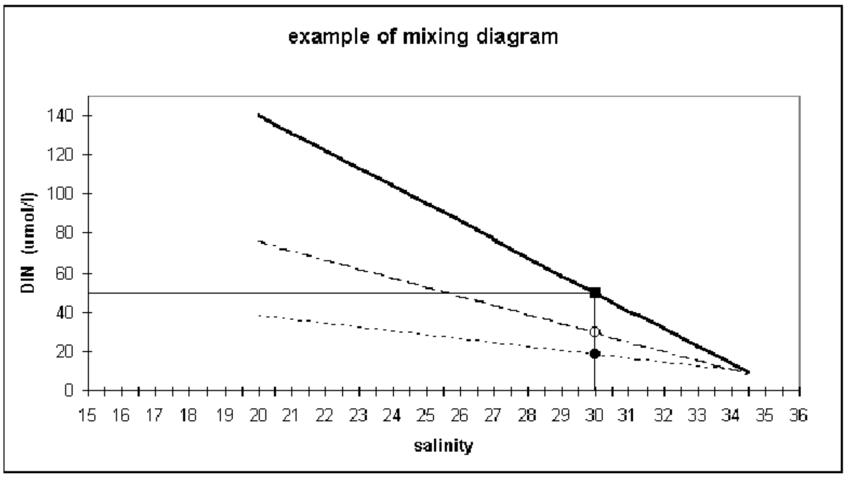
Mixing diagrams and figures of winter nutrients

This Annex contains the following example maps, figures and mixing diagrams:

1. Theoretical example of a mixing diagram
2. Examples of trends in salinity-related winter concentrations of DIP and DIN

1. Theoretical example of a mixing diagram

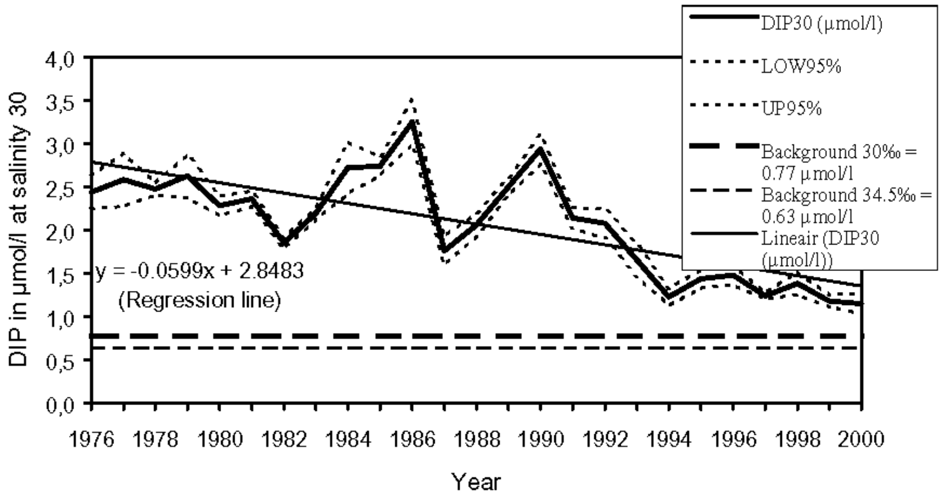
In coastal marine waters with salinity gradients, yearly trends in nutrient concentrations are assessed by plotting each year winter nutrient concentrations against the measured salinity values to produce nutrient –salinity plots. This procedure, often called mixing diagrams, was adopted by NUT in 1989. In winter, when algae activity is lowest, nutrients show more or less conservative behaviour and a clear linear relationship with salinity: i.e. decreasing concentrations with increasing salinity from coast to offshore.



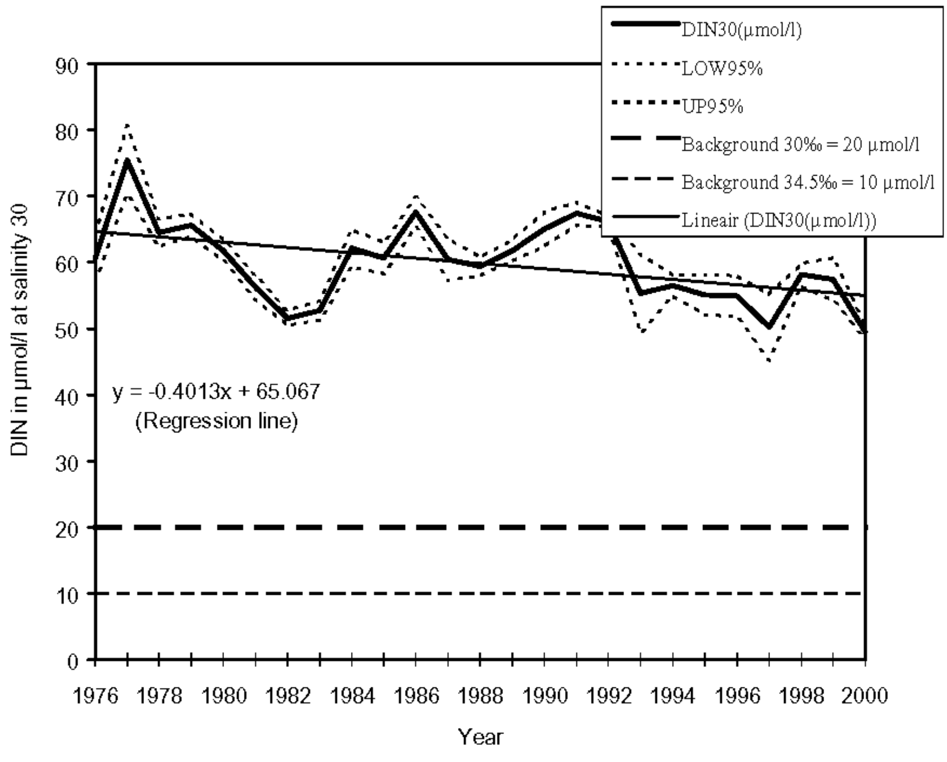
Black top line: linear relation between measured winter DIN concentrations and salinity.
Dotted middle line: 50% elevation of winter DIN contrations above background concentrations, all related to salinity
Dotted lower line: winter DIN background concentration related to salinity

Closed square: DIN concentration at a salinity of 30 psu
Open circle: 50 % elevation of DIN concentration above the background concentration at 30 psu
Closed circle: DIN background concentration at 30 psu

2. Examples of trends in salinity-related winter concentrations of DIP and DIN (Dutch coastal waters)



Trend in the year concentration of dissolved inorganic phosphate at the salinity of 30 psu at Noordwijk transect during the winter months (December till March) in the period 1976-2000 (data from all the monitoring excercises).



Trend in the year concentration of dissolved inorganic nitrogen compounds (nitrate, nitrite and ammonia) at the salinity of 30 psu at Noordwijk transect during the winter months (December till March) in the period 1976-2000 (data from all the monitoring excercices).

Annex 6b

Area-specific background concentrations of nutrients during winter (XI-II) and chlorophyll *a* during growing season (III-X) in relation to salinity, and their related assessment levels; oxygen levels

Updated from sources: OSPAR agreement 2002-20, OSPAR 2003, OSPAR Agreement 2005-3

Portugal has not submitted updated values. Values from the previous version of the Common Procedure have been included at Appendix 1 for this Contracting Party for reference.

Germany submitted information on 7 March 2014 and advised that background concentrations and assessment levels of nutrients and chlorophyll a are currently under revision in Germany with the aim of achieving harmonisation between OSPAR and WFD.

Please note: the Endnotes are not numbered consecutively but instead are country-specific (ie., numbered from "1" for each country)

A. Area-specific background concentrations and assessment levels of winter DIN / DIP (XI-II) and TN/TP

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
OSPAR Region	Contracting Party	Salinity[21] and area	Background concentration DIN µmol/l	Assessment levels DIN µmol/l	Background concentration DIP µmol/l	Assessment levels DIP µmol/l	Background concentration TN µmol/l[22]	Assessment levels TN µmol/l[22]	Background concentration TP µmol/l[22]	Assessment levels TP µmol/l[22]
II	Sweden[1,2]	≥20 South-North Kattegat (offshore)	4,5	3,5-5,6	0,4	0,6	n.a	n.a	n.a	n.a
		≥20 Kattegat (coast)	4,5	6,8	0,4	0,6	17	22	0,7	0,9
		≥27 Skagerrak (offshore)	6	9	0,5	0,75	n.a	n.a	n.a	n.a
		≥27 Skagerrak (coast)	6	9	0,5	0,75	19	24	0,7	0,95
	Norway	0 -20 (Estuary)	0,35-0,8	9-18,5	0,13-0,52	0,2-0,7	18-21	27-28,5	0,23-0,68	0,4-0,8
		>20 (Coastal)	<9	14	<0,5	0,7	<21	27	<0,7	0,8
	Denmark	18-28 Kattegat (offshore)	0,9 (annual mean) 3,7 (winter max)	1,35 (annual mean) 5,6 (winter max)	0,24 (annual mean) 0,5 (winter max)	0,36 (annual mean) 0,75 (winter max)	3,2 (annual mean) 5,2 (winter max)	4,8 (annual mean) 7,8 (winter max)	0,46 (annual mean) 0,66 (winter max)	0,69 (annual mean) 1,0 (winter max)
		13-28 Kattegat (coast)	1,0 (annual mean) 6,6 (winter max)	1,5 (annual mean) 9,9 (winter max)	0,24 (annual mean) 0,46 (winter max)	0,36 (annual mean) 0,69 (winter max)	3,3 (annual mean) 10,2 (winter max)	5,0 (annual mean) 15,3 (winter max)	0,45 (annual mean) 0,62 (winter max)	0,67 (annual mean) 0,93 (winter max)

[21] Nutrient concentrations can be shown as normalized for salinity 30, see example in Annex 6a of the COMP

[22] TN and TP are not part of the set of harmonised assessment parameters but can be assessed on a voluntary basis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
OSPAR Region	Contracting Party	Salinity[21] and area	Background concentration DIN µmol/l	Assessment levels DIN µmol/l	Background concentration DIP µmol/l	Assessment levels DIP µmol/l	Background concentration TN µmol/l[22]	Assessment levels TN µmol/l[22]	Background concentration TP µmol/l[22]	Assessment levels TP µmol/l[22]
		~32 Skagerrak (offshore)	2,0 (annual mean) 5,5 (winter max)	3,0 (annual mean) 8,25 (winter max)	0,37 (annual mean) 0,68 (winter max)	0,56 (annual mean) 1,02 (winter max)	5,5 (annual mean) 7,1 (Winter Max)	8,25 (annual mean) 10,65 (Winter Max)	0,65 (annual mean) 0,84 (winter max)	0,98 (annual mean) 1,26 (winter max)
		~32 Skagerrak (coast)	1,6 (annual mean) 4,9 (winter max)	2,4 (annual mean) 7,35 (winter max)	0,31 (annual mean) 0,61 (winter max)	0,47 (annual mean) 0,92 (winter max)	5,5 (annual mean) 6,3 (Winter Max)	8,25 (annual mean) 9,45 (Winter Max)	0,63 (annual mean) 0,79 (Winter Max)	0,95 (annual mean) 1,19 (Winter Max)
		>33 North Sea (offshore)	1,4 (annual mean) 3,9 (winter max)	2,1 (annual mean) 5,85 (Winter Max)	0,32 (annual mean) 0,57 (Winter Max)	0,48 (annual mean) 0,86 (Winter Max)	5,5 (annual mean) 5,9 (Winter Max)	8,25 (annual mean) 8,85 (Winter Max)	0,66 (annual mean) 0,78 (Winter Max)	0,99 (annual mean) 1,17 (Winter Max)
		~32 North Sea (coast)	1,3 (annual mean) 3,9 (winter max)	2,0 (annual mean) 5,9 (winter max)	0,23 (annual mean) 0,51 (winter max)	0,35 (annual mean) 0,77 (winter max)	6,6 (annual mean) 5,9 (winter max)	9,9 (annual mean) 8,9 (winter max)	0,57 (annual mean) 0,73 (winter max)	0,86 (annual mean) 1,1 (winter max)
		~30 Wadden Sea	2,4 (annual mean) 11,5 (winter max)	3,6 (annual mean) 17,25 (winter max)	0,18 (annual mean) 0,4 (winter max)	0,27 (annual mean) 0,6 (winter max)	8,4 (annual mean) 16,1 (winter max)	**12,6 (annual mean)** **24,1 (winter max)**	0,46 (annual mean) 0,63 (winter max)	0,69 (annual mean) 0,95 (winter max)
	Germany[1]	3.6-23.4 (WFD, T1 & T2)[2]	10.0-17.1	-	0.13-0.26	-	12.9-21.4	-	0.30-0.80	-
		18-30 (WFD, NEA 3/4)[2]	10.7-12.9	-	0.25-0.26	-	14.3-15.7	-	0.65	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
OSPAR Region	Contracting Party	Salinity[21] and area	Background concentration DIN µmol/l	Assessment levels DIN µmol/l	Background concentration DIP µmol/l	Assessment levels DIP µmol/l	Background concentration TN µmol/l[22]	Assessment levels TN µmol/l[22]	Background concentration TP µmol/l[22]	Assessment levels TP µmol/l[22]
		<30 (WFD, NEA 1/26c)[2]	9.3	-	0.25	-	12.1	-	0.65	
		28-34.5[3]	7.3-8.1	11-12.2	0.48-0.58	0.6-0.87	10.9-9.7	16.4-14.6	0.54-0.60	
		>35	8.1	12.2	0.59	0.87	9.6	14.3	0.60	
	Netherlands[1]	Wadden Sea <30	6,5	7	0,5	>0,7				
		Estuaries <30: Western Scheldt, Ems estuary	20 (normalized at sal =30)[2]	30 (normalized at sal = 30)	0,6 (normalized at sal = 30)	0,8 (normalized at sal = 30)				
		Coastal waters: <34,5	20 (normalized at sal = 30)[3]	30 (normalized at sal = 30)	0,6 (normalized at sal = 30)	0,8 (normalized at sal = 30)				
		Offshore >34.5: Southern Bight, Oyster Grounds, Dogger Bank	10	15	0,6	0,8				
	Belgium[1,2]	Estuary								
		30 (Inner CW)	17	25,5	0,6	0,8				
		33,5 (Outer CW)	10	15	0,6	0,8				
		> 34,5 (Offshore)	8	12	0,6	0,8				
	France	Estuaries and Coastal water Waters normalised to 33 Ecotype 1-26b English Channel [2]	n.a. [1]	33	n.a. Error! Bookmark not defined.1	n.a. [1]	/	/	/	/

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
OSPAR Region	Contracting Party	Salinity[21] and area	Background concentration DIN µmol/l	Assessment levels DIN µmol/l	Background concentration DIP µmol/l	Assessment levels DIP µmol/l	Background concentration TN µmol/l[22]	Assessment levels TN µmol/l[22]	Background concentration TP µmol/l[22]	Assessment levels TP µmol/l[22]
	France	Estuaries and Coastal water Waters normalised to 33 Ecotype 1-26b English Channel [2]	n.a. [1]	33	n.a. [1]	n.a. [1]	/	/	/	/
	UK – other than Scotland	Offshore >34.5 (normalised to 34.5) Coastal 30–<34.5 (normalised to 32) Estuary 0–<30 (normalised to 25)	Offshore 10 Coast 12 Estuary 20	Offshore 15 Coast 18 Estuary 30	– [1]	–				
	UK - Scotland	Offshore >34.5 (normalised to 34.5) Coastal 30–<34.5 (normalised to 32)	Offshore 10 Coast 12	Offshore 15 Coast 18						
	UK – other than Scotland	Offshore >34.5 (normalised to 34.5[2]) Coastal 30–<34.5 (normalised to 32) Estuary 0–<30 (normalised to 25)	Offshore 10 Coast 12 Estuary 20	Offshore 15 Coast 18 Estuary 30	–[1]	–				
	UK - Scotland	Offshore >34.5 (normalised to 34.5) Coastal 30–<34.5 (normalised to 32)	Offshore 10 Coast 12	Offshore 15 Coast 18						
III	Ireland	Tidal freshwater estuary (<0.5)	35 – 70	180	0.5 – 0.7	2.0				
		Inner estuary (17.0)		100		2.0				

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
OSPAR Region	Contracting Party	Salinity[21] and area	Background concentration DIN µmol/l	Assessment levels DIN µmol/l	Background concentration DIP µmol/l	Assessment levels DIP µmol/l	Background concentration TN µmol/l[22]	Assessment levels TN µmol/l[22]	Background concentration TP µmol/l[22]	Assessment levels TP µmol/l[22]
		Coastal waters (<35.0)	8	18	0.7	1.2				
		Offshore Irish and Celtic Seas (35.0)	8	12	0.6	0.8				
		Offshore Atlantic west coast (35.5)	10	15	0.6	0.8				
IV	Spain #[1,2,3]	Estuary (normalized salinity 2,3‰) [4]	84.4	160	0,68-1,29	1,02-6,2				
		Estuary (normalized salinity 11,5‰) [4]	63.4	120	0,6-1,06	0,90-4,7				
		Estuary (normalized salinity 24‰) [4]	33.4	64	0,49-0,73	0,74-2,5				
		Estuary (normalized salinity 32‰) [4]	14.2	27	0,42-0,52	0,63-1,1				
		Coastal (normalized salinity 35‰):								
		Coastal NEA 1/26a North East Cantabrian [4]	8,2	15	0,4-0,45	0,6-0,7				
		Coastal NEA 1/26a North Central Cantabrian [4]	n.a.	n.a.	0.4	0.6				
		Coastal NEA 1/26a Western Cantabrian Coast [4]	7.36	10.99	0.44	0.66				
		Coastal NEA 1/26e Spain western iberian upwelling coast [4]	10,11-13,59	15,09-20,28	0,61-0,88	0,91-1,31				
		Offshore								
		Offshore NorO1 [5]	0.2	n.a. (7)	0.1	n.a. (7)				
		Offshore Platform [5]	3	n.a. (7)	0.1	n.a. (7)				

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
OSPAR Region	Contracting Party	Salinity[21] and area	Background concentration DIN µmol/l	Assessment levels DIN µmol/l	Background concentration DIP µmol/l	Assessment levels DIP µmol/l	Background concentration TN µmol/l[22]	Assessment levels TN µmol/l[22]	Background concentration TP µmol/l[22]	Assessment levels TP µmol/l[22]
		Offshore SUR-OCEAN [6]	n.a.	n.a. (7)	0.2	n.a. (7)				
		Offshore P1 [6]	n.a.	n.a. (7)	0.3	n.a. (7)				
	France	Estuaries and Coastal water normalised to 33 Ecotype 1-26b English Channel [2]	n.a. [1]	33	n.a. [1]	n.a. [1]	/	/	/	/
	Portugal									

Endnotes to table on nutrients

Belgium

1: still under revision (status 10 March 2013)

2: normalisation of salinity per area.

France

1 : Nutrient values are being revised. Background concentrations or elevated levels should be available before the next Common Procedure application. Background concentrations or elevated levels will be assessed from long term data series analysis and/or from modelling.

2 : Combination of several water bodies according to the dilution area of drainage watershed.

Taking into account the summary note on the place of nutriments in the assessment of the quality of coastal waters and the ongoing work on nutrient indicators for the WFC (2000/60/EC) and with a view to harmonising the OSPAR and WFD approaches, it is proposed to amend the thresholds currently used in OSPAR's Common Procedure.

Therefore, for recent work concerning the assessment of the quality of water masses (in the sense of the WFD) for the nutrients quality element for the period 2007-2012 (Daniel et Soudant, 2013) and more particularly for dissolved inorganic nitrogen (DIN – corresponding to the sum nitrate + nitrate + ammonium), data have been grouped by « ecotypes » which are representative of the catchment areas in order to calculate a metric corresponding to the concentration of DIN normalised to 33 salinity. The values of normalised DIN for the whole of these ecotypes have been linked to their EQR to define the threshold values TB/B and B/M of DIN : for coastal and North Sea transition waters (ecotype 1-26b of WFD), the WFD threshold between good and average, equivalent to the limit in non-problem areas and problem areas of the Common Procedure, is faxed at 29µmol/L. For the Atlantic Channel ecotype ((1/26 a), it is fixed at 33 µmol/L.

It is not proposed to provide background concentration values in the near future, since the definition of NQE is not required for the physic-chemical elements of the WFD. These values could be defined for OSPAR on the basis of the analysis of long term series or products resulting from (ongoing) work on modelling.

The threshold values for the WFD indicator « biomass » of the quality element phytoplancton wll be used to define the OSPAR chlorophyll a values (Tables 1 and 2).

Table 1. Reference and limit values between the different quality categories for the biomass indicator of the Phytoplancton quality element of the WFD.

Ecotype North Sea / MEC & MET / NEA 1-26b.

Reference value	Very good	Good	Average	Bad	Poor
6.67 µg/L	1-10	10-15	15-22.5	22.5-45	> 45
EQR	*0.67 - 1*	*0.44 – 0.67*	*0.30 – 0.44*	*0.15 – 0.30*	*< 0.15*

Table 2. Reference and limit values between different quality categories for the biomass indicator of the Phytoplancton quality element of the WFD.

Ecotype Atlantic Channel/ MEC & MET / NEA 1-26a.

Reference value	Very good	Good	Average	Bad	Poor
3.33 µg/L	0 - 5	5 - 10	10 - 20	20 - 40	> 40
EQR	*0.67 - 1*	*0.44 – 0.67*	*0.30 – 0.44*	*0.15 – 0.30*	*< 0.15*

Germany

1: Background concentrations and assessment levels are in revision with the aim of achieving harmonisation between OSPAR and WFD

2: Background concentrations according to federal Surface Water Ordinance as applied under the WFD up to 1 nautical mile. Assessment levels not officially set.

3: Not valid in coastal waters where WFD applies

Netherlands

1: Assessment levels as used in the Dutch COMP 2008

2: Normalization has not been applied in NL COMP 2008, but for estuaries it is not certain whether the linear relationship holds for lower salinities

3: Normalization has not been applied in NL COMP 2008

Spain

Data for Spain in this table are for the Cantabrian and North Western Iberian Coast of Spain (South not included yet). **Nutrient values are in a revision process.**

(1) Spanish footnote to columns (4) and (6) heading: *Background concentrations* considered correspond to the Reference Conditions established in the ecological status national classification systems.

(2) Spanish footnote to column (4) and (5) heading: National ecological status classification systems assess nitrates, nitrites and ammonium separately. Only some regions have established RC and G/M values for DIN. Values shown are only representative of the regions where the data were available so these values should be taken with caution as they are not representative of the whole common type.

(3) Spanish footnote to columns (5) and (7) heading: *Assessment levels* considered correspond to the G/M threshold established in the ecological status national classification systems.

(4) National classification systems are established in an annual basis, with no distinction of the winter period

(5) Nutrients in winter period

(6) Levels established in an annual basis. In our latitudes light is not a limiting factor for primary production (chla values can be high any moment of the year, overall in upwelling areas such as Gulf of Cádiz. For the same reason winter values for nutrients are not the best basis to determine nutrient concentrations not affected by phytoplankton consumption.

(7) No assessment value has been applied (trend analysis to detect significant evidence of change)

Sweden

1: Reference to Swedish offshore data: HVMFS 2012:18, reference to Swedish coastal data: NFS 2008:1. n.a.: value is not available

HVMFS 2012:18 (Offshore data)

https://www.havochvatten.se/miljopolitik-och-lagar/lagstiftning/svensk-lagstiftning/havs--och-vattenmyndighetens-forfattningssamling/register/havs--och-vattenmyndighetens-foreskrifter-hvmfs-201218-om-vad-som-kannetecknar-god-miljostatus-samt-miljokvalitetsnormer-for-nordsjon-och-ostersjon.html

NFS 2008:1 (coastal values)

http://www.naturvardsverket.se/Documents/foreskrifter/nfs2008/nfs_2008_01.pdf .

2: Sweden would like to inform that the values put forward in this table for Kattegat may be subject to modification to consider future agreements within HELCOM. From the perspective of the MSFD the Kattegat Sea is a part of the MSFD North Sea Region and to be coordinated within OSPAR. However, Kattegat is also covered by the Helsinki Convention (HELCOM). Sweden has nationally determined limits on the eutrophication indicators level (HVMFS 2012:18) for both MSFD article 9 and 10. After that, HELCOM jointly agreed upon a set of target values for the Baltic Sea including Kattegat. For the moment of time the target values for nutrients and oxygen for Kattegat are not exactly the same in HELCOM and in the Swedish regulation.

United Kingdom

1: The UK used the N/P ratio = 24 as assessment level (corresponds with 0.625, 0.83, 1.25 µmol 1^{-1} DIP for offshore, coast and estuaries, respectively). The UK did not use winter DIP as nitrogen is the limininiting nutrient in UK waters.

2: In Irish Sea offshore salinity is >34 (normalised to 34)

B. Area-specific background concentrations and assessment levels of chlorophyll *a* during the growing season (III-X) in relation to salinity

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Region	Contracting Party	Salinity and area	Specify the analytical method for chlorophyll determination	Background concentration Chlorophyll *a* µg/l, means	Assessment levels Chlorophyll *a* µg/l, means	Background concentration Chlorophyll *a* 90th percentile	Assessment level Chlorophyll *a* 90th percentile
II	Sweden[1]	≥20 Kattegat (offshore)	Fluorometric method, extraction in ethanol 96%	1,0	1,5	n.a	n.a
		≥20 Kattegat (coast)	Fluorometric method, extraction in ethanol 96%	1,0	1,5	n.a	n.a
		≥27 Skagerrak (offshore)	Fluorometric method, extraction in ethanol 96%	1,1	1,8	n.a	n.a
		≥27 Skagerrak (coast)	Fluorometric method, extraction in ethanol 96%	1,1	1,8	n.a	n.a
	Norway	Estuary			3,5		5
		Coastal			3,5		6
	Denmark	Kattegat (offshore)					
		Kattegat (coast)				1,5	3
		Skagerrak (offshore)					
		Skagerrak (coast)				3	4
		> 32 North Sea (offshore)					
		~ 32 North Sea (coast)				5	7,5
	Germany[1]	18-30 (WFD, NEA 3/4)[2]	Photospectrometry	2,4	5,5	4,8	11,0
		18-30 (WFD, NEA 3/4 Ems)[2]	Photospectrometry	3.3	7.5	6.6	15.0

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Region	Contracting Party	Salinity and area	Specify the analytical method for chlorophyll determination	Background concentration Chlorophyll *a* µg/l, means	Assessment levels Chlorophyll *a* µg/l, means	Background concentration Chlorophyll *a* 90th percentile	Assessment level Chlorophyll *a* 90th percentile	
		< 30 (WFD, NEA 1/26c)	Photospectrometry	1.7	3.8	3.3	7.5	
		28-34.5 [3]	Photospectrometry	2.1-1.5	3.2-2.2	4.2-3.0	3.3-4.5	Elevated maximum chlorophyll a ug/l 8.4-6.0
		>35	Photospectrometry	1.5	2.3	3.0	4.5	Elevated maximum chlorophyll a ug/l 6.0
	Netherlands	Wadden Sea <30	acetone, followed by separation with HPLC and fluorescence detection	8	12	16	24	
		Estuaries <30: Western Scheldt, Ems estuary		3	4,5	6	9	
		Coastal waters <34.5		5	7,5	10	15	
		Offshore >34.5: Southern Bight, Oyster Grounds, Dogger Bank		1,5	2,25	3	4,5	
	Belgium	Estuary						
		30 (Inner CW)		4,5	9	12	18	
		33,5 (Outer CW)		2,6	5,25	7	10,5	
		Averaged (Inner and outer CW < 1nm WFD)				10	15	
		> 34,5 (Offshore)		2,9	4,2	5,6	8,4	
	France	Ecotype 1/26b (Part of the Eastern English Channel and southern bight of the North Sea)	Extracted chlorophyll in 90% acetone	Not used	Not used	6.67	22.5	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Region	Contracting Party	Salinity and area	Specify the analytical method for chlorophyll determination	Background concentration Chlorophyll *a* µg/l, means	Assessment levels Chlorophyll *a* µg/l, means	Background concentration Chlorophyll *a* 90th percentile	Assessment level Chlorophyll *a* 90th percentile
	United Kingdom – other than Scotland	Offshore >34,5 Coastal 30–<34,5	Extracted chlorophyll – acidification method	–[1]	–	Offshore 6,7 Coastal 10	Offshore 10 Coastal 15
	United Kingdom – Scotland[2]		Extracted chlorophyll – acidification method	–	–	–	–
III	United Kingdom – other than Scotland	Offshore >34,5 (34 in Irish Sea) Coastal 30–<34,5	Extracted chlorophyll – acidification method	–[1]	–	Offshore 6,7 Coastal 10	Offshore 10 Coastal 15
	United Kingdom – Scotland[2]		Extracted chlorophyll – acidification method	–[1]	–	–	–
	Ireland [1]	Tidal freshwater estuary (0.5)	Extracted chlorophyll using either cold acetone or hot methanol[2]	–	7,5	–	15,0
		Inner estuary (17.0)	Extracted chlorophyll using either cold acetone or hot methanol[2]	–	7,5	–	15,0
		Coastal waters (<35.0)	Extracted chlorophyll using either cold acetone or hot methanol[2]	1,64	5,0	3,40	10,0
IV	France	Ecotype 1/26a (Part of the western English Channel and Atlantic)	Extracted chlorophyll in 90% acetone	Not used	Not used	3.33	20

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Region	Contracting Party	Salinity and area	Specify the analytical method for chlorophyll determination	Background concentration Chlorophyll *a* µg/l, means	Assessment levels Chlorophyll *a* µg/l, means	Background concentration Chlorophyll *a* 90th percentile	Assessment level Chlorophyll *a* 90th percentile
	Spain [# 1, 2]	Estuary < 30 [3]	Spectrophotometer after extraction in acetone			5.33	12
		Estuary ≥ 30 [3]	Fluorescence CTD or Spectrophotometer after extraction in acetone			2.67	8
		Coastal NEA 1/26a North East Cantabrian [3]	Fluorescence CTD			1	3
		Coastal NEA 1/26a North Central Cantabrian [3]				2	6
		Coastal NEA 1/26a Western Cantabrian Coast [3]				4	9
		Coastal NEA 1/26e Spain western iberian upwelling coast [3]				5.33	12
		Coastal NEA 1/26a South [3]				3.3	10
		Offshore NorO1 [4]	Spectrophotometer after extraction in acetone			n.a.	n.a. (6)
		Offshore Plataforma [4]	Spectrophotometer after extraction in acetone			4.9	n.a. (6)
		Offshore SUR-OCEAN [5]	Spectrophotometer after extraction in acetone			0.9	n.a. (6)
		Offshore P1 [5]	Spectrophotometer after extraction in acetone			3.4	n.a. (6)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Region	Contracting Party	Salinity and area	Specify the analytical method for chlorophyll determination	Background concentration Chlorophyll *a* µg/l, means	Assessment levels Chlorophyll *a* µg/l, means	Background concentration Chlorophyll *a* 90^{th} percentile	Assessment level Chlorophyll *a* 90^{th} percentile
	Portugal						

Endnotes to Table on Chlorophyll a

Germany

1: Background concentrations and assessment levels are in revision with the aim to achieve harmonisation between OSPAR and WFD

2: Not yet calibrated

3: Not valid in coastal waters where WFD applies

Ireland

1: The values for Ireland are based on medians, not means.

2: Ireland has two sets of assessment levels based on the extraction method used which differ by a factor of 2 (assessment levels based on cold acetone extraction method are 50% lower than those based on hot methanol extraction). The values shown are based on cold acetone extraction.

Spain

Estuaries data for Spain in this table are for the Cantabrian and North Western Iberian Coast of Spain (South not included yet).

1: Spanish footnote to column (5) and (7) heading: *Background concentrations* considered correspond to the Reference Conditions established in the ecological status national classification systems.

2: Spanish footnote to column (6) and (8) heading: *Assessment levels* considered correspond to the G/M threshold established in the ecological status national classification systems.

3: National chla classification systems are established in an annual basis, with no distinction of a productive period. In water type “Coastal NEA 1/26e” in “Spain western iberian upwelling coast”, it is to be noted that values are as proposed for intercalibration in phase 3 (common type 1/26e)

4: Chla in blooming period.

5: Levels established in an annual basis. In our latitudes light is not a limiting factor for primary production (chla values can be high any moment of the year, overall in upwelling areas such as Gulf of Cádiz. For the same reason winter values for nutrients are not the best basis to determine nutrient concentrations not affected by phytoplankton consumption.

6: No assessment value has been applied (trend analysis to detect significant evidence of change)

Sweden

1: Reference to Swedish offshore data: HVMFS 2012:18, reference to Swedish coastal data: NFS 2008:1. n.a.: value is not available

United Kingdom

1: UK does not report means or maxima

2: Scotland reports extracted chlorophyll as part of the phytoplankton index only

C. Assessment levels for oxygen

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.

(1)	(2)	(3)	(4)	(5)
OSPAR Region	**Contracting Party**	**Salinity and area**	**Oxygen concentration in mg/l**	**Oxygen saturation in %**
II	Sweden[1,2]	≥20 Kattegat (coast)	3,0	n.a
		≥20 Kattegat (offshore)	5,0	n.a
		≥27 Skagerrak (coast)	3,0	n.a
		≥27 Skagerrak (offshore)	5,0	n.a
	Norway		5	50
	Denmark	Kattegat (offshore)	2 and 4	n.a
		Kattegat (coast)	2 and 4	n.a
		Skagerrak (offshore)	2 and 4	n.a
		Skagerrak (coast)	2 and 4	n.a
		> 32 North Sea (offshore)	2 and 4	n.a
		~ 32 North Sea (coast)	2 and 4	n.a
	Germany[1]		7,3	85% at S = 35 and 12˚C
	Netherlands	Wadden Sea <30	6	
		Estuaries <30: Western Scheldt, Ems estuary	6	
		Coastal waters <34,5	6	
		Offshore >34,5: Southern Bight, Oyster Grounds, Dogger Bank	6	
	Belgium		6	
	France	Coastal waters (only summer values, from June to August, measured on the bottom)	3 (10thpercentile)	n.a.

	United Kingdom	All salinity	4 (5^{th}percentile)	–
III	United Kingdom	All salinity	4 (5^{th} percentile)	–
	Ireland	Tidal freshwater estuary (0.5)	6.5 (5^{th}%ile) @ 20^{o}C §	<70 (5^{th}%ile) or >130 (95^{th}%ile)
		Inner estuary (17.0)	§	<70 (5^{th}%ile) or >130 (95^{th}%ile)
		Coastal waters (<35.0)	6.0 (5^{th}%ile) @ 20^{o}C §	<80 (5^{th}%ile) or >120 (95^{th}%ile)
IV	France	Coastal waters (only summer values, from June to August, measured on the bottom)	3 (10thpercentile)	n.a.
	Spain [1]	Coastal NEA 1/26a North East Cantabrian		59-85
		Coastal NEA 1/26a North Central Cantabrian		59
		Coastal NEA 1/26a Western Cantabrian Coast		54.27
		Coastal NEA 1/26e Spain Western Iberian upwelling coast		54.27
	Portugal			

Endnotes to Table on oxygen

Germany

1: The assessment levels are not applied in coastal waters where WFD applies

Ireland

§ The DO concentration values are indicative only. The assessment is based on dissolved oxygen saturation values – the DO concentration values are shown to indicate what the corresponding concentration would be at these saturation values.

Spain

1: Coastal normalised at salinity 35. Data for Spain in this table are for the Cantabrian and North Western Iberian Coast of Spain (South not included yet).

Sweden

1: Reference to Swedish offshore: HVMFS 2012:18, reference to Swedish coast: NFS 2008:1.

2: Sweden would like to inform that the values put forward in this table for Kattegat may be subject to modification to consider future agreements within HELCOM. From the perspective of the MSFD the Kattegat Sea is a part of the MSFD North Sea Region and to be coordinated within OSPAR. However, Kattegat is also covered by the Helsinki Convention (HELCOM). Sweden has nationally determined limits on the eutrophication indicators level (HVMFS 2012:18) for both MSFD article 9 and 10. After that, HELCOM jointly agreed upon a set of target values for the Baltic Sea including Kattegat. For the moment of time the target values for nutrients and oxygen for Kattegat are not exactly the same in HELCOM and in the Swedish regulation.

Additional information provided on assessment levels for phytoplankton (nuisance species)

The assessment level for Phaeocystis used by The Netherlands in the national COMP 2008 has been 10^7 cells/l.

The value of this assessment level is different from the value in the COMP (2005), which is 10^6 cells/l + duration > 30 days.

Belgium uses a level of 4 x 10^6 cells/l, which is evidence-based (Lancelot, 2009). NL is currently in discussion with Belgium in order to arrive at a consensus value to be included in the updated COMP. See also the Dutch work document 2012 (Baretta-Bekker & Prins, 2012).

Assessment levels of selected assessment parameters used by Contracting Parties in the application of the previous version of the Common Procedure

Assessment levels for winter DIN and winter DIP

Table 1 Salinity-related assessment levels used by Contracting Parties for winter DIN and winter DIP.

OSPAR Region	Contracting Party	Salinity: normalisation value (and nominal range)	Winter DIN (µmol/l) Range of salinity-related assessment levels			Winter DIP (µmol/l) Range of salinity-related assessment levels		
			Offshore	Coast	Estuary	Offshore	Coast	Estuary
II	Germany[23]	30	8	11-12	17-26	0.5	0.6	0.2-0.5
IV	Portugal	---	--	---	66[2] (0-36)	---	---	---

[2] Portugal used the measured value of 1993

Assessment levels for chlorophyll *a*

Table 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)								
		Offshore			Coast			Estuary		
		Mean	Max.	90th per.	Mean	Max.	90th per.	Mean	Max.	90th per.
II	Germany[24]	2.3	9		3	14				
IV	Portugal	---	---	---	---	---	---	7.4	56	15

[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.

Assessment levels for oxygen

Table 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)	% saturation
II	Germany	7.55 mg/l on average	70%, 85%**
IV	Portugal	8.4 (6mg/l, 10th percentile)	---

** applied additionally

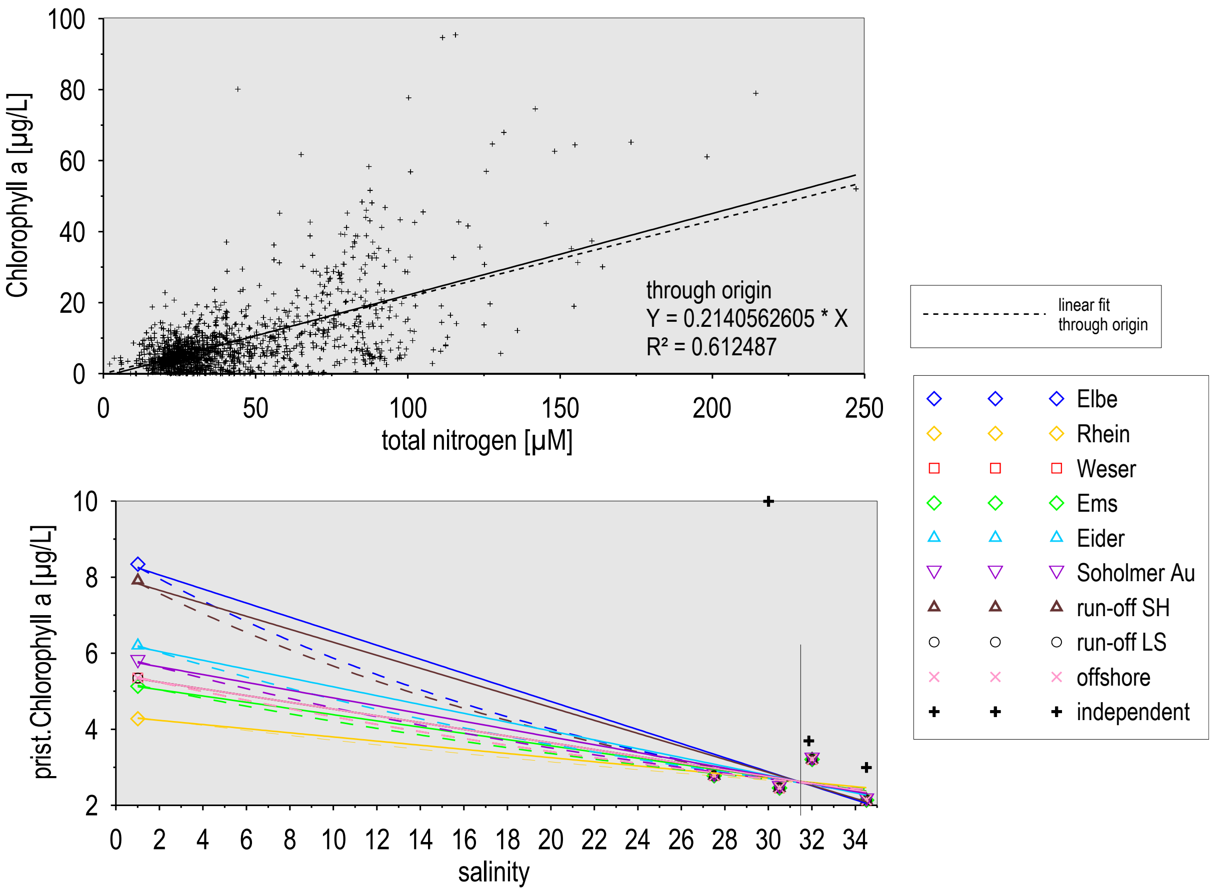
[23] NOT UPDATED

[24] NOT UPDATED

Correlations of TN with salinity and TN with chlorophyll *a* within the German territorial waters and exclusive economic zone at the surface during growing season

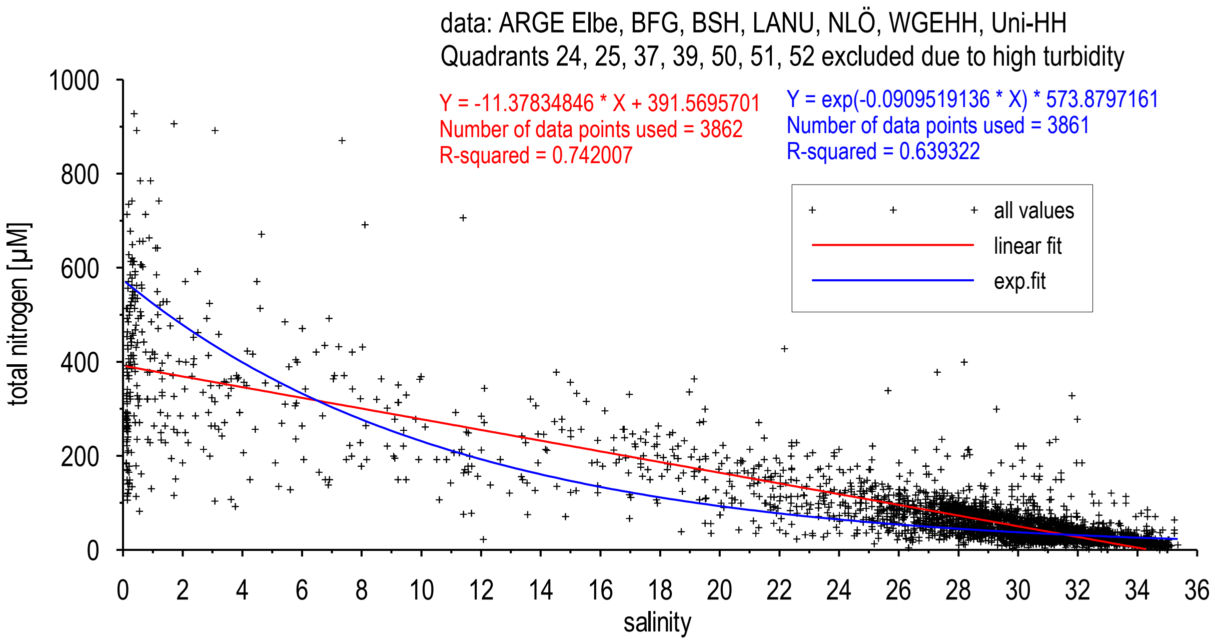
For the German Bight area linear correlations between TN and chlorophyll *a* were found during the growing season (a). Since TN is correlated with salinity as well (c), based on natural background concentrations of TN, assessment levels for chlorophyll *a* can be calculated for all salinities (b). This is in accordance with the assumption that eutrophication effects have their origin in the elevated nutrient discharges.

a) Data for 1980 – 2000



b) Correlations of calculated pristine chlorophyll *a* with salinity compared to independent estimations

Up to a salinity of 31.5 linear correlations are used, due to dominant mixing influences, beyond 31.5 it is suggested to use exponential fits, approaching open sea conditions.



c) Correlation of TN with salinity in the German Bight area during growing season (1980 – 2000)

General and physiological information of various phytoplankton indicator species

Phaeocystis spp

- Foam-forming nuisance species in colonial form; occurrence during spring-summer.
- Increased concentrations of more than 10^6 cells/l and increased bloom duration per year are an indication of nutrient enrichment.
- Occurrence of colony-formation depends on the physiological state and is related to the excess of nitrate as N-source during N-limiting under certain conditions by light.
- *Phaeocystis* outcompetes other species under N-limitation at low N/P ratios; it has a lower P demand than diatoms and needs a minimum temperature of 7°C; T_{opt} is 15°C.
- Relatively high abundance, increased frequency and duration of blooms in continental waters are strongly linked with nutrient enrichment.
- *Phaeocystis* free-living cells (but not colonies) are grazed by tintinnids, and not grazed by copepods; it therefore has a poor food value, is a bad food source for bivalves and has a negative effect on young oysters, probably due to its mucilage.

Noctiluca scintillans

- This large (0,3 mm) non-toxic heterotrophic (hence oxygen consuming) dinoflagellate forms regular tomato soup coloured surface accumulations in spring under calm weather conditions (<3-5 Bft) (nuisance species).
- Its high abundance (above 10^3 cells/l) leads to low oxygen concentrations below the top layer and to high ammonium concentrations which may be harmful to fish. Oxygen deficiency induced by *Noctiluca* blooms caused a mass kill of cockles in the Dutch Wadden Sea.
- Its high abundance may be due to its increased food resources as result of increased eutrophication.

Chrysochromulina polylepis

- Fish and benthos killing species; toxic above 10^6 cells/l; bloom occurrence in Spring.
- The exceptional bloom in May 1988 in Kattegat and Skagerrak waters is likely to be linked to eutrophication, with other factors (climate, hydrography) involved; its toxicity may be related to N/P ratios (more toxic under P-limitation).
- It seems to prefer nutrient rich water and high light intensities; the combination of a mild winter with high precipitation, followed by a warm spring with very stable water masses was probably the most important cause of its massive, toxic bloom in May 1988.

Gymnodinium mikimotoi (former name is *Gyrodinium aureolum*)

- Fish-killing species when cell density exceeds 10^3 - 10^6 cells/l; in the Channel, west UK, Danish, Norwegian and Swedish waters these blooms have caused fish kills.
- Bloom occurrence: late summer-autumn; first observation in 1966 along south-west Norwegian coast; optimal growth at 20 ^{0}C.
- It shows a preference for deeper water layers.
- Blooms develop mainly in dynamic light environments (fronts, stratified water layers, turbid waters) where they have ecological advantage due to their ability to adapt at different light intensities, to migrate and to assimilate N at low light intensities.

- *Gymnodinium mikimotoi* is believed to be an introduced species which has spread its occurrence in the Skagerrak, Kattegat and North Sea waters since first recorded in autumn 1966 in Norwegian Skagerrak and off south west UK. Some authors have suggested that blooms occurring in recent years are linked to and a consequence of long-term increases in nutrient levels where such increases have occurred; direct links between increased nutrient levels and organic matter and toxic dinoflagellate blooms may well be obscured by other factors as meteorology and hydrography. There is a need for further research.

Alexandrium **spp**

- Several species of *Alexandrium* (e.g. *A. tamarense. A. minutum/lusitanicum, A. ostenfeldii*) may be toxic (above 10^2 cells/l), depending on duration and cell concentration, and cause PSP.
- Toxicity months: May-June.
- Its appearance may be associated with a flux of water rich in nutrients, crossing fronts.
- It has been suggested that PSP-producing dinoflagellates may have spread geographically; summer blooms are recruited from resting stages which spend winter on the sea bottom.

Dinophysis **spp.**

- *Dinophysis acuminata, D. acuta, D. norvegica, D. caudata, D. fortii, D. sacculus, D. rotundata, D. skagii and D. tripos* are considered as DSP mussel-infecting species.
- Occurrence: late summer-autumn.
- More than 10^2 cells/l may give rise to DSP, depending on duration of occurrence.
- Its occurrence is associated with low salinity coastal waters and calm weather (wind < 2 Bft during 1 week) rather than with temperature.

Other species

The raphidophycean species *Fibrocapsa japonica* and *Chatonella* spp. are increasingly occurring in coastal European waters. Massive toxicity has been reported for the small sized *F. japonica* when cell concentration is exceeding 4×10^6 cells/l. This species may also directly affect marine mammals, whereas toxicity of *Chatonnella* spp. is mainly related to fish kills.

Annex 7b

Elevated levels of area-specific nuisance and toxic phytoplankton indicator species, and the type of their effects

Phytoplankton indicator species	**Elevated levels**	**Effects**
Nuisance species		
Phaeocystis spp. (colony form)	> 10^6 cells/l (and >30 days duration)	nuisance, foam, oxygen deficiency
Noctiluca scintillans	> 10^4 cells/l (area coverage > 5 km^2)	nuisance, oxygen deficiency
Toxic (toxin producing) species		
Chrysochromulina polylepis	> 10^6 cells/l	toxic; fish and benthos kills
Gymnodinium mikimotoi	> 10^5 cells/l	toxic; fish kills, PSP mussel infection
Alexandrium spp.	> 10^2 cells/l	toxic; PSP mussel infection
Dinophysis spp.	> 10^2 cells/l	toxic; DSP mussel infection
Prorocentrum spp.	> 10^4 cells/l	toxic; DSP mussel infection

Annex 8

Technical Annex elaborating suggested methods for the confidence rating of individual assessment parameters

PART A: Confidence of assessment against area-specific thresholds

A1) Introduction

An element in confidence rating of environmental classification can be assessments of statistical confidence, integrated in the classification procedure itself. In such a procedure, observations from a location or water body to be classified are used to calculate test values (e.g. averages or specified percentiles) with an uncertainty measure.

In the following, only one-sided classification against an assessment limit is considered, e.g. a limit for classifying a water body as a non-problem or potential-problem area. In order to limit the risk of misclassification as non-problem area, one may accept such a classification only if one can say with a previously chosen confidence level that the true state actually corresponds to non-problem status. To do this, a probable upper limit for the test value (e.g. average of observations) is calculated from the available data in such a way that it will, with a specified probability, be at least as large as the unknown true statistic; this probability is the confidence level and the calculated limit is the confidence limit. The probability does not apply to the specific case or the specific value, but to how often the estimation method will result in confidence limits which are larger than the unknown "true" values of the test statistic, if it is used on a number of different data sets.

The uncertainty of a statistical test value, e.g. an average, increases with variability of observations and decreases with increasing number of observations. If a certain confidence level is specified, a larger uncertainty of the test value will lead to the confidence limit being increased. The classification therefore tends to be more conservative with increasing uncertainty, decreasing the probability that a true value a specific distance below the limit will be classified as below limit.

Alternatively, one may choose to classify by simple comparison of test value and classification limit, but in addition, for cases where the test value is below the limit, estimate a post-hoc confidence level for the classification, based on the estimated uncertainty of the test value. This means asking "what is the largest *a priori* chosen confidence level that would lead to the conclusion that the test value is below the classification limit?" A larger uncertainty for a given test value will then not influence the classification, but lead to a lower confidence in the result. A combined approach may of course be used, by requiring a minimum confidence level for accepting classification as below the limit, and qualify accepted results by the post hoc confidence level. Again, the confidence level is not to be interpreted as the probability that the location is below the classification limit, but as a quantification of the confidence one may have that the answer is correct.

The classification limit might typically be defined from reference location data with a fixed tolerance margin to be taken into account in the classification. In the OSPAR classification of non-problem and problem areas, a 50 % deviation from reference conditions may be used. In the present study Norwegian eutrophication data from the national coastal monitoring program is analysed as examples, and the classification limits that are used have been chosen by considering the Norwegian classification limits, but also with a view to get illustrative results; they should not be considered as established or official limits.

If the test value is some sort of average, the uncertainty estimate will typically have the form of a standard error, and the upper confidence limit is calculated based on an assumption about the form of the statistical distribution of observations. Alternatively, the test criterion could be that the state variable should be below a limit for a specified fraction of the observation space (time or geographical area). The test of whether the requirement is fulfilled will then be based on non-parametric sample statistics without any assumptions about the form of the population distribution.

The same type of considerations goes into estimation of confidence intervals for distance to specified classification limits (distance to target).

A2) Data material

- The present analysis looks at selected data from the Norwegian Coastal Monitoring program: Winter values for total nitrogen and phosphorus
- Summer values for chlorophyll a.

The study uses data from stations Jomfruland, Arendal St. 2 and Lista (Figure 1), which have all been monitored from 1990 to 2010. Jomfruland and Arendal St. 2 have been monitored twice a month (but with some irregularities; 80 % of monitoring intervals are in range 12-28 and 9-26 days, respectively for the two stations). Station Lista has been monitored once a month (80 % of monitoring intervals are between 19 and 39 days).

Figure 1. Map of Southern Norway, with geographical names of stations marked by red ellipses.

A3) Classification limits

The classification limits in the Norwegian classification system for eutrophication (Molvær et al. 1997) and the proposed levels in Molvær et al. (2008) were in most cases used in this study. Only the limits for waters with salinity >18 are considered, since almost all observations are above this limit.

For total nitrogen and phosphorus, upper classification limits for *High* and *Good* status as proposed by Molvær et al. (2008) are listed in the table. The limits from Molvær et al. (1997) are also shown for comparison. The table shows limits both as original values in µg/litre from the referenced documents and converted to µM for direct comparison with the Coastal Monitoring data (Figure 2).

For ecoregion Skagerrak (stations Jomfruland and Arendal), the table shows a recommended common set of limits for open coastal and exposed archipelagic stations. For ecoregion North Sea (station Lista), limits for open coastal stations are shown. The proposed new limits from Molvær et al. (2008) are lower than the ones from Molvær et al. (1997) for nitrogen and about the same for phosphorus.

The rightmost column of the table shows the nutrient classification limits that have been chosen for the present study. They are about 15 % higher than the new limits for High Status. The limits have been chosen so as to be suitable for illustrating how results may depend on classification method, and are not intended as actual classification limits.

Table 1. Selected classification limits for winter values of total nitrogen and phosphorus in marine waters

			Upper class limits for 'High' and 'Good' Status µg/l High	µg/l Good	µM High	µM Good	classification limits for statistical study
Total nitrogen	Molvær et al. 2008	Skagerrak	262	312	18.7	22.3	22.0
		North Sea	206	233	14.7	16.6	16.5
	Molvær et al. 1997		*295*	*380*	*21.1*	*27.1*	
Total phosphorus	Molvær et al. 2008	Skagerrak	23	25	0.74	0.81	0.85
		North Sea	20	24	0.65	0.77	0.75
	Molvær et al. 1997		*21*	*25*	*0.7*	*0.8*	

For Chlorophyll in summer (June-August) Molvær (1997) specify a limit 2.0 µg/litre between *High* and *Good* status. To get limits suited to illustrate how results may vary with method, a lower value of 1.35 µg/litre has been used here as classification limit for average and 50 % percentile assessment, while a larger limit of 2.25 µg/litre is used for 85 % percentile assessment. The relative difference between the two limits corresponds roughly with the difference between the same percentiles in the actual distribution of Chlorophyll values.

A4) Preliminary exploration of data

Figure 2 shows the selected data series aggregated into yearly averages. The winter data include values from January and February only (December values are also often included in winter statistics, but for the coastal monitoring data the December values are on average lower than in January and February, and would inflate error estimates since the systematic seasonal variation is not taken into account in these plots; consequently they are not included). Summer data are from the period June to August. All values for total nitrogen and phosphorus are included in these plots (In recent coastal monitoring reports, winter observations where chlorophyll >0.62 µg/l have been excluded, since surface nutrient levels cannot then do not represent "true" winter values with low biological activity).

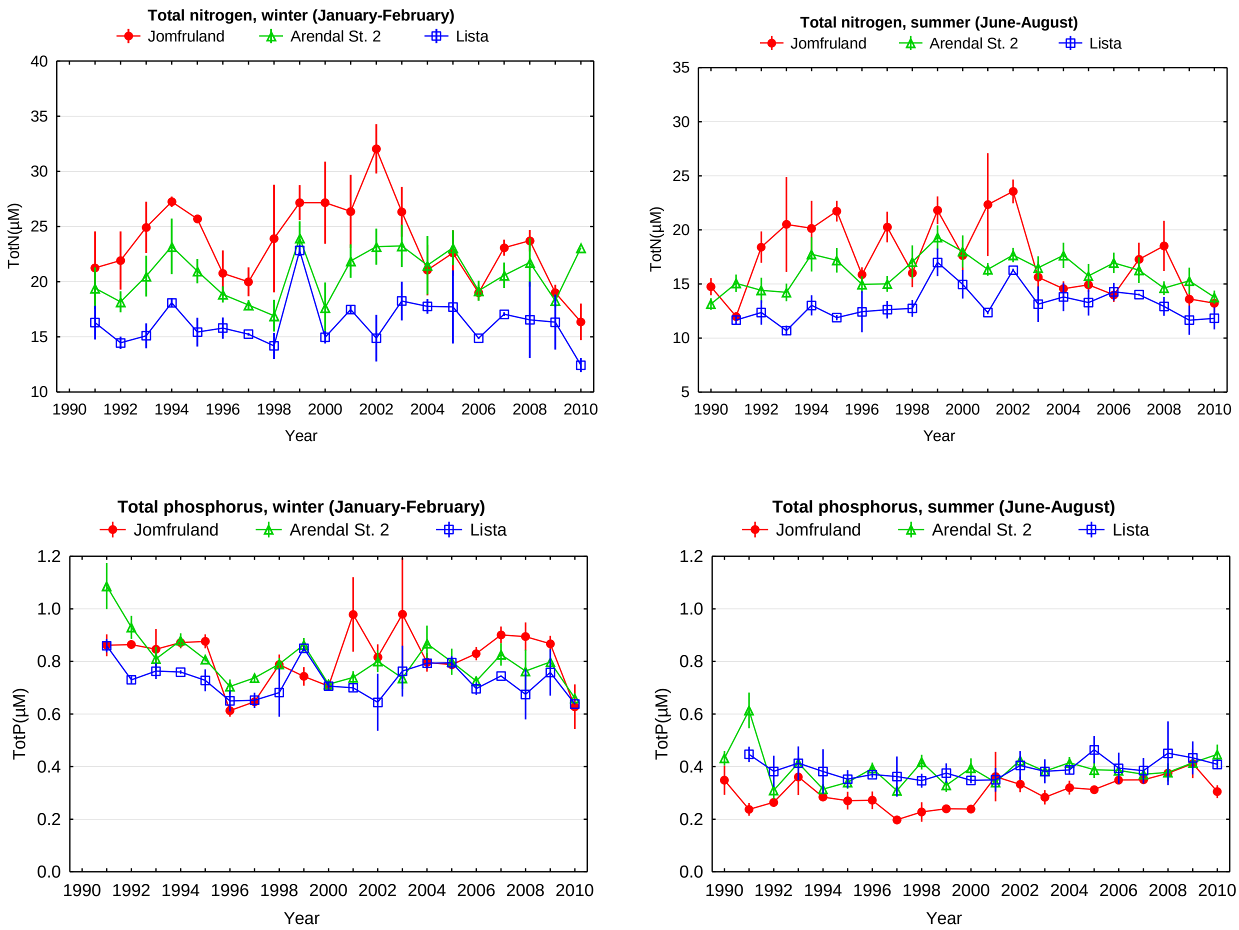
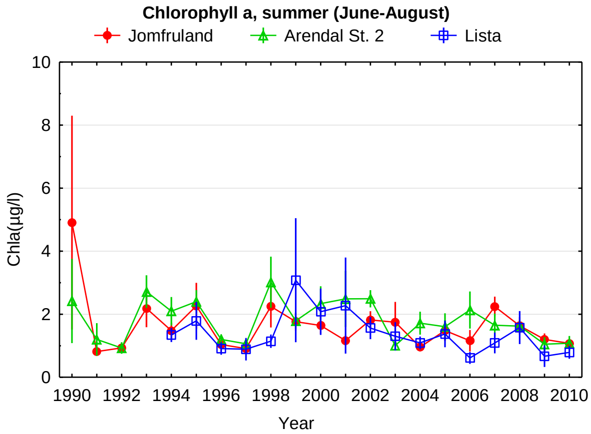


Figure 2. Time series if yearly averages from 0-10 m depth from the Norwegian coastal monitoring program. Raw data from 0, 5 and 10 m depth have first been averaged for each observation date, and yearly averages have then been calculated from the depth averages. Thus the error bars show the standard error based on variation between sampling events and depth.



The graphs are based on data from 0, 5 and 10 m depth. The data have first been averaged over depth, and then aggregated into yearly averages. The error bars in the graphs represent the standard error for each yearly average. The random residual variation between the three different depths is negligible, so observations at different depths are considered as pseudoreplicates with regard to spatial and temporal variation. The statistical analyses are therefore performed on depth-averaged data.

A5) Confidence limits and confidence levels for assessments based on parametric statistics

The assessment of confidence for classification is illustrated here with a simple calculation of overall average and standard error for selected data sets. Table 2 shows statistics for winter values (January-February) of total nitrogen and phosphorus, and summer values (June-August) for chlorophyll (note that chlorophyll statistics are based on natural logarithms of the concentrations to get a more symmetric distribution).

The statistics are based on the years 2001-2010. The calculations are done by first averaging over each combination of station and year. The general averages per station are finally calculated with standard error estimates based on the variation between yearly averages for each station. This procedure is simple and fairly robust, and leads to a sound estimate of uncertainty, independent of within-year variance structure in the data. At most, it may lead to lower number of degrees of freedom than necessary, if for instance the individual observations were fully independent, but as long as one has more than 5 averages, this does not have a large effect.

The table lists the relevant classification limits, and then shows Means, Standard errors and number of observations. Finally, three alternative ways of using confidence are shown.

First, a fixed 90 % confidence level requirement is used to assess whether the station can be characterized as belonging to a non-problem area. The *Test value* is the upper 90 % confidence limit. If this value is lower than the classification limit, the answer is *Yes* to the question (*Is the station in a non-problem area?*). The table shows that for this example non-problem status is not assigned to any of the stations in the case of winter nitrogen concentrations, but in the case of phosphorus, Arendal and Lista are classified as non-problem areas. For chlorophyll, only the station Lista is assigned a non-problem status.

The same procedure is followed for an alternative where 80 % confidence level is required for assigning to non-problem status. Most of the results are the same, but station Lista is now classified as non-problem area also in the case of nitrogen.

Finally, the classifications are performed by simple comparison of the mean value and classification limit, and a variable confidence level estimated for the conclusion that the station is a non-problem area. This result in a higher number of *Yes* answers, but some of them with fairly low confidence level. Only phosphorus concentrations (at Arendal and Lista) and chlorophyll (at Lista), have a high confidence level. As mentioned above, the assessments could be modified so that a confidence minimum >50 % would be required to accept classification as non-problem area. It would for instance seem reasonable to conclude that our confidence in the assessments for tot-P and chlorophyll at Jomfruland is too low to be accepted (52 and 66 % respectively), even if the mean is just below the classification limit. It should be noted that very high confidence levels are rounded to 100 % in the table, but will never be exact 100 % in reality.

Table 2. Assessments of station averages against upper class limits, with fixed confidence limit requirement, and variable confidence limit. Data from 2001-2010 is included in the calculations. Winter assessments of nutrients are based on data from January and February; Summer assessments include data from June-August. The statistics are calculated from Station*Year averages. For chlorophyll, natural logarithms are used, and the limit of 1.35 µg/litre converted accordingly to 0.30.

Variable and season	Station	Classification limit	Sample statistics			Fixed upper 90 % conf. limit		Upper 80 % conf. limit		Variable conf. levels for conclusion "Yes"	
			Mean	Std. Error	N	Test value	Non-probl. area	Test value	Non-probl. area	Non-probl. area	Confidence level for 'Yes'
totN [µM) Winter	Jomfruland	22	22.96	1.43	10	24.94	No	24.22	No	No	25.9 %
	Arendal St. 2	22	21.58	0.55	10	22.34	No	22.07	No	**Yes**	76.8 %
	Lista	16.9	16.34	0.57	10	17.13	No	16.84	**Yes**	**Yes**	82.4 %
totP (µM) Winter	Jomfruland	0.85	0.848	0.032	10	0.892	No	0.876	No	**Yes**	52.4 %
	Arendal St. 2	0.85	0.771	0.019	10	0.797	**Yes**	0.788	**Yes**	**Yes**	100 %
	Lista	0.75	0.721	0.018	10	0.746	**Yes**	0.737	**Yes**	**Yes**	92.9 %
ln(Chla (µg/l)) Summer	Jomfruland	0.30	0.263	0.086	10	0.382	No	0.339	No	**Yes**	66 %
	Arendal St. 2	0.30	0.361	0.106	10	0.508	No	0.455	No	No	29 %
	Lista	0.30	-0.022	0.117	10	0.140	**Yes**	0.081	**Yes**	**Yes**	99 %

A6) Confidence level for assessment based on percentiles

Molvær et al. (2008) proposed as a classification criterion that at least 85 % of single observations should be below the upper class limit for assignment to a given class. The assigned class for a location will then be the highest class where this criterion is met. The criterion is stated without considering the number of observations, and it should be interpreted as an intended requirement for the "true" 85 percentile, i.e. based on a large number of independent observations.

The same type of criterion can be applied to OSPAR classification into Problem/Non-problem areas. The requirement can be generalised as requiring that the "true" *p* percentile (i.e. over the complete set of hypothetically possible measurements) should be below the assessment limit if a station is to be considered as being in a Non-problem area. For a time series, this means that the value should be below the assessment limit for at least *p* % of the time. The question is whether the set of observations indicates that the "true" *p* percentile is below the assessment limit, and if so, how a confidence level for such a conclusion can be established.

If a random samples of *n* independent observations is ordered in a sequence of increasing values, the probability that value number *k* will be larger than the "true" *p* percentile is by definition the cumulative probability of the binomial distribution for at most *k*-1 successes of *n* trials with probability *p*/100 for success at each trial:

$$Probability(< k \text{ successes}) = \sum_{i=0}^{k-1} \binom{n}{k} \left(\frac{p}{100}\right)^{i} \left(1 - \frac{p}{100}\right)^{n-i}$$

This cumulative probability is the confidence level for the conclusion that the *p* percentile is less than value number *k*. Consequently, if *k* of *n* observations are below the classification limit, this confidence level also applies to the conclusion that the *p* percentile is less than the classification limit.

Examples are shown in the table below. In this table, *f* in the top row is the fraction [0…1] of observations below the limit. For each value of *n* the corresponding numbers of observations *k* are calculated as $f \cdot n$. *Conf. level* is the probability that observation number *k* in the ordered set of observations is above the "true" *p* percentile. Results are shown only where $f \cdot n$ is an integer. Combinations where the confidence level is larger than 90 % is shown in bold in the table.

If the assessment criterion is that the median (50 % percentile) should be below an assessment limit, 8 out of 10 observations must be below the limit to conclude that the data are sampled from a non-problem area with 95 % confidence level. With a total number of 20 observations, 14 observations (70 % of the total) must be below the limit to conclude with the same confidence level. For 40 observations, 26 (i.e. 65 %) below assessment limit are needed to make the same conclusion.

If the requirement is the 85 % percentile, then a larger part of the observations must be below the assessment limit to conclude with comparable confidence levels that the true percentile is below the limit: e.g. 20 out of 20 observations or 38 out of 40 observations.

Table 3. General examples of confidence levels for conclusions about population percentiles based on sample percentiles.

Confidence level for concluding that the true *p* percentile of the population distribution is lower than value number *k* in the ordered set of observations sorted by ascending values

p	*n*	Fraction (*f*) of observations below class limit						*k=f·n*
		0.5	0.600	0.650	0.700	0.750	0.800	
50 %	10	5	6		7		8	*k*
		0.377	0.623		0.828		**0.945**	*Conf. level*
	20	10	12	13	14	15	16	*k*
		0.412	0.748	0.868	**0.942**	**0.979**	**0.994**	*Conf. level*
	40	20	24	26	28	30	32	*k*
		0.437	0.866	**0.960**	**0.992**	**0.999**	**1.000**	*Conf. level*
	80	40	48	52	56	60	64	*k*
		0.500	**0.954**	**0.995**	**1.000**	**1.000**	**1.000**	*Conf. level*

p	*n*	Fraction (*f*) of observations below class limit						*k=f·n*
		0.85	0.900	0.925	0.950	0.975	1.000	
85 %	20	17	18		19		20	*k*
		0.352	0.595		0.824		**0.961**	*Conf. level*
	40	34	36	37	38	39	40	*k*
		0.393	0.737	0.870	**0.951**	**0.988**	**0.998**	*Conf. level*
	80	68	72	74	76	78	80	*k*
		0.424	0.866	**0.965**	**0.995**	**1.000**	**1.000**	*Conf. level*
	100	85	90	93	95	98	100	*k*
		0.432	**0.901**	**0.988**	**0.998**	**1.000**	**1.000**	*Conf. level*

It is important to note that the confidence levels estimated in this way are only valid if observations are independent. If the observations are grouped (for instance with a number of observations each year), the within-group variation may be less than the between-group variation, and this should be taken into account when considering whether to aggregate data before application of order statistics. Bootstrap analysis may be one way of correcting the calculation of confidence levels. Another possibility is to aggregate data, for instance into yearly averages, and set requirements for the collection of yearly values over a number of years, but this means to change the definition of the classification criterion and consequently also of the outcome of the classification. It could also be considered to adjust the degrees of freedom based on estimates of autocorrelation to avoid exaggerated confidence levels if measurements are taken so frequently that they are not independent.

Table 4 shows an illustration of percentile based assessments for summer chlorophyll concentrations (June to August) using data from 2001 to 2010. In the upper part of the table the requirement of the true median value is to be below an assessment limit of 1.35 µg/litre for the station to be considered to belong to a non-problem area. In the lower part the requirement is that 85 % of values should be below an assessment limit of 2.25 µg/litre. In both cases, the results are shown both for individual observations (depth averaged) and for classification based on yearly medians. For individual observations, within-group correlation is not taken into account. The individual depth-averaged values are assumed to be independent for this method demonstration; it is not claimed that they really are independent.

The results illustrate both the importance of defining how data should be aggregated before being used in classification, and the impact of choosing different types of requirement statistics (e.g. median or 85 % percentile). For instance, based on the 1.35 µg/litre limit for the overall median of individual observations, Lista would be assessed as a non-problem area, with a fair confidence level also in the case of Jomfruland. Assessments using the same limit on the median of yearly medians are much weaker, even if the fraction of values below limit are not so different; this is because absolute differences in number of values are more important than relative differences in fractions. The difference in apparent assessment power indicates that observations are not really independent, and that between-year variation is important; this would mean that the confidence levels based on simple statistics on individual observations across years are exaggerated.

If instead a requirement is set for the 85 % percentile, with a corresponding higher classification limit of 2.25 µg/litre, the difference in confidence levels between individual observations and yearly medians are turned around, so that the statistics on yearly medians are now more powerful than the confidence levels based on individual observations. Note that for this criterion, all three stations have the maximum confidence level that is attainable with 10 values; a higher confidence requires larger number of values.

In conclusion, depending on how data are aggregated, the same dataset may give different results, and this needs to be considered in relation to the purpose of the classification (ecological justification for abatement measures or extended monitoring, cost/benefit/risk analysis).

Table 4. Percentile statistics and confidence levels for Chlorophyll$_{-a}$, summer observations (June-August) from years 2001-2010, using two alternative criteria for classifying as non-problem area

Requirement for classifying as non-problem area:			50 %	of time below assessment limit	
		Classification limit:	*1.35 µg/l*		
Aggregation level:	Station:	Total number of values	Number of values <limit	Sample fraction <limit	Confidence level
Individual observations	Arendal	55	25	45 %	20.9 %
	Jomfruland	53	31	58 %	86.4 %
	Lista	30	22	73 %	99.2 %
Yearly medians	Arendal	10	4	40 %	17.2 %
	Jomfruland	10	6	60 %	62.3 %
	Lista	10	7	70 %	82.8 %

Requirement for classifying as non-problem area:			85 %	of time below assessment limit	
		Classification limit:	*2.25 µg/l*		
Aggregation level:	Station:	Total number of values	Number of values <limit	Sample fraction <limit	Confidence level
Individual observations	Arendal	55	46	84 %	30.6 %
	Jomfruland	53	45	85 %	40.0 %
	Lista	30	27	90 %	67.8 %
Yearly medians	Arendal	10	10	100 %	80.3 %
	Jomfruland	10	10	100 %	80.3 %
	Lista	10	10	100 %	80.3 %

A6) Concluding remarks

The approach for confidence rating presented here is a purely statistical approach. Hence it may represent an alternative or supplement to approaches that rely on a combination of statistical measures and expert judgement. It does not take into account all the aspects included by some other methods presented (and which managers still need to consider). However, the classifications rely only on test values and their uncertainty and the results are thus transparent.

A7) References

Molvær, J., Knutzen, J., Magnuson, J., Rygg, B., Skei, J, Sørensen, J., 1997: Classification of environmental quality in fjords and coastal waters. A guide. *In* Norwegian. TA report 1467/1997, Klif (SFT); ISBN 82-7655-367-2

Molvær, J., Magnusson, J. Pedersen, A., Rygg, B, 2008: Water Framework Directive: Development of a system for marine classification. Progress report autumn 2008.

PART B: Representativeness in space and time

Assessing the representativeness in space and time of monitoring data is an integral part of reporting assessment results and provides information on the quality of the monitoring design. The sampling should be regular within the assessed area and balanced between efforts and necessary resolution resulting in sufficient confidence. It is suggested to use a quantitative and transparent approach expressing the confidence as % of covered subareas considering gradients. This allows the estimation of confidence for different parameters in a comparable way. Such an approach, suitable for "traditional" monitoring data, is outlined below. As a prerequisite it is assumed that the sampling procedure and succeeding analytical steps correspond to quality assured standard methods.

The approach is generally not appropriate for assessing confidence in data stemming from novel observation tools (e.g. satellite data, automated moorings). Such data are often characterised by a very high measurement frequency in space and time but potentially low data accuracy. A method for combining in a confidence assessment data from traditional and novel sources has not been developed so far.

B1) Representativeness in space

Step 1: Division of assessed area into regular grid cells

The division of the assessed areas into grid cells is a simplified prerequisite for assessing the representativeness in space (see Fig. 2 for an example). The grid cells should all have the same size, independent of their distance from the coast, since the method is designed to indicate representativeness of sampling locations for the whole assessed area. It is recommended to use >10 to 100 grid cells which can simply be transferred to percentages. The grid cells allow to determine the percentage of area that was sampled and the representativeness of sampling distribution, which constitutes a first estimate of the degree of confidence. The assessment should be carried out per parameter and per defined assessment area and specified time period.

Step 2: Assessing the *representativeness in space*

Representativeness of sampling is indicated by the percentage of sampled grid cells and their distribution. Empty grid cells reflect uneven distribution of sampling. The extension of non-sampled grid cells can be quantified by counting how many grid cells surrounding a selected grid cell are not sampled.

Step 3: Considering the steepness of gradients for representativeness in space

In general, steep gradients require small distances between the monitoring stations to assess the eutrophication parameters with high confidence. For flat gradients the missing data can be interpolated for short distances by statistical programs, but for steep gradients only a sufficient resolution allows to estimate the extension of high or low values. Hence, it is suggested to consider the steepness of gradients for a representative minimum resolution of sampling distances. The gradients and their steepness can be taken from preceding assessments or screening. Steepness of gradients can be defined e.g. by the percentage distance Min-Max or to an overall mean or median. The higher extreme values are the lower are distant gradients for Min-Max or deviations from means. In these cases deviation from median may be considered.

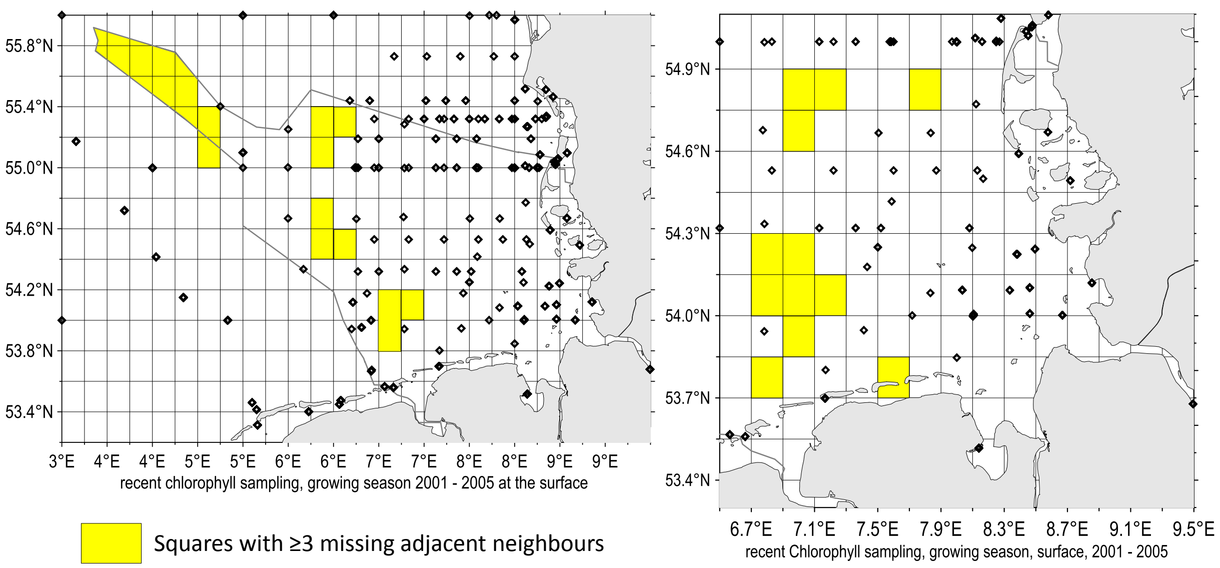


Figure 2. Map showing the German EEZ subdivided into >100 identical grid cells. Black dots indicate the location of the monitoring stations. Yellow grid cells are cells with ≥ 3 missing neighbors. Different scales will cause diverging distribution of empty grid cells as is shown for the subarea German Bight.

The standardised local steepness between next sampled locations can be calculated from the difference (%) between these stations. The confidence of each grid cell can simply be calculated by its distance as % of mean transects to the next sampled grid cell and the gradient as difference between the sampled grid cells as % of total Min-Max difference:

Confidence C (%) = 100 / distance (%) x gradient (%)

Since each grid cell is surrounded by eight other gird cells, the evaluation of the distance to the next sampled grid cell must be carried out in eight different directions. The largest distance stemming from this assessment should then be used in the formula above to calculate the respective confidence for that grid cell.

Sampled grid cells get the score of 1 % (of total 100 quadrants). Examples for grid cells not sampled in an assessed area of 100 quadrants of the same size with an assumed mean transect of 10 quadrants are listed in table 1. If one grid cell between two next sampled quadrants was not sampled (= 10 % of mean transect) and the gradient is 10 % (of total Min-Max): this grid cell gets the full score of 1% (of 100 quadrants). Short distances not sampled cause only a small decrease of confidence, especially when they cover flat gradients.

Table 5. Examples of confidence rating for representativeness in space assuming that sampled area was sub-divided into 100 grid cells. Distance 10 % = 1 missing grid cell, 20 % = 2 etc, Gradient 10 % = difference between 2 next sampled stations 10 % of total Min-Max difference. The last example in this table shows that for very flat gradients up to 4 quadrants between next sampled quadrants may not be sampled without this impacting on the confidence. Note: for oversampled area the confidence could reach > 100 %.

Distance %	Gradient %	Resulting confidence in %
10	10	1
10	20	0.5
20	10	0.5
20	20	0.25
30	10	0.33
30	20	0.16
10	8.5	1.17
20	2.5	2
30	2.5	1.3
40	2.5	1

Vertical sampling profiles and transects can also be assessed with this method. E.g. if along a vertical profile with 10 equidistant sections are indicated for sampling, the distance % in Tab. 5 is reduced to 1/10 (due to 10 sections only) applying the same calculation considering gradient steepness: e.g. if 2 sections have not been sampled (each has in one direction an empty section) and the gradient between the next sampled depths/stations is 20%, both sections get a score of 2.5% (100/ 2x20). If all other sections have been sampled, the total score will be 85 % (10 % for each sampled section), because the total confidence of sampling representativeness in the whole assessed area/transect/profile is simply the sum of individual grid cell/section confidences.

B2) Representativeness in time – confidence of time series

The assessed time period may be extended to several years, single seasons or events. These time periods should be characterised by a minimum of sampling at regular scales, considering the general duration of assessed events (e.g. blooms, passages of patches). Confidence of single stations with high flushing can be increased by combination with data from surrounding areas. The suggested method allows to assess multiple stations with similar annual cycling or complete areas. All confidence assessments should be carried out per parameter and per assessment area/location within defined time periods.

Step 1 – Division of the time period to be assessed into regular intervals

It is proposed to divide the time period to be assessed into about 100 regular intervals (e.g. for sampling spanning the whole year twice a week: 52*2 = 104, allowing the detection of bloom events and the passages of extended patches as well) corresponding to 100 %. The required frequency of confident sampling can be defined by the extent of differences in assessed eutrophication parameters between sampling intervals. To standardise these differences, deviations between min. and max. can be set = 100% or the maximum deviation from mean or median can be set = 100 %.

Step 2 – Assessing the representativeness in time

In general, periods with fast changes need a higher sampling frequency than those with slow changes. Higher sampling rates therefore may be required for steep gradients or in areas/stations characterised by strong fluctuations.

The representativeness in time can be assessed similar to the representativeness in space, following the method outlined above. For example a not sampled time period of 4 % at a changing rate of 2.5 % of min-max differences would not cause a lower confidence (corresponding to 40 % in Tab. 5). The confidence of sampling of regular time intervals can be defined according to Tab. 1, but considering only one dimension (time) by reducing the distance %/10 (corresponding to 1, 2, 3, 4 % in the first column).

B3) Overall confidence of representativeness in space and time

For assessing the overall confidence of the representativeness in space and time the worst score of either space or time should be taken. Additionally to the overall confidence scoring, low confidences in specific subareas (indicated in Fig. 2) or time sections (seasons) can be specified, allowing a more effective assessment.

Annex 9

Reference documents

Note: Shaded documents are key documents for the Common Procedure

Recommendations	
88/2	PARCOM Recommendation 88/2 on the Reduction in Inputs of Nutrients to the Paris Convention Area
89/4	PARCOM Recommendation 89/4 on a Co-ordinated Programme for the Reduction of Nutrients
92/7	PARCOM Recommendation 92/7 on the Reduction of Nutrient Inputs from Agriculture into Areas where these Inputs are Likely, Directly or Indirectly, to Cause Pollution.
Other agreements	
2013-04	JAMP Eutrophication Monitoring Guidelines: Nutrients (superseding 1997-02)
2013-05	JAMP Eutrophication Monitoring Guidelines: Oxygen (superseding 1997-03)
2012-12	JAMP Eutrophication Monitoring Guidelines: Chlorophyll *a* in water (superseding 1997-04)
1997-5	JAMP Eutrophication Monitoring Guidelines: Phytoplankton Species Composition (under review)
2012-12	JAMP Eutrophication Monitoring Guidelines: Benthos (superseding 1997-06)
2013-08	Common Procedure for the Identification of the Eutrophication Status of the Maritime Area, superseding 2005-03
2014-04	Principles of the Comprehensive Study on Riverine Inputs and Direct Discharges (RID) (supersedes 1998-5)
2001-5	Agreement on those Parts of the OSPAR Maritime Area to which the Comprehensive Procedure will be applied
2001-7	Principles for the Comprehensive Atmospheric Monitoring Programme (CAMP)
2002-13	OSPAR Co-ordinated Environmental Monitoring Programme (CEMP)
2002-14	JAMP Guidelines for General Biological Effects Monitoring
2002-20	Common Assessment Criteria, their Assessment Levels and Area Classification within the Comprehensive Procedure of the Common Procedure, superseded
2003-21	2003 Strategies of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. Replaced by 2010-03: North-East Atlantic Environment Strategy
2004-2a-2i	OSPAR HARPNUT Guideline 1: Framework and Approach of the Harmonised Quantification and Reporting Procedures for Nutrients (cf. HARPNUT Guidelines 2-9, agreements 2004-2b to 2004-2i)
2004-17 2010-04	Strategy for a Joint Assessment and Monitoring Programme (JAMP)
2005-4	Eutrophication Monitoring Programme, superseding the Nutrient Monitoring Programme 1995-5
2010-3	The North-East Atlantic Environment Strategy, including the updated Eutrophication Strategy.
2012-11	JAMP Eutrophication Monitoring Guidelines: Chlorophyll *a* in water – updated by HASEC 2012
2012-12	JAMP Eutrophication Monitoring Guidelines: Benthos – updated by HASEC 2012
2013-04	JAMP Eutrophication Monitoring Guidelines: Nutrients – updated by HASEC 2013
2013-05	JAMP Eutrophication Monitoring Guidelines: Oxygen – updated by HASEC 2013
Publications	
QSR 1993	Quality Status Report 1993, OSPAR publication no. 14 (1993), ISBN 1-872349-06-4
QSR 2000	Quality Status Report 2000, OSPAR publication no. 111 (2000), ISBN: 0-946956-52-9.
OSPAR 2001	Evaluation of the expected situation of the eutrophication status in the Maritime Area following the 50% reduction target for nutrient inputs, OSPAR publication no. 140 (2001), ISBN: 0-946956-76-6.
OSPAR 2003	OSPAR integrated report 2003 on the eutrophication status of the OSPAR maritime area based upon the first application of the Comprehensive Procedure, OSPAR publication no. 189 (2003), ISBN: 1-904426-25-5.
EMEP 2004	Atmospheric Nitrogen in the OSPAR Convention Area in the period 1990 – 2001, EMEP/MSC-W Technical Report, 4/2004, also published by OSPAR, publication no. 217 (2004), ISSN 0804-2446.
OSPAR 2007	Atmospheric nitrogen in the OSPAR Convention area in 1990–2004. EMEP report for OSPAR. OSPAR Commission, London, 2007. Publication 344/2007.

OSPAR 2008	Towards the 50% reduction target for nutrients. Assessment of implementation of PARCOM Recommendation 88/2 and 89/4. OSPAR Commission, London, 2008. Publication 310/2008.
OSPAR 2008	Nutrient reduction scenarios for the North Sea. Environmental consequences for problem areas with regard to eutrophication following nutrient reductions in model scenarios. OSPAR Commission, London, 2008. Publication 374/2008.
OSPAR 2008 (2009)	Eutrophication status of the OSPAR maritime area. Second OSPAR integrated report. OSPAR Commission, London, 2008. Publication 372/2008. (publication year 2009 on the cover)
OSPAR 2009	Trends in atmospheric concentrations and deposition of nitrogen and selected hazardous substances to the OSPAR maritime area. OSPAR Commission, London, 2009. Publication 447/2009.
OSPAR 2009	Trends in waterborne inputs. Assessment of riverine inputs and direct discharges of nutrients and selected hazardous substances to the OSPAR maritime area in 1990–2006. OSPAR Commission, London, 2009. Publication 448/2009.
QSR 2010	Quality Status Report 2010, Chapter 4, Eutrophication
OSPAR 2012	MSFD Advice Manual and Background document on Good environmental status - Descriptor 5: Eutrophication