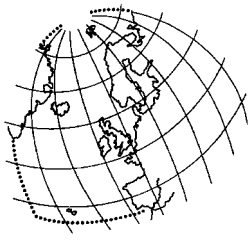
Biodiversity Series

Report on North Sea Pilot Project on Ecological Quality Objectives



OSPAR Commission

2006

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

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

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Executive Summary

Introduction

1. The Fifth North Sea Conference (Bergen, Norway, 2002) agreed on the adoption of a system of Ecological Quality Objectives (EcoQOs) as a means of applying the ecosystem approach to the management of human activities. Ecological quality was defined as *"an overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographic, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities."* Within this overall framework, an **ecological quality element** was defined as *"an individual aspect of overall ecological quality"*. For each ecological quality element, there would then be set an **ecological quality objective** (EcoQO), which was consequently defined as *"the desired level of an ecological quality (EcoQ)"*. The definition added that "*Such a level may be set in relation to a reference level*".

2. The idea of a system of EcoQOs as a means of ensuring an integrated, ecosystem approach has a long pedigree within the North Sea process. The Fourth North Sea Conference (Esbjerg, Denmark, 1995) gave an impetus to the widening of the 1992 OSPAR Convention to take account of issues other than pollution. This process culminated in the adoption of a new Annex V to the OSPAR Convention dealing with the impacts of human activities other than pollution. At the same time, the Intermediate Ministerial Meeting on the Integration of Fisheries and Environmental Issues (Bergen, Norway, 1997) encouraged work on the development of the ecosystem approach. Work continued under both the OSPAR Convention and the North Sea process, and the two strands of work were brought together by the acceptance by the OSPAR Commission in June 2002 of the invitation from the Fifth North Sea Conference to develop a North Sea Pilot Project on EcoQOs.

3. The EcoQO approach offers the added value of showing how the six OSPAR Strategies can work together to deliver the agreed general goal of a healthy and sustainable marine ecosystem throughout the OSPAR maritime area. It does this by defining the "envelope" within which that objective can reasonably be expected to lie, by providing precise bench-marks to show whether the different components are within that envelope, and thus showing whether the OSPAR Convention is achieving its aim.

Conceptual description of the system of EcoQOs

4. The overall quality of the marine environment can be assessed against a number of different issues. The Pilot Project selected ten. This review has suggested a slightly different arrangement which reduces the list of issues to nine: commercial fish species, marine mammals, seabirds, fish communities, benthic communities, plankton communities, threatened and/or declining species, threatened and/or declining habitats, eutrophication.

5. EcoQOs can take the form of targets (values where there is a commitment to attain them), limits (values where there is a commitment to avoid breaching them) or indicators (values which simply show what is happening). A description has been developed of what constitutes a good EcoQO. They need to have a clear scientific basis, to enable data to be collected effectively and economically, to have a clear reference level or target, and to be generally accepted by all stakeholders. They will thus perform better if they are easy to understand, measure accurately something which is affected by a manageable human activity but not subject to other influences, and are based on an existing body of data which allows the realistic setting of objectives. The classification of EcoQOs as targets, limits or indicators in this report is provisional pending further discussion in relevant OSPAR subsidiary bodies.

6. There needs therefore to be a cycle of activity in relation to each EcoQO involving gathering and assessing information, taking policy decisions on the objectives and the interventions needed to achieve them, implementing the policies and evaluating the work carried out – which leads back again to gather and assessing information.

7. The pilot project will then need to be expanded to give a complete picture of the marine ecosystems, reflecting the Driving force-Pressure-State-Impact-Response (DPSIR) framework for analysing approaches to managing human activities and their impacts on ecosystems.

Relationships between human activities and EcoQOs

8. The review has analysed the six OSPAR strategies (biodiversity and ecosystems, eutrophication, hazardous substances, offshore oil and gas industry, radioactive substances, monitoring and assessment) and their relationship with the proposed EcoQO approach, as well as the commitments made by the North Sea Conferences. Outside the themes of the OSPAR strategies, climate change is an important influence on the development of the North Sea ecosystems, which must be taken into account in setting the EcoQOs. There has then been an analysis of the different human activities under each of the OSPAR strategies, and

the other important activities such as fisheries, shipping, tourism, marine litter, etc, in order to see how they fit into the framework of EcoQOs agreed by the Fifth North Sea Conference.

Evaluation of the North Sea Pilot Project on EcoQOs

9. The core of the report is then an evaluation of the 21 ecological quality elements, and related EcoQOs, identified by the Fifth North Sea Conference. The review initially concludes that the existing 21 ecological quality elements should be re-ordered under the nine issues, as described at § 4 above.

10. Five of these EcoQOs form an integrated sub-set related to eutrophication. A sixth, over-arching EcoQO relating to the eutrophication status of the North Sea should be added to the sub-set. This sub-set of EcoQOs cannot be viewed in isolation, but must be considered together. In this form, they should be confirmed/adopted and applied as indicators. Coherent monitoring is needed for all the sub-set.

11. The review of the 21 EcoQOs (following the original ordering) concludes in summary as follows (the 10 pilot EcoQOs where the Fifth North Sea Conference formulated detailed objectives are each indicated by an asterisk):

* a ***Commercial fish species*****:** this EcoQO should be confirmed and applied as limit. OSPAR should use the results of this EcoQO to warn fisheries management authorities of the need for action to reduce fishing mortality.

b. **Threatened and/or declining species – presence and extent of threatened or declining species:** more work is needed in the light of the development of monitoring strategies for species on the OSPAR List of Threatened and/or Declining Species and Habitats.

* c. **Marine mammals – seal populations:** there should be separate EcoQOs for grey seals and harbour seals, with revised formulations. These EcoQOs should be adopted and applied as indicators.

d. ***Marine mammals – seal breeding sites:*** there should be no separate EcoQO of this kind;

* e. ***Marine Mammals – by-catch of harbour porpoises:*** this EcoQO should be confirmed and applied as a limit;

* f. ***Seabirds – proportion of oiled guillemots among those found dead or dying:*** this EcoQO should be confirmed and applied as an indicator, but there should be further work to define the sub-regions to which it is applied;

g. ***Seabirds – mercury concentrations in seabird eggs and feathers:*** seabird feathers should not be used, but otherwise an EcoQO should be adopted and applied as an indicator;

h. ***Seabirds – organochlorine concentrations in seabird eggs:*** an EcoQO should be adopted and applied as an indicator;

i. ***Seabirds – plastic particles in seabird stomachs:*** an EcoQO should be adopted and applied as an indicator;

j. ***Seabirds – local sand-eel availability for black-legged kittiwakes:*** an EcoQO should be adopted and applied as an indicator, but there should be further work on understanding its performance;

k. ***Seabirds – population trends as an indicator of seabird community health:*** more development work is needed;

l. ***Fish communities – changes in the proportion of large fish:*** considerable further development work is needed;

* m. ***Benthic communities – changes/kills in zoobenthos in relation to eutrophication:*** the EcoQO for zoobenthos kills should be confirmed and applied as part of the integrated eutrophication sub-set, but the EcoQO for changes in zoobenthos needs further development;

* n. ***Benthic communities – imposex in dog-whelks (****Nucella lapillus****):*** the EcoQO should be amended and applied;

o. ***Benthic communities – density of sensitive (e.g. fragile) species:*** considerable further development is needed.

p. ***Benthic communities – density of opportunistic species:*** this ecological quality element is not suitable for the development of an EcoQO;

* q. ***Plankton communities – phytoplankton chlorophyll a:*** the EcoQO for phytoplankton chlorophyll *a* should be confirmed and applied as part of the integrated eutrophication sub-set (with some modification).

* r. ***Plankton communities – phytoplankton indicator species for eutrophication:*** the EcoQO should in principle be confirmed, as part of the eutrophication sub-set, but more work is needed to develop area-specific assessment-levels;

s. ***Habitats – habitat quality:*** this EcoQO should be refocused on the quality and extent of threatened and/or declining habitats. Further substantial development work will be needed;

* t. ***Nutrient budgets and production – winter nutrient concentrations:*** this EcoQO should be confirmed (with minor modifications) and applied;

* u. ***Oxygen consumption – oxygen:*** this EcoQO should be confirmed (with a minor modification) and more work should be done on the area-specific assessment-levels.

12. There should be a period of reflection on the implications of implementing the EcoQO system, in order to allow for more thought on general issues such as the relationship with the developing European Marine Strategy, the resource implications and the best way of organising the necessary collective work. This should not, however, prevent as much progress as possible being made with the detailed tasks listed in Annex 4 (Programme of future work on EcoQOs).

13. ***Links to other major instruments:*** the EcoQO system is not in isolation – there must be links to the other goal-setting systems for the marine environment. The relation to the OSPAR strategies has been considered above. The review has also looked at the relationships to the emerging European Marine Strategy, the EC Water Framework Directive, the EC Birds and Habitats Directives, other relevant EC Directives, the EC Common Fisheries Policy and the Bonn Agreement and the MARPOL and other IMO Conventions. All can be fitted together.

14. ***Implementing the EcoQOs:*** the EcoQO system needs to be integrated into the OSPAR Joint Assessment and Monitoring Programme. The costs of implementation will be limited to the extent that it takes up existing policy goals and is based on existing information-collection systems. Nevertheless, there will be additional costs where these existing information systems rely on volunteer input and will need more coordination and support.

15. ***Completing the EcoQO System:*** the EcoQOs proposed by the Fifth North Sea Conference do not cover all the important aspects of the marine environment. The gaps can be identified by two different systems of analysis: one (internal) based on the food web, and the other (external) based on the analysis of human impacts. These two approaches suggest that the main areas needing further attention are: water and sediment quality, macrophytes, radioactive substances, persistent organic substances other than the classic chlorinated compounds, noise, non-indigenous species, use of marine space, and marine litter.

16. ***Views of stakeholders:*** a Stakeholder Workshop was hosted by Norway in December 2004. The views expressed there were substantially taken into account in drafting the whole of the report. In addition, a summary of the main conclusions of the workshop is included. These cover, among other things, the need to clarify the role of EcoQOs, the form of EcoQOs, the need to communicate the EcoQOs and what they mean to all stakeholders, the spatial and sectoral implications of EcoQOs, and their relationship to sustainable development and scientific research.

17. ***Communicating EcoQOs:*** when the EcoQO system is applied, there needs to be a sustained effort to communicate the purpose and implications to all stakeholders. This should involve identifying the audiences, clarifying the messages for those audiences, and developing communication means that the different Contracting Parties can use, so as to ensure a consistent communication in all North Sea States.

18. ***Evaluation:*** plans will be needed to evaluate the success of the implementation of the EcoQO system.

Récapitulatif

Introduction

1. La cinquième Conférence sur la mer du Nord (Bergen, Norvège, 2002) est convenue d'adopter un système d'objectifs de qualité écologique (EcoQO) qui permet d'appliquer l'approche écosystémique à la gestion des activités humaines. La qualité écologique a été définie comme *"Une expression générale de la structure et du fonctionnement de l'écosystème marin en tenant compte de la communauté biologique et des facteurs naturels physiographiques, géographiques et climatiques, ainsi que des conditions physiques et chimiques, y compris celles qui résultent des activités humaines".* Dans ce contexte général, un **élément de la qualité écologique** est défini comme *"un aspect individuel de la qualité écologique, prise dans son ensemble"*. Il serait alors établi, pour chaque élément de qualité écologique, un **objectif de qualité écologique** (EcoQO), qui serait donc défini comme *"le niveau souhaité d'une qualité écologique (EcoQ)"*. Cette définition précise également que "*Un tel niveau peut être fixé par rapport à un niveau de référence".*

2. L'idée d'avoir un système d'EcoQO qui permette d'assurer une approche écosystémique intégrée appartient à une longue lignée dans le cadre du processus de la mer du Nord. La quatrième Conférence sur la mer du Nord (Esbjerg, Danemark, 1995) a encouragé l'élargissement de la Convention OSPAR de 1992 pour y inclure des questions autres que la pollution. Ce processus a abouti à l'adoption d'une nouvelle annexe V à la Convention OSPAR. Cette annexe porte sur l'impact des activités humaines autres que la pollution. En même temps, la réunion ministérielle intermédiaire sur l'intégration des questions concernant la pêche et l'environnement (Bergen, Norvège, 1997) a encouragé les travaux sur le développement d'une approche écosystémique. Les travaux se sont poursuivis aussi bien dans le cadre de la Convention OSPAR que dans celui du processus de la mer du Nord. La Commission OSPAR a accepté en juin 2002 l'invitation de la cinquième Conférence sur la mer du Nord de développer un Projet pilote mer du Nord sur les EcoQO, ce qui a permis le fusionnement de ces travaux.

3. L'approche EcoQO présente l'attrait supplémentaire de montrer comment les efforts conjoints des six Stratégies OSPAR peuvent conduire à l'objectif général convenu d'un écosystème marin sain et durable dans l'ensemble de la zone maritime. Cette approche définit l'enveloppe dans laquelle devrait raisonnablement se situer cet objectif, en donnant des points de repère qui indiquent si les diverses composantes se situent dans cette enveloppe et révélant ainsi si la Convention OSPAR atteint son but.

Description conceptuelle du système d'EcoQO

4. Un certain nombre de questions distinctes permettent l'évaluation de la qualité générale du milieu marin. Le Projet pilote en a sélectionné dix. Les modalités que préconise le présent rapport sont légèrement différentes et le nombre de questions est limité à neuf: espèces halieutiques commerciales, mammifères marins, oiseaux de mer, communautés halieutiques, communautés benthiques, communautés planctoniques, espèces menacées et/ou en déclin, habitats menacés et/ou en déclin, eutrophisation.

5. Les EcoQO peuvent se présenter sous la forme de valeurs cibles (que l'on est tenu d'atteindre), de valeurs limites (que l'on est tenu de ne pas dépasser) ou de valeurs indicatrices (qui indiquent simplement ce qui se passe). Un bon EcoQO se définit comme suit: avoir une base scientifique claire, permettre de recueillir les données de manière efficace et économique, avoir un niveau de référence ou objectif clair, et être accepté de manière générale par toutes les parties concernées. Les EcoQO fonctionneront donc mieux s'ils sont faciles à comprendre, s'ils mesurent avec précision ce qui est affecté par une activité humaine gérable mais pas soumis à d'autres influences et s'ils se fondent sur une série de données existantes qui permet de fixer des objectifs réalistes. Dans le présent rapport, le classement des EcoQO en tant que valeurs cibles, limites ou indicatrices est provisoire, dans l'attente de discussions ultérieures par les organes subsidiaires pertinents d'OSPAR.

6. Il y a donc lieu d'inclure dans le cycle d'activités relatives à chaque EcoQO, le recueil et l'évaluation d'informations, la prise de décisions sur les lignes à suivre en ce qui concerne les objectifs et les interventions qu'ils nécessitent, la mise en œuvre de politiques et l'évaluation des travaux entrepris - ce qui nous ramène au recueil et à l'évaluation d'informations.

7. Il y aura alors lieu d'élargir le projet pilote afin d'obtenir un tableau complet des écosystèmes marins qui reflète le système d'indicateurs DPSIR (force motrice, pression, état, impact, réponses) pour analyser les approches relatives à la gestion des activités humaines et de leur impact sur les écosystèmes.

Rapports entre les activités humaines et les EcoQO

8. Le présent rapport a analysé les six Stratégies OSPAR (biodiversité et écosystèmes, eutrophisation, substances dangereuses, industrie pétrolière et gazière de l'offshore, substances radioactives, surveillance continue et évaluation) et leurs rapports avec l'approche EcoQO proposée, ainsi que les engagements pris par les Conférences sur la mer du Nord. Lors de la mise en place des EcoQO, il convient de tenir compte, en

plus des thèmes des stratégies OSPAR, des changements climatiques qui ont une influence importante sur le développement des écosystèmes de la mer du Nord. Une analyse des diverses activités humaines figurant dans chacune des Stratégies OSPAR a été effectuée ainsi que des autres activités importantes telles que la pêche, la navigation, le tourisme, les déchets marins, etc., afin de déterminer leur position par rapport au cadre des EcoQO convenu par la cinquième Conférence sur la mer du Nord.

Evaluation du projet pilote mer du Nord sur les EcoQO

9. Au centre du rapport se trouve donc une évaluation des vingt et un éléments de qualité écologique et des EcoQO qui s'y rapportent, déterminés par la cinquième Conférence sur la mer du Nord. Les conclusions préliminaires du rapport précisent que les vingt et un éléments de qualité écologique existants devront être reclassés sous les neuf questions (voir § 4 ci-dessus).

10. Une sous-série intégrée relative à l'eutrophisation se compose de cinq de ces EcoQO. Il conviendrait d'y ajouter un sixième: un EcoQO clef de voûte portant sur l'état d'eutrophisation de la mer du Nord. Les EcoQO qui constituent cette sous-série ne doivent pas être considérés séparément, mais comme un tout. Ils seront confirmés/adoptés sous cette forme et utilisés en tant qu'indicateurs. Il conviendra de surveiller toutes les sous-séries d'une manière cohérente.

11. Le rapport sur les vingt et un EcoQO (suivant le classement d'origine) se résume comme suit (les 10 EcoQO pilotes pour lesquels la cinquième Conférence sur la mer du Nord a déterminé des objectifs détaillés sont indiqués par un astérisque):

* a. ***Espèces halieutiques commerciales*****:** cet EcoQO sera confirmé et appliqué en tant que limite. OSPAR utilisera les résultats de cet EcoQO pour avertir les autorités responsables de la gestion de la pêche qu'il convient d'agir afin de réduire la mortalité du poisson;

b. ***Espèces menacées et/ou en déclin* – présence et étendue des espèces menacées ou en déclin:** il convient de poursuivre les travaux à la lumière des développements relatifs aux stratégies de surveillance continue des espèces figurant sur la liste OSPAR des espèces et habitats menacés et/ou en déclin;

* c. ***Mammifères marins* – populations de phoques:** phoques gris et phoques-veaux marins auront des EcoQO distincts, et leur description sera révisée. Ces EcoQO seront adoptés et appliqués en tant qu'indicateurs;

d. ***Mammifères marins – sites de reproduction des phoques:*** il n'y aura pas d'EcoQO distinct;

* e. ***Mammifères marins – prises accidentelles de marsouins:*** cet EcoQO sera confirmé et appliqué en tant que limite;

* f. ***Oiseaux de mer – proportion de guillemots mazoutés parmi ceux qui ont été trouvés morts ou mourant:*** cet EcoQO sera confirmé et appliqué en tant qu'indicateur, mais il convient de poursuivre les travaux afin de définir les sous-régions auxquelles il s'applique;

g. ***Oiseaux de mer – teneurs en mercure dans les œufs et les plumes des oiseaux de mer:*** un EcoQO sera adopté et appliqué en tant qu'indicateur, toutefois, les plumes des oiseaux de mer ne seront pas utilisées;

h. ***Oiseaux de mer – teneurs en organochlorés dans les œufs des oiseaux de mer:*** un EcoQO sera adopté et appliqué en tant qu'indicateur;

i. ***Oiseaux de mer – particules en plastique dans les estomacs des oiseaux de mer:*** un EcoQO sera adopté et appliqué en tant qu'indicateur;

j. ***Oiseaux de mer – disponibilité locale de lançons pour les mouettes tridactyles à pattes noires:*** un EcoQO sera adopté et appliqué en tant qu'indicateur, mais il conviendra de poursuivre les travaux permettant d'interpréter son exécution;

k. ***Oiseaux de mer – tendances des populations en tant qu'indice de la santé de la communauté des oiseaux de mer:*** il convient de poursuivre les travaux de développement;

l. ***Communautés halieutiques – changements dans la proportion des poissons de grandes dimensions:*** il convient de poursuivre les travaux de développement qui sont considérables;

* m. ***Communautés benthiques – changements/mortalité dans le zoobenthos liés à l'eutrophication:*** l'EcoQO pour la mortalité dans le zoobenthos sera confirmé et appliqué dans le cadre de la sous-série eutrophisation intégrée, mais il convient de développer plus avant l'EcoQO pour les changements dans le zoobenthos;

* n. ***Communautés benthiques – imposex chez le pourpre (****Nucella lapillus****):*** l'EcoQO sera amendé et appliqué;

o. ***Communautés benthiques – densité des espèces sensibles (c'est-à-dire fragiles):*** il convient de poursuivre les travaux de développement qui sont considérables;

p. ***Communautés benthiques – densité des espèces opportunistes:*** cet élément de qualité écologique ne se prête pas au développement d'un EcoQO;

* q. ***Communautés planctoniques – chlorophylle* a *phytoplanctonique:*** l'EcoQO pour la chlorophylle *a* phytoplanctonique sera confirmé et appliqué dans le cadre de la sous-série eutrophisation intégrée (moyennant certaines modifications);

* r. ***Communautés planctoniques – espèces phytoplanctoniques indicatrices d'eutrophisation:*** l'EcoQO sera en principe confirmé, dans le cadre de la sous-série eutrophisation, mais il convient de poursuivre les travaux afin de développer des niveaux d'évaluation propres à une zone;

s. ***Habitats – qualité de l'habitat:*** cet EcoQO se concentrera sur la qualité et l'étendue des habitats menacés et/ou en déclin: il convient de poursuivre les travaux de développement qui sont considérables;

* t. ***Budgets et production de nutriment – teneurs hivernales en nutriments:*** cet EcoQO sera confirmé, (moyennant certaines modifications mineures), et appliqué;

* u. ***Consommation d'oxygène – oxygène:*** cet EcoQO sera confirmé (moyennant une modification mineure) et il conviendra de poursuivre les travaux sur les niveaux d'évaluation propres à une zone.

12. Il conviendrait de prendre le temps de réfléchir aux conséquences éventuelles de la mise en œuvre du système d'EcoQO. Ceci permettrait de se pencher sur des questions d'ordre général telles que les rapports avec la Stratégie marine européenne en cours de développement, les répercussions du point de vue des ressources et la meilleure manière d'organiser les travaux collectifs nécessaires. Ceci ne devrait cependant pas restreindre les progrès à accomplir en ce qui concerne les tâches détaillées figurant en annexe IV (projet de programme de travail futur sur les EcoQO).

13. ***Liens avec d'autres instruments majeurs:*** le système d'EcoQO n'est pas un système isolé – il doit être lié aux autres systèmes qui fixent des objectifs pour le milieu marin. Nous avons vu ci-dessus les rapports avec les stratégies OSPAR. Le présent rapport s'est également penché sur les rapports avec la Stratégie marine européenne émergente, la Directive cadre sur l'eau de la CE, les Directives sur les oiseaux et les habitats de la CE, d'autres Directives pertinentes de la CE, la politique commune de la pêche de la CE, l'Accord de Bonn, MARPOL et autres conventions OMI. Tous ces instruments peuvent cohabiter.

14. ***Mise en œuvre des EcoQO:*** Il y a lieu d'intégrer le système d'EcoQO au Programme conjoint d'évaluation et de surveillance continue OSPAR. Le coût de cette mise en œuvre sera réduit dans la mesure où elle reprend des objectifs politiques existants et se base sur des systèmes existants de recueil d'information. Néanmoins, lorsque les systèmes existants de recueil d'information reposent sur un apport bénévole, il y a lieu d'assurer une coordination et un soutien, ce qui entraine des frais supplémentaires.

15. ***Achèvement du système d'EcoQO:*** les EcoQO proposés par la cinquième Conférence sur la mer du Nord ne couvrent pas tous les aspects du milieu marin. Deux systèmes d'analyse permettent de déterminer les écarts: l'un (interne) se base sur la chaîne alimentaire et l'autre (externe) sur l'analyse des impacts humains. Ces deux approches suggèrent que les zones principales auxquelles il convient de prêter attention sont: la qualité de l'eau et des sédiments, les macrophytes, les substances radioactives, les substances organiques persistantes autres que les composés chlorés classiques, le bruit, les espèces non-indigènes, l'utilisation de l'espace marin et les déchets marins.

16. ***Opinions des parties prenantes:*** un atelier des parties prenantes a été accueilli par la Norvège en décembre 2004 et la rédaction du présent rapport tient généralement compte des opinions qui y ont été exprimées. Il comporte un résumé des conclusions principales à savoir, entre autres, le besoin de clarifier le rôle des EcoQO, leur forme, le besoin de communiquer à toutes les parties prenantes les EcoQO et leur signification, leurs conséquences du point de vue spatial et secteurs industriels, ainsi que leurs rapports tant dans le cadre du développement durable que dans celui de la recherche scientifique.

17. ***Communication des EcoQO:*** lors de l'application d'un système d'EcoQO, il convient de s'efforcer de communiquer régulièrement à toutes les parties prenantes, le but et les conséquences de ces EcoQO A savoir: détermination du public, clarification des messages qui lui sont adressés et développement des moyens de communication utilisables par les diverses Parties contractantes afin d'assurer une communication cohérentes parmi les Etats de la mer du Nord.

18. ***Evaluation:*** il y aura lieu de prévoir une évaluation du succès de la mise en œuvre du système d'EcoQO.

Chapter 1 - Introduction

What is the North Sea Pilot Project on Ecological Quality Objectives?

1.1 A complete system of ecological quality objectives has the ability to help to provide a practical, scientifically based and consistent method to implement the ecosystem approach to the management of human activities affecting the marine environment, to which OSPAR committed itself in the statement adopted at the Second Ministerial Meeting of the OSPAR Commission (Bremen, Germany, June 2003). Such a system can also help to show the extent to which OSPAR is achieving its overall objectives of ensuring a healthy and sustainable marine environment in the North-East Atlantic.

1.2 **Ecological quality** (EcoQ) was defined by the Ministerial Declaration of the Fifth International Conference for the Protection of the North Sea ("the Fifth North Sea Conference" - Bergen, Norway, March 2002) as

> *"an overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographic, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities."*

An **ecological quality element** was likewise defined as

> *"an individual aspect of overall ecological quality"*.

An **ecological quality objective** (EcoQO) was consequently defined as

> *"the desired level of an ecological quality (EcoQ)"*. The definition added that "*Such a level may be set in relation to a reference level*".

1.3 A system of such EcoQOs can serve both to define what are the healthy and sustainable ecosystems that must be the general goal of OSPAR's policies and to focus those policies on measurable and clear objectives.

1.4 The Fifth North Sea Conference committed North Sea States to work towards such an EcoQO system for the North Sea. The Ministers agreed to a list of 10 ecological quality (EcoQ) issues, with 21 related EcoQ elements for which EcoQOs will be developed (Bergen Declaration, Annex 3, Table A). They further agreed that proposed EcoQOs for 10 of the 21 EcoQ elements will be applied as a pilot project (Bergen Declaration, Annex 3, Table B[1]).

1.5 The Ministers invited OSPAR in 2005 to review progress, in collaboration with ICES and other relevant bodies, with the aim of adopting a comprehensive and consistent scheme of EcoQOs (Bergen Declaration § 4 vi).

1.6 This report embodies the outcome of OSPAR's work, including the review. It is based upon work by the North Sea States and other OSPAR Contracting Parties, both in the run-up to the Fifth North Sea Conference, and subsequent follow-up, on collaboration with the International Council for the Exploration of the Sea (ICES) and the European Commission, upon inputs from many non-governmental organisations and upon a workshop with stakeholders' participation in late 2004.

Outline of this report

1.7 This report is structured in the following way:

a. this introduction (Chapter 1) provides information on the development of EcoQOs within OSPAR and within a broader context, and on their application;

b. in Chapter 2, the concept of EcoQOs is explained, and ecological issues and other relevant aspects of the selection and use of EcoQOs are described;

c. Chapter 3 describes the relationships between human activities affecting the marine environment, relevant policies applying to those activities in European marine waters and the intended system of EcoQOs;

d. Chapter 4 summarises the evaluation of each of the individual EcoQOs;

e. Chapter 5 summarises the links to other major instruments;

f. Chapter 6 sets out issues that arise over implementing the EcoQOs;

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[1] Bergen Declaration 2002: Fifth International Conference on the Protection of the North Sea, ISBN-82-457-0361-3.

g. Chapter 7 deals with the gaps that can be seen to exist in the present range of EcoQOs specified in the Bergen Declaration;

h. Chapter 8 sets out the views of stakeholders, as they emerged at the Stakeholder Conference held in Oslo, Norway, in December 2004;

i. Chapter 9 sets out proposals for communicating the EcoQO system to all those who need to know about it (the stakeholders);

j. Chapter 10 summarises the conclusions and recommendations from the pilot project.

Origins of the proposed EcoQO system

General

1.8 Marine ecological quality objectives are a logical outcome of the processes that have been under way over the last generation to protect the North-East Atlantic. The first steps, in the 1970s, focused on the steps of preventing pollution of the sea from obviously damaging activities (such as the dumping of chemical wastes and discharges of harmful substances), of managing fisheries in the newly extended national fisheries jurisdictions, and of creating a framework for handling shipping impacts. As these steps progressed, it became clear that we needed a better understanding of the overall results of the various human impacts on the oceans, and the need to integrate management in the different sectors.

1.9 The first International Conference on the Protection of the North Sea held in Bremen in 1984 highlighted the need for an overall assessment of the extent to which the North Sea was being affected by damaging activies. An initial assessment of the quality status of the marine environment was produced for the Second International Conference for the Protection of the North Sea, held in London in 1987[2]. Both showed how little was known or easily available, and resulted in a six-year process initiated by the Second North Sea Conference to produce by 1993 a more detailed Quality Status Assessment of the North Sea. This was accompanied by a commitment at the Third North Sea Conference in 1990 to elaborate techniques for the development of ecological objectives for the North Sea and its coastal waters – a commitment followed up by a workshop in Bristol, England[3].

1.10 At the same time, the need for integration of sectoral policies affecting the marine environment was recognised in Chapter 17 of Agenda 21, produced for the 1992 UN Conference on Environment and Development (UNCED). This committed national governments to integrating their sectoral policies, but significantly said nothing about the need for integration at the international level.

1.11 UNCED also adopted the Convention on Biological Diversity, which has led to agreements at the global level on the factors to be considered in achieving an ecosystem approach to the conservation of biodiversity and ecosystems, and on a mandate for conservation of marine biodiversity.

1.12 The 1993 North Sea Quality Status Report highlighted the need for better integration - policies on nature protection, fisheries management and pollution prevention were not demonstrably coherent, and much more thought was needed on how they should be related.

1.13 When this Report was considered by the Fourth North Sea Conference at Esbjerg, Denmark, in 1995, it was agreed that:

a. there was a need to take advantage of the possibilities offered by the 1992 OSPAR Convention to extend it beyond pollution prevention and seek to address the conservation of biological diversity and ecosystems, and

b. there was a need to consider the interactions between fisheries management and environmental conservation.

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2 Quality Status of the North Sea, 1987 (1987 QSR). A report by the Scientific and Technical Working Group, UK Department of the Environment. September 1987.

3 Paragraph 35.1(ii) of the Ministerial Declaration of the Third International Conference for the Protection of the North Sea, The Hague, the Netherlands, 8 March 1990.

Implementing the Esbjerg conclusions

1.14 The two conclusions of the North Sea Ministers were followed up by, on the one hand, the development of Annex V to the OSPAR Convention (on the protection and conservation of marine biological diversity and ecosystems) and, on the other hand, the organisation of a joint meeting of the North Sea Ministers responsible for fisheries and environmental protection (see §§ 1.17-1.19).

Widening the role of the OSPAR Convention

1.15. Annex V to the OSPAR Convention was adopted by the first Ministerial Meeting of the OSPAR Commission at Sintra, Portugal, in 1998. It entered into force for the first seven Contracting Parties in 2000. It has now been ratified by all except one OSPAR Contracting Party. The remaining OSPAR Contracting Party is committed to ratifying it.

Developing the ecosystem approach

1.16 In parallel, the North Sea Conference process continued to develop and refine the ideas of the ecosystem approach to the management of human activities that can adversely affect the marine environment.

1.17 In 1997, the North Sea Intermediate Ministerial Meeting on the Integration of Fisheries and Environmental Issues, in their Statement of Conclusions[4], called for the application of:

> "an ecosystem approach which, as far as the best available scientific understanding and information permit, is based on in particular:
>
> - the identification of processes in, and influences on, the ecosystems which are critical for maintaining their characteristic structure and functioning, productivity and biological diversity;
> - taking into account the interaction among the different components in the food-webs of the ecosystems (multi-species approach) and other important ecosystem interactions;
> - providing for a chemical, physical and biological environment in these ecosystems consistent with a high level of protection for those critical ecosystem processes".

1.18 The Intermediate Ministerial Meeting further recognised the need to develop an ecosystems approach based on this description, and said that

> "Such work should focus upon the critical ecological processes, the ecosystem interactions and the chemical, physical and biological environment. It should be based upon co-operation between the various competent authorities involved. It would be iterative and need to include:
>
> (1) in respect of fisheries management, consideration of the interactions among different species and how management decisions can be taken over the longer term;
>
> (2) in respect of environmental protection and conservation, assessment of the impact of human activities on North Sea ecosystems;
>
> (3) appropriate arrangements for integrating the different aspects".

1.19 The Ministers therefore invited the competent authorities to consider such development and its possible implementation and to analyse periodically the progress achieved and the problems remaining, doing so for the first time preferably before the Fifth North Sea Conference.

The development of the North Sea ideas

1.20 Following the 1997 Intermediate Ministerial Meeting, a Workshop on the Ecosystem Approach with respect to Fisheries was held in 1998 in Oslo, Norway. This workshop concluded, amongst other things, that clear objectives are needed as part of the development of an ecosystem approach. The workshop further suggested that Ecological Quality Objectives under development as a result of the Intermediate Ministerial Meeting could provide a solid basis for defining clear objectives. As a result a workshop specifically on Ecological Quality Objectives was organised in 1999 in Scheveningen, the Netherlands. On eutrophication, the definition of clear objectives in the form of EcoQOs would form part of the target-oriented approach of the OSPAR Eutrophication Strategy (the target-oriented approach runs in parallel to the source-oriented approach, which is aimed at reducing the inputs of nutrients).

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[4] ISBN 82-457-0154-8, http://odin.dep.no/md/nsc/Intermediate_meeting/023021-990005/dok-bn.html

1.21 The Scheveningen workshop concluded that EcoQOs should be developed for ten issues:

1. Commercial fish species;
2. Threatened and declining species;
3. Marine mammals;
4. Seabirds;
5. Fish communities;
6. Benthic communities;
7. Plankton communities;
8. Habitats;
9. Nutrient budgets and production; and
10. Oxygen consumption.

These ten issues cover the ecological quality objectives (EcoQOs) needed at the species, community and ecosystem level. These issues also more or less cover the range from structural (diversity) to functional (processes) aspects of the ecosystem.

1.22 The relevant OSPAR committee agreed in 2000 that this list of ten issues would form the basis for future work but did not preclude further improvement or extension of the proposed list of issues. The Netherlands, Norway, the International Council for the Exploration of the Sea (ICES) and the OSPAR Eutrophication Task Group (ETG) further developed the set of ten issues under guidance of OSPAR.

1.23 OSPAR submitted a report on the development of EcoQOs to the Fifth International Conference on the Protection of the North Sea. This report was based on the work of the Netherlands, Norway, ICES and the OSPAR Eutrophication Task Group (ETG). In general, groups of experts were asked to propose a number of metrics (to be kept to the minimum number possible).

1.24 This was a pragmatic approach. In most cases, the metrics proposed were those that were already being monitored. The suggested general objectives that were developed could thus be well supported by factual evidence. The suggestions of the groups of experts were then given an independent peer-review, to the extent that was possible, by ICES and the OSPAR Eutrophication Committee (EUC).

Considering the different fields

Marine mammals and seabirds

1.25 OSPAR asked ICES to develop EcoQOs for ‘Marine mammals’ and ‘Sea birds’. The work was carried out by several ICES Working Groups, including the Working Group on Marine Mammal Population Dynamics and Habitats (WGMMPH) and the Working Group on Seabird Ecology (WGSE). Further contributions were made by the Working Group on Ecosystem Effects of Fishing Activities (WGECO). A final scientific evaluation (quality assurance) and recommendation was provided by the Advisory Committee on Ecosystems (ACE). Basic information on both issues can be found in the ICES ACE 2001 report.

Habitats, Benthic communities, Threatened and Declining Species, Fish Communities and Reference Points for Commercial Fish Species

1.26 This set of issues was considered by the Norwegian-Dutch Steering Group (under the guidance of the OSPAR Biodiversity Committee (BDC)), involving the Institute for Marine Research (IMR - Norway), the North Sea Directorate (the Netherlands) and the National Institute for Coastal and Marine Management (RIKZ - the Netherlands) and by ICES. In addition, an EcoQO for Benthic Communities in relation to eutrophication was developed by OSPAR/EUC.

1.27. ICES provided advice on the issues of Benthic and Fish communities through WGECO, the Working Group on Fish Ecology (WGFE), and ACE (in the ACE 2001 and 2003 ACE Reports). ICES also provided advice on reference points for commercial fish species and on threatened and declining species through WGECO and ACE (in the 2001, 2002 and 2003 ACE reports).

Eutrophication

1.28 Issues for EcoQOs related to nutrients and eutrophication effects were developed by the OSPAR Eutrophication Task Group (ETG) and Eutrophication Committee (EUC). These issues include ‘Nutrient budgets and production’, ‘Phytoplankton communities’, ‘Oxygen consumption’, and ‘Benthic communities’. The five EcoQOs related to eutrophication were developed in parallel with, and derived from, the assessment

parameters and the assessment levels related to them in the "Comprehensive Procedure" part of the OSPAR "Common Procedure"[5]. The proposed integrated set of EcoQOs for nutrients and eutrophication effects is thus linked to existing monitoring and assessment procedures, and, consequently, to high quality information. The items are strongly interlinked along a cause/effect chain from nutrient enrichment to direct effects (chlorophyll *a* and phytoplankton nuisance and toxic indicator species) and indirect effects (oxygen deficiency and benthos kills).

1.29 A further scientific evaluation by ICES took place in 2002 in the Working Group on Plankton Ecology (WGPE), BEWG (for benthos) and the Advisory Committee on the Marine Environment, and further consideration has been given to these EcoQOs by the May 2004 meeting of the ICES Study Group to Review Ecological Quality Objectives for Eutrophication (SGEUT).

Stakeholder workshop

1.30 A workshop was organised at Schiphol, Netherlands, from 24-26 October 2001, where the EcoQOs were presented to stakeholders. Representatives from science, management, policy, NGOs and user groups gave their views on the definition and setting of EcoQOs and the work completed so far.

The Fifth North Sea Conference

1.31 All this work was presented to the preparatory meetings of the Fifth North Sea Conference, and embodied by them in the draft Ministerial Declaration. Agreement was reached on all points, and the Bergen Declaration of March 2002 accordingly committed the North Sea States and the European Community to:

a. implementing an ecosystem approach;

b. developing a coherent and integrated set of ecological quality objectives.

1.32 For this purpose, a North Sea pilot project for EcoQOs was set up. This was based upon the identified:

a. ten environmental quality issues;

b. total of 21 environmental quality elements under these issues, ranging from one element for some issues to six for seabirds;

c. initial total of ten ecological quality objectives (EcoQOs) for ten of the ecological quality elements.

Bringing together the OSPAR and North Sea strands

1.33 There had thus been two separate strands of work, one in OSPAR and one in the North Sea Conference. These two strands were brought together when OSPAR 2002 accepted the invitation of the North Sea Ministers to take forward the North Sea Pilot Project.

1.34 By the time of the Second Ministerial Meeting of the OSPAR Commission (June 2003 in Bremen, Germany), Annex V to the OSPAR Convention had been ratified by all but three of the Contracting Parties, and it was appropriate to amend the OSPAR Biodiversity and Ecosystem Strategy to reflect this. The amendments included provision (§2.2 (b) and (c)) for:

a. the completion of the pilot project for the North Sea on ecological quality objectives, involving the trial application of a set of agreed ecological quality objectives for a number of ecological quality issues and related elements, together with the development of further ecological quality objectives for other ecological quality issues and ecologically quality elements; and

b. in the light of the pilot project, evaluation of environmental quality against clear ecological quality objectives, both as a long-term system for the North Sea and in other OSPAR regions.

[5] OSPAR agreement, reference number 2005-3 updating and superseding the Common Procedure for the Identification of the Eutrophication Status of the Maritime Area of the Oslo and Paris Conventions (reference number: 1997-11), together with the Common Harmonised Assessment Criteria, their Assessment Levels and Area Cliassification within the Comprehensive Procesdure of the Common Procedure (reference no: 2002-20).

1.35 The importance of these elements lies in the way in which a system of ecological quality objectives can help integrate the many different aspects of work, both in OSPAR and elsewhere, to protect and conserve the marine environment, and thus deliver the integrated approach to the marine environment to which all OSPAR Contracting Parties are committed through the 1992 UN Conference on the Environment and Development and subsequent global commitments of a similar nature.

Implementation of the Pilot Project

1.36 To implement the pilot project, the Bergen Declaration committed the North Sea States to the following actions (see Bergen Declaration, §4):

a. the EcoQOs will include both the desired level of ecological quality and baselines against which progress can be measured;

b. the ecological quality baselines will be established for each element, either by utilising baselines already agreed (*e.g.* fish stock assessments), or by developing new baselines. EcoQOs must not permit any worsening of existing conditions;

c. by 2004, EcoQOs for the remaining elements will be developed and applied within the framework of OSPAR in coordination with the development of marine indicators in the EEA and environmental objectives in the EU Water Framework Directive. This work will include agreement on the procedures necessary for the sound application of the EcoQOs;

d. the pilot project will:

   i. assess the information that is, or can be made, available in order to establish whether the EcoQOs are being, or will be, met. Where the EcoQOs are not being met, the information will be used to determine the reason. Costs and practicability will be taken into account in deciding what information can be made available;

   ii. where an EcoQO is not being met, review any policies and practices which are contributing to that failure; and

   iii. if need be, reconsider the formulation of such EcoQOs;

e. coherent monitoring arrangements will be established, in order to enable progress towards meeting the EcoQOs to be assessed. These arrangements will be integrated into the OSPAR Joint Assessment and Monitoring Programme.

1.37 The Bergen Declaration further invited OSPAR 2005 to review progress, in collaboration with ICES and other relevant bodies, with the aim of adopting a comprehensive and consistent scheme of EcoQOs and to report on this to the North Sea Ministers. Thereafter, the value, use and practicability of the scheme of EcoQOs should be periodically reviewed by OSPAR, in cooperation with ICES and other relevant bodies.

OSPAR's further work and the possible extension to the rest of the OSPAR area

1.38 As has been said, OSPAR 2002 agreed to accept the invitations from the North Sea Conference to follow up many of the commitments of the Bergen Declaration, including the North Sea pilot project on EcoQOs. In agreeing to do so, the OSPAR Contracting Parties that are not North Sea States recognised the desirability of extending similar systems to the whole of the OSPAR maritime area, but stressed the need to take decisions on this in the light of the outcome of the pilot project.

1.39 Since then, the work has proceeded in the framework of the normal OSPAR meetings.

1.40 The emergence, from the Fifth EU Environmental Action Programme, of the development of a European Marine Strategy has implications for the development of EcoQOs. Although this started as one of the thematic strategies foreseen by that programme, it is developing in a way that means that it will have a pan-European aspect as well as a role within the framework of the European Union. Both aspects will need to be taken into account in the future development of EcoQOs within OSPAR (see Chapter 5).

1.41 The OSPAR work has been greatly assisted by an intersessional correspondence group, which has been led by the Netherlands and Norway. This report is greatly indebted to the work of the intersessional correspondence group, and its convenor (Mr Peter Heslenfeld, Netherlands).

1.42 The work was also assisted by a stakeholder workshop organised by Norway in December 2004, under the chairmanship of Mr Th. Stoltenberg, a former Norwegian Minister. This enabled a range of environmental and industrial non-governmental organisations and the scientific community to make an input to the development and review of the North Sea Pilot Project. The conclusions of this workshop are summarised in Chapter 8.

What is the added value of the ecological quality objectives to OSPAR?

1.43 The 1992 OSPAR Convention sets out high-level general obligations for cooperation between the Contracting Parties[6]. These goals are general for all aspects of the whole of the maritime area and, as explained below, can be summarised as seeking to achieve a healthy and sustainable marine ecosystem in the maritime area. These high-level general obligations and the related more specific provisions of the Convention have been particularised, and made operational, by the adoption of the five thematic strategies on hazardous substances, radioactive substances, eutrophication, the offshore oil and gas industry and biological diversity and ecosystems. The sixth strategy, on the Joint Assessment and Monitoring Programme, makes provision both for assessing progress with each of the strategies, and for assessing the overall quality of the marine environment.

1.44 The OSPAR strategies go into quite a lot of detail about specific aims in specific fields (for example, the "one-generation" cessation target for hazardous substances, and the focus on specific priority chemicals). This is needed to give sufficient focus on what should be the specific aims of regulation in the various fields. But it runs the risk that the sum of the particular aims may not equate to the overall objective of a healthy and sustainable marine ecosystem. The EcoQO system can provide the necessary counterbalance, focused on the overall health and sustainability of the ecosystems

1.45 In addition, the individual EcoQOs can demonstrate the success of source-oriented measures (such as the cessation of the use of tributyl-tin anti-fouling treatments on ships) on the actual effect(s) in the ecosystem (such as the reduction in the level of imposex in dog whelks).

1.46 Some EcoQOs are not related directly to the OSPAR strategies, but can be used to indicate other problems that impact the health and sustainability of the ecosystems in the OSPAR maritime area, such as the fisheries that were shown by the OSPAR Quality Status Report 2000 to have had a serious impact.

1.47 An EcoQO system, as it has been defined so far, and as it will be further developed, thus offers OSPAR a means of:

a. defining what is the "envelope" within which this overall objective of a healthy and sustainable marine ecosystem can reasonably be expected to lie;

b. judging whether the actual circumstances of the marine ecosystems of the maritime area are within that envelope; and

c. showing whether or not the OSPAR Convention is achieving its aims.

[6] In the view of some Contracting Parties, these obligations required the adoption of what is now Annex V and Appendix 3 to the Convention before they extended the obligations to aspects other than pollution.

Chapter 2 - Conceptual Description of the System of Ecological Quality Objectives

General

2.1 This chapter aims to explain the conceptual basis for the system of ecological quality objectives (EcoQOs) described at the start of Chapter 1. This conceptual basis has been developed for the North Sea and the North Sea Pilot Project. Any extension of a system of EcoQOs to other parts of the OSPAR maritime area will require separate consideration and decision.

2.2 The EcoQO system is a tool to help OSPAR to fulfil its commitment to applying the ecosystem approach to the management of human activities that may affect the marine environment[7]. The underlying concept is that of a "healthy and sustainable marine ecosystem". As the third recital to the OSPAR Convention says, the aim is to manage "human activities in such a way that the marine ecosystem will continue to sustain the legitimate uses of the sea and will continue to meet the needs of present and future generations"

2.3 In the context of the ecosystem approach, marine ecological quality is an expression of the structure and functioning of a marine ecosystem, taking into account its biological community and its natural physiography, geography and climate, as well as physical and chemical conditions, including those resulting from human activities. Ecosystems can be defined at a range of scales. In this context, the relevant ecosystem needs to be specified at a scale which relates to sensible management units.

2.4 The system of EcoQOs operates at two complementary levels:

a. reaching a judgement on the overall ecological quality of the marine environment;

b. considering the separate aspects of the marine environment, in order to derive policy conclusions on those aspects.

2.5 The basic requirements for the system of EcoQOs are agreements on:

a. the aspects of the marine environment that must be considered in forming a judgement on the overall ecological quality of that environment;

b. the way in which to structure the process of reaching both judgements on overall ecological quality and policy conclusions on the separate aspects;

c. the tasks that OSPAR must carry out to implement the system of EcoQOs.

Glossary

2.6 In following this process, and to avoid confusion, it is essential to be careful in the use of the different terms.

2.7 As has been said, **Ecological Quality (EcoQ)** can best be defined as "*An overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographic, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities*."

2.8 Within this overall concept, **Ecological Quality Issues** are the fields in which it is appropriate to attempt to measure aspects of the general ecological quality of the marine ecosystem under consideration. For the North Sea pilot project, these have been selected as:

1. Commercial fish species;
2. Threatened and declining species;
3. Sea mammals;
4. Seabirds;
5. Fish communities;
6. Benthic communities;

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[7] The overall marine ecosystem of the OSPAR maritime area can be seen as comprising a number of separate ecosystems, which may need to be considered separately. In what follows, separate consideration of such individual ecosystems is implied where it is necessary.

7. Plankton communities;
8. Habitats;
9. Nutrient budgets and production; and
10. Oxygen consumption.

2.9 Under each of these issues, the **Ecological Quality Elements** are the individual aspects of ecological quality on which it is appropriate to focus. The number of elements selected under each of the issues will vary.

2.10 An **Ecological Quality Objective (EcoQO):** is the desired level of an ecological quality. Such a level may be set in relation to a reference level.

2.11 The "**reference level**" is the level where the anthropogenic influence on the ecological system is minimal. Terms such as "reference conditions" or "background conditions" are also used interchangeably with "reference level". In the context of eutrophication, the reference level is referred to as "background concentration" or "background level". In this use, "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.

2.12 There will be a one-to-one relationship between ecological quality elements and ecological quality objectives. The desired level of ecological quality will be set in relation to a metric which can be objectively verified. EcoQOs can take the form of targets (values where there is a commitment to attain them), limits (values where there is a commitment to avoid breaching them) or indicators (values which simply show what is happening). In this report each EcoQO is provisionally classified as a target, a limit or an indicator.

2.13 For the purpose of eutrophication, the desired levels of ecological quality (the EcoQOs) are referred to as "**assessment levels**". They are based on levels of increased concentrations and trends as well as on shifts, changes or occurrence to take account of natural variability and to allow some eutrophication (or 'slight disturbance' in the terminology for the Water Framework Directive). Parameters which are found to be at levels above the appropriate assessment levels are referred to as "**elevated levels**".

2.14 The ecological quality issues, the related ecological quality elements and the ecological quality objectives (EcoQOs) agreed by the Fifth North Sea Conference are restated in Table 2.2 at the end of this chapter.

What constitutes a good EcoQO?[8]

2.15 According to the report from OSPAR on which the Fifth North Sea Conference based its conclusions on EcoQOs, a good EcoQO will unite the following qualities:

a. the EcoQO will have a clear scientific basis, linking it to significant aspects of the quality of a marine ecosystem;
b. data on the EcoQO can be collected effectively and economically across the whole range to which it applies;
c. there is a clear reference level or target against which the data on the EcoQO can be evaluated;
d. there is general acceptance of the validity of the EcoQO by all relevant stakeholders.

2.16 To achieve these qualities, EcoQOs will be better the more that they are:

a. relatively easy to understand by non-scientists and those who will decide on their use;
b. sensitive to manageable human activity;
c. relatively tightly linked in time to that activity;
d. easily and accurately measured, with a low error rate;
e. responsive primarily to a human activity, with low responsiveness to other causes of change;
f. measurable over a large proportion of the area to which the EcoQ metric is to apply;
g. based on an existing body or time-series of data to allow a realistic setting of objectives.

[8] The criteria listed in § 3.12 and § 3.13 have been updated in the context of the Ecosystem Approach working group in the framework of the European Marine Strategy.

2.17 Some EcoQOs will have a direct link to a single type of human impact (e.g. guillemots affected by oil, which will relate closely to oil discharges from ships and offshore installations). Others may just indicate a change in environmental conditions that may or may not be a result of human impacts (e.g. trends in seal populations may be affected by virus infections, or habitat changes). The latter category will contribute to evaluating whether the ecosystem in the OSPAR maritime area are within the overall envelope of health and sustainability defined by the EcoQO system and, if not, to point to issues that need to be explored. The former category of EcoQO will both do this and be able to be used to evaluate directly the success of OSPAR Strategies related to the human impact concerned.

2.18 Objectives can also be aimed to either avoid certain conditions (limits) or achieve certain conditions (targets). It is possible to derive limit objectives scientifically given a set of rules (such as we want to ensure that a species does not risk extinction), but such objectivity is much more difficult for targets. It is worth noting that conflicts between objectives are much more likely with targets as opposed to limits.

Aspects to be considered

2.19 The range of aspects of the marine environment to be considered must embrace both:

a. all the compartments of the marine environment that can be affected by human activities (including those human activities where OSPAR does not have competence to adopt programmes and measures); and

b. the human activities selected by OSPAR for consideration in its work on protecting the marine environment (see Chapter 3 of the OSPAR Quality Status Report 2000).

2.20 In effect, the human activities selected by OSPAR for consideration can be taken to cover all human activities that may adversely affect the ecological quality of the marine environment of the OSPAR maritime area, since:

a. the Quality Status Report 2000 has surveyed the quality of the whole marine environment in the maritime area, and has identified priorities for action;

b. future thematic assessments and comprehensive quality status assessments, as provided for in the OSPAR Strategy on the Joint Assessment and Monitoring Programme, will repeat this process at appropriate intervals;

c. the development of the OSPAR thematic strategies has reviewed most relevant sources of pollution and other non-polluting activities that may adversely affect the human environment.

2.21 The system of EcoQOs must both specify what can be seen as a healthy and sustainable state of the marine environment and allow judgements whether OSPAR is achieving its aims. In the most general terms, OSPAR has set itself the ultimate goals of achieving sufficiently high ecological quality in the marine environment of the OSPAR maritime area that:

a. the maritime area is protected against the adverse effects of human activities;

b. human health is safeguarded, and marine ecosystems and biological diversity are conserved;

c. where practicable, marine areas that have been adversely affected are restored;

d. concentrations of hazardous substances in the marine environment are near background values for naturally occurring substances and close to zero for man-made, synthetic substances;

e. concentrations of radioactive substances in the marine environment are near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances, taking into account legitimate uses of the sea, technical feasibility, and radiological impacts on man and biota;

f. anthropogenic eutrophication[9] does not occur in the marine environment.

These are the factors that must, at the most general level, be incorporated into the system of EcoQOs.

[9] In the rest of this report, references to eutrophication should be understood to refer only to anthropogenic eutrophication.

Structuring the process

2.22 The marine ecosystem has a natural variability, and can be viewed from each of a number of facets. Assessing overall ecological quality requires the selection of a manageable number of such facets, which can be grouped under a number of broader ecological quality issues. The individual facets are referred to as the ecological quality elements.

2.23 Each of these ecological quality elements will need to be evaluated. Together they constitute the different aspects of overall ecological quality. In the light of the natural variability of each element, appropriate levels can be set for various elements, in order to define an envelope of variability which equates to good ecological status. As long as the ecosystem is within that envelope of variability, it can be said to have good ecological status.

2.24 As has been said, ten ecological quality issues have been identified[10], and so far 21 ecological quality elements have been identified in relation to these issues. The final set must reflect the double task of assessing overall ecological quality and seeing whether potentially harmful human activities have been sufficiently well regulated that they do not interfere with the health and sustainability of marine ecosystems - in other words that progress is being made towards the ultimate goals of OSPAR. To achieve this it is necessary that:

a. the best indicators of the overall health of the marine ecosystem; and

b. the ecological quality elements, between them,

will give an assurance that there is adequate coverage of the effects of the range of human activities that OSPAR has selected for consideration on the ecological quality of the marine environment.

The task of OSPAR in relation to EcoQOs

2.25 The task of OSPAR, working in co-operation with ICES, is:

a. to agree desired levels ("ecological quality objectives" - EcoQOs) for each of the ecological quality elements identified as relevant to the overall function of the system of EcoQOs. The role of agreeing desired levels differs significantly between fields where OSPAR has a competence to adopt programmes and measures, and fields where it does not. In the latter field, the role of OSPAR is limited to drawing the attention of the relevant national authorities and international bodies to the need for action and the considerations which OSPAR considers relevant to such action;

b. to collect and evaluate the necessary data relating to these EcoQOs, both on overall ecological quality and in relation to the separate aspects;

c. to identify the need for programmes and measures to achieve those objectives. Where OSPAR does not have competence to adopt programmes and measures (for example, in relation to questions of fisheries management), OSPAR will need to draw the attention of the competent international bodies and national authorities to these needs. In other fields, the appropriate way of ensuring the adoption of the necessary programmes and measures will depend on the most effective means available. The interrelationships of the different instruments are discussed in Chapter 6; and

d. for questions outside the competence of OSPAR, to communicate to the relevant competent authorities the need for action to achieve the agreed EcoQOs.

2.26 The evaluation of overall ecological quality will require the development of a method that will enable an overall judgement to be formed on the basis of the evaluations of the individual ecological quality elements.

2.27 All this work will require continuing cycles of:

a. gathering scientific information about the marine environment;

b. assessing that information to reach conclusions on the quality status of the marine environment of the OSPAR maritime area, and what is advisable by way of intervention in the management of human activities;

c. policy decisions on:

[10] See the "Glossary" section earlier in this chapter.

i. the objectives to be pursued (and revisions of those objectives);

ii. interventions to be made in the management of human activities;

d. the implementation of the policy decisions on interventions in the management of human activities, including enforcing the decisions and checking that they have been implemented;

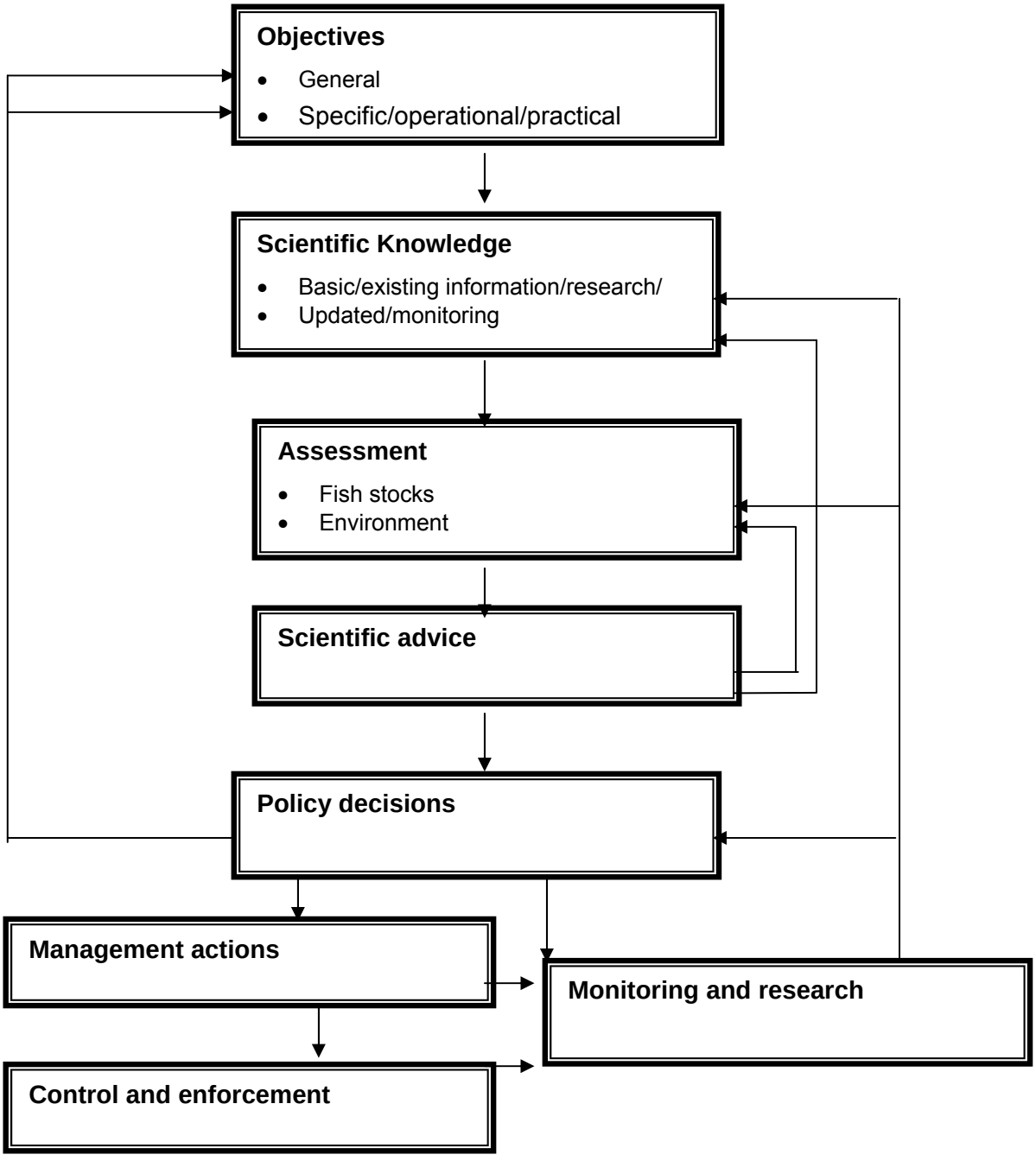
e. evaluation of the work carried out in the cycle.

These activities will be related to each other in a complex web, with the various aspects affecting other aspects directly, as well as feeding into each other through the main cycle.

2.28 As the ecosystem approach involves iterations of the cycle of observation, assessment, decision and implementation, each step in these iterated cycles must aim to do better than the last cycle. This implies a continuing improvement in our understanding of the marine environment, and in our techniques of assessment, decision-making and implementation. The OSPAR Strategies are aimed, *inter alia*, at providing the basis for such continuing improvement.

2.29 All stages of these cycles must include appropriate involvement of all stakeholders. Only by intelligent review and critique of what has been done previously can we hope to achieve continuing improvement, and such review and critique must drawn on all available well-informed opinion.

2.30 This process, which must involve all stakeholders in an appropriate manner in the steps relevant to them, can be summarised in the following diagram (Source: Annex 2 of the Bergen Declaration):



Making the EcoQO system complete

2.31 The suite of 10 EcoQOs in the North Sea pilot project is not a complete set, but was a selection of EcoQ elements considered ready by the time of the 5th North Sea Conference to be used as objectives on a trial basis. The ministers in the Bergen Declaration also agreed that eleven more EcoQ elements should be completed with objectives by 2004 and applied within the framework of OSPAR. Many of these additional EcoQ elements have not yet been developed to the stage where objectives can be set for them. The EcoQO system is therefore not yet complete and work remains to making it complete.

2.32 Subsequent chapters of this document review the sets of EcoQOs and EcoQ elements in relation to the OSPAR Strategies and the human activities covered by them. The completeness of the sets is also considered in relation to the biological compartments of the food web and the different human external pressures on the North Sea ecosystem. This constitutes a gap analysis that identifies some further developments of EcoQ elements towards making the set complete (Chapter 7).

2.33 The DPSIR framework (Driving force-Pressure-State-Impact-Response) (see Table 2.1) offers a structured approach to examining the set of EcoQOs before finalising it as a coherent and integrated set. This framework has played a prominent role in selecting indicators and sometimes objectives in areas of environmental quality and sustainable development. Evaluation against the DPSIR framework may include an examination of the balance between objectives set for state properties of the ecosystem versus objectives set on pressures, impacts and possibly even response properties.

2.34 The DPSIR framework can sometimes become confusing, because the classification of at least some things as a Pressure or State or Impact can depend very much on the context. A more detailed evaluation of the EcoQOs against the DPSIR framework would be a valuable exercise because, to the general public, environmental concerns are largely synonymous with concerns about State properties, and hence there would be a predisposition to set objectives for State properties of ecosystems. Any such evaluation would need to take into account the assessment products scheduled as part of the JAMP on pressures on the marine environment and the indicators and other indices relevant to driving forces developed by other international organisations. However, there is no guarantee that management is guided as effectively by objectives for State properties as it would be by objectives for Pressure, Impact, and possibly even Response properties.

2.35 The observation of achievements against ecological quality objectives will not, of itself, demonstrate the achievement of all OSPAR strategic objectives, since some of these strategic objectives are in the form of specific changes to be achieved in inputs to the maritime area (or other changes in activities), rather than the resulting ecological quality of the marine environment. Such changes must be monitored directly. Other adverse impacts resulting from catastrophic, rather than chronic, causes (such as shipping disasters) will also need to be looked at separately.

Table 2.1. The DPSIR framework

Conceptually, the DPSIR framework is compatible with evaluating the ecosystem effects of human activities. Considered in a specific context (for example, fisheries) the framework could be structured as follows:

Driving forces – these are the forces that exert pressure on the ecosystem and its components. They may be anthropogenic or part of the natural environment. For ecosystem effects of fishing, the direct drivers are economic and social policies of governments, and economic and social goals (implicit or explicit) of those who prosecute fisheries. Environmental drivers such as oceanographic conditions also affect fish populations and marine ecosystems, but would not be the subject of EcoQOs for keeping fisheries sustainable.

Pressures – these are the ways that the drivers are actually expressed, and the specific ways that ecosystems and their components are perturbed. For ecosystem effects of fishing, the central pressure would be Fishing Effort, of which there are many aspects and indicators.

State – these are the properties of the ecosystem itself. Where humans are considered part of the ecosystem, they are properties of the fishery. For ecosystem effects of fishing, there is a long list of potential State properties, from biomasses, total mortality rates, and size composition of targeted and non-targeted stocks through an array of biological community measures and including properties of the physical habitat. State indicators of the fishery itself include fleet size and composition, jobs provided, and landed value of catches.

Impact – these are the changes in State caused by the Pressures. For ecosystem effects of fishing, these would be things like fishing mortality and increase in the slope of the size spectrum of the fish community.

Response – these are society's actions, taken in response to impacts judged to require remediation. Examples for ecosystem effects of fishing might be a decommissioning policy for excessive fishing capacity, or a closed area to protect a specific habitat feature.

Table 2.2 Ecological quality issues, related ecological quality elements and corresponding ecological quality objectives (EcoQOs), as developed by the Fifth North Sea Conference.

(EcoQOs are shown in italics and advanced ecological quality elements and EcoQOs are shown in bold)

Issue	Ecological quality element *and related Ecological quality objective (EcoQO)*
1. Commercial fish species	**(a) Spawning stock biomass of commercial fish species in the North Sea** ***Above precautionary reference points[11] for commercial fish species where those have been agreed by the competent authority for fisheries management***
2. Threatened and declining species	(b) Presence and extent of threatened and declining species in the North Sea
3. Sea mammals	**(c) Seal population trends in the North Sea** ***No decline in population size or pup production of ≥10% over a period of up to 10 years*** (d) Utilisation of seal breeding sites in the North Sea **(e) By-catch of harbour porpoises** ***Annual by-catch levels should be reduced to below 1.7% of the best population estimate***
4. Seabirds	**(f) Proportion of oiled Common Guillemots among those found dead or dying on beaches** ***The proportion of such birds should be 10% or less of the total found dead or dying, in all areas of the North Sea*** (g) Mercury concentrations in seabird eggs and feathers (h) Organochlorine concentrations in seabird eggs (i) Plastic particles in stomachs of seabirds (j) Local sand-eel availability to black-legged Kittiwakes (k) Seabird population trends as an index of seabird community health
5. Fish communities	(l) Changes in the proportion of large fish and hence the average weight and average maximum length of the fish community
6. Benthic communities	**(m) Changes/kills in zoobenthos in relation to eutrophication[12]** ***There should be no kills in benthic animal species as a result of oxygen deficiency and/or toxic phytoplankton species*** **(n) Imposex in dog whelks (*Nucella lapillus*)** ***A low (<2) level of imposex in female dog whelks, as measured by the Vas Deferens Sequence Index*** (o) Density of sensitive (e.g., fragile) species (p) Density of opportunistic species

[11] In this context 'reference points' are those for spawning stock biomass, also taking into account fishing mortality, used in advice given by ICES in relation to fisheries management.

[12] The ecological quality objectives for elements (m), (q), (r), (t) and (u) are an integrated set and cannot be considered in isolation.

7. Plankton communities	**(q)**	**Phytoplankton chlorophyll *a*[12]** ***Maximum and mean chlorophyll a concentrations during the growing season should remain below elevated levels, defined as concentrations >50% above the spatial (offshore) and/or historical background concentration*** **(r) Phytoplankton indicator species for eutrophication[12]** ***Region/area-specific phytoplankton eutrophication indicator species should remain below respective nuisance and/or toxic elevated levels (and increased duration)***
8. Habitats	(s)	Restore and/or maintain habitat quality
9. Nutrient budgets and production	**(t)**	**Winter nutrient (DIN and DIP) concentrations[12]** *Winter DIN and/or DIP should remain below elevated levels, defined as concentrations >50% above salinity-related and/or region-specific natural background concentrations*
10. Oxygen consumption	**(u)**	**Oxygen[12]** ***Oxygen concentration, decreased as an indirect effect of nutrient enrichment, should remain above region-specific oxygen deficiency levels, ranging from 4 – 6 mg oxygen per litre***

Chapter 3 - Relationships between Human Activities and EcoQOs

3.1 The system of EcoQOs is intended both to provide a measure of the overall success of the ecosystem approach to the management of human activities affecting the marine environment (by giving an indication whether the resulting quality status of the marine ecosystems is within the envelope of what can be regarded as a healthy and sustainable ecosystem) and to guide the development and implementation of policies for the management of specific human activities (by providing metrics for the success of those policies).

3.2 It is therefore important that the system of EcoQOs adequately reflects all the relevant human activities. This chapter therefore looks at the way in which the system of EcoQOs and the relevant human activities fit together. The structure of the chapter is as follows:

a. it first considers the relationship between the system of EcoQOs and the OSPAR strategies and their goals for the management of the human activities that they cover;

b. it then considers the role of human activities that result in climate change, and explains why it is not appropriate for an OSPAR system of EcoQOs to try to reflect this type of impact of human activities;

c. it then surveys the human activities that may have adverse effects on the marine environment and explains how the system of EcoQOs will reflect them. Not every detail of the potential impact of a human activity can be covered by some aspect of the final suite of EcoQOs: the EcoQO system is intended to be a relatively broad-brush approach to establishing the health and sustainability of the marine ecosystems – see Chapter 2. There is also usually no simple one-to-one relationship between human activities and EcoQOs. Each EcoQO may well reflect impacts from a number of different human activities. Each group of human activities may affect a number of EcoQOs. Where gaps can be identified – in that there is no effective reflection of the potential adverse impact within the current set of EcoQOs – they are considered in Chapter 7;

d. it then gives a summary description of each of the EcoQOs and the human activities which will be relevant to them.

General relationship between the system of EcoQOs and the OSPAR strategies

3.3 The OSPAR Commission has adopted five thematic strategies (on Hazardous Substances, on Radioactive Substances, on Eutrophication, on the Offshore Oil and Gas Industry, and on Biological Diversity and Ecosystem) to guide its future work and a sixth strategy (on the Joint Assessment and Monitoring Programme) to evaluate the progress in implementing each of the five thematic strategies and to assess the overall quality of the marine environment.

3.4 The overall objectives of each of the five thematic strategies are a description (for the theme concerned) of what is needed to ensure an overall healthy and sustainable marine environment in the OSPAR maritime area. These partial descriptions for each thematic area of the overall requirements are consistent with each other. Between them, the strategies should be sufficient to address the human activities that they cover. As progress is made towards the overall objectives of the thematic strategies, conditions should be created which will ensure progressively the achievement of the EcoQOs. There should be no need for separate actions to deliver the EcoQOs in those fields.

3.5 The sixth strategy is implemented through JAMP, designed to assess the impacts by the separate human activities covered by the thematic strategies, as well as their combined effects on the overall quality of the marine environment. The thematic and general assessments to be conducted under JAMP are periodic “health” checks on the status of the marine ecosystems. The EcoQO system also focuses on the overall health and sustainability of the ecosystems and should therefore be used in close association with JAMP. This is particularly so because of the lack of a simple one-to-one relationship between human activities and the EcoQOs. While some of the EcoQOs relate directly to a manageable human activity and can be used operationally to regulate such activities, others contribute to defining the envelope of what constitutes a healthy and sustainable marine ecosystem. The whole set of EcoQOs should therefore periodically be used as part of the thematic and general assessments of JAMP.

3.6 The goals of the North Sea Conferences have effectively been assimilated to the strategic goals and objectives of OSPAR (except in relation to the management of fisheries and shipping). Separate programmes of work for delivering these goals (again except in relation to fisheries and shipping) will therefore not be needed. The North Sea Pilot Project of EcoQOs will therefore be useful to measure progress both towards the overall objectives of the OSPAR Strategies and the goals set out in the North Sea Conference Ministerial Declarations.

3.7 The North Sea EcoQO Pilot Project will also complement the work under the sixth OSPAR Strategy on monitoring and assessment. For the North Sea, it will offer an integrated approach to assessing the overall quality status of that sub-region of the OSPAR maritime area – that is, to judging whether, and how far, the quality status of the marine environment of the North Sea is within an envelope that defines a healthy and sustainable set of ecosystems. If the North Sea Pilot Project can be extended to cover other sub-regions of the OSPAR maritime area, it will be able to serve the same function there.

3.8 The situation is different with regard to fisheries (where OSPAR does not have the competence to adopt programmes and measures) and shipping (where the global nature of the industry will always mean that it is better to try to find solutions at the global level, but where action through OSPAR at the level of the regional seas may sometimes be appropriate). Here, both the application of the system of EcoQOs and the work of under the OSPAR strategies on monitoring and assessment and on the adverse impacts of human activities on biological diversity and ecosystems may result in assessments indicating that there are problems that need to be addressed. It will then be for OSPAR to take such issues forward in accordance with the provisions of Annex V to the OSPAR Convention.

Climate change

3.9 Human activities are having an important influence on the seas and their ecosystems through the way in which the climate is being changed. In particular,

a. the increased levels of greenhouse gases in the atmosphere, resulting from the burning of fossil fuels, are producing, or may produce, impacts on the seas through:

   (i) global warming – especially in the form of rises in the long-term average temperatures of the seas;

   (ii) rises in sea level, resulting from the melting of polar ice-caps and other glaciers;

   (iii) changes in salinity levels, again as a result of the melting of polar ice-caps;

   (iv) changes in the level of insolation (sun-shine), as long-term averages of cloud cover change;

   (v) acidification of seawater as a result of higher carbon dioxide levels in the atmosphere

b. these direct impacts may result in further changes in the form of:

   (i) changes in circulation patterns;

   (ii) changes in stratification patterns;

   (iii) changes in the biology of the system, particularly with respect to plankton

c. changes in the ozone layer are producing effects (for example, on the reproductive success of fish) though increases in the level of ultra-violet radiation penetrating the atmosphere.

3.10 All these impacts share the feature that the causes are global in their nature: the impacts arise from the sum of global human activities. Measures to address them therefore equally need to be global in their scope.

3.11 This has implications for the suite of EcoQOs, since the global community is developing measurement systems to look at impacts of this kind, as a basis for the necessary global measures. While some of the North Sea ecological quality elements may reflect the impacts of global climate change, any future consideration of whether North Sea/OSPAR objectives or monitoring strategies for the impacts of global change should be developed, needs to take account of what the North Sea/OSPAR States are doing in the global partnership, and risk giving only a partial picture, since they could focus only on the North Sea.

3.12 It does not therefore seem appropriate at present to set out to develop the North Sea EcoQO system so as to cover the impacts of the human activities that are bringing about global climate change. Those impacts need to be taken into account in any assessment of the health and sustainability of the North Sea, but

a. the ecological objectives,

b. the measures to deliver those objectives, and

c. the monitoring to see whether the objectives are being delivered,

all need to be developed and implemented at the global level.

How the system of EcoQOs will reflect human activities that may have adverse effects on the marine environment

Hazardous substances – discharge, emissions and losses

3.13 The OSPAR Hazardous Substances Strategy is concerned with discharges, emissions and losses of hazardous substances from land-based sources and from offshore installations. Hazardous substances discharged from ships are considered separately under the Biological Diversity and Ecosystems Strategy.

3.14 The ultimate aim of the OSPAR Hazardous Substances Strategy is specified in terms of concentrations of the hazardous substances (both naturally occurring substances and artificial man-made substances) in the sea water.

3.15 The approach so far in the development of EcoQOs for looking at the impact of discharges, emissions and losses of hazardous substances is mainly to look at what can be seen in the top predators as the substances tend to bioaccumulate.

3.16 The current selection of top predators is limited to sea-birds (the EcoQOs for ***mercury concentrations in seabird eggs and feathers*** and for ***organochlorine concentrations in seabird eggs***). It is not possible to look at all man-made substances and naturally occurring substances of concern.

3.17 There may be scope for extending this range of top predators to cover fish (such as sharks and cod) and marine mammals. There may also be scope for extending the range of EcoQOs relevant to the discharge of hazardous substances and including statistics on the incidences of diseases. These possibilities are considered in the next chapter. Possible approaches are considered in Chapter 7.

3.18 In relation to oil spills from offshore installations, the EcoQO on ***proportion of oiled common guillemots among those found dead or dying on beaches*** will also be relevant.

3.19 Further development of EcoQOs under the ecological quality issue "Habitats" may also offer possibilities for looking at the levels of hazardous substances in the marine environment, since the monitoring strategies developed for the hazardous substances identified for priority action will, in some cases, show concentrations in sea water. Where concentrations are not measured, the monitoring strategies for the hazardous substances concerned will indicate whether there are any grounds for concern about their concentrations in the maritime area.

Radioactive substances – discharges, emissions and losses

3.20 The OSPAR Radioactive Substances Strategy is concerned with discharges, emissions and losses of radioactive substances from land-based sources and from offshore installations. Radioactive substances discharged from ships would have to be considered separately under the Biological Diversity and Ecosystems Strategy, but so far there has not been any evidence that action is needed to address this issue beyond the global measures to reduce risk from the operations of nuclear vessels and from the carriage of radioactive substances as ships' cargoes.

3.21 The ultimate aim of the OSPAR Radioactive Substances Strategy is specified in terms of concentrations of the radioactive substances (both naturally occurring substances and artificial man-made substances) in the sea water.

3.22 So far, the development of EcoQOs has not addressed this aspect of the marine environment. Possible approaches are considered in Chapter 7.

Eutrophication

3.23 The human activities relevant to the OSPAR Eutrophication Strategy are discharges, emissions and losses of nutrients from urban waste-water treatment plants and industry, run-off of nutrients from agriculture, emissions of nutrients (nitrogen) from combustion by power stations and vehicles used for transport and from the escape of nutrients from aquaculture (including mariculture) installations.

3.24 Although the approaches to the control of these different activities will inevitably vary, the underlying factors (that is, the levels of nitrogen and phosphorus available for primary production, the consequent primary production levels and the consequences of the decay of the primary products) are common to them all, since the effects of these human activities on the marine environment are mediated through those common factors.

3.25 An integrated set of EcoQOs have accordingly been developed to help to address these factors, and will measure the success of programmes and measures to reduce the effects of the human activities contributing to eutrophication. This integrated set covers winter nutrient concentrations, phytoplankton

chlorophyll *a*, phytoplankton indicator species for eutrophication, oxygen deficiency, and changes/kills in zoobenthos in relation to eutrophication. The concentrations of nutrients directly affect levels of phytoplankton, which are measurable by chlorophyll *a*, and phytoplankton indicator species for eutrophication (cell counts). The fate of the phytoplankton is measurable by oxygen concentrations and the impacts on the benthos.

Offshore oil and gas industry

3.26 The OSPAR Offshore Oil and Gas Industry Strategy is concerned with establishing effective environmental management systems in the industry, with setting environmental goals for those management systems to achieve, and with ensuring that the offshore oil and gas industry delivers the objectives of the other OSPAR strategies relating to pollution.

3.27 The ultimate aim of the OSPAR Offshore Oil and Gas Industries Strategy is to prevent and eliminate pollution and take the necessary measures to protect the maritime area against the adverse effects of offshore activities[13] so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.

3.28 The human activities relevant to the OSPAR Offshore Oil and Gas Industries Strategy will in general be adequately covered by the EcoQOs related to the discharges, emissions and losses of hazardous substances. To the extent that the eventual system of EcoQOs covers radioactive discharges, that aspect of the offshore oil and gas industry will also be adequately covered. With one possible exception, no further EcoQOs specifically reflecting the human activities covered by this strategy are needed.

3.29 The possible exception concerns possible noise pollution from activities (especially seismic testing) relating to exploration for offshore mineral resources. This is also linked to the question of possible noise pollution from shipping. Both aspects are considered in Chapter 6.

Other human activities

3.30 Human activities which do not result in pollution as defined in the OSPAR Convention are covered by the OSPAR Biological Diversity and Ecosystems Strategy. The relevant human activities are fisheries, shipping and the activities to be evaluated specifically under that Strategy.

3.31 The OSPAR Strategy on Ecosystems and Biological Diversity has four main components:

a. the development of ***ecological quality objectives*** is the cross-cutting component that seeks to integrate the other three elements;

b. the identification of, and measures to protect, ***threatened and declining species and habitats*** is the component that addresses aspects of the marine environment that are under particular threat;

c. the identification of, and measures to protect, ***an ecologically coherent network of well managed marine protected areas*** is the component that seeks to maintain a core network in which representative ecosystems will continue to function in relatively natural conditions (that is, conditions which can be regarded as allowing the unimpeded functioning of the ecosystems);

d. the analysis of ***human activities*** that may adversely impact on the marine environment of the OSPAR maritime area, and the development of measures (either at national level or, where necessary, at the appropriate international level) to safeguard the marine environment generally from unacceptable adverse effects from those activities.

Fisheries

3.32 Six aspects of capture fisheries need to be reflected in EcoQOs:

a. the quantity of fish of commercial species that are taken from the marine environment – sustainable fisheries require that the fish stocks should be capable of sustaining themselves;

b. the quantity of fish taken from the marine environment by industrial fisheries – sustainable fisheries require that the fish stocks fished by industrial fisheries should not only be capable of providing food for sustainable stocks of commercial fish species, but also allow an adequate supply to other dependent predators;

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[13] Defined in the OSPAR Convention as:

"activities carried out in the maritime area for the purposes of the exploration, appraisal or exploitation of liquid and gaseous hydrocarbons."

c. the effect of capture fisheries on the age structure of the fish population – sustainable fisheries require that, as well as maintaining a sustainable total bio-mass of the relevant species, there should also be an appropriate level of fish of reproductive ages;

d. the effect of bottom-trawling capture fisheries on the benthos – the maintenance of a sustainable benthic ecosystem with a full range of species requires it not to be disturbed too frequently by bottom-trawling;

e. the levels and composition of by-catch – the non-target species caught by commercial fisheries can significantly affect the populations of seabirds, marine mammals and other fish species; and

f. the levels of discards – even if a level of discards is compatible with sustainable spawning-stock biomasses for the relevant species, high levels of discarding can distort other aspects of the marine ecosystems, for example, by encouraging scavenger species.

3.33 The first four of these aspects would seem to be adequately reflected in the EcoQOs which are eventually to cover:

a. ***spawning stock biomass of commercial fish species*** – the spawning stock biomass can be directly affected by the level of capture fisheries effort;

b. ***local sand-eel availability for black-legged kittiwakes*** – black-legged kittiwake breeding success is directly affected by the local availability of sand-eels;

c. ***proportion of large fish*** – the age structure (and therefore the likely reproductive success of the fish stocks) is directly related to the impact of fishing activities;

d. ***density of sensitive and opportunistic species*** – low density of the former, and/or high density of the latter would suggest excessive disturbance;

e. ***by-catch of harbour porpoises*** – this can measure the reduction in by-catch;

f. ***presence and extent of threatened and declining species*** which are impacted by fisheries – this is a further measure of the success of focusing capture fisheries on sustainable activities;

g. ***habitats*** which are affected by fisheries.

Shipping

3.34 The impacts of shipping can be analysed under two main headings:

a. discharges, emissions and losses arising from ships' hulls, cargoes and operations;

b. disturbances (especially noise) arising from the passage of ships.

3.35 Under the first heading, three EcoQOs cover part of the problems:

a. ***proportion of oiled common guillemots among those found dead or dying on beaches*** will address the problems arising from the illegal discharge of oil and from disasters resulting in oil discharges;

b. ***plastic particles in stomachs of seabirds*** will reflect the management of marine litter from shipping;

c. ***imposex in dog-whelks*** (*Nucella lapillus*) will reflect the (expected) reduction in the most serious problems arising from anti-fouling treatments of ships' hulls. Other measures may be needed as other anti-fouling treatments succeed organo-tin treatments.

3.36 The other issues which need to be reflected in the eventual suite of EcoQOs in order to cover this aspect of shipping fully seem to be marine litter (which results in a significant part from discards from ships) and alien species (since ships' ballast-water is a major source of the risk of the introduction of non-indigenous species). These issues are considered below (under "Marine litter") and in Chapter 7.

3.37 Under the second heading, the main impact is likely to be that caused by the noise of propellers, engine noise and hull noise of large vessels to marine mammals (especially cetaceans and fish). This is discussed with other noise pollution issues in Chapter 7.

Sand and gravel extraction

3.38 Successful (or otherwise) management of marine sand and gravel extraction will be reflected in the EcoQOs for:

a. ***spawning stock biomass of commercial fish species*** (for species for which gravel spawning/nursery grounds are important);

b. ***density of sensitive and opportunistic species*** in appropriate areas of the benthic communities (low density of the former, or high density of the latter, would suggest excessive extraction and insufficient time for regeneration);

c. ***presence and extent of threatened and declining species*** which are affected by dredging for sand and gravel; and;

d. ***habitats*** which are affected by dredging for sand and gravel.

Dredging for navigational purposes (and disposal of dredged material)

3.39 Successful (or otherwise) management of dredging for navigational purposes and disposal of dredged material will be reflected in the EcoQOs for:

a. ***spawning stock biomass of commercial fish species*** (for species for which in-shore spawning/nursery grounds are important); and

b. ***density of sensitive and opportunistic species*** in appropriate areas of the benthic communities (low density of the former, or high density of the latter over large areas would suggest that the balance between areas allocated to navigation and the areas allocated to other purposes has not been set correctly).

Placement of offshore structures, cables and pipelines other than those for offshore oil and gas

LAND RECLAMATION

3.40 The human activities which involve, land reclamation or the placement of structures, cables or pipelines are effectively the result of decisions on the allocation of parts of the maritime area for various purposes. Such allocation decisions are bound to have an impact on the marine ecosystems in the immediate area that they affect. The question from the point of view of the overall health and sustainability of the marine environment as a whole is the cumulative impact of such decisions. This cumulative impact should be reflected in the EcoQOs which are linked to the overall health of the different types of biota in the marine environment: marine mammals, sea birds, fish species, benthic species, threatened and/or declining species and threatened habitats.

3.41 It should not therefore be necessary to seek to develop specific EcoQOs to reflect this group of human activities, but as progress is made in considering the spatial control of human activities in the maritime area, it may be possible to develop some measures related to decisions on spatial planning. This is considered in Chapter 7.

Tourism

3.42 Tourism has much in common with the group of human activities described in § 3.40, in that it concerns the allocation of parts of the coastal zone to tourist activities. Some aspects of tourism, however, will result in activities which may have a particular and direct impact on certain aspects of marine ecosystems. The most serious is probably the disruption of breeding locations.

3.43 As well as the reflection of the cumulative impact through the EcoQOs which are linked to the overall health of the different types of biota in the marine environment: marine mammals, sea birds, fish species, benthic species, threatened and/or declining species and threatened habitats, there will therefore be a need to look specifically at the EcoQO for **threatened and/or declining species** for species needing areas that are subject to coastal development. If the regulatory process for tourism is adequate, declines in threatened and/or declining species or habitats with a coastal basis should be stopped or mitigated.

Marine litter

3.44 Marine litter is a problem with manifold and various causes. The shipping aspect has already been referred to. It is also linked particularly to tourism and to general waste-management practices. Two aspects of the problem can be specifically distinguished:

a. the cumulative impact of marine litter across the marine environment. This is partly reflected in the EcoQO for **plastic particles in stomachs of seabirds**; and

b. the site-specific impact in particular locations. This is not reflected in any of the current set of EcoQOs, and the need for it is considered in Chapter 7.

Protection of marine biodiversity

3.45 The protection of marine biological diversity has now become an important human activity in its own right, and it will be important to consider specifically how successful it is being in achieving its goals. The overall success will be reflected especially in the EcoQOs for the main groups of biota in the upper part of the food web:

a. Sea mammals: s**eal population trends** and **utilisation of seal breeding**. It will need consideration whether other populations of marine mammals also need to be considered (see next chapter);

b. Seabirds: **seabird populations**;

c. Commercial fish species: **spawning-stock biomass;**

d. **Threatened and declining species**.

3.46 Separately, there will be need to look at the success in protecting threatened and/or declining species and habitats and in achieving an ecologically coherent networked of well-managed marine protected areas. In relation to threatened and declining species and habitats, the success of the work will be reflected in the EcoQOs for ecological quality elements relating to threatened and/or declining species and to habitats. Some way will also be needed to achieve an indicator for the success of the network of marine protected areas. This is considered in Chapter 7.

Chapter 4 - Evaluation of the North Sea Pilot Project on EcoQOs

Introduction

4.1 This chapter reviews each of the EcoQ issues, the EcoQ elements that have been identified for them, and, where they have been set for the purposes of the North Sea Pilot Project, the EcoQOs for those elements. These reviews draw on work done by lead countries in OSPAR (which is being published separately in the Background Documents on each advanced EcoQO) and independent reviews of the EcoQ issues and elements and the EcoQOs by the International Council for the Exploration of the Sea (ICES).[14] Summaries of the Background Documents and the ICES reviews are given in Annexes 1 and 2 to this report.

General aspects of the EcoQOs

Organisation of the EcoQOs

4.2 Comments have been made that the ordering of the EcoQ issues in the Bergen Declaration could be made easier to understand. There is a particular logic in that ordering. As shown in the report of the 1999 Scheveningen Workshop (figure 2 in the workshop report), this is that the scope broadens as it goes through the list. The first four issues deal with particular species; the second four deal with particular communities and habitats; and the last two deal with ecosystem-wide issues.

4.3 However, the logic is neither particularly strong, nor immediately apparent, and there are strong arguments that a simpler approach would be more easily understood. This is reinforced by the conclusion in § 4.12 that there should be a single issue related to eutrophication. It is therefore recommended that the nine resulting EcoQ issues should be grouped, first, into six relating to specific groups of fauna and flora and, secondly, the remaining three relating to cross-cutting issues.

4.4 This would give the following sequence:

(1) Commercial Fish Species;

(2) Marine Mammals[15];

(3) Seabirds;

(4) Fish Communities;

(5) Benthic Communities;

(6) Plankton Communities;

(7) Threatened and/or Declining Species[16];

(8) Threatened and/or Declining Habitats[17];

(9) Eutrophication.

4.5 The discussion in the rest of this chapter, however, follows the sequence and numbering of the Bergen Declaration. The revised headings for the ecological quality issues given above are, nevertheless, used.

Eutrophication EcoQOs

4.6 The aim of the EcoQO system is to achieve the desired levels of overall ecological quality for the marine ecosystem. To do this, the complete set of EcoQOs describes the envelope within which the marine environment can be regarded as healthy and sustainable. Within this complete set, there can be sub-sets which can be seen as describing one aspect of ecosystem health and sustainability.

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[14] ICES (2004) Report of the ICES Advisory Committee on Fishing Management and the ICES Advisory Committee on Ecosystems 2004. Section 2.1.7.1. ICES Advice Volume 1, Number 2, pp 177-249.

[15] The Bergen Declaration speaks of “Sea Mammals”. However, “Marine mammals” is the more commonly used term – see, for example, article 65 of the UN Convention on the Law of the Sea. It is therefore proposed to replace “sea mammals” with “marine mammals” in further work on EcoQOs.

[16] The Bergen Declaration speaks of “Threatened and declining species”. OSPAR has adopted the term “Threatened and/or Declining Species”, to reflect the fact that the concern is with species that are in either or both categories.

[17] The Bergen Declaration speaks simply of “Habitats”. In view of the comments in paragraph 5.94 it seems appropriate to change to “Threatened and/or Declining Habitats”.

4.7 One such sub-set is the five EcoQOs related to eutrophication. The five Ecological Quality (EcoQ) elements to which these EcoQOs respond are:

(t) winter nutrient (DIN and DIP) concentrations;

(q) phytoplankton chlorophyll *a*;

(r) phytoplankton indicator species for eutrophication;

(u) oxygen;

(m) changes/kills in zoobenthos in relation to eutrophication.

4.8 The five EcoQOs (the "eutrophication EcoQOs") form an integrated subset, responding primarily to nutrient enrichment. All five reflect shared cause/effect relationships. Although each may also be affected by other cause/effect relationships, they have in common a response to human activities resulting in elevated inputs of nutrients to the maritime area. All five have to be assessed in relation to area-specific assessment levels.

4.9 The eutrophication EcoQOs should be used as an integrated subset of the full set of EcoQOs and relate to the Comprehensive Procedure of the Common Procedure for the identification of the eutrophication status of the OSPAR maritime area in the following way:

a. the full set of Ecological Quality Objectives will be used to describe the overall ecological quality of the marine ecosystem. The full set of EcoQOs has several subsets that can be seen as indicators of ecosystem health, and responding to different human pressures. The integrated set of the five cause and effect related area-specific eutrophication EcoQOs is one such subset, considered to be responding primarily to nutrient enrichment;

b. the eutrophication EcoQOs will continue to be separately used as an integrated subset of the full set for the purpose of assessing eutrophication status and for monitoring the response of the marine ecosystem to eutrophication measures;

c. the use of the integrated subset of five eutrophication EcoQOs is identical to the application of the Comprehensive Procedure, both in procedure and frequency of application, and they can be seen as part of the target-oriented approach of the Eutrophication Strategy.

4.10 The OSPAR Eutrophication Monitoring Programme[18] and its related guidelines provide adequate monitoring data (including supporting environmental information) for eutrophication issues. Coherent monitoring, in accordance with the OSPAR Joint Assessment and Monitoring Programme (JAMP) and the JAMP guidelines should be maintained.

4.11 The relationships between the eutrophication EcoQOs and the nutrient-related aspects of the EC Water Framework Directive are discussed in Chapter 5.

4.12 To reflect the close association with the Comprehensive Procedure, and to simplify presentation, there are strong arguments for making changes in the way that the total set of EcoQOs, and the subset of eutrophication EcoQOs, are formulated. The following changes are recommended:

a. the EcoQ issues "Nutrient budgets and production" and "Oxygen consumption" (9 and 10) should be merged into a single EcoQ issue "Eutrophication";

b. the EcoQ elements and EcoQOs under this merged EcoQ issue should include all five of the integrated subset of eutrophication EcoQOs;

c. where an EcoQ element and its EcoQO are also relevant to another EcoQ issue, they should also be included under that issue, and treated as equivalent (as with some JAMP products);

d. within the integrated set of eutrophication EcoQOs, there should be an additional (sixth), overarching EcoQ element and EcoQO for the EcoQ issue "eutrophication";

e. this EcoQ element and EcoQO should be formulated as:

EcoQ element: "*Eutrophication status of the North Sea"*

EcoQO: "*All parts of the North Sea should have by 2010 the status of non-problem areas with regard to eutrophication, as assessed under the OSPAR Common Procedure for the*

[18] Agreement on the Eutrophication Monitoring Programme, reference number 2005-4, updating and superseding the Nutrient Monitoring Programme, reference number 1995-5.

Identification of the Eutrophication Status of the OSPAR Maritime Area (which consists of the (one-off) Screening Procedure and the (iterative) Comprehensive Procedure)";

f. this EcoQO should be regarded as a target.

4.13 Although some further work is needed on some EcoQOs within this integrated subset, the conclusion is that work should start as soon as possible on applying the subset, and that this should not be delayed until the further work has been completed. The present integrated set of five EcoQOs for eutrophication can be used within the OSPAR framework.

THE INDIVIDUAL ECOLOGICAL QUALITY ISSUES, ELEMENTS AND OBJECTIVES

Ecological quality issue 1. Commercial fish species

Ecological quality element and objective (a): Spawning stock biomass of commercial fish species – (North Sea pilot EcoQO)

4.14 The establishment of any ecological quality objective relating to commercial fish species must start from the fact that questions of fisheries management are for the competent authorities for fisheries management, and not for OSPAR. Nevertheless, OSPAR has functions in assessing the health and sustainability of the overall marine ecosystem, and in bringing issues relating to fisheries management where action is desirable to the attention of the national authorities and international bodies competent for questions of fisheries management ("the fisheries managers").

4.15 There is no doubt that any set of measures of the overall health and sustainability of marine ecosystems should include an element related to the well-being of commercial fish species. As the OSPAR Greater North Sea Quality Status Report 2000 concluded[19], the impacts of fisheries are widespread and ecologically important. The differing functions of the fisheries managers and the OSPAR Convention consequently imply that:

a. OSPAR must accept the decisions of the fisheries managers (taken in the light of such issues as OSPAR brings to their attention[20]) on the objectives for the management of commercial fish species, but

b. OSPAR should continue to monitor and assess the levels of commercial fish species as part of its monitoring and assessment of the quality status of the marine environment according to its Annex IV, and

c. the management objectives set by the fisheries managers, based on advice from ICES, should be the ecological quality objectives for commercial fish species, used when marine ecosystems are monitored and assessed.

4.16 The EcoQO included in the Bergen Declaration for commercial fish species is to keep spawning stock biomass of commercial fish species "*Above precautionary reference points for commercial fish species where these have been agreed by the competent authority for fisheries management*". The Bergen Declaration adds that "*In this context, reference points are those for the spawning stock biomass, also taking into account fishing mortality, used in advice given by ICES in relation to fisheries management*". This EcoQO contributes to the further integration of fisheries and environmental policies and management, as called for in the Statement of Conclusions from the Intermediate North Sea Ministerial Meeting in Bergen in March 1997.

4.17 In agreeing precautionary reference points, the fisheries managers use the system of precautionary reference points for spawning stock biomass (SSB, B_{pa}) and fishing mortality (F_{pa}) as a response to the uncertainty which inevitably surrounds determinations of SSB and F. The system is designed to ensure that there is a high probability of keeping away from the limit reference points for these two factors (B_{lim} and F_{lim}), taking into account the degree of uncertainty of determinations of SSB and F. The limit reference points B_{lim} and F_{lim} have ideally to be designed, on the basis of the fish stock dynamics, as those below which there is a high probability that the stock will collapse. ICES has also in some cases set the limit reference points associated with the lowest observed spawning stock size, to prevent the stock from coming into an area with unknown stock dynamics.

4.18 The ICES system is generally based on assessments carried out in year y on the basis of historical series of data up to year *y-1*. These assessments yield estimates for SSB at the beginning (or at spawning

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[19] OSPAR Commission 2000. Quality Status Report 2000, Region II – Greater North Sea, OSPAR Commission, London. Section 6.2.2 (first paragraph)

[20] Such as the issues drawn to the attention of the European Commission, the Icelandic Fisheries Ministry and the Norwegian Fisheries Ministry as a result of the Quality Status Report 2000.

time) of year y and estimates of F for year *y-1*. Advice is given for management measures to be adopted for year *y+1* on the basis of catch and SSB forecasts made under different scenarios for years y and *y+1*. In this context, the following procedure should be used:

a. the EcoQO should be taken, as agreed in the Bergen Declaration, as "SSB above precautionary reference points (B_{pa}) for commercial species where these have been agreed by the competent authority for fisheries management".

b. on the basis of ICES work, OSPAR should compile SSB values for commercial species having populations, at least partially, in the North Sea. The assessment of the ecological status of the North Sea in year y will then be obtained by comparing the current estimates of SSB with the agreed B_{pa};

c. on the same basis, OSPAR should also compile F values for the same stocks, not for the purpose of assessing the current ecological status (year y), but in order to compare this with the agreed values of F_{pa} and warn fisheries management authorities that, if fishing mortality is kept at that level, then there is likely to be a risk that the SSB will fall below B_{pa} under average conditions of recruitment (it is possible that the catch forecasts indicate no immediate risk of SSB falling below B_{pa}, but the warning is a useful indication of misperformance of the fishery).

4.19 At present, the fisheries managers with competence for North Sea stocks have agreed values for B_{pa} for a number of stocks. For some joint stocks, such as cod, haddock, whiting saithe, plaice, herring and mackerel, these have been adopted jointly by Norway and the EU in the context of their consultations on mutual fishing possibilities. The EU has also adopted a B_{pa} for the northern stock of hake, which occurs partially in the North Sea.

4.20 In OSPAR's assessments of the marine environment against EcoQOs, there is a strong case for aggregating the results for each of the separate commercial fish stocks for which precautionary reference points have been set. There are 26 of these fish stocks. To present each as a separate EcoQO is likely to give an imbalanced picture in relation to the other EcoQOs. It is therefore proposed that the results should be presented by stating the proportion of these fish stocks for which the operational objective is met, while spelling out the fish stocks for which it is not met (so that the environmental, social and economic implications of these failures can be assessed). On this basis, the EcoQO would be reported as "x out of 26 commercial fish stocks are assessed to meet the EcoQO criteria on spawning stock. Those which fail to do so are…."

4.21 This EcoQO was not met in 2003 for many stocks. On the basis of the 2003 ACFM report, out of 26 stocks in the North Sea, only 10 met the EcoQO. Of the remaining 16 stocks, 7 were assessed not to meet the EcoQO, while for 9 stocks, the situation was unknown or uncertain. It should be noted, however, that of the 10 stocks meeting the EcoQO, 4 stocks were harvested in 2002 at F values in excess of F_{pa}, and this will require attention by managers. The stocks that did not meet the EcoQO include cod in the North Sea and the Skagerrak, cod in Kattegat, North Sea plaice, and North Sea mackerel.

4.22 The overwhelmingly dominant human activity affecting the biomass of commercial fish species is, of course, the commercial fishing industry. Regulation of this takes many forms. The main issues for the fisheries managers are: regulation of fishing effort (whether by catch quotas, size of fleets or "days at sea"), regulation of the areas that may be fished, regulation of the fishing gear used ("technical measures") and regulation of the size of fish that may be landed and of discarding.

4.23 Other human activities may, nevertheless, be relevant, since decisions on the locations of certain activities (offshore installations, wind-farms and internationally-approved shipping lanes) may be equivalent to creating closed areas for fishing activity. OSPAR needs to consider the implications for commercial fish species of decisions on these activities.

4.24 The conclusions therefore are that:

a. the inclusion of an element on commercial fish species in the EcoQO system should be confirmed;

b. the EcoQO should be taken, as agreed in the Bergen Declaration, as "SSB above precautionary reference points (B_{pa}) for commercial species where these have been agreed by the competent authority for fisheries management";

c. in assessing the marine ecosystem against this EcoQO, OSPAR should report it as proposed under 4.20 above.

Ecological quality issue 2. Threatened and/or declining species

Ecological quality element (b): Presence and extent of threatened and declining species in the North Sea (less advanced)

4.25 The general aim of selecting this ecological quality element is to show whether the range of human activities that are leading to species being threatened or put into decline are being adequately managed. In addition, threatened and declining species are those particularly vulnerable to the impact of human activities, and can therefore act as a sensitive measure (a "miner's canary") of whether the combined impact of human activities is being adequately managed.

4.26 There are a number of practical problems with the EcoQ element as currently stated. In particular, some formerly abundant but now vulnerable species are now too scarce to be caught during monitoring surveys.

4.27 ICES have proposed an alternative EcoQ element, as a response indicator: "the proportion of all the listed species for which a recovery plan had been prepared and implemented". A corresponding EcoQO would be to achieve 100% adoption of Recovery Plans for all listed threatened species.

4.28 The problem with the approach proposed by ICES is that it is a measure of the response by management authorities to the issue, rather than a measure of whether management measures are delivering the desired results. In the context of the ecosystem approach, therefore, it is not describing the state of, or the impact on, the ecosystem.

4.29 OSPAR is developing monitoring strategies for the threatened and/or declining species on the OSPAR list. These should enable criteria to be developed for judging whether what level of protection has been achieved for these species. "Good conservation status" is, of course, the level which the EC Habitats and Birds Directives seek to achieve for the species to which they apply (which over lap with the species on the OSPAR list). It would make sense for the ultimately desired ecological quality level for all the species on the OSPAR list to be the same.

4.30 The conclusion on this EcoQO is therefore that it should refer to "threatened and/or declining species in the North Sea, as shown in the Initial OSPAR List" and that more development is needed, in the light of the development of monitoring strategies for the species on the OSPAR List.

Ecological quality issue 3. Marine mammals

Ecological quality element and objective (c): Seal population trends in the North Sea (North Sea pilot EcoQO)

4.31 The agreed EcoQO is that there should be "*no decline in population size or pup production of 10% or more over a period of up to 10 years*".

4.32 This EcoQO is still relevant, but needs further definition to take account of the biology and distribution of the two seal species in the North Sea. Separate EcoQOs should be adopted for grey seals and harbour seals, based on their differing biological characteristics and taking into account the different population sub-units in the North Sea.

4.33 The conclusion is therefore that this EcoQO should be made more precise and divided into two. These two EcoQOs should then be applied as indicators in the North Sea. The reformulations should be:

a. EcoQO for the harbour seal population trend in the North Sea:

"*Taking into account natural population dynamics and trends, there should be no decline in harbour seal population size (as measured by numbers hauled out) of ≥10% as represented in a five-year running mean or point estimates (separated by up to five years) within any of eleven sub-units of the North Sea. These sub-units are: Shetland; Orkney; North and East Scotland; South-East Scotland; the Greater Wash/Scroby Sands; the Netherlands Delta area; the Wadden Sea; Heligoland; Limfjord; the Kattegat, the Skagerrak and the Oslofjord; the west coast of Norway south of 62°N*".

b. EcoQO for the grey seal population trend in the North Sea

"*Taking into account natural population dynamics and trends, there should be no decline in pup production of grey seals of ≥10% as represented in a five-year running mean or point estimates (separated by up to five years) within any of nine sub-units of the North Sea. These sub-units are: Orkney; Fast Castle/Isle of May; the Farne Islands; Donna Nook; the French North Sea and Channel coasts; the Netherlands coast; the Schleswig-Holstein Wadden Sea; Heligoland; Kjørholmane (Rogaland)*."

Ecological quality element (d): Utilisation of seal breeding sites in the North Sea (less advanced)

4.34 There is no agreed EcoQO for this ecological quality element. The reasons for identifying it is that seals are widely distributed species through the North Sea, and the use of their breeding grounds shows whether the spatial impact of human activities is being properly managed. In general, the public wishes the current distribution of seals in the North Sea to be maintained and possibly allowed to increase.

4.35 In the light of what is known about seal breeding sites at present, an EcoQO would be relevant only in relation to grey seals and only for a limited part of the North Sea, since harbour seal pups leave their birth sites within a matter of hours. Even for the relevant aspects, there is little additional information to be gained for this as compared with the EcoQO on seal populations. This is largely because the reasons for changes in grey seal breeding sites are not clear, and may be related to meteorological conditions.

4.36 This EcoQO would not therefore add sufficient value to EcoQO(c), to justify maintaining it as a separate EcoQO, particularly for harbour seals. No further work should therefore be done on it. Where information on the utilisation of grey seal breeding sites in the North Sea is available, it should be used in support of the EcoQO on the grey seal population.

Ecological quality element and objective (e): By-catch of harbour porpoises (North Sea pilot EcoQO)

4.37 The agreed EcoQO is that *the annual by-catch of harbour porpoise should be reduced to levels below 1,7% of the best population estimate*.

4.38 In general, this EcoQO performs well. The weakest aspects of this EcoQO are the lack of full reporting of by-catch from all major fisheries and the comparatively sparse information about the genetic or geographical North Sea population sub-structure of harbour porpoises.

4.39 This EcoQO should be implemented if a full set of EcoQOs is to be developed. The best way of improving the EcoQO would be to improve (a) by-catch recording in French and Norwegian fisheries; (b) the definition of the North Sea harbour-porpoise population substructure, after which the underlying model would require further validation.

4.40 This EcoQO should be confirmed and applied as a limit. At the same time, further work should be done to improve it through incorporating data from France and Norway and examining further the definition of the harbour porpoise substructure.

Ecological quality issue 4. Seabirds

Ecological quality element and objective (f): Proportion of oiled Common Guillemots among those found dead or dying on beaches (North Sea pilot EcoQO)

4.41 The agreed EcoQO is that the proportion of oiled common guillemots should be less than 10% of those found dead or dying in all areas of the North Sea.

4.42 This is an example of a good EcoQO. The reference point is clear – there should be no guillemots killed by oil. The goal is clear, since the proportion of deaths due to oiling is immediately obvious. There is a clear link to human activities (the illegal discharge of oil), and the public could see the relevance. There were, however some problems, such as the absence of data from two North Sea countries (France and Norway).

4.43 It may also be sensible to analyse the data by North Sea sub-regions, in order to allow baselines to be set for these regions. A period of at least five years in which an average of less than 10% of the recorded dead or dying common guillemots can be attributed to oiling will be needed before the conclusion that the objective has been reached can be justified statistically. This EcoQO is also linked to the objectives of the Bonn Agreement and MARPOL and the other IMO Conventions aimed at reducing oil pollution.

4.44 Only in some areas the EcoQO is met, mainly in the northern North Sea. In most other areas the EcoQO is not met. In some places the amount of oiled guillemots is even over 50%. Management measures are needed to reach this EcoQO. These can be: control and enforcement of MARPOL, prevention, oil recovering/clearing and education.

4.45 The conclusion therefore is that this EcoQO should be confirmed and applied as an indicator in the North Sea, but that in presenting the results there should be a differentiation between sub-regions, in order to allow for the differences between the level of the problem in them. Further work is needed to define these sub-regions.

Ecological quality element (g): Mercury concentrations in seabird eggs and feathers (less advanced)

4.46 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that it is a good measure of the local distribution of mercury contamination, since sea-birds feed near their breeding grounds during the summer. Seabirds are high in the food web, and

mercury is an acceptable proxy for general contamination with heavy metals – particularly now that the major point sources are being rigorously controlled.

4.47 This is a useful EcoQ element, but should be modified to cover only the use of the eggs of seabirds, preferably of common terns and oyster-catchers. Although the use of seabird feathers was also originally agreed in the Bergen Declaration, they should not be used for this EcoQ element, since further investigation has shown that the proposed use of museum specimens of birds' feathers (which would have permitted a time-series reaching into the past) are likely to have been contaminated with mercury during the preservation process.

4.48 An EcoQO for this ecological quality element should be formulated in terms of reducing mercury levels to the lowest levels recorded in current monitoring schemes. It could best be formulated as follows:

> *The average concentrations of mercury in the fresh mass of ten eggs from separate clutches of common tern (*Sterna hirundo*) and Eurasian oystercatcher (*Haematopus ostralegus*) breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, should not significantly exceed concentrations in the fresh mass of ten eggs from separate clutches of the same species breeding in similar (but not industrial) habitats in south-western Norway and in the Moray Firth.*

4.49 The conclusion therefore is that an EcoQO in these terms should be adopted and applied as an indicator in the North Sea. Reviews of existing OSPAR monitoring programmes for mercury should take account of the EcoQO, since there may be an extent to which they are all in effect monitoring the same progress in eliminating mercury pollution.

Ecological quality element (h): Organochlorine concentrations in seabird eggs (less advanced)

4.50 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that levels of organochlorines in seabirds show an immediate response to changes in contaminant loads in the marine environment.

4.51 In setting the EcoQO, consideration will need to be given to the range of organochlorines for which analysis will be carried out. For organochlorines such as DDT and PCBs, where total bans have been in force for some time, the data would, it is hoped, show the rate at which these banned substances are being flushed out. However, there are indications that such substances still enter the marine environment from diffuse sources and that there is therefore a need to monitor any such continued inputs. To relate to the current and future management of human activities, the data might have to be extended to include new groups of substances such as brominated flame retardants where management action may be needed.

4.52 ICES have reviewed this EcoQ element and recommend that it should be widened to include the following organohalogens, which should also be included in monitoring programmes:

a. a range of bromodiphenylether (BDE) congeners intended to cover the three major polybrominated diphenylether (PBDE) formulations which have been, or are still being, used as flame retardants in Europe (minimum of BDE47, BDE99, BDE100 (penta-mix), BDE183 (octa-mix), BDE209 (deca-mix), plus HBCD (hexabromocyclododecane), and TBBP-A (tetrabromobisphenol-A));

b. a suite of dioxins and furans (PCDDs/PCDFs).

If these are included, the name of the EcoQ element would, of course, need to be changed accordingly, to "Organohalogen concentrations in seabird eggs".

4.53 Further work would be needed to define an EcoQO for this full extended range of organohalogens. However, the EcoQO for some organohalogens could be formulated as:

> *"For each site, the average concentrations in fresh mass of the eggs of common tern (Sterna hirundo) and Eurasian oystercatcher (*Haematopus ostralegus*) should not exceed: 20 ng g^{-1} of PCBs; 10 ng g^{-1} of DDT and metabolites; and 2 ng g^{-1} of HCB and of HCH. Sampling should be of ten eggs of each species from separate clutches of birds breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, and in similar (but not industrial) habitats in southwestern Norway and in the Moray Firth."*

4.54 The conclusion for this EcoQO is therefore that it should be adopted and applied in the North Sea as an indicator in the form set out above, and that further development work should be undertaken to see whether it could be extended to the full range of organohalogens proposed by ICES. If such an extended EcoQO is adopted, there may be the possibility of reviewing existing OSPAR monitoring programmes for the relevant organohalogens, since there may be an extent to which they are all in effect monitoring the same progress in eliminating organohalogen pollution.

Ecological quality element (i): Plastic particles in stomachs of seabirds (less advanced)

4.55 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that there is evidence that, for the species that retain plastic particles in their stomachs, there is an increase in the incidence of the phenomenon, and this seems to be related to an increasing problem of marine litter consisting of plastics.

4.56 ICES have reviewed this EcoQ and concluded that stomach-contents analysis of northern fulmars washed up on North Sea beaches offers a reliable monitoring tool for changes in the abundance of plastic litter at sea

4.57 ICES recommend that the EcoQO should be formulated as:

> *"There should be less than 2% of northern fulmars (Fulmarus glacialis) having ten or more plastic particles in the stomach in samples of 50–100 beach-washed fulmars found in winter (November to April) from each of fifteen areas of the North Sea over a period of at least five years."*

4.58 Plastic litter in the sea is a significant pollution problem. It is important to have a satisfactory scientific measure of its prevalence.

4.59 The conclusion on this EcoQO is therefore that it should be adopted and applied as an indicator in the North Sea.

Ecological quality element (j): Local sand-eel availability to black-legged Kittiwakes (less advanced)

4.60 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that sand-eels are a species which are targets for other fish species, for seabirds and for industrial fisheries. The local availability for seabirds (measured by the availability for the black-legged kittiwake) is a measure of the success of management measures based on a multi-species approach.

4.61 The proposed EcoQO is considered to be generally sound as a strategy to protect seabirds in part of the North Sea coastal areas from consistent local depletion of sand-eels by industrial fishing, and from competition with fisheries in times when food supply is low for three consecutive years or longer. However, it provides no protection against short-term and local unavailability of sand-eels, whatever the cause, and provides no information about the ecosystem effects of the fishery in much of the North Sea. Short-term depletions of food supply are not considered to pose a threat of serious or irreversible harm to kittiwake populations unless the depletions are persistent (three years or longer).

4.62 The black-legged kittiwake should be used as an indicator species for the predators that depend on sand-eels Ammodytes marinus as an important food resource. The EcoQO should be:

> *"Breeding success of the black-legged kittiwake (*Rissa tridactyla*) should exceed (as a three-year running mean) 0.6 chicks per nest per year in each of the following coastal segments: Shetland, north Scotland, east Scotland, and east England."*

4.63 Once a scientifically sound method has been developed to measure changes in sand-eel availability, the relationship of the indicator, i.e., the breeding success of black-legged kittiwakes, to the abundance of sand-eel should be quantified further and a test of the performance of the EcoQO as a guide to management should be carried out. The EcoQO should be capable of being extended to other parts of the North Sea that have black-legged kittiwake populations (France, Germany, Norway). Germany has started research to see whether black-legged kittiwakes have a diet of sand-eels. France and Norway should be asked to undertake similar research, and all three Parties should be asked to consider establishing monitoring schemes for breeding success and diet of these populations. Establishment of these schemes should be reported to UK as lead country in order to help consistent development of this EcoQ Element.

464 The conclusion on this EcoQO is therefore that it should be adopted and applied as an indicator in the North Sea, but that further work should be carried out to improve understanding of the performance of the EcoQO.

Ecological quality element (k): Seabird populations trends as an index of seabird community health (less advanced)

4.65 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is, as for the seal population metrics, that the trends in seabird populations integrate well the manifold impacts of human activities. Seabird populations will be affected by a wide range of human activities, in much the same way as threatened and declining species.

4.66 ICES have reviewed this EcoQ and concluded that it would be useful as part of a more advanced framework of EcoQOs.

4.67 ICES recommend that a detailed analysis of trends in individual colonies of kittiwakes should be carried out on the existing data (predominantly from UK seabird surveys and monitoring). This could provide for a better understanding of how colony selection may be made to render an EcoQ metric that is representative of the North Sea as a whole. The EcoQO previously suggested by ICES (≤ 20% decline over ≥ 20 years) could act as a precautionary limit to trigger further investigation, but would need to fit into a more advanced framework for EcoQOs before becoming operational.

4.68 The conclusion on this EcoQO is therefore that further development work should be undertaken.

Ecological quality issue 5. Fish communities

Ecological quality element (l): Changes in the proportion of large fish and hence the average weight and average maximum length of the fish community (less advanced)

4.69 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that, where fish are exploited by a fishery, the larger fish generally suffer higher fishing mortality than smaller individuals and the size distribution becomes skewed towards the smaller end of the size spectrum. This implies that stocks of smaller species and of species that mature early are likely to increase in relative abundance. Reproductive success of fish species that mature later may also be affected.

4.70 This EcoQO presents problems in that there is only one long time-series of information on this subject, and that has recently been discontinued. The EcoQ element "proportion of large fish" could be meaningful, but further development of the metrics of mean weight and mean maximum length of fish is required. The metrics are also closely related to the area fished and the gear used. There are therefore difficulties in deriving useable conclusions from this EcoQO.

4.71 The conclusion on this EcoQO is therefore that considerable further development work is needed before it could be considered for adoption. Since ICES already undertake much work in this field, they should be invited to consider undertaking this development.

Ecological quality issue 6. Benthic communities

Ecological quality element and objective (m): Changes/kills in zoobenthos in relation to eutrophication (North Sea pilot EcoQO)

4.72 This is one of the integrated subset of eutrophication EcoQOs (see paragraphs 4.6 – 4.13). The agreed EcoQO is that "*There should be no kills in benthic animal species as a result of oxygen deficiency and/or toxic phytoplankton species*". Within the eutrophication cause/effect scheme, this EcoQO relates to an indirect effect of nutrient enrichment.

4.73 The technical evaluation by ICES revealed that the links to human activities were not always straightforward. Thus changes in, or kills of, zoobenthos can be the result of processes not related to eutrophication – such as changes in hydrographical and climatic conditions. Also other human activities than those causing eutrophication can lead to changes in zoobenthos – for example bottom trawling, dredging, disposal of dredged materials, sediment contamination.

4.74 The EcoQO for zoobenthos kills should be confirmed and applied as an indicator, as part of the integrated subset of eutrophication EcoQOs. There should be further development work on an EcoQO for changes in benthic communities. Consideration of this work could start from the identification of lists of area-specific benthic indicator species (or groups of species) (see Annex 1).

Ecological quality element and objective (n): Imposex in dog whelk (Nucella lapillus) (North Sea pilot EcoQO)

4.75 The agreed EcoQO is that there should be a low (<2) level of imposex in female dog whelks as measured by the *Vas deferens* sequence index.

4.76 The existence of TBT contamination can be inferred from the level of imposex in the dog whelk. Other species of gastropods are also sensitive to TBT and are already being used for monitoring TBT pollution. These gastropods are, or may be, useful to cover areas where Nucella does not occur naturally, or where it has become extinct. Species which are useable, besides the dog whelk, are the red whelk (*Neptunea antiqua*), and to a lesser extent, also the whelk (*Buccinum undatum*) and the netted dog whelk (*Nassarius reticulatus*). The EcoQO for these species should be a level of imposex in female red whelk, whelk and netted dog whelk of respectively <2.0, <0.3 and <0.3, as measured by the Vas Deferens Sequence Index. A consistent approach over the whole OSPAR region, with a selection of relevant species, would be possible.

4.77 Monitoring for this EcoQ element should be started, or continued, using the dog whelk, or, where this species does not occur naturally or where it has become scarce or extinct, other gastropod species: red

whelk, whelk or netted dog whelk. The EcoQ element should therefore be re-worded as:

> "*Imposex in dog whelks* Nucella lapillus *or other selected gastropods*",

4.78 To take account of the need to use varying species, and the differing levels of imposex that are significant, the EcoQO should also be re-worded as follows:

> "*The average level of imposex in a sample of not less than 10 female dog whelks (*Nucella lapillus*) should be consistent with exposure to TBT concentrations below the environmental assessment criterion (EAC) for TBT – that is, < 2.0, as measured by the* Vas deferens *Sequence Index, Where Nucella does not occur naturally, or where it has become extinct, the red whelk (*Neptunea antiqua*), the whelk (*Buccinum undatum*) or the netted dog whelk (*Nassarius reticulatus*) should be used, with exposure criteria on the same index of <2.0, <0.3 and <0.3, respectively*".

4.79 The conclusion on this EcoQO therefore is that it should be applied as an indicator in the North Sea, in the amended form set out above.

Ecological quality element (o): Density of sensitive (e.g. fragile) species (less advanced)

4.80 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that sensitive species, such as the heart urchin (sea potato), the helmet crab and cold-water corals are the first to disappear under mechanical disturbance of the sea-bed. The EcoQO would therefore measure the extent to which more of the sea-bed is being disturbed than is thought appropriate to allocate to the human activities producing mechanical disturbance. To develop an effective EcoQO, it may be necessary to focus on specific types of benthic community.

4.81 ICES have reviewed this EcoQ and concluded it has the potential to be developed into an effective EcoQO, but only through wise selection of the species to be used as indicators. A more useful formulation of EcoQ element (o), on the density of sensitive (e.g. fragile) species, would make use of a limited selection of sentinel species rather than extensive lists of such species. This would require, amongst others, a further examination of the behaviour of metrics on a range of different scales, and the development of a set of criteria for the rational selection of sensitive species.

4.82 The conclusion on this EcoQO is therefore that it needs considerable further development before it could be adopted or applied.

Ecological quality element (p): Density of opportunistic species (less advanced)

4.83 No EcoQO has been agreed for this ecological quality element. The justification for identifying this ecological quality element is that it is the counterpart of ecological quality element (o) – just as sensitive species will be the first to be negatively affected by mechanical disturbance of the seabed, so opportunistic species will tend to proliferate where the seabed is mechanically disturbed. Parallel issues arise in relation to it.

4.84 ICES have reviewed this EcoQ and concluded that opportunistic species are ubiquitous and hard to define unambiguously. Their status is difficult to quantify with accuracy and precision, and changes in abundance are not closely linked to specific human impacts; thus, they may fail to correctly trigger management actions. For these reasons ICES recommends that OSPAR consider dropping this EcoQ element.

4.85 The conclusion therefore is that this EcoQ element is not suitable for the development of an EcoQO and that the impact of anthropogenic physical disturbance will be adequately reflected by ecological quality element (o).

Ecological quality issue 7. Plankton communities

Ecological quality element and objective (q): Phytoplankton chlorophyll a (North Sea pilot EcoQO)

4.86 This is one of the integrated subset of eutrophication EcoQOs (see paragraphs 4.6 – 4.13). The agreed EcoQO is that "*Maximum and mean chlorophyll* a *concentrations during the growing season should remain below elevated levels, defined as concentrations > 50% above the spatial (offshore) and/or historical background concentration*". Within the eutrophication cause/effect scheme, this eutrophication EcoQO is a direct effect of nutrient enrichment.

4.87 ICES considered chlorophyll *a* to be a useful indicator of nutrient conditions and advised that it should be included in the suite of eutrophication indicator variables. In this respect it is very important to perform the required monitoring on the area-specific chlorophyll *a* in conjunction with environmental physical and biological conditions (such as light climate and grazing) as prescribed in the Comprehensive Procedure, the OSPAR Eutrophication Monitoring Programme and its adherent guidelines. Although there is no fixed relationship that can be generally applied, there is a positive trend whereby concentrations of chlorophyll *a*

are seen to increase with increasing nutrient inputs. Reference conditions (background concentrations) should be determined which will be dependent upon the local conditions in the different types of areas. ICES advised that the robustness of using a constant value of 50% above natural background conditions should be explored for a range of local conditions, to evaluate whether there are circumstances where a different value than 50% could be used to achieve the intent of this EcoQO.

4.88 The conclusion therefore is that the EcoQO for chlorophyll *a* in relation to eutrophication should in principle be applied as an indicator/limit, but should be reformulated to take into account the area-specific aspects of background concentrations and assessment levels. This reformulation should be: "*Maximum and mean chlorophyll* a *concentrations during the growing season should remain below a justified area-specific % deviation from background not exceeding 50%"*. Monitoring should be performed in a coherent way taking into account area-specific circumstances, as advised by ICES.

Ecological quality element and objective (r): Phytoplankton indicator species for eutrophication (North Sea pilot EcoQO)

4.89 This is one of the integrated subset of eutrophication EcoQOs (see paragraphs 4.6 – 4.13). The agreed EcoQO is that "*Region/area-specific phytoplankton eutrophication indicator species should remain below respective nuisance and/or toxic elevated levels (and increased duration)*". Within the eutrophication cause/effect scheme, this EcoQO is a direct effect of nutrient enrichment.

4.90 Two types of phytoplankton indicator species should be distinguished here, nuisance species (forming dense "blooms") and toxic species (which can be toxic even at low cell concentrations).

4.91 The ICES technical evaluation emphasised that the links between toxic species and manageable human activities may be limited, even more so than for chlorophyll *a*. ICES advised caution in using "harmful algal blooms" as indicators of eutrophication, since such species do not always have a relevance to eutrophication. However, ICES confirmed that there is growing evidence that there is a relationship for some areas for some toxic phytoplankton species with nutrient enrichment and elevated N/P ratios. ICES advised that further work should be done to develop the scientific basis for setting area-specific EcoQOs.

4.92 This EcoQO should in principle be confirmed as an indicator, as part of the integrated subset of eutrophication EcoQOs. It should, however, only refer to "area-specific indicator species", to avoid confusion with the OSPAR Greater North Sea region, and the reference to duration should be clarified. The reformulation should read: "*Area-specific phytoplankton eutrophication indicator species should remain below the respective nuisance and/or toxic elevated levels (and there should be no increase in the average duration of blooms)*". More work should be done to develop area-specific assessment-levels for phytoplankton abundance. Any monitoring should be performed in a coherent way together with the other EcoQOs for eutrophication.

Ecological quality issue 8. Habitats

Ecological quality element (s): Restore and/or maintain habitat quality (less advanced)

4.93 There is no agreed EcoQO for this ecological quality element. The general aim of selecting this ecological quality element is to show whether the range of human activities that are leading to species being threatened or put into decline are being adequately managed. Similar considerations apply as for ecological quality element (b).

4.94 In its review of this EcoQ element ICES encountered problems with the definition of habitat quality, and recommends that this EcoQ element be changed to:

> "Restore and/or maintain the extent of threatened habitats".

Features of flat oyster beds, intertidal mudflats, and littoral chalk communities should be further developed as a basis for an EcoQO for this revised EcoQ element. ICES recommends that features of two other threatened and declining habitats in the North Sea (that is, sea-pen and burrowing megafauna communities and sea-grass beds), should not at present be used as a basis for EcoQOs.

4.95 The conclusion on this EcoQO is therefore that the EcoQ element should be re-worded "*Restore and/or maintain the quality and extent of threatened and/or declining habitats in the North Sea, as shown on the Initial OSPAR List*", but that, even then, substantial further development work will be needed in the light of the development of monitoring strategies for the habitats on the OSPAR List.

Ecological quality issue 9. Nutrient budgets and production

Ecological quality element and objective (t): Winter nutrient (DIN and DIP) concentrations (North Sea pilot EcoQO)

4.96 This is one of the integrated subset of eutrophication EcoQOs (see paragraphs 4.6 – 4.13). The agreed EcoQO is that "*Winter DIN and DIP (that is, concentrations of dissolved inorganic nitrogen and dissolved inorganic phosphate) should remain below elevated levels, defined as concentrations >50% above salinity-related and/or region-specific natural background concentrations*". Within the eutrophication cause/effect scheme, this EcoQO is a parameter for nutrient enrichment.

4.97 The ICES technical evaluation found that this EcoQ element scores relatively high on all the criteria and is therefore a very useful EcoQ element. This is primarily because winter nutrient concentrations respond directly to nutrient loads. ICES was not able to conduct a scientifically sound evaluation of the EcoQO (50% elevation above reference concentrations) as data necessary to provide a quantitative basis for the review of the EcoQO area by area were not available. ICES advised that EcoQOs for this EcoQ element should be developed only at area-specific scales, and that the entire water column and the salinity gradient should be considered when determining concentrations at relevant, area-specific reference salinities. The robustness of using a constant value of 50% above natural background conditions should also be explored for a range of local conditions.

4.98 The conclusion therefore is that the EcoQO for winter nutrient concentrations in relation to eutrophication should be in principle be applied as an indicator, but should be reformulated to take into account the area-specific aspects of background concentrations and assessment levels. This reformulation should be: "*Winter DIN and DIP (that is, concentrations of dissolved inorganic nitrogen and dissolved inorganic phosphate) should remain below a justified salinity-related and/or area-specific % deviation from background not exceeding 50%."*

Ecological quality issue 10. Oxygen consumption

Ecological quality element and objective (u): Oxygen (North Sea pilot EcoQO)

4.99 This is one of the integrated subset of eutrophication EcoQOs (see paragraph 4.6 – 4.13). The agreed EcoQO is that "*Oxygen concentrations, decreased as an indirect effect of nutrient enrichment, should remain above region-specific oxygen deficiency levels, ranging from 4-6 mg oxygen per litre*." Within the eutrophication cause/effect scheme, this EcoQO is an indirect effect of nutrient enrichment.

4.100 The ICES technical evaluation showed that this EcoQ element scored fairly low on the criterion on the relationship with human activities that are subject to regulation. This is because natural environmental factors, both physical and biological, also have large influence, and may distort or disguise the effects of anthropogenic eutrophication. ICES considered that oxygen is conceptually a useful indicator of potential eutrophication conditions, and should be included in the suite of eutrophication indicator variables. ICES advised that the development of EcoQOs at area-specific scales should continue, based on measurements taken close to the bottom at the time of year of the annual minimum (autumn). The robustness of the range 4 - 6 mg oxygen per litre should be explored for a range of local conditions, to evaluate whether there are circumstances where the appropriate value needed to achieve the intent of this EcoQO may be outside this range.

4.101 As mentioned by ICES, and as described in the OSPAR Comprehensive Procedure, the risk of misinterpretation of the cause of oxygen depletion is substantially reduced when this factor is assessed together with the other EcoQOs forming part of the integrated subset of eutrophication EcoQOs (for example, nutrient concentrations, and phytoplankton) and the area-specific supporting environmental information.

4.102 Since this EcoQO is part of the integrated subset of eutrophication EcoQOs, the conclusion is that it should be confirmed and applied as an indicator in the North Sea, but that the reference to "region-specific oxygen deficiency levels" should be replaced with "area-specific assessment levels", and that further work should be done to achieve specifications for those levels more precise than the current generic "4 – 6 mg oxygen per litre".

The way forward

4.103 The implementation of an EcoQO system is a major undertaking. Full development of a system which can reflect on all aspects of the health of the marine ecosystems of the North Sea implies the identification and validation of EcoQOs for a number of issues beyond those included in the North Sea Pilot Project (see Chapter 7). And the field to be covered is not one where information is readily available on all issues from standard reference sources. It is essential to remember that the marine environment – even of the North Sea – remains generally poorly know and understood in comparison to terrestrial environments.

4.104 Even implementation of the EcoQOs included in the North Sea Pilot Project requires both putting in place systems to collect and organise much additional data and the development of ways of linking that data to policy analysis and development.

4.105 As described in Chapter 6, there are major resource implications in making the EcoQOs operational. More time is needed to develop more precise estimates and to work out organisational arrangements – especially where it is foreseen that partnerships with voluntary organisations will play a large part.

4.106 As described in Chapter 6, there are also likely to be implications for the EcoQO system from the European Marine Strategy. It would be imprudent to start new organisational arrangements for the EcoQO system until it is sufficiently clear what will need to be done under the European Marine Strategy that OSPAR can be confident that the arrangements for the EcoQO system will not involve fruitless effort.

4.107 All this points to the need for a space of reflection before detailed implementation work starts. Where the conclusion of this review is that an EcoQO should be applied, therefore, this should be understood to mean that it should be included in the general preparations for implementing the EcoQO system. Those general preparations should take the form of consideration by all the relevant OSPAR main committees of what is involved in implementation of the EcoQOs in their fields and how the various issues mentioned above can be addressed.

4.108 At the same time, this should not stand in the way of making as much progress as possible with the more detailed products mentioned in Annex 4 (Programme of future work on EcoQOs). It may well not be feasible to develop these products on the timetable suggested in that programme of work, but the aim should be to make as much progress as is possible, consistent with consideration of the more general issues.

Chapter 5 - Links to Other Major Instruments

5.1 The system of ecological quality objectives (EcoQOs) is intended to integrate for the marine environment the evaluation of the success of all the relevant policies. It therefore needs to be considered in relation to each of the main sets of policies. This chapter deals with the main instruments other than the OSPAR strategies. The brief descriptions of the various European and international instruments in this chapter do not necessarily represent the considered views of all, or any, of the OSPAR Contracting Parties on the exact effects of those instruments.

The developing European Marine Strategy

5.2 The European Union has proposed the development of a European Marine Strategy, to cover all the seas around Europe (and not just those adjacent to EU Member States). One aspect of this strategy would be a thematic strategy under the EU Sixth Environmental Action Programme. It is proposed that other aspects will be developed to give a coverage of all aspects of European seas and to involve non-EU States. The European Union has also indicated that it will develop proposals on wider aspects of maritime affairs.

5.3 The proposals for the development of the European Marine Strategy so far put forward by the European Commission are based on an analysis of the threats to the marine environment, the formulation of an overall vision, principles (related to a shared vision, integrated, strategic, adaptive and trans-sectoral planning and management, sustainable development addressing the desired quality status of the structure and dynamic functions of the marine ecosystem, the precautionary, polluter-pays, and preventative principles, the use of BAT and BEP, and coordinated programmes for monitoring, assessment, implementation and enforcement), and strategic goals.

5.4 Under each strategic goal, there will be a number of specific objectives (22 have so far been suggested). The policies, programmes and measures needed to give effect to these objectives are to be made operational by the use of an ecosystem approach to the management of human activities.

5.5 Guidance is simultaneously being developed on the application of this ecosystem approach. This emphasises that the ecological and operational objectives needed to implement the ecosystem approach must be specific, measurable, achievable, realistic and time-bound (SMART). They will need to be supported by indicators, limits and targets. Indicators will show what in fact is happening. They are said to need to be:

a. ***Measurable*** Effective Indicators should be measurable in practice and in theory. They should be measurable using existing instruments, monitoring programmes and analytical tools available in the regions, and on the time-scales needed to support management. They should have minimum or known bias (high level of QA), and signal should be distinguishable from noise.

b. ***Cost effective*** Indicators should be cost-effective because monitoring resources are limited. Monitoring should be allocated in ways that provide the greatest benefits to society and the fastest progress towards sustainable development.

c. ***Concrete*** Indicators which are directly observable and measurable rather than reflecting abstract properties which can only estimated indirectly are desirable because concrete Indicators are more readily interpretable by the diverse stakeholder groups that contribute to management decision making.

d. ***Interpretable*** Indicators should reflect properties of concern to stakeholders and their meaning should be understood by as wide a range of stakeholders as possible. Public understanding of the Indicator should be consistent with its technical meaning.

e. ***Grounded in theory*** Indicators should reflect features of ecosystems and human impacts that (according to well-accepted peer-reviewed scientific theory) are relevant to the achievement of Objectives. They should not be based on theoretical links that are poorly defined or validated.

f. ***Sensitive*** Trends in the Indicator should be sensitive to changes in the ecosystem properties or impacts, which the Indicator is intended to measure.

g. ***Responsive*** Indicators should be responsive to effective management action and provide reliable feedback on the consequences of management actions, both in the short term (where a rapid response is needed) and in the long term.

h. ***Specific*** Indicators should respond to the properties they are intended to measure rather than to other factors and/ or it should be possible to disentangle the effects of other factors from the observed response.

5.6 The specific objectives would require to be worked out into operational objectives for each marine region. These would be divided into:

(i) targets (or "target reference points"). These would indicate the preferred state of the ecosystem;

(ii) limits (or "limit reference points"). The Guidance appears to consider two possible level so of "limit" - precautionary and boundary[21] (precautionary limits are to be set so that, for a chosen level of statistical probability, we can be sure that the inherent uncertainty in measuring indicators will not allow us to cross the boundary limit). Where these limit reference points are exceeded (or breached), the ecosystem would be subject to serious or irreversible harm, or would have been driven by society to a state where society does not want it to be;

(iii) indicators. These would show the progress being made towards the desired state of the ecosystem.

It appears that the overarching goal is likely to be formulated in terms of working towards good environmental status. Environmental status would be good when the targets for all indicators that underpin the Strategy have been met, moderate when all precautionary limits were avoided and poor if any precautionary limits were not avoided.

5.7 There obvious and close links between the EcoQO system and the emerging ideas on the European Marine Strategy. At one level, the OSPAR development of the EcoQO system may prove to be a good model for practical ways of implementing at the regional level the European Marine Strategy. At the same time, it may be necessary to rethink some of the terminology used in the EcoQO system and to make clear the way in which the OSPAR system will relate to the European Marine Strategy.

The EC Water Framework Directive

5.8 The Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (EC Water Framework Directive) is largely concerned with questions relating to fresh water. However, it also overlaps with the OSPAR maritime area. This is because it defines the waters to which it applies as being:

a. "transitional waters" and

b. "coastal waters";

c. as far as concerns chemical status, the waters of the territorial sea.

5.9 The directive imposes requirements on EU and EEA Member States (and therefore on all OSPAR Contracting Parties which are coastal states) to ensure that:

a. their coastal and transitional waters (defined as within 1 nautical mile) achieve "good surface water status" by 2015. This requires that they achieve both "good ecological status" and "good chemical status" (taking into account only substances in annex X of the EU WFD); and

b. in the view of some, the rest of their territorial sea (defined as from 1 to 12 nautical miles) is monitored for "good chemical status" (all substances) by 2015.

5.10 "Good ecological status" is a classification based, for transitional and coastal waters, on a defined set of classification factors. The factors are effectively the same for transitional and coastal waters, except that, for transitional waters, the composition and abundance of fish fauna are included. Within the set of classification factors there are possible linkages to the ecological quality elements from the following classification factors:

a. composition, abundance and biomass of phytoplankton;

b. composition and abundance of benthic invertebrate fauna;

c. composition and abundance of fish fauna;

d. oxygenation conditions ;

e. nutrient conditions ;

f. pollutants.

[21] The Guidance does not give a name for the non-precautionary limits, so this document uses "boundary limit" (even if the phrase is pleonastic) for those limits that are meant to be avoided if at all possible.

5.11 "Good chemical status" is defined as the water quality achieved by a body of surface water in which concentrations of substances (including priority substances) listed in the annex X of the directive do not exceed the environmental quality standards established under the EC Water Framework Directive and under other relevant Community legislation setting environmental quality standards at Community level. Here the "one out, all out" approach applies. This means that, where the concentration of ***any*** annex X substance exceeds the quality criterion, then the status of the water body as a whole is not 'good'. The same is true for chemical substances that are considered as supporting the description of the ecological status.

5.12 As far as coastal waters are concerned, it is thus clear that the EC Water Framework Directive is significantly more narrowly focused than the concept of "a healthy and sustainable ecosystem", which is the envelope that the EcoQOs are aimed at defining. No consideration is given under the EC Water Framework Directive in coastal waters to fish, marine mammals or sea birds or to threatened and declining species and habitats. There are good reasons for this difference, given the obligatory nature of the requirements to deliver "good surface water status" and the many factors that can affect these aspects of the marine environment that are outside the control of States.

5.13 For transitional waters, fish are included, but the transitional waters overlap only with the most upstream parts of the OSPAR maritime area. The emphasis for transitional waters is on the freshwater aspects: even though "partly saline", they must be "substantially influenced by freshwater flows", while the OSPAR maritime area stops at the point when, at low tide in periods of low freshwater flow, there is "an appreciable increase in salinity". And even for transitional waters, there is no consideration of marine mammals and sea birds.

5.14 It will, nevertheless, be important to ensure that, as the concepts and systems of the EC Water Framework Directive (WFD) are developed, they are consistent, if not identical, with the approaches to the EcoQOs dealing with the factors where there is an overlap between the two systems. This applies particularly to the set of EcoQOs dealing with eutrophication, where there is a considerable overlap.

5.15 The integrated set of EcoQOs for nutrients and eutrophication effects shows obvious similarities with the EC WFD, but also some differences. A comparison of the WFD biological quality elements, and the OSPAR ecological quality elements and OSPAR's harmonised assessment parameters shows considerable similarities. The integration of these criteria into the classification is different, however. The classification system of the ecological quality of water bodies shows a difference in the number of classes, but these could well be integrated with regards to the eutrophication status. It is clear that developments related to EcoQOs relating to eutrophication and to the EC Water Framework Directive (WFD) could well benefit from each other.

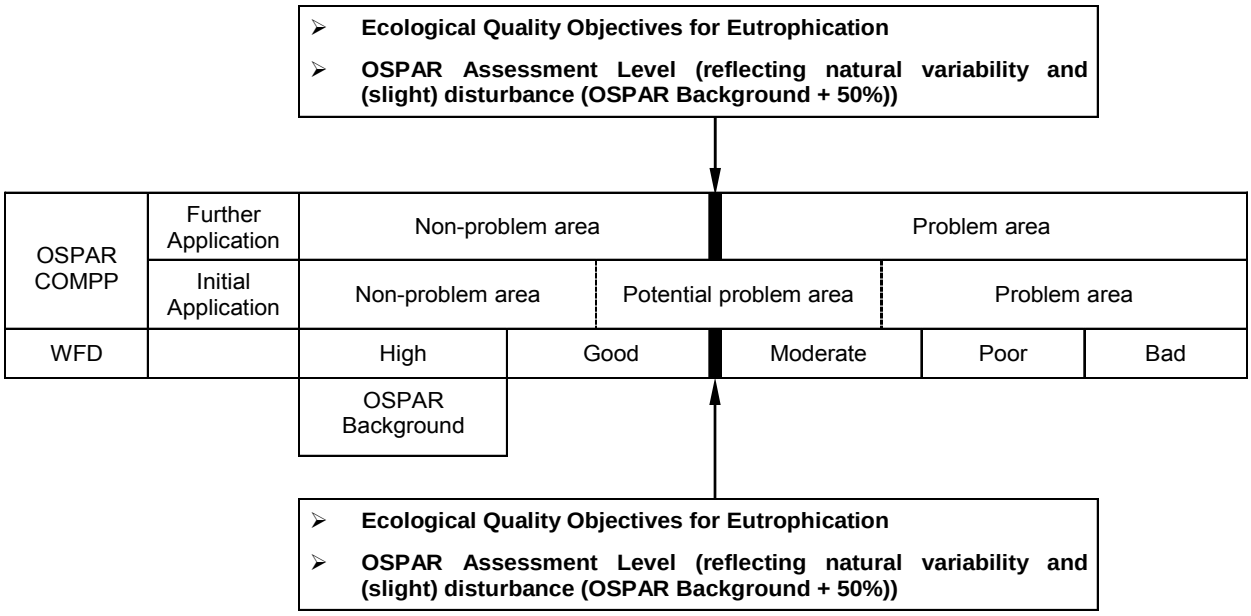

Figure 6.1. Relationship between the classification under the Comprehensive Procedure, the integrated set of EcoQOs for eutrophication and the Water Framework Directive.* (OSPAR COMPP = the Comprehensive Procedure; WFD = the Water Framework Directive).

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

Other EC instruments

The EC Birds and Habitats Directives

5.16 The EC Council Directive 79/409/EEC on the conservation of wild birds (the "EC Birds Directive") and the EC Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the "EC Habitats Directive") are also more narrowly focused than the concept of a "healthy and sustainable ecosystem" that underlies the EcoQO approach. The two directives focus on the identification of certain species and (for the EC Habitats Directive) certain types of habitat which are to be conserved. The aim is to achieve "good conservation status" for these species and types of habitat, largely through the protection of "special protected areas" (EC Birds Directive) and "special conservation areas (EC Habitats Directive), which together will form the NATURA 2000 network of protected areas.

5.17 The selection of marine species and types of marine habitat for conservation under the two directives is incomplete. This is likely to change over time as there is more cooperation under the European Marine Strategy between the regional seas organisations and the European Community in identifying the crucial species and types of habitat and cooperating in their conservation. Nevertheless, for the time being, the aim of the EcoQO system will be more widely drawn.

5.18 There may, thus, be synergies between EC Directives and the EcoQOs that are (being) developed for birds, marine mammals and habitats. In so far as the system of EcoQOs is aimed at ensuring the health and sustainability of the marine ecosystems, it will automatically cover the general aspects of conserving biological diversity and ecosystems, although (since it has a broad brush approach) it may not provide all the detail needed to demonstrate the delivery of all the objectives of these EC Directives.

5.19 These directives are not, of course, relevant to the OSPAR Contracting Parties that are not EU Member States.

Other relevant EC Directives

5.20 The EC **Nitrates Directive** (91/676/EEC) aims to control excessive inputs of nutrients from agricultural run-off. The implementation of this Directive for the OSPAR Contracting Parties that are bound by it (and of parallel national legislation for Switzerland) is already included in the OSPAR Eutrophication Strategy, and is therefore reflected in the integrated set of EcoQOs for eutrophication effects.

5.21 Likewise, the EC **Urban Waste Water Treatment Directive** (91/271/EEC), as well as setting standards for the provision of municipal waste water collection systems, seeks to control excessive inputs of nutrients from urban waste water treatment plants and certain industries (mainly related to food and drink). As with the Nitrates Directive, its aims and effects are reflected in the integrated set of EcoQOs for eutrophication effects.

5.22 There will therefore be scope for synergies between the monitoring systems required for these two Directives and those needed for the EcoQOs. In practice, the integrated set of EcoQOs for nutrients should be closely related to the measurement of the success of the EC Directives.

5.23 The EC **Environmental Impact Assessment** (85/337/EEC and 97/11/EC) and **Strategic Environmental Assessment** (2001/42/EC) Directives both require prior assessment of certain human activities before they occur. They differ in the scale of their assessments, with the former being location and activity specific and the latter looking more broadly at the contextual plans and programmes. Both Directives offer the opportunity to manage human activities to be consistent with the EcoQO framework and indeed they have been taken account of in the implementation of these Directives by at least one Contracting Party.

The EC Common Fisheries Policy

5.24 For the OSPAR Contracting Parties that are also EU Member States, the EC Regulation 2371/2002 on the Common Fisheries Policy not only sets important objectives relating to fish stocks but also both provides mechanisms to deliver them and sets out arrangements to monitor that delivery. These objectives and mechanisms, together with the supporting EC regulations (such as the regulation on technical measures) also have to take account of environmental, social and economic considerations. The EcoQOs relevant to fisheries are designed to be consistent both with this EC Regulation, but also with the relevant national legislation of Contracting Parties in the areas not covered by the Regulation or left to their discretion by it.

The Bonn Agreement, MARPOL and IMO Conventions

5.25 The Bonn Agreement for the Protection of the North Sea Area against Pollution by Oil and other Hazardous Substances (1969, revised in 1983), the 1973/78 International Convention on Marine Pollution by

Ships (MARPOL) and a number of other international conventions and protocols under the aegis of the International Maritime Organisation (including those dealing with liabilities for pollution by oil and other hazardous substances, preparedness for responses to pollution incidents, crewing standards, anti-fouling treatments and ballast-water management) play an important part in ensuring that healthy and sustainable ecosystems are not menaced by pollution from ships or by the introduction on non-indigenous species. However, pollution from shipping continues to occur. The development of the EcoQOs will help in assessing the effectiveness of these measures.

5.26 In relation to discharges and losses of oil and hazardous substances, the system of EcoQOs should be adequate to reflect the impacts of sea-based sources (vessels and offshore installations) on the marine environment, since the system is designed to reflect the impacts of all sources of such contaminants. Since the introduction of alien species (for example, through mismanaged ballast water) is not yet addressed by the system of EcoQOs, it may be necessary to address this issue further (see Chapter 7).

5.27 The UN Convention on Migratory Species (CMS) has a mechanism for Parties to CMS to create Agreements to conserve relevant species. Three such Agreements cover the North Sea area: the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), the Agreement on the Conservation of Seals in the Wadden Sea and the African-Eurasian Waterbird Agreement. The EcoQOs for by-catch of harbour porpoises and for seals are consistent with the aims of these Agreements. Work within the Agreements will help to ensure that the EcoQOs are met.

Chapter 6 - Implementing the EcoQOs

What needs to be achieved?

6.1 OSPAR (and the North Sea Conferences) has set a number of strategic objectives and goals, and the timeframes within which specified steps are to be taken to achieve these objectives. These objectives and timeframes will continue to determine policy.

6.2 The EcoQOs are an integrated method of measuring progress towards marine ecosystems that are within an envelope, defined by the EcoQOs. When marine ecosystems are within that envelope, everyone can accept that they are healthy and sustainable. The EcoQOs will therefore be a measure of the progress of the OSPAR strategies in achieving their objectives.

6.3 The implementation of the goals defined by the EcoQO system has therefore been under way since 1998, when the first strategies were adopted.

6.4 What needs to be achieved is to make explicit the iterative process involved in implementing the strategies and the EcoQO system that is described in the flow-chart set out in Chapter 1, and to link this to the work of implementing the OSPAR strategies and to resource this. This is described below.

Options

6.5 OSPAR needs to ensure that there is a continuous cycle of gathering information, assessing that information, identifying the problems, taking policy decisions on goals, and then implementing and enforcing programmes and measures to deliver those goals, flowing back once more into gathering information. Current OSPAR practices have long been based on this approach, and a major tool in the armoury for delivering it is now the Strategy for the Joint Assessment and Monitoring Programme (JAMP).

6.6 OSPAR Contracting Parties have adopted a commitment, for the implementation of the JAMP, that they will each commit an appropriate level of resources in order to achieve the common purposes.

6.7 The two options available are:

a. to integrate the EcoQO system into the JAMP; or

b. to run it as a separate exercise.

6.8 There can be no doubt that the more effective, efficient and economic course will be to integrate the EcoQO system into the JAMP, and this course should therefore be selected. This will mean that the various JAMP products will need to be reviewed so that steps can be taken to make them include, and be consistent with, the collection and assessment of information relating to the EcoQOs. This will need to be factored into the provision of resources for the implementation of the JAMP – including making available the human resources (especially the time of experts who are under pressure from other directions).

Costs

6.9 To a large extent, the North Sea pilot project has been based on existing exercises in data collection. This has been essential to ensure that the baselines can be derived against which to measure future progress. It also means that much of the implementation of the EcoQO system can be achieved without additional work for those Contracting Parties which have been collecting this data in the past.

6.10 In assessing the costs of implementing the EcoQO system, there are two aspects to be considered:

a. the costs of monitoring the ecosystems and assessing the data, so as to enable conclusions to be reached on how far EcoQOs are being achieved;

b. the costs of the programmes and measures that will be needed to deliver the EcoQOs.

6.11 In general, it can be expected that the cost of the necessary programmes and measures to deliver EcoQOs will far exceed the cost of monitoring and assessment. However, OSPAR already has adopted a set of thematic strategies covering all its fields of responsibilities, and similar strategic objectives already exist in other fields in the North Sea, under such instruments as the EC Common Fisheries Policy, the EC Habitats and Birds Directives, Norwegian fisheries and nature conservation legislation and North Sea Conference commitments. To the extent that the EcoQO system is simply giving precision to these obligations and commitments, it cannot be regarded as adding to the cost of the programmes and measures necessary to deliver them. This particularly applies to the eutrophication EcoQOs, which parallel the OSPAR Common Procedure, adopted for the purposes of the OSPAR Eutrophication Strategy, and the EC/EEA Nitrates and Urban Waste Water Directives.

6.12 In some fields, the additional precision given by the EcoQO system may mean that additional expenditure on programmes and measures will be needed to deliver what, at the moment, are rather general, aspirational objectives. This could be the case, for example, with regard to plastic marine litter. But until more work has been done to collect and assess data, and then to work out what will happen with such objectives in the absence of further new programmes and measures, the costs of such new programmes and measure cannot be estimated.

6.13 Turning to the costs of monitoring and assessment, an accurate estimate of the cost of implementing the EcoQO system will require three steps:

a. identifying which Contracting Parties will need to undertake new data collection exercises to provide the information needed by the EcoQO system, as embedded in the JAMP;

b. reviewing the relationship of these new data-collection processes, and of the assessment of that data with the data-collection systems and assessment processes already planned in the JAMP;

c. establishing in consequence what new data collection and assessment processes will be needed by which Contracting Parties and then costing them.

6.14 This work can only be done in full when conclusions have been reached on the outcome of the pilot project and the desirable shape of a permanent EcoQO system, and how to incorporate it into the JAMP.

6.15 Nevertheless, some preliminary observations on such monitoring and assessment costs can be made, and are set out in the following table.

Table 7.1 Estimated costs of EcoQO Monitoring and Assessment implementation

Ecological quality element	Estimated cost of implementation
(a) Spawning stock biomass of commercial fish species in the North Sea	Sufficient obligations for monitoring and assessment already exist under the instruments of the EC Common Fisheries Policy and corresponding Norwegian legislation to deliver the monitoring and assessment needed for this EcoQO
(b) Presence and extent of threatened and declining species in the North Sea	This EcoQO requires further development. Monitoring and assessment costs can only be estimated when that development is complete.
(c) Seal population trends in the North Sea	The monitoring of seal populations is not required under any EU or international legislation, but many relevant Parties already undertake this as part of national legislation or policies. Seal monitoring on Special Areas of Conservation set up under the EU Habitats Directive is required and it seems sensible to be able to place such monitoring in context. The minimum frequency of such monitoring is about once every six years. Seal monitoring in the Wadden Sea is undertaken as part of the trilateral monitoring programme. Costs of these programmes are not known.
(d) Utilisation of seal breeding sites in the North Sea	
(e) By-catch of harbour porpoises	Those Contracting Parties which are EU Member States are required under the Habitats Directive (92/43/EC) to introduce a system to monitor the incidental capture and killing of all cetaceans. In light of the results of this monitoring, Member States are required to undertake further research or conservation measures to ensure that the incidental capture and killing does not have a significant negative impact on the species concerned. This work should provide practically all that is needed for this EcoQO. Any additional monitoring and assessment work needed by Norway cannot be easily estimated.
(f) Proportion of oiled Common Guillemots among those found dead or dying on beaches	The costs depend on the actual situation of the monitoring programme and the length of the coastline. The costs are higher when the base of the monitoring programme needs still to be established. Assuming that the survey work is done by volunteers, costs are estimated at € 1 500 per country plus travel costs for the volunteers, which vary

	according to the country. The international co-ordination by the lead country is estimated at € 13 250.
(g) Mercury concentrations in seabird eggs and feathers	Costs cannot be estimated until the EcoQO is agreed.
(h Organochlorine concentrations in seabird eggs	Costs cannot be estimated until the EcoQO is agreed.
(i) Plastic particles in stomachs of seabirds	Costs cannot be estimated until the EcoQO is agreed.
(j) Local sand-eel availability to black-legged Kittiwakes	If volunteer observers are used for monitoring, then the extra costs associated with this EcoQO are small and maybe amount to €7 500 in total for the North Sea. If dedicated researchers were to be employed to monitor colonies, then costs would be substantially higher. Cost estimates therefore depend on agreement on implementation.
(k) Seabird population trends as an index of seabird community health	This EcoQO requires further development. Monitoring and assessment costs can only be estimated when that development is complete.
(l) Changes in the proportion of large fish and hence the average weight and average maximum length of the fish community	This EcoQO requires further development. Monitoring and assessment costs can only be estimated when that development is complete.
(m)Changes/kills in zoobenthos in relation to eutrophication	The monitoring requirements for this EcoQO (as for all the eutrophication EcoQOs) are covered by the monitoring already required for the OSPAR Comprehensive Procedure and the EC Water Framework, Nitrates and Urban Waste Water Directives. Additional assessment work is likely to be very small.
(n) Imposex in dog whelks (*Nucella lapillus*)	The monitoring and assessment requirements for this EcoQO are already covered for the most part by the commitments under the OSPAR Coordinated Environmental Monitoring Programme.
(o) Density of sensitive (e.g., fragile) species	This EcoQO requires further development. Monitoring and assessment costs can only be estimated when that development is complete.
(p) Density of opportunistic species	Proposed not to be pursued.
(q) Phytoplankton chlorophyll *a*	As for EcoQO (m)
(r) Phytoplankton indicator species for eutrophication	As for EcoQO (m)
(s) Restore and/or maintain habitat quality	This EcoQO requires further development. Monitoring and assessment costs can only be estimated when that development is complete.
(t) Winter nutrient (DIN and DIP) concentrations	As for EcoQO (m)
(u) Oxygen	As for EcoQO (m)

Chapter 7 - Completing the EcoQO System

7.1 The system of EcoQOs is intended to provide a means of assessing whether the ecosystems of the North Sea are within the envelope of what can be regarded as healthy and sustainable, as well as a means of monitoring the overall progress of the OSPAR Strategies and other relevant international policies and instruments.

7.2 There are three ways of checking that the EcoQO system has an adequate coverage of all the aspects of the marine environment that need to be included:

a. checking that the issues covered by OSPAR Strategies and other international policies and instruments are adequately covered by the system of EcoQOs. This aspect has been examined in section B of Chapter 3 for OSPAR strategies and in Chapter 5 for other international policies and instruments;

b. the ***internal*** (food-web-based) approach. Under this there would be a systematic analysis of the structure and functioning of the marine ecosystem, to ensure that all the critical parts and functions are covered;

c. the ***external*** (impact-based) approach. Under this there would be a systematic analysis of the external influences on the marine ecosystems, to ensure that their potential effects are covered.

7.3 In practice, it is desirable to combine all three approaches.

The internal (food-web-based) approach

7.4 A thorough examination of the detailed structure and functioning of marine ecosystems would be a major undertaking, which would require a disproportionate effort. Nevertheless, it is possible to carry out a consideration of the outlines of the marine ecosystems to ensure that there is no major facet that has been ignored. In the near-coastal waters, however, the work on biota for the EC Water Framework Directive will be relevant, and the two systems should be developed together.

7.5 For this purpose, it is possible to start from the food web and the reproductive cycles of main populations and to consider for each major level of the food-web whether there are elements of the EcoQO system that reflect the various steps in the food web and in the life cycles of populations.

7.6 In all this, it has to be remembered that the EcoQO system is meant as a practical means of observing the main outlines of the development of marine ecosystems and cannot aim to provide a detailed picture. Any other approach would require a level of resources which cannot be envisaged.

7.7 At a very general level, the following tiers of biota can be identified for both the food web and the production processes:

a. ***phytoplankton:*** the basic influences on the food-web aspects and the production of phytoplankton can be regarded as insolation, hydrographical conditions including stratification and temperature and the availability of nutrients. Insolation and hydrography are aspects of climate variability and change, which as driving forces for biological and ecological variability should be considered in assessments, while not being included in the EcoQO system *per se*. The availability of nutrients, and the resulting growth and production of phytoplankton are covered by the set of EcoQOs relating to eutrophication. There are other relevant factors (such as the transport of phytoplankton in ships' ballast water). The development of the regional management plan under the International Convention on Ballast Water Management should enable this factor to be covered in due course;

b. ***zooplankton:*** zooplankton are not currently identified as an environmental quality element. They play an essential role as the link between phytoplankton and higher levels of the food web. Their dynamics are governed both by physics and by predation by fish and other organisms. Zooplankton should be taken into account in assessments, but they do not lend themselves easily to be used as EcoQOs;

c. ***macrophytes:*** this tier of biota is also not currently identified within the scheme of EcoQOs. It is likely that the habitats EcoQO will need to address some macrophytes (eelgrass for example), Macrophytes grow in shallow water and are specifically included as a quality element for transitional and coastal waters in the EC Water Framework Directive (WFD). There may not therefore be a need for additional inclusion of macrophytes in the EcoQO system, given harmonisation with the WFD. This will, however, vary in different parts of the North Sea, depending on the boundaries of "coastal waters" for the purposes of the Water Framework Directive;

d. ***fish:*** by observing the overall growth, reproduction and stock size of fish populations, both demersal and pelagic, account is taken by the EcoQO system of overall influences on them both from their biotic (prey and predators) and chemical and physical environment (pollution and habitat), as well as of the impacts from fisheries. Specific aspects of the external impacts (fisheries) and environmental conditions will be looked at by the fish size EcoQ (if that proves practicable). Environmental conditions will be specifically examined in assessments, including considerations of water quality (partially studied under the EC Water Framework Directive, and more generally by the JAMP);

e. ***benthic species including crustaceans and molluscs:*** this group of biota may be included in the list of threatened and declining species, (if that proves practicable), and is in addition included in the EcoQOs in relation to human external impacts: through nutrient inputs leading to benthos kills and effects on molluscs by tributyl-tin from ships' hulls, EcoQOs for species identified as threatened or declining may provide links to effects of fishing and dredging;

f. ***reptiles:*** no aspect of reptiles is currently identified specifically by the suite of EcoQOs. In the North Sea, reptiles are not a major tier of biota. At the relatively coarse level of resolution that is represented by the EcoQO system, there does not seem a strong case for seeking to change this;

g. ***seabirds:*** as with fish, overall population figures should serve as a general measure of the way in which food supplies and environmental impacts affect this tier. There is no reflection of direct external human impacts (by-catch by fisheries and hunting being the most obvious forms of external impact). However, there are already identified a range of other specific environmental conditions related to human activities (mercury, organochlorines, plastics, oil pollution). There is also a possible linkage to the FAO international action plan for the protection of seabird populations from fisheries;

h. ***marine mammals:*** the seal species are covered in a way analogous to the fish species in relation to their food supply and environmental conditions affecting reproductive success. Direct human external impact through fisheries, and indirect human external impact through disturbance and habitat loss can also be regarded as covered (particularly if some form of the EcoQO relating to breeding sites can be developed). For harbour porpoise, which is a common and ecologically important small cetacean species in the North Sea, the direct external impact through fisheries is covered by the EcoQO on by-catch in a way which relates the impact to likely changes in population status.

7.8 This brief review suggests that the fields in which it would be appropriate to consider whether there is a case for further EcoQOs would be:

a. water and sediment quality (including the presence of anthropogenic radioactive substances) This aspect may be further developed as part of the work on developing EcoQOs for habitats in addition to it being included in the WFD and in JAMP;

b. whether macrophytes are adequately covered.

The external (impact-related) approach

7.9 The second section of Chapter 3 seeks to carry out an analysis of the impacts of human activities on the marine environment of the North Sea. The conclusions that are reached are that there are cases for considering whether there should be additional EcoQOs for the following issues:

a. the presence of ***radioactive substances*** from anthropogenic sources. This will largely be addressed by the planned collection of data on concentrations in the marine environment (water, and biota). An EcoQO for this should therefore be capable of being developed;

b. ***persistent organic substances*** other than the classical chlorinated compounds (PCBs, DDTs, etc.). There are increasing attentions to new groups of POPs appearing in the marine environment where they may have serious biological effects. These substances include dioxins and brominated flame retardants. It is possible to include such substances in an extended list covered by the EcoQO for seabird eggs. It must also be considered whether there is a need to include other biota such as fish and harbour porpoise (using for instance dead individuals by-caught in fisheries) in the matrixes for analysing and setting EcoQOs for POPs;

b. ***noise pollution*** in relation to fish and marine mammals is an issue that has not been substantively considered by OSPAR. BDC has been asked to give it consideration from the point of view whether it should be examined in more detail. Any further EcoQO in this field would need to await the outcome of this work;

c. the introduction of ***non-indigenous species*** is an issue which is related to shipping, mariculture and other activities such as trade with aquarium organisms. In relation to mariculture, OSPAR has reached the conclusion on the basis of a review by its Biodiversity Committee that this does not justify further work by OSPAR. On that basis, it would not justify further consideration in the context of EcoQOs. Accidental introduction of non-indigenous species in ships' ballast water is, however, a serious issue. In the light of the development of a regional implementation strategy for the new IMO Convention, there is a case for considering an EcoQO in this field;

d. ***use of marine space***: the use of the space in the maritime area is relevant to four aspects of human activities: fisheries, mariculture, oil and gas exploration, placement of offshore structures (including wind-mill parks), placement of cables and pipelines and land reclamation. At present there is little basis on which an EcoQO could be considered for several of these activities. However, with further work on spatial planning of the maritime area, there may be possibilities which could be explored. EcoQOs related to the use of marine space should also be considered in the further work on developing EcoQOs for habitats;

e. ***marine litter:*** as explained in Chapter 6, the issue of the general level of marine litter (of which plastics are the most significant component) is adequately addressed by the EcoQO on plastic contents of seabirds' stomachs. However, the significance of concentrations of marine litter in specific areas – especially coastal areas of breeding importance – is a separate issue which could merit further consideration.

Marine protected areas

7.10 A separate issue is raised by the question of how to measure the success of the OSPAR network of marine protected areas. These areas will be important for the protection of some of the threatened and/or endangered species and habitats. Since much further work is needed on the ecological quality issues relating to threatened and/or declining species and habitats, a means will be desirable to link the reporting on marine protected areas into the EcoQO system.

Conclusion

7.11 There is therefore a case for ensuring that these eight issues are kept under review and action is taken to develop further EcoQOs as and when this seems appropriate.

Chapter 8 - Views of Stakeholders

8.1 A stakeholder workshop "Towards the finalisation of the EcoQO framework and individual EcoQOs" was held in Oslo 13-14 December 2004 where the draft Report on the North Sea Pilot Project was presented. The participants of the workshop were informed about the EcoQO framework and specific EcoQOs.

8.2 The target group of the workshop was representatives from industry organisations representing human activities (such as fisheries, shipping, agriculture, aquaculture), environmental NGOs, government agencies, and scientists. Some attendance from most of these groups was achieved.

8.3 The aim of this workshop was to discuss the opportunities and difficulties connected with the pilot project, and to give stakeholders the possibility to give their views on the pilot project (the report in general, the framework and the individual EcoQOs) before the evaluation of the North Sea pilot project is finalised by OSPAR in 2005.

8.4 The chairman's conclusions from the work programme were as follows:

8.5 The workshop participants welcomed the further opportunity to make an input to the North Sea Pilot Project on ecological quality objectives (EcoQOs). No objections were raised to the general thrust of the project for the development of EcoQOs for the North Sea. The main views expressed can be summarised as follows.

Role of EcoQOs

8.6 It is essential to have a consistent and clear relationship between the EcoQOs resulting from the North Sea Pilot Project and other over-arching goals for the management of human activities affecting the marine environment. This applies particularly to the objectives of the OSPAR thematic strategies and to the strategic goals and objectives of the developing European Marine Strategy, but also applies in such fields as the EC Common Fisheries Policy and OSPAR assessments of the quality status of the marine environment.

8.7 Opinion was divided on whether a complete and coherent set of EcoQOs was essential for an EcoQO system. Some thought that it was. Others took a more pragmatic approach, and thought that developing an EcoQO system would be worth while if it dealt only with those issues where it was necessary to focus political and public opinion on urgent issues.

8.8 A system of EcoQOs can only be justified if it adds value to the existing agreements on goals for the management of human activities affecting the marine environment and the existing related monitoring systems. The report on the pilot project needs to show how this added value is created. Added value can arise in a number of different ways: the existence of a ***system*** of EcoQOs can underpin the delivery of commitments to an ecosystem approach to management; ***individual*** EcoQOs can crystallise general commitments to progress in certain fields and enable management tools to be developed to deliver them; a ***complete set*** of EcoQOs defining an acceptable envelope for marine ecosystems can show whether general commitments to the health and sustainability of the marine environment are being delivered. In order to help judge the value added by a system of EcoQOs, every effort should be made to quantify the costs that it would impose, both through the changes needed in the real world to achieve them, and through the operation of the system itself (particularly in monitoring, reporting and assessment).

8.9 To achieve consistency and clarity, an EcoQO system needs to have an internal logic for the way in which the EcoQOs are expressed. Some of the EcoQOs that are being developed are general indicators of progress with some aspect of ecosystem health and sustainability, rather than specific objectives to be delivered by a particular management system, while others are clearly focused on particular cause/effect relationships. These differences make it difficult to interpret the overall role of the EcoQO system as so far developed. It was suggested that one possible way of clarifying the logic of the EcoQO system was to reflect a distinction between EcoQOs that measure the level of some parameter in the environment and those that set limits to the impacts of some human activity.

8.10 Such difficulties produce problems for stakeholders in understanding the implications of the EcoQO system for themselves and their activities. There is a need to bring out for the different industrial and commercial sectors which EcoQOs are relevant to their activities, and the way in which they interact with each other and with the overall EcoQO system

8.11 Where specific international management arrangements exist for certain human activities affecting the marine environment (such as fisheries or shipping), it must be the competent authorities under those arrangements that take decisions on management actions in the light of OSPAR's assessments of what the EcoQOs show.

8.12 It was not appropriate to expect stakeholders to take "ownership" of the EcoQO system or of individual EcoQOs. EcoQOs should determine, or at least influence, the ways in which regulatory systems are applied to industrial and commercial stakeholders. Such stakeholders can accept those implications, and even in some cases build them into their own internal management systems, but for the most part the EcoQOs will remain for them external pressures rather than internal goals.

Form of EcoQOs

8.13 It is clear that the EcoQOs in the pilot project have different functions. Some EcoQOs are formulated as limits, and thus show what conditions must be avoided Others are formulated as targets, and thus show what conditions are desirable, even though failing to achieve them may be consistent with a healthy and sustainable marine environment. Yet others are formulated as indicators, and thus simply set a threshold for investigations to see whether (and, if so, what) management actions are needed. The different implications of the different forms of EcoQOs (limit and target) need to be brought out. Targets, in particular, can reflect aspirational goals set in the North Sea Ministerial Declarations.

8.14 The EcoQOs are at varying levels in relation to the marine environment. For example, EcoQO (a) (commercial fish stocks) covers twenty-six separate stocks. A question arises whether this should be considered separately in relation to each stock, or whether all the stocks should be aggregated together (perhaps showing the percentage of stocks where the EcoQO is not achieved for the individual stock, as recommended by ICES). If they are aggregated, then important information may be ignored – the North Sea cod or herring stocks have considerably greater significance than some of the other stocks, and if attention is not drawn to failures to meet the EcoQO in relation to them, the wrong impression may be created. This situation should be contrasted with an EcoQO which relates specifically to one aspect of one species (such as EcoQO (e) (by-catch of harbour porpoises). The same issue arises over some of the contaminant EcoQOs.

8.15 If attention is not paid to this question of the proper level of aggregation, misleading pictures may be presented when an attempt is made to give an overall view of the health and sustainability of the ecosystems: ecological quality issues which are disaggregated into separate aspects may be made to appear, unwarrantedly, to be much more significant than others which cover a single aspect.

8.16 However, especially for communicating with the public, the emphasis needs to be on simple, easily understood indicators with an immediate impact on public understanding – and , in particular, on direct cause/effect relationships with identifiable human activities that are subject to regulation.

8.17 This question of aggregation/disaggregation cannot be separated from questions of presentation, because different audiences may need information at different levels of aggregation.

8.18 The forms of the North Sea Pilot Project EcoQOs do not distinguish clearly between those which have a clear cause/effect linkage to specific human activities (such as EcoQO (e) (by-catch of harbour porpoise, which has a direct link to fisheries) and those which are a more generalised index of a range of aspects of the marine environment (such as EcoQO (c) (seal population trends)). This is again an important issue of presentation. The present set of EcoQOs also relates to different aspects of the Driver-Pressure-State-Impact-Response analysis. There is emphasis, in particular, on "state" and "impact". There are arguments for more emphasis on the earlier aspects of the analysis, especially on "pressures".

8.19 The formulation of EcoQOs also needs to be looked at against the terminology used in formulating other systems of objectives, indicators and goals - especially the European Marine Strategy. It is not helpful to have variations between systems which cannot be quickly and easily understood. It would be important to show clearly how EcoQOs relate to the various objectives proposed to be set under the European Marine Strategy, and to the various criteria under the EC Water Framework Directive.

8.20 The form of EcoQOs needs to enable cost-effective monitoring. This may mean that more effort should be put into developing the monitoring of biological effects (including bio-markers) and the monitoring of causes rather than of effects.

Communicating EcoQOs

8.21 It is important that the EcoQO system and its results are communicated effectively to the target audiences. There are at least five different target audiences with different needs (the general public, decision-makers at the political level (including those responsible for allocating regulatory resources), those responsible directly for the regulation of various human activities, commercial and industrial managers in the different sectors and the scientific community).

8.22 An effective communications strategy needs to address these different needs, and also needs to be pro-active: it is not sufficient to make information available and to leave those affected to find out about it for themselves.

8.23 These different needs also have implications for the formulation of EcoQOs and the presentation of results in relation to them. The language and terminology used needs to be consistent for all audiences, but needs to be capable of being understood by each in their own terms.

Spatial and sectoral implications of EcoQOs

8.24 The Pilot Project EcoQOs will have different implications in different areas within the North Sea. An increase or decrease of one percentage point in EcoQO (proportion of oiled guillemots among those found dead or dying on beaches) will have a very different significance in the Shetlands area (where current levels are about 2%) compared with the Netherlands coast (where current levels are about 10%). These spatial differences should be taken into account in setting up the system.

8.25 There will also be varying sectoral implications of some EcoQOs. Some will only be relevant to specific industrial or commercial sectors, while others will be affected by a wide range of such sectors. These varying sectoral implications also should be taken into account.

8.26 At the most extreme, it may be necessary to have variations in some EcoQOs within the North Sea area. For example, if there is a deliberate policy of culling seals in some parts of the North Sea area, then the goal for EcoQO (c) (seal population trends) may need to be modified in such parts.

8.27 Spatial and sectoral implications may also be important for reporting on the outcomes of EcoQOs. In the first place, clarity is needed whether to adopt a “one out, all out” approach to judging whether health and sustainability is being delivered. That is, it must be clear whether a failure to achieve one EcoQO (or one of some group of EcoQOs (such as the suite related to eutrophication)) is to be regarded as meaning that the North Sea is not healthy and sustainable, or whether the judgement can be made that, in spite of some shortfalls, the general objective is being achieved. This is particularly important for the eutrophication EcoQOs, which must be interpreted as a whole.

8.28 In addition, where the EcoQOs are being used as a guide to management response, it will sometimes (or, perhaps, often) be necessary to have different levels of response in different areas because of the different situations (for example, the proportion of oiled sea-birds is much higher hear shipping-lanes). Where this is necessary, reporting for managers may need to be more detailed than reporting for other audiences.

8.29 Where a North Sea Pilot Project EcoQO is linked to a species, it should either be clear that the species is found in much the same way throughout the North Sea. If it is not, and different species are allowed to be used in different parts of the North Sea, there needs to be good scientific evidence of the intercalibration of the species.

Other points

8.30 Sustainability involves three “pillars” – environmental, social and economic factors. The EcoQOs are focused primarily on the first. The second and third must not, however, be forgotten. At the same time, it must be remembered that social and economic policy are essentially for each State (or for each economic integration organisation, like the European Community, to which States’ social and economic functions have been transferred), while all States have an interest in ensuring that other States’ environmental policies do not have adverse transboundary effects.

8.31 The creation of an EcoQO system cannot proceed faster than the available science to underpin it. In some areas, it may be a relatively long time before there is adequate good science to cover some of the aspects which a comprehensive system of EcoQOs needs to cover. At the same time, the need for sound science must not be allowed to over-ride the precautionary principle.

8.32 There was concern over the complexity of the EcoQO system and the cost of implementing it. The development of the EcoQO system should not be at the expense of new initiatives to make changes in the real world by improving ecosystem health.

8.33 In some fields (such as the benthos), there may be good arguments for focusing on communities rather than individual indicator species. In particular, it is inconsistent with the precautionary principle to set as a target the avoidance of “kills” of a species in an area – there must be good reason for action to prevent this before that level is reached. On the other hand, the general public may find it much easier to understand impacts on single species than changes in the composition of communities.

8.34 Some participants considered that it was important for OSPAR to put resources into developing EcoQOs for the threatened and/or declining species and habits and for benthic communities, since these aspects of the marine environment had not yet received sufficient attention, particularly in data collection.

Chapter 9 - Communicating EcoQOs

9.1 Communication with stakeholders has been a central issue all along in the process in developing Ecological Quality Objectives. A stakeholder conference was organised in Scheveningen, the Netherlands in 1999 where methodology developed was applied and parameters for the EcoQOs for the North Sea as a test case were suggested. The proposal was then elaborated by scientists and presented at a stakeholder workshop at Schiphol, The Netherlands in 2001, for discussion.

9.2 A specific strategy is proposed in this chapter to promote the understanding of the EcoQO system, so that stakeholders can learn how it can contribute to achieving a healthy and sustainable marine ecosystem. This strategy recognises the diversity within the group of stakeholders (target groups), the message for each of these groups, the variety of communication means, a time-frame and budget (no budget is included in this chapter) estimate for the implementation, and an approach for the evaluation of the communication strategy.

Target groups

9.3 The following stakeholders have been identified: OSPAR Contracting Parties, EU, National Ministries, Fisheries, Environment- and other relevant Ministries and Agencies, (other) International Regulatory Commissions (e.g. HELCOM, Barcelona Convention), non-governmental organisations (NGOs) including representatives of industries with links to, or effects on, the marine environment (for example, the fishing industry, agriculture and chemical industries) and environmental campaigning organisations, and scientific organisations. There are also other key players in society less directly involved.

Aims of the communication on EcoQOs

9.4 The communication strategy aims to:

a. Increase knowledge and mutual understanding, to assure understanding of the concept of EcoQOs (among others by the general public, sectors, green organisations)

b. Influence attitude, to create involvement and motivation of the stakeholders with respect to EcoQOs so that they contribute to a sustainable use of the sea (sectors)(what sectors?)

c. Change behaviour, to let stakeholders implement EcoQOs (sectors, developers of EcoQOs).

Target groups are specified here to reach the specific aims; developers (policy makers and researchers, managing authorities, sectors and green organisations.

Communication message

9.5. The main message will be that Ecological Quality Objectives contribute to a sustainable use of the sea, by demonstrating responses to management measures to control the impacts of human activities within acceptable levels. By doing so, they safeguard the important role of the sea in supporting sustainable development more generally.

9.6 The EcoQOs are designed to meet several criteria, including the needs for them to be understandable, to relate to human activities that are subject to regulation, and to be underpinned by available information on reference levels for assessment, and by monitoring of what is happening.

9.7 The perception of stakeholders needs to that the EcoQOs are neither ‘difficult’, nor expensive, but useful and provide vital information for achieving healthy and sustainable ecosystems.

9.8 The following messages can be identified for different target groups:

For those developing and making policy and for researchers supporting policy development

a. the advanced EcoQOs as defined for the Pilot Project are ready for implementation;

b. the EcoQOs need to be communicated to stakeholders;

c. some of the less advanced EcoQOs are, and some are not, suitable for further development;

d. many of the EcoQOs can be applied in other regulatory frameworks as well (e.g. EC Water Framework Directive, EC Birds and Habitats Directives, EC European Marine Strategy et cetera), and are already part of existing monitoring programmes (though some refinements may be needed). Therefore, the additional costs are not high;

e. EcoQOs have been set at certain levels, but adjustments may be needed in the future;

For authorities responsible for regulating or managing human activities

f. there are EcoQOs ready to apply for the North Sea;

g. monitoring for most of the EcoQ elements has already been established in existing monitoring programmes;

h. the EcoQOs are often related to other regulatory frameworks, such as the EC Water Framework Directive;

For industrial sectors and environmental campaigning organisations

i. EcoQOs will be applied as part of the OSPAR Strategies. In other words, the overall objectives for management already exist – the EcoQOs simply give more precision to what has already been agreed;

j. EcoQOs are the tools to support the development and application of an ecosystem approach to the management of human activities;

k. where objectives are not reached, (additional) measures will need be taken to reduce the impact of human activities.

Communication means

9.9 There are several ways to communicate the messages to and with the various groups of stakeholders:

For those developing and making policy and for researchers supporting policy development:

a. the aim in this field is to develop the EcoQOs necessary as tools for implementing the ecosystem approach, and to keep an eye open for further developments.

b. to stimulate further development and implementation of EcoQOs, the communication means should facilitate discussion of, and evaluation of experiences with, existing EcoQOs, in order to

   (i) show the value which EcoQOs can add to existing initiatives, by making objectives more precise and by demonstrating clearly whether the initiatives are achieving their stated objectives;

   (ii) identify the need for further development of less advanced, or new, EcoQ(O)s,

   (iii) adjust objectives,

   (iv) improve technical aspects, document information, etc;

c. in addition to the OSPAR-related documents, the most relevant communications means for these goals are: workshops with stakeholders, an internet forum (internal pages), and articles in (scientific) journals;

For authorities responsible for regulating or managing human activities

d. the aim in this field is to speed up the process of implementation process by providing the necessary information.

e. for the implementation of EcoQOs, clear descriptions of them are necessary. For the individual EcoQOs, such descriptions are provided by the background documents on the EcoQOs. But the underlying concept and OSPAR's purposes in developing the EcoQOs need to be clarified.

f. the most relevant communication means are further educational work, discussions, and evaluations. These can be delivered through: (stakeholder) workshops, power-point presentations, an internet forum, fact sheets and newsletters;

For representatives of industrial sectors and environmental campaigning organisations

g. the aim in this field is to facilitate the involvement of stakeholders in the process of development, implementation, and evaluation of EcoQOs.

h. Industrial sectors are the people that may need to take actions to reduce the impact of human activities in order to reach objectives. Although some representatives are, or have been, included in the development of EcoQOs, others on the "shop floor" need to be convinced of the relevance of the objectives that have been set. In contrast to such stakeholders, environmental campaigning organisations do not need to implement measures. But they may need to be convinced of the significance of the EcoQO system for the goals which they are pursuing. For both groups, the need is to establish a two-way traffic of information.

i. as has become clear from the EcoQO workshops, involvement of these stakeholders can best be established by

   (i) increasing participation in the various forums where stakeholders meet,

   (ii) helping representatives from stakeholder organisations to inform their members about meetings that they attend,

   (iii) providing fact sheets and newsletters to explain what EcoQ and EcoQOs are and why we need them, and

   (iv) developing a website;

For the broader audience of people from industrial sectors and environmental campaigning organisations and the general public:

j. the aim in this field is to keep people informed about the concept and application of EcoQOs;

k. several communication means can be used, to provide information, to encourage questions about what is not understood, or to promote discussion.

l. the most appropriate communication means for these purposes are therefore the journals and newsletters of the specific sectors, a web site with internet forum, brochures, etc.

Implementation

9.10 The following communication means should be developed:

a. ***an internet forum site***

A website should be established (probably as part of the OSPAR website) to inform stakeholders, scientists and management about the concept of EcoQOs and details of EcoQO elements (e.g. background documents, evaluations, etc). Within this website, an internet forum site should be developed and managed, to serve as a window for questions, and to discuss experiences and problems with other stakeholders;

b. ***publications in (scientific) journals***

Although background documents have been prepared and the EcoQOs have been evaluated by ICES, further scientific acceptance of the methodology, and specific approaches and objectives, should be pursued, in order to meet the requirements of the Ecosystem Approach. (In future, scientific publication would also provide a means to communicate (monitoring) results on the implementation of EcoQOs).

c. ***Power-Point presentation(s)***

General Power-Point presentations should be developed for use by Contracting Parties, and representatives from stakeholders, as the basis for informing national stakeholders, and by the OSPAR community as the basis for informing international stakeholder organisations.

d. ***Preparation of brochure(s)***

A general (updated) folder should be used to explain OSPAR's concept of EcoQOs and their purpose to a wide audience. These folders should be produced in different languages, but can be of a general nature, that is, not directed to a specific group of stakeholders.

e. ***Preparations of fact sheets, publications in journals and newsletters of specific industrial sectors***

A broad audience of stakeholders (sectors, green organisations, the public in general) can be reached by publications in specific journals and newsletters. For the various sectors, the relevant journals and newsletters should be identified across the North Sea (or even OSPAR wide). Use can be made here of the inventory of human activities related to EcoQOs (BDC 04/2/5). For each human activity, the general concept of EcoQOs and details of the relevant EcoQO elements should be described.

In addition, a newsletter could be established for EcoQOs, to distribute to people involved in the development and implementation of EcoQOs, from authorities, sectors, and green organisations.

Planning

9.11 The following milestones could serve to develop further, and to evaluate progress on, the implementation of this Communication strategy:

BDC 2005: to develop proposals for further elaboration of the Communications strategy;

OSPAR 2005: to consider and approve the BDC work programme, and to establish an intersessional correspondence group;

ICG 2005: to take forwards a stepwise construction of relevant documentation with clear, agreed and univocal messages. The step-wise activities include the preparation of fact-sheets on the overall concept and on individual EcoQOs, the preparation of Power-Point presentation(s), the preparation of folders, establishing a web-site (where the information can be made available), and an internet forum site (for interactive communication).

Once these two lines are established, Contracting Parties should implement "communication", by distributing materials to relevant stakeholders, and to use stakeholder meetings for presentations.

BDC 2006: to evaluate the progress made, and to identify further actions in relation to the implementation of the EcoQOs in general.

Evaluation

9.12 After the implementation of the communication plan, its effect should be evaluated. The important question to answer is whether the aims of the Communication Strategy have been reached or not.

9.13 Understanding of EcoQOs could be evaluated by means of questionnaires or interviews. Alternatively, or in addition, the success of implementing the strategy could be evaluated by listing the "outputs". For example, how many publications have been produced in the various newsletters and journals, how many times has the website been visited, how many participants have made use of the internet forum, how many folders have been distributed?

Chapter 10 - Conclusions and Recommendations

10.1 This chapter summarises the conclusions and recommendations in this report. These conclusions and recommendations apply to the North Sea. Any proposal to apply them in other parts of the OSPAR maritime area would require separate consideration and agreement.

General

10.2 The overall conclusion is that the system of Ecological Quality Objectives (EcoQOs) developed by the Fifth North Sea Conference and set out in the 2002 Bergen Declaration is a workable and scientifically valid system that is a suitable operational tool for implementing the ecosystem approach to the management of human activities and that can add value to the implementation of the OSPAR Strategies, particularly by ensuring the integration of the different themes. However, it is not yet a comprehensive system of EcoQOs, covering all the main aspects of the marine environment.

10.3 Furthermore, there need to be a number of adjustments to refine what was in the Bergen Declaration, and additional steps need to be taken to ensure a successful implementation. Further steps are desirable to bring the EcoQO system to completion.

10.4 As progress is made towards the overall objectives of the five thematic strategies (Biodiversity and Ecosystems, Eutrophication, Hazardous Substances, Offshore Oil and Gas Industry, and Radioactive Substances), conditions should be created which will ensure progressively the achievement of the EcoQOs. There should be no need for separate actions to deliver the EcoQOs in those fields. The EcoQO system can make a valuable contribution towards the monitoring and assessment of the marine environment and the whole set of EcoQOs should therefore periodically be used as part of the thematic and general assessments of the Joint Assessment and Monitoring Programme.

10.5 There are obvious and close links between the EcoQO system and the emerging ideas on the European Marine Strategy. It may be necessary to rethink some of the terminology used in the EcoQO system and to make clear the way in which the OSPAR EcoQO system will relate to the European Marine Strategy.

Global climatic change

10.6 The North Sea EcoQO system does not need to be developed so as to cover the impacts of the human activities that are bringing about global climate change. Those impacts need to be taken into account in any assessment of the health and sustainability of the North Sea, but specific objectives, measures and monitoring should be developed and implemented at the global level.

Types, adoption and application of EcoQOs

10.7 EcoQOs can be targets, limits or indicators as explained in Chapter 2. Each of these types has different implications. When an EcoQO is adopted and applied, it should be made clear which type it is, so that the way in which it will be used is clear. When it is agreed that an EcoQO should be applied, this means that BDC (or the other appropriate body or bodies overseeing its application) should work out the precise means of application. The classifications adopted in this report are provisional, pending further discussion by the OSPAR subsidiary body overseeing the application, which needs to make clear how the application of the EcoQOs should be managed and what are the consequences of a situation where an EcoQO is not met.

Structure of the system of EcoQOs

10.8 There should be some changes in the overall structure and nomenclature of the EcoQ issues, to produce a structure in which there are six issues relating to specific groups of flora and fauna, and three relating to cross-cutting issues (including a single issue relating to eutrophication). They should accordingly be reorganised[22] as follows:

(1) Commercial Fish Species;

(2) Marine Mammals;

(3) Seabirds;

(4) Fish Communities;

[22] The numbering and names from the Bergen Declaration are, however, used in the rest of this chapter.

(5) Benthic Communities;

(6) Plankton Communities;

(7) Threatened and/or Declining Species;

(8) Threatened and/or Declining Habitats;

(9) Eutrophication.

The individual EcoQOs relevant to these issues are discussed below. Where no change is proposed from the formulation in the Bergen Declaration, the EcoQO should be confirmed. In other cases, new formulations are proposed for adoption.

Eutrophication EcoQOs

10.9 There should be an additional (sixth), overarching EcoQ element and EcoQO for the EcoQ issue "eutrophication". This EcoQ element and EcoQO should be formulated as:

EcoQ element: *"Eutrophication status of the North Sea"*

EcoQO: *"All parts of the North Sea should have by 2010 the status of non-problem areas with regard to eutrophication, as assessed under the OSPAR Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area (which consists of the (one-off) Screening Procedure and the (iterative) Comprehensive Procedure)".*

This EcoQO should be adopted as a target.

10.10 This new EcoQO sets an overarching framework for the five EcoQOs (m), (q), (r), (t) and (u) (the "eutrophication EcoQOs"). Together these form an integrated subset, although they have to be assessed in relation to area-specific assessment levels. The eutrophication EcoQOs should be applied as an integrated set. They complement the Comprehensive Procedure of the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area. For the North Sea, they can be seen as part of the target-oriented approach of the Eutrophication Strategy.

10.11 The OSPAR Eutrophication Monitoring Programme provides adequate monitoring for this integrated subset.

10.12 Although some further work is needed on some EcoQOs within this integrated subset, work should start as soon as possible on applying the subset. This should not be delayed until the further work has been completed.

Individual EcoQOs

Ecological quality issue 1. Commercial fish species

Ecological quality element (a): Spawning stock biomass of commercial fish species

10.13 This EcoQO should be confirmed and applied as a limit/indicator. In reporting on this EcoQO, OSPAR will state the proportion of fish stocks for which the operational objective is met, while spelling out the fish stocks for which the objective is not met. OSPAR should use the results of this EcoQO to warn fisheries management authorities of the need for action to reduce fishing mortality.

Ecological quality issue 2. Threatened and/or declining species

Ecological quality element (b): Presence and extent of threatened and declining species in the North Sea

10.14 This EcoQ element should refer to "threatened and/or declining species in the North Sea, as shown on the Initial OSPAR List". More development is needed, in the light of the development of monitoring strategies for the species on the OSPAR List.

Ecological quality issue 3. Marine mammals

Ecological quality element and objective (c): Seal population trends in the North Sea

10.15 This EcoQO should be made more precise and divided into two. The two EcoQOs should be adopted and applied as indicators, with the following formulations:

a. EcoQO for the harbour seal population trend in the North Sea:

"*Taking into account natural population dynamics and trends, there should be no decline in harbour seal population- size (as measured by numbers hauled out) of ≥10% as represented in*

a five-year running mean or point estimates (separated by up to five years) within any of eleven sub-units of the North Sea. These sub-units are: Shetland; Orkney; North and East Scotland; South-East Scotland; the Greater Wash/Scroby Sands; the Netherlands Delta area; the Wadden Sea; Heligoland; Limfjord; the Kattegat, the Skagerrak and the Oslofjord; the west coast of Norway south of 62°N".

b. EcoQO for the grey seal population trend in the North Sea

"*Taking into account natural population dynamics and trends, there should be n o decline in pup production of grey seals of ≥10% as represented in a five-year running mean or point estimates (separated by up to five years), and in breeding sites, within any of nine sub-units of the North Sea. These sub-units are: Orkney; Fast Castle/Isle of May; the Farne Islands; Donna Nook; the French North Sea and Channel coasts; the Netherlands coast; the Schleswig-Holstein Wadden Sea; Heligoland; Kjørholmane (Rogaland)*."

Ecological quality element (d): Utilisation of seal breeding sites in the North Sea

10.16 This EcoQO would not add sufficient value to EcoQO(c), to justify maintaining it as a separate EcoQO, particularly for harbour seals. No further work should therefore be done on it. Where information on the utilisation of grey seal breeding sites in the North Sea is available, it should be used in support of the EcoQO on the grey seal population.

Ecological quality element and objective (e): By-catch of harbour porpoises

10.17 This EcoQO should be confirmed and applied as a limit. At the same time, further work should be done to improve it through incorporating data from France and Norway and examining further the definition of the harbour porpoise substructure.

Ecological quality issue 4. Seabirds

Ecological quality element and objective (f): Proportion of oiled Common Guillemots among those found dead or dying on beaches

10.18 This EcoQO should be confirmed and applied as an indicator. In presenting the results, there should be a differentiation between sub-regions. Further work is needed to define these sub-regions.

Ecological quality element (g): Mercury concentrations in seabird eggs and feathers

10.19 This EcoQO should concern seabird eggs only and be adopted and applied as an indicator, with a formulation as follows:

"The average concentrations of mercury in the fresh mass of ten eggs from separate clutches of common tern (Sterna hirundo) and Eurasian oystercatcher (Haematopus ostralegus) breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, should not significantly exceed concentrations in the fresh mass of ten eggs from separate clutches of the same species breeding in similar (but not industrial) habitats in south-western Norway and in the Moray Firth."

Ecological quality element (h): Organochlorine concentrations in seabird eggs

10.20 The EcoQ element should be renamed "Organohalogen concentrations in seabird eggs". The EcoQO should be adopted and applied as an indicator, with the following formulation:

"*For each site, the average concentrations in fresh mass of the eggs of common tern (*Sterna hirundo*) and Eurasian oystercatcher (*Haematopus ostralegus*) should not exceed: 20 ng* g^{-1} *of PCBs; 10 ng* g^{-1} *of DDT and metabolites; and 2 ng* g^{-1} *of HCB and of HCH. Sampling should be of ten eggs of each species from separate clutches of birds breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, and in similar (but not industrial) habitats in southwestern Norway and in the Moray Firth*."

10.21 Further development work should be undertaken to see whether it can be extended to cover also brominated flame retardants (bromodiphenylether (BDE) congeners (BDE47, BDE99, BDE100 (penta-mix), BDE183 (octa-mix), BDE209 (deca-mix)) and HBCD (hexabromocyclododecane), and TBBP-A (tetrabromobisphenol-A)), together with a suite of dioxins and furans (PCDDs/PCDFs).

Ecological quality element (i): Plastic particles in stomachs of seabirds

10.22 This EcoQO should be adopted and applied as an indicator, with the following formulation:

*"There should be less than 2% of northern fulmars (*Fulmarus glacialis*) having ten or more plastic particles in the stomach in samples of 50–100 beach-washed fulmars found in winter (November to April) from each of fifteen areas of the North Sea over a period of at least five years."*

Ecological quality element (j): Local sand-eel availability to black-legged Kittiwakes

10.23 This EcoQO should be adopted and applied as an indicator with the following formulation:

> *"Breeding success of the black-legged kittiwake (*Rissa tridactyla*) should exceed (as a three-year running mean) 0.6 chicks per nest per year in each of the following coastal segments: Shetland, north Scotland, east Scotland, and east England."*

10.24 France and Norway should be invited to carry out research, comparable to that being put in hand by Germany, to see whether their black-legged kittiwake populations have a diet of sand-eels. If this can be shown, the EcoQO should be extended to the coastal segments concerned.

Ecological quality element (k): Seabird populations trends as an index of seabird community health

10.25 Further development work on this EcoQO should be undertaken.

Ecological quality issue 5. Fish communities

Ecological quality element (l): Changes in the proportion of large fish and hence the average weight and average maximum length of the fish community

10.26 ICES should be invited to consider undertaking the considerable further development work needed on this EcoQO.

Ecological quality issue 6. Benthic communities

Ecological quality element and objective (m): Changes/kills in zoobenthos in relation to eutrophication

10.27 The EcoQO for zoobenthos kills should be confirmed and applied as an indicator, as part of the integrated subset of eutrophication EcoQOs. There should be further development work on an EcoQO for changes in benthic communities. Consideration of this work could start from the identification of lists of area-specific benthic indicator species (or groups of species), (see Annex 1).

Ecological quality element and objective (n): Imposex in dog whelk (Nucella lapillus)

10.28 This EcoQO should be adopted and applied as an indicator, with the following formulation:

> "*The average level of imposex in a sample of not less than 10 female dog whelks (*Nucella lapillus*) should be consistent with exposure to TBT concentrations below the environmental assessment criterion (EAC) for TBT – that is, < 2.0, as measured by the* Vas deferens *Sequence Index, Where* Nucella *does not occur naturally, or where it has become extinct, the red whelk (*Neptunea antiqua*), the whelk (*Buccinum undatum*) or the netted dog whelk (*Nassarius reticulatus*) should be used, with exposure criteria on the same index of <2.0, <0.3 and <0.3, respectively*".

Ecological quality element (o): Density of sensitive (e.g. fragile) species

10.29 Further development should be undertaken on this EcoQO

Ecological quality element (p): Density of opportunistic species

10.30 This EcoQ element is not suitable for the development of an EcoQO.

Ecological quality issue 7. Plankton communities

***Ecological quality element and objective (q): Phytoplankton chlorophyll* a**

10.31 This EcoQO should be adopted and applied as a limit/indicator, as part of the integrated subset of eutrophication EcoQOs, with the formulation:

> *Maximum and mean chlorophyll* a *concentrations during the growing season should remain below a justified area-specific % deviation from background not exceeding 50%.*

Ecological quality element and objective (r): Phytoplankton indicator species for eutrophication

10.32 This EcoQO should in principle be confirmed as an indicator as part of the integrated subset of eutrophication EcoQOs, with a minor amendment so that it reads "*Area-specific phytoplankton eutrophication indicator species should remain below the respective nuisance and/or toxic elevated levels (and there should be no increase in the average duration of blooms)*". However, more work should be done to develop area-specific assessment-levels for phytoplankton abundance.

Ecological quality issue 8. Habitats

Ecological quality element (s): Restore and/or maintain habitat quality

10.33 The EcoQ element should be reformulated as "*Restore and/or maintain the quality and extent of threatened and/or declining habitats in the North Sea, as shown on the Initial OSPAR List*". More development is needed, in the light of the development of monitoring strategies for the habitats on the OSPAR List.

Ecological quality issue 9. Nutrient budgets and production

Ecological quality element and objective (t): Winter nutrient (DIN and DIP) concentrations

10.34 This EcoQO should be confirmed and applied as a limit/indicator, as part of the integrated subset of eutrophication EcoQOs (with a minor amendment to take into account area-specific aspects of background concentrations and assessment levels.

Ecological quality issue 10. Oxygen consumption

Ecological quality element and objective (u): Oxygen

10.35 This EcoQO should be confirmed and applied in the North Sea as a limit/indicator, as part of the integrated subset of eutrophication EcoQOs (with a minor amendment to refer to "area-specific assessment levels"). Further work should be done to achieve specifications for those levels more precise than the current generic "4 – 6 mg oxygen per litre".

The way forward

10.36 There should be a period of reflection on the implications of implementing the EcoQO system, in order to allow for more thought on general issues such as the relationship with the developing European Marine Strategy, the resource implications and the best way of organising the necessary collective work. This should not, however, prevent as much progress as possible being made with the detailed tasks listed in Annex 4 (Draft programme of future work on EcoQOs)

Completing the EcoQO System

10.37 The eight additional issues (water and sediment quality, macrophytes, radioactive substances, persistent organic pollutants, noise, non-indigenous species, use of marine space, marine litter) mentioned in Chapter 7 as possible further elements for the EcoQO system should be kept under review and action should be taken to develop further EcoQOs as and when this seems appropriate.

Communications

10.38 A communications strategy should be implemented. To implement this, the following communication means should be developed: an internet forum site; publications in (scientific) journals; Power-Point presentation(s); brochure(s); fact sheets, publications in journals and newsletters of specific industrial sectors.

10.39 An intersessional correspondence group should be established to manage this communications strategy.

10.40 The communications strategy should be evaluated when it has been in place for a few years.

Annex 1: Descriptions of the ten advanced EcoQOs

The material in this Annex has been prepared by relevant lead countries and summarises the material from the Background Documents

Spawning stock biomass of commercial fish species

1. EcoQ Issue: 1. Commercial fish species

2. EcoQ Element: a) spawning stock biomass of commercial fish species

3. EcoQObjective (as adopted in the Bergen Declaration): (a) Above precautionary reference points for commercial fish species where these have been agreed by the competent authority for fisheries management. In this context, reference points are those for the spawning stock biomass (SSB) used in advice given by ICES in relation to fisheries management.

4. Justification for development of this EcoQO: Although questions of fisheries management are for the competent authorities for fisheries management, OSPAR has responsibilities under Annex IV of the Convention for assessing the health and sustainability of the overall marine ecosystem. Commercial fish species are important components in marine ecosystems. Several species have large populations in the North Sea (e.g. herring and mackerel), and they have major roles in the structuring and functioning of the North Sea ecosystem. North Sea fisheries have a major impact on the North Sea ecosystem, directly on the targeted fish stocks, and indirectly through trophic (e.g. predator-prey) interactions. Inclusion of commercial fish species in the set of EcoQOs for the North Sea is therefore highly relevant if the EcoQO system is to reflect the major features of the marine ecosystem.

5. Technical evaluation:

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	While the science and analysis underpinning this EcoQO are quite complex, the output is readily communicable and understood.
	Sensitive to a manageable human activity	Occasionally	Among the several causes that determine the survival of fish up to the age of spawning, fishing is by far the most important one. By managing fishing activities, it is generally possible to anticipate the size of the spawning stock that would survive after each fishing season. Few exceptions to this rule are short-lived fish like anchovy and sandeel.
	Relatively tightly linked in time to that activity	Usually	The rate of change in SSB following changes in fishing will vary for different stocks, depending on life history and environment.
	Easily and accurately measured, with a low error rate	Usually	The uncertainty in individual assessments is usually known. The status relative to a reference point is less uncertain than the SSB point estimate itself, making the aggregate EcoQO more accurate than individual estimates of SSB and F.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally	Spawning biomass is primarily sensitive to changes in rates of fishing mortality, but changes in spawning stock biomass will also be influenced by year-class strength, the effects of environmental variation and change and food-web interactions.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Exploited fish stocks assessed by ICES are widely distributed in the North Sea.

	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	Excellent time series, often covering several decades, are available.
b.	**Ecological relevance/basis for the metric**	Strong. Commercially exploited stocks dominate fish community biomass.	
c.	**Current and historic levels (including geographic areas)**	Presented in ICES (2003).	
d.	**Reference level**	For North Sea stocks, 100% of stocks above their conservation biomass limit with high probabililty (i.e., >$\mathbf{B}_{pa}$).	
e.	**Limit point**	Consistent with a precautionary approach, anything less than 100% of estimates of stocks above precautionary reference points for spawning biomass would be unacceptable and will trigger management action. Thus 100% would also be the limit reference point.	
f.	**Time frames**	*Detection of change*	Annual changes tabulated from individual assessments.
		Management advice	Every year.
g.	**Advice on EcoQO options (scenarios)**		
h.	**Monitoring regimes**	Routine assessments carried out annually. Information readily available.	
i.	**Management measures to achieve EcoQO**	Autonomous and joint fishery management decisions by the EU and Norway concerning catch and effort limitations, area closures and technical specifications of gears.	

6. Further considerations

The present framework for providing fisheries advice is under revision as a response to plans to increase the use of formalised management plans in fisheries management in the Northeast Atlantic area. SSB-based conservation limits referring to the maintenance of the reproductive capacity of the population will still define the boundaries for management, while targets will be identified based on societal objectives within these boundaries. SSB will remain as the basic conservation parameter and **B**lim as the basic limit reference point. However, the approaches used to ensure a low risk of SSB falling below **B**lim are likely to improve.

Bpa and **F**pa for the majority of stocks are both set on the basis of single-species dynamics assuming that all population dynamics parameters have constant values over time. However, while improvement of these estimates is a priority, ICES recognizes that the move towards the incorporation of climatic or multispecies information into the setting of reference points will have to be incremental.

ICES (2004) advised that this EcoQO should be applied at the aggregate level for all commercial fish stocks and not for each single stock that is managed according to limit and precautionary reference points. There is a strong case for aggregating the results for each of the 26 separate commercial fish stocks for which precautionary reference points have been set, to present each as a separate EcoQO is likely to give an imbalanced picture in relation to the other EcoQOs. It is therefore proposed that the results should be presented by stating the proportion of these fish stocks for which the operational objective is met, while spelling out the fish stocks for which it is not met (so that the environmental, social and economic implications of these failures can be assessed). On this basis, the EcoQO would be reported as “x out of 26 commercial fish stocks are assessed to meet the EcoQO criteria on spawning stock biomass. Those which fail to do so are….”

7. Conclusions

Based upon the overall conclusion that that the biological basis for the EcoQO is sound the conclusions are therefore that:

a. the inclusion of an element on commercial fish species in the EcoQO system should be confirmed;

b. the EcoQO should be taken, as agreed in the Bergen Declaration, as "SSB above precautionary reference points (B_{pa}) for commercial species where these have been agreed by the competent authority for fisheries management";

c. in assessing the marine ecosystem against this EcoQO, OSPAR should report it as proposed above.

8. References

ICES, 2003. Report of the ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 50-62.

ICES, 2004. ICES 2004. Report of the ICES Advisory Committee on Fishery Management and the Advisory Committee on Ecosystems, 2004. ICES Advice. Volume 1, Number 2. 1544pp.

Seal population trends in the North Sea

1. EcoQ Issue: 3. Marine Mammals

2. EcoQ Elements: c) Seal population trends in the North Sea

3. EcoQ Objective (as adopted in the Bergen Declaration): (c) No decline in population size or pup production of >10% over a period of up to 10 years

4. Justification for development of this EcoQO: In general, the public wish to see healthy populations of seals in the North Sea. We cannot tell what a healthy population is, but if the population starts to decline, or large numbers are found dead, there is usually an adverse public reaction.

5. Technical evaluation:

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	
	Sensitive to a manageable human activity	Occasionally	Sensitive to intentional killing; less sensitive to exposure to chemical pollution, habitat disturbance, by-catches or overfishing.
	Relatively tightly linked in time to that activity	Usually	Linked tightly to intentional killing, but not to exposure to pollution.
	Easily and accurately measured, with a low error rate	Usually	Good standardized monitoring methodology.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally	Also sensitive to epizootic events.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Geographical sub-units have been proposed in the suggested new formulation of the EcoQOs to obtain valid trends.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	Consistent methods and long time series.
b.	**Ecological relevance/basis for the metric**	Seals are an important part of the North Sea ecosystem.	
c.	**Current and historic levels (including geographic areas)**	Current and historic levels collected at a fine spatial scale through regular monitoring at specific sites.	
d.	**Reference level**	Largely unknown.	
e.	**Limit point**	Unknown.	
f.	**Time frames**	*Detection of change*	The maximum survey interval is once every five years, but many surveys are annual. Power to detect change varies with species and area.
		Use in advice	Minimum is annual, but changes in advice depend on the power to detect change.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	Well-developed on an area basis. See ICES (2003).	

i.	**Management measures to achieve EcoQO**	Management measures to avoid population decrease caused by directed killing (both licensed and unlicensed) are straightforward and would be timely. For other changes, the initiation of a research programme would be necessary.

6. Further considerations

Grey seals give birth in terrestrial habitats and are best counted as numbers of pups produced per year, while harbour seals give birth in intertidal habitats and are best counted as one-year-old or older seals during the period that they haul-out terrestrially to moult.

This EcoQO would be triggered rather often due to the interannual variations in numbers of seals (both pups counted or numbers on haul-outs). The probable level of "alarms" is felt to be too high, and thus a five-year running mean might be applied to these figures. Such an approach would detect long-term changes in pup production of grey seals or haul-out numbers of harbour seals. The disadvantage of this is that mortality events, such as caused by epizootics, would not trigger the EcoQO. ICES felt that this was not a major disadvantage as large mortality events are already investigated in depth, whereas more subtle long-term changes might be easily overlooked.

The EcoQO as stated in the Bergen Declaration does not differentiate between sub-units of the North Sea and it is unclear whether the EcoQO applies to the whole North Sea population or only to parts of it. It is not scientifically possible or valid to assess trends for the whole North Sea as there is a variation in counting methods depending mostly upon the habitat in which the seals are giving birth or hauling out. Scientifically consistent trends can be derived for sub-units of the North Sea, but it should be noted that these sub-units are not necessarily biologically separate.

7. Conclusions

This EcoQO is still relevant, but needs further definition to take account of the biology and distribution of the two seal species in the North Sea.

8. Reference:

ICES. 2003. Report of the ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 62–68.

Bycatch of harbour porpoises

1. EcoQ Issue: 3. Marine Mammals

2. EcoQ Element: e) Bycatch of harbour porpoises

3. EcoQ Objective (as adopted in the Bergen Declaration): Annual bycatch levels should be reduced to levels below 1.7% of the best population estimate

4. Justification for development of this EcoQO: One of the unwanted side effects of some fishing techniques is the bycatch of marine mammals. In the North Sea it is considered that the bycatch of harbour porpoises in some fisheries is greater than is sustainable by the population. This EcoQO sets a target of achieving sustainability in this bycatch. It should be noted that ultimately all fisheries should be aiming to minimise bycatch to the greatest extent possible, so achieving this EcoQO would be only a step towards this.

5. Technical evaluation:

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	
	Sensitive to a manageable human activity	Usually	
	Relatively tightly linked in time to that activity	Usually	
	Easily and accurately measured, with a low error rate	Rarely	Variance of by-catch is estimated by Vinther and Larsen (2004). CV for one abundance estimate: 14%. Risk of bias due to long intervals between assessments of population abundance.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Measurable, but not measured everywhere in the North Sea at present.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Rarely	EcoQO is based on a single population dynamics simulation modelling, with limited use of North Sea-specific vital rates (IWC, 2000).
b.	**Ecological relevance/basis for the metric**	By-catch in fisheries is the major identified source of human impact on mortality for the North Sea harbour porpoise population.	
c.	**Current and historic levels (including geographic areas)**	No information on historic levels is available. Geographic borders for sub-populations are uncertain; a boundary is drawn across the northern North Sea from about Kinnairds Head (north of Aberdeen) to the Norwegian coast just north of Stavanger.	
d.	**Reference level**	0% (the pre-fisheries level).	
e.	**Limit point**	No limit given; 1.7% of estimated abundance is a provisional precautionary point.	
f.	**Time frames**	*Detection of change*	Change in by-catch is detectable within a year.
		Use in advice	Annual.

g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	Scenarios are not needed. EcoQO is specified.
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	Abundance estimation (see Hammond *et al*., 2002); there are proposals for a 2005 abundance survey. Monitoring of by-catch in all national fisheries by season and area; techniques are described by WGMME. Description of sub-population structure (genetics and biomarkers) (see, e.g., Andersen *et al*. (2001), as well as Tolley and Heldal (2002)). Stage-structured population dynamic modelling (mature, non-mature), with feedback from population level and population structure in by-catches (discussed in IWC, 2000).	
i.	**Management measures to achieve EcoQO**	If reduction in by-catch is required, it may presently be achieved by a number of measures: i) overall effort reduction, ii) use of pingers in fixed gears, iii) gear modifications of fixed gears, iv) gear modifications of pelagic trawls, and v) other mitigation measures (see ICES, 2002). Measures should apply to all North Sea areas.	

6. Further considerations

The metric to which the EcoQO is related requires three pieces of information to specify the EcoQO: (1) an estimate of by-catch, (2) an abundance estimate of harbour porpoises, and (3) information on population sub-structure in the North Sea. Further, estimates of variances are needed for each component to judge the probability of whether the EcoQO is met.

By-catch rates are available from observer programmes in fisheries and from reported strandings. The most recently published information indicates a decline in by-catch in Danish and UK fisheries due to reduced fishing effort during the past ten years (ICES, 2002, 2003; Vinther and Larsen, 2004). However, total fishery by-catch cannot be evaluated because other fisheries (in particular Norwegian and French fisheries) are not yet monitored for by-catch. The European Commission has issued a fishery regulation that reinforces the requirement for monitoring by-catch.

Abundance: There is only one complete estimate of harbour porpoise abundance in the North Sea, from 1994 under the SCANS I project. The North Sea harbour porpoise population was estimated at 300,000, with a CV ≈ 0.14. A new estimate under the SCANS II survey is planned for 2005.

Population sub-structure: The population structure of the harbour porpoise in the North Sea is not well known; however, there is likely to be some geographical structuring (Tolley *et al*., 1999; Tolley and Heldal, 2002). Genetic studies indicate differences between porpoises in the northwestern North Sea and those in the southern North Sea, and between them and porpoises on the Celtic Shelf. There is likely to be further subdivision of the population in the waters surrounding Jutland (ICES, 2003), however the precise boundaries of this sub-structuring are not known (Andersen *et al*., 2001). A relatively arbitrary boundary has been drawn across the northern North Sea from about Kinnairds Head (north of Aberdeen) to the Norwegian coast just north of Stavanger, which is not contradicted by the most recent review (Andersen, 2003).

7. Conclusions

In general, this EcoQO performs well. The weakest aspects of this EcoQO are the lack of full reporting of bycatch from all major fisheries and the comparatively sparse information about the genetic or geographical North Sea population sub-structure of harbour porpoises. The best way of improving the EcoQO would be to improve a) bycatch recording in French and Norwegian fisheries; b) the definition of the North Sea harbour porpoise population substructure after which the underlying model would require further validation.

8. References:

Andersen, L.W. 2003. Harbour porpoises (*Phocoena phocoena*) in the North Atlantic: distribution and genetic population structure. *In* Harbour porpoises in the North Atlantic, pp. 11–29. Ed. by T. Haug, G. Desportes, G.A. Víkingsson, and L. Witting. NAMMCO Scientific Publications, Vol. 5. Tromsø, Norway.

Andersen, L.W., Ruzzante, D.E., Walton, M., Berggren, P., Bjørge, A., and Lockyer, C. 2001. Conservation genetics of harbour porpoises, *Phocoena phocoena*, in eastern and central North Atlantic. Conservation Genetics, 2: 309–324.

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., and Øien, N. 2002. Abundance of the harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39: 361–376.

ICES. 2002. Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report, 254: 2–17.

ICES. 2003. Report of the ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 68-72.

IWC. 2000. Report of the IWC-ASCOBANS Working Group on Harbour Porpoises. Journal of Cetacean Research and Management, 2 (Suppl.).

Tolley, K.A., and Heldal, H.E. 2002. Inferring ecological separation from regional differences in radioactive caesium in harbour porpoises *Phocoena phocoena*. Marine Ecology Progress Series, 228: 301–309.

Tolley, K.A., Rosel, P.E., Walton, M., Bjørge, A., and Øien, N. 1999. Genetic population structure of harbour porpoise (*Phocoena phocoena*) in the North Sea and Norwegian waters. Journal of Cetacean Research and Management, 1: 265–274.

Vinther, M., and Larsen, F. 2004. Updated estimates of harbour porpoise (*Phocoena phocoena*) bycatch in the Danish North Sea bottom-set gillnet fishery. Journal of Cetacean Research and Management, 6: 19–24.

Oiled Guillemots

1. EcoQO Issue: 4. Seabirds

2. EcoQO Element: Proportion of oiled Common Guillemots among those found dead or dying on beaches.

3. EcoQO Objective (as adopted in the Bergen Declaration): The proportion of such birds should be 10% or less of the total found dead or dying, in all areas of the North Sea

4. Justification for the development of this EcoQO: This is a good example of a good EcoQO. The reference point is clear – there should be no guillemots killed by oil. The goal is clear, since the proportion of deaths due to oiling is immediately obvious. There is a clear link to human activities (the illegal discharge of oil), and the public could see the relevance. There were, however some problems, such as the absence of data from two North Sea countries (France and Norway).

It may be sensible to analyse the data by North Sea sub-regions, in order to allow baselines to be set for these regions. A period of at least five years in which an average of less than 10% of the recorded dead or dying common guillemots can be attributed to oiling will be needed before the conclusion that the objective has been reached can be justified statistically. This EcoQO is also linked to the objectives of the Bonn Agreement and MARPOL and the other IMO Conventions aimed at reducing oil pollution.

5. Technical evaluation

		Comments
a.	**ICES criteria**	
	Relatively easy to understand by non-scientists and those who will decide on their use	A guillemot polluted with oil will die soon, because it is not able anymore to dive for gathering food.
	Sensitive to a manageable human activity	The guillemots are sensitive to oil. Input from oil arises mainly from shipping, oil incidents and to lesser extent from the offshore mining industry.
	Relatively tightly linked in time to that activity	A guillemot polluted with oil will die soon, because it is not able to dive to gather food.
	Easily and accurately measured, with a low error rate	Volunteers can search on the beaches for dead guillemots, keeping counts of those polluted by oil. If volunteers are educated the error rate can be very low.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	In a natural situation there should be no oil in the North Sea. All oil pollution originates from Human Activities.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	In each country sub-regions should be chosen to sample the entire coastline appropriately. The selection of sub-regions should take into account local conditions and will vary between countries, with different strategies in those whose coastline is mainly comprised of long sandy beaches and countries where the coast consists of numerous islands, fjords or long stretches of cliff. A representative fraction of the coast directly bordering the sea should be chosen and remain standardised over the years. The length of coast chosen should produce sufficient beached birds of the most common species to enable the calculation of reliable oil rates. Information on the amounts of input of oil should be available.
	Based on an existing body or time-series of data to allow a realistic setting of objectives	The most North Sea countries have already measured oiled guillemots. There are already certain time series.

b.	**Ecological relevance/basic for the metric**	To avoid killing of sea birds by oil.
c.	**Current and historic levels (including geographical areas)**	The most North Sea countries have already measured oiled guillemots. There are already certain time series.
d.	**Reference level**	There should be no Common Guillemots killed by oil.
e.	**Limit point**	
f.	**Time frames**	The average proportion of oiled common guillemots should be 10% or less of the total found dead or dying in each of 15 areas of the North Sea over a period of at least 5 years.
g.	**Advice on EcoQO options (scenarios)**	Ready for implementation in the North Sea.
h.	**Monitoring regimes**	By volunteers. For each count, the following information should be recorded: date, place, km surveyed, km of coast with visible oil, characteristics of the oiling, name(s) of observers, mark used to avoid double counts, completeness of survey and problems encountered, other significant pollution of the beach, list of beached birds.
i.	**Management measures to achieve EcoQO**	The North Sea is a "Special Area" under MARPOL which means that discharge into the sea of oil or oily mixture from any oil tanker and ship over 400 gt is prohibited. See further also OSPAR-OIC agreements with off-shore industry. Other possible measures are related to control and enforcement of MARPOL, prevention, oil recovering/clearing and education.

6. Further considerations

The implementation of this EcoQO can be relatively cheap. In most of the North Sea countries there is already experience with monitoring by volunteers.

The costs depend on the actual situation of the monitoring programme and the length of the coastline. If the programme is running, there is not too much effort to keep it running. Costs are higher when there is no previous base on which to establish the monitoring programme.

On the basis that a national co-ordinator in each country collects data and send this to the international co-ordinator of the lead country costs are estimated at € 1.500 per country (excluding travel costs for the volunteers, which vary per country). The international co-ordination by the lead country is estimated at € 13.250.

7. Conclusions

This EcoQO is almost fully developed. Only information from Norway and France has to be gathered.

The EcoQO is only met in some areas, mainly in the northern North Sea. In most other areas the EcoQO is not met. In some places the amount of oiled guillemots is even over 50%.

8. References

OSPAR Commission, 2005. ISBN 1-904426-91-3. Background Document on the Ecological Quality Objective on Oiled Guillemots - North Sea Pilot Project on Ecological Quality Objectives.

Imposex in dogwhelk Nucella lapillus

1. EcoQO Issue: 6. Benthic Communities

2. EcoQO Element: (n) Imposex in dogwhelk *Nucella lapillus*

3. EcoQO Objective (as adopted in the Bergen Declaration): a low (<2) level of imposex in female dogwhelks, as measured by the Vas Deferens Sequence Index

4. Justification for development of this EcoQO:

TBT, or tributyl tin, has been extensively used as an antifouling agent on ships' hulls. Adverse effects of TBT were demonstrated in the 1980s, when TBT was linked to the incidence of imposex in dogwhelk (*Nucella lapillus*). Imposex is the condition where female individuals develop non-functional male characteristics, eventually leading to sterilisation and a serious population decline. A standard method exists for measuring imposex: the Vas Deferens Sequence Index (VDSI). The dogwhelk is particularly sensitive to TBT, but adverse effects have been demonstrated in other molluscs and in crustaceans. The occurrence of TBT in marine mammals is another cause for concern. The toxicological effects of TBT on molluscs occur at very low concentrations in seawater, below the levels that can currently be routinely measured by most laboratories. Consequently, the existence of TBT contamination is frequently inferred from biological indicators.

5. Technical Evaluation (adapted from ICES, 2004a):

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	Dogwhelks are very sensitive to TBT. A number of scientific reports documenting this are available.
	Sensitive to a manageable human activity	Usually	Several documented cases of a recovery in dogwhelk populations after the decrease in the use of TBT.
	Relatively tightly linked in time to that activity	Usually	Detection of change after a decrease in the use of TBT should be less than 10 years.
	Easily and accurately measured, with a low error rate	Usually	There is a standard method (VDSI).
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	There is a clear cause-effect relationship between the presence of TBT and imposex in dogwhelks.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually or occasionally	Dogwhelks are widely distributed in the North Sea area, but only on rocky substrates and predominantly intertidally.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	Data exist from "pristine areas" where TBT concentrations are zero or almost zero.
b.	**Ecological relevance/basis for the metric**	The cause-effect relationship between the presence of TBT and imposex in dogwhelks is clear and direct. The toxicological effects of TBT on gastropods occur at very low concentrations in seawater, below the levels that can be routinely measured by most laboratories.	
c.	**Current and historic levels (including geographic areas)**	The historical level of TBT is zero, with a corresponding VDSI<0.3. At present, elevated levels occur in many coastal areas. Trends are now decreasing due to regulations on TBT use.	
d.	**Reference level**	Reference level for TBT concentration (and imposex) is zero (VDSI<0.3).	
e.	**Limit point**	VDSI > 5, which means that dogwhelks cannot reproduce.	

f.	**Time frames**	*Detection of change*	Less than ten years.
		Use in advice	
g.	**Advice on EcoQO options (scenarios)**		
h.	**Monitoring regimes**	Monitoring should be focused on areas where the risk of high TBT concentrations is evident (harbours, etc.).	
i.	**Management measures to achieve EcoQO**	There is an IMO resolution banning the presence of TBT on ships' hulls from 2008 onwards. Dumping of dredge spoil from harbours should be avoided in cases where these contain high amounts of TBT. Spoil materials should be assessed for TBT.	

6. Further considerations

The ultimate aim in the OSPAR strategy on Hazardous Substances is to achieve concentrations in the marine environment for man-made synthetic substances such as TBT which are close to zero. It could be argued that 'near zero' concentrations of TBT should result in 'near zero' imposex. Therefore, achieving the EcoQO may not be perceived to meet the OSPAR objective. However, the ecotoxicological assessment criteria (EAC) of TBT in water lies at <0.1ng TBT/l (OSPAR Agreement 1997-15), which would result in a VDSI for *Nucella* of <2. Therefore, the EcoQO can be described as the level of imposex that indicates exposure to TBT concentrations below the EAC derived for TBT. It is expected that achieving the OSPAR EAC will also meet the definition of 'good ecological status' in the *physico-chemical quality elements for specific synthetic pollutants* of the Water Framework Directive (EC).

This EcoQO will provide a basis for monitoring the level of TBT in the environment after the implementation of the IMO resolutions on the restriction of TBT in antifouling paints from 2003, and on the complete ban from 2008.

7. Costs of Implementation:

Costs for monitoring depend highly on the number of sites sampled. Sample sizes should consist of at least 20 females per site. Monitoring of TBT specific biological effects have been a mandatory component of the OSPAR Co-ordinated Environmental Monitoring Programme (CEMP) since 2003. Whether or not the objective is met should therefore be derived from reports on the existing monitoring (not necessarily using dogwhelk), and there should be no additional cost for implementing this EcoQO. The monitoring of intersex in *Littorina sp.* (ICES, 2004b) is not useful for this EcoQ element, because of the lower sensitivity for TBT of this species.

8. Conclusions:

The existence of TBT contamination can be inferred from the level of imposex in the dogwhelk. Also other species of gastropods are sensitive to TBT and are being used already for monitoring TBT pollution. These gastropods are, or may be useful to cover areas where *Nucella* does not occur naturally, or where it has become extinct. Species which are useful, besides the dogwhelk, are red whelk (*Neptunea antiqua*), and to a lesser extent also whelk (*Buccinum undatum*) and netted dog whelk (*Nassarius reticulatus*). The EcoQO for these species should be a level of imposex in female red whelk, whelk and netted dog whelk of respectively <2.0, <0.3 and <0.3, as measured by the VDSI. A consistent approach over the whole OSPAR region, with a selection of relevant species, would be possible.

10. References:

ICES, 2004a. Report of the ICES Advisory Committee on Ecosystems (ACE), 2004

ICES, 2004b. Report of the ICES Working Group on Biological Effects of Contaminants (WGBEC), 2004.

Integrated set of Ecological Quality Objectives for Nutrients and Eutrophication Effects

1. EcoQ Issue:

Issue 6. Benthic communities

Issue 7. Plankton communities

Issue 9. Nutrient budgets and production

Issue 10. Oxygen consumption

Questions to be addressed

The whole suite of EcoQOs will form an important operational component of, and tool for applying, the Ecosystem Approach. The EcoQOs for eutrophication provide the operational and more specific framework for evaluating the 50% nutrient (N and P) reduction target, for assessing whether the general goal "to achieve by the year 2010 a healthy marine environment where eutrophication does not occur" is achieved, and for assessing the need for further action.

The EcoQOs for eutrophication relate to four issues defined in the Bergen Declaration: Issue 9. Nutrient budgets and production; Issue 7. Plankton communities; Issue 10. Oxygen consumption; and Issue 6. Benthic communities.

2. EcoQ elements

The integrated set of pilot EcoQOs for eutrophication was developed in parallel with and derived from the harmonised assessment parameters and their respective assessment levels of the Comprehensive Procedure of the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area[23]. They form part of the target oriented approach of the OSPAR Eutrophication Strategy. The set of eutrophication EcoQOs are interrelated through a eutrophication cause/effect scheme (see Figure 1), which includes the elements below. The categories in roman I, II and III, refer to the classification system of the Comprehensive Procedure, which are specified below:

1. Winter nutrient concentration (Dissolved Inorganic Nitrogen: DIN; Dissolved Inorganic Phosphate: DIP)

   (Category I, Degree of nutrient enrichment)

2.a. Phytoplankton chlorophyll *a*

   (Category II, Direct effects of nutrient enrichment)

2.b. Phytoplankton indicator species for eutrophication

   (Category II, Direct effects of nutrient enrichment)

3. Oxygen

   (Category III, Indirect effects of nutrient enrichment)

4. Changes/kills in zoobenthos in relation to eutrophication

   (Category III, Indirect effects of nutrient enrichment)

3. Integrated set of EcoQOs for eutrophication

Ecological Quality Objectives with respect to nutrients and eutrophication effects were adopted as an integrated set at the 5th North Sea Conference.

The overall ecological objective is to achieve by the year 2010 a healthy marine environment where eutrophication does not occur. This corresponds to a situation where areas are indicated as non-problem areas with respect to eutrophication (see Table 1).

[23] OSPAR agreement, reference number 2005-3, updating and superseding the Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area (reference number: 1997-11), and the Common Assessment Criteria, their Assessment Levels and Area Classification within the Comprehensive Procedure of the Common Procedure (reference number 2002-20).

Specific objectives agreed at the 5th North Sea Conference in relation to eutrophication are[24]:

a. Winter DIN and/or DIP should remain below elevated levels, defined as concentration > 50% above salinity-related and/or region-specific natural background concentrations;

b. Maximum and mean chlorophyll *a* concentrations during the growing season should remain below elevated levels, defined as concentrations > 50% above the spatial (offshore) and/or historical background concentration;

c. Region/area–specific phytoplankton eutrophication indicator species should remain below respective nuisance and/or toxic elevated levels (and increased duration);

d. Oxygen concentration, decreased as an indirect effect of nutrient enrichment, should remain above region-specific oxygen deficiency levels, ranging from 4-6 mg oxygen per litre;

e. There should be no kills in benthic animal species as a result of oxygen deficiency and/or toxic phytoplankton species.

[24] The Ecological Quality Objectives for elements (m), (q), (r), (t) and (u) form an integrated set and cannot be considered in isolation (cf. Bergen Declaration, Annex 3, Table B).

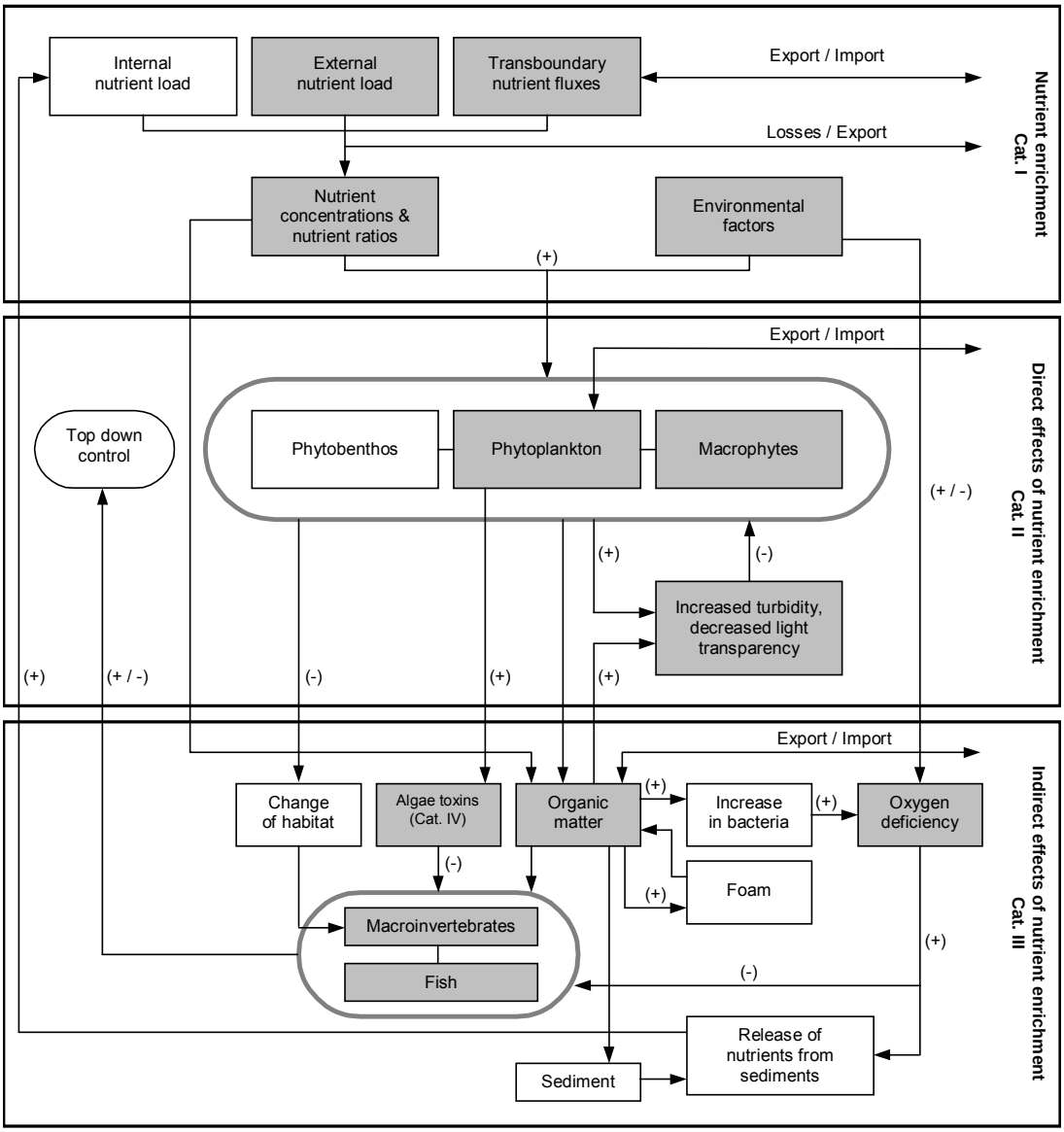

Figure 1. Generic conceptual framework to assess eutrophication in all categories of surface waters

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

An important feature of the eutrophication EcoQOs is that they are area-specific and that the evaluation or assessment should be made on the integrated set. The integration step is explained in detail in the Comprehensive Procedure. Its aim is to classify areas into problem areas, potential problem areas, or non-problem areas (see Table 1).

Table 1. Examples of the integration of categorised assessment parameters to give an initial classification. **The eutrophication EcoQOs are indicated in bold.**

	Category I Degree of nutrient enrichment Nutrient inputs **Winter DIN and DIP** Winter N/P ratio	Category II Direct effects **Chlorophyll *a*** **Phytoplankton indicator species** Macrophytes	Categories III and IV Indirect effects/other possible effects **Oxygen deficiency** Changes/**kills in zoobenthos**, fish kills Organic carbon/matter Algal toxins	Initial Classification
a	+	+	+	problem area
	+	+	-	problem area
	+	-	+	problem area
b	-	+	+	problem area[25]
	-	+	-	problem area[25]
	-	-	+	problem area[25]
c	+	-	-	non-problem area [26]
	+	?	?	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 1

(-) = Neither increased trends nor elevated levels nor shifts nor changes in the respective assessment parameters in Table 1

? = 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.

It follows from Table 1 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 1). In such a situation section 3.2(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.

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 input may be transferred to adjacent areas where they can cause detrimental environmental effects and Contracting Parties shall 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.

4. Justification for the development of the eutrophication EcoQOs

This set of EcoQOs for eutrophication has a clear link to human activities, i.e. activities causing elevated inputs of nutrients. The EcoQOs for nutrients and eutrophication effects are interrelated based upon their cause/effect relationship with nutrient enrichment. They are developed in parallel with the harmonised assessment parameters, and their respective assessment levels, used for the classification of the eutrophication status of the OSPAR maritime areas under the Comprehensive Procedure. For concentrations (except for oxygen) and for N/P ratios, the assessment level is defined as a justified area-specific % deviation from background not exceeding 50%, thereby taking into account natural fluctuations, and allowing

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

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

a certain level of eutrophication (the slight deviation from the background level is actually corresponding to the distinction in good/high status, as defined in the EC Water Framework Directive (see Figure 2)). The elaborated eutrophication EcoQOs should, *inter alia*, be considered as an integrated set to help evaluate the 50% nutrient (nitrogen and phosphorus) reduction target in relation to the general objective, which is to achieve by the year 2010 a healthy marine environment where eutrophication does not occur. They form an integral part of the OSPAR Eutrophication Strategy. The OSPAR Eutrophication Monitoring Programme[27] and its adherent guidelines are available, guaranteeing the production of monitoring data, including supporting environmental information. There is a recognised opportunity to fit the EcoQOs for eutrophication in the context of the Water Framework Directive and the European Marine Strategy.

5. Technical evaluation

The comments in Table 2 are based on previous documents to ETG/EUC and on the advice in 2004, from the ICES Study Group to Review Ecological Quality Objectives for Eutrophication (SGEUT) and ICES Advisory Committee on Ecosystems. The previous ETG/EUC document on EcoQOs for eutrophication related to the Comprehensive Procedure and contained a firm basis on the EcoQOs for eutrophication and for their use as an integrated set and a mechanism for integration. Furthermore, it is also based on an earlier draft, and includes the latest information from the draft updated Comprehensive Procedure and ETG/EUC documents from 2003 on eutrophication EcoQOs.

ICES was asked to give advice on the use and implementation of the current integrated set of eutrophication EcoQOs and to develop a list of zoobenthos indicator species in relation to long-term eutrophication. The evaluation by ICES was done mainly at the scale of Ecological Quality elements because the data necessary to provide a quantitative basis for the review of the EcoQOs area by area were not available. ICES found the five EcoQ elements to be useful, and supported their use as an integrated set. ICES noted, however, that more work was needed in developing the EcoQs into EcoQOs for eutrophication. ICES evaluated the EcoQ elements both individually and in the context of their application as an integrated set. As already indicated in the Comprehensive Procedure, the risk of misinterpretation of the causes of direct and indirect effects is substantially reduced when all categories (nutrient enrichment, direct effects, and indirect effects) as well as supporting environmental information are assessed together.

ICES supported the area-specific aspect as formulated now in the present EcoQOs for eutrophication. ICES noted, however, that the appropriate spatial scale chosen for an area on which to set EcoQOs for eutrophication is not clear and recommended further work on this spatial scale aspect.

In Table 2 and below a further technical evaluation is made for each of the eutrophication EcoQOs of the integrated set.

EcoQO for winter nutrient (DIN and DIP) concentrations in relation to eutrophication

ICES considered winter nutrient concentrations as very useful EcoQ element, since they directly respond to nutrient loads. It was recommended that the EcoQO should be developed only at area-specific scales and that assessments should include the entire water column and salinity gradient in order to determine the concentrations at a relevant, area-specific reference salinity.

The following reformulation of this eutrophication EcoQO is suggested in order to take account of the area-specific aspects: *Winter DIN and/or DIP should remain below a justified salinity-related and/or area-specific % deviation from background not exceeding 50%.*

EcoQO for phytoplankton chlorophyll a *in relation to eutrophication*

ICES considered chlorophyll *a* to be a useful indicator of nutrient conditions and that it should be included in the suite of eutrophication indicator variables. In this respect, it is very important to perform the required monitoring on the area-specific chlorophyll *a* in conjunction with environmental physical and biological conditions (such as light climate and grazing) as prescribed in the Comprehensive Procedure, the OSPAR Eutrophication Monitoring Programme and its adherent guidelines. Although there is no fixed relationship that can be generally applied, there is a positive trend whereby concentrations of chlorophyll *a* are seen to increase with increasing nutrient inputs. Reference conditions (background concentrations) should be determined which will be dependent upon the local conditions in the different types of areas. ICES advised that the robustness of using a constant value of 50% above natural background conditions should be explored for a range of local conditions, to evaluate whether there are circumstances where a different value than 50% could be used to achieve the intent of this EcoQO.

[27] Agreement on the Eutrophication Monitoring Programme, reference number 2005-4, updating and superseding the Nutrient Monitoring Programme, reference number 1995-5.

The following reformulation of this eutrophication EcoQO is suggested in order to take account of the area-specific aspects: *Maximum and mean chlorophyll a concentrations during the growing season should remain below a justified area-specific % deviation from background not exceeding 50%.*

EcoQO for phytoplankton indicator species for eutrophication

Two types of phytoplankton eutrophication indicator species should be distinguished: nuisance and toxic species.

ICES considered that harmful algal blooms most often have no direct relevance to eutrophication, and that toxic algal blooms in response to eutrophication should be regarded as second-order rather than first-order responses.

There is evidence that certain nuisance species blooms are reliable, area-specific indicators of increased nutrient loading and changed N/P ratios in some areas. With respect to toxic species, becoming toxic at low levels, the relationship with nutrient enrichment is less clear. There is some evidence, however, that there may be a relationship with nutrient enrichment and elevated N/P ratios, e.g. for the elevated levels of *Chrysochromulina polylepis* and *Gymnodinium mikimotoi* in Skagerrak and, for the latter species, also in the sedimentation area Oysterground and in the Frisian Front area during stratification. In this respect it is very important to perform the required monitoring on the area-specific phytoplankton indicator species in conjunction with environmental physical and biological factors as prescribed in the Comprehensive Procedure, the Eutrophication Monitoring Programme and its adherent guidelines.

EcoQO for oxygen in relation to eutrophication

ICES considered that oxygen is a useful indicator of eutrophication and should be included in the suite of eutrophication indicator parameters. ICES advised that the development of EcoQOs at area-specific scales should continue, based on measurements taken close to the bottom at the time of year of the annual minimum (autumn). The robustness of the range 4-6 mg oxygen per litre should be explored for a range of local conditions, to evaluate whether there are circumstances where the appropriate value to achieve the intent of this EcoQO may be outside this range. ICES noted that this EcoQO may not be relevant for some areas where a cause/effect relationship cannot be established.

ICES confirmed, as mentioned also in the Comprehensive Procedure, that the risk of misinterpretation of the cause of oxygen depletion is substantially reduced when monitored together with the other categories, e.g. nutrients, phytoplankton, and the area-specific supporting environmental factors.

EcoQO for changes/kills in zoobenthos in relation to eutrophication

Two elements are recognised: kills in zoobenthos, and long-term changes in species composition of the zoobenthos. As indicated in the formulation of the EcoQO, only kills and not changes in the zoobenthos are considered. With regard to kills in zoobenthos in relation to eutrophication, the relationship is clear in case the impact is assessed in relation to the cause/effect scheme that interrelates the different eutrophication EcoQOs. Whereas kills in shallow areas may arise in the short-term, it may take several months to years before oxygen deficiency may be established in deeper areas as a result of long-term eutrophication.

ICES considered that an EcoQO for changes in zoobenthos was premature and that the element needed further development and implementation. ICES advised, however, that the EcoQ element should be retained since the (macro)zoobenthos community provides an integrated response to processes in the water column. Specific actions recommended by ICES included identification of area-specific macrozoobenthos species or groups which are particularly sensitive to oxygen depletion and eutrophication, and the identification of background concentrations (reference levels) and assessment levels for those species and areas. In the view of ETG/EUC, an EcoQO on changes in zoobenthos can be further developed by proposing a list of area-specific (groups of) benthic indicator species in relation to long-term eutrophication, for which no proposals were provided yet by ICES.

Effects on zoobenthos resulting from eutrophication can sometimes be hard to discriminate from those due to other sources of disturbance (sediment contamination, dredging, bottom trawl fishing, etc.). The risk of misinterpretation of the cause of changes in the zoobenthos community is substantially reduced when monitored together with the other eutrophication categories, e.g., nutrients, organic matter, phytoplankton and near-bottom oxygen concentration, as well as monitoring of other relevant activities in the wider context of the JAMP.

Table 2. Evaluation of the integrated set of the five eutrophication EcoQOs

		General and specific comments are based on ETG/EUC documents (Comprehensive Procedure and EcoQO documents), and ICES, see Appendix 1.
a.	**ICES Criteria**	
	Relatively easy to understand by non-scientists and those who will decide on their use	Yes, there is growing awareness about the importance of nutrient levels and their related effects in ecosystems (also as a result of the implementation of the Water Framework Directive for fresh and marine waters).
	Sensitive to a manageable human activity (in relation to measures)	Yes, the EcoQOs for eutrophication are interrelated, following a cause/effect relationship where the cause is linked to anthropogenic inputs of nutrients. Since other environmental factors and human activities may be contribute to the response as well, the risk of misinterpretation of this cause/effect relationship is substantially reduced when a coherent monitoring is performed of all relevant parameters involved (Fig.1).
	Relatively tightly linked in time to that activity (in relation to measures)	The response is more direct and more tightly linked for the direct effect EcoQOs. The links between nutrient input and direct and indirect effects of eutrophication may, however, be spatially and temporally separated through transboundary effects. Ecosystem or environmental factors (e.g. nutrient dynamics in sediments) may cause time lags.
	Easily and accurately measured, with a low error rate (monitoring)	Yes, all elements are part of the JAMP monitoring programme and guidance is available for accurate measurement, including monitoring of the relevant supporting environmental factors (such as salinity, and temperature). Monitoring of direct and indirect effects should be performed in a coherent way, and with appropriate frequency and area coverage.
	Responsive primarily to a human activity with low responsiveness to other causes of change (in relation to measures)	Yes, whereby an integrated monitoring and assessment of the cause/effect-related parameters is needed in order to relate the response to human activities, taking into account environmental factors and (local) ecosystem properties.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply (monitoring)	Yes, all the eutrophication EcoQO metrics are measurable in all areas.
	Based on an existing body or time series of data to allow a realistic setting of objectives (monitoring)	Yes/No. For a number of North Sea areas there are time-series available going back to at least 1990. For some areas, however, there is insufficient information on the eutrophication EcoQOs for phytoplankton indicator species, oxygen deficiency and changes/kills in zoobenthos. Furthermore, frequency and spatial coverage of monitoring has not been satisfactory for some areas.
b.	**Ecological relevance/basis for the metrics**	The integrated set of EcoQOs for eutrophication is area-specific and the ecological relevance is high.
c.	**Current and historic levels (including geographic areas)**	Yes, current area-specific levels are available through the Eutrophication Monitoring Programme and other sources of information. Historic levels on most of the elements are available for some areas.

d.	**Reference level (= area-specific background concentrations)**	Yes, area-specific reference values have been derived, on the basis of historic levels, offshore levels, or by following the salinity-dependent approach. Since the approach used for the setting of reference levels considers area-specific levels, the approach can be applied for other OSPAR and EU marine/estuarine waters.
e.	**Limit points** (area-specific assessment levels)	Yes, assessment levels are area-specific, and allow a certain deviation not exceeding 50% from the related area-specific background to take account of natural variability. The area-specific assessment levels approach, allowing a certain level of deviation, links to the approach of the Water Framework Directive in terms of good and high ecological quality (see Figure 2 and related text). Kills of zoobenthos is an ultimate "limit point" and there is some physiological basis for the limit for oxygen. For the other EcoQOs for eutrophication there is no clear "limit point" (assessment level) elaborated on a biological or ecological basis, except perhaps for some area-specific nuisance and toxic phytoplankton indicator species.
f.	**Time frames**	Detectable changes are estimated to be demonstrated in five to ten years. According to the OSPAR Strategy, eutrophication should no longer occur by the year 2010. Some level of eutrophication is, however, acceptable as long as areas are classified as non-problem areas (see Figure 2).
g.	**Advice on EcoQO options (scenarios)**	-
h.	**Monitoring regimes**	Monitoring of the EcoQOs for eutrophication is established in the Eutrophication Monitoring Programme, which is implemented in all OSPAR areas, including the North Sea. Monitoring includes estuaries, coastal and offshore areas, and has therefore a broader scope than monitoring requirements for the Water Framework Directive. For some (sub) areas, spatial and temporal coverage should be improved. In problem areas, and potential problem areas, monitoring should include all EcoQOs for eutrophication and accompanying environmental factors every year. In non-problem areas only nutrients need to be monitored, and only once per three years.
i.	**Management measures to achieve EcoQOs**	In general: Reduction of nutrient discharges from diffuse sources, point sources and atmospheric deposition. Management measures have been decided upon. The measure under evaluation by means of the set of eutrophication EcoQOs is to reduce nitrogen and phosphorus inputs in the order of 50% compared with 1985. It has to be evaluated if this reduction in nutrient inputs will lead to achievement of the overall objective. Since the nitrogen reduction has not been reached in many areas (generally about 30%), additional attention should be paid to reduction of inputs through agriculture, industries, households, and sewage treatment plants. Tools are available through the OSPAR recommendations and EU Directives.

		Although phosphorus reductions have been successful, nutrient enrichment is still relevant as a result of sediment releases. Alternative measures may be considered to reduce the impacts from nutrient releases, e.g. by creating marsh areas on the fresh-marine interface that store or process nutrients.

6. Further considerations

Link with EC Water Framework Directive and European Marine Strategy

Developments related to EcoQOs for eutrophication and to the EC Water Framework Directive (WFD)[28] could well benefit from each other. There are obvious similarities, but also differences in approaches and in quality elements. The OSPAR classification could be further specified according to the WFD classification into high, good (both non-problem areas), moderate, poor and bad (all problem areas) quality, where the eutrophication EcoQOs provide the borderline between good and moderate quality (see Figure 2).

Since background (reference) levels and assessment levels are area-specific, the approach of eutrophication EcoQOs could also be applied for OSPAR wide marine/estuarine waters and other EU marine/estuarine waters. The link with the European Marine Strategy is currently under examination.

In the context of eutrophication, the OSPAR Comprehensive Procedure seeks to finally divide waters into two classes, non-problem areas (high/good under the WFD), which is the desired state, and problem areas (moderate/poor/bad under the WFD). There is a possibility within the OSPAR Comprehensive Procedure to further discriminate classes of problem areas into moderate, poor and bad. In addition, water bodies which show an elevated level of nutrient enrichment but no or yet unknown levels of eutrophication effects are initially classified as potential problem areas. Latest within five years of their classification, monitoring and assessment in conformity with the Comprehensive Procedure and/or research has to prove whether they finally classify as non-problem or problem areas. It should be noted however, that for example chemical contamination may alter the status of an area from that derived from assessment of eutrophication only. Thus a non-problem area with regard to eutrophication may have moderate-bad quality due to effects of hazardous substances.

As a starting point, the assessment level for some of the assessment parameters established in the first application of the Comprehensive Procedure was defined as a maximum % deviation of 50 compared to the natural background level. For the second application of the Comprehensive Procedure the assessment level shall be determined as a justified area-specific % deviation from background not exceeding 50%. In relation to this, the OSPAR assessment for the coastal areas and the Water Framework Directive's intercalibration process complement each other. In the context of eutrophication, the boundary between a problem area and a non-problem area in the coastal region should align with the boundary between the good and the moderate ecological status in the WFD (see Figure 2).

[28] 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 (hereinafter: the "Water Framework Directive" or "WFD").

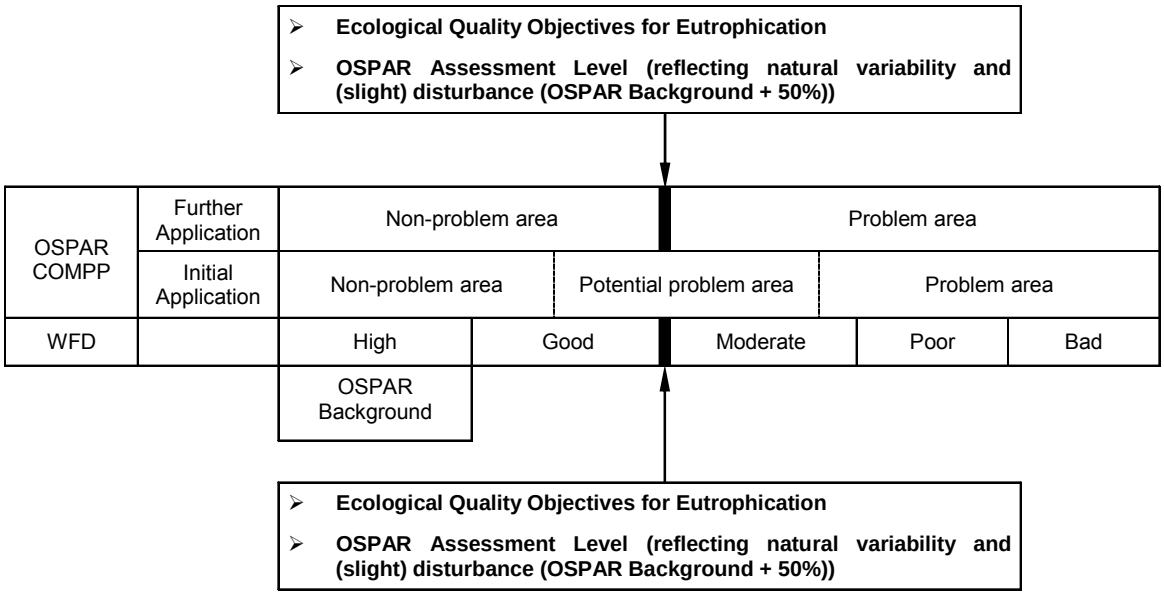

Figure 2: Relationship between the classification under the Comprehensive Procedure, the integrated set of EcoQOs for eutrophication and the Water Framework Directive.

Note: Assessment levels are based on a justified area-specific % deviation from background not exceeding 50%.
OSPAR COMPP = the Comprehensive Procedure; WFD = the Water Framework Directive

The EcoQOs for eutrophication will be used (according to the mechanism as described in the Comprehensive Procedure) to evaluate whether the 50% nutrient (N and P) reduction target (PARCOM Recommendations 88/2, 89/4, and 92/7) is at present sufficient to reach the general ecological objective to achieve by the year 2010 a healthy marine environment where eutrophication does not occur.

7. Cost of implementation

The monitoring of the elements of the EcoQOs for eutrophication is undertaken as part of the Joint Assessment and Monitoring Programme (JAMP), see also Table 2. While monitoring is in place for most parameters in some areas, it is likely that monitoring must be established with higher frequency or extended in other areas. Some additional costs for monitoring of EcoQOs for eutrophication are therefore expected to fulfil the increased spatial and temporal coverage that has been advised for some areas.

Although zoobenthos are included in some monitoring programmes, it is likely that this EcoQO will require some increase in monitoring effort. While documentation of kill events may require dedicated efforts, there is a need to have regular monitoring of benthic species and communities in areas where eutrophication effects on zoobenthos may occur. Analysis of zoobenthos requires taxonomic skills and is time consuming.

8. Conclusions

The following conclusions should therefore be drawn:

a. The integrated set of five area-specific EcoQOs for eutrophication is useful and at present has been developed to the extent possible. They were developed in parallel to the Comprehensive Procedure as part of the target oriented approach of the OSPAR Eutrophication Strategy. They are interrelated through a eutrophication cause/effect scheme and already incorporated in the OSPAR Eutrophication Monitoring Programme. Through practical application they may undergo further development and improvement.

b. An EcoQO on changes in zoobenthos can be developed in relation to long-term eutrophication effects by proposing a list of area-specific (groups of) benthic indicator species.

c. In some areas, monitoring on direct and indirect effects in relation to EcoQOs for eutrophication and the Comprehensive Procedure should be more frequent and have a better coverage. The monitoring should be performed in a coherent way.

d. Results from the first application of the Comprehensive Procedure contained in the “OSPAR integrated report 2003 on the eutrophication status of the OSPAR maritime area based upon the first application of the Comprehensive Procedure” show that there are several problem areas, indicating that the integrated set of EcoQOs for eutrophication has not been met.

e. The present integrated set of five EcoQOs for eutrophication can be adopted within the OSPAR framework and implemented for the North Sea.

f. A new overall OSPAR EcoQO for eutrophication could be formulated as: *All parts of the North Sea should have by 2010 the status of non-problem areas with regard to eutrophication, as assessed under the OSPAR Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area (which consists of the (one-off) Screening Procedure and the (iterative) Comprehensive Procedure).*

g. Some further development of EcoQOs for eutrophication is recommended, especially an EcoQO for changes in zoobenthos in relation to long-term eutrophication. This requires a list of area-specific (groups of) benthic indicator species to be provided by ICES.

h. If additional eutrophication EcoQOs need to be developed because of area-specific ecosystem properties (e.g. zoobenthos indicator species, macrophytes) then this could be done after establishing first the area-specific background concentrations and assessment levels.

Appendix 1

ICES Evaluation of the EcoQOs-eutro

In this Appendix, summary tables from the evaluations of the EcoQOs-eutro by ICES are given. This includes a general assessment by the ICES Advisory Committee on Ecosystems (ACE) and reviews of the individual EcoQs provided by the ICES Study Group to Review Ecological Quality Objectives for Eutrophication (SGEUT) (ICES CM 2004/ACE:04, on request by OSPAR ETG/EUC).

SGEUT evaluated EcoQ elements as "an integrated and coherent set sensitive to required metrics, time and geographical areas within OSPAR purview". In the ACE summary table (Table 1) it is concluded that "all EcoQOs on eutrophication are useful, but that the EcoQO for changes is zoobenthos is premature".

Table 1. Summary of the ICES evaluation of the EcoQ elements, and where relevant, the status of the EcoQOs related to eutrophication. All EcoQOs on eutrophication are part of the North Sea pilot project

Ecological Quality element	Good EcoQ element?	Good EcoQO?
(q) Phytoplankton chlorophyll *a*	Useful	Suggestion offered
(r) Phytoplankton indicator species for eutrophication	Useful (needs development)	Needs work
(t) Winter nutrient (DIN and DIP) concentrations	Useful	Reformulation offered
(u) Oxygen	Useful	Reformulation offered
(m) Changes/kills in zoobenthos in relation to eutrophication	Useful	Premature

Technical evaluation tables according to ICES ACE 2004, and in brackets SGEUT 2004

EcoQ Winter nutrient (DIN and DIP) concentrations in relation to eutrophication

Anthropogenic nutrient input increases the nutrient loads and nutrient pools in coastal and marine waters. During the period of minimum phytoplankton production in winter, this may be reflected in increased levels of the inorganic forms of nitrogen and phosphorus nutrients.

		Comments	
a.	**ICES criteria**	(SGEUT)	
	Relatively easy to understand by non-scientists and those who will decide on their use	Occasionally (yes)	Some public awareness has been raised about the importance of nutrient levels in ecosystems.
	Sensitive to a manageable human activity	Usually (yes)	There is generally a relationship between input and winter nutrient concentrations.
	Relatively tightly linked in time to that activity	Usually (yes)	There may be time delays due to retention and recycling of pools of nutrients in the environment.
	Easily and accurately measured, with a low error rate	Usually (yes)	Salinity-normalized winter nutrient concentrations can be measured using standard oceanographic methods. Coastal area flushing rates are more problematic.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally, Usually (yes/no)	Depends on the magnitude of inputs and flushing rate of receiving coastal water body. Climatic variability (e.g. precipitation, runoff and ocean circulation) may also influence winter nutrient concentrations.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually (yes)	The measurement of coastal nutrients is standard in many monitoring programmes while the measurement of offshore nutrient concentrations is less common.

	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally (yes/no)	Most available data are from the period after anthropogenic sources began to increase. Some information which can be used to estimate historical inputs and, possibly, concentrations is available.
b.	**Ecological relevance/basis for the metric**	High relevance, as nutrients are at the basis of phytoplankton biomass formation.	
c.	**Current and historic levels (including geographic areas)**	At present, there are elevated concentrations to a varying degree in some coastal areas, compared to historical levels. Historical levels are poorly known for almost all areas, however.	
d.	**Reference level**	Two options: either use offshore (unaffected) values or a salinity-dependent approach based on reconstructing or extrapolating to historical loads. The EcoQO should be developed on an area-specific scale.	
e.	**Limit point**	Values are only meaningful on an area-specific scale.	
f.	**Time frames**	*Detection of change*	About ten years. If correction for runoff is possible, maybe five years.
		Use in advice	Application on an area-specific scale.
g.	**Advice on EcoQO options (scenarios)**		
h.	**Monitoring regimes**	High spatial coverage in winter focusing on the salinity gradient.	
i.	**Management measures to achieve EcoQO**	Reduction of anthropogenic nutrient discharges from diffuse sources, point sources, and atmospheric deposition, including transboundary ocean fluxes.	

EcoQ Phytoplankton chlorophyll a *in relation to eutrophication*

Anthropogenic input of nutrients leads to increased growth of plants including phytoplankton. The increased growth is often associated with an increased amount of phytoplankton. This is reflected in an increase in the concentration of the plant pigment chlorophyll *a* which is an indicator of phytoplankton biomass.

		Comments	
a.	**ICES Criteria**	(SGEUT)	
	Relatively easy to understand by non-scientists and those who will decide on their use	Occasionally (yes)	The public and managers are generally aware of the problem of excessive algal growth although they may not be aware of chlorophyll *a* as an entity itself.
	Sensitive to a manageable human activity	Occasionally (yes (clear waters))	Usually in clear-water areas, but not in turbid waters (e.g parts of the Wadden Sea) or where grazers and other controlling factors keep chlorophyll *a* low.
	Relatively tightly linked in time to that activity (i.e., nutrient loading)	Occasionally (yes)	
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally (yes)	Chlorophyll *a* responds also to natural conditions, e.g. physical events and changes in grazer communities.
	Easily and accurately measured, with a low error rate	Usually (yes)	Analytical and sampling procedures are very well known for chlorophyll *a*.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually (yes)	Satellite remote-sensing technology enables estimates of chlorophyll *a* concentrations over large areas.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally (yes)	(But in some areas too low frequency / area coverage of monitoring)
b.	**Ecological relevance/basis for the metric**	Chlorophyll *a* responds directly to nutrients through the growth of phytoplankton, which are consumed by grazers and lead to consumption of oxygen during decomposition.	

c.	**Current and historic levels (including geographic areas)**	Historical time-series data exist for some areas. Where such data are not available, modelling results or offshore data may be used. Tested models exist which could be parameterized to serve this purpose for some areas.	
d.	**Reference level**	See comment for c). These should be made relevant to the area that is being described.	
e.	**Limit point (thresholds)**		Difficult to determine
f.	**Time frames**		Need to be developed for specific geographical locations
g.	**Advice on EcoQO options (scenarios)**		
h.	**Monitoring regimes**	Chlorophyll *a* is included in the OSPAR nutrient monitoring programme. Sampling frequency should be at least monthly and the spatial coverage should be adequate to describe the conditions within the entire water body.	
i.	**Management measures to achieve EcoQO**	Reduction of nutrient discharges from the relevant diffuse sources, point sources, and atmospheric deposition, taking into account transboundary fluxes in the sea.	

EcoQ Phytoplankton indicator species for eutrophication

Increased input of nutrients to coastal and marine waters led to stimulated growth of phytoplankton, including nuisance and/or toxic species. Such species may therefore be used as potential indicator species for eutrophication.

		Comments	
a.	**ICES criteria**	(SGEUT)	
	Relatively easy to understand by non-scientists and those who will decide on their use	Occasionally (yes)	Individual species are easy to understand but there is low public awareness of the importance of individual species.
	Sensitive to a manageable human activity	Occasionally (yes)	Individual species have been demonstrated to be related to known human activities in certain areas.
	Relatively tightly linked in time to that activity	Occasionally (yes)	Where links exist, these are usually tightly linked in time.
	Easily and accurately measured, with a low error rate	Usually, rarely (yes)	Laboratory analysis is accurate with specialist people; however, it is time-consuming, so not *easily* measured. (SGEUT concludes that it can be accurately measured by specialist people.)
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally (yes/no)	In defined areas, the response can be linked to nutrient enrichment (but in open waters it may be more difficult to link.)
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually (yes)	Phytoplankton are measurable over all waters (and should already be at place according to the monitoring programme.)
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally (yes/no)	Time series of phytoplankton species counts exist for some areas (whilst it should be available for all OSPAR areas, according to the monitoring programme.)
b.	**Ecological relevance/basis for the metric**	Understanding of phytoplankton dynamics (both individual species and functional groups) and primary production is essential in defining ecological structure. However, phytoplankton dynamics are highly variable in space and time, and need to be related to specific areas and seasons.	

c.	**Current and historic levels (including geographic areas)**	There exist a few long, high-quality time series on phytoplankton occurrence (>25 years).	
d.	**Reference level**	Dependent on area. Expert groups responsible for monitoring in each area should define reference conditions and action levels.	
e.	**Limit point**	"Limit" in this case may be *upper* limit for abundance of indicator species. Limits will have to be species- and area-specific. (OSPAR data and ecophysiological information is however available (see Comprehensive Procedure))	
f.	**Time frames**	*Detection of change*	Observed changes need to be stable over time to be conclusive. They should deviate substantially from a reference trend. Dependent on the natural variability in the area; responses rarely detectable on time scales of less than five to ten years.
		Use in advice	Unknown until better developed, but likely to require assessments on an annual basis.
g.	**Advice on EcoQO options (scenarios)**		
h.	**Monitoring regimes**	Selection of main observation areas for sampling, usually with need for taxonomic expertise to be available where samples are processed.	
i.	**Management measures to achieve EcoQO**	Reduction of nutrient discharges from diffuse sources, point sources, and atmospheric deposition.	

EcoQ Oxygen in relation to eutrophication

Increased input of nutrients leads to stimulated growth of phytoplankton. This may in turn lead to increased consumption of oxygen by animals nourished by the plants and by micro-organisms decomposing the organic material from plant production. This may cause conditions of low or no oxygen in deeper water layers particularly during periods of stagnation.

		Comments	
a.	**ICES criteria**	(SGEUT)	
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually (yes)	The public and decision-makers are generally aware of the importance of oxygen in water.
	Sensitive to a manageable human activity	Occasionally (yes)	There may be clear relationships between anthropogenic nutrient load and oxygen in some areas. However, low oxygen events may also be caused by natural physical and biological conditions.
	Relatively tightly linked in time to that activity	Occasionally (no)	Oxygen depletion may occur far away (in space and time) from the causal nutrient source due to ocean circulation and stagnation.
	Easily and accurately measured, with a low error rate	Usually (yes)	Methods for measuring oxygen are well known and standardized.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Rarely (no)	Bottom-water oxygen concentrations are determined by a number of different processes besides eutrophication.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually (yes)	Use of 3-D models
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally (yes/no)	For some areas, time series dating back to the 1960s or earlier exist.
b.	**Ecological relevance/basis for the metric**	Oxygen values vary regionally, depending on cause-effect relationships. However, the amount of oxygen in the water can be a critically important property of local areas.	

c.	**Current and historic levels (including geographic areas)**	Area-specific values exist for many areas.	
d.	**Reference level**	Area-specific pre-eutrophication levels and natural variability. Can in some cases be determined by the use of numerical models.	
e.	**Limit point**	Area-specific limit points can be set based on physiological tolerance of species or groups of organisms.	
f.	**Time frames**	*Detection of change*	Five to ten years.
		Use in advice	Depends on local oxygen dynamics; may require frequent sampling, at least at some times and places.
g.	**Advice on EcoQO options (scenarios)**		
h.	**Monitoring regimes**	Oxygen is included in the OSPAR monitoring programme. Measurements should be obtained during the annual minimum (autumn), but the annual cycle in oxygen should also be described. Oxygen profiles with depth should be examined.	
i.	**Management measures to achieve EcoQO**	Reduction of nutrient discharges from diffuse sources, point sources, and atmospheric deposition, where relevant, and to levels necessary to remove oxygen depletion problems.	

EcoQ Changes/kills in zoobenthos in relation to eutrophication

Increased production of plants caused by eutrophication may lead to low oxygen events or blooms of toxic species that may in turn lead to mortality of benthic animals.

		Comments	
a.	**ICES criteria**	(SGEUT)	
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually (yes) (yes)	Changes in zoobenthos are already widely in use in monitoring of human impact on the marine environment. Kill events can receive substantial public awareness if they occur in accessible areas.
	Sensitive to a manageable human activity	Occasionally (yes)	Zoobenthos change or kills can be the result of natural processes not associated with eutrophication.
	Relatively tightly linked in time to that activity	Occasionally (yes)	When kills are the result of eutrophication, they will be linked closely in time to oxygen depletion, but oxygen depletion may not be linked closely in time to anthropogenic causes of eutrophication.
	Easily and accurately measured with a low error rate	Occasionally (yes)	Monitoring experience shows that, with a feasible standard sampling regime designed to account for spatial variability, changes are measured with low error.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally (yes)	Oxygen depletion due to natural causes may cause kills of zoobenthos in some areas. Changes in zoobenthos may also occur due to other human activities such as fishing and dredging.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually (yes)	Measurable in all waters where eutrophication is a problem.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally (yes/no)	Time series of zoobenthos kills are not numerous, but are also not necessary for setting realistic EcoQOs. Sound monitoring regimes have been developed which can allow the incidence of kills to be detected. Interpreting the meaning of a kill event requires knowledge of the cause of the kill (see “Sensitive to a manageable human activity”) more than historical rates.

b.	**Ecological relevance/basis for the metric**	The zoobenthos community provides an integrated response to processes including eutrophication in the water column and in the sediments; thus, responses in the zoobenthos community are useful as an EcoQO of eutrophication, so long as other factors causing zoobenthos change are taken into account. It should be related to the other eutrophication EcoQQs.	
c.	**Current and historic levels (including geographic areas)**	Information on some zoobenthos kill events is available but time series of such events are limited. (SGEUT gives more detail)	
d.	**Reference level**	No kills of species or substantial changes in the benthic community, caused by eutrophication.	
e.	**Limit point**	Kills on scales or with frequencies that place the continuity of the zoobenthos community at risk of irreversible change.	
f.	**Time frames**	*Detection of change*	Depends on factors such as water depth and community type. Zoobenthos kills may require months to years of oxygen depletion to develop.
		Use in advice	Annual monitoring, which would allow annual advice. Opportunistic investigation of kills might allow "fast-track" advice.
g.	**Advice on EcoQO options (scenarios)**		(See SGEUT p. 5)
h.	**Monitoring regimes**	Zoobenthos is included in several monitoring programmes. To be able to document the maximum effects of eutrophication on the zoobenthos, sampling should be undertaken annually just after the annual bottom oxygen minimum period, in addition to a reference monitoring in late spring. Determining the time for optimal sampling may be facilitated by ancillary measurements, e.g., concentrations of nutrients, chlorophyll *a*, and organic matter in the upper mixed layer, and sedimentation rates of particles to the benthos.	
i.	**Management measures to achieve EcoQO**	Control (reduction) of nutrient discharges from diffuse sources, point sources, and atmospheric deposition (if eutrophication is identified as a cause of zoobenthos change).	

Annex 2 - Descriptions of the eleven less advanced EcoQOs

Material in this annex has been prepared on the basis of the reviews of each of the less advanced EcoQOs carried out by ICES. These reviews are published in full in the 2004 Report of the ICES Advisory Committee on Ecosystems (Section 2.1.7.1)[29]

Threatened and declining species

1. EcoQ Issue 2: Threatened and declining species

2. EcoQ Element: (b) Presence and extent of threatened and declining species in the North Sea

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: The general aim of selecting this ecological quality element is to show whether the range of human activities that are leading to species being threatened or put into decline are being adequately managed. Threatened and declining species are those particularly vulnerable to the impact of human activities, and can therefore act as a sensitive measure (a "miner's canary") of whether the combined impact of human activities is being adequately managed. There are roughly five categories of human activities which impact on different groups of threatened and endangered species: fisheries; discharges, emissions and losses influencing water quality; coastal development and/or the use of the seabed in ways which produce habitat loss; trace organic contaminants from antifouling treatments of ships (particularly tributyl tin), and; noise pollution. The regulation of the latter has so far only been addressed by some Contracting Parties in relation to seismic exploration for offshore minerals.

5. Technical evaluation:

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	
	Sensitive to a manageable human activity	Occasionally	Depends on the cause of the decline and source of threat. If threat is by-catch, pollution, etc., it may be very sensitive. If threat is climate change, deplacement by invasive species, etc., it may not be sensitive at all.
	Relatively tightly linked in time to that activity	Occasionally	If threat is direct human-induced mortality (e.g., by-catch), can be very tightly linked. If threat is habitat degradation due to pollution, physical damage, etc., response can be much longer term. If threat is climate change, link is very long-term.
	Easily and accurately measured, with a low error rate	Occasionally	Detectability and ability to measure species trends vary from low to high. Power to detect a change in status of a rare species is very low unless there is extensive sampling.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally	Species-dependent. Depends on type of threat causing the decline (see Sensitive, above).
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	See "easily and accurately measured". If the species can be measured, it can be measured over a large proportion of the area.

[29] ICES 2004. Report of the ICES Advisory Committee on Fishery Management and the Advisory Committee on Ecosystems, 2004. ICES Advice. Volume 1, Number 2. 1544pp.

	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally	Several time series of survey data exist, with additional sampling going back several decades. Identification of rare species is sometimes unreliable (Daan, 2001), and the catchability of species is highly variable.
b.	**Ecological relevance/basis for the metric**	High relevance. Threatened and declining species are an important aspect of management to protect biodiversity. Presence and extent are core aspects of the status of such species.	
c.	**Current and historic levels (including geographic areas)**	Information on presence and extent is highly variable, depending on the species of concern. Information on current and historic levels is certainly *not* available consistently for all species.	
d.	**Reference level**	Not available for any threatened or declining species.	
e.	**Limit point**	There is a large body of scientific literature on setting minimum viable population levels, but many models are untested for species with marine life histories.	
f.	**Time frames**	*Detection of change*	Usually requires a number of years to detect the effectiveness of recovery plans.
		Use in advice	Specific to Recovery Plans.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	Monitoring the status of rare and declining species requires a substantial commitment of resources. Even for species with high catchability in existing surveys, annual levels of survey effort are often inadequate to detect effects in less than a decade.	
i.	**Management measures to achieve EcoQO**	Varied and possibly considerable management effort may be required to implement individual recovery plans. Often requires species-specific recovery plans. Requirements of different plans may conflict, e.g., where two threatened species are predator and prey.	

6. Further Considerations: The technical analysis highlights a number of practical problems with the EcoQ element as proposed. Some formerly abundant but vulnerable species are now too scarce to be caught during monitoring surveys. This means that when conservation concern is greatest, monitoring may provide little or no information on whether species are further declining or starting to recover in response to management action. Species-specific EcoQOs for threatened and declining species would proliferate quickly, because each species would require a separate EcoQO, and there are many candidate species, no subset of which can be considered representative of all such species.

7. **Cost of Implementation**: Not Known

8. Conclusions: Based on this analysis, ICES recommended an alternative EcoQ element and associated EcoQO as a response indicator: “the proportion of all the listed species for which a recovery plan had been prepared and implemented”. For which an appropriate EcoQO would be to achieve 100% adoption of Recovery Plans for all listed. However, this is a measure of the response by management authorities to the issue, rather than a measure of whether management measures are delivering the desired results. The conclusion on this EcoQO is that it should refer to “threatened and/or declining species in the North Sea, as shown in the Initial OSPAR List” and that more development is needed, in the light of the development of monitoring strategies for the species on the OSPAR List.

9. References

ICES 2004. Report of the ICES Advisory Committee on Fishery Management and the Advisory Committee on Ecosystems, 2004. ICES Advice. Volume 1, Number 2. 1544pp.

Utilisation of seal breeding sites in the North Sea

(Prepared by the United Kingdom)

1. EcoQ Issue: Marine Mammals

2. EcoQ Elements: d) Utilisation of seal breeding sites in the North Sea

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for development of this EcoQO: Seal populations can be described by both their population size and distribution. In general, the public wishes the current distribution of seals in the North Sea to be maintained and possibly allowed to increase.

5. Technical evaluation:

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	
	Sensitive to a manageable human activity	Occasionally	Partly to human disturbance.
	Relatively tightly linked in time to that activity	Occasionally	
	Easily and accurately measured, with a low error rate	Usually	Techniques and surveys already exist (ICES, 2003).
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Rarely?	In individual cases, will be responsive, but not always.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	Reviewed by ICES WGMME and predecessors in the past.
b.	**Ecological relevance/basis for the metric**	Seals are an important component of the North Sea ecosystem. Distributional range is important, alongside population size. The public may be concerned if breeding sites disappear.	
c.	**Current and historic levels (including geographic areas)**	Grey seals are known to breed in the following sites in the North Sea: Orkney, Fast Castle/Isle of May, Farne Islands, Donna Nook, northwestern France, The Netherlands, Schleswig-Holstein Wadden Sea, Helgoland, Kjørholmane (Rogaland).	
d.	**Reference level**	The nine sites listed above.	
e.	**Limit point**	Loss of one of the above breeding sites.	
f.	**Time frames**	*Detection of change*	Grey seals are surveyed in most areas of the North Sea on at least a five-year interval. Loss in any one survey would be detectable.
		Use in advice	Every five years at a minimum—biennial or triennial would be possible.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	
		Scenario 2	
		Scenario 3	

h.	**Monitoring regimes**	In most North Sea countries, monitoring capable of detecting loss of breeding site is already being carried out. Methods and survey programmes are described in a number of ICES WGMME reports (see also, e.g., ICES, 2003).
i.	**Management measures to achieve EcoQO**	Reduction in disturbance, or maintenance of low disturbance. Many sites are already in areas protected for nature conservation purposes.

6. Further considerations: No Ecological Quality Objective has been set for this EcoQ element and, as with the seal population trends, the biology of the two seal species makes it sensible to separate the species. The key difference between the species for this EcoQ element is that harbour seals give birth in intertidal habitats, with the precise location apparently being influenced by both tidal and meteorological factors, while grey seals generally give birth in terrestrial habitats. The fluidity of precise breeding locations for many parts of the harbour seal population means that any definition of "site" would need to be drawn rather widely—at present there appears to be insufficient information to show how wide. In contrast, grey seal breeding sites are reasonably well-known and in the UK data exist for location usage over a number of years (OSPAR, 2004). For example, there are 24 locations where grey seals are known to have bred within Orkney (a site). Of these, breeding has ceased at only two since 1960, while breeding has started at several other locations, roughly in parallel to the growing size of the population. There are several well-known grey seal breeding sites further south and east in the North Sea on coasts of the UK, The Netherlands, Germany, and Norway, but the locations used for breeding by the Shetland and French populations are less well-known.

7. Conclusions: In the light of what is known about seal breeding sites at present, an EcoQO would be relevant only in relation to grey seals and only for a limited part of the North Sea, since harbour seal pups leave their birth sites within a matter of hours. Even for the relevant aspects, there is little additional information to be gained for this as compared with the EcoQO on seal populations. This is largely because the reasons for changes in grey seal breeding sites are not clear, and may be related to meteorological conditions.

8. References:

OSPAR. 2004. Progress in the development of EcoQ elements and objectives for seals. OSPAR Biodiversity Committee, Bruges, Belgium, 16–20 February 2004, Document BDC 04/02/08. 12 pp.

Mercury concentrations in seabird eggs and feathers

1. EcoQ Issue: 4. Sea birds

2. EcoQ Element: (g) Mercury concentrations in seabird eggs and feathers

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: Mercury is a highly toxic metal that is introduced into the environment by human activities at a rate that exceeds natural inputs. Mercury levels in seabird eggs provide a very reliable measure of trends over years in local contamination since seabirds feed close to their breeding colony during the period of egg formation. Mercury levels in body feathers reflect mercury in the seabird diet over the summer period prior to moult. Analysis of body feathers of seabird skins in museum collections has demonstrated changes in mercury contamination over the last 150 years in a number of food chains and geographical regions with an approximately four-fold increase in mercury levels over the last 150 years in many North Sea seabirds, thus, an EcoQ to reduce mercury contamination should be a high priority. The analysis of seabird eggs and body feathers could provide a robust way to measure trends in mercury contamination. This can be easily explained to, and understood by, the public and by managers. The main source of mercury has been various types of land-based discharges. The dominant source of these (the chlor-alkali industry) has largely been brought under control, and will progressively decline as the mercury-based process is abandoned. This will leave the emphasis on other land-based sources, particularly large coal-burning power stations. Other minor land-based sources (dentists' amalgam and cremations in particular) have also been addressed

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	There is a clear link between the anthropogenic input of mercury into the environment and the concentration of mercury in bird eggs.
	Sensitive to a manageable human activity	Usually	Mercury in the environment is predominantly anthropogenic.
	Relatively tightly linked in time to that activity	Rarely	Mercury in the environment is very persistent, and tends to increase up food chains. Because of this persistence, a time lag would exist between applying management measures and the response in seabird eggs (and feathers).
	Easily and accurately measured, with a low error rate	Usually	Eggs are readily available and the analytical methods are well established.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally	Mercury concentrations in birds' feathers reflect dietary intake, but this is complicated by a pattern of storage of mercury in soft tissues between moults and excretion of most of the mercury into growing feathers during the moult.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Some seabirds are common and widely distributed.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally	Recent research indicates that, for establishing historic levels of trace metals, bird feathers from mounted specimens in museum collections are of limited use (Hogstad *et al*., 2003). For mercury in eggs, no historical reference material exists.

b.	**Ecological relevance/basis for the metric**	Mercury is a toxic metal that is predominantly introduced into the environment through human activities. Concentrations increase up food chains.	
c.	**Current and historic levels (including geographic areas)**	Levels of mercury in the eggs of several species of seabirds have been monitored for some decades. Current levels vary between areas and species.	
d.	**Reference level**	Given recent evidence concerning the limited use of bird feathers from mounted specimens in museum collections for establishing reference levels (Hogstad *et al*., 2003), a reference level in bird feathers is difficult to establish. A reference level for bird eggs is not possible to establish given the lack of reference material.	
e.	**Limit point**	Unknown	
f.	**Time frames**	*Detection of change*	The persistence of mercury in the environment means that there is a time lag between taking action to reduce inputs and the response in seabird eggs and feathers.
		Use in advice	Reporting annually would be of little use. A two- to five-year reporting cycle would be useful.
g.	**Advice on EcoQO options**	The mercury concentrations in seabird eggs in any area of the North Sea should not significantly exceed the level recorded in seabird eggs from non-industrial reference areas in the North Sea.	
h.	**Monitoring regimes**	A standardization of monitoring is required; monitoring should be implemented in different selected areas, and reference areas should be chosen. The monitoring rate should be annual.	
i.	**Management measures to achieve EcoQO**	Management measures to reduce the input of mercury into the environment are in place. Monitoring mercury for this EcoQO could help in establishing whether the existing measures are successful, or additional measures would be required.	

6. Further Considerations: For eggs sampling should be annual, with a sample size of ten eggs (one per nest) per site and species. Costs and time could be saved by combining the sampling with the sampling for the EcoQO on organochlorine concentrations in seabird eggs, and possibly other monitoring programmes, such as those for monitoring other organohalogen levels.

7. Conclusions: This is a useful EcoQ element, but should be modified to cover only the use of the eggs of seabirds, preferably of common terns and oystercatchers. Although the use of seabird feathers was also originally agreed in the Bergen Declaration, they should not be used for this EcoQ element.

Organochlorine concentrations in seabird eggs

1. EcoQ Issue: 4. Sea birds

2. EcoQ Element: (h) Organochlorine concentrations in seabird eggs

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: Marine pollution with environmental chemicals is a worldwide problem, endangering marine organisms and ecosystem health. Man-made persistent toxic substances such as organochlorines, which decompose only slowly, are of special concern. These substances may affect all ecosystem levels. Seabirds may be harmed, for instance, via impairment of reproduction through eggshell thinning or embryonic mortality. Levels of organochlorines in seabirds show an immediate response to changes in contaminant loads in the marine environment; consequently, they clearly indicate changing levels and reflect changes in anthropogenic discharges and emissions of organochlorines. In this way, the effectiveness of measures of reduction of contamination can be demonstrated. Trend data are available for various parts of the North Sea for nearly forty years. OSPAR has published guidelines for sampling and analysing seabird eggs. The key compounds are PCBs, DDT and metabolites, HCB, and HCH isomers, which can be analysed synchronously using the same analytical procedure.

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	Most organohalogens are man-made substances; their level in birds' eggs provides an indication of their level and trends in the ecosystem.
	Sensitive to a manageable human activity	Usually	Most of these substances enter the ecosystem entirely through human activities.
	Relatively tightly linked in time to that activity	Occasionally	Bioaccumulation and persistence in ecosystems mean that some linkage will occur, but not always.
	Easily and accurately measured, with a low error rate	Usually	A standardization of methods and ways to express the data is necessary.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	Due to the persistence of many of these compounds, it will take many years before they disappear from the environment.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Some seabirds are common and widely distributed.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	For most of these substances, the historic level is zero. For certain substances, time series exist (decades).
b.	**Ecological relevance/basis for the metric**	Organochlorines, and organohalogens in general, are for the most part man-made, and in many cases are highly toxic substances with long half-lives. Seabird eggs offer a reliable way of measuring the levels and trends of these substances in the environment.	
c.	**Current and historic levels (including geographic areas)**	Time series exist for some decades for some organochlorines for some parts of the North Sea. Monitoring for other substances has only started recently. Current levels are different in different areas of the North Sea.	
d.	**Reference level**	Most reference levels would be zero, given the fact that most of these substances are exclusively man-made.	
e.	**Limit point**	Unknown in most cases.	

f.	**Time frames**	*Detection of change*	Given the persistence of most of these substances, firm conclusions on trends and on reaching the EcoQOs can only be made on a relatively long time frame (years).
		Use in advice	Reporting should be on a two- to five-year period.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	The level of most of these contaminants in the environment should be zero, given the fact that they are entirely man-made. Dioxins, however, can arise from combustion, including forest fires, and so have a natural "background" level. Given the long half-lives and the continued, sometimes indirect input into the environment of some of these substances, it is not likely that EcoQOs can be reached in a short or even medium term after cessation of the input.
		Scenario 2	For each site, the average concentrations in fresh mass of the eggs of common tern and Eurasian oystercatcher should not exceed 20 ng g^{-1} of PCBs; 10 ng g^{-1} of DDT and metabolites; and 2 ng g^{-1} of HCB and of HCH. For other substances, EcoQOs (maximum levels) should be established.
		Scenario 3	There should be a downward trend in the levels of these substances in bird eggs in all areas of the North Sea. Levels should reach, or fall below the current levels in non-industrial reference areas.
h.	**Monitoring regimes**	For monitoring purposes, a limited selection of bird species (non-migrating, present in a wide area) should be made, and a further standardization of methods is needed. Also, there should be a further refining of the geographical specificity of monitoring by focusing on areas of high riverine input and other hot spots of organohalogen inputs. With respect to the ongoing atmospheric inputs (especially of PCBs), reference areas where lower organohalogen levels are to be expected should be covered.	
i.	**Management measures to achieve EcoQO**	A number of general measures are in place for the substances currently monitored, but additional measures for certain substances are required. This EcoQO could indicate where additional measures are required, or for which substances, and in which areas reasons for concern exist.	

6. Further Considerations: Any future sampling in relation to this EcoQ should be combined with sampling for the EcoQO on mercury concentrations in seabird eggs.

7. Conclusions: This is a useful EcoQ element. For monitoring purposes, two species of birds should be selected, and methods and ways in which data are expressed should be further standardized. There should also be a further refining of the geographical specificity of monitoring by focusing on areas of high riverine input and other hot spots of organohalogen inputs. This wider standardization of species, monitoring locations, and methods would facilitate broadscale comparisons. This EcoQ element could be widened to include the following organohalogens, which should also be included in monitoring programmes:

a. a range of bromodiphenylether (BDE) congeners intended to cover the three major polybrominated diphenylether (PBDE) formulations which have been, or are still being, used as flame retardants in Europe (minimum of BDE47, BDE99, BDE100 (penta-mix), BDE183 (octa-mix), BDE209 (deca-mix), plus HBCD (hexabromocyclododecane), and TBBP-A (tetrabromobisphenol-A));

b. a suite of dioxins and furans (PCDDs/PCDFs).

Plastic particles in the stomach of seabirds

1. EcoQ Issue: 4. Sea birds

2. EcoQ Element: (i) Plastic particles in stomachs of seabirds

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: Plastics are man-made and not naturally occurring, all plastic found in seabird stomachs is due solely to human activity. Inputs to the marine environment can therefore be controlled by human management intervention. Seabirds ingest plastic particles floating in the seas and oceans, presumably confusing them with food. While some kinds of seabirds regurgitate pellets of indigestible stomach contents, and so lose these plastic pellets, certain kinds of seabirds accumulate these fragments of plastic in their stomach (gizzard) and retain them for many months or years. Large quantities of plastic retained in the gizzard can reduce the ability of a bird to process food, and so can lead to a deterioration in body condition. In the North Sea, the only abundant Procellariiform seabird is the northern fulmar, so this species would be the one to sample to measure plastic burden. It is known to ingest plastic.

The dominant sources of plastics that can end up in sea-birds' stomachs will be:

a. land-based waste-disposal, which is regulated in the same way as other land-based sources of discharges and emissions (where discharges and emissions can be expected) and by specific waste-management regulation (which will also seek to control unexpected/unintended losses);

b. ships' garbage (which is regulated under MARPOL, and by specific measures requiring the landing of wastes before sailing);

c. coastal litter from the public.

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	
	Sensitive to a manageable human activity	Usually	
	Relatively tightly linked in time to that activity	Rarely	There would be a time delay from taking action to reduce plastic input due to the amount and persistence of plastic currently in the system.
	Easily and accurately measured, with a low error rate	Usually	
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	
b.	**Ecological relevance/basis for the metric**	Plastic should not be in the ocean and can have a negative effect on a wide range of organisms. Population-level effects are not known.	
c.	**Current and historic levels (including geographic areas)**	Historical level would be zero, current levels are known; patchy data in between.	
d.	**Reference level**	Zero	

e.	**Limit point**	Unknown	
f.	**Time frames**	*Detection of change*	Not known
		Use in advice	If all plastic litter discharge ceased, the persistence of plastics would mean that it would be a few years (possibly five) for reductions to be detectable in birds.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	No plastic particles in 50–100 fulmar stomachs.
		Scenario 2	<2% of fulmars have ten or more plastic particles in their stomachs.
		Scenario 3	
h.	**Monitoring regimes**	Established and cost-effective, especially if conducted alongside oiled bird surveys.	
i.	**Management measures to achieve EcoQO**	Management actions are in place, but are not enforced or are difficult to enforce. Enforcement of port waste collection and tightening of litter control from landward sources would probably be most effective.	

6. Further Considerations (if required): The work started by the EU-funded "Save the North Sea" project could be continued after its present end date in December 2004. Further investigations are required into the variability in plastic loadings between years.

7. Conclusions: Plastic litter in the sea is a significant pollution problem. It is important to have a satisfactory scientific measure of its prevalence. Stomach contents analysis of beach-washed northern fulmars (*Fulmarus glacialis*) offers a reliable monitoring tool for changes in the abundance of plastic litter at sea. ICES have recommended that the EcoQO should be formulated as:

> *"There should be less than 2% of northern fulmars (Fulmarus glacialis) having ten or more plastic particles in the stomach in samples of 50–100 beach-washed fulmars found in winter (November to April) from each of fifteen areas of the North Sea over a period of at least five years."*

The conclusion on this EcoQO is therefore that it should be adopted and applied as an indicator in the North Sea.

8. References

ICES. 2003 Report of the ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 72-80, 93–95.

Van Franeker, J.A., and Meijboom, A. 2002. LITTER NSV, Marine litter monitoring by northern fulmars; a pilot study. Alterra Green World Research, Alterra rapport 401, Wageningen, The Netherlands. 72 pp.

Van Franeker, J.A., and Meijboom, A. 2003. Marine litter monitoring by northern fulmars: progress report 2002. Alterra Green World Research, Alterra rapport 622, Wageningen, The Netherlands. 49 pp.

Local sandeel availability to black-legged kittiwakes

(Prepared by United Kingdom)

1. EcoQ Issue: 4. Seabirds

2. EcoQ Element: (j) Local sandeel availability to black-legged kittiwakes

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for development of this EcoQO: This EcoQ element uses the black-legged kittiwake *Rissa tridactyla* as an indicator species for the community of predator species that depends on sandeels *Ammodytes marinus* as an important food resource. The EcoQ element assumes that if black-legged kittiwakes are unable to breed successfully for several years in succession, then it is likely that sandeel abundance is low, representing a serious risk of adverse effects on many animal species.

5. Technical evaluation:

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	Number of chicks fledged as an indicator of food availability is relatively easy to understand. Linkage to the status of sandeel stocks is less obvious.
	Sensitive to a manageable human activity	Occasionally	Only sensitive when sandeels are at very low abundance in areas close to breeding colonies (ICES, 2000).
	Relatively tightly linked in time to that activity	Rarely	The effect on breeding success is reflected on a yearly basis; the indicator is only triggered after three years, and benefits of management actions will accrue only in subsequent years.
	Easily and accurately measured, with a low error rate	Usually	Protocol for monitoring chick breeding success is tested and documented.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally	Many factors affect chick breeding success. However, the requirement of a three-year average for the indicator means that the EcoQO is likely to be triggered only by persistent low abundance of sandeel in coastal areas.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Rarely for fishery; Usually for kittiwakes	Applies in areas of Shetland, north Scotland, east Scotland, east England. These are the main kittiwake breeding areas but they only partly overlap with the areas of sandeel fisheries (ICES, 2000).
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	See ICES (2004).
b.	**Ecological relevance/basis for the metric**	High relevance. Black-legged kittiwakes in the above-mentioned areas are considered to feed primarily on sandeels. If kittiwakes are unable to breed successfully for a series of years, it is likely that sandeel abundance is low, which in turn is likely to have adverse effects on many animal species that prey on sandeels.	
c.	**Current and historic levels (including geographic areas)**	See ICES (2004).	
d.	**Reference level**	Estimated from long-term monitoring to be above 0.6 chicks per nest, measured as a running mean over a three-year period.	
e.	**Limit point**		

f.	**Time frames**	*Detection of change*	Minimum of three years.
		Use in advice	Quantify chick production annually. Each year that production is low, examine information on possible causes.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	Scenarios are not needed. EcoQO is specified.
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	The number of chicks in nests can easily be monitored. Standard protocols are well established and widely used (Walsh *et al*., 1995; Mavor *et al*., 2002).	
i.	**Management measures to achieve EcoQO**	Review information on causes of breeding failure of kittiwakes, and trigger research action as appropriate. Consider excluding the sandeel fishery from coastal areas used heavily for seabird foraging.	

6. Further considerations: This use of black-legged kittiwakes as a sentinel assumes that a) the breeding success of black-legged kittiwakes can easily be monitored with a high level of accuracy, and b) black-legged kittiwake breeding success is low when sandeel availability is low within 50 km of the breeding sites.

Environmental influences cause substantial variation in the abundance of small pelagic fish and low sandeel abundance can have many causes other than depletion by industrial fishing. Likewise, unfavourable weather events can cause high mortality of kittiwake chicks, such that a single year of failed breeding is not necessarily indicative of inadequate food supply. Historic evidence indicates that repeated poor fledging over several consecutive years is, however, likely to be the result of inadequate food supply and unlikely to be caused by storms, predators or non-food-related factors. Under the conditions of consistently poor food supply, it is appropriate to consider measures that reduce any potential competition between kittiwakes (and other predators on sandeels) and industrial fisheries, even when the fisheries are not demonstrably the cause of the low availability of sandeels. There is strong evidence that variation in black-legged kittiwake breeding productivity can provide an indication of local variation in the abundance of their fish prey, in this case specifically one-year-old and older sandeels.

Clearly establishing the mechanistic link between 1+-aged sandeel abundance early in the breeding season and subsequent black-legged kittiwake breeding productivity would strengthen the case that this metric is sensitive to a manageable human activity, since the sandeel fishery primarily targets 1+-aged sandeels. Similarly, if 1+ sandeel abundance was to be critically reduced by a fishery at the same time that adult black-legged kittiwakes, building up to breeding condition, were utilizing the same resource, then one might expect the metric to be tightly linked in time to the fishing activity. Breeding productivity two months later on in the same season would be compromised. The performance of this metric with respect to the criterion that it be primarily responsive to a human activity would also be strengthened, but this would still remain the weakest aspect.

7. Conclusions: The proposed EcoQO is considered to be generally sound as a strategy to protect seabirds in part of the North Sea coastal areas from consistent local depletion of sandeels by industrial fishing, and from competition with fisheries in times when food supply is low for three consecutive years or longer. However, it provides no protection against short-term and local unavailability of sandeels, whatever the cause, and provides no information about the ecosystem effects of the fishery in much of the North Sea. Short-term depletions of food supply are not considered to pose a threat of serious or irreversible harm to kittiwake populations unless the depletions are persistent (three years or longer).

8. References:

ICES. 2000. Sandeel/seabird interactions. *In* Report of the ICES Advisory Committee on the Marine Environment, 1999. ICES Cooperative Research Report, 239: 7–10.

ICES. 2004. Report of the Working Group on Seabird Ecology. ICES CM 2004/C:05.

Mavor, R.A., Pickerell, G., Heubeck, M., and Mitchell, P.I. 2002. Seabird numbers and breeding success in Britain and Ireland, 2000. Joint Nature Conservation Committee, Peterborough. UK Nature Conservation, No. 26.

Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W., and Tasker, M.L. 1995. Seabird monitoring handbook for Britain and Ireland. JNCC / RSPB / ITE / Seabird Group, Peterborough.

Seabird population trends as an index of seabird community health

1. EcoQ Issue: 4. Sea birds

2. EcoQ Element: (k) Seabird population trends as an index of seabird community health

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: Seabird populations will be affected by a wide range of human activities, in much the same way as threatened and declining species. On a short-term scale, seabird population size is not the parameter most sensitive to environmental change. Due to the longevity and delayed maturity of most seabirds, several years are usually needed before changes in their reproduction or immature survival rates affect their breeding numbers. Nevertheless, changes in population sizes are reasonably good indicators of important changes in seabird community structure, where density-dependent effects may easily reduce the usability of other population parameters. Furthermore, the population size of breeding birds and birds wintering in coastal areas is far easier to monitor extensively throughout the geographical range of the target populations.

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	
	Sensitive to a manageable human activity	Occasionally	Some human activities directly affect numbers, but most changes are less easily related to any particular factor.
	Relatively tightly linked in time to that activity	Occasionally	Some human activities are tightly linked, but see point above.
	Easily and accurately measured, with a low error rate	Usually	Variable precision and ease of measurement between each species, but generally good.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Rarely	Variable (again); some changes can be linked, but many cannot.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	Those species for which EcoQOs can be established have a good historical body of information.
b.	**Ecological relevance/basis for the metric**	Seabirds are an important part of the North Sea predator and scavenger community.	
c.	**Current and historic levels (including geographic areas)**	Species-dependent, see Mitchell *et al*. (2004) and references therein for up-to-date information.	
d.	**Reference level**	Usually available at a species level.	
e.	**Limit point**	Potentially this could be extirpation or loss of a major colony.	
f.	**Time frames**	*Detection of change*	For some species, annual monitoring would enable detection of relatively rapid and certain change in status (e.g., less than five years), but for other species decadal monitoring would mean that twenty years might be needed.

		Use in advice	As above.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	There are sufficient, quality-assured monitoring regimes in place around the North Sea to be able to provide information to evaluate the state of the EcoQ. If an increase in frequency of monitoring is required, then further resources would be necessary.	
i.	**Management measures to achieve EcoQO**	Species- and case-specific. Some examples exist in the North Sea already. The most expedient way of generating these would be through a "species recovery" or "species action plan" process. The triggering of the EcoQO might lead to further research.	

6. Conclusions: This could be a useful EcoQ element as part of a more advanced framework of EcoQs. A detailed analysis of trends in individual colonies of kittiwakes should be carried out on the existing data (predominantly from UK seabird surveys and monitoring). This could provide for a better understanding of how colony selection may be made to render an EcoQ metric that is representative of the North Sea as a whole. The EcoQO previously suggested by ICES (≤ 20% decline over ≥ 20 years) could act as a precautionary limit to trigger further investigation, but would need to fit into a more advanced framework for EcoQOs before becoming operational.

7. References

ICES. 2003. Report of the ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 95–97.

Fish communities

1. EcoQ Issue: 5. Fish communities

2. EcoQ Element: (I) Changes in the proportion of large fish and hence the average weight and average maximum length of the fish community

3. EcoQ Objective: No objective has been agreed for this ecological quality element.

4. Justification for the development of this EcoQO: In exploited fish assemblages, larger fish generally suffer higher fishing mortality than smaller individuals and the size distribution becomes skewed towards the smaller end of the size spectrum. The susceptibility of late-maturing and larger fish species to fishing implies that small and early-maturing species increase in relative abundance. There is evidence that a change in the size distribution of fish communities in the North Sea has taken place. The average weight or maximum length can be expected to be proportional to fishing effort, though natural factors will impact the size distribution as well. From a conservation perspective, appropriate EcoQOs would move these metrics towards a larger proportion of large fish and would improve fisheries yields. The dominant activity relevant to this EcoQ is fisheries, to which the remarks under ecological quality element (a) are relevant. There may, however, be less direct influences on the reproductive success and life-cycle of fish from land-based sources of discharges and emissions of chemicals.

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	The public clearly understands the importance of the size of fish as a measure of impact.
	Sensitive to a manageable human activity	Usually	
	Relatively tightly linked in time to that activity	Occasionally	Response time can be slow and the response is often non-linear.
	Easily and accurately measured, with a low error rate	Usually	Measurement is straightforward and well-established protocols and surveys exist, usually with an element of quality control.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	Metric is significantly influenced by climate as well as fishing in some ecosystems: in other ecosystems, fishing effects appear to outweigh those of climate.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	
	Based on an existing body or time series of data to allow a realistic setting of objectives	Rarely	Many time series exist in many regions, but they will not necessarily help with the process of setting EcoQOs.
b.	Ecological relevance/basis for the metric	Effects of fishing on fish populations may reflect effects of fishing on other ecosystem components.	
c.	Current and historic levels (including geographic areas)	Trends have been reported by ICES (2003a, 2003b) for the whole North Sea and subunits of the North Sea. Trends demonstrate that average weight and mean maximum length have declined over the period studied.	
d.	Reference level	Not available	
e.	Limit point	Not available	

f.	Time frames	*Detection of change*	Typically more than five years, in some cases more than fifteen years (survey-, metric-, and area-specific), are needed to detect expected responses to management actions.
		Use in advice	Typically more than five years would elapse following a management action before the success of management could be judged.
g.	Advice on EcoQO options (scenarios)	*Scenario 1*	Not available, but would simply be a value of weight and length.
		Scenario 2	Not available
		Scenario 3	Not available
h.	Monitoring regimes	Suitable data for calculating these metrics are already collated on a number of fisheries surveys in the North Sea (ICES, 2003b).	
i.	Management measures to achieve EcoQO	Regulation of the spatial and temporal distribution and intensity of fishing effort.	

6. Further Considerations: While different but spatially comparable surveys have shown similar trends, the actual levels of the metrics have varied considerably. This is not surprising because each gear samples a specific assemblage within the total fish community present, with the bias dependent on the relative catchabilities for individual species. While the absolute bias is unknown, the relative bias among different gears might be evaluated, but this would be a major exercise. At present, we have to accept that different surveys reveal different patterns, and selecting a particular survey as the basis for an EcoQO for a broader area would be arbitrary and involve a specific bias. As different surveys cover different time periods and/or areas, a cross-calibration of surveys would allow an expansion of the spatial extent of coverage.

ICES (2003a) tested the power of a large-scale annual trawl survey (North Sea International Bottom Trawl Survey, IBTS) to detect trends in mean weight and mean maximum length. The analyses showed that the power of the trawl survey to detect short-term trends (five years) in these metrics was generally poor. Thus, while the community metrics did provide good long-term indicators of changes in fish community structure, they would only support long-term rather than short-term management decisions.

There are also concerns with these indicators that the theoretical understanding of their response to fishing is not well developed, because the spatial processes underlying changes in fish community structure are not understood and they are influenced by both direct and indirect fishing effects.

7. Conclusions: The EcoQ element “proportion of large fish” could be meaningful, but considerable further development work is needed on the metrics mean weight and mean maximum length of fish is required. The metrics are closely related to the area fished and the gear used. Reference points that could be developed would therefore also be specific to the surveys and areas.

8. References

ICES. 2002. Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report, 254: 54–59.

Density of sensitive (e.g. fragile) species

1. EcoQ Issue: 6: Benthic communities

2. EcoQ Element: (o) Density of sensitive (e.g., fragile) species

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: The presence of indicator or sensitive species has been identified as a good metric of ecological quality in benthic communities. There are several indicator species, often consisting of habitat-forming species such as corals and epifaunal organisms that are known to be sensitive to bottom fishing disturbance. The use of indicator species obviates the need to identify all species in benthic samples. The fragile species would be the first to disappear under mechanical disturbance of the seabed, especially by towed bottom fishing gears. Examples are the heart-urchin or sea-potato and helmet crab. Sensitive species and their natural densities differ between benthic communities, and in some communities there may not even be an obvious sensitive species.

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	The public has some understanding of "fragile" and "sensitive", but this may not correspond to the interpretation of the term among technical experts. Technical experts do not always agree on what constitutes a "sensitive species" (WGECO, BEWG).
	Sensitive to a manageable human activity	Occasionally	Some good examples exist, but the selection of species to be used in the evaluation is important.
	Relatively tightly linked in time to that activity	Occasionally	When threats to the species are primarily owing to damage by human activities, such as mobile fishing gears and some pollutants, they can be very tightly linked. Broad-scale oceanographic and climatic changes are also responsible for changes in the abundance of many sensitive species.
	Easily and accurately measured, with a low error rate	Rarely or occasionally	Likely to be highly species-dependent. Further research is needed on selected "sentinel" species. Analysis of the pattern of spatial distribution of a number of taxa of bivalves and polychaetes, and seapen species indicated that at the scale of the North Sea, the survey would have little power to detect a change.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Species-dependent	Highly species-dependent. Disruptive human activities are likely to affect the most sensitive species, but many sensitive species are also likely to be affected by biotic and abiotic interactions.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Occasionally	Species-dependent. For species which can be measured well, they are likely to be able to be measured over their full range of distribution.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Rarely	Few time series of zoobenthos exist.

b.	**Ecological relevance/basis for the metric**	Impact on sensitive species is an important issue and these species can play an important ecological role. Life-history traits of sensitive species mean that often many occur together, so site-based protection is therefore important.	
c.	**Current and historic levels (including geographic areas)**	There are limited historical data to identify historical abundance levels. Current levels are completely species-dependent.	
d.	**Reference level**	No long-term and lasting changes of sensitive species in a given benthos community.	
e.	**Limit point**	Reduction of species to abundances where the viability of the population is at risk.	
f.	**Time frames**	*Detection of change*	Although impact may be instantaneous, assessment of density change relies on regular sampling. If sampling is reliable, detection of effects can be rapid.
		Use in advice	Advice would be to cease or move activity causing the impact.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	Status of a species x (one which is readily sampled).
		Scenario 2	Status of species y (one which is very difficult to sample).
		Scenario 3	Status of species z (one which varies greatly in response to environmental forcing).
h.	**Monitoring regimes**	Strategy not yet established for many species in this category, but ICES has provided guidance on appropriate sampling (e.g., North Sea Groundfish Survey).	
i.	**Management measures to achieve EcoQO**	Regulation of human activities would be required to mitigate impact.	

6. Further Considerations: The term “sensitivity” takes into account both the tolerance to and the time needed for recovery from the stressor. Fragile species are considered to be especially susceptible to physical/mechanical disturbance. When choosing sensitive species for individual EcoQOs, priority should be given to the monitoring of species that play a key role in the structure and functioning of structural habitats, e.g., *Modiolus* beds (horse mussel), *Lophelia* reefs (cold-water corals), and *Sabellaria* reefs (polychaete). This is especially relevant for protection purposes because any impact on these kinds of structural habitats may have cascading effects which may be irreversible.

If an EcoQO is applied over all sampling points in the North Sea, spatial distribution of sensitive species means that the variance will be higher, and hence the survey power less, to detect a change in the EcoQO metric of density. To improve this situation, the number of EcoQOs must be increased. At the most biologically realistic scale, the assemblage types defined by the North Sea Benthos Survey, there would be eight EcoQOs for each species with a North Sea-wide distribution; however, most species would not occur in all eight assemblage types.

7. Conclusions: This EcoQ element has the potential to be developed into an effective, but only through wise selection of the species to be used as indicators. The EcoQO should be advanced by the selection of a very limited suite of “sentinel” species rather than extensive lists of such species. This could be made operational, at least for the physical impacts of towed fishing gears on the benthos, requiring, *inter alia*, a further examination of the behaviour of metrics on a range of different scales, and the development of a set of criteria for the rational selection of sensitive species.

Density of opportunistic species

1. EcoQ Issue: 6: Benthic communities

2. EcoQ Element: (p) Density of opportunistic species

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: Some species show a so-called opportunistic response to physical disturbance of the seabed: after disturbance their densities increase. These species are characterised by a short generation time and a high reproductive potential, and some may be used as indicator species. Some examples are the polychaete worms *Spio filicornis, Owenia fusiformis* and *Magelona* spec.

5. Technical evaluation

		Comments	
a.	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Rarely	"Opportunistic" species is not a concept familiar to the public, and technical experts often have trouble developing non-circular definitions of "opportunistic".
	Sensitive to a manageable human activity	Occasionally	Sometimes can respond quickly to human activities that disturb "old" communities, but if already common in an area, they may not show any response at all to further perturbation.
	Relatively tightly linked in time to that activity	Occasionally	Many definitions of "opportunistic" mean that they necessarily respond rapidly to *any* major change. Abundances are likely to be highly patchy in space and variable in time.
	Easily and accurately measured, with a low error rate	Rarely	With a sample size of one, temporal variance cannot be estimated. Hence, comparing annual survey data will require an alternative approach, and simple temporal trend analysis of annual means may be more appropriate. Alternatively, one could perhaps aggregate years of data, and compare the means of five annual mean density estimates between two groups of five years of data, deriving the temporal variance from each set of five individual annual means.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Rarely	Environmental factors are also responsible for change in the density of opportunistic species and it is very difficult to partition effects of human activities.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Changes can be measured if sampling programmes exist.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Rarely	Few time series of zoobenthos exist.
b.	**Ecological relevance/basis for the metric**	There are many causes of change of opportunistic species, including human activity. These changes can be ecologically important.	

c.	**Current and historic levels (including geographic areas)**	Historical levels of sampling are insufficient to identify time series changes. The whole concept of a "natural" level of abundance for an opportunistic species may be questionable.	
d.	**Reference level**	Inappropriate concept.	
e.	**Limit point**	Inappropriate concept.	
f.	**Time frames**	*Detection of change*	Within weeks/months.
		Use in advice	Cease or reduce perturbation which is making conditions suitable for opportunistic species.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	Although impact may be instantaneous, assessment of density change relies on regular sampling. Few monitoring regimes are currently in place for any zoobenthos.	
i.	**Management measures to achieve EcoQO**	Cessation or relocation of activities.	

5. Conclusions: Opportunistic species are ubiquitous and hard to define unambiguously. Their status is difficult to quantify with accuracy and precision, and changes in abundance are not closely linked to specific human impacts; thus, they may fail to correctly trigger management actions. The conclusion therefore is that this EcoQ element is not suitable for the development of an EcoQO.

Restore and/or maintain habitat quality

1. EcoQ Issue: 8: Habitats

2. EcoQ Element: (s) Restore and/or maintain habitat quality

3. EcoQ Objective: No objective has been agreed for this ecological quality element

4. Justification for the development of this EcoQO: Threatened and declining habitats are obvious candidates in need for protection measures and associated EcoQOs as management objectives supporting those measures. The OSPAR Annex V strategy gives priority to the identification of threatened and declining species and habitats. Once such habitats have been identified in the ongoing process in BDC, appropriate specific EcoQOs can be worked out and agreed in the process of considering measures.

5. Technical Evaluation

		Comments	
a.	**ICES Criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	Public awareness for protecting "habitat quality" is high. However, the definition of quality is lacking, and there are significant challenges to developing an unambiguous science-based definition.
	Sensitive to a manageable human activity	Usually for oyster beds, littoral chalk communities, and intertidal mudflats	The decline is due to damage by fishing activities, and land reclamation and littoral structures. In general, many types of habitats can be sensitive to management activity, particularly in natural "low energy" environments (not exposed to frequent natural disturbance by waves, storms, strong currents, etc.).
	Relatively tightly linked in time to that activity	Occasionally	The status of oyster beds is closely linked in time with fishing and overexploitation. Littoral chalk community status is directly linked to land reclamation and littoral defence structures.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	The threats are significant primarily as a result of the relatively restricted distribution and small total area of these habitat types.
	Easily and accurately measured, with a low error rate	Usually	Mapping procedures are well known.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	There is good evidence of decline in the oyster beds and littoral chalk communities, and threats to intertidal mudflats in the North Sea. Overall habitat mapping is only partially completed for the North Sea area.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally	An EcoQO to increase spatial extent may be valid even though accurate estimates of pre-impacted habitats do not exist.
b.	**Ecological relevance/basis for the metric**	Although generally of limited extent, many of the habitats specified by OSPAR are important parts of the coastal zone.	
c.	**Current and historic levels (including geographic areas)**	There is a good evidence for decline in the North Sea of the habitats specified above. Historic data are in most cases not available.	

d.	**Reference level**	There is no quantitative basis for identifying historical abundances, but these habitats were known to be more extensive, and some quantitative information is available for many habitat types.	
e.	**Limit point (thresholds)**	To be developed.	
f.	**Time frames**	*Detection of change*	Detection of impact can be rapid.
		Use in advice	Detection of response to remediation is likely to require at least five years.
g.	**Advice on EcoQO options (scenarios)**	*Scenario 1*	
		Scenario 2	
		Scenario 3	
h.	**Monitoring regimes**	Detailed habitat mapping will be needed to record the current extent of the habitats. Monitoring of areas where management measures are in place can be tractable and cost-effective.	
i.	**Management measures to achieve EcoQO**	Cease or relocate disruptive activity. Sometimes habitat-specific rehabilitation may be possible. Management measures taken to ensure that the benthic environment is not significantly physically altered (e.g., by sediment deposition or trawling impacts) and ensure that water column quality is favourable to these habitats will promote the restoration/maintenance of habitat quality.	

6. Further Considerations (if required)

Although it is unlikely that accurate estimates of pre-impacted habitat extents exist, for some local areas in the OSPAR regions it may be possible to access historical data and descriptions of a state towards which it may be sensible to move. Even if such estimates are not available, an EcoQO to increase spatial extent without prior knowledge of the reference level will still be valid. For all such metrics, detailed high-resolution mapping technology could be used to describe areas of habitat, and to assess progress towards the objective of reversing the downward trend.

7. Conclusions. There are difficulties with the definition of habitat quality. It may therefore be better to focus this EcoQO on the restoration or maintentance of threatened habitats in the North Sea. By giving higher degree of protection to a selected representative subset of the main habitats of the North Sea, the associated benthic species and communities would be maintained in a less disturbed state. The selected habitats would serve as nucleus areas that could help to strengthen recruitment and populations of benthos and fish species in surrounding areas. An EcoQO to increase the spatial extent may still be valid even though accurate estimates of the extent of the pre-impacted habitat do not exist. The precise formulation of an EcoQO for this revised element still needs further work.

8. References

ICES. 2002. Report of ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report, 254: 68–71.

ICES. 2003. Report of ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 33–39, 134–140.

Annex 3 - Summary of links between strategies, impacts, pressures & EcoQO

Main OSPAR Strategy	Impacts	Human pressures	Related EcoQOs[30],[31]	Major link between impacts and EcoQOs
Biodiversity	Disturbance from activities rather than the introduction of substances: Capture of fish, crustacea and molluscs Disturbance of seabed Noise Conflicting uses of sea space	Fisheries Exploration for minerals Placement of offshore installations and pipelines and other structures in the maritime area Sand and gravel extraction Shipping Military activities Recreation	**(a)Commercial fish species** **(c) Seal population trends** (d) Seal breeding sites **(e) Harbour-porpoise by-catch** (j) Sand-eel availability for kittiwakes (l). Proportion of large fish (o) Density of sensitive benthic species	Direct physical impacts between capture/seabed disturbance and EcoQOs (a), (e), (j), (l) and (o). Indirect impacts through effects on the food web for (a), (c), (j) and (l). Indirect impacts through general disturbance on (d).
Eutrophication	Elevated emissions and discharges (and resulting concentrations) of nutrients (N and P); and consequential effects from creation of eutrophic conditions	Anthropogenic land-based inputs from agriculture, food industries, sewage and traffic. River- and sea-based inputs from aquaculture (including mariculture)	**Integrated set of eutrophication EcoQOs:** **(m) Changes/kills in zoobenthos related to eutrophication**[32] **(q) Phytoplankton chlorophyll-*a*** **(r) Phytoplankton indicator species** **(t) Winter nutrient concentrations** **(u) Oxygen** **(v) Eutrophication (General)**[33]	Causal link between elevated emissions and discharges and elevated concentrations in the marine environment (subject to denitrification processes *en route*) Causal links between elevated marine concentrations and eutrophication problems, including changes/kills in phytoplankton and zoobenthos.

30 The EcoQOs included in the North Sea Pilot Project are shown in **bold.**

31 The EcoQOs related to threatened and/or declining species (EcoQO(b)), and to threatened and/or declining habitats (EcoQO(s)) are not included here, since the relationship to impacts and human pressures will depend on the detail of the pressures on, and threats to, the individual species and habitats.

32 Further work is needed on the changes aspect of this EcoQO.

33 The EcoQO proposed in § 4.12

Main OSPAR Strategy	Impacts	Human pressures	**Related EcoQOs** [30] [31]	Major link between impacts and EcoQOs
Hazardous substances	Concentrations in the marine environment of hazardous substances, resulting from land-based and sea-based discharges, emissions and losses of Hazardous Substances (including oil)	anthropogenic land-based discharges, emissions and losses (largely from industry and sewage plants) through direct and riverine inputs Shipping Dumping of dredged material Sea-based discharges (largely offshore industry and shipping) Marine litter	**(c) and (c) *bis* Seal population trends** **(f) Oiled Guillemots** (g) Mercury in seabird eggs (h) Organohalogens in seabird eggs (i) Plastic particles in seabird stomachs (k) Seabird populations **(n) Imposex in dog whelks**	Breeding success and life expectancy of top predators (seabird, seals) will be affected by the integrated effects of concentrations of hazardous substances in the marine environment. Specific contaminants and marine litter have a causal link to (f), (g), (h), (i) and (n)
Offshore oil and gas industry	Disturbance Contributions to impacts of hazardous substances and radioactive substances	Exploration and creation of offshore installations and pipelines Sea-based discharges, emissions and losses of hazardous and radioactive substances		
Radioactive substances	Concentrations of radioactive substances in the marine environment	Discharges, emissions and losses from nuclear and non-nuclear sectors	So far no relevant EcoQO	

Annex 4 - Future work

2005/2006 Meeting Cycle

Biodiversity Committee

2005/2006 Product 1: Detailed arrangements for the application of the following EcoQOs:

Based upon: Proposals by the task manager, in the light of guidance to be developed by the Intersessional Correspondence Group and endorsed by MASH, covering, *inter alia,* reporting arrangements, methods for assessing whether the EcoQO has been met, and procedures for reporting outcomes and (where an EcoQO has not been met) for deciding action

(a) Spawning stock biomass of commercial fish species

Task Manager: Norway

(c) Seal population trends in the North Sea

Task Manager: United Kingdom

(e) By-catch of harbour porpoises

Task Manager: United Kingdom

(f) Proportion of oiled Common Guillemots among those found dead or dying on beaches

Task Manager: The Netherlands

2005/2006 Product 2: Programme for the development of additional communication means for implementing the EcoQO communications strategy[34] (brochures, fact sheets, journal publications and industrial newsletters) *(if the proposals for the programme are approved, further products will need to be inserted in future years for the management of the programme)*

Task Manager: The Netherlands and Norway

Eutrophication Committee

2005/2006 Product 11: Proposals on how to take forward the development of further EcoQOs for eutrophication, in particular for changes in the zoobenthos in relation to eutrophication

Task Managers: Netherlands and Norway

2005/2006 Product 12: Detailed arrangements for the application of the six eutrophication EcoQOs

Based upon: Proposals by the task managers, in the light of guidance developed by the Intersessional Correspondence Group (see BDC 2005/2006 Product 1)

Task Managers: The Netherlands and Norway

Hazardous Substances Committee

2005/2006 Product 20: Draft Background Document on organohalogen concentrations in seabird eggs

Task Manager: To be identified

[34] The Secretariat will arrange an internet forum on the OSPAR website, and will produce a Power-Point presentation for use by itself and the Contracting Parties.

2005/2006 Product 21: Detailed arrangements for the application of EcoQO (n) Imposex in dog whelks (*Nucella lapillus*) or other selected gastropods:

Based upon: Criteria to be developed by the Intersessional Correspondence group and proposals in the light of those criteria to be developed by the task manager

Task Managers: Belgium and Portugal

2006/2007 Meeting Cycle

Biodiversity Committee

2006/2007 Product: Draft Background Document on the EcoQO for plastic particles in seabirds' stomachs

Based upon: Draft from the task manager

Task Manager: to be identified

2005/2006 Product 1: Detailed arrangements for the application EcoQO (j) Local sand-eel availability to black legged kittiwakes

Task Manager: United Kingdom

2006/2007 Product: Proposals for the formulation of the following EcoQOs, supported by draft Background Documents

(b) Presence and extent of threatened and/or declining species in the North Sea, as shown in the Initial OSPAR List.

Task Manager: to be identified

(k) Seabird population trends as an index of seabird community health

Task Manager: to be identified

(o) Density of sensitive (e.g., fragile) species

Task Manager: to be identified

(s) Restore and/or maintain the quality and extent of the threatened and/or declining habitats in the North Sea, as shown in the Initial OSPAR List.

Task Manager: to be identified

2006/2007 Product: Conclusions on whether to develop EcoQO systems for parts of the OSPAR maritime area other than the North Sea (*if the conclusions are that development should take place, the necessary work will need to be included in the work programmes for the following years.)*

Task Manager: to be identified

2006/2007 Product: Conclusions whether to develop EcoQOs on any of the topics mentioned in Chapter 8 of the EcoQO Report (*if the conclusions are that development should take place, the necessary work will need to be included in the work programmes for the following years. If the conclusions are against development at this point, the issue should be revisited at a later date)*

Task Manager: Secretariat

Hazardous Substances Committee

2006/2007 Product: Draft Background Document on the EcoQO for mercury concentrations in seabird eggs

Task Manager[35]: to be identified

[35] The United Kingdom is lead country for mercury in HSC

2006/2007 Product: Detailed arrangements for the application of EcoQO (h) Organohalogen concentrations in seabird eggs:

Based upon: Criteria to be developed by the Intersessional Correspondence group and proposals in the light of those criteria to be developed by the task manager

Task Manager: to be identified

2007/2008 Meeting Cycle

Biodiversity Committee

2007/2008 Product: Conclusions from initial results from EcoQO monitoring (other than the eutrophication EcoQOs and the chemical EcoQOs) whether there is sufficient integration with OSPAR programmes and measures and with measures adopted by other competent authorities

Task Managers: The Netherlands and Norway

2007/2008 Product: Detailed arrangements for the application of EcoQOs (i) Plastic particles in stomachs of seabirds

Based upon: Proposals by the task manager, in the light of guidance developed by the Intersessional Correspondence Group (see BDC 2005/2006 Product 1)

Based upon: Background Document (see BDC 2006/2007 Product)

Task Manager: to be identified

Eutrophication Committee

2007/2008 Product: Conclusions from initial results from eutrophication EcoQO monitoring whether there is sufficient integration with OSPAR programmes and measures and with measures adopted by other competent authorities

Task Managers: to be identified

Hazardous Substances Committee

2007/2008 Product: Conclusions from initial results from chemical EcoQO monitoring whether there is sufficient integration with OSPAR programmes and measures and with measures adopted by other competent authorities

Task Managers: to be identified

2007/2008 Product: Detailed arrangements for the application of EcoQO (g) Mercury concentrations in seabird eggs:

Based upon: Criteria to be developed by the Intersessional Correspondence group and proposals in the light of those criteria to be developed by the task manager

Task Manager: to be identified

2008/2009 Meeting Cycle

Biodiversity Committee

2008/2009 Product: Evaluation of the results of the EcoQO system as a contribution to the development of the Quality Status Report 2010

Task Manager: to be identified

2009/2010 Meeting Cycle (Ministerial Meeting)

Biodiversity Committee

2009/2010 Product: In the light of the emerging Quality Status Report 2010, an evaluation of experience with the EcoQO system over the period 2002 - 2010

Task Manager: to be identified

Memorandum

(1) At a suitable point, there should be an evaluation of the EcoQO communications strategy.

(2) When the details of the European Marine Strategy are clear, there should be a consideration of how the EcoQO system and the European Marine Strategy's hierarchy of goals, objectives and indicators fit together, and any consequential changes needed in the EcoQO system.

(3) At a suitable point, there should be a review of priorities in developing further EcoQOs.

(4) At a suitable point, there should be a review of how to complete a full suite of EcoQOs.

(5) When ICES has completed studies on the EcoQO related to the proportion of large fish in fish populations, there should be consideration of whether and, if so, how to develop the EcoQO.