Report from North Sea Task Force Workshop on Ecological Quality Objectives

Geilo, Norway, 20-22 September 1993

Chairman: H. R. Skjoldal

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CONTENTS:

SUMMARY REPORT

The Third North Sea Conference of ministers in Den Haag 1990 requested the North Sea Task Force to elaborate techniques for the development of ecological objectives for the North Sea and its coastal waters. NSTF has had this item on the agenda on almost all of its meetings since 1990. At NSTF-7 it was decided to establish a subgroup on Ecological Quality Objectives that met during a workshop in Bristol in March 1992. At NSTF-8 Norway was appointed as lead-country for the further work on Ecological Quality Objectives (EcoQOs). Norway presented a brief progress report to NSTF-9, and it was decided to arrange a 2nd workshop in Norway in spring 1993. At NSTF-10 it was decided to postpone the workshop till September 1993 and that Norway was to prepare a brief progress report for presentation at the Ministerial Meeting in Denmark in December 1993.

The workshop was held at Geilo for 3 days with 17 participants from 6 countries (Germany, The Netherlands, Norway, Portugal, United Kingdom and USA) (Annex II). Representatives from the EEC, Belgium, Denmark, France and Sweden were regretably unable to attend the workshop.

At the 1st workshop in Bristol the main emphasis was on clarifying terminology and the feasibility of setting EcoQOs. The meeting adopted the following definition of Ecological Quality (EcoQ):

> *EcoQ is an expression of the structure and function of the ecological system taking into account natural physiographic, geographic and climatic factors as well as biological, physical and chemical conditions including those resulting from human activities.*

It was concluded that the setting of EcoQOs for the North Sea was possible in principle and would be a useful goal, but the tools required to properly define the variables to be included in the EcoQO were generally not yet available.

At the Geilo workshop, the conclusions and recommendations from the Bristol workshop were taken as the basis for further discussions. The main emphasis was on the establishment of criteria for selection of parameters to be included in integral expressions of EcoQ. This was discussed mainly on a general level, but an attempt was also made to address the choice of variables for the specific cases of a coastal marine environment and the whole North Sea (Agenda in Annex III).

The meeting was organized as a mixture of presentations of ongoing national activities (Annex V) in plenary sessions and work in smaller working groups (Annex IV). On the first day two working groups addressed the criteria for choosing parameters for expression of EcoQ from the Ecosystem perspective and the Pollution perspective, respectively. On the second day two parallel groups addressed the issue of selecting variables from a more practical and methodological perspective. The reports from the four working groups are appended as Annexes VI-IX. Minutes from the plenary sessions are given as Annex I.

The meeting reached agreement on general criteria for selection of parameters or variables to be included in expressions of EcoQ. These criteria fall in two broad categories, one reflecting basic ecosystem properties and the other reflecting human use or influence on the marine environment. The conclusions and recommendations from the workshop are given below.

The meeting recognised that describing EcoQ and setting EcoQOs is a complex issue which requires time and reflection as there are both theoretical and practical difficulties to overcome. There is a need to proceed in a stepwise manner towards the goal of setting EcoQOs based on sound scientific principles. The Geilo workshop represented the step where criteria for selecting parameters were discussed and identified. This issue needs further elaboration on a more specific level and there is a need for implementation of the principles on a trial basis for chosen habitats and ecosystems.

Further steps and remaining important tasks are:

1. Developing means of expressing EcoQ based on the information content of the chosen parameters.
2. Developing tools for setting objectives for EcoQ in a way which reveals cause-and-effect links. This will help to clarify policy options.

CONCLUSIONS

1. Criteria for selection of variables to be included in expressions of EcoQ should be based on basic ecosystem properties and aspects of human use of marine environments and resources. The choice of variables for expression of EcoQ of any given habitat or ecosystem needs to be made with due consideration to the specific ecological properties and human use of that given system.

2. Basic ecosystem properties should include productivity, diversity, stability, resilience and trophic structure. Quantitative information is also required on habitat types, areal extent and rarity within the system. The degree of openness of an ecosystem and the degree of connectedness with neighbouring systems are also important characteristics.

3. Human use aspects include pollution, fishing and various types of habitat changes and disturbances. Choice of contaminant variables should be based on identified problems, amounts and use of substances, and information on their toxicity, persistence and bioavailability.

4. A general list of parameters for the description of the marine environment has been produced, based on the above criteria. This list can serve as a basis for

further work on selecting variables for expression of EcoQ in both smaller scale coastal environments and the large scale North Sea ecosystem. The list of parameters includes physical, chemical and biological properties as well as variables describing biological effects and human use.

5. The proposed list of parameters includes to a large extent information which is presently collected from the North Sea for a variety of management and research purposes. For the future more coherent and system-oriented data collection will be required. This can be used as a basis for expressing EcoQ and setting objectives for management of the marine habitats and ecosystems with their living resources.

6. More emphasis than at present should be given to fluxes of sediment, water, organisms and contaminants in coastal environments and the North Sea. More emphasis needs also to be given to biological effects of contaminants, fishing activity and other human use.

RECOMMENDATIONS

1. There is a need for further effort on the choice of parameters to be included in expressions of EcoQ. Selection based on the identified criteria should be implemented on a trial basis for chosen habitats and ecosystems. Effort also needs to be spent on harmonisation of national approaches and on Quality assurance.

2. A next step in this quantitative approach is to further develop means of expressing EcoQ based on the information content of the chosen parameters. Alternative approaches (e.g. semiquantitative) should also be explored.

3. There is a need to continue efforts to better reveal the links between human uses and their effects in the marine environment. Work on biological effects techniques and ecotoxicological experiments and risk analysis needs to be intensified. Further developments of models relating human uses to ecological effects should be encouraged as their application may improve the scientific basis for setting standards.

4. There is a need to further develop information systems for handling the data required for expressing EcoQ. Models for water circulation should be validated and used to a larger extent to describe fluxes of water, biota and contaminants within and between habitats and ecosystems.

Annex I

NORTH SEA TASK FORCE: WORKSHOP ON ECOLOGICAL QUALITY OBJECTIVES

20.-22. September 1993 at Geilo, Norway.

MINUTES OF THE MEETING

1. Opening of the meeting

1.1 The meeting was opened at 0900 on 20 September. Hein-Rune Skjoldal (N), Chairman of the meeting, welcomed the delegates to Geilo and expressed his hope that the scenic mountain surroundings would inspire the delegates in their work.

1.2 The meeting was attended by representatives from Germany, the Netherlands, Norway, Portugal, the United Kingdom and USA. A list of the participants is found in Annex II. The meeting noted with regret that representatives from the EEC, Belgium, Denmark, France, Sweden and the Common Wadden Sea Secretariat had been unable to attend the workshop.

1.3 The Chairman started a "tour of the table" for a brief presentation of each participant hence to educational background, current work, etc.

1.4 The draft agenda was adopted with a few slight amendments (Annex III). Documents for consideration at the meeting were circulated and some were also distributed later during the meeting.

2. Review of progress in ongoing work on Ecological Quality Objectives (EcoQOs)

2.1 The Chairman started with a brief summary of the history of work on the EcoQOs under the North Sea Task Force (NSTF). At the 1st NSTF workshop on EcoQOs in Bristol in March 1992 the main emphasis was on terminology and concepts. At that meeting it was concluded that the setting of EcoQOs for the North Sea was possible in principle, but the tools required to properly define the variables to be included in the EcoQOs were generally not available.

2.2 The Chairman outlined the goal for the present workshop which was, besides producing a report, to elaborate on a list of variables needed to express the EcoQ for the North Sea. The meeting was asked to address this issue specifically for two types of systems:

1) An open coastal marine environment.
2) The North Sea as a Large Marine Ecosystem.

2.3 During the discussion it was noted that several countries had started work on EcoQOs and it could be difficult to agree on a "unified approach". It is important that the work on EcoQOs within each participating country should continue, but emphasis must also be given to harmonization of national approaches. There is a need in the end to integrate the national approaches for coastal regions in a system common for the whole North Sea, based on comparable ways of expressing EcoQ and setting standards and objectives.

2.4 The program for the workshop was discussed. Working groups on The Ecosystem Perspective, the Pollution Perspective and the Methods Perspective (two parallel groups) were set up. The participants of the 4 working groups are given in Annex IV.

2.5 Lectures on progress and national activities were given by different participants in plenary introductory sessions to the themes for the working groups. A list of these presentations is given in Annex V.

Ecosystem perspective

2.6 As an introduction to the Ecosystem perspective, Ned Cyr presented work on characterizing Large Marine Ecosystems (LME`s) based on bathymetry, hydrography, productivity and trophodynamics/trophic links. There are 49 LME`s identified throughout the world and many of them are productive and/or hardly stressed areas. Important work in each ecosystem is:
- to identify the driving forces of the system, and
- to characterize the system´s health based on sets of parameters.

2.7 For each parameter a list of measurements which are carried out in current monitoring programs is given. Different parameters are then combined to calculate indexes for diversity, stability, yield, productivity and resilience.

Pollution perspective

2.8 Jarle Klungsøyr gave an overview of present knowledge with regard to inputs and the current situation in the North Sea for some main groups of contaminants. The measurements carried out under the NSTF Monitoring Master Plan (MMP) identified areas of sediments with different concentrations of metals, organic compounds etc. It was difficult to get a good overall picture of the spatial distribution of contaminants in North Sea sediments due to different sampling intensity in different areas and due to use of different methods (e.g. analysis of only fine fraction or total sediment). Very few good data on time trends exist.

2.9 For further work it is important not only to measure concentrations but also to estimate fluxes of contaminants between the atmosphere, water, sediment, and biota. Physical, chemical and biological modelling will be necessary tools in such studies.

2.10 Peter Bird underlined the importance of the lack of information about different contaminants, known and unknown, and also of time series for known pollutants. It is also often difficult to relate effects seen in laboratory experiments with effects found in nature after exposure to the same concentrations.

2.11 Jan Aure presented a model for circulation patterns in Norwegian fjords, where the intermediate circulation and the tide are important factors determining the time scale for water exchange. Together with empirical data for oxygen consumption, the effects of organic load can be estimated. This method appears promising to separate anthropogenic and natural organic loads.

Methodology perspective

2.12 Janet van Buuren gave a lecture on the progress of the AMOEBA-project, its targets and strategies. The AMOEBA-approach is a method to give a practical and easily understandable status report on selected species or groups of species in the Dutch coastal zone. She also gave an introduction to the Aquatic Outlook which aims at selecting sets of variables for all major types of aquatic ecosystems found within the Netherlands (presently about 180 variables). The main goal for both the AMOEBA and the Aquatic Outlook is to have an approach where EcoQOs are used to achieve a sustainable use of the areas in concern.

2.13 Jakob Asjes described work in the Netherlands where the Dutch Continental Shelf was divided into 9 subareas based on basic ecosystem characteristics. The subareas with the highest (potential) ecological values were selected and on this basis an Environmental zone was constructed. At present the Environmental zone will be evaluated in 4 projects:
Milzon/ECO - Ecology of 6 groups of organisms,
" /MANS - Intensity and distribution of 7 types of activities,
" /RAM - Effects of 6 types of disturbances,
" /MAAT which is management regulations.
Asjes described Milzon/ECO in more details and presented the criteria for the determination of ecological values. These criteria are used for comparing different areas.

2.14 Peter Bird gave a presentation of the role of EcoQ in the UK. They had taken an objective approach with relatively simple systems which could be integrated into their legistation. For freshwater systems, both water quality indexes and classification systems (RIVPACS) have been developed. RIVPACS integrate physical, chemical and biological parameters which are used to calculate a score. This system uses a classification of species based on their sensitivity to pollution. Recent tests of RIVPACS indicate that the predictive capability of the system was not as good as the initial work had indicated. This classification system therefore needs some further development and validation.

2.15 For marine waters a simple system for classification exists. Further work is being carried out to explore the description of ecological quality in the form of indexes.

2.16 Uli Claussen gave a short progress report on the ongoing work on EcoQO's in a national working group within Germany. It was recognized that lack of older data to describe "optimal" reference levels for the ecosystems considered was a major difficulty in trying to establish quantitative objectives. The main question during the discussion on EcoQOs is whether these values can be used to take political decisions or measures. In this context questions on the following issues are addressed:

- availability of scientific knowledge and data on natural variability of the ecosystems considered,
- possibilities to distinguish between natural and anthropogenic influences on realistic time scales (e.g. 5-10 years), and
- ability to recognize on similar time scales changes in the large natural variability.

Additionally there is a need for scientific proof to distinguish between natural and anthropogenic causes for detected effects. Present monitoring strategies seem in many cases not able to provide data and information in the way needed today and in some cases also in the future. The Precautionary Principle has an overriding priority for German environmental policy, and EcoQOs will be introduced additionally only when they fulfill this principle. EcoQOs will only be used if able to establish a clear scientifically provable link between observed effects and political measures against these adverse effects.

2.17 Harald Marencic gave an overwiew of the work and progress of the Wadden Sea Eco-Target Group (ETG). This group has participants from Denmark, Germany and the Netherlands. The ETG was commissioned with the following tasks:

- to select a set of ecosystem parameters;
- to assign reference values to the selected parameters;
- to develop ecological targets for the selected parameters for the year 2010.

The ETG finished their work in September 1993 with a "Final Report" to the Trilateral WG.

2.18 As a practical consideration the ETG made a distinction between dynamic and static parameters. Due to recognized problems with regard to variablity of biological parameters (numbers of individuals) it was decided to focus on habitat conditions instead. If the habitat quality is good then species can develop in an undisturbed and natural way. In quantifying reference values the ETG concluded that there is a difference between parameters that are indicative for the health of the ecosystem and parameters that describe the richness of the ecosystem. For the first category of parameters it is in principle possible to develop objective reference values. Parameters of the second category can in general not be quantified in an objective way. It is, however, possible to set references for them in qualitative terms.

2.19 Harald Marencic also described ecosystem research in Germany on the concept of regeneration capacity as an ecological quality objective. This research focuses on benthic communities and on their ability to react on disturbances. The regeneration capacity describes the development potentials of the communities and the habitats. It takes into account a variety of parameters and interactions and is therefore a comprehensive indicator for the quality of a system.

2.20 Tor Bokn presented a system for classification of environmental quality and degree of pollution in fjords and coastal waters in Norway. This system has been developed during recent years. It is based on monitoring data collected during several years along the Norwegian coastline.The system considers impact by nutrients, organic matter, heavy metals and persistant organic compounds.

3. Choice of variables for expression of Ecological Quality

3.1 Two parallel working groups were established and given the task to elaborate on selection of variables for expression of EcoQ. This was done as an attempt to apply the selection criteria for two types of system:
a) a coastal marine environment, eg. an open coastal stretch of the southern North Sea, and
b) the whole North Sea.
The groups were also asked to consider methods for expression of EcoQ based on the information content of the selected variables, and to consider terminology.

3.2 The reports from the two groups are given as Annexes VIII and IX. The reports were presented and discussed in a plenary session on the last day of the meeting.

3.3 Group A decided not to produce a list of variables and placed instead emphasis on the general aspects of selection criteria. Prior to selection of variables there should be agreement on the political targets for a given system. The selection should relate to habitat characteristics and issues of concern for the system.

3.4 In the ensuing discussion it was emphasised that there is a need for an iterative process between politicians and scientists. Politicians have asked for help in elaborating techniques for setting EcoQOs. Based on scientific expressions of EcoQ politicians can make their choices and set priorities for the human use and impact on the ecosystems. Based on the political decisions, expressions of EcoQ may have to be tailored to better reflect the specific human uses.

3.5 Group B produced an annoted list of parameters for expression of EcoQ (Annex IX). The list was of general character and similar in many respects to current data collection schemes in research and monitoring programs. The group did not attempt to produce separate lists for coastal environments and for the whole North Sea, but different emphasis has to be put on different parameters depending on the system. Parameters reflecting fluxes and effects were included in the list. It was recognized that there are still considerable difficulties associated with the development and application of biological effects techniques.

3.6 In the discussion of the report from Group B some concern was expressed concerning the practicality of implementing such a broad list of parameters. It was noted, however, that the information required to a large extent is already collected in ongoing research and monitoring. This data collection is done for a variety of reasons and management purposes. What is needed is a holistic perspective and a sector-integrating approach in order to have a cost-efficient scheme for gathering information required for expressing and setting objectives for EcoQ. Models should be used as an integral tool for estimating fluxes.

3.7 Uli Claussen expressed the view that a quantitative approach to setting EcoQOs contained many difficulties and could be a distant goal. In the meantime there is a need for political objectives based on overall principles for environmental management. Qualitative approaches remain a possibility that could fulfill this need in the short term.

4. Methods for expressing EcoQ

4.1 The chairman introduced this issue by pointing to the basic similarity in different approaches to setting EcoQOs, departing from a set of chosen parameters or variables. The difference between approaches lies in the way the information content is expressed and visualized. The Dutch AMOEBA approach uses a graphical spider-web presentation with all variables shown as lines from the center. There are a number of multivariate techniques which offer promise in expressing the information content of variables in a concise although somewhat abstract manner. The UK RIVPACS approach for freshwater is an example of such an approach. A third type of approach is to compress the information in several parameters into fewer indexes reflecting underlying ecosystem properties, eg. the US approach to express the state or health of Large Marine Ecosystems. A fourth possible approach is to use modelling as an integrating tool to express quantitatively basic dynamic properties of systems.

4.2 The two groups on methods perspective were asked to consider means of expressing EcoQ. Only Group A found time to discuss this issue.

4.3 Group A considered that the methods for expressing EcoQOs would depend on whom one addresses. It was further recognized that scientific advice would be required to reach the objectives. Work with EcoQ and EcoQOs would be facilitated by having an informaton system available for handling the large amount of information required.

4.4 The issue of expressing EcoQ needs to be addressed in a further meeting on EcoQOs attended by experts on techniques for statistical, multivariate and graphical analyses.

5. Glossary of terms

5.1 The term Ecological Quality Objective was defined and a common glossary of terms was proposed at the EcoQO workshop in Bristol in March 1992. The definitions in this glossary were considered to be for internal use within the EcoQO sub-group of the NSTF. The chairman asked the meeting to consider this glossary of terms in the discussions of the methods group. Only one group had a brief discussion and proposed to replace Ecological Quality Objectives with Ecological Objectives to distinguish them from Environmental Quality Objectives. Time did not allow further discussion of the subject in the plenary.

6. Workshop report - conclusions and recommendations

6.1 In the final plenary session the results from the workshop were discussed. The chairman summarized the major points of conclusions and recommendations. Following some discussion a list of 6 main conclusions and 4 recommendations was adopted.

6.2 The meeting agreed on the procedure for finalizing the report from the workshop. The chairman would produce a brief summary which together with the conclusions and recommendations would form the main part of the report. Minutes from the meeting and the reports from the working groups would be included as annexes to the report.

6.3 The draft report was to be distributed to participants of the workshops for their comments. Based on such comments the report would be amended. The final version was to be submitted to the next meeting of the NSTF and to the preparatory process for the minesterial meeting in Denmark in December this year.

6.4 The meeting was closed at 1230 on 22 September. The chairman thanked the participants for their effort and wished them a safe journey home.

NSTF EcoQO WORKSHOP, GEILO, 20-22 September 1992 **Annex II**

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NSTF Workshop on Ecological Quality Objectives,
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Annex III

AGENDA

1. Opening of the meeting.

2. Review of progress in ongoing work on EcoQOs.

3. Choice of variables for expression of EcoQ of:
a) a coastal marine habitat,
b) a Large Marine Ecosystem, e.g. the North Sea.

4. Methods for expressing EcoQ (indexing, visualization, modelling, etc.)

5. Glossary of terms.

6. Workshop report - conclusions and recommendations.

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Overview of Working Groups **Annex IV**

Working Group on Ecological Perspective
Hein Rune Skjoldal (chairman)
Ned Cyr (rapporteur)
Arne Ervik
Elizabeth McDonnell
Harald Marencic
Uli Claussen
Janet van Buuren
Jakob Asjes
Turid Winther-Larsen
Jon Heikki Aas
Eva Degre

Working Group on Pollution perspective
Jarle Klungsøyr (chairman)
Peter Bird (rapporteur)
Per Erik Iversen
Tor Bokn
Jan Aure
Tereza Vinhas

Working Group A on Methods perspective
Janet van Buuren (chairman)
Harald Marencic (rapporteur)
Peter Bird
Tor Bokn
Arne Ervik
Jarle Klungsøyr
Per Erik Iversen
Tereza Vinhas

Working Group B on Methods perspective
Hein Rune Skjoldal (chairman)
Elizabeth McDonnell (rapporteur)
Jakob Asjes
Turid Winther-Larsen
Jon Heikki Aas
Jan Aure
Eva Degre
Uli Claussen
Ned Cyr

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Annex V

List of presentations

20 September

Ecosystem perspective

Ned Cyr	Progress on the Theory and Monitoring of Large Marine Ecosystems (LMEs)

Pollution perspective

Jarle Klungsøyr	Pollution monitoring: importance of fluxes and effects
Jan Aure	The importance of physical exchange processes for effects of organic enrichment and oxygen conditions

21 September

Methods perspective

Janet van Buuren	On methods for ecological quality objectives
Jakob Asjes	Ecological values used in environmental zoning
Peter Bird	Ecological quality objectives - the UK experience
Uli Claussen	Short progress report on the ongoing work on Ecological Quality Objectives in a national working group within the Federal Republic of Germany
Harald Marencic	Regeneration capacity as an ecological quality objective
	The Eco-Target Group
Tor Bokn	A scheme for classification of water quality in fjords in Norway

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Annex VI

Report from Working Group on Ecological Perspective

Participants: HR Skjoldal (chairman), N Cyr (rapporteur), A Ervik, E McDonnell, H Marencic, U Claussen, J van Buuren, J Asjes, T Winther-Larsen, JH Aas, E Degre

Working group participants reached agreement that a suite of basic ecosystem properties should be considered in the establishment of ecological quality objectives. These properties include:

productivity,
diversity,
stability,
resilience, and
trophic structure.

An index of yield as a reflection of the economic importance of commercially harvested living marine resources within an ecosystem was considered not to be included among basic ecosystem properties. It was felt that yield was better placed in expressions of human use of the ecosystem.

The group noted that definitions of these basic ecosystem properties vary, and that definitions should be pertinent to the specific system to which they are applied. This is particularly true of properties such as stability, which may not be applicable to systems characterized by frequently changing states. It was also regognized that there are practical difficulties in application of these theoretical properties to measures of ecosystem health, for example in situations when very ambitous monitoring programs would be required to provide data necessary for assesment.

The importance of various habitat types within the larger ecosystem was also discussed. Conclusion was reached that quantitative information is required on type, areal extent and rarity of habitats, in order to determine the significance of a particular habitat within an ecosystem.

Degree of openness of an ecosystem, or connectedness between ecosystems, was also agreed to be an important characteristic. Ecosystems must be considered in terms of their physical exchange, and also exchange of biological components, seston and contaminants, with other ecosystems. Thus, the importance of smaller habitats, such as coastal fish spawning or nursery grounds, can be seen for the larger ecosystem.

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Annex VII

Report from Working Group on Pollution perspective

Participants: J Klungsøyr (chairman), P Bird (rapporteur), PE Iversen, T Bokn, J Aure, T Vinhas

Defining criteria for selection of variables

It will be necessary to only look at a selection of compounds (model substances) which are already in the environment as there are so many compounds present that it would not be possible to look at them all. New manmade substances would be subjected to tests before they are accepted for commercial use.

Substances would be selected by:

Toxicity
Persistance
Bioavailability
Sources
Loads

There may well be a second list which relates to substances present by both natural and anthropogenic routes e.g.

Nutrients
Organic loads

There will very often be problems with the proper definition of what can be assumed to be background levels and what can be thought of as anthropogenic inputs. Selection of substances will also have to take account of local effects of short lived compounds. Care should be taken to ensure that the analysis of effects takes account of the proper species. Where work is being carried out at several laboratories it will be necessary to ensure that careful analytical quality control (AQC) programmes are compiled to ensure that the results are compatible and that effort is not wasted.

Choice of chemical substances.

The initial choice will be of those chemicals which give rise to a recognised problem. These will be associated with both organic and inorganic chemicals. Once a substance has been selected some other variables apart from the toxicity should be examined:

What is the bioavailability of the compounds (e.g. speciation of metals)?
How is the chemical transported in the environment?
What is the phase of transport and what is the dynamic equilibrium of the compounds between different media ?
Is atmospheric transport applicable ?

There is always a great uncertainty in the fluxes of the substances, e.g. are food chain transportation methods involved ? There is a need for dynamic modelling of the transport systems to ensure that the final sinks of the substances in the environment are monitored. Current monitoring needs to be carefully reviewed to ensure that there is a proper benifit from the programmes.

Monitoring around point sources should be the remit of the particular nation but the monitoring of international waters needs to be properly co-ordinated. Programmes should be carefully constructed towards the information required for the completion of the project taking into account the statistics of variation before data are collected. Where more than one nation is involved AQC is an important factor to ensure that all collected data are compatible.

Biological and ecological effects

It is important to ensure that the laboratory tests used are relevant to the environment to be protected. Tests need to be developed which will actually protect the most sensitive parts of the environment. Tests which are convenient but not relevant to the environment should be avoided. It may be necessary to run the substances through a number of tests to achieve the proper level of protection rather than rely on a single toxicity test. In addition field and/or mesocosm studies may be needed to study combined effects of chemicals on populations and communities (e.g. additive or synergistic effects). Toxicity tests should be developed which reflect key species in the food chains which occur in the North Sea. To do this we need a better understanding of how different species in the food chains interact.

Nutrients and other natural substances

The concern for these substances is not due to the direct toxic effect but high concentrations giving rise to eutrophic conditions and the possible disturbance of the balance of organisms in the ecosystem

Nutrients may come from rivers , atmosphere or direct discharges and may be inorganic in nature or associated with the organic fraction of the suspended particles. There are problems associated with the inshore coastal areas receiving nutrients as well as the problems associated with the long range transportation of nutrients and suspended matter. Fluxes of nutrients can be seriously affected by the distribution of nutrients into sediments and the repartition at a later date back into the water column.

Biological effects

More information is needed about the negative effects of anthropogenic inputs of nutrients. We need long time scale observations to be sure that dramatic changes are identified correctly and are not associated with natural events which occur regularly. When considering long time scale collection of data on a restricted budget it would be better to concentrate on a few well placed stations sampled intensly rather than a dispersed, less frequent analysis programme.

Research needs

Establish long term monitoring programmes which are related to environmentally important stations and ensure that a suitable AQC programme is in place.

Investigate toxicity tests using biological species which would accurately identify susceptible points and key species in the food chains etc.

Investigate the processes which are being used to transport toxic and non-toxic substances around the North Sea and identify sinks.

Investigate the processes used to transfer substances between different media from source to degradation or final sink.

NSTF EcoQO Workshop, Geilo, 20-22 September 1993

Annex VIII

Report from Working Group A on Methods perspective

Participants: J. van Buuren (chairman), H. Marencic (rapporteur), P. Bird, T. Bokn, A. Ervik and J. Klungsøyr, Per Erik Iversen, Tereza Vinhas

The group discussed the following questions:

1. Choice of variables for expression of EQ of coastal marine habitats/whole North Sea.
2. Methods for expressing EQO.
3. Terminology

Choice of variables for expression of EQ of coastal marine habitats/whole North Sea.

A. The first step in defining a list of variables for EQ is an agreement on the political targets being general for all marine waters or rather specific for certain areas.

B. The selection of variables should relate to habitat characteristics and "issues of concern":

- At least the main characteristics of physical structure (P_i), biota (B_i) and the natural chemical quality of water (C) and sediments of the habitats (H_i) have to be addressed. Criteria for the selection of the characteristics are the (possible) anthropogenic influence (A_i).

Specific habitat	Human use/interference
H1.....Hn	
P1......Pn	A1.....An
C1.....Cn	
B1.....Bn	

- Issues of concern for both coastal zones and the whole North Sea ecosystem were identified like:

1. Climate change
2. Input of substances (eutrophication, micropollutants, xenobiotics)
3. Exploitation (fishery, extraction of sand, oil and gas)
4. Risk of calamities (shipping, pipelines)

5. Recreation (coastal areas).

These issues threaten the characteristic feature of the ecosystem or specific habitats.

The relation of EQO to measures for achieving the objective should be taken into account.

C. A harmonized list of variables should be elaborated for the North Sea as a whole by an international working group.
For the coastal zones the area specific characteristics will result in a different set of variables.

D. The scientific bases for setting priorities in issues of concern is too small.

Methods for expressing EQO

- Methods for expressing EQO depends to whom you address.
- Both quantitative and progress in reaching the objectives require scientific advisory.
- The building of an information system aids to give an overall and detailed assessment of EQO.

Terminology

It was suggested to replace the old EQo into EO (Ecological objective) in order to avoid confusion with the term "Environmental quality objective".

NSTF EcoQO Workshop, Geilo, 20-22 September 1993

Annex IX

Report from Working Group B on Methods perspective

Participants: HR Skjoldal (chairman), E McDonnell (rapporteur), J Asjes, T Winther-Larsen, JH Aas, J Aure, E Degre, U Claussen, N Cyr.

While each ecosystem will have its own defined suite of specific variables, a basic set of parameters can be described which can be used to define the ecological status of the ecosystem. Such a preliminary list is outlined below. The applicability and choice of variables from such a list will vary depending on the openness and type of ecosystem and the extent of human interaction with the system.

Coastal systems can be divided into different types of environments, eg
true coastal
estuarine
salt marsh
fjords.
Each of these contain a number of different types of habitats. While recognizing that the issue of habitats needs to be taken into account, the group decided to use an open coastal environment of the southern North Sea as a general test case when producing the list of parameters for expression of EcoQ. As a second test case, the whole North Sea was considered. The same basic list of parameters covers both cases, although the emphasis and priority would be different depending on the size and type of ecosystem.

The group decided to use 5 general categories of parameters to describe the basic function and use of ecosystems:
physical
chemical
biological
biological effects
human use.

PHYSICAL

* topography	3D information considered a basic requirement
* water transport	Circulation pattern information required to model and quantify fluxes. Water circulation models

should be linked to meteorological information and include water characteristics. Validation of models is an absolute necessity. 3D models with suitable resolution to describe coastal dynamics are required.

* hydrography	Temperature and salinity data are collected in large numbers. The extent of data collection is probably sufficient but should be tailored more to the need dictated by water circulation models and monitoring requirements for expression of EcoQ.
* tides	Information on tidal fluctuations is required.
* light climate	This is influenced by turbidity and season and has large effects on primary productivity. Many general data are already available which provide an input to modelling.
* meteorology	Important driving force for much of the ocean dynamics. Standard meteorological data provide important input to models. For estimating atmospheric inputs of contaminants, however, data on precipitation over the North Sea is not yet sufficient.
* sediment characteristics	Grain size is a governing factor influencing species distribution and also influences distribution of chemical species.

CHEMICAL

* seston	Information required for both inorganic and organic phases, particularly for coastal systems where seston influences both the light climate and the flux of chemical species.
* nutrients	Data on nutrient inputs are required, temporally as well as spatially. Diffuse land sources are known to be important but there is a lack of data to characterise them. Better data on atmospheric inputs is required due to the difficulty in extrapolating coastal measurements to open water. Data on nutrient concentrations are required both temporally and spatially within the system. The nutrient variables proposed by the NUT group were considered to provide the basic set of nutrient parameters needed to estimate nutrient budgets.

Data on inputs and concentrations in an ecosystem need to be combined with physical water circulation models to provide estimates of fluxes.
A nutrient budget plays a role in characterising the ecosystem. In coastal water, information is required to determine the dynamic flux and changes in the ratios of nutrients due to the large influence of riverine inputs.
The flux of nutrients between water and sediments may show seasonal trends. This is identified as an area for basic research rather than as a component of a standard monitoring program. The importance of phosphate flux, nitrification and denitrification to the overall budgets for energy and material flows needs to be clarified.

* oxygen and pH	Data is collected particularly in relation to productivity calculations and can provide useful information on the overall balance between autotrophic and heterotrophic processes.
* organic substances	Humic substances (Gelbstoff) can potentially be used to trace circulation and origin of water masses. Each water mass may have identifiable specific spectral characteristics reflecting the presence of organic substances. This is an area where further research is needed prior to routine application.
* metals	The quality status report has identified problem areas and this report should be taken into account when deciding what metals to monitor. Information on the bioavailablity of metals in situ is required. Such information may be obtained by supplementing chemical monitoring with the mussel watch programme. This information is particularly important for coastal zones but also in more open ocean areas there is a need to more clearly reveal whether metal contamination represents a problem. Research on the importance of transport processes between coastal and offshore regions and of atmospheric inputs is required.
* organic pollutants	Persistent organohalogens represent identified problem substances and should be targetted for inclusion in considerations of EcoQ. There is a need

to provide more specific information on which substances and where to monitor. Biota and sediments may be important in showing temporal trends. But for persistent chemicals the measurements may reflect historic pollution. If the species is mobile the site of contamination will be unknown. The choice of species would need to be site and strategy specific.
The quality status report has identified TBT as an important problem substance which should be monitored throughout the North Sea. Similarly PAHs have been identified but in specific deposition areas.

* oil hydrocarbons — Monitoring in coastal and offshore areas of water and sediments should be considered. Oil slick surveys may provide inportant information with regard to risk for seabird contamination.

* Contaminant flux — For all the groups of contaminants, data on fluxes are important. Such data can be derived from models or measured directly with e.g. sediment traps.

BIOLOGICAL

* primary production — Either directly measured or calculated indirectly from chlorophyll.

* phytoplankton biomass — Can be obtained from cell counts, particle volume, particulate C, N, P, and algal pigment spectra. Information on pigment spectra possible from satellites, but special algorithms are required for coastal waters with high turbidity and content of yellow substances.

* phytoplankton species composition — Data are obtained in coastal monitoring programmes and from research activities. Continuous plankton recorder data provide long-term timeseries from open water. Research on nanoplankton, including heterotrophic flagellates and other components of the "microbial loop", is required.

* zooplankton biomass — Information important both from a productivity perspective and to tie this in with the issue of algal

blooms.

* zooplankton production — New methods may be applicable for determining this, e.g egg production.

* zooplankton species composition. — Such data will provide information related to productivity, diversity and trophic structure. Data on biomass and production should be available for dominant species.

* zooplankton transport — Flux of zooplankton should be quantified between different regions for the North Sea. A coastal region or the whole of the North Sea are to a large extent influenced by plankton tranport which has an important effect on food availability for higher trophic levels. Models for water circulation could be used as a basis for estimating plankton fluxes.

* microbial activity — In coastal zones some measure of microbial activity in sediments could be considered, eg total respiration as O_2 consumption or measures of specific microbial processes. Information on coliform bacteria may also be relevant.

* zoobenthos biomass and community structure — Data on benthic species composition and biomass are important in several respects. Zoobenthic communities provide information on ecological characteristics of a system as well as on a number of human influences. Information can be derived on trophic types and structure, and benthic communities provide a basis for different types of classification schemes.

* phytobenthos — Changes in species and depth distribution patterns have been well documented in relation to changes in nutrient status. Phytobenthos is a relevant component only in shallow coastal environments.

* fish — For a small coastal system there will be great variability due to fish migration which make monitoring and interpretation of changes difficult. The role of coastal areas as fish spawning and nursery areas are, however, important to consider and monitor. At the North Sea scale, data on major demersal and pelagic fish stocks are collected routinely as part of the fisheries management work. Information should include biomass and size of fish

stocks, species composition, diversity, and presence of rare species.
Research is required to move from catch related data to more structured population estimates. More use should be made of available data from catches of non commercial stocks.
Physico-climatic variability has important effects on fish recruitment and stock size. There is need to better determine such climatic effects in order to provide a better basis for separating the influence of man on fish stocks from natural variability.
Models of water circulation should be used in determining transport of fish larvae and their prey.
An important question to be addressed in future work is whether selection pressure from fishing results in genetic changes to fish stocks.
Measurements of migrating fish stocks entering the North Sea were also considered to be an area where information was required.

* sea birds — Sea birds can form important components of ecosystems. Several issues of concern were raised, including effects of fishing on population size and oiling of birds. Information is needed on population size, the number of different populations in the North Sea, and their distribution. It may be possible to tie this in with fish population distribution and benthic infauna populations.

* sea mammals — There is little information on the occurrence, abundance and stock size of smaller species both in coastal and open water, as well as on their reproductive capability. To gather such information may require a large effort.

* fish diseases and parasites — There is a need for more information on the variation in the occurence of fish diseases in the environment, perticularly with the aim to identify and separate anthropogenic from natural effects. This is an area where the need for further research was highlighted.

BIOLOGICAL EFFECTS

These will be reflected in the structure and function of biological communities. The impact may however be large before such changes become distinctly recognisable above the natural variability. There is therefore an urgent need to develop techniques for linking pollutants with their effects in the marine environment.

There are a range of proposed techniques some of which hold promise for wider and more routine application. The meeting recognized however that there is still much research required before these techniques are properly tested and evaluated.

* enzyme methods — Enzyme methods such as the EROD technique show potential for use as pollution indicators but there is as yet variability in the results reported. It was noted that chemical species can compete and alter induction.

* physiological methods — Physiological measurements such as scope for growth should be considered.

There is a need for better ecotoxicological data to assist in linking concentrations of pollutants with effects. The group raised the question of how to interrelate the described biological effect variables particularly in the context of describing multi - variable interrelations and effects.

HUMAN USE

The North Sea is a heavily exploited environment and there are a number of human uses of the North Sea which may influence the structure and functioning of the North Sea ecosystem. Any set of variables for expression of EcoQ need to encompass the effect of human impact upon the environment since it is important that the North Sea is maintained as a sustainable environment and resource.

Quantifiable parameters reflecting human use include fishing efforts and fish catches, inputs of contaminants, destruction and alteration of habitats, and various types of physical disturbances of wildlife.