Proceedings

3rd North Sea Seminar 1989

Distress Signals,
signals from the environment
in policy and decision-making

May 31 until June 2, 1989
Rotterdam
the Netherlands

Cato C ten Hallers
Auke Bijlsma
Editors

Werkgroep Noordzee
Vossiusstraat 20[111]
1071 AD Amsterdam
Tel. (020) 761477

DISTRESS SIGNALS

Financial support for the organization of the 3rd Nort Sea Seminar and the publication of the Proceedings was given by:

- **Ministry of Transport and Public Works, Netherlands**
- **Ministry of the Environment, Netherlands**
- **Ministry of Agriculture and Fisheries, Netherlands**
- **Ministry of Economic Affairs, Netherlands**
- **Commission of the European Communities**
- **World Wildlife Fund**
- **Netherlands Marine Research Foundation**
- **Prins Bernard Fund**
- **Netherlands Fisheries Foundation**
- **European Cultural Foundation**
- **Van den Berch van Heemstede Foundation**

The 3rd North Sea Seminar was organized by Werkgroep Noordzee
Supporting organizations were: Seas at Risk Federation, European Environmental Bureau, Friends of the Earth International, Netherlands Marine Research Foundation, and Marine Forum.

Published by Werkgroep Noordzee, Amsterdam

Proceedings of the
3rd North Sea Seminar 1989

Distress Signals,

Signals from the environment in policy and decision-making

Rotterdam, May 31, June 1,2, 1989

Cato C ten Hallers-Tjabbes &
Auke Bijlsma

Editors

Colofon

Published by: Werkgroep Noordzee, Amsterdam

editors: Cato ten Hallers, Auke Bijlsma

design: Koos Staal

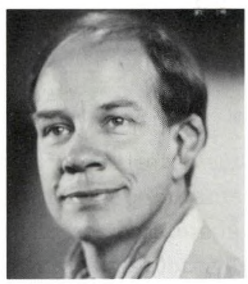
type setting: Reproform bv, Groningen

printed by: Brummelkamp bv, Aalsmeer

ISBN 90-70643-04-9

Preface

Cato ten Hallers-Tjabbes



Auke Bijlsma

This volume contains the Proceedings of the 3rd International North Sea Seminar which was held in Rotterdam from 31st May until 2nd June, 1989. The Seminar was organised by the Dutch non-governmental environmental organisation Werkgroep Noordzee (Amsterdam) in cooperation with the Seas at Risk Federation, the Netherlands Marine Research Foundation, the Marine Forum, Friends of the Earth International and the European Environmental Bureau.

The volume contains the full text of the papers presented at the first five sessions of the Seminar, reports of the discussions which took place at the close of each session, a report of the Forum discussion during the last session of the Seminar, and the final Statement as worded in the last session and supported by the delegates.
The basis papers, which were published previous to the Seminar as information papers, are annexed to this volume.
In the executive summary to the volume, observations and recommendations as presented during the Seminar are summarized by the editors.

The organisers of the Seminar hope that these Proceedings will be a valuable contribution to the preparations for the Third International Conference for the Protection of the North Sea in 1990.

November 1989

Cato ten Hallers-Tjabbes
general coordination

Auke Bijlsma

The editors

Contents

Executive Summary to the Proceedings

Auke Bijlsma, Cato ten Hallers

Introduction
The theme of the 3rd North Sea Seminar was: cooperation between policy-makers and scientists in view of decision processes for the protection of the North Sea environment, based on an adequate assessment of the health and ecological quality of the marine environment.

As a forerunner to the Seminar the Werkgroep Noordzee had published a volume of basis papers (Annex III) which highlighted the central theme of the Seminar as well as the particular fields of North Sea policy which the Seminar intended to cover.
The papers presented at the seminar sessions discussed, the general theme - Science as a basis for political decision-making and the Basic Concepts in Policy -, Policies for specific fields - Effluent Waters, Fisheries, and Offshore Activities -, and Cooperation between Policy and Science, in that order.
A plenary discussion concluded each session.
The last session of the Seminar summarized the foregoing sessions, and was followed by a forum discussion which included two presentations by forum members and a debate on the Precautionary Principle and the concept of Assimilative Capacity. The Final Session ended with the formulation of conclusions and observations which were laid down in the final Statement.

The authors of the papers, in presenting their specific expertise, drew conclusions and made recommendations. The editors of the Proceedings have carefully selected the observations of a concluding or recommendatory character which were made during the paper presentations and the discussions.
These observations, arranged (by the editors) according to the Seminar focusing points, are presented below in brief. The authors have been informed about the observations which were selected from their papers to serve as a basis for this executive summary.

The summarised conclusions refer respectively to:
1. The state of the North Sea and connected waters

2. Cooperation between science and policy, and specific implications for either of these:

- for science: in relation to the questions to be solved and to the attitude of scientists towards society, environmental NGOs, policy, representatives of specific interests, and the basic material subject to investigation - the sea and its live system.
- for policy: in relation to the questions to be asked and to the attitude of political decision-makers towards the public and scientists, and in relation to factual matters in specific fields of policy and national and international policies, North Sea Conferences, and the Precautionary Principle

3. Industry (including the fisheries industry)
4. The general public and the environmental NGOs
5. Education

The summarised recommendations follow the conclusions for each specific field, and are ordered according to referent.
1. Protection of the North Sea Environment
2. Cooperation between Science and Policy
3. Scientists
4. Policy-makers
5. Industry
6. The general public and the environmental NGOs
7. Education

Observations and recommendations

1. The state of the North Sea

The situation of the North Sea and connected waters was generally recognised to be in need of a protective policy, since today's ecosystem is incomplete and unbalanced, and has since 1930 undergone a considerable shift from long living species to species with a shorter life-span. Halving pollution (the first step in the North Sea Action Plan) would only delay the process of ecological decay.

According to the authors several means of improving the protective potential for the North Sea could be identified. The problems confronting the North Sea environment demand an anticipatory protection policy as an important step towards improvement of the sea's health. Since the 1987 North Sea Ministers Conference common objectives have been: to obtain, sustain and guarantee a healthy marine environment and to explore and use its potentials in an environmentally acceptable way. Under such sustainable use irreversible changes in the North Sea ecosystem are unacceptable.
Sustainable development was considered to be sufficiently guaranteed if the situation was returned to 75% of the 1930 reference values.

It was observed that the North Sea distress signals indicate the urgent need for a dialogue between European scientists and environmentalists and European politicians and policy-makers.

2. Cooperation between science and policy

It was generally recognised that cooperation and communication between scientists and political decision-makers was not optimal. Several reasons for this were identified:

- The malfunctioning of the communication process between policy-makers and the scientific community, which contributed to the limited influence of science in the decision-making process.
- Institutional deficiencies, such as the flawed coordination of research and monitoring, the low awareness of the importance of a clear distinction between science and politics, the language barrier between policy-makers and scientists, and the sparse translation of the scientific message.
- The absence of a firm basis for progress assessments, a basic rationale for an intensified research and monitoring effort. A perspective in which institutional deficiencies in the scientific-political complex might be far more crippling in the coming years than they have been up to now.
  However, over the last few years the co-operation between science and policy-making has increased, which thought to be a result, most probably, of the increased attention for environmental questions among the public.

The authors suggested means for improvement, addressing both scientists and policy-makers in doing so.

Policy-makers should develop a clear perspective on the future management of the North Sea, so that direction can be given to scientific activities. They should inform scientists exactly about the type of information they require. This requires a maximum clarity on the philosophy for the management approach to the North Sea and on the questions connected with it. Policy-makers should also consider long term (decade) measures and learn to accept the nature of marine information.

Scientists and policy-makers alike should alter their attitude towards environmental sciences by not regarding predictions as 'The Truth' or 'The Final Answer', but by accepting a higher uncertainty in the predictions of environmental science. The policy-maker should not blame the scientist but should stimulate him to re-answer questions which could be re-formulated and answered more precisely.
Scientists should carefully consider how to deal more effectively with uncertain factors and they should have the courage to arrive at the best professional judgement,

optimally using existing knowledge, placing less emphasis on gaps in knowledge, and being prepared to adjust scientific reports later if necessary.
In order to arrive at the best possible professional judgement, without fear of making mistakes, scientists should be able to operate in relative independence, such as is achieved by long term guarantees for the financing of pure scientific research and financing of applied science on a long-term basis.

Academic programmes that address social and political issues could educate scientists to integrate their work more successfully into policy debates.
To help structure discussions, vague general goals should be translated into specific and verifiable objectives. Such pre-determined goals can help to evaluate the effect of measures, through the use of scientific research.
Four fundamental functions are needed for an effective transfer of scientific input:
- coordination of research and monitoring
- separation between science and policy-making
- communication between scientists and policy-makers
- co-optation, i.e. Politicisation of scientific findings

Coordination should imply the use of positive, general incentives within a broad, explicit "master-plan" and not day-to-day interference from the world of politics. The perspective must be long-term, i.e. at least 5 - 10 years.

An adequate national infrastructure should enable Dutch scientists and decision-makers to operate successfully in a European framework. Research efforts in the fields in which the Dutch excel, such as ecosystem research, climatic research and coastal zone research, should therefore be supported. Although the various national laboratories and research institutes are the basis for marine scientific research in the North Sea, international scientific collaboration is an absolute necessity. This could best be coordinated by a small, flexible, non-bureaucratic organisation.
Scientific advice given by an international group of scientists can be more independent than purely national science since the different national policy judgements may polarize scientists in different ways.

Formal, routine feedback loops between scientists, policy makers and the public should be established.
The government should invest in the communication process between policy-makers and the general public, and in the communication process between science and the public.
The public is more likely to support research if they understand why such research is important and relevant.
Good co-operation between environmental scientists and policy-makers should be complemented by good co-operation between environmental scientists and the 'green' environmental groups.

The International Conferences on the Protection of the North Sea

The Ministers Conferences were broadly seen as important, having acted as a catalyst for the work of the various existing international management bodies, and having been a major stimulus for better cooperation. Possible reasons for their success were identified:

- The non legally binding character, which allows the debate to take place at a high political level and thus provide a strong political impetus to all of the bodies and administrations involved in the protection of the North Sea.
- The institutional separation, i.e. the establishment of a separate Policy Working Group, which was able to use the STWG (Scientific and Technical Working Groups) report as a point of departure for its own clarification and mediation efforts.
- The establishment of the North Sea Task Force, which was praised for the positive interaction between scientists and decision-makers now developing in the group. The Task-force was expected to increase significantly in importance in the future and to develop into perhaps one of the most important groups for the protection of the North Sea.

Several authors recommended ways to strengthen this role and the effect of the ministers conferences on national and international policies.

The decisions taken at the North Sea Conferences should receive a firm legal basis, both in the EEC and the Paris Convention. The Precautionary Principle must be elaborated here in practical legislation.
It is necessary to respect and strengthen the basic distinction between science and politics. Politicized science gives decision-makers skewed signals, leading to more or less irrational policies.
To have separate scientific and political working groups in the preparatory work for more high-level international meetings might contribute to more "constructive" and less polarized meetings. The separation should be as factual as possible.
Policy Group meetings may function as a more evaluative think-tank.

Effluent waters

The papers on policies for effluent waters demonstrated that an approach which focuses on the sea only is insufficient, since:

- Discharges of many dangerous substances are still continuing at frequently high levels, while even less has been achieved in the field of prevention. For industrial effluents the scientific data base covering potential damage to the marine environment is very incomplete, with no obvious cause and effect established in many cases. In very few cases it has been possible to demonstrate a clear causal link between the input and effect of a contaminant.
- Production, use and discharges of wastes of new and potentially harmful products continue before the first effects are observed and sufficient evidence is gathered to pinpoint the suspected product as the causing agent. The difficulties of predicting environmental consequences were illustrated by the debate about the consequences of the Danish reductions in nutrient discharges. This demonstrates that even by extensive scientific research and monitoring over several years it is very difficult to predict when the marine system is overloaded with, e.g. nutrients, or is not in an equilibrium state.
  The potential for the use of information from biological systems to monitor environmental quality was seen as great since organisms are capable to act as integrators over the range of contaminants.

A cross-media approach was recommended as well as ways to found the policies on sustainable use and a precautionary concept.

The policy based on precaution, namely not to discharge certain substances unless the absence of harm is shown, should be used with priority for xeno-biotics and especially for those that bioaccumulate, are persistent and are screened to be toxic or are to be produced in bulk quantities. The unknown assimilative capacity for these substances is the very reason of existence for the precautionary principle.
The application of available technologies should be stimulated by taxing critical nutrients and pollutants and providing financial support for countries such as the DDR, CSSR and Poland to develop control devices.
Joint seminars should be stimulated between the technical staff and environmental scientists in early stages of the development of technical processes or products.
The industry should be educated to see environmentally based costs as production costs. The emphasis should shift from managing discharges to minimising discharges by clean technology and optimum use of resources and energy sources.

For a discharge identified as containing a significant load, it is important that its flow is reliable and accurately measured at a point as near as possible to the point of discharge. Decisions about which inputs may need to be reduced, should have access to an inventory of all significant tidal discharges of trade or sewage effluent to the river and register the harmful substances.
Monitoring the effects of the discharge reductions should make it possible to adjust priorities with respect to sources in the future.
Biological and chemical techniques have an essential interdependence which should be recognised in designing monitoring programmes.
Scientists need to summarize all monitoring information and focus on ecological end-effects rather than on distribution of chemicals. They should also indicate measures to achieve the 75% reduction. Monitoring programmes and management models have to be evaluated and adjusted continuously.

The authors acknowledged disadvantages resulting from differences in approach in national and international policies and between various regulatory and advisory bodies, where both the institutional arrangements created and the measures agreed were fragmented.
And although case studies have shown that notification and classification of new substances is important, though totally insufficient in preventing potentially dangerous substances from entering the market, present policies for the control of dangerous chemical substances suffer from a tremendous delay with regard to classification, testing and legislation. It was therefore recommended to prevent potential environmentally dangerous substances from entering the market in an early stage in order to be able to control future legislation. This could for instance be done by amending the EC 79/831 Directive and implementing article 6b of the Paris Convention. A uniform procedure for the selection of dangerous substances must be developed.

Fisheries

Although the sufficiency of the (biological) fisheries research was acknowledged, the implementation of the advice was seen as insufficient; particularly the excessive catch capacity of the North Sea fishing fleet and inadequate enforcement and control were seen as hampering, but also the fragmented fishing industry's inability to present a unanimous point of view.
Moreover, the existing fisheries policy does not include specific environmental objectives.
It was also observed that it seems a bit unfair to expect reliable stock assessments from scientists who have to spend much energy to find out what is actually fished.

The following means to reach a sustainable use of fisheries resources were recommended.
The catch capacity of the fishing fleet should be reduced.
A management strategy for the composition of fish stocks in the North Sea should take the natural variations in recruitment to the stocks into consideration by

economizing with the abundant year-classes and saving the juvenile fish.
In addition to advice from natural sciences, fisheries policy should be based on information including socio-economic factors.
ICES could improve its current way of presenting the recommendations for fisheries policies, by giving one specific advice instead of a list of options.
Fisheries regulations should be made simpler and more effective. A flexible policy of closing and opening areas for specific types of fishing operations would be worth trying in the North Sea in order to protect recruitment and to facilitate enforcement.

Offshore activities
Although for offshore activities, in the North Sea at least, science and policy seemed to cooperate somewhat better, flaws were identified: in the North Sea as well as in US waters, most waste generated by offshore activities is permitted to be discharged, not because such wastes are harmless, but because other options such as complete recycling are not as economically attractive. The knowledge about the individual and cumulative impacts of all discharges from offshore activities, and about the effects of such discharges in combination with other effluents from other industries in the same region is considered very limited.

Recommendations were:
Criteria for the application of the precautionary principle to oil activities in particularly sensitive areas need to be developed.
Knowledge about environmental impact of production water and additional chemicals should be developed. All information about discharges and used chemicals associated with offshore activities should be freely accessible.
Sediment concentrations and exposed mussels should be monitored over a grid in the entire North Sea.

The general public
Several authors identified a lack of information at different levels of society and particularly with the general public, while it was recognised that conservation of (marine) ecosystems will only be politically interesting if supported by the public at large. The success of the "Coastwatch" project shows that international educational projects on the marine environment are feasible.

It was recommended to introduce environmental education at the earliest possible age and to incorporate such education through all levels of schooling.
The government should stimulate the communication between policy-makers and the general public by explaining plans and regulations, and by stimulating the communication between scientists and the public so that the features of ecosystems, why they may be threatened and what should be done to prevent further deterioration may be explained to a wider audience.

The environmental NGOs
The important role of environmental NGOs in the decision-making processes was recognised since improvements in the health of the environment would find far less support without strong pressure from scientists, environmental groups and the public. The potential of the NGOs was analysed. National and international non-governmental organizations were seen as having potential of contributing substantially to the process of amplifying and 'translating' scientific research into premises and demands for new policy proposals. Communication between 'main-stream' scientists as well as 'main-stream' NGOs was seen as reasonably good, giving these NGOs an important mediating function. The chain of communication between NGOs and policy-makers, however, could take different routes for action-oriented and lobbying environmental organizations. Media distortion was declared to need careful attention. The difference in time horizon, language and so on may be more significant between scientists and environmentalists than between scientists and politicians.
In view of this, formal routines for communication between policy, science and NGOs were recommended. It was further recommended that the nature conservation lobby should improve its professionalism and strength in order to be an effective counterweight against the strong lobbies of the "short-term users" of the North Sea ecosystems, who are organised in strong, professionally organised lobbies, and that resources should be reallocated by the media, a new key player. Environmental journalists are essential if the media are to play a constructive role in the dialogue, but in most countries there are very few of them.

AMOEBA, a device for communication and cooperation
A specific approach was recommended for improving communication and cooperation between scientists and policy-makers.
The Amoeba concept (Annex II), which was presented in the beginning of the Seminar by the Dutch Minister of Transport and Public Works, and to which several authors referred later on, was recognised as an optimum approach for communication between scientists and policy-makers as well as for communicating the concept of sustainable use and the impact of policies in view of sustainable use to the general public.
The approach would, through monitoring, be able to present a yearly gauge of the situation of the North Sea ecosystem, a sort of Dow-Jones index for the quality of the North Sea environment. The method is also a tool for setting well defined management goals.

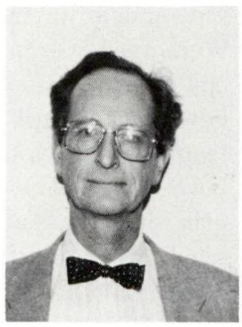
I
Opening of the Seminar

The seminar was opened by Ms J. Stefels, Chairman of Werkgroep Noordzee, who invited speakers to express an opinion on the proposition that, 'In today's environmental policy, the guiding role of science is close to nil'. She also asked

i) whether science is indeed capable of playing a role in policy making; 'if not, has this to do with the character of science and its performers or with its social and political position', and

ii) 'whether politicians are able to use scientific information adequately'.

Chairman of the Seminar



Earl of Cranbrook

Session I

Science as a basis for political decision-making and the basic concepts in policy

Chairman
Earl of Cranbrook

Review from National Policy

Mrs. N. Smit-Kroes
Minister of Transport and Public Works of the Netherlands.

Distress Signals

The North Sea has frequently given distress signals in the past. The recent fatal epidemic among seals and the algal bloom are still fresh in our memory. I am referring now to signals which everyone can see. There are also many invisible signals, which attract less attention and are recognized only by a small group of experts. These signals are grave enough to be taken seriously, and they also give rise to a great deal of confusion.

They confuse scientists, because it is usually impossible to determine the true significance of these phenomena immediately. Is it a minor disturbance which the ecosystem will overcome itself? Or is it perhaps the tip of an iceberg, the start of an irreversible change whose consequences will be felt by future generations? Confusion is also found among policy-makers, especially as long as the true causes of the phenomenon have not been clearly established. Is urgent action required? What measures are appropriate and how effective are they likely to be?

You will therefore understand that I have gladly taken up the invitation extended to me by the North Sea Working Group to deliver an address here today. Indeed, a seminar on the role of 'distress signals in policy and decision-making' is the right place to bring my views on a number of developments in international cooperation to the attention of scientists and policy-makers so that they can be discussed. I believe that the time is also right, since the results of these discussions can be taken into account in the preparations for the Third International Conference on the Protection of the North Sea, to be held in The Hague in March 1990.

Role of scientists and politicians

It has struck me that the scientific community often does not know how to handle distress signals and is unable to advise the authorities concerned quickly enough on their significance. At the same time, however, policy-makers do not seem fully able to make clear to scientists what information on the North Sea is required. Both knowledge and cooperation are clearly lacking.'

Politicians - who make decisions - are therefore confronted with uncertainties, often at a time when immediate and effective action is required. I am convinced that it is politically undesirable to continue giving the North Sea the benefit of the doubt in the event of uncertainties. This will seriously undermine the credibility and acceptance of policy on the North Sea, especially in the longer term. Doubts are a luxury we cannot afford, certainly not where matters of life and death are concerned.

To make my meaning clear, I would emphasise that I am not advocating the abandonment of the precautionary principle. I am merely saying that a policy for the North Sea based on knowledge and facts can be much more effective than a policy based exclusively on the precautionary principle. Policy-makers therefore need to develop an unambiguous perspective on the future management of the North Sea, so that direction can be given to scientific activities. In addition, the marine sciences need to take on more of the characteristics of applied sciences. This means coming up with scientific data more quickly even if researchers are not one hundred percent certain. It also means making better use of existing knowledge. To reach this goal the marine sciences must manifest themselves more as applied sciences to be used for policy-making.

The Second International Conference on the Protection of the North Sea

I shall return to this question shortly, but first I would like to make a few remarks about the Second International Conference on the Protection of the North Sea held in London in 1987.

In the run-up to that Conference, an international group of scientists drew up a Quality Status Report, so that a good up-to-date survey of the ecological status of the North Sea would be available during the conference. Despite all the useful information contained in the Report, it became all too clear how little we actually know about the North Sea. A proper assessment of the ecological condition of the North Sea as a whole proved unrealistic. Nevertheless, important progress was made at the London conference.

Unfortunately, however, I must point out that the distance between policy and science, which was apparent in London, has grown. If politicians decide to take measures without a definitive scientific report, both the scientific community and the policy-makers should be well aware of the attendant risks.

Strenuous efforts to learn more about the North Sea must therefore be made quickly. Fortunately a sound basis for this was laid in London. For example, an international Task Force was set up which will prepare a new and better Quality Status Report on the North Sea for 1992. This Task Force, in which both policy-makers and scientists are represented, is to give direction to the international research and monitoring programmes.

I have no doubt that this work will lead to a review of the role of science in the political decision-making process, and also to a reconsideration of the attitude of policy-makers to science. I regard this as an important result of our ministerial consultations in London.

I would now like to take a closer look at the changes required in relations between science and politics.

First, as I said a moment ago, scientists should carefully consider how to deal with uncertain factors more effectively. I believe that marine scientists should have the courage to make assessments based on the best professional judgement. This means making optimum use of the knowledge and information available, placing less emphasis on the gaps in knowledge, and not being afraid to adjust scientific reports later if necessary. Economics - a field where I feel more at home - might serve as an example here. Financial and economic policy also requires direct political action, and up-to-date economic forecasts are indispensable for this purpose. It goes without saying that these forecasts are constantly adjusted in accordance with the latest information. The OECD, for example, adjusts its economic reports every year.

I am well aware that this requires a degree of courage and maybe even a change of philosophy.

Secondly, it is also important for policy-makers to let scientists know exactly what type of information they require - more so than they did in the past - and what they expect of science in concrete terms. Politicians will have to provide suitable premises on which to proceed. This means maximum clarity on management philosophy from which the problems of the North Sea are approached. It also means clarity on the questions we are confronted with when tackling these problems. I would like to give you my views on this matter. (Sustainable use.)

Sustainable Use as a basic philosophy for the management of the North Sea

I endorse the ideas expressed in the Brundtland Commission's report, 'Our common future' in that I believe the concepts of sustainable use and sustainable development are crucial in the management of the North

Sea. This means that we must accept and continue to use the opportunities offered to us by the North Sea, but within ecological parameters which will safeguard the sustainability of the ecosystem.

In my view, sustainability is determined by three criteria. The first of these is that production capacity must be maintained. This means that harvesting can be continued, but not at the expense of basic stocks. The second is that the diversity of flora and fauna should be preserved. As you know, life in the sea exists by virtue of the eat and be eaten principle
Diversity of species is therefore essential if food chains are to remain intact and life itself continue.

The third criterium is the ability of the North Sea to regulate itself. This means for example that the function of the seal nursery at Pieterburen should again be taken over by the sea itself. This would be the best possible proof that the North Sea was a healthy place again.

The AMOEBA Approach
To me, sustainability means that irreversible changes in the North Sea ecosystem are unacceptable. After the second North Sea Conference I therefore asked the Public Works Department to provide me with a clear picture setting out the life forms of the North Sea and the changes which have taken place in the course of time. I very much want to present you with this picture, which we have called AMOEBA. It is a brand new way of presenting scientific information - you are the first to see it - and, I believe, an excellent way of presenting such a large amount of data in a way that administrators can understand.

The numbers of some thirty species of marine flora and fauna, assuming almost no human interference, have been estimated. These are the reference values which are shown on the circle of the AMOEBA chart. In rough terms these values correspond to the situation in the Dutch sector of the North Sea in 1930 or thereabouts. The distance to the centre of the circle represents the number of the species in the reference year.

The current number of each species are indicated with reference to the circle. this has resulted in an AMOEBA-like figure. As you can see, the structure of the North Sea ecosystem has undergone a considerable shift since 1930.

Mammals have been decimated and some have disappeared completely. Fish populations have also declined sharply. The outline bulges outwards at certain points, reflecting the proliferation of certain species, notably algae. The impression one gains is that the ecosystem has been dislocated, the general trend being a shift from long-living species to short living species. Today's ecosystem is incomplete and unbalanced.

The AMOEBA figure shows clearly the results of sixty years of intensive human exploitation. Ecological estimates indicate that the ecological decay will continue for the next ten years. Even if pollution were reduced by half as a first step in the Rhine Action Programme and the North Sea Action Plan it would do no more than delay this process. The only conclusion I can come to is that we are not at present heading towards sustainable development.

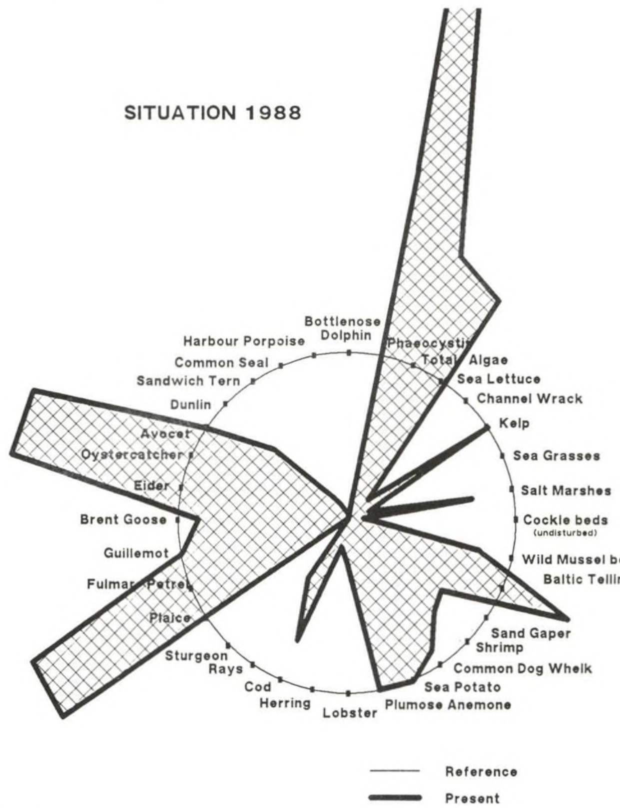
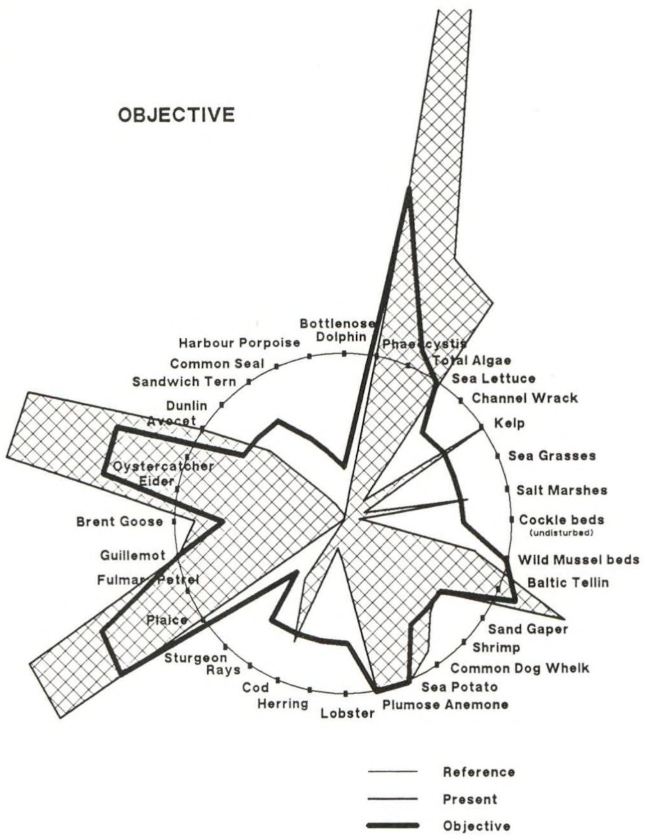


Fig. 1.

Sustainable development in the AMOEBA approach
What road should we take then, I hear you ask. This brings me back to my assertion that it is not only a question of scientists adopting a different attitude, but also of politicians making it clear what they expect of the scientists.

I believe that more natural systems, as indicated in the AMOEBA circle, provide certain guarantees for sustainable development. We can not turn the clock back entirely, nor indeed is that necessary. There are simply too many people living around the North Sea for that to be possible. At the moment I believe that sustainable development would be sufficiently guaranteed if the situation was returned to approximately 75% of the reference values shown on AMOEBA.



Obviously, such a dialogue can only take place in an atmosphere of trust. As a new and simple policy concept, AMOEBA may serve as a link between policy-makers and scientists in that dialogue.

I hope that this seminar will contribute much towards this much-needed cooperation and wish you success in the days to come.

My challenge to you, as scientists, is to indicate to me the measures which will achieve this. I call upon your creativity to devise measures which will have the greatest possible effect while costing relatively little in terms of both funding and effort.

I consider the AMOEBA to be an ecological Dow-Jones Index for the North Sea, a gauge of the effectiveness of North Sea policy.

Concluding remarks
In conclusion I would add the following. I have used the word 'doubt' a number of times in my speech. I said, for example, that policies which are based solely on a principle which is itself based on doubt - the precautionary principle - may well be proved ineffective in the long term. Besides the best possible use of existing knowledge I therefore urged that scientific information should be made available quicker and in greater bulk so as to serve as the basis for political decisions and that it should be the result of a dialogue between policy-makers and scientists if it is to be of optimum use to the politicians.

This means that policy-makers will have to practice posing the right questions at the right time. Scientists will have to be prepared to provide answers even if they are not yet one hundred percent certain of what they are saying.

From Plancius to North Sea modelling

Dr. J. H. Stel,
Netherlands Marine Research Foundation
The Hague, Netherlands

In this paper the relation between policy, science and technology is discussed. Traditionally scientific research is seen as a frontier activity using modern technology to investigate nature, leading to an up-to-date understanding of for instance, the marine environment and in the long run to management measures for this environment. In this paper science, technology and policy are seen as equal and strongly related aspects of a rational North Sea management plan. A prerequisite for such a plan is that policy makers are taught to formulate the right questions, and that scientists address these questions with the right, most highly sophisticated technology, and that they develop accurate test to detect key variables for the North Sea environment. Since the development of scientific ideas is an ongoing process it is essential that policy-makers and scientists understand the transient nature of both the information and the state-of-the art techniques of observation.

Introduction

Several recent events have emphasized the importance of the marine environment on a global and regional scale. The importance of the ocean for the global climate was demonstrated by the disastrous 1982-1983 El Niño which caused billions of US dollars in damage and considerable loss of life. On a regional scale the increased number of diseases among seals and fishes in the North Sea as well as the increasing number of algal blooms indicate that this marine environment is under human-induced stress.

The title for this paper mentions Plancius and North Sea modelling, both demonstrating the old links between the Dutch and the marine environment. Cartographers like Plancius enabled the European superpowers of the 16th and 17th century to explore our planet. Now, we live in an era of space exploration. In a recent study NASA demonstrated that more than 30.000 spinoffs have emerged from their thirty years of space operations. Spinoffs in almost every part of our daily life. In general we can say that the technology push after World War II has changed our views drastically. Until recent times, severe weather, seasonal extremes and longer term climatological patterns of temperature and precipitation appeared to be driven by unknown forces. It was not easy to discern the influence of even familiar things like vegetation, the oceans or the sun. The focus of human activity was on providing better shelter and improved agriculture. At present we are learning to think globally (figure 1). In the media our planet is seen as a carefully designed and vulnerable spacecraft. In Loverlocks's 'Gaia hypotheses' the earth is seen as an organism.

Modern scientists see our planet as a system with many subsystems and with different timescales. The earth system is very dynamic and changes occur on all time and geographic scales. The earth itself holds testimony of ancient warm climates and crushing ice sheets, variations far beyond those known to modern civilization. Many of these changes are the result of a variety of interrelated natural processes including changes in the climate system, in solar processes, in the earth's orbit, in volcanic processes and in the distribution of biological species like man. The next decades will be a new period of global exploration. Unlike Plancius we now will try to understand our environment. For this we have to explore the unknown three quarters of our planet: the marine environment.

The global dimension

Marine scientists have always known the difficulty of making measurements in situ. Typically, we spend a lot of time collecting a small precise set of data, and then we study that for a long time in shorebased laboratories. However, at present we encounter a different problem - the one of trying to use such measurements to construct a global or regional view of marine processes.

As we look at problems of global environmental changes we need global measurements and averaging techniques such as chemical tracers, acoustic tomography and satellites. Satellite measurements are less accurate than traditional ground measurements but the relative loss of precision is more than made up by the improved synoptic sampling grid. Satellites enable oceanographers and meteorologists to scan the entire earth on a daily basis.

Other instruments make it possible and practical to monitor the ocean depth continuously, just as meteorologists can monitor the three dimensional atmosphere. Satellite measurements are producing large data sets. Yet, with all these data there is still a problem: in general, ocean users are neither prepared nor equipped for the influx of remotely sensed data. Supercomputers, however, can digest millions of data

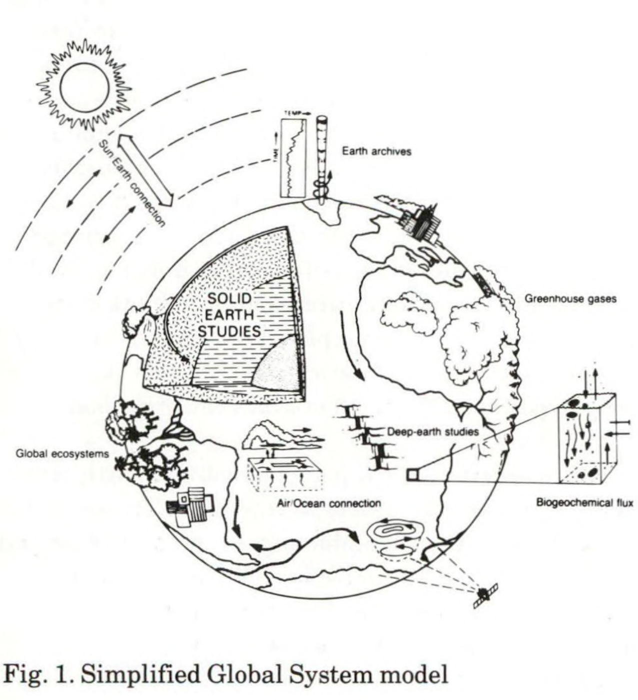


Fig. 1. Simplified Global System model

and objectively blend the traditional, precise but undersampled observations, with the new, less precise data. Moreover, the cost of computers and data-management equipment is declining exponentially (35% per year) and there is a tenfold improvement every seven years, resulting in a dramatic increase in performance. Satellites and computers now allow scientists to construct models for both the ocean and the atmosphere. Coupling these models and regularly updating them with new observations represents a major step forward in the prediction of the climate.

El Niño, a phenomenon of natural global change

Anchovy fishery off the Peruvian coast has long been one of the major fisheries of the world. It depends upon the

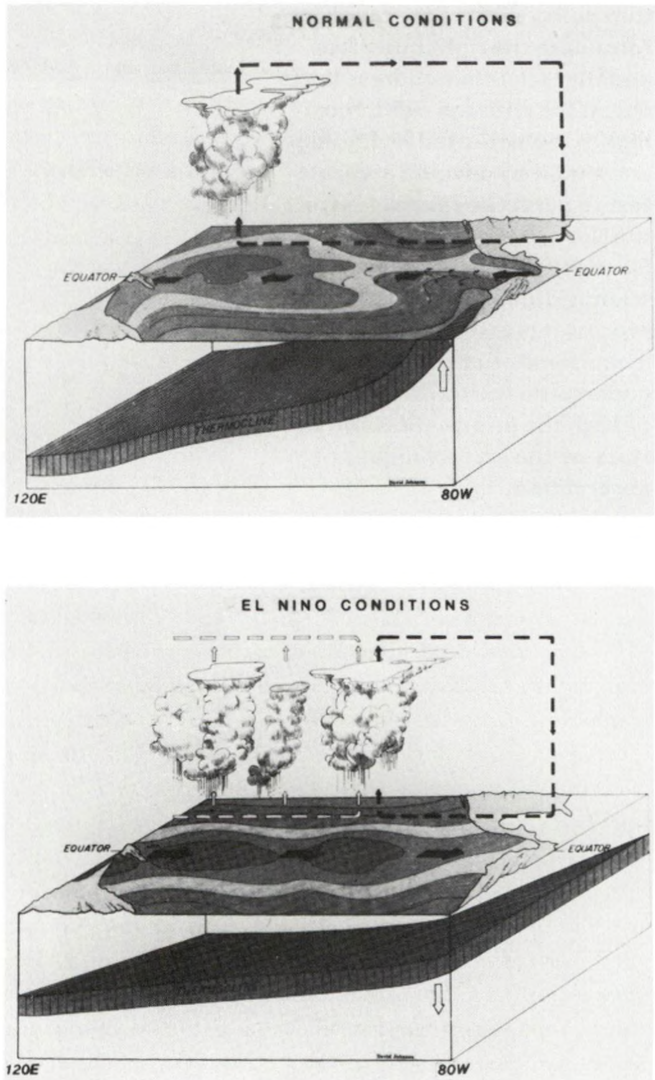


Fig 2. El Niño theory
During normal conditions, the thermocline is shallow as it nears the South American coast to bring cold, nutrient-rich water to the surface and the warm water in the western Pacific heats the atmosphere to produce rain. During El Niño conditions, the thermocline slides eastward, cutting off upwelling and displacing the rainfall zone

upwelling of cool nutrient rich water. Every few years, usually around Christmas, the upwelling stops and the anchovies disappear; this phenomenon is called El Niño. We now know that this is just one manifestation of an interrelated set of changes in the global atmospheric and oceanic circulation. Satellite monitoring revealed El Niño's character (figure 2 a & b). The most widely supported hypothesis at present is that El Niño occurs as an internal oscillation of the tropical Pacific Ocean-atmosphere system. It is generally accepted that the El Niño condition only evolves after an unstable cycle of positive feedbacks between ocean and atmosphere established along the equator in the central Pacific. Along the coast of Peru and in the equatorial region around the Galapagos Islands, the south-easterly trade winds normally pump cool, nutrient rich water from below the shallow thermocline into the surface layer. During El Niño, the winds in the western and central Pacific decrease or reverse, generating Kelvin waves propagating eastward. This leads to the depression of the thermocline and thickening of the upper ocean warm layer in the eastern Pacific. Although the winds in the east are changed little and continue to favour the upwelling, the cooler nutrient rich water is deeper and as a consequence less available to be upwelled. The sunlit surface waters becomes warmer and depleted of the life-sustaining nutrients. The higher sea surface temperature (SST) pumps excess latent evaporation heat into the atmosphere, further weakening trade winds farther west and thus contributing to the increase of instability. As the surface sterility persists and increases, microscopic algae become less abundant and the biomass and distribution of other forms of marine life are drastically altered.

We learned that El Niño is a phenomenon that occurs every 3-4 years (strong ones every 6-7 years) and has global climatic and economic impacts. It is closely linked to the so-alled Southern Oscillation, a large-scale exchange of tropical air masses between the eastern and western hemisphere. Historical data from the archives, privateer logs and the early accounts of post-conquest Spanish and Peruvians historians as well as data from the Quelccayca Ice Cap and recently living corals in the Galapagos Islands indicate the occurrence of an El Niño-like phenomenon dating back 500 years or more. Studies of sediments, molluscan assemblages along the Peruvian coast indicate that El Niño-like events (e.g. massive coastal floading, faunal changes etc.) have occurred since roughly 30.000 years.
What were the economic losses of an El Niño? When the change is severe, floods sweep away people, homes and crops. During the 1982-1983 Southern Hemisphere summer, about 600 people died. The flooding and poor fishing cost Peru an estimated US $ 2 billions; in Ecuador the economic loss was about US $ 640 million. On the opposite side of the Pacific, El Niño signals drought. In 1982 and 1983 Australia suffered its worst dry period in a century. Drought conditions brought death and the destruction of livehoods in Indonesia, India and the Philippines. At the same time, severe winter storms produced flooding, mud-slides, beach erosian, and death along the US West Coast. Heavy rain and flooding also brought havoc along the Gulf Coast.
El Niño was initially seen as an oceanic phenomenon. Marine and atmospheric scientists learned through the application of new tools - satellites, computers and numerical models - that El Niño is part of a coupled variation in air/sea conditions that extends across the entire tropical Pacific!

Investigating man-induced global change
The pace of global change has been accelerating since the start of the industrial revolution and left few places on the Earth untouched. Some environmental changes can be attributed to industrial activities. For example, the presence of many toxic chemicals such as DDT and PCB's and ozone-depleting chlorofluorocarbons (CFC's) in the environment can be contributed to human activities. In the latter case policy makers internationally agreed on counter measures in the so-called Montreal Protocol (signed on the 16th September 1987; in force in 1989) hopefully leading to a 50% decrease below 1986 levels in 1999. A year later scientists discovered that the severity of the ozone depletion is also linked to the directional change in the wind flow pattern in the lower stratosphere over the equator.

Before the Second World War the eye and the light microscope mostly determined the observational window of marine scientists. After this war new technologies and techniques became available, such as radiometric techniques, seismology, computers, satellites and modelling. They greatly enlarged our observational window. I believe that one of the most important points man learned is that the human and economic cost of environmental changes (natural or anthropogenic) are enormous and that the human impact on the Earth takes time to manifest itself. The impact of a decision to burn coal, clear the Amazon for agriculture, raise production by using fertilizers etc. may not be noticed for decades, but will be noticed sooner or later.

The North Sea: wheels within wheels
In the days of Plancius the North Sea was explored and exploitedby cartographers, sailors and fishermen. At that time Europe's population (USSR included) was only about a hundred million people; today this is eight times more! The North Sea's surface area is about 575.000 km^2, being less than 0.17% of the world's water covered area. On the other hand, the southern and eastern coastal regions belong to the most densely populated and heavily

industrialized areas of the world. The North Sea has always been exploited by man. Since the Second World War the activities have been expanded (e.g. offshore) and intensified. Just as for the Wadden Sea in the sixties, the increased and sometimes conflicting uses of the North Sea environment have led and are leading to the formulation of national and international policy and management plans.

In the seventies a series of Directives were adopted by the CEC mostly concerning dangerous pollutants. The Conventions of Oslo (1974) and Paris (1978) and the London Dumping Convention (1975) refer to discharges from land-based sources and dumping at sea. So far, these measures are a treatment of symptoms (or in the sense of this seminar 'distress signals'). In the late eighties a more coherent environmental approach started to develop. Unfortunately the present policy is still lacking a firm scientific basis and seems often to be based on 'simple' economic principles or in the worst case is just a political compromise. It is easy to blame politicians and policy makers, but this is not fair. Scientists mostly do not or cannot provide the right quantitative and/or clear cut answers policy makers ask for. As said before, we are just starting to understand the earth system and its different sub-systems of which the North Sea ecosystem is only one.

Chrysochromulina polylepis, an unknown 'distress signal'

Early May 1988, fish farmers in the Fullmar fjord on the west coast of Sweden observed abnormal behaviour among encaged rainbow trout. A couple of days later, fishfarmers along the Swedish and Norwegian coast were warned for a mortal algal bloom. The causes of the mortality were not clear. No phytoplankton species known to be dangerous to fish had been observed in harmful concentrations. But, in a light microscope the phytoplankton community was dominated by 'a circular object' which, 10 days later, was identified by electron microscopy as Chrysochromulina polylepis. In response to the algal bloom, an expert group was formed with the task to co-ordinate the monitoring of the algal distribution and relevant environmental conditions. Daily forecasts of the position of the algal front were distributed by radio, television and newspaper. Very little was known about the algae concerned. Research of its physiology and its effect on other organisms were carried out jointly with the monitoring effort. The forecasts were used for precautionary measures by the rapidly growing fishfarming industry, with an annual production of about US $ 750 million. Real-time NOAA satellite data played an important role in this monitoring effort. Because of the observed beneficial effects of low salinity, sea farm cages were relocated by towing them from the bloom-exposed coastal region to the relative safety in the brackish waters of the inner parts of the fjords. Due to those measures the loss for the fishfarmers along the southern coast of Norway was reduced to approximatedly US $ 5 million. What does this 'distress signal' demonstrate?

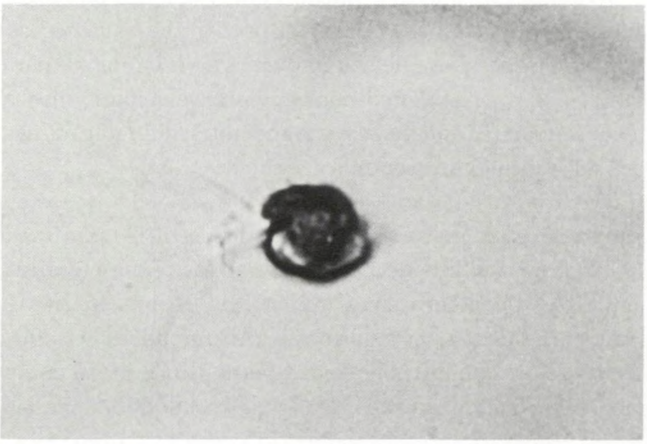


Fig.3: *Chrysochromulina polylepis* observed under a light microscope

- First of all, it shows our limited knowledge of the ecophysiology and toxicology of phytoplankton. For instance, the ecological causes for this bloom and for the production of toxin are not known. In my opinion research of the micro-element of the North Sea environment is still a white spot and needs to be stimulated.
- Secondly, it clearly demonstrates that science is a dynamic process: today's certainty is tomorrow's mis-interpretation.
- Thirdly it emphasizes the direct relation between science and its observational techniques. Without electron microscopy the cause of this bloom could and would not have been identified. A lesson also given by the El Niño phenomenon which we could not understand without satellites and computers.
- Finally, policy measures, monitoring programs and management models, based upon the present state of knowledge and executed with the most advanced technology should also be looked at as a process. As knowledge is gained and new technologies and techniques are constantly developed, these measures and programs have to be evaluated and adjusted all the time. In my opinion it is essential that policy makers understand this. On the other hand, scientists should develop accurate tests to detect key variables (such as in this case the various types of toxic algae) for the North Sea environment.

The Dutch touch

In this paper I showed that oceanography is a technology-led science. When a major new piece of equipment is introduced, big advances in science follow within a time lag of about a decade. The introduction of towed magnetometers in the 1950's led to the hypothesis of plate tectonics in the 1960's. The development of deep-ocean manned submersibles in the late sixties led to the discovery of black smokers some ten years later. The use of research satellites in the late seventies (Seasat, Nimbus-7) led to a better understanding of global processes like El Niño, the ozone depletion etc. The role of the Netherlands in these developments was minor. However, if we look at North Sea research I think we have some strong points. Our role in the development of ecosystem modelling is internationally recognized.

Since the early eighties the policy of the Netherlands Marine Research Foundation is to concentrate the Dutch effort on promising fields and to embed this in an international, especially European, context. To implement this objective it is necessary that the national infrastructure is adequate. At present this is not yet the case. There is a need for a national approach; it is time that research institutes like the Netherlands Institute for Sea Research (NIOZ) and the Netherlands Research Institute for Nature Management (RIN) etc, start to think and operate as national institutes; it is time that our so-called national pool of oceanographic equipment is brought to the state-of-the-art level that Dutch scientists and decision makers need to operate successfully in a European and international framework.

It is a pity that in the Netherlands the idea of science policy never got a fair chance. As a consequence supra-ministerial co-ordination in marine research is difficult. However, if we take the 'distress signals' of the North Sea seriously we have to co-operate nationally, and perform in a European framework. With 1992 only three years ahead it is not so difficult to predict the European developments. The first MAST (Marine Science and Technology) Programme (1989-1992), the EUROMAR project within EUREKA, the European Science Foundation (ESF) and CEC initiatives concerning polar and marine science and many others, all indicate a growing awareness of our marine environment.

The Framework Programme for Community activities in the field of research and technological development (1987-1991) provides for a specific programme in Marine Science and Technology. MAST is a three year programme with a budget of 50 million Ecu (= Hfl. 125 million). The overall purpose of the programme is to contribute to the establishment of a scientific and technological basis for the exploration, exploitation, management and protection of European coastal and regional seas as well as to introduce the necessary Community dimension to various on-going research activities. The Netherlands Marine Research Foundation acts as the national co-ordinating body for MAST and actively assists the relevant scientists and industries.

EUROMAR was established in 1986 in London as EUREKA project number 37. EUREKA was launched in July 1985 by an European Council decision. The major objective of EUREKA is to enhance the productivity and competition of European industries through closer co-operation with research organizations. Environmental protection is not only one of the most serious issues raised by the expansion of industry, but it's also a major technological challenge that EUREKA has quickly seized upon as one of its priorities. So far, eighteen 'environmental' projects have been submitted. They make up 7% of the number of EUREKA projects for a total projected R & D investment of about 400 million Ecu (= Hfl. 1 billion). Among these proposals EUROMAR and EUROTRAC aim at a better understanding of the two most alarming forms of pollution: pollution of the marine environment and pollution of the atmosphere. At present twelve countries participate in the EUROMAR initiative.

Under the Dutch chairmanship of Prof.dr. E. Duursma, theNetherlands Marine Research Foundation and the 'Rijkswaterstaat' took the initiative to organize the first EUROMAR technology market (the Hague, 7-8 September 1988). The market functioned as a 'brain tank' for about 200 participants from 77 industries and research organizations from 9 European countries. The market was based on the simple principle that participants presented their 'Offers' and 'Demands' for technological expertise in leaflet and poster form. During the market compatible 'Offers' and 'Demands' were discussed and 200 business contacts or proposals for joint international R & D projects were agreed upon. A second EUROMAR market will be organized in Italy early 1990. Moreover, just as in space research, a European organization for Marine Research will develop.

In these initiatives the Netherlands has played and plays an initiating role. (other examples are the establishment of a European Consortium for Ocean Drilling, now leading to an overall European co-operation in marine research as well as the initiatives for a better and more cost-effective use of the European marine infrastructure and the introduction of research containers enabling a better use of the European scientific potential. Seen in an international context these successes indicate that the time is there to create a small, flexible, non-bureaucratic organization for the co-ordination of marine research in Europe. If we take our opportunities and are prepared to do the relevant investments, the Netherlands, as a small, politically non-threatening country, with excellent air- and railconnections can play a leading role in many European developments.

Dutch North Sea policy

The Netherlands is a complex, highly industrialized country with a very long successful history in water management. Rijkswaterstaat (Public Works Department) of the Ministry of Transport and Public Works is known worldwide for activities integrating water and land management. Within our North Sea management, the Interdepartmental Coordinating Committee for North Sea Affairs (ICONA) plays an important role. Long term harmonization of North Sea policy began in 1979 with the following main objectives:

- To carefully balance conflicting interests related to uses of space, offshore platforms and coastal and offshore land reclamation.
- To minimize marine pollution and protect the environment.
- To maximize the contribution of the North Sea to human affairs and to increase scientific knowledge of the area.

As one of the consequences of ICONA's activities a North Sea Water Quality Management Plan was formulated (1986) and a study called Management Analysis North Sea (MANS, figure 4) was initiated. The aim of this study is to develop and apply analytical tools in support of the formulation of policy plans and decision-making with respect to the management of the North Sea. MANS started in 1988, will run to 1992 and will cost about five million US dollar. MANS will have a relationship with BEON, an independent ecological research programme co-ordinated by the Rijkswaterstaat and executed by the Netherlands Institute for Sea Research (NIOZ). There will also be a relation with MARIS, our national Marine Information System. MARIS is an experiment which started in 1989, is funded by several ministries, and has to be financially self supporting within a couple of years. Although the MARIS concept is a good one, the 'venture capital' provided by the Dutch government till 1990 is too small to give the organization a fair chance.

The Dutch expertise in coastal defense, coastal research and modelling has expanded enormously through the execution of the Delta plan. The greatest engineering accomplishment was the design and construction of the surge barrier across the mouth of the eastern Scheldt estuary. The study of environmental and biotic changes within the Delta region by for instance the Delta Institute for Hydrobiological Research are well known. Despite the Delta Works a possible sea level rise caused by the greenhouse effect poses a new threat to the Netherlands. For policy makers it is almost impossible to assess the effects of this scientifically complex and not

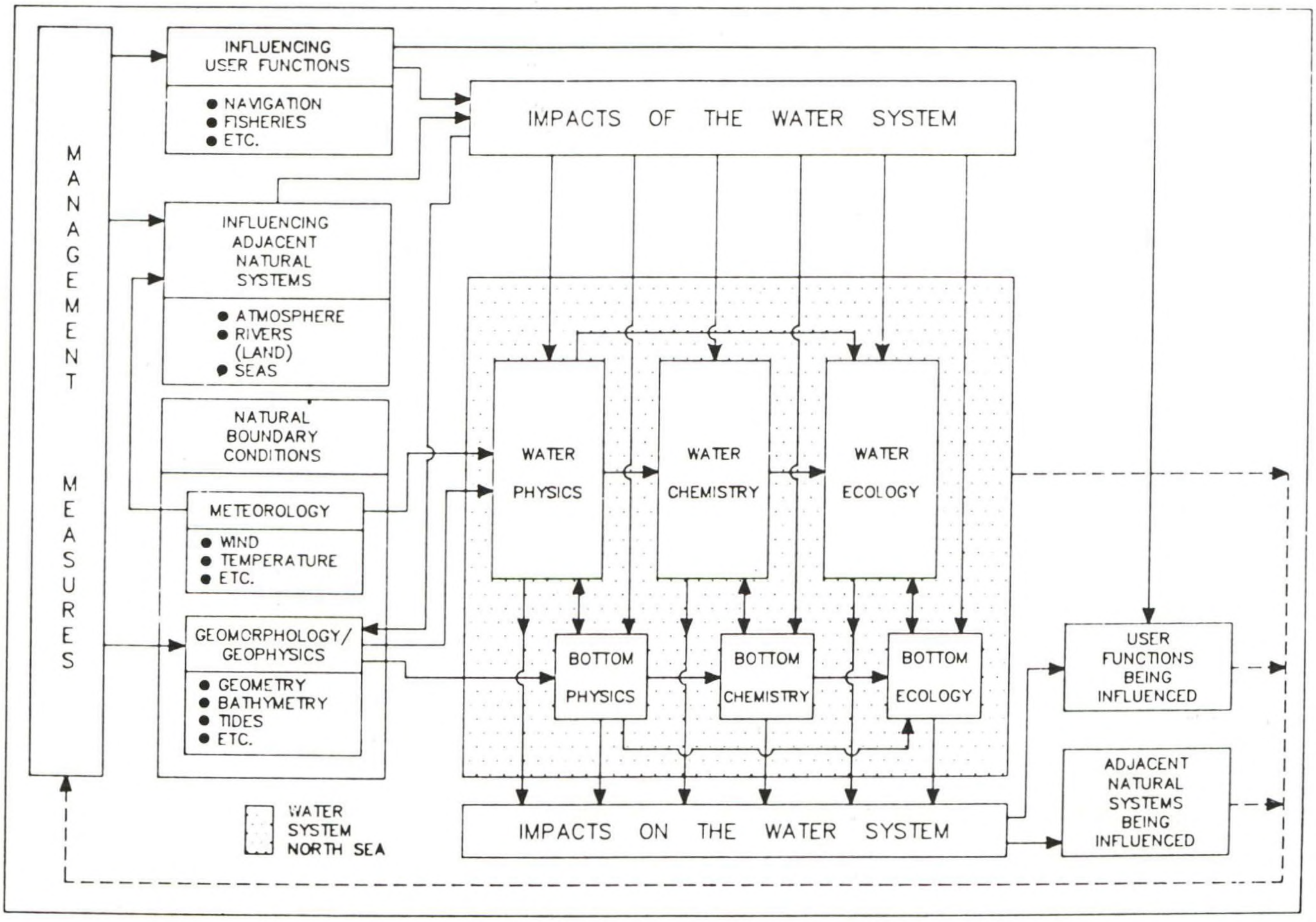


Fig. 4. Simplified MANS system diagram

completely understood phenomenon. On a national scale we should concentrate our knowledge in a Climate Research institute, whereas internationally we ought to have our finger on the pulse in order to know what is going on. Therefore, the Netherlands is now actively participating in Antarctic research. Moreover, SOZ stimulates research within the international World Ocean Climate Experiment (WOCE) and the Joint Global Oceans Flux Study (JGOFS). All three activities are yielding information which, if properly 'translated' by scientists, is highly important for policy makers. Another field of expertise which has suffered strongly from the cutbacks of the Rijkswaterstaat is basic and applied coastal zone research. Together with Delft Hydraulics, the Universities of Delft and Utrecht, the SOZ is now trying to find ways to save our present expertise and to reorganize this in a European Centre for Coastal Morphology. It is hoped that we will be able to realize on a national level the necessary 'venture capital' to operate successfully within a European framework.

Conclusion

In my opinion the North Sea distress signals do not only inform us about the health of a sea. They demonstrate the lack of basic knowledge of the marine environment. Marine processes are interlinked in a way we are just beginning to understand. Moreover, marine processes often have to be studied from a global perspective. Processes in the Antarctic can and do form a threat to our lives and vice versa. The Netherlands ought to concentrate its research efforts in fields in which we are good, so we can compete and perform internationally. Such fields are ecosystem research, climate research and coastal zone research.

The present North Sea distress signals also indicate the urgent need for a dialogue between European scientists and environmentalists and European politicians and policy makers. Scientists should develop key variables, politicians should start to think in long term (decade) measures and policy makers should learn to accept the nature of marine information. They also have to pose the right questions. Finally there is a need for European co-operation by a non-burocratic European organization for marine research, funded among others by CEC.

Table 1
Investment for the future: Science

- lack of basic knowledge, especially the micro element
- special effort areas:

ecosystem modelling	NIOZ
coastal research	WL, RUU, TUD
climatic research	KNMI, IMOU
remote sensing	BCRS

- execute European programmes, within MAST, ESF etc.
- creation of a European coordinating body for marine science

Table 2
Investment for the future: technology

- need for a stimulation of technology
- development of new technology within EUROMAR
- stimulate the existing 'new' technology such as the use of remote sensing techniques
- better use of existing techniques

Table 3
Main trends in Netherlands policy on water management

During the sixties:
- quantitative management
- safeguarding the Netherlands from flooding (Delta Works)
- prevention from salinitation

during the seventies:
- qualitative management of fresh waters
- start of science policy

during the eighties:
- more attention for quality of salt waters
- development of the concept of integrated water management
- shift from health standards to toxicological standards
- shift from emission and toxicological research to ecosystem research
- shift from national policy to international policy on water management

1. General overview of the various frameworks pertinent for the protection of the North Sea.

2. Focus on the particularities of the co-operation established in the framework of the North Sea Conferences (the unique forum dealing with all aspects of protection of the sea; the homogeneity of the region concerned; the performance of the decision making process; the non legally binding character of the decisions).

3. The Community action: Its specificity.

4. The assessment of the municipality of actions and initiatives:
a) the inconveniences: complexity, apparent duplications, excessive needs of administrations with regard to human resources;
b) the advantage, and in particular the convergence of all of these actions towards an improved protection of the North Sea.

5. Conclusions: The need for more political commitments, implementation at national level of international political commitments, general assessment of past actions, perspectives.

International Cooperation for the Protection of the North Sea

Mr A. Barisich
Commission of the European Communities, directorate-general environment, nuclear safety and civil protection XI/B/1
Brussels - Belgium

Introduction
Before coming to the basic theme of this meeting, namely the incorporation of scientific knowledge in the political decision-making process for the protection of the marine environment, let me briefly recall the various international forums dealing with the protection of the North Sea.

The North Sea is, in fact, without any doubt, the most scientifically studied, analysed, scrutinized and assessed sea in the world.

Organizations dealing with the North Sea
If we look at the official organisations dealing with the protection of the North Sea, the first consideration to be expressed is that the list of such organisations is a very long one indeed. I would also recall from the beginning and with a great deal of sympathy that numerous initiatives of international co-operation are taken by NGOs. Such initiatives are fundamental, inter alia, to convey in a structured manner the concern and the legitimate expectation of the public.

Coming back to the official bodies, several worldwide organisations are pertinent for the protection of the North Sea, in particular:
- International Council for the Exploration of the Sea (ICES) dealing with several aspects related to the pollution of the sea;
- International Maritime Organization (IMO) dealing with ship-generated pollution;
- London Dumping Convention (LDC) dealing with dumping at sea.

At an enlarged regional level one should mention:
- the Paris Convention for land-based pollution;
- the Oslo Convention for dumping at sea;
- The Memorandum of Understanding on Port State

Control (MOU on PSC) for ship-generated pollution.

At the level of the North Sea region:
- the Bonn Agreement for accidental pollution.

And, at the level of smaller regions:
- The Wadden Sea trilateral co-operation, and the various bilateral and multilateral agreements for dealing with accidental pollution.

Indirect, but fundamental effects are also expected from river Conventions, mainly the Rhine Convention.

When one looks at this impressive list the first impression is that the only possible negative result of all of these initiatives could be that the North Sea is over-protected.

In the circumstances would it really have been a good idea to add the North Sea Conference to this list (which added in itself, at a later stage, another baby forum - the North Sea Scientific Task Force)?

The reply to this is however largely positive. The North Sea Conference has its own specificity and works on another level in comparison with the above-mentioned bodies and has produced an impetus which the other forums have not done.

Firstly, it concerns a rather homogeneous region both from the oceanographic point of view and from the socio-economic one.
Secondly, it constitutes a unique framework in which all of the aspects related to the protection of the North Sea are dealt with: in other terms, it covers the fields of activity of all of the above-mentioned bodies.
Finally, it should be underlined that decisions from the North Sea Conference do not have, in a stricter sense, a legally binding character. This character provides participants (Ministers of the Riparian States and the European Commission) with the possibility to keep the debate at a high political level and give a strong political impetus to all of the bodies and administrations involved in the protection of the North Sea.

Having mentioned all of these international organisations, some words should be added with regard to the activities of the Community which are relevant for the protection of the sea. The work carried out in the Community framework is playing an increasing role in the activities for the protection of the North Sea. Three points should be noted in this context. The first is that when regional Conventions were negotiated, only a third of the Contracting Parties were members of the EEC: this proportion is now two thirds.

The Second is that since the entry into force of the Single Act, Community environmental policy has taken on increasing importance: does not the Single Act call for more stringent environmental standards?

Finally, the legally binding character of the decision adopted in the Community framework, the possibility to open infringement procedures against Member States in the European Court of Justice, and even more, the public pressure to have Community legislation observed by the Member States, gives Community action a particular dynamism. In addition, one should also remember that the Environmental Council, which corresponds to a Ministerial Conference, but takes legally binding measures, meets several times each year.

Let me now come back to the basic theme which is the right use of scientific knowledge.

My first consideration is that, in my opinion, this is a problem which changed drastically in its order of magnitude a couple of years ago.

I personally observed this drastic change in the Rhine Action Programme and it was even more evident in the final phase of preparation and the ministerial negotiation at the Second North Sea Conference.

If you try to have a 'lateral lecture' of these important events you could perhaps consider, as I do, that the major achievements of these political meetings no longer have scientific grounds in its traditional acceptance. More precisely, the changed form of the decisions which have been adopted shows that action-oriented work has taken over from the traditional way of working.

Decision-making process

The precautionary principle, the reversal of the onus of the proof, the bulk reductions of inputs of dangerous substances and nutrients (minus 50% in 10 years) are, again in my personal opinion, decisions which constitute a sort of break or at least a very important relaxation in the traditional link between scientific assessment and policy decision.

I would now like to turn to the first two questions which all of the speakers here today were asked by the organisers:

Do you find the incorporation of scientific knowledge in the political decision-making process sufficient, effective, and successful?

- if you would answer 'yes' can you indicate what makes it so successful;
- if you would answer 'no', can you indicate the deficiencies and how this could be improved.

My personal reply to this question is unfortunately a little outside of the field which has been defined.

I feel, in fact, that important clarifications should intervene concerning the role of scientific inputs in the decision making process with regard to environmental questions.

If you look at how the major forums in which environmental decisions concerning the North Sea are prepared, you can see that the scientific assessments constitute more or less the unique basis for decision.

This situation leads the representatives of the different parties involved to make as much effort as possible to force the scientific argument for obtaining a decision in accordance with their own objectives.

But these objectives are generally defined not only on a scientific basis but also take into account other considerations of a socio-economic nature such as the legitimate expectations of the public.

In the circumstances, one could consider, as I do, that the decision-making process should be re-structured and should be based on a more elaborate scheme than at present, to be able in particular to give the necessary importance to the concerns of public opinion.

The move towards schemes of this nature will allow the scientific sector to recover its own role of fundamental assessment and objectivity.

This could, inter alia, contribute to avoid having, in future, the unbelievable debates which took place in the past on questions such as fish diseases, whereby a group of high level scientists promise, with their hand on their heart, that there is no scientific evidence on the possible relation between fish diseases and the present pollution levels, and yet another group of equally high level scientists promise, also with their hand on their heart, that the present pollution level is responsible for the outbreak of fish disease.

In the same way, such an evolution could favour a dialogue with the public, the NGO's and all other concerned parties - including the industrial sector - without mixing anything together and avoiding too many people being called upon to intervene with scientific reasons capable of justifying the request for action, or to demonstrate that no action is necessary.

However, such evolution does not only have positive perspectives. Such an approach implies that those responsible for administrative questions at different levels will have more and more need to arbitrate between assessments of a different nature.

Implementation

Let me now turn to another fundamental question related to the international policies for the protection of the sea, and that is the problem of the implementation of international commitments decided in the various international bodies, often at highest political level.

This is, again in my personal opinion, the weakest point which I find when looking at this 'boiling' and sometimes frantic international activity.

In fact, if one is to observe the implementation of the conclusions as far as international forums are concerned, the first consideration to be expressed is that the main objective of some technicians and scientists seems to demonstrate that such conclusions cannot be implemented, that it is first necessary to agree upon baselines of the present levels of inputs of pollutants, that it is impossible to implement the reversal of the onus of the proof (which has been one of the major achievements of the Second North Sea Conference), and so on.

Another good example of such academic attitudes is the new debate of a very philosophical nature which is taking place in various forums, namely the point where limit values should be checked. In-depth and long discussions take place on this subject in which some participants often hide to a certain extent their real objectives. Technical and scientific arguments are exchanged but common sense and a real wish to progress towards a better protection of the aquatic environment seem to be completely absent from the discussions.

I ensure you that this is certainly not the attitude of the Commission. In spite of our difficulties which depend on the scarcity of our staffing, on the necessity to legislate at the level of five different regional seas and on the enormous differences of the ecological and socio-economic conditions in the Community, we continue our task. This task includes translating into legally binding regulations the main conclusions reached in the international forums in which we participate.

Some of you may recall the introductory speech of my Commissioner at the Second North Sea Conference. He clearly stated that the Commission will never accept that technical international meetings will serve to weaken the political decisions we have reached.

We in the Commission, expect that all of the states participating is such international forums consider themselves equally committed in front of their citizens and also that they adopt a similar attitude at national level.

One final remark concerning Community policy that I would like to make does not actually concern the theme for the meeting today, but I do hope that I will have the possibility during the debate to spend a little time on the important changes which are taking place at this particular moment with regard to the new directives in preparation which will have a rather different character when compared with traditional directives.

I think it is now time to try and summarize the contents of my speech today and arrive at a conclusion.

The first point which I would like to underline is that, in my personal opinion, scientific assessment should from now on be considered one among other components for the establishment of the decision-making process in environmental matters.
Socio-economic assessment must be considered an equally fundamental basis for such a process. A second point which I would mention is that the water protection policy is progressively changing towards more complex and more ambitious regulations which call for a real management of the water systems at regional and local level.

International co-operation should also evolve to take into account such an evolution. In this context we should bear in mind the proliferation of the international meetings related to the protection of the North Sea. It has been estimated that in 1989, no less than 40 meetings will take place. Of course, all of these forums will push the trolley in the right way. Of course scientific and technical sectors need absolutely meeting and discussing at an international level. But, on the other hand, we should avoid going towards international over-bureaucratization and try to keep the international co-operation in this field at its right level, namely a decision oriented co-operation.

Finally, meetings have never cleared up a single cubic centimetre of water. Improvements are due to field work, e.g. by real investments both from private and public sectors, by changes in methods and practices by operators, and by changes in behaviour.
In the circumstances, I would call upon international experts, such as I am supposed to be, to have a more modest attitude and to attempt to re-establish a better balance between all those concerned with the decision making process, and the practical implementations of the decisions.

The Role of International Science in Political Decision-making

Concern about the health of the North Sea as a whole originated from obvious environmental deterioration in heavily stressed but essentially localized areas. Different political pressures in the various North Sea states resulted in polarized attitudes in which a scientific analysis of the situation played a relatively minor role. In recent years there has been a welcome agreement about much of the scientific data base, although there remain areas of uncertainly and disagreement. There have also been a convergence of approaches in waste management (as revealed by EC Directives) and independent reviews of the basic principles of marine pollution. Now that scientific considerations have entered the debate, research priorities to fill gaps in knowledge have been identified and international programmes to fill them have been instituted.

Prof. Dr R.B. Clark
University of Newcastle upon Tyne, U.K.

I have always understood that science is the objective and verifiable study of the natural world. There have always been different national politics about how and at what level scientific research should be supported, and different national priorities or fashions about the kinds of science to prosecute. The science itself, however financed and whatever the subject, has to convince by reason and verifiable evidence, the international community of scientists in the subject. There is some evidence that marine pollution research has not always been aware of that discipline, and I will return to that later.

Science, whether national or international, has obviously a role of play in political decision-making, but it is a much more limited role than many people, especially scientists, seem to believe or to expect. Science is overshadowed by political considerations, and rightly so, as I shall explain in a moment.

The role of science

Figure 1 shows the cost of treating an uncontroversial waste; sugar beet pulp. The cost rises exponentially with the degree of treatment, and at the margin, costs can easily double for a trivial improvement in the quality of the effluent. A similar exponential curve applies to the cost of treating most other wastes.

A policy decision is required about where, on this exponential curve, a standard should be set. The scientist can probably predict fairly well the effect on the local environment of any particular level of discharge. What he cannot say is what is the appropriate trade-off between the environmental cost and the financial cost of disposing of the waste. That must be a political decision and one that takes account of other matters, such as the value placed on the local environment, public perceptions of risks, or social costs if a factory is forced out of business by high effluent treatment costs.

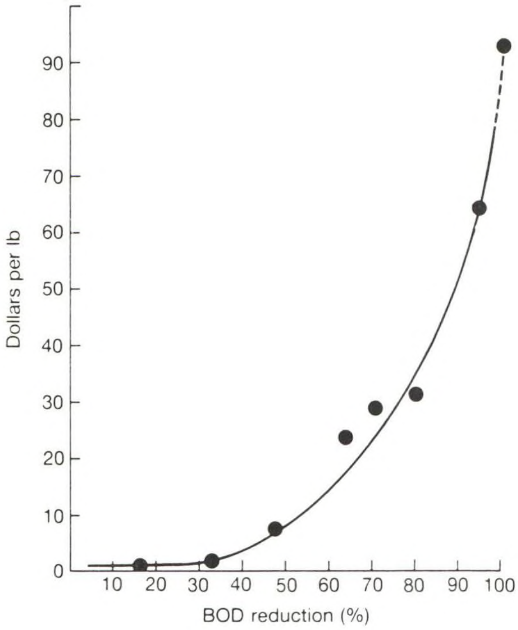


Fig. 1
Cost of reducing the organic content (as measured by BOD) of the wastes from a sugar beet factory. (From Meadows, D.H. et al., (1972). The Limits to Growth, Earth Island Ltd., London).

Specifically, what priority shoud be given to environmental conservation in competition with other calls on the private and public purse, such as schools, public health, the police, street lighting, and a dozen other desirable things?

What decision is finally taken is unlikely to please everyone, but in a democracy we elect politicians to make these sorts of judgements. Science is part of the equation, but only a part. Politicians are rarely far ahead or far behind the perception of the bulk of their electorate for very long. Public concern about the environmental consequences of waste disposal practices have changed in recent years and have resulted in a shift to the right in the position set on the exponential curve, but no-one can claim that there is a strict scientific basis for whatever position was accepted a few years ago or what is accepted now.

The role of scientists

Scientists sometimes become impatient with their limited role, or when their scientific advice is outweighed by non-scientific considerations. If, as a result, scientists become particularly identified with one approach rather than another to the solution to waste disposal problems, i.e. they take a political stand, they are in danger of losing their scientific credibility.

I am reminded of the situation that developed in the United States in the late 1960s and early 1970s when oil pollution was widely regarded as the greatest threat to the marine environment. Science and scientists became totally polarized and labelled as 'conservationists' and 'in the pay of the oil companies'.

One senior scientist, who was then in the environmentalist camp, claimed, in print, that scientists should falsify their research reports to exaggerate the impact of oil-spills, on the ground that they had probably detected only part of the damage caused by the oil-spill, but also to alarm the public and politicians and force the pace of political control of oil industry activities.

The result of this polarization of views was that no-one believed the research findings of members of the opposite camp, and, more seriously, it became impossible to get scientific advice on the subject from American scientists that was accepted as objective. Lawyers dealing with claims arising from oil-spills had to go abroad, usually to Europe, to get dispassionate advice. We may note, incidentally, that oil pollution, then regarded as a major threat to the seas, now has a much lower profile.

The best service environmental scientists can provide is dispassionate prediction of the environmental consequences of various levels of waste discharges at specific places. The scientist should also place confidence limits on his predictions and not imply a certainly which often demanded by politicians who do not understand the scientific process. In other words, the scientist should provide a range of options with environmental price tags (plus or minus). The democratic processes of the country must then set these environmental costs against financial, social and political costs and arrive at a policy decision. No-one will be well served if the scientific input to this process is unreliable.

Although I am a scientist, I must point out one defect of scientists: they are specialists. A scientist sufficiently expert to give reliable advice about the consequences of waste discharges to the sea will rarely be able to give equally expert advice about the environmental consequences of disposing of the wastes in a different environment. My complaint about most conferences on marine pollution that I attend is that they are not concerned with solving the problem of waste disposal, but merely with transferring it elsewhere.

Policy prejudgements

Policy decisions are taken on the basis of the current scientific analysis of the situation, strongly influenced by non-scientific considerations (or in many cases, based primarily on non-scientific considerations). These are political judgements and tend to become slogans which inhibit dispassionate thought. More importantly, they have the effect of encouraging future science in a particular direction dictated by the policy decision and that leads to a rigidity of thinking. The policy decision is, in fact, a prejudgement.

Fortunately, science is international. The reason marine pollution is a controversial subject, particularly as it affects the North Sea and the reason we are holding this meeting, is that different countries have arrived at different policy judgements. And if each country has polarized its scientists to some degree, at least they are polarized in different ways. As a result, international science can give an independence of thought that purely national science may find difficult.

If we examine some of the policy prejudgements, or slogans that have been made in recent years, we may see how they impinge on science and, in turn, how international science has modified policy.

The precautionary principle
As applied to the North Sea, this suggests that no discharges should be made unless they can be shown to be harmless. It is impossible to satisfy this requirement and it should follow that no wastes should be discharged to sea. In that case, no further marine research is required.

However, it is impracticable to take such an absolutist position. Anything added to the sea produces some change, even if it is microscopic and the area affected is minuscule. The Vorsorgeprinzip obviously cannot be taken so absolutely. The question is then the amount of change caused by an input and the area affected. The Vorsorgeprinzip is not a precise instrument. Nevertheless, it encourages scientists to the negative task of seeking damage caused by discharges rather than to the more positive role of developing more sophisticated and less damaging waste disposal practices.

Best available technology
This allows that some wastes should be discharged, but they should be minimized by whatever technical means are currently available. A considerable investment in research into waste treatment is implied by this, but there appears to be little demand for environmental studies. Strictly speaking, no account is taken of the cost to industry for waste treatment, and the social costs that may entail, nor of the environmental benefit that may result; in other words, whether it is cost-effective. In practice, however, costs do matter, and the BAT principle is tempered in an imprecise way by the qualification that the costs must be 'reasonable'.

Environmental capacity
This also allows that wastes may be discharged to sea, but limits them to those that will not cause pollution. Pollution is defined as waste discharges that cause a threat to human health, damage natural resources, interfere with legitimate uses of the sea, etc.

This is a concept that has been taken over from the disposal of sewage into rivers. Organic material is broken down by bacteria, and provided the rate of discharge is adjusted to the river flow, this can be achieved without any serious impact on the river fauna and flora. If too much waste is discharged, a stretch of the river becomes deoxygenated and foul. Sanitary engineers have been well aware of this for over a century. The science and technology is competent; whether or not a river is fouled by waste discharges is simply a matter of how much a town is prepared to pay for waste treatment. Since, as they say, 'there are (or have been until recently) no votes in sewage', many stretches of rivers have been fouled in this way.

In the sea, the situation is a little different. Organic wastes discharged to sea are subject to the same laws as in rivers: the solution to pollution in dilution. When organic wastes are discharged into sea areas with low water exchange such waters can receive less waste than those with a large dilution capacity. But the discharges also contain persistent materials such as heavy metals and pesticides, and while they may be diluted to harmless concentrations, they are permanent additions to the marine environment.

In 1986, GESAMP (the UN Group of Experts on the Scientific Aspects of Marine Pollution) published a detailed study of how the concept of environmental capacity can be used as a management tool in the disposal of wastes to sea without causing pollution. It involves critical path analysis, and a sophisticated decision analysis and risk assessment. This approach does not lend itself to political slogans or simple explanations, but it directs science into making a comprehensive contribution to the political decision-making process.

Coming, as this analysis does, from a respected international group of scientists, it is more likely to win acceptance than if it was proposed by a national group, such is the distrust engendered by the polarization of scientific opinion in pollution matters. the importance of authoritative international sources of advice, such as GESAMP and ICES (International Council for the Exploration of the sea) can hardly be exaggerated. These bodies provide an open window on world science and also a forum where scientists can explore their differences. Progress would be much slower and more acrimonious without them.

Uniform Emission Standards

Some of the tools used to control waste discharges in the past have lacked this sophistication. One of these was the imposition of uniform emission standards favoured by some sections of the European Community, but heartily disliked by the United Kingdom. Its chief merit was that it was administratively simple to apply and accorded with the 'harmonization' rules of the EC. The British objection to it was that it ignored geographical reality. Britain did not have enough sun to grow oranges, but that was no reason for prohibiting Spain or Italy from doing so. In the same way, Britain was favoured by its turbulent seas with their high environmental capacity, and saw no reason why it should be prevented from making use of them.

Besides, the adoption of Uniform Emission Standards did not afford a realistic protection of the marine environment since it took no account of the number of discharges – all of which might meet the UES – into a sea area, nor the environmental capacity of the receiving waters.

Environmental Quality Standards

The deficiencies of the Uniform Emission Standard approach has been increasing recognized, and it is now being superceded by the use of Environmental Quality Standards.

For these to be set, a decision is required about the use to which a body of water is to be put and the water quality required for that use. It is then possible to specify appropriate levels of discharge into that body of water which will allow the Quality Standard to be met. It follows, of course, that emission standards will vary widely from place to place.

Best Practicable Environmental Option

An alternative approach which has been strongly advocated by several Royal Commissions in Britain, is that of seeking the Best Practicable Environmental Option for waste disposal.

The philosophy underlying this is that human societies inevitably produce wastes that have to be disposed of somewhere, somehow. Waste disposal has a financial cost, but it also has an environmental cost. The objective should therefore be to reduce the environmental cost to a minimum. That means that all disposal routes should be evaluated without prejudice. In some circumstances, sea disposal, although environmentally damaging, may be preferable to disposal in a different environment where it would cause greater environmental damage or a greater threat to human health.

This kind of multimedia assessment has rarely been used in a formal way, but an interesting recent example -- although the term Best Practicable Environmental Option is not used -- has been the analysis of disposal options for New York's sewage sludge.

About 10 million tonnes of sewage sludge per year have been dumped at the 12-mile site in New York Bight since 1924. The effects are undoubtedly damaging. The Environmental Protection Agency interpreted an amendment to the Marine Protection, Research and Sanctuaries Act in 1977 as an absolute ban on the ocean disposal of all sewage sludge. The New York waste disposal authority then had to examine its other options. Of these, only incineration offered a long-term, land-based alternative to sea disposal. A detailed and sophisticated comparison of these two options followed, including a consideration of public health, environmental, economic and public perception factors.

The results of this analysis were as follows. Ocean disposal is preferable in respect of human health risks, costs and public perceptions. Both incineration and ocean dumping would be environmentally damaging, but incineration less so and is preferable on environmental grounds. So far as risk analysis is concerned, it is ironic that because of the concern about ocean dumping and the many investigations it had generated, it is possible to quantify the risks associated with it much more precisely than the risks associated with incineration. Public perceptions were quantified by the techniques of market research and they were clearly opposed to incineration.

Conclusions

Pollution has become an emotive word and it would aid clear thinking if we talked instead about waste disposal options. There is no doubt that the amount and variety of wastes generated by human society could be reduced, though that will undoubtedly be at some financial and social cost. That is one area for discussion. However, there will always remain wastes to dispose of and waste disposal will inevitably entail financial and environmental costs. How much we reduce the quantity and nature of the wastes, and how we dispose of the wastes that remain will be determined very largely by political considerations which include, importantly, public perceptions that are not necessarily closely related to scientific assessments.

The scientist has a vital role in supplying objective information to the decision-making process, but in practice, the scientist is not a remote, dispassionate contributor. In all countries, senior scientists become involved in the political decision-making process. In a controversial subject, such as waste disposal into the North Sea, where different countries responding to their own national public perceptions, take different standpoints, the scientists and their science inevitably become related to their national outlook. To a degree, they become blinkered.

The importance of the international dimension of science cannot be overstated. It allows a diversity of approach that is impossible within one country. It allows unfashionable proposals to be evaluated in depth. Above all, it prevents the stagnation of the scientific evaluation of waste disposal options and the stultification of imaginative thought that follow once policy decisions have been made.

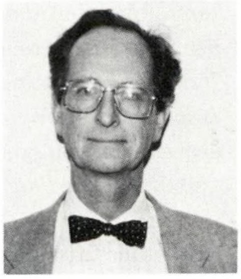
References

GESAMP (1986). Environmental capacity: an approach to marine pollution prevention. UNEP Regional Seas Reports and Studies, No. 80, UNEP.

Gift, J.J., Plugge, H., Rue, W.J., Rubin, B.L., Fava, J.A. & Storms, S.E. (1989). Incineration versus ocean disposal of sewage sludge: a multimedia assessment of New York City management options. In: Oceanic Processes in Marine Pollution. Vol. 3. Marine Waste Management: Science and Policy (M.A. Champ & P.K. Park, eds.), pp. 297-313. Krieger, Malabar, Florida.

Royal Commission on Environmental Pollution (1988). Best Practicable Environmental Option. HMSO, London.

The Anglian Water Authority's North Sea Conference Action Plan



Earl of Cranbrook, Ph.D.
(Non-executive Board Member, Anglian Water)

1. Science and implementation
At the Second International Conference on the Protection of the North Sea, held in November 1987 Ministers agreed to:
take measures to reduce urgently and drastically the total quantity of substances that are persistent, toxic and liable to bioaccumulate teaching the aquatic environment of the North Sea, with the aim of achieving a substantial reduction (of the order of 50%) in total inputs from these sources between 1985 and 1995.

There are three sections of the Ministerial declaration that have particular implications for U.K. water authorities. They are:

i) inputs via rivers and direct inputs to estuaries and coastal waters of substances that are persistent, toxic and liable to bioaccumulate;
ii) inputs of nutrients;
iii) dumping at sea.

In this note, I examine the scientific and technical problems faced by the Anglian Water Authority in implementing the Ministerial decision.

2. Inputs via rivers and direct inputs to estuaries
The Anglian Water area stretches from the Humber Estuary in the north of the region, to the Thames in the south. Anglian Water is the pollution control authority for all discharges from the south bank of the Humber and a number of smaller estuaries between the Humber and the Thames (Figure 1).
Table 1 is a list of the freshwater flows to these estuaries. About 60% of all freshwater from the Anglian Region flows to the North Sea via the Wash.

In the first instance, monitoring the non-tidal river at the tidal limit will establish the importance of all upstream direct inputs to the total catchment load. Inputs of both trade and sewage effluent downstream of the tidal limit will need to be monitored directly.

Fig.1: AW Estuaries

Table 1
Anglian water average daily freshwater flows to estuaries

River	Flow in cumecs
Bedford Ouse	16.3
Ely Ouse	15.6
Witham	12.7
Nene	9.2
Welland (and Glen)	7.5
Blackwater	5.0
Stour	4.9
Wensum (to Yare estuary)	4.9
Ancholme (to Humber estuary)	3.2
Waveney	3.2
Middle Level Main Drain (to Ouse estuary)	3.1
Yare	2.9
Colne	2.8
Bure	2.4
Chelmer (to Blackwater estuary)	2.2
Gipping (to Orwell estuary)	1.2
Nare (to Ouse estuary)	1.2
Babingley (to Ouse estuary)	1.0
Louth Canal (to Humber estuary)	0.9

NB
Some of these flows are measured at points which are located a significant distance upstream of the tidal limit. They are, however, the nearest flow measurement points to the tidal limit.

In many cases there is little information about pesticides in discharges. In order to improve knowledge, screening surveys will be undertaken. Three data sets should give sufficient information to enable a decision to be taken on whether to include a discharge in the main surveys (which will begin in 1990) and, if so, for which parameters.

It is difficult to be certain which inputs should be included in the screening surveys. Anglian Water has sent a questionnaire to trade dischargers and hopes to use the returns to identify discharges that need to be screened. A similar exercise is being carried out for Anglian Water's own sewage inputs. Preliminary assessments suggest that 11 rivers, 36 sewage effluents and 35 trade effluents should be screened.

Whilst for the screening surveys, an approximation of the flow of a discharge will probably be sufficient for load calculation purpose, this will not be true for the main surveys in 1990. Once a discharge is identified as containing a significant load, it will be important to ensure its flow is reliably and accurately measured.

It will be necessary to ensure appropriate flow measuring equipment is installed by the discharger at a point as near as possible to the point of discharge and, where flow measuring equipment is already installed, to ensure that the discharger keeps it in full working order.

In order to facilitate decisions about which inputs may need to be reduced, it will be necessary to prepare an inventory of all significant tidal discharges of trade or sewage effluent to each river catchment and prepare a list of all 'Red' List substances which may be present in significant amounts [1]). Anglian laboratories cannot at present analyse for many of the 'Red' List substances. It will be necessary to arrange for a specialist laboratory to carry out the 1989 screening surveys.

3. Baseline loads

The baseline for the 50% reduction in input load is the load that was actually being discharged in 1985. Archive data for 1985 is limited. In some cases the loads (particularly for sewage works) are calculated on the basis of a large flow and a very low limit of detection concentration. This inevitably gives an unreliable figure. This needs to be borne in mind in using the information.

[1]) The 'Red' List, published by the UK Department of the Environment on 10 April 1989, covers substances qualifying for abatement procedures under the 1987 North Sea Conference agreement. See Appendix 1.

Data for 'Black' list substances exists for 1986 and 1987 and will shortly exist for 1988 (Figures 2, 3 and 4). Baseline loads for these years are being calculated in the same way as has been done for 1985. It will not be possible to calculate baseline loads for the remaining 'Red' list substances before the end of 1989.

In some cases, since 1985 the amount of a 'Red' list substance present in a particular discharge may have decreased as a result of a change in raw material or production process. It is important that an estimate of this former load is made and included with the 1989 baseline.

A Water Research Centre report, 'Estimates of Loads of Certain List 1 and List 2 Substances Discharged to the North Sea', and a Quality Status Report were issued for the Conference. Where these estimates differ significantly from those chosen as the initial baseline the reason for the difference will need to be explained.

4. Load reductions since 1985

From the baseline surveys it will be necessary to calculate the total load of each 'Red' list substance being discharged both within each estuary catchment and within the whole of the Anglian area and, for each 'Red' list substance, to identify inputs which produce the bulk of the load. Load reductions will then have to be negotiated with the discharges and the consent varied accordingly.

5. Reducing annex B inputs

Annex B of the Ministerial Declaration lists examples of potentially significant pollutants, the input of which to the North Sea should be reduced. The metals (copper, chromium, lead, nickel and zinc, Figures 5-9) are obvious targets for reduction. Some monitoring data on sources and loads for these substances do exist.

Using a similar procedure to that proposed for 'Red' list substances, it should be possible to identify those catchments and inputs which produce the bulk of the grey list metal load and negotiate an appropriate reduction in load with the discharger and vary the consent accordingly.

6. Diffuse sources

Diffuse sources, by their very nature, are difficult to identify and quantify. The only way to recognise a problem caused by diffuse source pollutants is by means of a catchment budget for all significant pollutants.

Where the total load of a pollutant from known discharges is significantly less than that present in the receiving water, then diffuse source inputs have to be assumed. Where a significant diffuse source input has to be

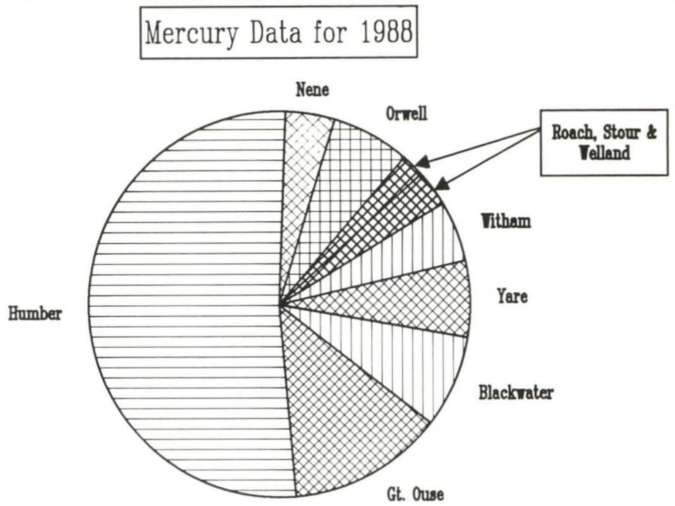


Fig. 2: 1988 Total Mercury Load: 176 kg/year

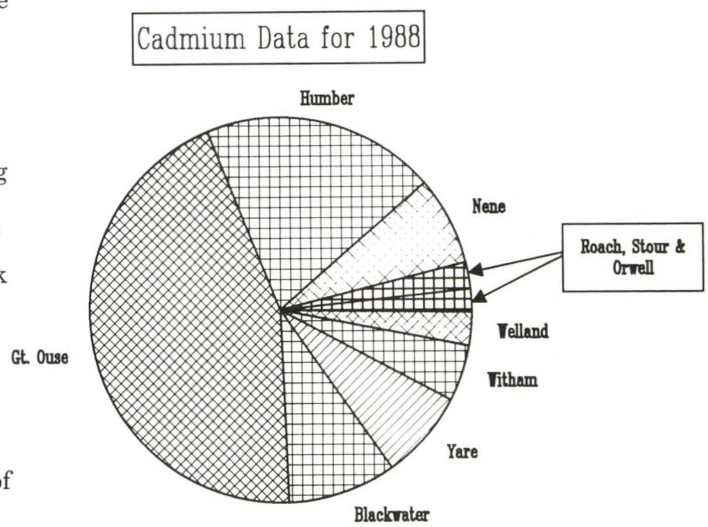


Fig. 3: 1988 Total Cadmium Load: 425 kg/year

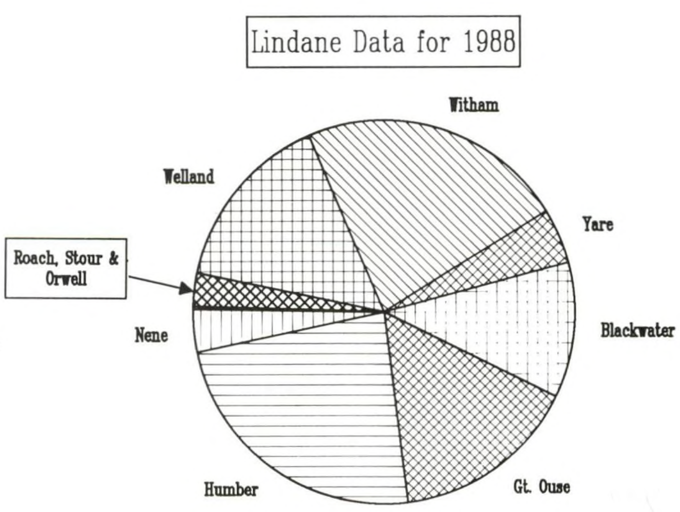


Fig. 4: 1988 Total Lindane Load: 67 kg/year

assumed to balance the budget, it will be necessary to investigate the use of the pollutant in question within the catchment in order to identify and quantify these inputs. Cadmium (Figure 3) may prove to be an example.

Existing legislation does not give powers to control diffuse source inputs. Where such inputs are identified as a problem, the most that Anglian Water can do is to produce an inventory and forward it to central government with a request for legislative action.

To implement effective pollution control within an estuary there needs to be an agreed set of Environmental Quality Objectives (EQO's) and Environmental Quality Standards (EQS's) for the estuary. 'Red List' substances being controlled by the 'precautionary concept' will still need to be judged against a relevant set of EQO's and EQS's.

7. Sewage sludge to sea

About 11% of the sludge produced in the Anglian region is dispersed at sea (about 14.000 tonnes per annum as dry solids). The sludge comes from three sewage treatment works:
Tilbury, Colchester and Ipswich. Two dispersal grounds are used: Harwich Deeps (or Roughs Tower) and South Falls. Anglian Water expects the amount of sludge it takes to sea to increase by about 22% in the period up to 1992.

The North Sea Conference decided that contaminant levels in sludge disposed to the North Sea should not rise above that of 1987. In order to meet this requirement a baseline of 1987 contaminant levels is needed for relevant metals and certain organics. Data for metals in sludge already exist. Using these data, a baseline for 1987 metals has been agreed. It will now be necessary to ensure, by means of trade effluent control, that the contaminant metal load in the sludge does not rise above that agreed level.
A survey of organic contaminants in sludge taken to sea has just been carried out. This survey covered the period August-December, 1988, and included the following substances:
alpha, beta & gamma - HCH, Dieldrin, p,p'-DDT, p,p'-DDE, p,p'-DDD, hexachlorobenzene, and PCB's (as Aroclor 1254). Once the results are available it will be possible to calculate a 1987 baseline.

Regular monitoring of the contaminant level in sludge will be needed to demonstrate that the initial baseline values are not being exceeded. Similarly, monitoring of water quality and sediments in the dumping ground area will be needed to demonstrate no adverse effect. In practical terms, the following action is required:

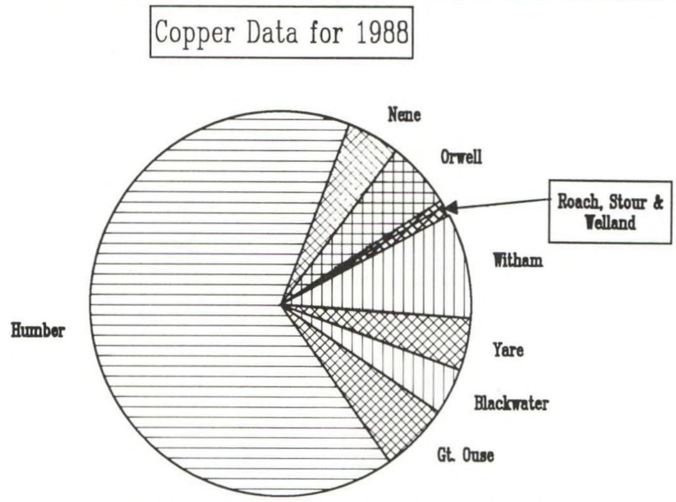


Fig. 5: 1988 Total Copper Load: 38,759 kg/year

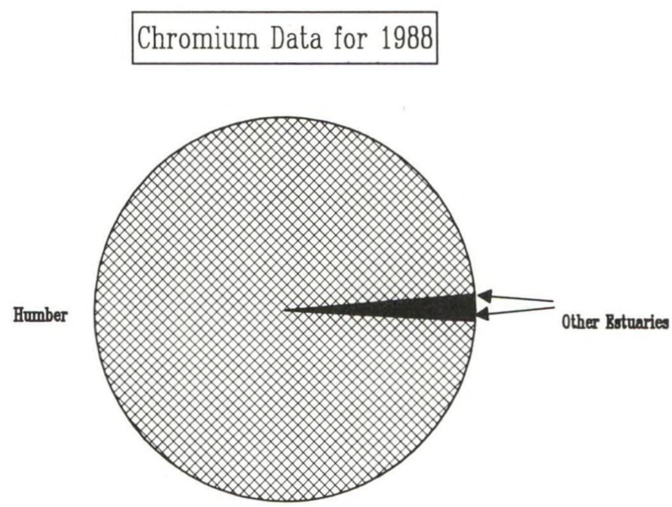


Fig. 6: 1988 Total Chromium Load: 221,540 kg/year

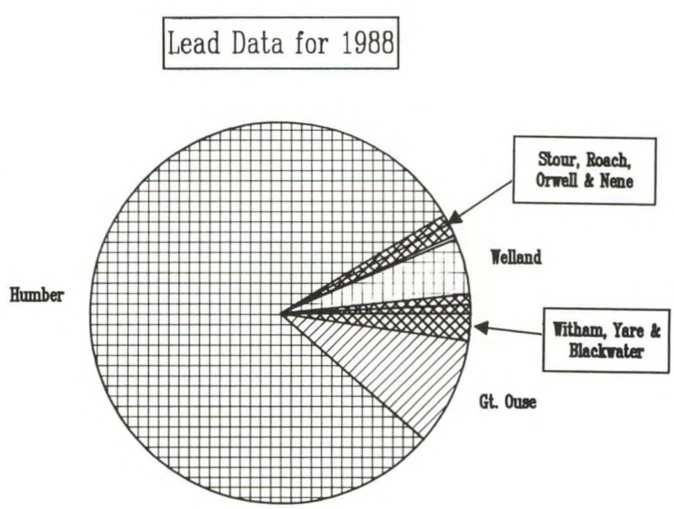


Fig. 7: 1988 Total Lead Load: 32,737 kg/year

Determine the scope for reducing the input of 'Red' list substances to sewer and initiate appropriate trade effluent control procedure.

Determine whether alternative outlets for sewage sludge are needed and, if so, by when.

Identify alternative sludge dispersal routes and the costs involved.

Assess costs of any necessary increase in monitoring either in the marine dispersal grounds or for trade effluent control purposes.

8. Nutrients

In the UK side of the North Sea, there are no known problems resulting from the input of nutrients to estuaries and coastal waters (Figures 10 and 11). The level of nutrients in coastal waters is far lower than commonly found in freshwaters. Limits of detection and the concentration range determined need adjusting when analysing marine samples. It is also important to have salinity data for correct interpretion.

9. Costs

All that has been estimated so far is the cost of the three screening surveys at about 70.000. Routine surveys will need to be carried out twelve times per year rather than just three. The cost could therefore be four times as high as the screening surveys at about 300.000 per year. Until screening results are available it is difficult to anticipate any saving, but there are several areas where additional costs can be foreseen. The principal ones are:

i) extra sewage sludge monitoring

ii) In 1990 a major survey for Paris Commission purposes will be needed.

iii) Present monitoring for nutrients in estuaries and coastal waters will have to increase and analytical techniques will need to be improved.

iv) If consent conditions are to be renegotiated with traders then additional staff time will be needed.

v) In a largely agricultural area such as the Anglian region, diffuse inputs are likely to be a major source of 'Red' list substances in rivers and estuaries. Identifying, locating and quantifying these inputs could be a difficult, time consuming and very expensive task.

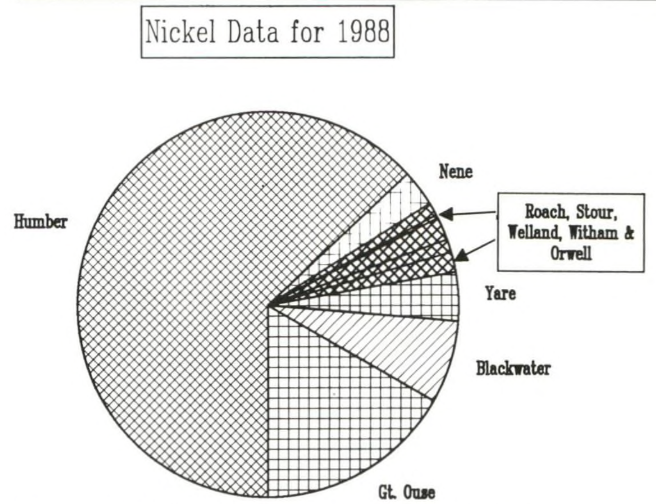


Fig. 8: 1988 Total Nickel Load: 28,632 kg/year

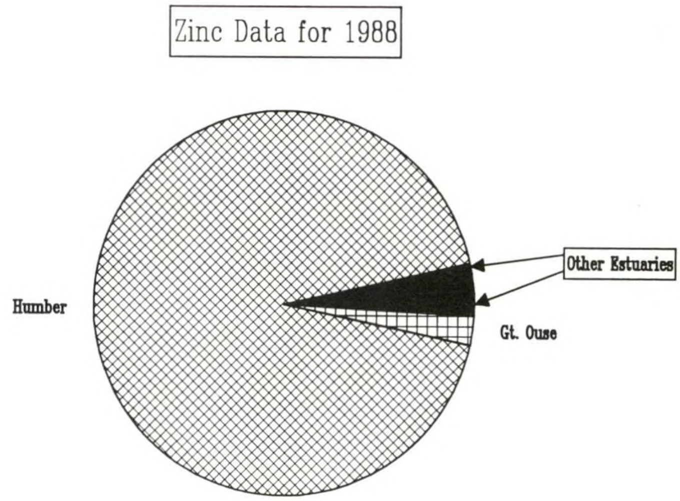


Fig. 9: 1988 Total Zinc Load: 523,673 kg/year

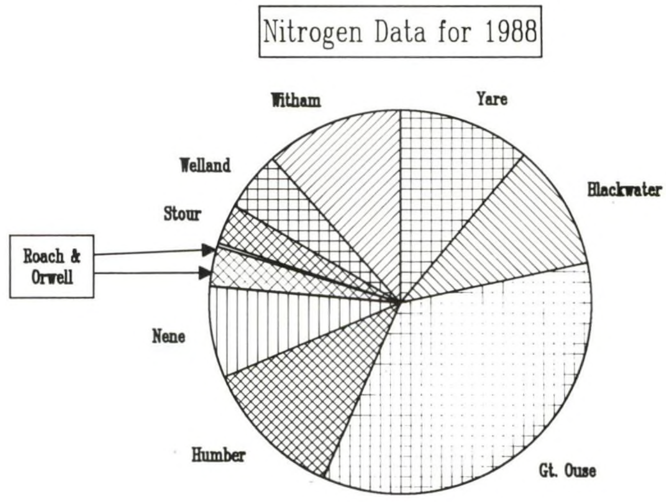


Fig. 10: 1988 Total Nitrogen Load: 34,360 kg/year

10. Conclusion

This paper outlines the extensive and expensive work that needs to be carried out by Anglian Water to meet the commitments of the North Sea Conference Ministerial Declaration. Time scales are very short but it is the intention to make every effort to meet them (Figure 12).

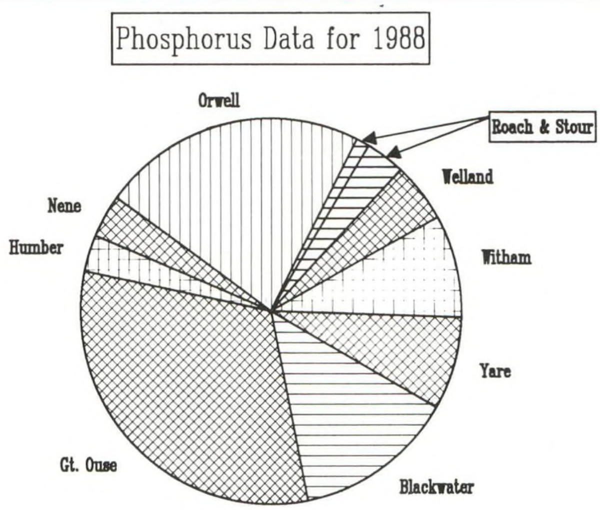


Fig. 11: 1988 Total Phosphorus Load: 3,734 tonnes/year

Figure 12.
Timetable of proposed action

Action points		1989	1990	1991	1992	1993	1994	1995
Questionnaire	– direct discharge	■						
	– to sewer	■						
	– follow ups	■	■					
Surveys	– screening	■						
	– full Red List		■					
	– Paris Commission		■	■	■	■	■	■
	– nutrients		■	■	■	■	■	■
Loads	– check flow measurement	■	■					
	– prepare catchment inventories		■	■				
	– calculate 1985 baselines	■	■					
	– calculate 1986-1988 loads	■	■					
	– identify main inputs		■	■				
Reductions	– negotiate load reductions			■	■	■	■	
Diffuse source	– calculate catchment budgets		■	■				
	– identify diffuse input areas			■	■			
	– inform DOE of diffuse problems				■	■		
Consents	– determine deemed consents		■	■	■			
	– review other consents		■	■	■	■	■	

Action points:

Questionnaire-direct discharges
-to sewer
-follow ups

Surveys-screening
-full Red List
-Paris Commission
-nutrients

Loads-check flow measurement
-prepare catchment inventories
-calculate 1985 baselines
-calculate 1986-1988 loads
-identify main inputs

Reductions-negotiate load reductions

Diffuse sources-calculate catchment budgets
-identify diffuse input areas
-inform DOE of diffuse problems

Consents-determine deemed consents
-review other consents

Appendix 1

The agreed 'Red' list of substances published by the U.K. Department of the Environment, News Release no. 194, 10th April, 1989

Substance	CAS Number
Mercury and its compounds	
Cadmium and its compounds	
Gamma-Hexachlorocyclohexane	00058-89-9
DDT	00050-29-3
Pentachlorophenol	00087-86-5
Hexachlorobenzene	00118-74-1
Hexachlorobutadiene	00087-68-3
Aldrin	003090-00-2
Dieldrin	00060-57-1
Endrin	00072-20-8
Polychlorinated Biphenyls	01336-36-3
Dichlorvos	00062-73-7
1, 2-Dichloroethane	00107-06-2
Trichlorobenzene	12002-48-1
Atrazine	01912-24-9
Simazine	00122-34-9
Tributyltin compounds	
Triphenyltin compounds	
Trifluralin	001582-09-8
Fenitrothion	00122-14-5
Azinphos-methyl	00086-50-0
Malathion	00121-75-5
Endosulfan	00115-29-7

Discussion

Rapporteur:
Renske Postma, University of Utrecht

Chairman: Earl of Cranbrook

Members of panel:
Mr Barisich, Prof. Dr Clark, Dr Stel, Mr Tromp

Mr Lankester (North Sea Working Group East Anglia) states that science appears to present conclusions diverse from the most urgent needs of society and earth. Scientists seem reluctant to share their investigations with 'ordinary' people, perhaps through fear of misinterpretation, but in decision-making politicians need that knowledge. Politicians receive knowledge sieved by their political leaders, a selectivity which causes L the greatest concern. Scientists should take objective views and divulge their knowledge through education. At the moment this role is almost entirely a function of environmental pressure groups, which may not be desirable. Furthermore, science is anthropocentric, the major concern is how damage to the earth is going to affect human beings and human life upon the earth, exemplified by the study of the greenhouse effect which focuses on the question whether the sea-level will rise and whether consequently human populations will drown, rather than whether the earth will function as an entity with or without human life.
Science seems to have been applied to the North Sea in a selective way, as is demonstrated from the evaluation of sewage discharges. Sewage outflow pipes collect sewage from different sources and discharge it into the sea in a differing way from natural conditions, where nitrogen run-off would flow through wetlands or salt marshes, which would soak up nutrients. At present, the much modified coastline causes nutrients to reach the sea directly through drainage pipes. Such aspects are not evaluated in science. L suggests that science as the centre of political action is very dubious. He prefers a more or less philosophical approach as the centre and science as filling the gaps.
Mr Stel says that science has just learned - by recently developed technology - that the earth is a system. Since not all aspects of the system can be studied, a science policy is needed. Scientists should make clear that the truth they state is a truth limited by technological potential. Scientists also tend not to communicate their most interesting findings to the public, as if withheld by fear of P.R.
Mr Tromp mentions that in preparing the 1990 conference on the North Sea, most of the people he contacts are working in the interface between science and policy. Politicians struggle with the question whether science is heading in the right direction, since many years may pass before findings from the 'laboratory' end up in political decisions. Scientists should be more interested in the politicians' needs, and science should be guided.
Mr Clark disagrees with the implications of Lankester'sremark on science being the centre of political decision-making, and hence implicating that we live in a rational world. Political decisions are not based on science but on what the public will stand. Besides, most scientific issues are very complicated. The public has to choose for the best option or menu, and all of the options have their economical and environmental price tags.
Mr Barisich agrees with what has been said about scientists, but scientists can not be expected to change their minds and their assessments. Negotiations should be started between defined assessments.
Mr Tromp returns to the role of science in politics. According to him science plays a very important role in the first phase of policy-making by informing the politicians. In the ultimate phase of decision making, however, other aspects dominate and science then plays a minor role.
Lord Cranbrook mentions Minister Smit-Kroes's view which is based on the sustainability concept and her three criteria for sustainability are scientific ones!
Mr Lees (Foe-UK) is concerned about the monitoring of black and red list substances as carried out in the U.K. If monitoring is so poor how can scientists draw the right conclusions?
Mr Sayers (Anglian Water) answers that questions from policy can not be foreseen years hence, so monitoring always starts too late.

Mr D'Hondt (Min Environment, Belgium) asks Mr Barisich to explain the new water policy of the E.C. He agrees that the E.C. should play a major role in global water policy.
Mr Barisich mentions three major events of last year:
1. A summit of E.C. member states
2. The Council's initiative for a resolution
3. The ministers Seminar in Frankfurt on the orientation of E.C. water policy.
These events took place in the period of the algal blooms; public pressure stimulated the forming of conclusions, which asked for a more stringent E.C. policy.
Four E.C. priority fields were indicated:
1. Dangerous substances: reductions of these substances were not progressing fast enough. The Commission was mandated to accelerate the reduction substance by substance, to follow the sectorial approach (sectorial control), and to follow the objective approach of limit values.
2. Reduction of phosphorus and pesticides.
3. Obligatory waste water treatment for all member states.
4. Legalism on ecological water quality.
Specific problems should be tackled by specific tools. As a result the frame work of regulations will become broader. The E.C. has chosen for the principle of subsidiarity: the member states will be responsible for the implementation of the regulations but efficient control should come from the E.C.
Lord Cranbrook mentions two impressions from the ministers conference in Frankfurt:
1. The Southern member states took initiatives and brought in the most important impressions.
2. The situation in Southern Europe is different from here: in the South fresh water is a limited source and the level of waste water treatment is low.

Session IIA

Policies for Effluent Waters

Chairman
Prof. Förstner

Policies for Effluent Waters

Prof. Dr U. Förstner,
TU Hamburg - Harburg

Introduction

Session II A will discuss policies for effluent waters. A major reason for this session is the decision taken at the 2nd Ministerial North Sea conference for reducing river inputs of some toxic or eutrophicating substances by 50% between 1985 and 1995. Transformation into reality of this political option, which indicates a clear shift from the principle of assimilative capacity to the precautionary principle, will pose many questions. One is the harmonization of the different institutional arrangements and the measures agreed by individual countries during the last 35 years; Dr. Graham Bennett will review past and present control policies of polluting discharges to the North Sea and will outline ideas for greater integration of international environmental policy-making. A closer look at the national policies shows remarkable inconsistencies in quality objectives and control measures; this is evidenced by Mr. Folkert de Jong from the contents of the different 'lists', and it is suspected that such confusion is an indication of the defective perception of the precautionary principle in certain countries. At this turning point of environmental policy, governments and the community in particular expect signals from industry regarding an adjustment of their production to the needs of the environment; recent experience and efforts from inorganic pigment industry is presented by Mr. Derek Pearce. Another series of open questions are connected with the adequate management of control activities. Even with the precautionary principle most decisions will be made on a cause-effect basis; Dr. Tony Stebbing will give an overview on monitoring strategies, and, since criteria for environmental quality are ultimately biological, the advantage of bioassays by using their integrating effects on different contaminants will particularly be stressed.

In addition to these presentations, a few introductory remarks are needed with respect to the levels of technology necessary for reaching the before-mentioned objectives. In several of the North Sea riparian countries

negotiations on the reduction of phosphorus and nitrogen inputs from agricultural and urban settlements have been started. There will be no greater problem than reducing the phosphorus concentrations in effluents. In West Germany, during the last few years, the percentage of phosphorus-containing detergents has decreased to approx. 5% in 1989. Precipitation of phosphorus in sewage treatment plants is quite efficient and can be performed at reasonable costs. On the other hand, reduction of nitrogen compounds in municipal waste is still a matter of future development, and it can be expected that the additional costs for denitrification will be an order of magnitude higher than for reduction of phosphorus.
Recently, the West German states around the River Elbe (Hamburg, Schleswig-Holstein, Niedersachsen) have indicated that they do expect to reach this goal of 50 percent reduction. For the River Elbe as a whole the 50 percent reduction cannot be achieved, due to the high inputs from the German Democratic Republic and Czechoslovakia. Adjustment of the municipal and industrial treatment plants in these countries at least to the generally accepted rules of technology (the lower level of purification technology in West Germany) should be one of the priority requests presented by the other North Sea riparian countries. In this context, however, it should be mentioned that the State Government of Hamburg has estimated the cost of 'sanitation' of the seven major dischargers in the German Democratic Republic to about 6.4 billion German Marks.

On the other hand, there is a good example, also from the Elbe River, that even with much less financial efforts considerable improvements could be reached. Recent data of the water quality station of the coastal states in Northern Germany indicate that the signal of mercury pollution has now reached the outer estuary and coastal zone as an increase by a factor of 5-7 over natural background data. A similar situation existed in the early seventies in the River Rhine. A rapid succession of new purification techniques in the chlor-alkali-industry reduced the discharges of mercury from 100 g per ton of chlorine to less than 2 g per ton, which means by more than 98%. Consequently the overall discharges in the River Rhine decreased from 75 tons of mercury in 1973 to 10 tons in 1983. It has been stressed that a similar effect could be attained at the River Elbe now at much smaller expenses, and the City State of Hamburg took an initiative to the Länder Council, the 2nd House, for financial assistance of the chlor-alkali-industry in the German Democratic Republic by 20 million Marks. Generally, financial support for these control devices is preferable to the very small additional effects achieved by relative high investment in the already 98% efficient plants in West Germany.

This example should indicate that many of the problems with toxic chemicals can be solved simply by applying the available technologies. However, it is important to define new objectives in connection with the river inputs into the sea. There is already some experience with effluent control for other objectives. Initially, regulations were installed for indirect discharges for securing the function of the biological step in sewage treatment plants. These standards can be reached relatively easily by conventional techniques. To reduce the direct discharges from the treatment plants, taxes for critical nutrients and pollutants, such as mercury and cadmium can be imposed; these costs will usually be revolved from the treatment plant to the indirect dischargers, and in many cases this then stimulates application of more advanced technologies. A similar development can now be seen in relation to the contamination of sewage sludge; the acceptance by agriculture is strongly declining and there are also problems with the land disposal of these materials. Here too, the application of a higher standard technology is requested. Such a standard may include measures for source avoidance or reduction, as well as - also for economical reasons - recovery and re-use of certain components from the waste stream.

With respect to the North Sea, pollution of both water and solid matter has to be considered. Even if some improvement has been achieved in the water phase, there may still be problems with contaminated sediments. In addition, as the distance increases from the point of discharge, causes and effects can rarely be linked together. Therefore, with the acceptance of the precautionary principle, a high standard of technology is required for effluent control in all North Sea riparian countries.

The International Control of Land-based Discharges to the North Sea A Policy Review

International efforts to control land-based polluting discharges into the North Sea can be traced back over 15 years. The dominant characteristic of these efforts has been their fragmentation, both of the institutional arrangements created and the measures agreed: the North Sea states have each developed their own national control policies, three international organisations are involved in varying respects in the control of land-based discharges to the North Sea, and the many existing agreements and legislative programmes have led to many incompatible policy objectives and control instruments. These arrangements are reviewed and the fragmentation of the different regimes is highlighted. The prospects for improvement have nevertheless improved considerably in the past two years. The North Sea conferences have played an important role in bringing about this change, operating as a catalyst for the work of the various existing international management bodies. At the same time, developments in a number of areas and countries have underscored this process. The major policy task now is to further advance these developments and to elaborate the precautionary principle and the cross-media approach to pollution control into usable policy instruments.

Dr G. Bennett
Institute for European Environmental Policy, Arnhem, Netherlands

Introduction

There can be few environments anywhere in the world which are subject to such a complex and obscure system of control arrangements as the North Sea. Apart from the national policy measures which prevail in each of the eight North Sea states, there are also the controls which apply in a further eight non-riparian states from which discharges may enter the North Sea through international rivers or the Baltic Sea (Austria, Switzerland, Luxembourg, Finland, the German Democratic Republic, Poland, Czechoslovakia and the Soviet Union), the many formal agreements made under the auspices of nine international organisations which are directly concerned with the North Sea environment [1]) and, finally, a number of less formal intergovernmental declarations. This fragmentation of control is not only a problem for the observer of North Sea affairs, it has clearly acted as a serious impediment to the development of a coordinated management policy.

If the sources of all pollutants entering the North Sea are compared, it becomes apparent that the aggregate input from rivers amounts to about 30-40 per cent of the total pollution. [2]) A major improvement in the quality of the North Sea is therefore only likely to be feasible if significant reductions in the discharges to these rivers can be achieved. It is the purpose of this paper to review the arrangements for the control of such indirect discharges to the North Sea and to assess the prospects for instituting a more effective regime.

International controls on land-based discharges to the North Sea

In many ways the North Sea is a classic example of an environmental commons.[3]) Not only that, most of the indirect discharges enter the North Sea through international waterways. Effective management therefore requires cooperative action by all the parties which use these aquatic systems in one way or the other. That this is indeed recognised is demonstrated by the creation of various institutional frameworks over the past 35 years within which a large number of international agreements have been negotiated. In the case of land-based discharges, three such institutions are of importance:

- the Paris Commission
- the European Community (EC)
- the International Commission for the Protection of the Rhine against Pollution (commonly known as the International Rhine Commission or IRC).

These institutions now administer a surprisingly large number of international agreements concerning the control of discharges to the North Sea. The most important are set out in table 1.

The Paris Convention is concerned only with discharges to the North Sea and northeast Atlantic Ocean, including those via rivers. The convention has been ratified by Belgium, Denmark, the Federal Republic of Germany (FRG), Spain, France, Iceland, Ireland, the Netherlands, Norway, Portugal, Sweden, the UK and the EC. EC measures are applicable to all 12 Member States (though only discharges from Belgium, Denmark, the FRG, France, Luxembourg, the Netherlands and the UK enter the North Sea). The two Rhine conventions are concerned with discharges to the Rhine from its five riparian states, the FRG, France, Luxembourg, the Netherlands and Switzerland; the EC, however, is also a party to the Chemical Convention.

It is notable that the same basic approach to control has been adopted by the Paris Convention, the Rhine Chemical Convention and the EC framework for controlling discharges of dangerous substances, namely that substances are divided into two categories, a 'black list' and a 'grey list'. The underlying philosophy of this approach is that pollution by black-list substances should be ended and pollution by grey-list substances should be substantially reduced. In practice, however, it is not feasible to prohibit entirely all discharges of the black-list substances, so internationally agreed emission standards have been fixed for many of the substances.

There are, however, two important differences between the three regimes. First, the lists drawn up under the Paris Convention differ from those drawn up by the EC and the IRC (which were negotiated simultaneously and are virtually identical), though there are similarities. Second, unlike the Paris and Rhine conventions, the EC framework permits Member States to choose between two alternative instruments for controlling discharges of dangerous substances: emission standards or quality objectives. The emission standards applying to each discharge are to be at least as strict as the uniform limit values laid down in so-called 'daughter directives'; minimum quality objectives - also laid down in the same daughter directives - are to be met by fixing appropriate emission standards (which may therefore vary from case to case). Of the 12 EC Member States, only the UK has opted to base control on quality objectives - indeed, it was only because of UK pressure in the original negotiations that this alternative was included in Directive 76/464.

The overlapping obligations of the Member States of the EC and the countries which have ratified either or both of the Paris and the Rhine conventions are illustrated in Figure 1. This shows that only three countries - the FRG, France and the Netherlands - are subject to all three regimes. Six countries - Belgium, Denmark, Spain, Ireland, Portugal and the UK - are both party to the Paris Convention and are members of the EC, while Luxembourg alone is both party to the Rhine Convention and a member of the EC. The remaining seven countries have obligations under only one of the three regimes. This degree of fragmentation has clearly been less than conducive to the development of a consistent international policy on the control of land-based discharges to the North Sea.

It is, however, important to be clear about the exact nature of this fragmentation. Three crucial differences can be noted. First, the three regimes obviously have very distinct environmental constituencies. The Paris Convention has but a single objective: the control of land-based discharges to the marine environment. Its area of concern, however, extends beyond the North Sea to the northeast Atlantic. The IRC also has but a single objective: the control of discharges to the Rhine. But although the Rhine makes up the single largest riverine input of pollutants into the North Sea, the protection of the marine environment is not a specific objective of the IRC's work. The objective of EC water pollution control policy is to harmonise the national measures applying in 12 countries spread over a large part of Western Europe, experiencing a wide range of problems and discharging to a large number of waters - from small streams through major watercourses (both national and international) to coastal waters in the Baltic Sea, the North Sea, the Irish Sea, the Atlantic Ocean, the Mediterranean Sea, the Adriatic Sea and the Aegean Sea. This means not only that it is inappropriate - for both political or administrative reasons - to utilise EC environmental policy specifically to protect the North Sea, but also that any measures which might serve to protect the North Sea will have to be adapted to the needs of other coastal states in the Community; an environmental standard or a control procedure which is suited to the UK may be highly inappropriate in Greek circumstances.

Second, most rivers entering the North Sea do not cross a national frontier; the administrative task of managing river quality is therefore relatively straightforward. However, five of the rivers which discharge into the

Table 1:
International agreements on the control of land-based discharges to the North Sea

Paris Commission

- Convention for the prevention of marine pollution from land-based sources [the 'Paris Convention'] (Paris, 4 June 1974).

European Community

1. Discharges of dangerous substances

- Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (76/464/EEC, OJ L129, 18 May 1976).

- Council Directive on limit values and quality objectives for mercury discharges by the chlor-alkali electrolysis industry (82/176/EEC, OJ L81, 27 March 1982).

- Council Directive on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry (84/156/EEC, OJ L74, 17 March 1984).

- Council Directive on limit values and quality objectives for cadmium discharges (83/513/EEC, OJ L291, 24 October 1983).

- Council Directive on limit values and quality objectives for discharges of hexachlorocyclohexane (84/491/EEC, OJ L274, 17 October 1984).

- Council Directive on limit values and quality objectives for discharges of certain dangerous substances included in list I of the Annex to Directive 76/464/EEC [DDT, carbon tetrachloride and pentachlorophenol] (86/280/EEC, OJ L181, 4 July 1986).

- Council Directive amending Annex II to Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC [drins, chloroform, hexachlorobenzene and hexachlorobutadiene] (88/347/EEC OJ L158, 25 June 1988).

- Council Decision concerning a supplement, in respect of carbon tetrachloride, to Annex IV to the Convention for the Protection of the Rhine against Chemical Pollution (88/381/EEC, OJ L183, 14 July 1988).

- Council Decision concerning a supplement, in respect of mercury originating in sectors other than the chlor-alkali electrolysis industry, to Annex IV to the Convention for the Protection of the Rhine against Chemical Pollution (88/382/EEC, OJ L183, 14 July 1988).

2. Controls over industries

- Council Directive on waste from the titanium dioxide industry (78/176/EEC, OJ L54, 25 February 1978).

- Council Directive on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry (82/883/EEC, OJ L378, 31 December 1982).

3. Controls over products

- Council Directive on the approximation of the laws of the Member States relating to detergents (73/404/EEC, OJ L347, 17 December 1973).

- Council Directive on the approximation of the laws of the Member States relating to methods of testing the biodegradability of anionic surfactants (73/405/EEC, OJ L347, 17 December 1973).

- Council Directive on the approximation of the laws of the Member States relating to methods of testing the biodegradability of non-ionic surfactants (82/242/EEC, OJ L109, 22 April 1982).

- Council Directive amending Directive 75/405/EEC on the approximation of the laws of the Member States relating to methods of testing the biodegradability of anionic surfactants (82/243/EEC, OJ L109, 22 April 1982).

International Commission for the Protection of the Rhine against Pollution

- Convention for the protection of the Rhine against chemical pollution (Bonn, 3 December 1976).

- Convention for the protection of the Rhine by chlorides (Bonn, 3 December 1976).

North Sea or the Baltic Sea are major international waterways which pose severe management problems. The Elbe, the Weser, the Rhine, the Scheldt and the Meuse all carry prodigious quantities of pollutants, yet only in the case of the Rhine has a formal body been established to coordinate the control of discharges by the riparian states. The problems of managing an international waterway with respect to polluting discharges are very different to those of a river which does not cross a national frontier. These problems are exacerbated where, as in the case of the Elbe and the Weser, the frontier concerned is with an Eastern European country. The Elbe, for example, discharges 25 tonnes of mercury into the Baltic Sea each year; of this total no less than 24.8 tonnes originate from the German Democratic Republic and Czechoslovakia.

Third, an important distinction between the EC and other international bodies is that EC regulations and directives are legally binding on the Member States. Indeed, in the entire field of international relations the EC is unique in being able to impose binding obligations on sovereign states. This imparts far greater significance to EC measures, though it can also act to make the Member States more cautious in the adoption of environmental protection measures precisely because of the legal consequences of their decisions.

Prospects

It is clear that a number of serious obstacles are hindering the further development of a comprehensive international management regime for land-based discharges to the North Sea: the three existing regimes each have different environmental constituencies; most of the international waterways through which pollutants enter the North Sea are not subject to an international management authority; and EC measures have a much firmer legal foundation than the Paris and Rhine conventions. At the same time there is one common feature which is of major significance: all three regimes base their control strategy for dangerous substances on the concept of black and grey lists.

Gazing into the future it is possible to discern four developments which will play an important part in the further development of controls on land-based discharges to the North Sea. First, there is clearly a growing trend towards the adoption of ad hoc measures. As the incidence of environmental problems concerning the North Sea increases, governments are forced to respond in a reactive way by agreeing case-by-case measures. The agreement during the second North Sea conference to reduce inputs of nutrients into vulnerable coastal waters by about 50 per cent is a good example of such a response in the face of the now persistent growth of algal blooms in the Skagerrak and Kattegat. That these types of incidental measures are necessary is obvious; they are nevertheless a second-best option to a coordinated and anticipatory North Sea management policy.

Second, these problems are forcing existing international bodies concerned with the North Sea environment to cooperate far more intensively than was previously the case. Thus, because of the transboundary nature of both the causes of the nutrient enrichment and the algal blooms themselves, the agreement to reduce nutrient inputs by about 50 per cent required broader action than by the North Sea states alone. It was consequently reaffirmed in a decision of the Helsinki Commission for the Baltic Sea, a recommendation of the Paris Commission[4]) and a resolution of the EC Council of Ministers.[5]) The role of the North Sea conference as a catalyst in this process deserves emphasis.

Third, there is now a growing awareness that the problems confronting the North Sea environment demand an anticipatory protection policy. Indeed, this was formally acknowledged in the Ministerial Declaration at the second North Sea conference when it was agreed to apply the precautionary principle to emissions of dangerous substances. This affirmation of the precautionary principle was, however, linked to the use of the best available technology. This is bound to lead to a substantial weakening of the principle in practice since it amounts to little more than a confirmation of the use of technology standards. Moreover, best available technology is defined in this context as taking into account the economic availability of the technology. The significance of these qualifications was emphasised during the tenth meeting of the Paris Commission in June 1988 when the FRG entered a reservation on a recommendation to apply the best available technology in order to prevent increases in pollution, on the grounds that this did not reflect the principle of cautionary action.[6]) But while there may be problems in applying the precautionary principle in practice, it nevertheless encourages a reorientation of policy towards indicators of potential effects, irrespective of their origin, and therefore towards a concern with environmental quality rather than emission controls as such. Inevitably, however, the central issue raised by the principle will become of increasing importance in the years to come: what degree of cost is society prepared to bear in order to avoid risk?

Finally, another pollution control principle which is currently gaining increasing attention in several countries is the cross-media approach. In the Netherlands, Sweden, some states in the FRG (particularly Hamburg) and the UK, initiatives have been taken with the aim of assessing the environmental effects of polluting activities in an integrated framework rather than in the traditional sectoral fashion. The objective of this approach is to derive the optimum measures through which to protect vulnerable environmental receptors. It may be preferable in environmental terms, for example, to install abatement equipment which converts residues into a solid waste for subsequent controlled disposal rather than a liquid effluent which would be discharged into a watercourse. Given a comprehensive assessment of the environmental stress suffered by the North Sea and the sources of the pollutants, the cross-media approach can then be applied to bring about a reordering of the inputs through the various emission vectors and thereby reduce the overall pollution burden on the North Sea. It must be emphasised that the North Sea is not viewed in isolation in this process; the cross-media approach inherently involves the consideration of emissions to alternative environmental media, such as air or soil, in the search for an environmental optimum - implying that it might be beneficial to divert waste streams currently entering the North Sea to other environmental media.

Conclusions

International efforts to control land-based polluting discharges to the North Sea can be traced back over 15 years. The dominant characteristic of these efforts has been their fragmentation, both of the institutional arrangements created and the measures agreed: the North Sea states have each developed their own national control policies, three international organisations are involved in varying respects in the control of land-based discharges to the North Sea, and the many existing agreements and legislative programmes have led to many incompatible policy objectives and control instruments.

The prospects for progress have nevertheless improved considerably in the past two years. The second North Sea conference has played an important role in bringing about this change, operating as a catalyst for the work of the various existing international management bodies. The increasing number of specific measures agreed and the formal adoption of the precautionary principle for the control of dangerous substances are notable examples. At the same time, developments in a number of areas and countries have underscored this process - both for negative reasons (such as the algal blooms off the Danish coast) and for positive reasons (the shift towards a cross-media approach to pollution control). It will be the task of the third North Sea conference to advance this process still further and to elaborate the precautionary principle and the cross-media approach into usable policy instruments for the management of the North Sea.

1 hese are: the United Nations, the International Maritime Organisation, the European Community, the Paris Commission, the Oslo Commission, the Helsinki Commission, the secretariat to the London Dumping Convention, the secretariat to the Bonn Agreement and the International Rhine Commission.

2 The uncertainty is due to the lack of data on atmospheric inputs.

3 See Garrett Hardin, 'The Tragedy of the Commons', Science, 162, 1243-1248, 1968.

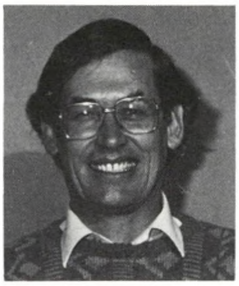
4 PARCOM Recommendation 88/2, 17 June 1988.

5 Council Resolution of 28 June 1988 on the protection of the North Sea and of other waters in the Community, 88/C 209/02, OJ C209, 9 August 1988.

6 PARCOM Recommendation 88/3, 17 June 1988.

Monitoring the North Sea: Biological Techniques in an Integrated Strategy

Implicit in the concept of monitoring is not only the need to maintain an awareness of environmental quality, but the overall strategy for monitoring must provide the means to effect control action. This requires that the monitoring information is of the right kind to base policy or legislative decisions, communicated effectively from scientist to environmental managers. This paper describes a biological monitoring strategy that is evolving in working groups of ICES and IOC, indicating how measured toxic effects can be linked to their chemical causes, thus providing a data base for environmental managers to act upon.
The case for deploying biological methods for monitoring is becoming much stronger, partly because of the large number of chemical contaminants and the impossibility of measuring more than a small proportion at regular intervals. Furthermore, chemical analyses can not be expected to take into consideration factors of biological significance such as the combined effects of contaminants, their degradation products and their interactions with environmental factors that change their bioavailability. To rely on chemical analysis alone presupposes that the contaminants likely to be biologically significant are known and are monitored - an assumption that the toxic effects caused in European estuaries by TBT (tributyl tin) clearly demonstrated were not justified.
The use of biological techniques to monitor water quality have been strongly advocated since their potential role was highlighted by the ICES/EPA Workshop in Beaufort USA in 1979. In more recent times the IOC Group of Experts on Effects of Pollution and the ICES Working Group on the Biological Effects of Contaminants have been advocating the adoption of biological techniques worldwide to monitor the effects of environ-



Dr A.R.D. Stebbing
Plymouth Marine Laboratory, Plymouth, UK

Introduction

One of the conclusions made in the Quality Status Report of the North Sea - Summary (1987) is that although there are data on inputs, concentrations and biological effects, what is now required is to establish to what extent they are linked, by improving monitoring and scientific programmes. It is therefore timely to consider some of the recent developments in biological monitoring since the ICES/EPA Workshop held at Beaufort in the USA (MacIntyre and Pearce, 1980). It was important because for the first time an international workshop was used to identify 'biological effects techniques' that could be incorporated in monitoring programmes. Despite this initiative, biological effects techniques have not found the role that the Beaufort workshop considered important, a conclusion confirmed by the recent review of Biological Effects Monitoring by the Joint Monitoring Group (1988). There appear to be a number of explanations for this:

1. Biological techniques typically employ generalised responses of organisms to toxic stress. This is both their weakness and their strength in that responses provide an integrated index of the effect of various toxic determinants of biological water quality, but leaves the further problem of needing to identify the causal contaminant(s) to be controlled.

2. The primary requirement of monitoring is to serve environmental legislation, which is typically expressed in chemical terms. This is partly because of the greater rigour with which chemical legislation can be formulated and enforced, and partly because the role of biological techniques that do not indicate deleterious effects is unclear to those responsible for monitoring programmes.

3. A number of sensitive techniques that indicate the activity of adaptive responses, often at biochemical and cellular levels of biological organisation, is now available. However, there are difficulties in interpreting such responses in monitoring programmes, because their

mental contaminants, using their workshops at Oslo in Norway and on Bermuda to demonstrate the effectiveness of the approach. The two groups plan a joint workshop in the North Sea based at Bremerhaven in March 1990.
The advantage of using environmental bioassays of water samples and sediments, or the deployment of sentinel organisms, is clear because the criteria for environmental quality are ultimately biological. The use of biological monitoring techniques is not advocated as an alternative to chemical techniques, but as its complement, enabling chemical analytical resources to be used more efficiently. Biological techniques act as a filter, so that chemical effort need only be deployed where there is a demonstrable biological problem. Contamination is primarily significant where it has a biological impact, so concern relates not to the presence of contaminants in the environment, but to their toxic effects. Organisms act as integrators of the effect of many contaminants - known and unknown - responding to their combined effect over the periods of exposure.
Biological techniques have not yet been deployed on a large scale because the detection of toxic effects in the environment is not an adequate basis for control action without establishing causal links with the chemical contaminants responsible. However, a number of techniques are now becoming available that make this possible, strengthening the case for the adopting biological monitoring techniques.

Contents

relevance to the protection of populations and communities is not always apparent to those who would need to implement them.

4. Monitoring requires a long term commitment of effort and resources, so it tends to be primarily directed to specific inputs and problem areas. This kind of application does not utilise the advantage that biological techniques have of providing an integrated measure of water quality, enabling the detection of new or unsuspected contaminants at biologically significant concentrations.

In recent years, partly through the international activities of the IOC Group of Experts on the Effects of Pollution (GEEP) and its practical workshops in Oslo (Bayne, Clarke and Gray, 1988) and Bermuda, and partly through the work of the ICES Working Group on the Biological Effects of Contaminants, there is a better range of field tested techniques for use in monitoring programmes than ever before and a strategy within which to apply them.

It is self-evident that contaminants in the environment are of significance, not because of their presence, but because of their effects, so the essential interdependence of biological and chemical techniques should be recognised in designing monitoring programmes. What seems to prevent their wider adoption is the failure to recognise the potential that biological techniques provide as a means of using chemical effort more effectively, directing it to where there are demonstrable biological problems

Anticipatory Pollution Control Measures
The release of specific inputs of potentially toxic wastes into estuaries and coastal waters typically requires consents from the appropriate authorities. Recommendations are made on the pretreatment and an appropriate release rate to ensure that the anticipated concentration of the waste outside the immediate mixing area remains non-toxic. Such control measures aim to predict what will happen in the environment on the basis of laboratory toxicity data, knowledge of its degradation in seawater, its partitioning between soluble and particulate phases, the hydrographic conditions at the point(s) of release and other relevant data (Fig.1).

What the environmental decision maker needs of scientists is the best understanding and information that is available to make sound decisions. However, the best information that exists is not always applied -sometimes because it is in an inaccessible form in the scientific literature, because of delays in the dissemination of information or because it is in a field in which the decision maker has no expertise. It must therefore be a

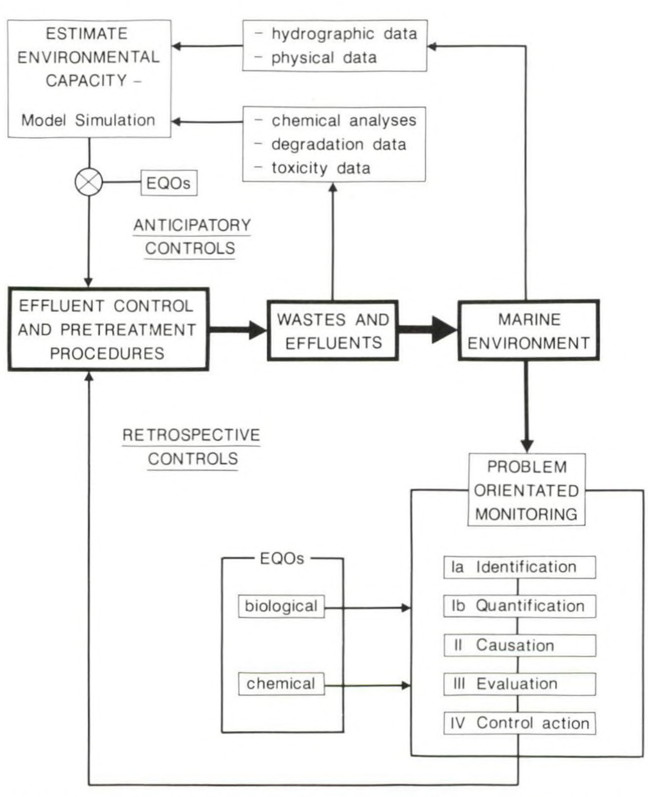


Figure 1. A strategy for monitoring that includes both 'anticipatory' and 'retrospective' components, incorporating biological and chemical indices, in an integrated strategy for monitoring the marine environment.

priority for scientists and decision maker alike to close the gap that exists between those who acquire understanding and those who need to use it.
The most potent means of expressing this understanding is as computer software in its various forms, such as expert systems and simulation models. A number of contaminant models for the North Sea are now being developed that integrate the chemistry, hydrography and sometimes the biological elements of coastal ecosystems (see review by Taylor, 1987). An important step being taken to communicate scientific advances to the decision maker is to make research models accessible to the non expert. (Stebbing and Harris, in press.)

At Plymouth Marine Laboratory, in a project funded by the UK Department of the Environment, we are developing 'simulators' from research models to predict the fate and dispersion of contaminants in estuaries. These simulators are novel in the sense that they place in the hands of the decision maker, in a desktop computer, the means of using current understanding of estuarine processes and contaminant behaviour. The first of these is a TBT Simulator (Harris and Cleary, 1987), which will soon be available for wider distribution. Such simulators are designed to give approximate solutions using pre-existing data, enabling the user to identify the most important factors that determine contaminant concentrations in estuaries. It is expected that the simulators will prove useful to environmental decision makers, whether they are formulating legislation, enforcing it, or having to abide by it.

It must be our objective to improve the quality of anticipatory control measures (Fig. 1), because the need for retrospective control measures implies that anticipatory measures have in some respect failed. The priority for research must be to provide an understanding of the system that is adequate to predict the consequences of our actions before we take them, so the capacity of the environment to assimilate new wastes should be determined in advance, rather than retrospectively by overloading it.

Retrospective Pollution Control Measures

For those wastes that are released into the environment, it is the retrospective measures that provide a means of knowing whether the anticipatory measures provided an adequate measure of environmental capacity, or whether it is being overloaded. The purpose of monitoring is control action, and the 'action cycle' is an idealised approach to policy making whose key elements are an assessment of the state of the environment, which leads to the identification of problems requiring action, the formulation of objectives, the design of control measures that meet the objectives and the enforcement of the objectives (DOE, 1982). The purpose of monitoring is to provide the information necessary for an environmental control system to operate, and its essential feature is to provide a feedback loop by which information about the state of the system is related to some preferred state or objective (Bennett and Chorley, 1980).

A simple example is provided by a chemical contaminant for which there is an EQS or EQO an Environmental Quality Standard or Objective, specifying a maximum permitted concentration. This is 'factor monitoring' in Holdgate's terminology which in the marine context is typically chemical, in contrast to 'target monitoring' which tends to be biological (Holdgate, 1980). In any such system analytical data for environmental concentrations are related to the EQS, and if it is exceeded, the requirement for some control action is indicated. The level at which an EQS is set is typically some function of the toxicity of the compound and an estimate of the environmental hazard that a contaminant represents can be determined by relating a range of environmental concentrations to laboratory toxicity threshold concentrations (Fig.2). In the case of mercury, the absence of any overlap indicates that it did not represent a general environmental hazard (Stebbing, 1976), but similar plots for environmental and toxicity data for tributyl tin (TBT) demonstrate a significant problem (Cleary and Stebbing, 1987).

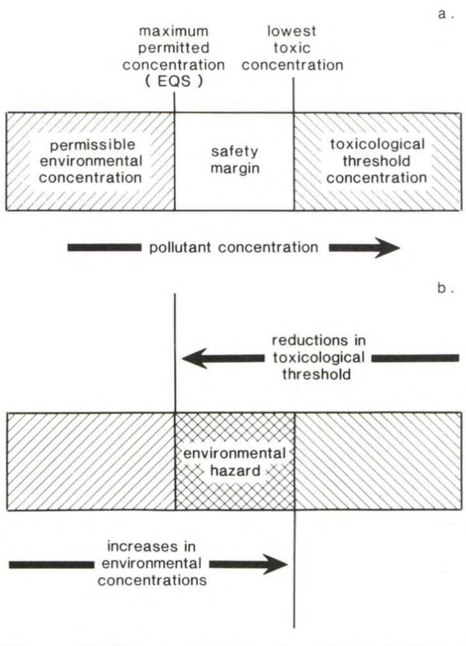


Figure 2. Diagram showing the relationship between environmental concentrations and laboratory toxicity thresholds indicating (a) the preferred situation that allows a 'safety margin' designed to avoid toxic effects in the environment and (b) a situation that leads to the recognition of an environmental hazard and the acceptance of probable toxic effects due to contaminants in the environment.

Chemical Monitoring

The problem with factor monitoring in the marine environment is that the numbers of chemical contaminants in estuarine and plume waters are numbered in tens of thousands (an estimated 40,000 in the Rhine plume) and the geographic scale is such that the analytical chemical load to provide adequate monitoring is massive. As the number of new compounds likely to become environmental contaminants grows significantly each year, and as the toxicity of some (like TBT) may be such as to have deleterious effects at concentrations of parts per million million, the analytical load for laboratories with monitoring responsibilities has become too great. Apart from the volume of analyses now required for effective monitoring, dependency on chemical monitoring alone makes a number of assumptions:

1. that the chemical contaminants likely to be toxic are already known and that chemical monitoring programmes monitor all the contaminants likely to occur at biologically significant concentrations.

2. that chemical analyses measure the fraction, phase or formof the contaminant that is likely to be biologically available and therefore toxic.

3. that sampling programmes account for the large temporal variations in contaminant concentrations that occur, particularly in estuarine and coastal waters (as much as twenty fold on a tidal cycle for TBT).

4. that data for contaminants loads can be considered in a manner that takes into account their interactions with one another (synergism and antagonism- and with the major environmental factors that affect bioavailability such as salinity, complexing capacity and particulate load.

5. that sufficient analytical effort can be deployed to provide adequate discrimination in space and time, giving an overall indication of the current state of the environment.

6. that the time taken to feedback data indicating water quality is rapid, so that environmental damage is minimised, where contamination is increasing, before control action can be initiated. The effectiveness of any control strategy incorporating feedback (Figure 1) depends on the speed and frequency with which information is passed to the point in the system at which control procedures can be initiated.

None of these assumptions can be made with confidence, invalidating any strategy that relies on chemical monitoring alone. Most programmes do include at least some biological elements. Nevertheless, the chemical and biological components of monitoring programmes are rarely deployed as an integrated strategy in the way that is now being advocated.

Biological Monitoring

There are a number of advantages in using organisms to monitor water quality by using indigenous populations, by deploying transplanted organisms, or in some cases by water quality bioassays. These include:

1. The responses of organisms from the environment, or deployed as transplants, can be expected to provide an indication of the biological quality of the conditions preceding its sampling. 'Sentinel organisms' (Holdgate, 1980) like mussels, provide an integration of environmental conditions over time, whether they are being used as chemical samplers in a 'Mussel Watch' approach, or whether a biological index.

2. The responses of an organism provides an integrated index of the environmental factors that impinge upon it and a measure of environmental quality as it relates to that organism. What is important for those monitoring environmental pollution is that the organism provides an integrated response to the totality, to all the contaminants at concentrations that exert a toxic load, whether they are known or unknown. This point is important, because it is only in this way that new or unsuspected contaminants with toxic properties can be detected.

3. In responding to a complex mixture of contaminants, the response of the organism is, by definition, only to those toxicants that are bioavailable. Furthermore, the response accounts for interactions between contaminants and for all those factors that affect toxicity in complex mixtures.

Interpretation of Results from Biological Indices

The effect of toxic load upon a homeostatically controlled process is the sum of the load imposed by the toxicant and the level of adaptive response originating from the control mechanism which works to neutralise that load (Stebbing, 1981). Interpretation of indices is complicated by the use of both the adaptive counter responses (Figure 3b) and deleterious effects (Figure 3a) as indices of toxic action. Below the threshold the toxicant causes load, whose effect homeostatic control systems respond to neutralise, increasing to counter higher loads (Figure 3b). Once the response ofthe system to counter perturbation is maximal, no further increase in load produces a greater response, so the response curve flattens and the articulation in the effect curve results (Figure 3a) as the process becomes inhibited.

This conceptual model was developed to represent the

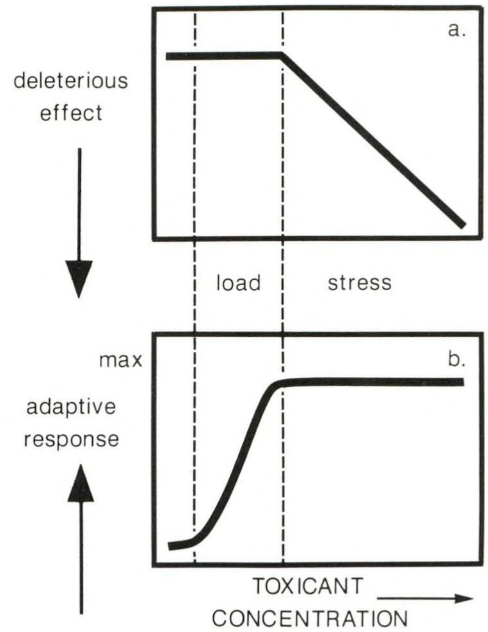


Figure 3. Diagram showing the links between a concentration-response relationship (a) and an adaptive homeostatic response (b) whose overloading provides an interpretation for the onset of the deleterious effect (a- (after Stebbing, 1981).

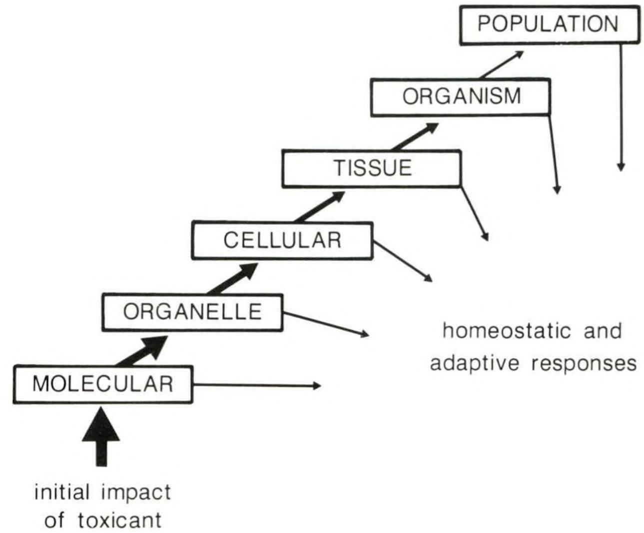


Figure 4. Diagram indicating the impact of a toxicant upon the hierarchical organisation of an organism, showing how the perturbation is dissipated as it passes up through the hierarchy (after Bayne et al., 1985).

behaviour of growth control mechanisms under toxic inhibition (Stebbing and Brinsley, 1984), but it applies equally well to other homeostatic mechanisms and to the behaviour of biochemical systems (eg metallothionein induction and MFO systems- of the kind described by Livingstone et al., 1988). In fact it is an appropriate model for any self regulating system that responds adaptively to toxic load.

Organisms have a number of levels of organisation, and the view of an organism as a hierarchy of self-regulating mechanisms, each with a capacity to resist toxic perturbation (Figure 4), is helpful in interpreting how organisms respond to toxicants and in the indices that should be chosen to reflect responses and effects (Bayne et al.,1985). Toxic contaminants first impinge on organisms at the biochemical level, causing a perturbation to the controlled equilibrium that then passes upwards to higher levels of organisation. At each level there exist control systems of the kind discussed above (Figure 3) that contribute to neutralising the effects of toxic load. Their hierarchical arrangement means that the effects of toxic load are progressively dissipated as it passes upwards through each level of organisation, by the adaptive responses at each level that neutralise or counteract perturbation. Consequently a significant perturbation caused by low concentrations of toxicants at lower levels may be dissipated and not have any effect at the organismal level. Such behaviour provides what has been termed a 'stratified stability' and may account for the evolution of such complexity. However, for the investigator even when a subtle effect is detected at the organismal or population level, the effect is so far removed from the time and site of action, that the mechanism and cause of toxicity is impossible to unravel.

This interpretation of the way organisms are organised and respond to toxic perturbations, suggests the following conclusions:

1. Toxic contaminants first exert their effect upon organisms at the biochemical and cellular levels. It follows that responses at these levels are more rapid than those at higher levels.

2. Any search for mechanisms of toxic action should begin at those levels where the primary impact of the toxicant occurs, and is most likely to provide a means of linking biological effects to the class of contaminants responsible (metallothionein and MFO induction).

3. In seeking sensitive techniques capable of detecting contamination gradients in the field, adaptive responses are likely to be more sensitive as they are induced at lower levels of toxic load than the more obvious and deleterious consequences of their overloading the self-regulating capability (Figure 3). In addition indices at lower levels of organisation are also likely to be more sensitive because the ameliorating effects of adaptive responses at higher levels have played no part in dissipating what is detected at lower levels.
It is inevitable that policy makers and politicians are more interested in the use of indices at higher level (population and community), but scientists are more concerned with those at lower levels (molecular and cellular) because they shed light on mechanisms and causes, besides being more sensitive. Techniques of both kinds therefore have roles to play in monitoring programmes.

4. One of the most difficult problems in environmental toxicology is the paucity of toxicological data in relation to the number and diversity of species in marine ecosystems. There are data for less than 1% of all species, so the requirement to extrapolate is considerable. It is a biological truism that the lower the level of biological organisation that organisms are considered, the greater the similarity of diverse taxa. It follows that indices at lower levels of organisation offer the best prospect of extrapolating toxicological data between taxa, and maximising the use of both techniques and data.

It follows that to maximise sensitivity and speed of response to detect gradients on the one hand, and to reach an understanding of mechanisms that can help to identify causes on the other, investigators have inevitably moved towards lower levels of biological organisation, but in doing so the indices have moved away from what can easily be related to populations and communities. It appears a problem which is unlikely to be reconciled that the level at which biological indices are 'relevant' is not that at which they are most sensitive or most informative about their causes. There is an important role in monitoring programmes for indices at the biochemical and cellular levels, because it is often these indices whose sensitivity is needed to differentiate gradients or whose specificity identifies the class of contaminant that induced it. More important is the need to utilise biological techniques because of their ability to provide an integrated index of environmental quality and the means of detecting new and unsuspected contaminants at toxic concentrations.

The Need for an Intregated Strategy
Within the major national and international organisations concerned with the marine environment (eg ICES and IOC) there are separate biological and chemical groups, each confronting different halves of the same problem. Disciplinary boundaries do not serve the interests of the environment, where an ability to cross them is so often essential in solving environmental problems.

With the growing difficulty in monitoring the range and number of organic compounds now occuring as environmental contaminants, there has never been a better case for using biological systems as 'filters'. Thus monitoring would depend largely on the use of biological systems to provide a continuous means of measuring marine environmental quality (Figure 1), allowing chemical analytical effort to be reserved for those times and places where there are demonstrable problems. Clearly there is little point in directing expensive analytical resources to the repeated detection of trace or inconsequential concentrations of contaminants, particularly if it is only possible to monitor a small subset of those that could be important. Much better to use a system that provides a single integrated index of water quality, that at the same time has the capability of detecting toxic concentrations of new and unsuspected contaminants not covered by chemical monitoring.

Recent Biological Monitoring Initiatives in the North Sea

1. The work of Drs Bryan and Gibbs (PML) have shown that imposex (imposition of male sexual characteristics on the female) in the gastropod *Nucella lapillus* is induced by TBT. Initially their work was directed at establishing that imposex was not caused by any other contaminant, before proceeding to demonstrate that it was induced by concentrations as low as 3-5 ng/l TBT and apparently by no other contaminant. Since then they have refined the use of imposex as a specific biological monitor for TBT pollution and are using it in the UK to assess the effectiveness of the legislation to control the use of antifouling paints containing TBT. The imposex index is being adopted for monitoring the effects of TBT in various parts of the world, including the European coast of the North Sea.

2. Scope for growth is a physiological stress response in the mussel (*Mytilus edulis*), which, in a programme coordinated by Dr Widdows (PML), will soon be deployed on the East Coast of the UK in collaboration with the MAFF and DAFS 'Mussel Watch' programme. Recent advances will make it possible to provide a toxicological interpretation of tissue residue data, based on experimentally derived relationships between tissue concentrations of toxicants and sublethal physiological responses. It is our hope to link with various European North Sea programmes using scope for growth in mussels to provide a coordinated interpretation and synthesis of the data for the next Quality Status Report for the North Sea.

3. The ICES WG on the Biological Effects of Contaminants and the IOC Group of Experts on the Effects of Pollution are organising a joint Workshop to be based at the Alfred Wegener Institute in Bremerhaven 12-30 March 1990 (Stebbing et al., 1989). Its primary objective is to test biological effects techniques on established contamination gradients in the North Sea (German Bight, oil platform and incineration area), and thus to initiate a biological effects monitoring programme. Nearly 50 proposals have been accepted that fall into 3 main areas: fish pathology (gross and cellular pathology and biochemistry), water quality bioassays and benthic studies (sediment bioassays and community structure). With extensive collaboration from chemists and some specifically chemical proposals, we hope to relate biological and chemical data in a way that allows some interpretation, and to initiate an international biological effects monitoring programme for the North Sea.

Conclusions

1. A research priority for ecotoxicologists must be to acquire an understanding of the system so as to predict the consequences of releasing wastes and effluents in the marine environment in advance. The need for retrospective control measures implies that in some respect anticipatory controls have failed, so emphasis should be given to improving the quality of anticipatory decisions and control measures.

2. The potential for the use of biological systems to monitor environmental quality remains largely unrealised, but, with the requirement to monitor the large and growing number of contaminants chemically, the capacity of organisms to act as integrators over the range of contaminants and with time will become indispensible.

3. A monitoring strategy that incorporates the use of biological effects techniques in an integrated strategy could provide an increased awareness of environmental quality and an improved level of environmental protection.

References

Bennett, RJ and Chorley, RJ, 1980. Environmental Systems - Philosophy, Analysis and Control. Methuen: London 624 pp.

Bayne, BL, Brown, DA, Burns, K, Dixon, DR, Ivanovici, A, Livingstone, DA, Lowe, DM, Moore, MN, Stebbing ARD, Widdows, J, 1985. The Effects of Stress and Pollution on Marine Animals. Praeger: New York.

Bayne, BL, Clarke, KR, Gray, JS (eds.) 1987. Biological effects of pollutants. Mar. Ecol. Prog. Ser., 46, 278 pp.

Cleary, JJ and Stebbing, ARD, 1987. Organotin in the surface microlayer and subsurface waters of Southwest England. Mar. Poll. Bull., 18, 238-246.

DOE, 1982. Monitoring the Marine Environment - into the Eighties. Pollution Report No.14 42 pp HMSO: London.

Harris, JRW and Cleary, JJ, 1987. Particle-water partitioning and organotin dispersal in an estuary. In: Oceans 87, Proceedings of the Organotin Symposium, 5 pp.

Joint Monitoring Group, 1988. Biological effects monitoring. Report to 13th Meeting of Joint Monitoring Group of the Oslo and Paris Commissions, 26pp.

Livingstone, DL, Moore, MN and Widdows, J, 1988. Ecotoxicology: biological effects measurements on molluscs and their use in impact assessment. In: Salomens, W, Bayne, BL, Duursma, EK, and Forstner U. Pollution of the North Sea. Springer-Verlag: Berlin.

MacIntyre, AD and Pearse JB, 1980. Biological effects of marine pollution and the problems of monitoring. Rapp. P.-v. Reun. Cons. int. Explor. Mer, 179, 346 pp.

Scientific and Technical Working Group, 1987. Quality Status of the North Sea. Second International Conference on the Protection of the North Sea 88 pp HMSO: London.

Stebbing, ARD, 1976. The effects of low metal levels on a colonial hydroid. J. mar. biol. Ass. U.K., 56, 977-994.

Stebbing, ARD, 1981. Stress, health and homeostasis. Mar. Poll. Bull., 12(10), 326-329.

Stebbing, ARD and Brinsley, MD, 1985. The effects of load and stress induced by cadmium on the growth of a yeast. In: Gray, JS and Christiansen, ME. Marine Biology of Polar Regions and the Effects of Stress on Marine Organisms. Wiley: New York.

Stebbing ARD, Dethlefsen, V, Heip, C and Thurberg, F, 1989. ICES/IOC Workshop on the biological effects of contaminants, Bremerhaven, Federal Republic of Germany 12-30 March 1990. ICES (mimeo), CM 1989/ E:40.

Stebbing, ARD and Harris, IRW, in press. Computer models: - scientific interpreters for environmental decision makers. Paper given at 5th European Ecology Symposium, Siena Italy 25-29 September.

Taylor, AH, 1987. Modelling contaminants in the North Sea. Sci. Tot. Environ., 63, 45-67.

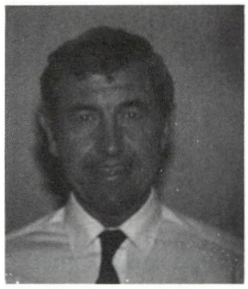
Industry & The Environment

This paper is presented as an industrial view or vision of the environment over the next ten years rather than as an official CEFIC policy paper. Presentation is by an industrialist from a chemical industry which has a number of plants producing a 'green' product whose wastes have been discharged to the North Sea.

Industry is responding to the environmental demands made on it by society and community. There are choices to be made in industrial waste disposal and we must ensure that the correct ones are selected. All waste disposal has some effect on our environment and if we adopt the 'Precautionary Principle' then the philosophy should apply to each of the options.

A framework for Environmental Management is available through the discipline of Total Quality Management or Quality Assurance. Here the environment is treated as a 'customer' for our wastes deserving the same respect, consideration and control systems as do our customers - for example, right first time and standards geared to the environment's needs.

Since changes in environmental expectations and legislation are driven by community issues, we cannot talk about physical environment without the involvement and development of people. Much effort has recently been invested in developing both community relations and our own employees. Open communication with the public on details of our activities has acquired high priority.



Dr D. Pearce,
Tioxyde Group, UK

Introduction

This paper is not about official CEFIC policy. What I am going to talk about is an industrial view of our response to environmental issues, the responsibilities which industry must own, the frustration which it bears and our vision of what can be achieved by the year 2000.

Industry is without question a part of the problem and has an important part to play in the solutions. A partnership between consumer, manufacturer and community is the only way forward. This implies the need for industry in general to become less defensive about environmental issues and to become more visibly involved in the environmental debate. Only then will the community be able to make sensible judgements about the part which industry plays in contributing to our environmental problems.

The theme of this conference is the incorporation of scientific knowledge in the political decision-making and implementation processes for the marine environment. By looking at one particular area of the chemical industry, that is to say the industry in which I am involved, I want to show that environmental concerns can quickly become complicated or driven by other political issues, in our case unfair competition, and to look at the real dangers of having a scientific data base which lags behind the political pressures for change.

Choices

In looking at the handling and disposal of wastes, most operations will find that there are choices to be made. Typically, all these options will have some negative effect on the environment and the difficulty is to ensure that the right choice is selected.

Who is to choose and what are the criteria? What is the definition of environmentally acceptable and for whom? In a Capitalist economy, industry is there because the consumer wants its products and in a Communist state it exists because Government wants its products. But effects on the environment concern the whole community.

Every human activity in some way changes the environment. It is essential that we take a holistic view here. Land, water and the atmosphere all have to be managed and they are inextricably linked - they cannot be decoupled. Should this seminar be about the environment or should it be a seminar solely about the North Sea? If our industry makes - or is forced to make - one set of choices, it may benefit the North Sea but contribute to huge environmental problems elsewhere.

In the chemical industry, reduction of liquid wastes by recycling will typically involve the input of large amounts of energy to remove, for example, water from a dilute waste stream in order to concentrate for re-use. This will invariably involve the consumption of fossil fuels with the associated impact on the atmosphere contributing to the 'Greenhouse Effect'. Alternatively, some kind of neutralisation and land dumping of solid wastes will also carry environmental effects with it. The transport of large quantities of solid will increase air pollution through dust and higher fuel consumption and in addition will lead to increased risk of human injury on our roads.

A recent newspaper article on cleaning up industry featured a company using recycling techniques for the recovery of non-ferrous metals from liquid waste streams. At the end of the process, the article pronounced, the materials had been completely recycled and there was 'no effluent'. There was no recognition of the fact that the process involved high temperature rotating kilns with the associated consumption of large quantities of fossil fuels.

Which is currently the greater environmental problem - the greenhouse effect or the state of the North Sea?

Science and Politics

A broad view of the position regarding the interface between scientific, political and other interests for the North Sea is well summarised in the basis papers for this conference. For industrial effluents the scientific data base covering potential damage to the marine environment is very incomplete, with no obvious cause and effect established in many cases. Early debate centred around the Emission Standards approach versus the Environmental Quality Objectives and Standards (EQO/EQS) approach as a means of regulating discharges to levels consistent with the capacity of the environment to absorb them, that is, the Environmental Capacity principle.

The EQO/EQS approach concentrated directly on the quality of the receiving waters and accepted that local geographical differences could mean that similar levels of discharge would give rise to widely differing effects on the marine environment. Such an approach requires the definition both of a mixing zone around the discharge and of acceptable concentrations of each constituent in the receiving waters. From these it is possible to work back to an acceptable analysis of the effluent at the point of discharge. An implication of this is that some locations would have a natural advantage for non-persistent toxins e.g. highly tidal coastal estuaries, compared with discharges into non-tidal areas. In some situations for persistent toxins, for example mercury, the EQO/EQS approach may be a more stringent requirement. By contrast the Emissions Standards approach demands an emphasis on analysed levels in the discharge itself, seemingly without primary concern for damage to the environment. Such an approach may be justifiable in the interests of progress if insufficient data are available on the combined impact of a number of discharges and the separation and definition of impact zones for each discharge is a prohibitively complicated problem.

The basis papers for this conference point out that 'the weighing and balancing of different interests is often more crucial to the accomplished decisions than the presented scientific information'. In particular, the politics of unfair competition often represent a major driving force for legislation in Europe. Two recent examples of this were the EEC Commission decision ordering the Netherlands to suspend a plan to offer tax-breaks for low pollution cars and the pressure put on the Danish bottle recycling programme by other European Community bottle manufacturers. But in a landmark decision the European Court has upheld the Danish programme - the first signs of a message which says that the importance of environmental protection might transcend both the demands for free trade or the harmonisation of costs.

In the titanium dioxide pigment industry the proposed EEC harmonisation directive is driven almost entirely by unfair competition arguments. Approaches from the UK Government that the EQO/EQS method should be adopted met with a response that this would be acceptable, provided that resulting costs were the same for all manufacturers irrespective of the approach used. (1).

As a contrast to this Environmental Capacity approach, the Precautionary Principle assumes that uncertainty surrounding the nature of potentially long-term damage to the ecosystem should give rise to a policy which is primarily concerned with taking the utmost care.

Whichever of these principles is used, it must apply to all possible options for waste disposal and not just to those involving the marine environment.

The Second International Conference on the Protection of the North Sea agreed to take measures to reduce urgently and drastically the total quantity of persistent toxins and substances liable to bio-accumulate reaching the aquatic environment of the North Sea with the aim of achieving a substantial reduction (of the order of 50%) in total inputs from these sources between 1985 and 1995. Reduction of discharges to the marine environment by 50% clearly implies that the wastes must be processed in some other way for disposal or re-use. Such an agreement prompts the question which ones are persistent toxins and what environmental problems will reduction in their emissions make elsewhere? It is unclear whether this problem was realistically addressed.

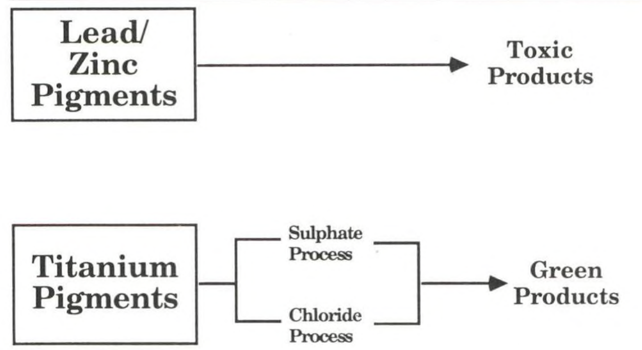
Public opinion also plays a part in policy decision making. The consumer is becoming increasingly pre-occupied not only with the product he or she is buying but also with the process by which it was manufactured. The pressure which members of the public exert for political change require that they have access to the best information possible, otherwise policies emerge which can be little more than change for changes sake. Not only, therefore, must industry be much more open in everything it does, but there is a strong case for legislation requiring more freedom of information for example through specific directives.

My Own Industry

The titanium dioxide industry manufactures white pigments which were quickly taken up as an environmentally acceptable alternative to their lead and zinc counterparts used fifty years ago. The product is essentially non-toxic and is used as a raw material in the finishing of a wide variety of manufactured products and in foods. It has recently been included as an acceptable product in a well known green consumer directory.

There are two processes available for its manufacture - the sulphate route and the chloride route. The main environmental problem associated with the sulphate process is the potentially chronic effect of liquid waste streams whereas in the chloride process it rests with the major hazard aspect of fluids used in the processing.

Early arguments concerning the effects of sulphate waste streams in Europe spawned a specific directive for the titanium dioxide industry 78/176/EEC (figure 3). Despite the initial preoccupation with environmental concerns this directive clearly accepted the need to address the politics of unfair competition (2).



OPTIONS

- **Acid recycling**
- **Neutralisation and land dumping**
- **Marine disposal**

COUNCIL DIRECTIVE
on waste from the titanium dioxide industry

78/176/EEC
Feb. 1978

The programmes ..... shall set general targets for the reduction of pollution from liquid, solid and gaseous waste ......

..... the Commission ..... (shall) ..... submit suitable proposals to the Council for the ..... improvement of the conditions of competition in the titanium dioxide industry.

Prime constituents of the sulphate waste streams are dilute acid, transition metal ions and iron in varying quantities depending on the feedstocks used. From the beginning, the major preoccupation has been with the acid component of the waste and to some extent the iron fraction primarily because of its obvious visibility - that is the visual pollution. The three most obvious disposal options are acid recycling (figure 2), neutralisation and land dumping or marine disposal. A House of Lords Select Committee in the UK after hearing representations from the industry, water authorities and pressure groups concluded that marine disposal represented the most environmentally acceptable disposal option.

Even earlier than this, as a direct result of environmental concern, Tioxide had mounted an extensive programme to monitor the effect of discharges from its factories world-wide on the marine environment. This programme is still under way and we have recently been able to draw conclusions, for the first time, which provide us with a direct correlation between chemical constituents of our wastes and their effects on marine life.

Whilst the interest of this conference rests with our factory at Grimsby on the Humber Estuary and perhaps to a lesser extent the factory at Calais, the results I shall present will be those from our Australian and Canadian factories since in marine terms both plants are relatively isolated from the effects of discharge from other industries and this enables us to draw more precise conclusions.

At Grimsby environmental interference caused by discharges from other operations in a highly tidal estuary makes such correlations very difficult.

Survey Results

Analysis of the effects of liquid waste discharges on biological resources has, in general, moved away from predictions based on static laboratory bioassays or caged tests in the field. Apart from obvious difficulties in the use of arbitrarily selected test species, whose susceptibility to effluent may be quite different from organisms actually resident in the receiving waters, continuous exposure to liquid wastes has little relevance to environmental conditions in the sea. Eye damage previously reported to be induced by industrial effluent in caged herring, for example, is now known to be a caging artifact caused by excessive exposure to light in surface waters of the sea (3).

Discharge of liquid wastes is also likely to have much more complex effects than mere short-term acute toxicity and may have an impact on growth and reproduction

PROPOSED COUNCIL DIRECTIVE
on wastes from the titanium dioxide industry

COM(88) 849 Final - SYN 27
89/C73/07
Jan. 1989

Whereas the different levels of environmental protection ..... have created disparities in the cost of the end product, ... according to member states ;

Whereas the *principal object* of the present Directive is consequently the *elimination of the distortions of competition* that exist between the different producers of titanium dioxide ;

ENERGY CONSUMPTION FOR ACID RECYCLE
(Grimsby)

Units	Pigment Recycle	Effluent	Total
GJ/te	34.5	25.5	60
Barrels oil/year	600,000	450,000	1,050,000
Tonnes oil/year	95,000	71,000	166,000
Tonnes CO_2/year	300,000	223,000	523,000

over several generations. Most recent studies have therefore been designed to investigate how relatively low concentrations of effluents may affect biological communities over a long period of time.

It is widely recognised that benthic organisms (ones that live on the sea bed - as opposed to 'pelagic' ones which swim or float in the sea) are particularly suitable for the study of ecological impact of liquid wastes since such organisms are unable to evade changed environmental conditions and effectively integrate long-term effects over several seasons and/or generations.

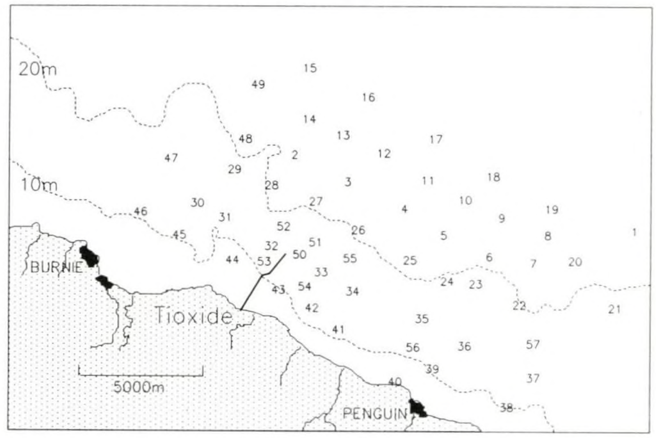
We have therefore carried out a series of detailed surveys in conjunction with Marine Ecological Surveys Ltd of the impact of liquid waste discharges on the benthic organisms on all of our sites worldwide and are now in a position to make some general inferences on the size of impact zones as well as on the possible components of the effluents which are inducing changes in community structure.

Recent advances in the analysis of community structure make it possible to use Group Average Sorting and Multi-dimensional Scaling (MDS) techniques to identify communities which are characteristic of particular sites within a discharge area. These multi-species communities may then be related spatially and temporally to the discharge of liquid wastes and can be used to show whether a modification of the community has occurred in the receiving waters of the disposal zone (4).

One of the problems in the use of these techniques for sandy and muddy deposits is that the variety of large organisms (macrofauna) is often sparse. Much more sensitive comparisons can be made between stations which have a diverse assemblage of organisms and for this reason several recent investigations (including those of Tioxide) have included the smallest components of the fauna (meiofauna) in the analysis of community structure. The meiofauna are also generally regarded as more sensitive to changes in water quality than the larger components of the fauna. Hence potential biological impact zones can be determined with some precision.

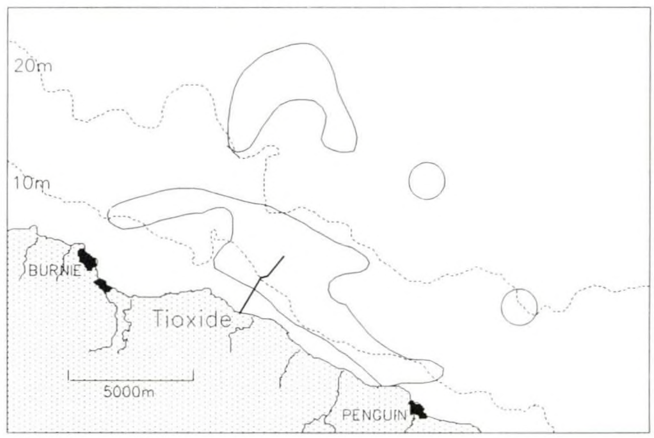
The high density and difficulty of extraction and identification of the meiofauna makes a complete analysis in relation to a particular discharge a laborious task. We have, however, found this approach to be useful in defining the impact of discharge of acid-iron wastes in a wide variety of systems and now have sufficient information to identify not only the area of biological impact, but the probable causes of changes in community composition in the zone of dispersion of wastes.

BURNIE, TASMANIA



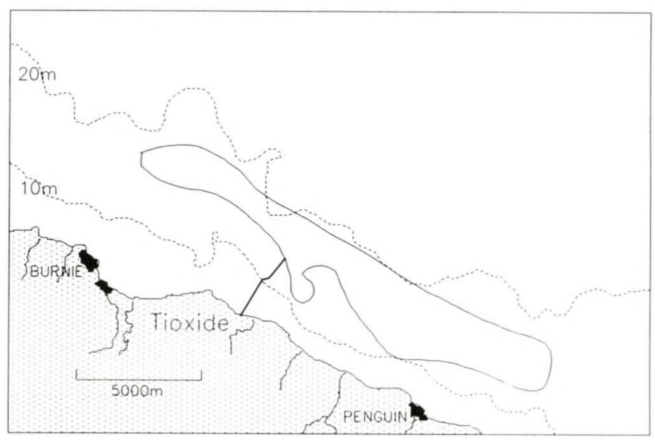
MAP OF SURVEY AREA.

Fig. 1



AREA OF BIOLOGICAL IMPACT

Fig. 2



ELEVATED LEVELS OF CHROMIUM IN THE SILT+CLAY FRACTION.

Fig. 3

We collect material by means of a small grab which covers 0.1m2 of the substratum and takes approximately 10 litres of sediment. These samples are taken at a minimum of 50 stations positioned both within and surrounding the zone of dispersion of effluent.

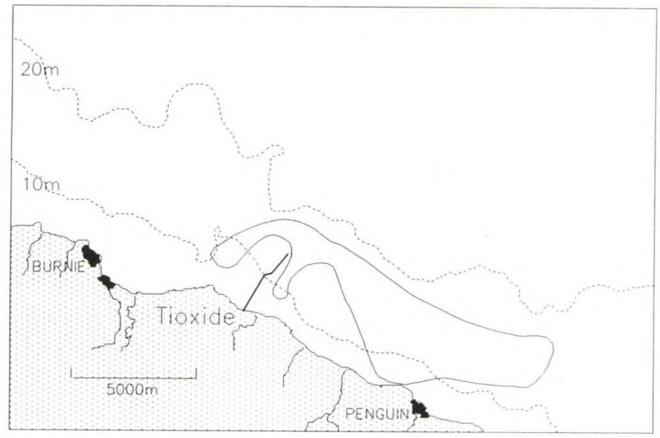
Two such samples are taken at each station and are broken down into known volumes of up to 100 ml for subsequent extraction of the meiofauna and the pooled material fixed with formalin. Two 500 ml samples are taken and fixed with formalin for subsequent extraction of the small invertebrates on a 500 m mesh sieve and a final sample of 500 ml is taken for granulometric and chemical analysis. The volume of the residual material (normally approximately 18 litres) is then measured before washing through a 2 mm mesh sieve for extraction of the large macrofauna. All results can then be expressed quantitatively as numbers of individuals per litre of sediment.

Results are presented for our sites at both Burnie in Tasmania, Australia discharging into the Bass Strait and Tracy in Quebec, Canada discharging into the St. Lawrence River (figure 1-14). In both cases we show the extent of the survey area and envelopes containing firstly the zone of biological impact as determined above followed by analysis of silts for the metals chromium, manganese, zinc, vanadium and iron as shown by those areas exceeding the 75 percentile value. The assemblages correspond with the zones of dispersion of wastes from the outfalls whose positions are marked. In the case of Burnie, the potential impact zone is relatively large and extends over an area ca 15 km by 4 km. This is in an area where currents are relatively weak and are mostly wind driven. For Tracy the direction of flow of the river is also shown and it will be seen that the potential impact zone extends roughly 2,5 km and is elongated in the direction of the current flow. In other locations, where the current flow is weak, the zone of biological impact is roughly circular and is symmetrical around the outfall.

An important point in interpreting these data is that the community in the 'impact zone' is not necessarily sparse compared with those in the surrounding deposits. It comprises an altered species composition, presumably through the removal of species susceptible to that particular effluent and their replacement by other more resistant species. Both the species abundance and numbers of individuals are often high and the zone of potential biological impact could therefore not be detected from relatively simple studies of the species diversity or abundance of individuals alone.

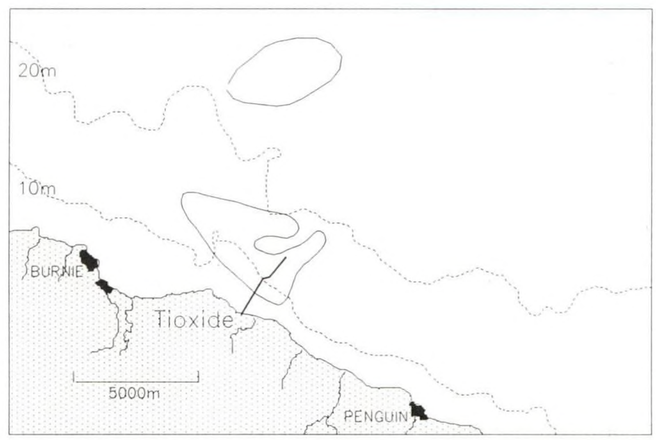
A second important point is that the zone of biological impact extends, in all cases, considerably outside the

BURNIE, TASMANIA



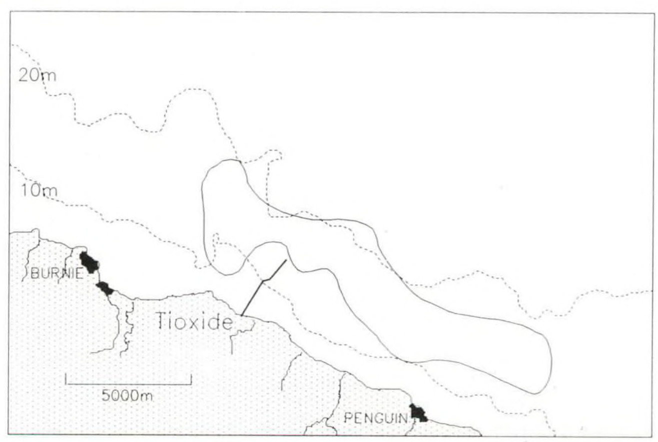
ELEVATED LEVELS OF MANGANESE IN THE SILT+CLAY FRACTION.

Fig. 4



ELEVATED ZINC LEVELS IN THE SILT+CLAY FRACTION.

Fig. 5



ELEVATED LEVELS OF VANADIUM IN THE SILT+CLAY FRACTION.

Fig. 6

zone of reduction of pH. In the case of Burnie the pH has risen to 8.0 i.e. to that of sea water within 20 m of the end of the outfall. For the St. Lawrence discharge the pH had risen to the level of the receiving waters (7.0) at 90 m downstream of the outfall. In other locations, the pH is similar to that in the receiving waters within 50 m of the outfall. This implies that modification of the biological communities in the zone of dispersion of acid-iron wastes is not induced by acidity, reinforcing the view that acid is not a persistent toxin.

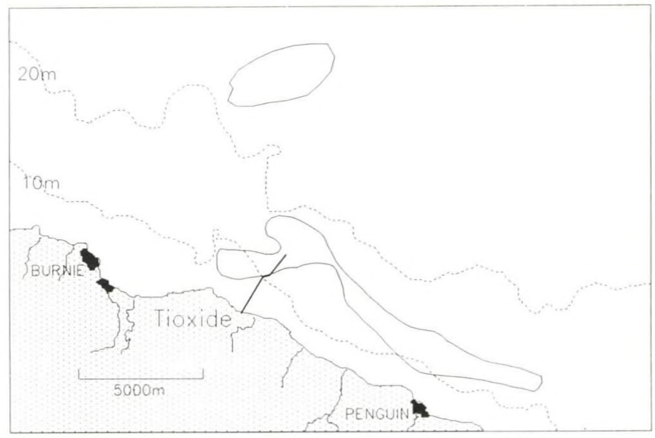
We now have information from many of the survey areas which suggests that the accumulation of precipitated metallic oxides from the neutralised effluent is primarily responsible for modification of benthic communities in the receiving waters. Our results have shown the remarkable correspondence between enhanced concentrations of a variety of these components in the sediments and the biological impact both in the Bass Strait and in the St. Lawrence River.

These results suggest that heavy expenditure on acid recovery systems, which are extremely energy-expensive (figure 19) and in themselves contribute to other environmental effects (including the greenhouse effect), may not be aimed at the principal source of impact. Although acid recovery will also result in some recovery of metallic components of the effluent, a more useful approach would be to develop methods of removal of these components either from the feedstock at the minehead or within the factory during the process of manufacture.

As a result of the proposed EEC Harmonisation Directive and of similar political pressures world-wide our company, which by any standards is only of medium size, is committed to a capitalinvestment programme on environmental improvement of 200 million over the next five years. Since the directive and other pressures are primarily concerned with the acid effluent, the largest proportion of current investment is concerned with the recovery of this acid rather than of the heavy metals. In the event, therefore, so far as the marine environment is concerned, this capital might have been spent much more efficiently. Responsible action from industry is unlikely to be forthcoming against such a frustrating background to the management of its business in general and its capital investment programmes in particular.

This is a prime example of what can happen when the scientific data base lags behind the political pressures for change. In spite of this, industry at large must make its recovery and recycling processes much more efficient and look for new business opportunities in the supply of one industry's waste products as the feedstock for another.

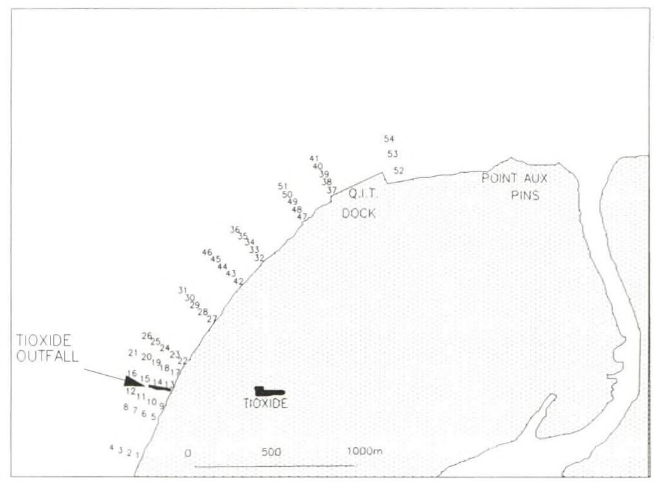
BURNIE, TASMANIA



ELEVATED LEVELS OF IRON IN THE SILT+CLAY FRACTION.

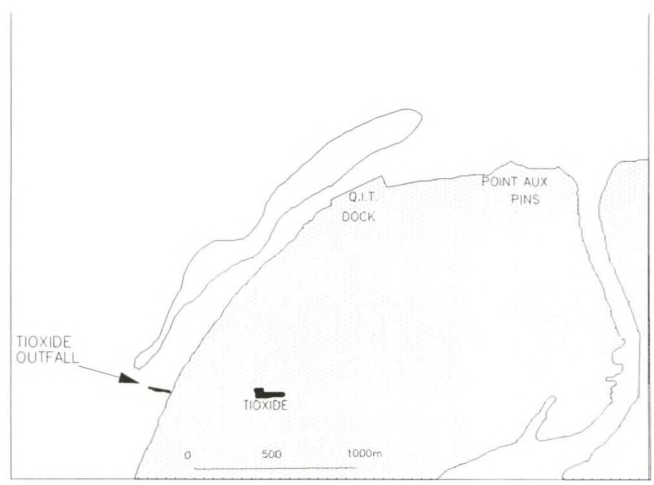
Fig. 7

TRACY, QUEBEC



THE SURVEY AREA WITH SAMPLING POSITIONS.

Fig. 8



THE AREA OF BIOLOGICAL IMPACT (NEWELL, 1986).

Fig. 9

Total Quality Management

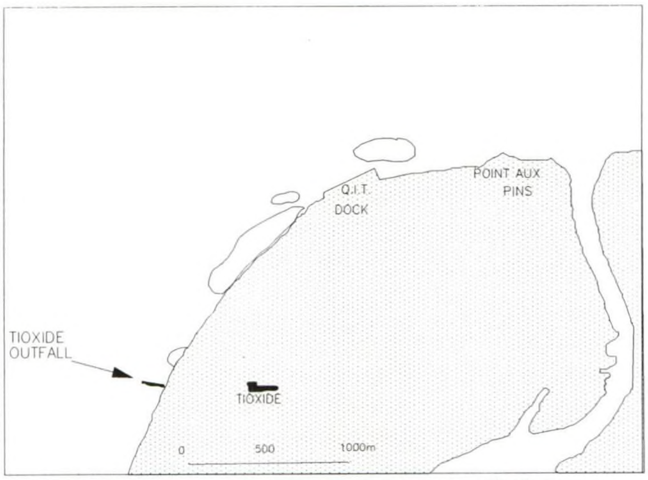
In recent years, in the fight to become more competitive and to survive against stiffer global competition, industry has focussed increasingly on quality issues. This drive has been concerned with all aspects of quality and has involved a complete change in philosophy. It is this single-minded commitment which has driven Japanese industry for so many years.
The emphasis moves from one which is primarily production orientated to one which is customer orientated. In order to encourage people to pursue this line of approach and to reflect the importance which Western Governments increasingly attach to it, Standards Institutions, for example BSI, have been charged with the authority to assess quality systems in industry (BS 5750, ISO 9002). These systems are becoming increasingly important as Governments begin to restrict purchasing to suppliers who are registered to such standards.

The key features of Quality Assurance are the identification of activities critical to the pursuit of the particular quality issue, the specification of associated procedures and the setting up of systems both for internal audits and for corrective action. This leads to the preparation of a quality manual concerning the description of systems together with manuals on associated control procedures, work instructions and training requirements for people. The essence of the whole system is that it is self-regulating and that every person in the line becomes directly concerned with control of quality. We are only as strong as our weakest link and the preparation and training of people must assume a much increased priority in this area.

If we are to ensure constant attention to and continuousimprovement in our environmental performance, then it seems appropriate to include the environment in all of these systems. This is effectively saying that we should treat the environment as a customer for our wastes, deserving the same respect, consideration and control systems as our final product customers. Such an arrangement is not primarily about the needs of the company but about the needs of the environment.

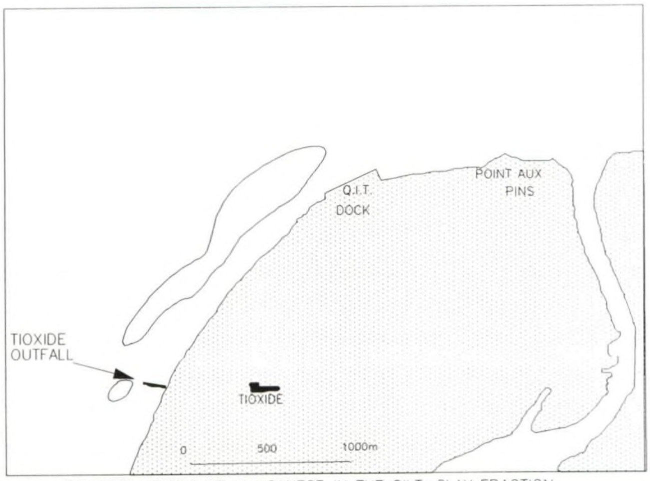
Necessary stages in this process will be:
- detailed identification and measurement of all emissions and wastes
- monitoring of effects on atmosphere, water and land
- setting up systems - written procedures and codes of practice
- establishing internal audits - frequency and reporting structure
- acknowledging the requirement for continuous improvement and review

TRACY, QUEBEC



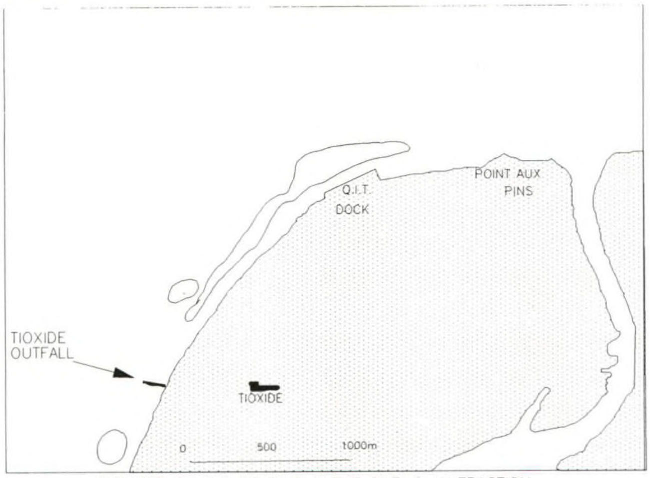
ELEVATED LEVELS OF CHROMIUM IN THE SILT+CLAY FRACTION.

Fig. 10



ELEVATED LEVELS OF MANGANESE IN THE SILT+CLAY FRACTION.

Fig. 11



ELEVATED LEVELS OF ZINC IN THE SILT+CLAY FRACTION.

Fig. 12

One step in this direction would be for individual companies to incorporate environmental procedures within their Quality Assurance requirements even though these would not at the moment form part of the scope of the officially registered system. We think it would be a good idea if the Standards Institutions were to make environmental standards a compulsory part of formal registration. We invite them seriously to consider this.

Community

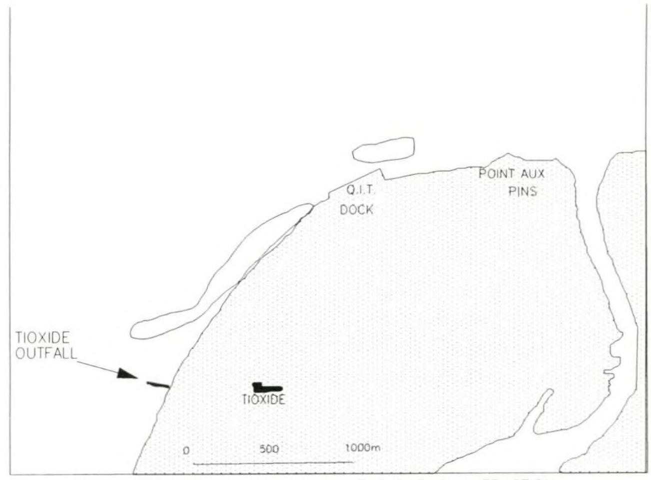
Changes in environmental expectations and therefore legislation are also driven by community issues. It is significant that despite the fact that as yet most people have not been affected to a great degree by the consequences of the greenhouse effect, or by many other environmental concerns, they are nonetheless demonstrating their determination that the environment should become a greater priority for legislators. This is symptomatic of an emerging change in values.

A creative tension exists between community pressure for environmental improvement on the one hand and the costs which the consumer and tax payer has to bear on the other. Some waste disposal options and environmental improvement programmes carry with them a heavy political, economic or social cost which outweighs the benefits as perceived by the public. The resignation of the Dutch Prime Minister only a few weeks ago was caused by problems concerning the financing of his environmental programme. Similarly, the UK public were not prepared to buy much lead-free petrol until the price differential between unleaded and leaded petrol increased significantly.

Despite this tension, public image is one of the keys to the future prosperity of the chemical industry and this will depend in part upon its willingness to take responsible action on the environment. To reinforce the point made in the introduction, the only way forward is in a partnership between the consumer, the manufacturer and the community.

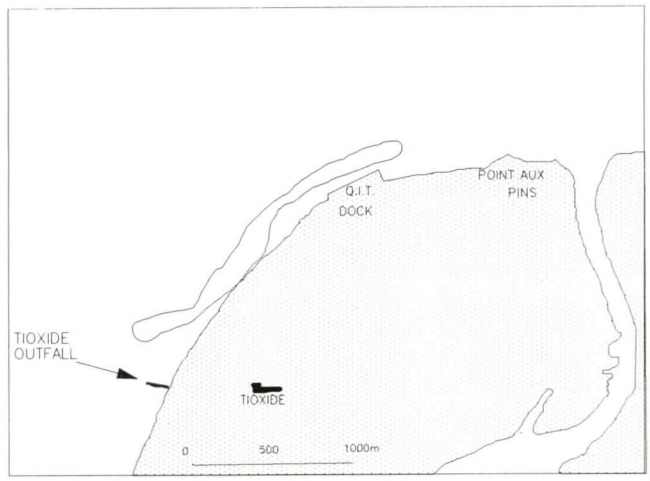
We manage our business through the notion of three stakeholders: the shareholders, our employees and the wider community. Each of these must be considered when decisions are taken and they are all involved in the life of the company. It is this concept that already leads to the community assuming the importance that it does in our strategy. Examples of recent community involvement are:
- setting up units to develop enterprise skills in the community
- the supply and resourcing of a caravan to support the science curriculum in Primary schools

TRACY, QUEBEC



ELEVATED LEVELS OF VANADIUM IN THE SILT+CLAY FRACTION.

Fig. 13



ELEVATED LEVELS OF IRON IN THE SILT+CLAY FRACTION.

Fig. 14

TOTAL QUALITY MANAGEMENT

- **Identification of waste problem**
- **Monitoring of effects**
- **Setting up systems and codes of practice**
- **Establishing internal audits**
- **Continuous improvement and review**

- provision of a community and environmental module which is included in developmental workshops attended by employees at all levels within the company
- facilitation for the setting up and management of community projects by school children, some of which by their own choice are about the physical environment

As a company, we are increasingly focussing upon releasing enterprise in people in the community instead of relying on Public Relations programmes.

If individual company policy is to help to shape legislation and itself to take a lead, then it is essential for industry to do more than just to respond to pressure. Appropriate legislation in the physical environment and the development of effective mechanisms for environmental safety will depend in large measure on the quality of relationships and trust between companies and legislators. Industrialists must therefore understand legislators, single issue groups and the public sector. Community participation is one way of developing experience in the working of these kinds of partnerships. In addition, these will develop through, for example in the UK, the CIA Responsible Care Programme, Open Days and the provision of information on major hazard installations to the community.

In the past we have perhaps been too defensive, isolated and largely concerned with our own interests. If, however, industry is to take such a broad holistic concept of the environment as including the community, then the public sector must develop in the same way.

To summarise, human beings affect the physical environment which in turn impacts on people. Does all this mean therefore that statements about the physical environment are meaningless unless they also include statements about the involvement of people?

Summary and Conclusions

Industry must recognise and accept its responsibility for the protection of the environment. Governments and the community expect responsible signals from industry in showing a positive way forward. This will be achieved by a more open debate and higher levels of trust. We have argued strongly for a holistic approach to the environment in general.

In the past, industry in general - and the chemical industry in particular - has had a poor reputation and press concerning its effect on the environment. In many cases this has largely been driven by other political issues including, for example, unfair competition. At best this leads to an unnecessarily damaged reputation and at worst to heavy capital investment directed into the wrong areas. In this context EEC legislators must see environmental issues as more important than those based on unfair competition.

It is most important that we improve the scientific data base in this area and this means more marine biologists co-operating and greater resource available for this purpose. Industry could band together to help provide this. The accent in the future must be less on waste disposal and more on waste recovery and re-use with much reduced intermediate processing leading to fewer environmentally negative sides in other areas. This is likely to require many more engineers working on new recovery processes.

Recycling of waste material can also clearly be achieved in the supply of one industry's waste products as the feedstocks for another and it is seen as important that industry actively looks for new business opportunities in this way. There are already many examples of this and in our own area there have been major advances in the use of both raw and neutralised wastes in other industries and applications, for example, hydrated ferrous sulphate in water and sewage treatment or use of gypsum in cement or for plaster board manufacture. Not only do these reduce pressure on waste disposal sites but they also contribute to the wealth generation process.

SUMMARY

COMMUNITY	INDUSTRY
• **Information**	• **Controls**
• **Development**	• **Total Quality**
• **Changing values**	• **Responsibility**

ENVIRONMENT

Land

Marine

Atmospheric

A major current pre-occupation within industry is in the area of Total Quality Management and this is seen to provide a useful framework for control and continuous improvement of our environmental performance.

All of these measures carry with them heavy implications for the education, development and training of people not only within industry itself, but also in the wider community. The environment is important to everybody and is likely to assume a higher priority in the future. The only way in which attention can be focussed where it is most needed is by the development of an improved climate of trust between industry, on the one hand, and legislators and the community on the other. A much higher quality of community participation is one way of achieving this.

Environmentalists and pressure groups must also be prepared to contribute to this process but it is unhelpful to have their input managed entirely on a conflict basis. These are, I believe, the key areas for attention to take us forward to the year 2000. It is reassuring to see that not only are these about changes which should occur but are about changes that are already occurring in industry.

References

1 Titanium dioxide proposed Harmonisation Directive - Official Journal of the European Communities No. C 73/5 March 1989

2 Council Directive on waste from the titanium dioxide industry 78/176/EEC Article 9 Official Journal of the European Communities No. L 54/19, February 1978

3 International Maritime Organisation - Scientific Group on Dumping LDC/SG.10/4/2 page 3, April 1987

4 J.G. Field et al - Marine Ecology - Progress Series Vol. 8 page 37, 1982

**The histories of the development of policies regarding control of discharges of the North Sea and Irish Sea littoral states and the EEC are outlined in brief.
The impact of the 2nd North Sea Conference (1987) on present policies, in particular the impact of the decisions made to reduce inputs of dangerous substances and nutrients by 50% between 1985 and 1995, are analyzed: do they reveal the initiating of important changes in policies and practice with the objective to meet with the above decisions?**

Important aspects of the reduction measures are the assessment of the 1985 base levels, the selection of the dangerous substances to be reduced by 50 %, and the definition of areas in which nutrients cause pollution. The methods to actually determine the above matters are critically analyzed.

Especially the selection of priority list substances and the scientific arguments for the selection processes will be addressed. As yet four North Sea countries have published different priority lists. The need for a uniform approach is discussed as well as the development of a legal basis for the selection of priority substances. To prevent new substances continually entering the environment, the incorporation of the precautionary principle in legislation seems indispensable. Moreover a legal basis for the precautionary principle may be the only effective way of combatting contamination of the environment through diffuse discharges.

Based on the above information an analysis is presented on the possible effects of the different national measures on the North Sea and Irish Sea ecosystems.

Finally national views on the future ecological qualities of the

Effluent Waters: National Policies and Concepts

Folkert de Jong,
Seas At Risk Federation, Amsterdam, Netherlands

Introduction

Practical environmental legislation with regard to discharges of environmentally dangerous substances into fresh and salt waters in the North Sea countries has a history of some 15 years.
The most important international legal instruments are the Paris Convention (1974), the EC Directives and the Rhine Chemical Treaty (1976).
National legislation, in general following international legislation, is the most important factor in the actual process of controlling discharges. Reference will therefore be given throughout this paper to national examples of implementation and enforcement.

The development of North Sea environmental policy has also been strongly influenced by the Ministerial North Sea Conferences and the Ministerial Rhine Conferences.

In this paper I shall first evaluate the efficacy of the existing legislative framework. I shall then evaluate the possible impact of the Ministerial North Sea Conferences, and in particular the second.
I will do this by considering two aspects. The first is the problem of sanitation of existing discharges, both point sources and diffuse. The second is the use of preventive measures.
Lastly I will address the role of science in policy making.

1. Sanitation

1.A. Evaluation of existing legislative framework

The Paris Convention came into force in 1974. The contracting parties agreed to 'pledge themselves to take all possible steps to prevent pollution of the sea, by which is meant the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as hazards to human health, harm to living resources and to the marine ecosystems, damage to amenities or interference with other legitimate uses of the sea' (Art. I).
To this end the contracting parties undertake:
a. to eliminate, if necessary by stages, pollution of the

North Sea and Irish Sea are summarized and analyzed, as well as proposed feed back mechanisms. In which way will the results of the reduction measures be monitored? What will be the basis for evaluating the data and consequently the adjustment of the reduction measures?

maritime area from land-based sources by substances listed in Part I of Annex A to the present Convention. (Art. 4 1a).

Part 1 of Annex A contains the so-called *black list* substances:

1. Organohalogen compounds, with the exclusion of biologically harmless ones
2. Mercury and mercury compounds
3. Cadmium and cadmium compounds
4. Persistent synthetic material
5. Persistent oils and hydrocarbons.

The contracting parties agreed to 'strongly reduce' pollution of the maritime area by so-called *grey-list* substances like organic phosphorus, silicon and tin compounds, arsenic, chromium, copper, lead nickel and zinc.

In 1976 the EEC adopted a Directive on chemical pollution of the aquatic environment (76/464). In Article 2 of the Directive the member states agree to take every suitable measure to eliminate pollution of surface water, ground water, estuaries and coastal waters by substances listed in list 1 (black list) of the Directive. The list contains 8 categories of substances:

1. Organohalogens
2. Organic phosphor-compounds
3. Organic tin-compounds
4. Carcinogenic substances
5. Mercury and mercury-compounds
6. Cadmium and cadmium-compounds
7. Persistent mineral oils
8. Persistent synthetic substances

Based on the criteria of toxicity, persistence and bio-accumulation the Commission selected 129 priority substances for list 1. This priority list was submitted to the Council in 1982.

List 2 (grey list) to the Directive contains substances discharges of which should be reduced. List 2 includes heavy metals with the exception of mercury and cadmium and biocides.

In Table 1 an overview is given of the present state of implementation on dangerous substances. The first 10 substances are those discharges which should be eliminated according to the Paris Convention and the EEC; discharge limits and quality standards have been fixed for these substances.

PCBs and TBT are regulated by way of limitations on production and use.

With regard to national implementation the list is tentative.

Enforcement

Enforcement of legislation on a national level is the main instrument for controlling discharges of effluents. Although most North Sea countries are in possession of reasonable legal instruments, the enforcement, which is primarily determined by political will, quite often is insufficient.

Some national examples will be given:

U.K.

According to a Greenpeace study proper enforcement in the UK is lacking. Table 2 summarizes the number of water pollution incidents and prosecutions in England and Wales in the period 1980 - 1988.[1]

The Netherlands

The Dutch enforcement of the Act on Pollution of Surface Waters (WVO) in the period 1970 - 1985 was evaluated by the National Auditor's Office (Rapport Rekenkamer). With respect to enforcement the conclusion is that this has been wholly insufficient.[2]

Denmark

In Denmark the Water Act passed Parliament in 1987. This Act states that local and regional authorities should stop illegal discharges. This is 13 years after the implementation of the Environmental Protection Act, which came into force in 1974 and which forbids illegal discharges.

Results of policies for effluent waters

What has been the result of 15 years of national and international policies for effluent waters?
Some examples will be given:

Black list Substances:
In Figure 1 the development of concentrations of mercury and cadmium in the river Rhine at the monitoring point Lobith is presented.[3]
Figure 2 shows the decline in the PCB and DDT content of guillemot eggs in the Baltic in the period 1967 - 1982. In the same figure the development of PCB and DDT production in the USA is given.[4]

However the PCB and DDT concentrations in guillemot eggs seem to stabilize and even slightly increase as of 1984 (Figure 3).[5]
A similar trend is noticeable in the concentrations of Lindane (Figure 4) and PCBs in the river Rhine.[6]
This seems to illuminate the special problem of diffuse inputs of persistent substances. I want to refer here to an alarming article in The Ecologist, published last year by Joseph Cummins:
About 15% or some 150,000 tonnes of the total amounts of PCBs in the world can be found in the developing

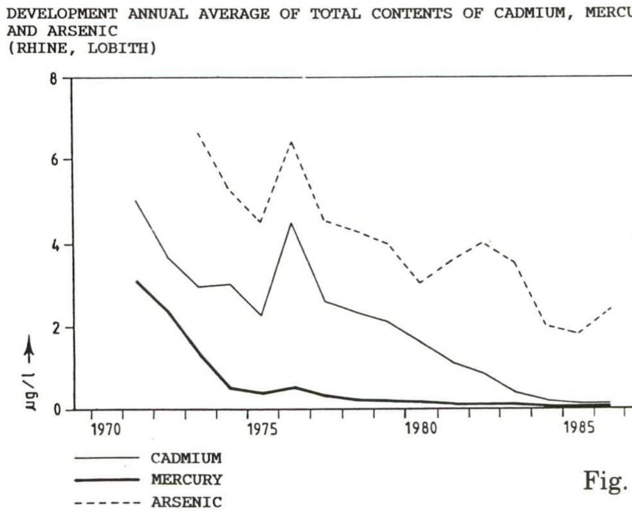


Fig. 1.

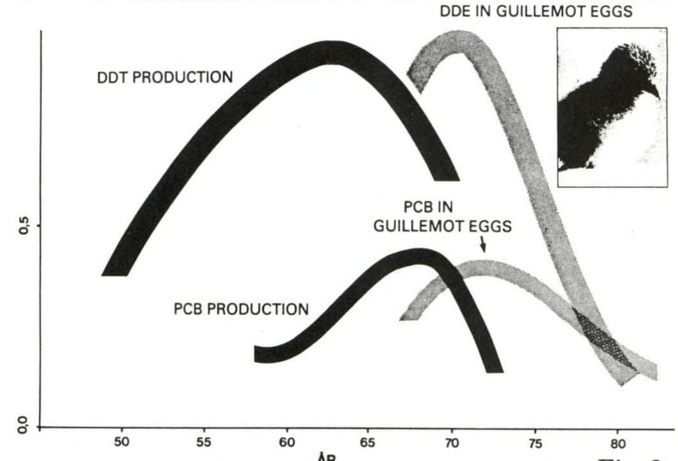


Fig. 2.

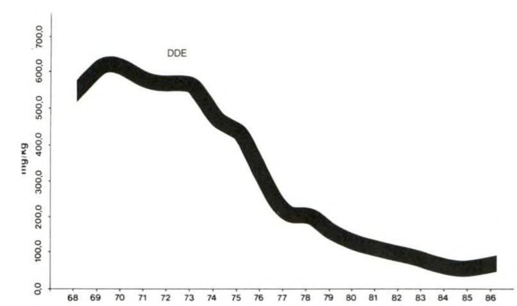


Fig. 3a.

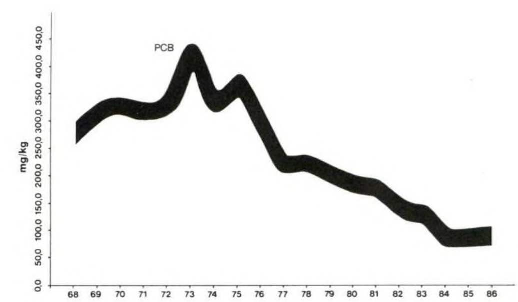


Fig. 3b.

countries. The proper disposal of PCBs will be much harder there than in the industrial countries. According to Cummins the release of all the PCBs from the developing countries into the marine environment would mean the extinction of marine mammals.[7]

Grey list Substances:
With regard to grey-list substances the situation is far from satisfying. Concentrations of, lead, copper, nickel, zinc and chromium in the Rhine have not dropped further since 1982 (RWS, DBW 1987).[8]
The quality of other continental rivers, i.e. the Meuse, the Scheldt and the Ems, is also bad, especially with regard to PCBs, PAH's and cadmium.[9, 10, 11, 12]
According to a recently published report by Greenpeace the quality of UK rivers has rapidly declined: between 1985 and 1989 there was a net deterioration of 895 km of rivers

River loads of nutrients have not (nitrogen) or hardly (phosphorus) declined in the last 15 years.[14]

The situation with regard to the pollution of ground water by pesticides and nitrates is alarming, especially taking into account the fact that due to the long migration time of ground water the worst is still to come.[15]

In the North Sea, the recipient of much of the contents of rivers, atmospheric deposition and land run-off, some very clear signals of environmental deterioration have been recorded: 1988 was the year of the algal bloom off the southern Norwegian coast and the year of the seal epidemic.

A study of changes in species diversity in Dutch coastal waters in the period 1930 - 1988 by the Dutch Tidal Water Division shows a clear disturbance of the ecosystem:
an analysis of over 7000 observations, reported since 1931, reveals that 40 species have disappeared or decreased drastically in number. 4 species have increased in number.[16]

The conclusion to this chapter is clear: both at national and international level, policies to control water pollution have failed. Moreover we are faced with an historical inheritance of polluted ground water, polluted sediments and disturbed fresh and salt water ecosystems.

1.2. The Ministerial North Sea Conferences

As a result of increasing public awareness about the state of the North Sea environment, the Ministers of the North Sea riparian countries met in Bremen in 1984. The lack of practical results of this Conference is well known.

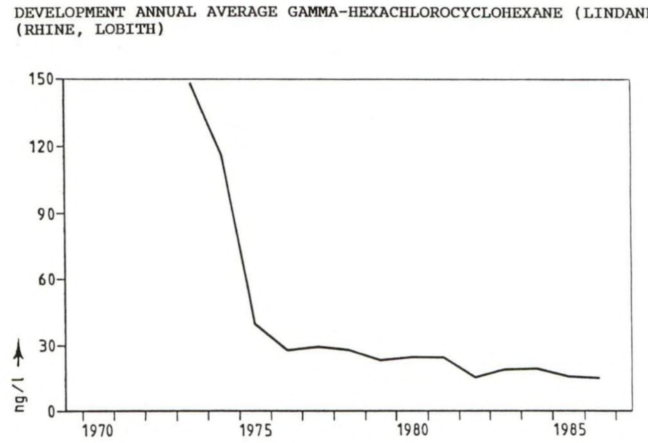


Fig. 4.

Table 1.
List of binding decisions for dangerous substances (Period 1974 - 1989)

	EC	Paris	NL	FRG	UK	DK	S	N
Mercury	x	x	x	x	x	x	x	x
Cadmium	x	x	x	x	x	x	x	x
DDT	x	x	x	x	x	x	x	x
CarbonTetraCl	x	-	x	?	x	x	-	-
PentaClFenol	x	-	x	?	x	x	x	-
Drins (3)	x	-	x	?	-	x	x	x
HexaClBenzenex	-	x	?	-	x	x	x	
HexaClButad.	x	-	-	?	-	x	-	-
Chloroform	x	-	-	?	-	x	-	-
HexaClCyclohex	x	x	x	?	-	x	x	-
TBT	-	-	-	-	x	-	x	x
PCB	x	-	x	x	x	x	x	x

Table 2.
Water pollution incidents and prosecutions Englang and Wales

Year Rate	Total reported Pollution Rate	Total reported Prosecutions	Enforcement
1980/1	12,500	91	0.70 %
1981/2	12,600	129	1.02 %
1982/3	13,100	124	0,95 %
1983/4	15,400	173	1,12 %
1984/5	18,635	206	1,11 %
1985/6	19,994	254	1,27 %
1986/7	21,404	215	1,00 %
1987/8	23,253		

At the 2nd Ministerial Conference for the Protection of the North Sea (London 1987) the results were more obvious, although not received with uniform appreciation.[17,18,19,20]
With regard to discharges from land-based sources the Ministers decided to reduce inputs of dangerous substances via rivers and estuaries to the North Sea by 50% between 1985 and 1995 and to reduce inputs of nutrients into areas where these inputs are likely, directly or indirectly, to cause pollution, by 50% , also in the period 1985 - 1995.[21]
Some foreseeable problems inherent in the wording of these decisions were the determination of the 1985 reference levels, the definition of dangerous substances and the definition of 'nutrient-sensitive' areas.

Priority lists.
So far, the United Kingdom, the Netherlands, Denmark, Sweden and Norway have published a list or draft list of substances of which inputs to the North Sea should be reduced by 50% between 1985 and 1995 (see Annex 1). The Federal Republic of Germany will use the same list as the Netherlands.
The lists have been drafted in different ways:
The UK has used a so-called "short term" selection procedure (Fig. 5) in which acute toxicity, persistence and bio-concentration are the criteria.[22]
The list proposed by the Netherlands and the FRG contains 40 substances and is mainly the result of political negotiations. This list also contains grey list metals and nutrients. The number of organic substances is 30.
Denmark will use a list containing 69 substances, also including grey list metals and nutrients. The Danish list is based on an extensive list containing 161 dangerous substances. The substances on this extended list were screened for quantities used in Denmark, both in production and consumption.
All lists contain the 12 substances for which already EEC legislation exists. This is undesirable since it could give countries the opportunity to postpone reduction measures: according to the EC 76/464 Directive discharges of black list substances must be phased out, the London Declaration only calls for a 50% reduction within a 10 year period.

It is clear that there is no uniformity at all in the different proposals. Setting aside the practical value of priority lists, it is obvious that the present approach only creates obscurity.

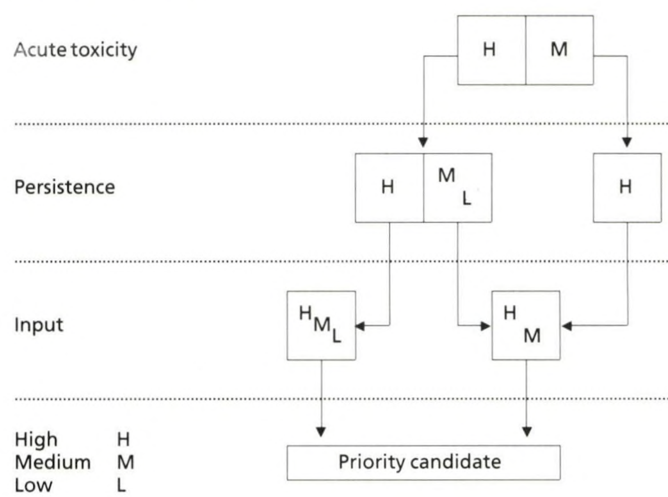
Negotiations at the next North Sea Conference about a uniform list will possibly result in a list very similar to the list of substances for which legislation already exists (see table 1).

water quality ranges from class 1 (good quality) to class 3 (bad quality) (Table 3).[13]

Table 3.
Length of class 3/4 rivers in water authority areas (km)

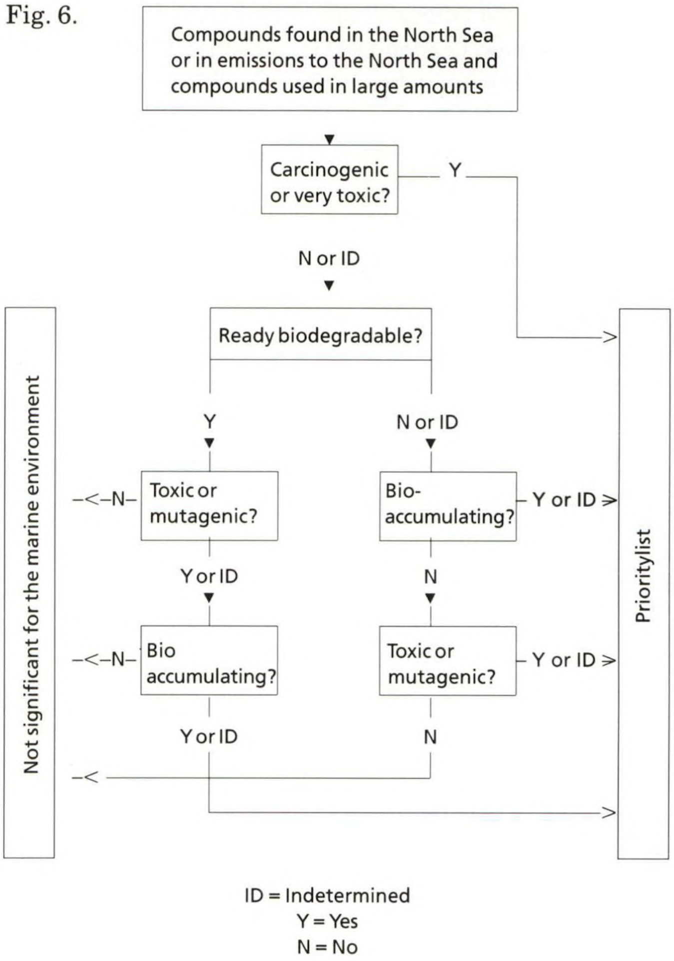
	1980	% of total	1987/8	% of total
Anglian	424	10	396	9.0
Northumbran	108	3.9	66	3.0
North West	867	17	1224	23.0
Severn Trent	395	9.4	620	12.0
Southern	93	4.6	164	8.2
South West	158	4.9	355	12.0
Thames	179	5	122	3.4
Welsh	313	6.8	308	6.7
Wessex	113	5.6	143	5.8
Yorkshire	647	11.2	794	14.0
Total	3297	7.84	4192	9.71

Fig. 5: Short term scenario for selecting red-list substances
(ID = In determined)



Many more substances however are under consideration, very probably meaning that they are considered dangerous for the fresh and / or salt water ecosystems. Sweden has proposed a selection scheme in which persistence and bio-accumulation are the major criteria (see Figure 6).[23] The argument is that we cannot afford to let the ecosystem be polluted by persistent substances since it will take too long before they will have disappeared again; the PCB problems, described earlier, support this approach. Sweden has screened 52 organic substances from priority lists proposed by the UK, NL and Norway, and from the EEC list of 129 black list substances, according to this scheme. Only two were found to be relatively harmless. For 5 substances there were no data. This means that at least 45 organic substances would be on a priority list according to this procedure.

Fig. 6.



2. Prevention

2.1. Evaluation of existing legislation.

There are now some 100,000 chemical substances on the European market of which 30,000 are classified as dangerous according to the European Inventory of Existing Commercial Chemical Substances (EINECS).[24] Existing chemical substances are those registered before 17 september 1981.
Chemicals brought on the market after that date have to be notified first according to the EEC 79/831 Directive. The Directive gives rules for a.o. the classification, labelling and packaging of new substances. 300 new substances have so far been tested and classified.

Legislation on existing dangerous substances lags far behind the amount of existing substances. And this gap is increasing every year.
In order to be able to control future legislation it is essential to prevent potential environmentally dangerous substances entering the market in an early stage. Once a substance is used by society, it is hard to replace and to remove it: a dependence has grown, new substitutes must be found, the substance must be collected and disposed of in an environmentally sound way.

The only instrument for limiting and eventually forbidding the use of dangerous substances is the EEC 76/769 Directive; through this Directive production and use of for instance PCBs are forbidden.
The Directive is not a very efficient tool: including a new substance is a very laborious and time-consuming process.

I will illustrate the need for an effective legal instrument to control the process of dangerous substances entering the market with the case of PCB substitutes.

The Ugilec case

As of 1983 a substitute for PCB with the tradename of Ugilec 141 has been used on a large scale in hydraulic systems in mines in West-Germany: 700 to 1000 tonnes per year are necessary to compensate for leakage losses. The physical, chemical and ecotoxicological properties of Ugilec 141 are however quite similar to PCBs.
In the annual report for 1986 of the Nordrhein-Westfalen Regional Office for Water and Waste (LWA), dated February 1987, the following is stated about Ugilec 141:

'Tests carried out on mine water and coal washing water from coal mines in Nordrhein - Westfalen have indicated a PCB content of just 1 mg/l, but Ugilec 141, the PCB substitute, has been found in concentrations of up to 100 mg/l. The sediment of rivers into which the mine waters are directed have been found to contain considerably higher concentrations of Ugilec 141. Solid materials absorb Ugilec 141 well, as they do PCBs. Ugilec also accumulates, as PCBs do, in fish tissues. Ugilec 141, however, does not only appear in mining. It has also been found from time to time in used oil and in household waste. This will cause problems if used oil or household waste which is contaminated with Ugilec 141 is disposed of by incineration. Laboratory research into the behaviour of Ugilec 141, when burnt, has been carried out on behalf of the LWA. It has shown that Ugilec 141 (as do PCBs) releases polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurane. Ugilec 141 is therefore not a suitable substitute for PCBs.' [25]
In 1983 another PCB substitute, Ugilec 121, was notified. The toxicological information on this substance was therefore available before it was brought on the market. As yet Ugilec 121 has not been used.

Last year again a substance with similar ecotoxicological properties was admitted to the market. The substance with the tradename DBBT, also a PCB substitute, was registered by the UK producer the Great Lakes Company, according to the Notification of New Substances Regulations on 26 February 1988. These Regulations are the UK implementation of the EC 79/831 Directive which prescribes notification and classification of new substances. As of 11 april 1988 DBBT was allowed in all EEC countries.
The Netherlands forbid the sale and use of DBBT, but also of Ugilec 121 and 141, by national decrees.

This case shows that notification and classification of new substances is important (the Dutch authorities were thereby warned), but totally insufficient in preventing potentially dangerous substances from entering the market.
The Dutch Chemical Substances Act covers national implementation of the EEC 79/831 Directive, but unlike the Directive this Act also empowers authorities to forbid new substances, even at very short notice.
Unfortunately the national ban on the production and use of these substances cannot prevent its introduction into Dutch waters and sediments. Ugilec 141 can now be detected in fish in the river Roer in the southeast of the Netherlands; the concentration in 1988 was four times as high as in the previous year.[26]

The European Commission will soon publish a proposal for a Directive which will give rules for the handling of the above mentioned PCB substitutes. Unfortunately only the handling; the Commission did not even propose to forbid them.

Denmark and Sweden have also legal instruments to prevent production and use of new substances.

The Paris Convention contains opportunities for preventing new substances from entering the market. Article 6.b. reads as follows:
'With a view to preserving and enhancing the quality of the marine environment, the Contracting Parties, ..., shall endeavour to forestall any new pollution from land-based sources, including that which derives from new substances.'
This article has, however, not been elaborated.

2.2. The Ministerial North Sea Conferences.

At the 1st North Sea Ministerial Conference the Precautionary Principle was introduced into international North Sea policy, although not by name. In the final declaration of the Conference a precautionary approach can be found in article C9: 'If the state of knowledge is insufficient, a strict limitation of emissions of pollutants at source should be imposed for safety reasons'.[27]
At the 2nd North Sea Conference this approach is reaffirmed. Moreover the principle is defined with regard to inputs via rivers and estuaries of substances that are persistent, toxic and liable to bio-accumulate. Article XVI.1 of the final declaration reads as follows:
'accept the principle of safeguarding the marine ecosystem of the North Sea by reducing polluting emissions of substances that are persistent, toxic and liable to bio-accumulate at source, by the use of the best available technology and other appropriate measures. This applies especially when there is reason to assume that certain damage or harmful effects on the living resources of the sea are likely to be caused by such substances, even when there is no scientific evidence to prove a causal link between emissions and effects (the principle of precautionary action)'.[28]

The acceptance of the precautionary principle by all North Sea countries seems a step in the right direction. However, the definition of the principle, as given here, is a very limited one.
It only applies to 'reducing polluting emissions of dangerous substances at source'. Two words in this quotation are important: firstly 'reducing'. Prevention would have been the appropriate word here. Secondly 'polluting', used here as an adjective to 'emissions'. If there are polluting emissions then there must also be non-polluting emissions. And so we are back at the environmental capacity approach, which uses as a basic assumption the fact that the environment has a capacity to receive wastes without the occurrence of unacceptable impact.[29]
In the German Report 'Umweltprobleme der Nordsee' from 1980, the precautionary principle was first applied to the North Sea. One possible definition of the principle reads as follows: '...There should be no interference with matter- and energy cycles, as well as with the species composition of an ecosystem, especially not by xenobiotic substances, which are not or hardly bio-degradable, or which are bio-accumulating. The toxicity of a xenobiotic substance, be it on its own or in combination with other substances, is in this respect not taken into account.' [30]

The definition of the precautionary approach, as agreed upon at the 2nd Ministerial North Sea Conference, is no sound basis for a policy which aimed at preventing potentially dangerous substances from entering the environment.

The precautionary principle must be clearly defined. It must apply to all aspects of pollution, not only to discharges via rivers and estuaries. It should essentially be a prevention principle.
The precautionary principle must be elaborated in practical legislation: the EC 79/831 Directive must be amended so as to achieve a firm legal basis for the prevention of potentially dangerous substances from entering the market; article 6b of the Paris Convention must be implemented in the same way.

3. The role of science

Scientific proof

An important conclusion from the foregoing is that present policies for the control of dangerous chemical substances suffer from a tremendous delay with regard to classification, testing and legislation.
A lack of political will resulting from economical pressure is a major cause of this delay. But science also plays a role here.
Natural science has fixed itself almost exclusively on establishing causal relationships. Especially in the field of ecosystem toxicology this a very time-consuming process.
Policy has used this factor in delaying or postponing implementation and enforcement.

The discussions, which have taken place in the last 15 years in the EC, the Paris Convention and the North Sea Conferences, with the aim of solving the controversy whether the Environmental Quality (EQ) or the Uniform Emission (UE) approach should be used as a basis for water quality policies, have certainly delayed the process of international legislation in this area.[31] [32]

The above not only goes for the marine environment. The necessary tackling of acid rain has been delayed for years; the scientific argument that there was no clear causal relationship between acid rain and dying trees, was an important reason for this delay.

Environmental capacity

In the foregoing the principle of 'Environmental Capacity' was already mentioned. This principle is the basis of the Environmental Quality (EQ) approach. The Environmental Quality Approach is primarily determined by economical factors.
Scientific arguments and scientific proof are used to back the environmental capacity approach; scientific data are used to set environmental quality standards. This despite the fact that every scientist in this field is aware of the limited knowledge of the effects of pollutants on the marine ecosystem. Important factors not taken into account by the EQ approach are mixed contaminant streams and chronic effects. There is ample evidence from ecotoxicological research about the limited value of acute toxicity and the importance of mixtures of contaminants.[33]
EQSs do not take into account the fact that many substances are not or hardly biodegradable.
Despite this, natural science has been, and still is, used to validate the EQ-concept which is in fact an economic concept.
It is therefore remarkable that the EQS adepts reproach those in favour of a preventive approach of not using sound scientific arguments, in this case clear causal relationships.

Subjectivity

Scientists are often not the independent researchers they claim to be. Especially financial pressure may influence the scientific interpretation of data or the fact whether a report is published or not. Also the political point of view seem to influence the scientific stand. An analysis of the first Quality Status Report shows a clear difference in the interpretation of the same data by British and continental scientists.'[34]

Because the interpretation of scientific research is so clearlysubjective it is important that information becomes available to everyone. Freedom of information in every country is therefore crucial in the process of policy making.

Scientist also have a responsibility for the way in which their work is used by others, especially by politicians and officials. They cannot confine themselves to the simple delivery of their product to the body that commissioned it.

Public opinion

In the process of political decision-making the direct role of the scientist is limited.
Indirectly, especially through public opinion, scientists can play a role they often underestimate, both in a negative and a positive way.
As a recent example I want to mention the scientific furore that accompanied the epidemic of the common seal in the Wadden Sea.
Some scientists saw a clear relationship between the epidemic and water quality. Others pointed to the fact that epidemics occur more often and are a natural phenomenon.
Various theories and assumptions have been aired, for example the one about the Greenland sledge dogs.
Last month the first results of a study into the effects of contaminated fish on the immune system of seals were published.
These show that blood vitamin A and Thyroid hormone contents were lower in seals which had eaten contaminated fish. These are strong indications of a weakened immune system.[35]
Some of these findings must have been known less than a year ago. There were anyway already strong indications of effects of certain substances on the immune system in general.[36]
If for example a group of experts on seals and ecotoxicology would have presented a statement on the possible relationship between pollution and the immune system of seals, the impact on public opinion and consequently the political impact would have been much greater.
Another possibility would have been to release the information through pressure groups.
Scientific information is crucial for interest groups.
Industry has its own scientists and carries out its own research.
The results are generally not made public.
Most environmental organisations cannot afford research. They fully depend on publications and direct information from experts.

Prediction

Scientists, especially in the field of ecotoxicology and law, have an important role to play in the development of a practical basis for the precautionary principle and a uniform selection procedure for potentially dangerous substances.
They must develop effective tools, especially tools which make fast prediction of environmental toxicity possible. This is necessary to catch up on the arrears in the screening of existing and new dangerous substances. The study into Quantitative Structure-Activity Relationships (QSARs) seems promising,[37] but both field and laboratory testing must continue for the supply of basic data for the improvement of predictive models.
The AMOEBA model developed by the Dutch Tidal Water Division is a good example of how science can deal with uncertainties and not only rely on clear-cut causal relationships. However, the proper operation of this model, especially the predictive value, depends to a large extent on the actual control of the discharge situation.

Summary and Conclusions

Policies for the control of discharges of dangerous substances to surface water and salt water in North West European countries have failed: only for a few out of the thousands of potentially dangerous substances has legislation aiming at the elimination of discharges been achieved. Discharges of many dangerous substances are still, after some 15 years of environmental policy and legislation in this area, continuing at frequently high levels. Even less has been achieved in the field of prevention. The tackling of the problem of diffuse pollution has only just started. As a result of this policy we now face serious problems of sanitation of existing discharges, the proper disposal of large stocks of dangerous substances, sediments in which large amounts of pollutants have accumulated and groundwater that is polluted with nutrients and pesticides.

The Ministerial North Sea and Rhine Conferences have speeded up the very slowly moving machinery of sanitation. This momentum must be used by the EEC-members and the contracting parties to the Paris Convention to accelerate the present implementation processes.
But this alone will not suffice.
It is important that at the third Conference some decisions thatwere taken in London in 1987 are elaborated:

Precautionary Principle

The precautionary principle must be clearly defined. It must apply to all aspects of pollution, not only to discharges via rivers and estuaries. It should essentially be a prevention principle.

Dangerous substances

A uniform procedure for the selection of dangerous substances must be developed. The precautionary principle must have an important role in this selection: if information on a suspected substance is insufficient than it should be placed on the priority list.

The 12 substances for which international legislation already exists must be phased out by 1995. In this way the EC members will have complied with their commitments to the EEC.

Legislation

The decisions taken at the North Sea Conferences need a firm a legal basis, both in the EEC and the Paris Convention. The precautionary principle must be elaborated here in practical legislation: the EC 79/831 Directive must be amended so as to achieve a firm legal basis for the prevention of potentially dangerous substances from entering the market; article 6b of the Paris Convention must be implemented in the same way.

Science

Scientists must direct their efforts more towards the development and validation of predictive models and the handling of uncertainties.
Since the interpretation of scientific data is always subjective, these data should be freely accessible to everybody.
Scientists do not play a major role in political decision making, however, through public opinion their influence can be indirectly substantial. Scientists should be aware of this and therefore communicate and preferably co-operate more intensively with environmental pressure groups.

Acknowledgements

I wish to thank the following persons for their contribuiton to this paper:
- Haavard Bjordal and Aamund Maage, Norges Naturvernforbund
- Peter Willers, Aktionskonferenz Nordsee
- Gunnar Noren, Svenska Naturskyddsföreningen
- Peter Van Houtte and Ward Dossche, Bond Beter Leefmilieu
- Hennig Mork Jörgenson, Danmarks Naturfredningsforening
- Jacqueline Stefels, Cato Ten Hallers and Roelof Veeningen, Werkgroep Noordzee
- Hans Revier, Landelijke Vereniging tot Behoud van de Waddenzee
- Bob Dekker and Mario Cerutti, DGW-RIZA
- Mr. A. Barisich, EC-DG XI

Annex 1. Priority lists

United Kingdom

Mercury
Cadmium
Gamma-hexachlorocyclohexane (Lindane)
DDT
Pentachlorophenol (PCP)
Hexachlorobenzene (HCB)
Hexachlorobutadiene (HCBD)
Aldrin
Dieldrin
Endrin
Chloroprene
3-Chlorotoluene
PCB (Polychlorinated Biphenyls)
Triorganotin Compounds
Dichlorvos
Trifluralin
Chloroform
Carbon Tetrachloride
1,2-Dichloroethane
Trichlorobenzene
Azinphos-methyl
Fenitrothion
Malathion
Endosulfan
Atrazine
Simazine

Netherlands

Mercury and its compounds
Cadmium and its compounds
Hexachlorocyclohexane
DDT
Pentachlorophenol
Hexachlorobenzene
HexachlorobutadieneAldrin
Dieldrin
Endrin
Chloroform
Carbon tetrachloride
1.2 dichloroethane
Trichlorobenzenes
Organotin-coumpounds
Parathion
Endosulfan
L.l.l. trichlorethane
Trichloroethene
Tetrachloroethene
Monochloroanilines
Monochloronitrobenzenes
Chromium
Benzene
PCB's (Polychlorinated biphenyls)
Copper

Nickel
Zinc
Lead
Fosfates
Ammonium
Nitrate
Dioxines: PCDD's en PCDF's
Polychlorocamfenes
Mineral oil
Polycyclic aromatic hydrocarbons
Atrazine
Simazine
Bentazon
Dithiocarbamates

Denmark
2.4.-D (and salts and esters)
Ammonia
Ammonium
Arsenic and inorganic compounds
Arsenic pentoxide
Arsenic trioxide
Atrazine
Betazone
Benzene
Benzylchloride
Cadmium and coumpounds
Cadmium sulfide
Carbontetrachloride
Chlorbenzene
Chlorinated paraffins
Chloroacetic acid
Chloroform
Chlorpropene, 3-
Chromium
Chromium potassium sulfate
Copper
Copper oxide
Copper sulfate
Cresol (mixed isomers)
Cresol, m-
Cresol, o-
Cresol, p-
Dichlorobenzene, 1,2-
Dichlorobenzene, 1,3-
Dichlorobenzene, 1,4-
Dichlorphenol, 2,4-
Dichlorprop
Dichlorpropane, 1,2-
Dichlorpropene, 1,3-
Diisodecyl phthalate
Dimethoate
Dioxines (PCDD + PCDF)
Epichlorhydrin
Ethylhexyl phthalate
Hexachlorcyclohexane
Lead (and compounds)
MCPA
Mecoprop
Mercury and compounds
Mercury oxide
Mercury sulfate
Nitrate
Nitrogen dioxide
Nitrogen oxides
Nonyl-phenol-ethoxylates
PCB and PCT
Parathion
Pentachlorphenol
Phenol
Phosphates
Phthalates (long-chained)
Simazin
Sodium Dichromate
Tetrachlorethylene
Tri-o-tolylphosphate
Triarylphosphate
Tributyltinoxide
Trichlorethane, 1,1,1-
Trichlorethane, 1,1,2-
Trichlorethylene
Triphenyltinhydroxide

Footnotes

[1] Birch, Tim. 1989. Poison in the System. Water Pollution: a critical review of the role of industry, water authorities, the public and the Control of Pollution Act. Greenpeace UK, London.

[2] Tweede Kamer. 1987. Milieubeleid Oppervlaktewateren. Algemene Rekenkamer. Tweede Kamer 1986-1987, 20020 nrs.1-2.

[3] Broekhoven, A.L.M. 1987. De Rijn in Nederland. Toestand en ontwikkelingen anno 1987. Nota nr. 87.061. RWS DBW/RIZA, Arnhem.

[4] Olsson, M. and L. Reutergärdh. 1986. DDT and PCB pollution trends in the Swedish aquatic environment. Ambio 1986 15(2): 103-109.

[5] National Swedish Environmental Protection Board. 1987. Action Plan for the Marine Environment.

[6] Ibid. footnote 3.

[7] Cummins, J.E. 1988. Extinction: the PCB threat to marine mammals. The Ecologist Vol.18. No.6. pp. 193-195.

[8] Ibid. footnote 3.

[9] Stichting Reinwater. 1988. Maas + Vervuilers. Stichting Reinwater, Amsterdam.

[10] RIWA. 1989. De Maaswaterkwaliteit getoetst aan het Maasmemorandum '88. RIWA, Amsterdam.

[11] Stichting Reinwater. 1988. De Ems, de gevolgen van een gedoogbeleid. Stichting Reinwater, Amsterdam.

[12] Internationale Scheldewerkgroep. 1989. Aktieplan

voor verbetering van de waterkwaliteit van de Schelde. ZMF, Goes.
[13] Ibid. footnote 1.
[14] Ibid. footnote 3.
[15] OECD. 1986. Water Pollution by Fertilizers and Pesticides. OECD, Paris.
[16] Smit-Kroes, N. 1989. Address by the Minister of Transport and Public Works of The Netherlands at the Third North Sea Seminar, 31 May 1989, Rotterdam. These Proceedings.
[17] ENDS Report. 1987. UK Policy shifts on dumping, discharges pave way for successful North Sea Meeting. ENDS Report 154.
[18] De Jong, F. 1988. The second Ministerial Conference on the Protection of the North Sea: An historical event? North Sea Monitor 87-4: 2-4.
[19] IJlstra, A. and F. De Jong. 1988. The 1987 International North Sea Conference. International Journal of Estuarine and Coastal Law. Vol. 3. Nr. 3: 246-265.
[20] Wettestad, J. 1988. Science, Politics and Ocean Pollution. Explaining the outcome of the 1987 North Sea Conference. International Challenges. Vol.8 No.3: 26-31.

[21] Second International Conference on the Protection of the North Sea, London 24-25 November 1987. Ministerial Declaration. 1988. DOE, London.
[22] Department of the Environment. 1988. Inputs of dangerous substances to water: Proposals for a unified system of control. [23]Baltic Marine Environment Commission-Helsinki Commission. 1989. Report on the meeting of the informal working group on guidelines for the reporting on the implementation of the Helcom Declaration.
[24] Krisor. 1989. Presentation at EEB workshop on chemical pollution, Brussels 4 March 1989.
[25] Translation by European Environmental Bureau.
[26] Volkskrant 4 Februari 1989.
[27] Internationale Nordseeschutzkonferenz Bremen, 31 Oktober und 1 November 1984. Deklaration. 1985. Bundesminister des Innern, Bonn.
[28] Ibid. Note 21.
[29] FAO. 1986. Environmental Capacity. Reports and studies no. 30.
[30] Par 1443 from: Rat von Sachverständigen für Umweltfragen. 1980. Umweltprobleme der Nordsee. Sondergutachten Juni 1980. Kohlhammer Verlag, Stuttgart.
[31] Dekker, R.H. 1983. Zwarte-lijststoffen. Stand van zaken in de Europese Gemeenschappen. H20 (16) 1983. Nr.12: 274-279.
[32] Saetevik, S. 1988. Environmental cooperation between North Sea States. Belhaven Press, London.
[33] Ten Hallers-Tjabbes, C.C. 1986. The North Sea. Impact on the Ecology. Proceedings of the 2nd North Sea Seminar Vol. 1 pp 31-37. Werkgroep Noordzee, Amsterdam.
[34] De Jong, F. 1986. The quality of the North Sea: national points of view. Proceedings of the 2nd North Sea Seminar Vol. 1, pp. 39 - 54. Werkgroep Noordzee, Amsterdam.
[35] Brouwer, A., P.J.H. Reynders and J.H. Koelman. 1989. Polychlorinated biphenyl (PCB)-contaminated fish induces vitamin A and thyroid hormone deficiencies in the common seal (Foca vitulina). Aquatic Toxicology Nr. 20.
[36] Vos, J.G., H. van Loveren, P.W. Wester and A.D. Vethaak. 1988. The effects of environmental pollutants on the immune system. European Environment Review Vol. 2, No. 3: 2-7.
[37] Hoornstra, J.S. 1988. QSARS. Een hulpmiddel bij het beoordelen van milieu-eigenschappen van chemische stoffen. Nota nr. 88.025. RWS. DBW/RIZA, Lelystad.

Discussion

Rapporteur:
Jan Andries van Franeker,
Research Institute for Nature Management

Chairman: Prof. Förstner
Members of Panel:
Dr Bennett, Mr de Jong, Dr Pearce, Dr Stebbing,

Mr Jensen (Danish Isotope Centre) remarks that the reduction schemes of the UK and Sweden as mentioned by Mr de Jong can not be applied to nutrients.
Mr DE JONG answers that the schemes refer to 'dangerous substances', but that the position of nutrients might be reconsidered in view of dangerous substance listing.

Mr Lankester (North Sea Work Group UK) asks Mr Stebbing if it would not be preferable to use ecological monitoring instead of biological monitoring; in his opinion the TBT example was 'obvious' and does not prove the case of biological monitoring. He also wonders whether computer modelling would not obscure the view on reality; how should the correctness of computer predictions be tested?
Mr Stebbing explains that the causal relationships of the TBT example are not as simple as RL suggested and that to establish such relationships had been a considerable effort. Modelling work has been well developed, a model such as on TBT is now working perfectly well.

Mr Lankester (RL) and MR Pearce (DP) discuss the issue of the requirements for industry.
RL suggests that since industry is always one jump ahead, legislation may be replaced by freedom of information, with 'Product Ecological Consequence Statements' on any product, to be approved by an independent organization.
DP points out that legislation already exists - requiring data on hazards of substances produced. He states that a holistic approach has to be preferred above single substance judgments and exemplifies this with the recycling of acids in the tioxide industry; this might cost so much energy that to do so might not balance against the environmental damage from discharges.
RL pleads for full freedom of information on alternative products, so the public may decide on which product to choose.
DP agrees, but wants to stress that the information should be about the whole production process, not just the product. Apart from that, shaping industrial processes according to public demands takes time.
Mr de Jong thinks that one should not rely too heavily on the choice of the public; governments have to take advance action to prevent certain products from entering the market.
Lord Cranbrook appreciates the example of the seal virus case in the contribution of Mr de Jong because it is a good test of the input of scientific view in policy making. Contradicting views of scientists are still not resolved.
Mr de Jong remarks that recent publications indicate that contaminated food affects the immune system by lowering blood levels of vitamin A and thyroid hormones.

Mr McGarvin (Greenpeace consultant) refers to the problems with the wording of the precautionary principle. Firstly, the economical aspect is evaluated. Studies indicate that investments into the precautionary principle do not negatively affect economy at a macro-economic level.
Secondly, the word pollution is used in a sense commonly given to 'contaminants', which means not requiring proof.
Thirdly, the Bremen declaration used 'best practical means' and not 'best available technology'.
The definition of 'toxic and bio-accumulative' does not cover all dangerous substances (e.g. CFCs). He suggests to apply 'reverse listing' with a reversed burden of proof for producers to show that a substance does not damage the environment. He pleads for governments to stimulate clean technologies in stead of combatting pollutants.
Mr Pearce remarks that the definition of 'best available technology' is practical, not philosophical.
Mr EARL (Marine Conservation Society) states that freedom of information is essential to the implementation of the precautionary principle. If new substances enter the market, governments and industry often stifle the debate and the usual process of scientific peer review.

Ms Dubsky (Coastwatch Europe) asks Derek Pearce whether he uses raw data in his communication with the public, or polished summary results. IN connection with the recycling of acids and not metals she wants to know if heavy metals are not part of the acids, and are therefore largely recycled along with them?
Mr Pearce answers that raw results of the investigation are available and are being distributed to a wide range of organizations. The remark about recycling metals with the acids, although partly correct, is beside his point of possibly making wrong investments when not looking at energy demands of recycling compared with the discharge of wastes.

Mr Stebbing add a nuance to the dissemination of information. He finds Mr de Jong's proposal to invest in communication and education crucial too, but thinks that this will only partly work, since not all researchers are very good at communicating. As for the Institute for Marine Research, Mr de Jong or anyone else is welcome to visit the laboratories.
Mr de Jong gladly accepts the invitation, but remarks that he thinks in general expert researchers should be stimulated to select and disseminate important information to others, such as pressure groups.

Session IIB

Policies for Fisheries

Chairman
Mr v. d. Meer

Policies for fisheries: review from policy

The North Sea ecosystem is complex. Two examples from fisheries illustrate this; the first is the inability to elucidate the relationship between spawning stock biomass and the recruitment to the stock generated by that biomass; the second is the inter-actions between different species. Some would argue that, in these circumstances, the 'Precautionary Principle' should be applied. In the current and foreseeable state of knowledge of the North Sea ecosystem, this would require a policy of 'Stop fishing'. This is not acceptable. The fish stocks represent an exploitable, infinitely renewable resource. A fisheries policy must be concerned with harvesting that resource in order to obtain the maximum economic benefit. In the light of existing knowledge, such a policy will maintain the fish stocks.

The manner in which fish stocks should be managed, at least on a single-species basis, is well understood. As a result of the organization of fisheries research, there has been a rapid flow of information between fisheries scientists and the administrators responsible for the development and administration of policy, as well as an equally rapid implementation of the management models developed by fisheries scientists. However, no-one would argue that the fish stocks of the North Sea are well managed. The North Sea stock of mackerel had collapsed by 1982 and has not yet recovered. All stocks are heavily exploited with 70% of the fish being caught each year in the case of haddock. Furthermore, catches consists predominantly of small fish which have attained only a low proportion of their growth potential.

The reason for this is that fishing capacity is greatly in excess of that needed to take the catch possibilities. The stocks of North

Mr M.J. Holden
Commission of the European Communities

The views expressed in this paper are those of the author and do not necessarily represent those of the Commission of the European Communities.

1 The Fisheries Policy for the North Sea

The start of effective management of the fish stocks of the North Sea can be dated to 25 January 1983 when the European Economic Community (EEC) adopted the conservation measures which completed its Common Fisheries Policy. Although this represented the culmination of several years of negotiation, two earlier key decisions can be identified as providing the bases which were to make effective management possible. The first of these was the adoption by the EEC of Council Regulation (EEC) No. 2141/70 of 20 October 1970 (1) which established equal access by Member States to each other's fishing zone. Thus, when Member States subsequently agreed to extend their fisheries limits to 200 miles on 1 January 1977 there was formed a single Community sea for whose management the EEC, not the six North Sea coastal Member States, was competent.

The other major step was the establishment of an Agreement on Fisheries between the EEC and the Kingdom of Norway which provided for co-operation to ensure the conservation and management of fish stocks. (Council Regulation (EEC) No. 2214/80 of 27 June 1980 (2)).

The importance of these two decisions is that they resulted in there being only two parties responsible for the conservation of the fish stocks of the North Sea, not seven as there might otherwise have been. The history of the North East Atlantic Fisheries Commission suggests that effective management would not have been possible had this been the case. Furthermore, these two parties had formally agreed to co-operate.

However, the Agreement between the EEC and Norway does not contain a specific statement of policy for fisheries management other than the general policy

Sea fish were a common property resource until 1977 when fishery limits were extended to 200 miles or median lines. Even though a system of total allowable catches was introduced in 1983, fleet capacity has not been controlled except to a limited extent in recent years.

The main thrust of future fisheries policy must be to reduce fishing capacity and to increase the average size of the fish caught. However, this will not be easy to achieve. Policy developments cannot take place in a vacuum. Reducing fishing capacity will have major social implications, while increasing the size of fish caught will have perceived, if not actual, adverse short-term effects, both of which will be reflected at political level. Those who consider that they will be affected by these changes will resist them.

Achieving the objectives of this policy will not only result in a rationally managed, economically viable fishing industry, but will also protect 'the environment'.

stated in Article 7 of the Agreement which provides that 'The Parties undertake to cooperate to ensure proper management and conservation of the living resources of the sea, and to facilitate the necessary scientific research in this respect'.

The EEC similarly has only a general fisheries conservation policy which is stated in Article 1 of Council Regulation (EEC) No. 170/83 of 25 January (3) as follows:

*) In order to ensure the protection of fishing grounds, the conservation of the biological resources of the sea and their balanced exploitation on a lasting basis in appropriate economic and social conditions, a Community system for the conservation and management of the fishery resources is hereby established.'

Despite the absence of an explicit statement, the implicit objectives of the two Parties could be summarised as:

- to maintain catches at a level at which they can sustain economically viable fisheries;
- to maintain catches at a stable, high level;
- to maximise economic benefits.

None of these objectives refers specifically to the conservation of the stocks but good scientific knowledge of the fish stocks and reliable scientific advice are essential for effective fisheries management. Conservation is, therefore, implicit in these objectives.

2 The Development of Policy

2.1 The Incorporation of Scientific Knowledge in the Decision making Process

Science has always played a major role in the development of fisheries policy and there has always been close co-operation between fisheries scientists and the administrators responsible for fisheries policy. Two important factors contributing to this situation can be identified.

The first is the foundation in 1902 of the International Council for the Exploration of the Sea (ICES) in order to co-ordinate the rapidly expanding science of fisheries research. It was recognized that, because fisheries were internationally exploited, successful research could not take place unless it was also internationally co-ordinated. ICES developed this role very successfully and became recognized as the organization responsible for providing impartial, scientific advice of high quality. Its advice is the only scientific basis on which the EEC and Norway consult. The Commission of the European Communities also bases most of its proposals in the field of fisheries conservation on its advice, although usually after consulting with its own Scientific and Technical Committee for Fisheries.

The second factor is that the majority of fisheries laboratories established in European countries to undertake applied fisheries research are government funded, the scientists are government employees and there is inevitably close co-operation between the scientists and the administrators responsible for policy. It is common for many of these administrators to spend much of their careers in their respective fisheries departments with the consequence that they gain an intimate knowledge of the relevant sience. In the past, a few of them were elected Presidents of ICES.

Thus the basis for the successful incorporation of scientific knowledge in the political decision making process exists but, paradoxically, it has not been effective. The reasons for this are examined in the next section.

2.2 Policy Implementation

Policy implementation cannot be based only on scientific criteria but must take account of the social and economic environment in which it has to be implemented. It is for this reason that the EEC policy refers specifically to 'appropriate economic and social conditions'. In 1977, when fisheries limits were extended, the conditions were those resulting from more than a century of over-exploitation of the resources. Until 1977, the regime was one of unrestricted access which resulted in all the well known problems with stem from such a regime, among which are over-exploited stocks, low catches consisting predominantly of small fish and low profitability of the fleets.

Resolving the problems of over-fishing, which did not stop in 1977, requires actions which inevitably result in adverse economic consequences before the predicted benefits are obtained. The disadvantages and benefits may accrue to the same group of fishermen, as when legal minimum mesh sizes are increased, and so provide an apparent incentive to adopt such measures. But in some cases those fishermen who are adversely affected may not gain any of the benefits, as when fishing is banned in a nursery area from which the fish later migrate to an area outside the range of the vessels of the coastal fishermen. The latter fishermen have no incentive to support the adoption of such conservation measures, at least under the existing EEC regime. In a democracy, socio-economic considerations will inevitably affect decisions about how policies are implemented and governments will hesitate to take decisions which would result in large numbers of fishermen suffering serious economic hardship or becoming unemployed, particularly as fishing is often the 'employment of last resort' in many coastal areas.

Thus, while many fishermen agree that conservation measures to safeguard the fish stocks of the North Sea are urgently needed, they usually object to specific measures which are proposed for fear of the adverse effects on their livelihoods and undertake political lobbying in order to ensure that their government oppose such measures. In a democracy a government, dependent as it is on being elected, will frequently respond to these pressures.

Furthermore, scientists rarely advise specific actions. Their advice on total allowable catches, for example, is in the form of options and it is for the industry and the managers to decide which option to choose, in the light of 'appropriate social and economic conditions'. The industry can, and does, argue that these conditions do not justify adopting options which would restrict their catches.

Three factors exacerbate this situation. Firstly, there is a lack of understanding both within the industry and at political level of the fundamental principles underlying fish stock management.

Secondly, the scientific advice for the North Sea stocks has often proved wrong. Even though this can be attributed to a paucity of data and the manner in which the stocks are being exploited, it has consequences for the industry which can be particularly serious when catch possibilities are underestimated or they have to be changed during the course of the fishing year.

Thirdly, the fishing industry considers that it is insufficiently consulted about the drafting of conservation measures, a complaint for which there is some justification. But there is a reason for this. The industry is very fragmented, both at international and national level and is unable to present a unanimous point of view or to send representatives to meetings who can speak for the industry as a whole. This disparity of views amongst the fishing industry combined with an apparent lack of knowledge about the fundamental principles underlying fish stock management, to which reference has already been made, make effective consultation very difficult. The Consultative Committee for Fisheries established by the EEC provides a forum for consultation but the above-mentioned problems greatly limit its effectiveness. ICES has also tried to improve this situation by organizing a series of 'Dialogue Meetings' but to date little effective dialogue has been achieved.

2.3 Policy for the Future

If the scientific advice cannot be effectively implemented under the present conditions, how can these be changed to allow its implementation? The key to resolving this problem is limitation of fishing effort. In the North Sea today there are too many fishing vessels chasing too few fish. The only effective way in which to resolve this problem is to reduce the number of fishing vessels, a policy which is being implemented by the EEC under its Multi-annual Guidance Programmes. These Programmes have the objective of balancing the fishing effort which can be exerted by the EEC fleets with the available resources by 2002. Financial grants are available for scrapping vessels, selling them for permanent use outside EEC waters or permanent use other than fishing within EEC waters. Temporary lay-up premiums are also available.

Some EEC Member States have introduced additional measures, establishing systems whereby vessels must have a licence before they can fish or before they can fish for certain stocks. The ultimate in management is embodied in the policy being implemented by the Australian government in which the whole industry will be licensed and managed at a level which will generate the maximum economic rent, part of which will then be used to defray the costs of management such as research and enforcement.

Once the economic state of the industry starts to improve, it can confidently be expected that the pressures generated to stop scientific advice being implemented will lessen. Reducing the over-exploitation of the stocks will result in more accurate predictions; more reliable advice will be more readily accepted.

Inevitably the industry will be subject to limited entry; it is already moving in that direction. Once that is achieved those who have licences to fish will support conservation measures because they will know that the benefits from their introduction will accrue to them and not be dissipated amongst new entrants to the fishery attracted by the benefits.

It is not foreseen that the system of total allowable catches (TACs) will disappear. A means to prevent all the fishing effort being concentrated on a few species which would then become over-exploited, will be required. TACs could achieve this objective although they would not be administered as now.

3. Fisheries and the 'Precautionary Principle'

As the concept of the 'Precautionary Principle' has not been precisely defined, it is difficult to examine whether it should be applied to fisheries. If the concept is interpreted strictly, in the sense that no action whose effects on the ecosystem cannot be totally predicted, should be taken, applying the concept would stop all fishing. Fishing removes fish from the sea and must have an impact on the ecosystem. Predicting what that impact will be, is at best, very difficult, at worst, impossible. For example, attempts have been made to examine the effect of fishing on the main commercial species of the North Sea, taking into account the inter-relationships between them. However, this model includes only nine species of fish from the post-larval phase. Even so, it is very complex and the results it gives are not considered sufficiently reliable by the scientists who have developed it to use as a basis for giving management advice. The complexities which would be introduced into such a model by including more species and by attempting to understand the inter-actions between them at the larval stage, let alone the problems of collecting the necessary data, are such that is highly improbable that a realistic model of the North Sea ecosystem could ever be developed. That the relationship between spawning stock biomass and the recruitment generated by that biomass is not yet understood despite many years of research demonstrates the difficulties of advancing the state of knowledge in the marine environment.

If, on the other hand the Precautionary Principle is interpreted less rigidly, as appears to be the case in the environmental field, fisheries policy can be held already to respect it. Even though fisheries management has been based on single species models, the fish component of the ecosystem has responded mainly in the manner predicted. Therefore, continuing in the same manner as in the past can be argued to be in accordance with the principle. If there have been problems, they have resulted from the scientific advice being ignored. Of the two North Sea stocks which have collapsed, that of herring has recovered following implementation of the scientific advice, that of mackerel has not, but the scientific advice; in respect of this stock has not been followed. This is not to deny that there have been inexplicable variations in the abundance of some species such as the sudden increase and subsequent decline in the abundance of sprat in the period 1971-1987 and the increase in recruitment to the stocks of cod, haddock and whiting since 1963. However, variability is a feature of all ecosystems.

In one respect, the Precautionary Principle, in its less rigid interpretation, is already implemented. A large proportion of the TACs fixed by the EEC are termed 'Precautionary TACs'. This term is used to describe TACs for which there are insufficient data to make an analytical assessment from which to calculate the catch possibilities for the coming year. Instead, TACs are fixed on the basis of all the available data on the assumption that if these TACs are respected the stocks should not be endangered. In the long term, it is hoped that sufficient data will become available for the most important commercial stocks for analytical assessments to be made. For the other stocks, it is realised that they may be too small to warrant the research expenditure necessary to collect the data required to make analytical assessments. The Precautionary TACs should continue to protect these stocks.

However, it should be noted that Precautionary TACs are strongly criticised. The fishing industry considers that its catch possibilities should not be restricted in the absence of scientific evidence to the contrary. The parallel with certain aspects of the debate concerning disposal of waste materials into the North Sea is evident. However, whereas political pressure concerning disposal of waste supports the Precautionary Principle, as evidenced by the conclusions of the 2nd North Sea Conference, the opposite is true for Precautionary TACs. It is probably fair to say that they would not have survived within the EEC system if the quota allocated to each Member State was not based on a fixed percentage of the TAC for each stock. This has the consequence that a Member State which has no allocation is excluded from fishing in the area to which the TAC refers. If no TAC is fixed for the stock, fishing on that stock by all Member States is permitted.

4 Fisheries and the Environment

The existing policy does not include specific environmental objectives. It does not, for example, include as one of its objectives trying to modify fishing techniques to more 'environmentally friendly' methods. One case which has been cited in this context is that of beam trawling, which has serious detrimental effects on certain benthic species and therefore, it is claimed, on the food chain dependent on the affected species. For this reason it is argued that it should be banned. Not only is this case not proved but a more appropriate remedy might be found if consideration were given to why beam trawling is so intensive and why such heavy gear, which admittedly does destroy much of the benthos, is used. This type of beam trawling has evolved as fishermen sought to maximise their revenues as the stocks of sole decreased. The improved gear caused the stocks to decline even further and so the gear was further 'improved'. If the stocks could be rebuilt, as suggested in this paper, there would not be the need for such intensive beam trawling and, as also indicated, part of the solution would be to reduce fishing effort.

Similar arguments have been made in favour of using passive rather than active gears. However, these gears introduce their own problems; gillnets entangle marine mammals and, when lost, continue to catch fish. It is not possible to exploit all fish species using hooks and traps.

5 Conclusions

It is concluded that:

- the basis for effective incorporation of scientific knowledge in the political decision making process exists;
- incorporation is, however, not effective, because pressures are exerted by the fishing industry which is in poor economic condition as a consequence of over-fishing of the stocks and which is unwilling to accept measures which will make that situation worse, even though this might be only in the short term; lack of understanding of the principles on which fisheries management is based, inaccurate forecasting and inadequate consultation exacerbate this situation;
- reducing fishing effort is the key to resolving this situation in that it would not only improve the economics of the industry but co-incidentally improve the scientific advice, removing one of the main reasons for its present inacceptability;
- management of the fisheries of the North Sea already respects the 'Precautionary Principle' as it is presently interpreted, in particular with respect to Precautionary TACs.

7 References

1. Official Journal of the European Communities No. L236, 27.10.1976, p. 36 (Regulation No. 2141/70 was subsequently re-enacted without substantial amendment as Council Regulation (EEC) No. 101/78 of 19 January 1976, Official Journal of the European Communities No. L20, 28.1.1970, p. 19.

2. Official Journal of the European Communities No. L226/47, 29.8.1980, p. 47.

3. Official Journal of the European Communities No. L24, 27.1.1983, p. 1.

Fisheries Management: A Review from Science

Prof. Dr. J. M. McGlade
Arbeitsgruppe Theoretische kologie
Jülich, FRG and
Dept of Zoology
University of Cambridge, UK

Introduction

Overexploitation, pollution and environmental degradation are commonplace in marine ecosystems throughout the world. However, a clear set of distress signals that can predict either the onset or the outcome of such events on fisheries productivity has yet to be developed. More often than not, natural systems do recover from large environmental perturbations, but how Nature achieves such changes is often viewed as more mysterious than the workings of her male analogue God. Quite clearly the nature of management depends on the quality of the science that supports it, but progress towards good management has been slow. In this paper I will examine why this is, how the Precautionary Principle put forward by the London North Sea Conference is insufficient for fisheries management, give an overview of those aspects of science most likely to help surmount the problems of overfishing and effort reduction and discuss whether these approaches are any better than simply relying on a laissez-faire attitude to decisions concerning the management of the North Sea.

Fisheries Science: A Slow Boat to Management

The North Sea has in many ways been the showpiece of fisheries science, for despite the fact that it only represents 0.16% of the world's oceans, 5% of the world's marine catches come from its waters. Scientific research on fish species, their biology and exploitation in the North Sea, northeast Atlantic and Baltic was formalized in 1902 when the International Council for the Exploitation of the Sea (ICES) was founded in Copenhagen. Operating within three committees on migration, overfishing and the Baltic, fisheries scientists, such as Garstang and Petersen, were able to draw public attention to the general problem of overfishing and the special case of immature fish removal off the coasts of the Netherlands, Germany and Denmark. But these early attempts by ICES to create a consensus on the cause of problems in the fishing industry were a failure.

The reason can now been seen in hindsight as characteristic of the problems that still plague fisheries: firstly, the variability in the raw data collected on research cruises was enormous, and secondly, there was no well defined theoretical basis for the resolution of overfishing and recruitment variability.

The axioms of fisheries science came soon after from the work of Russel (1931), who stated that fish stocks must be self contained and fished systematically over a broad area. He laid out the differences between the catchable stock and the stock left behind in the relationship given below:

$$S_b = S_e + (A + G) = (C + M)$$

where:

S_b is the weight of stock at the beginning of the year S_e at the end; A is the annual recruitment in weight; G is the annual weight increment by growth; C is the annual decrement by catch; M is the annual decrement due to natural mortality.

From this, Russel stated that the catch of commercially utilizable fish could be set at a level which would not cause a diminuition of the stock. But he also stressed that recruitment fluctuations would change the amount available in any year, and so suggested it would be practical to alter the amount available to the fishery if the variations in abundance could be foretold ahead of time.

This then was the beginning of management by maximum sustainable yield and the basis for total allowable catches (TAC's), which were eventually established some 40 years later.

Contributions were also being made in other parts of the world; for example in 1937 Thompson saw that the decline in Pacific halibut was directly related to fishing effort, but in his models he used constant recruitment to calculate the number of survivors at different annual rates of fishing and natural mortality. Indeed recruitment overfishing was not tackled. Graham also put forward two propositions: first that with a reduced death rate, the average age of the stock should increase and second, that there was a profitable area at which to harvest fish. Hjort and co-workers had previously shown that a maximum yield could be taken from a natural population. Graham went on to adapt the logistic equation of flat topped growth used by Hjort to the age distribution of fishes and to the data collected on stock density and fishing effort. Hence a maximum yield was established alongside the scientific justification for the increase in age at first capture, given by the mesh size in the cod ends of trawls.

In 1946 the Overfishing Convention was held in London, and signed by most European countries. It proposed minimum landing sizes for demersal fishes and mesh sizes for trawls, except those for herring and shrimp, but there was no agreement as to limited entry to a fishery. This Convention became ratified, and the Permanent Commission established in 1954. Here then was embodied the contributions of Russel and Graham - that control of growth overfishing could be wielded through agreed minimum mesh sizes. But what could not be foreseen was that simply altering mesh size could not cope with the effects of a lack of limited entry in the post-war industrialization of the North Sea fleets.

During this later period, fisheries science developed a more theoretical basis with the work of Ricker published in 1948, Beverton and Holt in 1957 and Schaefer in 1954, making reference as they did to the much earlier work of Baranov which was published in 1918. It was at this time that one of current axioms of fisheries science came to be stated: i.e. that the instantaneous rate of fishing mortality is proportional to the fishing effort:

$$F = qf$$

where F is the instantaneous rate of fishing mortality; q is the catchability coefficient; and f is the fishing effort in time.

Whilst much of the scientific work at this time was key to establishing international agreements, the theoretical basis and biological understanding of such issues as environmental effects on recruitment variability, the relationship between parent stock and recruitment, density-dependent changes in juvenile mortality and the impact of changes in abundance on catchability did not truly progress. And even today, three decades after the seminal work by Beverton and Holt in 1957, we are struggling to put biological facts to the many demands of the models that they proposed.

In the intervening years however, there has been a growing awareness of the complexity of the marine fish populations that governments are trying to manage. The advent of sequential population analyses (SPA), put forward in its current form by Gulland in 1965 as virtual population analysis (VPA) and in its simpler form by Pope in 1975 as cohort analysis, in a sense transformed the procedures to calculate yields. Based on the catch equation of Baranov, and using reasonable estimates of fishing and natural mortality to begin an iterative procedure, SPA allows the scientist to get an estimate of the fishing mortality, independent of effort data, which best fits to the observed catches given in numbers at age in a year class. In Pope's method the calculation starts with the last age in the catch at age matrix; successive catches at age from older to younger age groups in the year class reduce the error in estimates of fishing mortality, the final goal of these procedures. Natural mortality estimates are introduced as constant losses throughout the lifetime of a cohort.

However, the quality of data on natural and fishing mortality are still debateable, especially given the spatial and temporal context from which they are derived. To alleviate some of these problems, the concept of Status Quo Catch has been introduced, which assumes that fishing mortality is constant, in order to make forecasts based on recruitment variability and variations in stock size.

Within the framework of these models we have seen the advent and acceptance of TAC's, which have now come to dominate fisheries management in the North Sea. Catch predictions are made with respect to a management objective, which in practice is the maximum sustainable yield (MSY) or something less in terms of fishing mortality, e.g. F0.1U where the slope of the yield curve against fishing mortality is one tenth of that at the origin in a fishery undergoing light exploitation.

Other developments in model based predictions have occurred,
a) using the Schaefer model of surplus production, in which the curve of surplus yield against stock or against fishing effort at equilibrium is given as a parabola and the dependence of catch per unit effort against effort is assumed to be linear;
b) a more detailed exposition of the density dependence of growth in larval and early juvenile stages;
c) the multispecies approach, for which there are a number of examples around the world, and which can be seen in the model used by Shepherd in 1988 for the North Sea. The most important results from these are perhaps that estimates of juvenile natural mortality are much higher than had previously been estimated, and that the subsequent increases generated in recruitment and biomasses, tend to flatten the curves for yield per recruit against fishing mortality. The results of the Multispecies Working Group are worrying, because they show not only predation mortality as being a major factor in the North Sea, but the predictions of yields contradict many of the single species assessments. Indeed the conclusion of the Working Group is that long term advice must be based upon multispecies models.

Yet whilst the ideas lying behind MSY are technical in the sense of defining a point on a hypothetical concave curve, they have also been given an identity in certain treaty documents. The effort to tie biological ideas into the Precautionary Principle is therefore not so clearly defined, because of the multifaceted nature of the fishery. This is a key point, and underlines the idea that making science simple enough for a statement in a legal convention is not a sinecure for its success.

What the multispecies models have shown however, is the fact that the difference in relative management strategies is much less striking than in the single species assessments. The three common objectives of management - greatest yield, greatest value and maximal employment become deeply entwined, with no intuitive gain as to what might happen if one or another aspect are altered. For example, what one species loses in yield could be achieved via another, whereas a reduction in fishing effort of about 40% might not produce any increase in yield, except in the herring industrial fishery, but fishermen would lose their jobs, although the per capita earnings might increase. Although the Precautionary Principle is being fulfilled to some extent at the biological level, it is certainly not being addressed at the socio-economic end. The task now is to take the biological models of conservation that have been so long in development, and put them in juxtaposition to the human aspects of choice, behaviour and expectation in the industry and community.

Integrated Fisheries Management: Fishermen and Fishes Together

In the last decade of the twentieth century, it is clear that biological principles alone will be insufficient to ensure the continued yield of resources form the North Sea. Ecology and economics at this point must be set together, but both have suffered a lack of axiomatic and pedagogical groundwork, so that the future of fisheries management can only look bleak when pitted against the problems yet to face it in the North Sea. In the next section I shall try to lay out an avenue along which policy and decision-makers can proceed that might ease some of the problems of enforcing limited entry and effort restrictions for resource conservation.

Fisheries biology and economics have both developed rapidly during this century, but their evolution has not been as strongly coupled as one might have expected. The main reason for this is that biological conservation has been the main target for controlling local and national fisheries, even though policy statements stress the need for a 'balanced exploitation on a lasting basis in appropriate economic and social conditions' (ICES No. 170/83).

On the human side, it is now generally appreciated that this approach stems from a lack of property rights amongst fishermen for the resources, and the escalation of governmental intervention in response to declining catches. But the modus operandi of enforcement and litigation ignores the potential impact of positive incentives, social and community constraints, market-led forces and a host of other human factors to stop overfishing. Compounding this from the biological side, there is still a limited understanding of those processes controlling recruitment and growth in fish populations. Any attempt to predict catches accurately from year to year is thus seriously undermined. Uncertainly in the two domains rises when concatenated, so that human events can exacerbate the failures of a biological model to predict the fate of a cohort of fish.

Despite society's preoccupation with the environment, the interrelationships between human activities and biological responses are barely known, the escalation of problems arising from the human and biological sides easily reduces fisheries management to social manipulation, a course of action fraught with ideological pitfalls. One of the fundamental challenges of fisheries science and management must be to improve ideas about the connections between the human and biological domains, and to equip ourselves with an effective set of distress signals.

Achieving such a goal will not be easy. It will be necessary to understand such phenomena as the role of oceanographic and aquatic processes in the population biology of species, how the dynamics of individual species are embedded into the ecology of a community, and the role and impact of the human realm on aquatic communities. The incompleteness of our knowledge of these tasks has led to a basic lack of understanding of the relationships among phenomena occurring on different scales, and the dynamic processes underlying the emergence of patterns. Thus the linkages between the human and aquatic realms remains almost virgin territory.

To establish a more integrated approach I shall adopt an analytical framework which examines in turn 'How complex are the systems and the issues to be studied?', 'What are the management goals and how is performance measured?' and 'What institutional structures exist to facilitate activities?'. These broader questions can be equally applied to management goals and to the aims of scientific research, and will allow the performance of fisheries management and science to be assessed in terms of goals, systemic structures and institutional constraints. For example, we may ask such questions as: 'Can legal frameworks and institutions respond in sufficient time to avoid stock collapses?', or 'To what degree do differences in the expectations of the participants in a fishery prevent socio-economic policies from being achieved?', or 'Are the temporal and spatial scales of certain species incompatible with current management practices?'.

Using this type of framework much of the complexity of fisheries in the North Sea can be unravelled. Initially to get at the idea of complexity, I will present a series of questions that would enable fisheries scientists to examine what is known about the evolution of spatial and temporal pattern in marine resources, harvesting/culturing factors, economic, resource use and socio-cultural factors. From this it becomes possible to analyze management strategies, and the principles of economic efficiency, social well-being, conflict resolution and conservation. Finally it can be seen that once the goals and the complexity of fisheries have been assessed, then possible solutions are constrained by the institutional structures in place, as evaluated from the individual to international entities.

Analysis of System Complexity: Management Objectives and Institutions

How does pattern form in the absence of a detailed blueprint or bauplan? In this regard Nature is the strong female corollary to God in its inconsistencies and inconsistency.

History has shown us that parts of communities do not necessarily develop simultaneously. Thus earlier ideas of equilibrium, constancy, homogeneity, stability and predictability which arose in conjunction with concepts of climax stable states can no longer be considered as absolute attributes. Rather, it is the variation in the rates of change that is crucial to unravelling the development of structure and pattern.

In many disciplines a central question has been how a few basic rules, largely local in nature can generate consistent patterns of organization at higher levels. In 1952, Turing demonstrated that symmetry could be broken through local autocatalysis, reinforcing random inhomogeneities. But if these local perturbations remain unchecked, then the initial unevenness will eventually spread and give rise to new patterns that are homogeneous, regular or chaotic. Implicit in Turing's model is the idea that local instability or short-range activation is in opposition to a longer-range coupling that eventually stabilizes pattern and retards the spread of a disturbance. Given that these two processes are all that are needed to produce a wide variety of patterns, it then becomes possible to separate process from pattern.

In marine ecosystems it is now known that planktonic organisms are patchily distributed at a variety of scales ranging from 1 cm to 10 m in the horizontal and 1 cm to 10 cm in the vertical. Most important is the fact that the micropatches are common and persistent even in turbulent seas, and that organisms and nutrients are found in coassociation. This is a fundamental idea in determining patterns of association between a higher set of relationships i.e. between humans and fishes. Spatial matching is what fishing is all about, and information is the key to success. In previous works I have tried to lay out ways in which fishermen's behaviour, reflecting as it does expectations, information about resources, personal attitudes and economics, is the key to understanding some of the day to day complexity of fishing and the catches that eventually arrive at the dockside for marketing. However, in a system such as the North Sea, cultural preferences, social wellbeing, technological differences and access to varying markets, all compound the basic problems of an industry in which there is too much effort concentrated on too few resources. Solutions will not be found amongst the single cause-single action scenarios derived from the models such as those used within ICES.

Rather the situation has to be examined from many vantage points. The framework presented below allows scientists to look at all these aspects, and evaluate the problems associated with making changes in policy at the national and international level, i.c. making management part of the contextual regime in which it must operate, and not some rather distant set of objectives that are largely controlled by administrative convenience.

An Integrated Fisheries Management Assessment Framework

The integrated management framework poses a series of questions designed to examine the relative importance of resource complexity and institutional structures in implementing successful management. The three aspects of this problem are:

i) 'How is performance measured?' (management goals)

ii) 'How difficult are the issues?' (system complexity) and

iii) 'What tools are available?' (institutional structures).

Each of these items are explored individually and as the affect each other. Progress or deterioration of performance are assessed by looking at historical data and the evolution of the management system.

A Management objectives

In general order of importance, the three principle management objectives are: i) economic efficiency and social well-being, ii) conflict resolution and iii) conservation, although in certain situations the order may change, and the degree to which the objectives are separable will vary.

1 Economic efficiency and social well-being.

a Increasing economic rent.

b Industry rationalization.

c Increasing yield per unit effort.

d Stabilization of yield and income.

e Equity in employment opportunities, multipliers and income distribution.

f Failures in the market.

g Conflicting time horizons and discount rates.

h Significancee of administrative mechanisms.

i Macroeconomic and sectoral impacts on resource management.

j Community and family stability.

k Cultural cohesiveness - ability of cultural and ethnic groups to withstand stress.

l Housing, nutrition and vital statistics.

m Population structure - ability to retain young people.

2 Conflict resolution

a Identification of conflicts (parties, issues, etc.)

b Type, intensity, frequency and duration of conflicts.

c Competition for markets and resource use.

d Types of share groups for fishermen, e.g. national and foreign, vessel classes, artisanal and industrial, fixed and mobile gear.

e Impact on non-fishing sectors (recreational, transport, development, etc.).

f Property and use rights conflicts (e.g. impacts on aquaculture).

3 Conservation

a Resource productivity.

b Risk of resource collapse (intensity, frequency and duration).

c Effects on pollution of resource recruitment, survivorship, quality etc. (finfish, shellfish, mammals, plants etc.).

d Human health hazards (water quality, contamination).

B Analysis of system complexity

The management system is described as the intersection of four realms: resource, harvesting, economic and socio-cultural. The complexity of each and how they interact determine the degree of complexity in the overall resource management system.

1 Resource factors

a Mobility

b Distribution

c Trophic interactions

d Environment/habitat

2 Harvesting/culturing factors
a – interactions
b Shared access
c Degree of intensity of aquacultural practices.

3 Economic and resource use factors
a Market economies
i) institutional and regulatory constraints
ii) market size and revenue
iii) investment in boats, equipment and infrastructure
iv) terms of borrowing and credit
v) operating and maintenance costs.

b Non-market economics
i) property and use rights
ii) community institutions and decision making
iii) role of marine resources in community life.
iii) role of marine resources in community life.

4 Socio-cultural factors
a Degree of geographic isolation, proximity ot urban areas.
b Family, community, and sub-national interdependency or self-sufficiency.
c Cultural and ethnic diversity and interactions.
d Complexity of resource/human interactions.

C Institutional structures
Once the goals and complexity of the problem have been assessed, the possible solutions are constrained by the institutional structures in place. The structures are evaluated ranging from the individual to international entities.

1 Resource user level
a Legal/regulatory instruments.
b Modification of property and use rights.
c Zoning of effort and resource development.
d Cooperative/community management schemes.
e Degree of co-management (involvement of fishermen, decentralization etc.).
f Licences, quotas and allocations.
g Economic (market) mechanism vs. administrative (arbitrary) resource allocations.
h Financial inducements for rationalization.
i Credit facilities.
j Information dissemination and technology transfer.

2 Supporting infrastructure
a Improving flexibility of equipment.
b Investment in production facilities and aquaculture.
c Storage, transport and marketing.
d Development of resource indicators and resource assessment.
e Statistics and enforcement.

3 National and international structures
a Taxation and subsidies.
b Policies towards trade in marine resource products.
c Coordination of sectoral development politics.
d Management of habitat and pollution.
e Integration of institutional roles.

D Final assessment
The performance of living marine resources management systems is assessed in terms of goals, systemic structures and institutional constraints. For example, one could address such questions as: 'To what degree do conflicting goals jeopardize management success?', 'To what degree does institutional weakness determine management performance?', or 'Can legal frameworks and institutions be corrected in sufficient time to avoid stock collapses?'

Conclusions
Effective fisheries management can only arise through a more integrated approach than has been used in the past. Arguments from administrative centres that too much complexity will only cloud the real issues of overcapacity merely serve to obfuscate the avenues along which real solutions to local problems can be solved. Indeed the somewhat drastic changes in biological advice that have occurred in more recent years with respect to TAC's have been marooned and exposed to criticism, when in fact the issues are deeply embedded in the problems of socio-economics and human behaviour. Integrated models that incorporate the dynamics of fishing, economics, recruitment and multispecies interactions can only serve to improve our understanding of the system. But change for change's sake cannot be elicited without due regard to the inherent variability in the resource itself. Expectations then, which governments lean on for year to year credibility, should seek to avoid the sinecure of prediction, and in turn concentrate on building up long-term goals in which to overcome the exigencies of the boom and bust cycle syndrome.

Almost more important than anything else that can be said is that it has been shown that institutions have a life of their own, and the fisheries of the North Sea, being controlled as they are by the CEC, come under a bureaucracy that is intricate but certainly amenable to change. The question that has to be faced however, is whether the structures in place, causing a dynamic as they do in their own right, are any better than a laissez-faire attitude with little or no intervention. Experience in the national economics that purport to be market-led and market-driven suggests that because fisheries resources are not neutral, i.c. communities are not equally placed to gain access to fish, then intervention by government may still be a necessary cog in the future.

However, fisheries science is ill-equipped to solicit change on its own, and it must now turn to the other disciplines for support in the remaining years of this decade, to ensure that not the ideals of the Precautionary Principle apply to the industry as a whole, but that distress signals can be developed to anticipate change.

From Short-Term Necessities of Circumstance towards a Horizon of Long Term Benefits for all

Mr S. Munkejord.
Regional Director of Fisheries, Rogaland, Norway.

1. Introduction.

The intention of the organizers of this seminar was that this intervention should express opinions from a fisheries point of view. I shall, therefore, make it quite clear to the audience that I am not myself a representative from the fishing industry.
However, my work within the Norwegian Fishery Administration, in a section which we call the 'Advisory Service', brings me in daily close co-operation with all categories of professionals of the fishing industry, - both fishermen and fish processing people.
This makes me relatively confident that the points of view I am about to express have a fair amount of backing in the industry. They are, nevertheless, still on my own account.

I will begin by referring to the increased awareness in the fishing industry and its organizational and political surroundings of the importance to protect and maintain the marine environment as THE fundamental base for the potential or future production in the sea.
Further on, I will look into the somewhat sad state of affairs for some major fish stocks in the North Sea, and some historical and current, closely corresponding fishery and fishery management issues.

Finally, I will try to pin down a few key problems and challenges that will have to be tackled in order to make our efforts in fishery management and regulation more practical and result-oriented.

2. Awareness.

There is no doubt that the awareness and anxiety has increased substantially in the 'fishing world' of Norway concerning the environmental status of the North Sea. I venture to guess that this is also the case in other fishing nations around the basin. At random, I can indicate a couple of issues that have been in the focus of public attention recently.
The organized protests against the plans to establish a nuclear waste facility at Dounreay is a good example.

The exceptionally massive blooms a year ago of the algae species Crysochromulina polylepis and Gyrodinium aureolum also shook up a formidable interest and debate. - Different activities related to the oil industry, such as the intense and continuous seismic surveys, have been topics of discussion in fishery organizations for many years.
However,the environmental implications of the fishing activity itself and the patterns in which the fisheries are conducted, are by no means forgotten. - It is only fair to add, though, that the commercial fisheries are matched by a very well developed, national and international, marine research sector, and that the consequences of poorly managed fisheries are better known and more clearly demonstrated for everyone to see than many other sectors' contribution to the North Sea environment.

3. The complexity of fisheries management.
It is not difficult to compile a long list of errors and bad cases, maybe not so much relating to scientific advice as to the implementation of scientific advice in fisheries policy, and relating to the enforcement of the policy and actual fishery practice. This applies to fisheries management in the North Sea as well as in other waters. - I will revert to this shortly.

As an exercise to stay sober, it might be useful to keep in mind the enormous complexity of the task we are facing. In my country a lot of concern has been expressed in recent years, and certainly with ample justification, in relation to what is happening in the Barents Sea. A number of alarm signals, such as yearly invasions of starved arctic seals, famine in sea-bird colonies, cod and other fish in poor and apparently starving condition, etc., have been observed. The situation has been referred to as an ecological break-down, and scientists, the fishery administration and the fishing industry have all been blamed.
What gives food for reflection is that the well-known scientist Johan Hjort presented a description of the situation as it was in 1903, with all the elements of crisis that I just mentioned. The fisheries at that time were totally insignificant.
The lesson is not, of course, that fishing activity cannot bring about ecological disruption. The lesson is that the ocean and the marine ecosystem is not in itself a stable, balanced system. It would, therefore, perhaps be advisable to add a certain amount of humbleness to any ambition in the direction of perfect fisheries management schemes.

4. Review of recent and current North Sea fisheries and fish stocks. Development trends.
A review of the last 25 years of North Sea fisheries reveals the following main features:

* The herring stocks in the area were overexploited during the 1960s, mainly as a result of a Norwegian purse seine fishery on adult herring and a Danish trawl fishery on juvenile herring. In the mid-1970s, a total ban on direct herring fisheries was eventually introduced. These stocks have increased significantly over the last 7-8 years, and are now considered to be back at the 1960s level.

* The North Sea-spawning mackerel was heavily overexploited in the course of the late 1960s and early 1970s, as the stock became the target of the purse seine fleet in step with the dwindling of the herring. This stock does not, as yet, show signs of recovery.

Almost all of the mackerel caught in the North Sea in recent years belongs to the stock which spawns south-west of the British Isles. This stock has decreased steadily since 1972. Due to several good year-classes in the 1980s, the spawning stock is, however, still on a reasonably acceptable level.

* The sprat in the North Sea decreased from a relatively high level in the late 1970s to almost nothing now. Extensive fishery pressure has undoubtedly contributed to this development. But it is very likely that poor recruitment success and competition from increasing masses of juvenile herring have contributed as well.

* The stocks of cod, haddock and whiting had a spectacular boom during the 1960s, the so-called 'Gadoid outburst'. Since then, these stocks have been steadily decreasing, mainly due to heavy fishing pressure and a generally bad pattern of exploitation. The stocks of cod and haddock are, for the time being, at an all time low.

* The saithe stock (coley) was in very good condition in the beginning of the 1970s. Except for a brief period of recovery in the early 1980s, it has since been decreasing. The spawning stock reached an all time low in 1985/86, - and seems to have recovered slightly recently.

* Stock assessments of Norway pout and sandeel cannot, at the present state of the art, be made until after the respective year-classes have been exposed to a fishing season. Even then the assessments are quite uncertain. - The apparent situation is that the Norway pout has decreased during the 1980s, whilst the sand eel seems to have increased sharply the last 2-3 years.

* The total output of shrimps from the North Sea was tripled during the decade from 1978 to 1987. The recruitment was good until 1984, and has been weak since then with the exception of the 1988 year-classes, which seems to be promising so far. The spawning stock is expected to decrease in 1989 and 1990, and the degree of exploitation is largely too high.

5. Diagnosis.
I have directed my attention in this short review towards some of the fish stocks that are of greatest importance to the Norwegian North Sea fisheries, without of course, any pretention of having presented an exhaustive picture. The review has revealed a number of cases with an up and down development pattern, unfortunately more downs than ups.
From a fishing industry point of view, a stable situation of long term maximum output would be the ideal. This is identical with the goal of the fishery management authorities. It is, however, a lot easier to agree on principles than on practices.

The composition of fish stocks in the North Sea is a complex one, and the natural variations in recruitment to the stocks are considerable. This calls for a management strategy which takes these natural variations into consideration. The main principles of such a management strategy are very simple, and can be summed up in only two points:

First : Economize with the abundant year-classes! These will have to bear the burden of exploitation in many years of weak recruitment, and should not, therefore, induce an immediate increase of catches. The function of such year-classes should be to build up the stock, to allow for a more stable long term yield. This has been a major message from science for a long period of time.

Second : Save the juvenile fish! It is evident that the tonnage of a certain number of individual fish increases dramatically if the fish are allowed to grow for a few years instead of being caught in kindergarten, so to speak.

These two simple and evident principles of management have, unfortunately, not been much heeded in the North Sea fisheries.

The haddock fishery is a relevant example. From 1980 to 1987, approximately 1.1 million tons of haddock was landed from the North Sea. It has been calculated (ICES figures) that the actual catch in the same period was 1.7 million tons. In other words, 60000 tons of haddock are discarded yearly. The discard consists of juvenile fish, - too small for marketing and production purposes. An enormous number of individual fish, representing a huge tonnage potential, wasted. Now, if Mother Nature provides us with an extraordinary abundant year-class of haddock, it is pre-destined to be fished and discarded before the fish are of much commercial interest, if the current pattern of exploitation is continued.

The cod and haddock fisheries are more or less identical,- same vessels, same gear. One can only wonder why the calculated discards of cod are quite insignificant compared to the haddock discards.
The North Sea herring fisheries gives food for very much the same sort of considerations. In the 1980 - 1987 period, the official catch reports were 2.1 million tons. ICES figures for actual catches were 2.8 million tons. The ICES corrections in 1980 - 1983 were more than 100%! It seems a bit unfair to expect reliable stock assessments from our scientists when they have to spend so much energy to find out what is actually fished.

6. Medicine.
The situation I have just presented undoubtedly gives reason for concern. Who is to blame? Is it science that has misled political and administrative authorities with stupid advice? My answer is no. Science and the relevant scientific bodies are in the clear, with a possible exception relating to the overfishing of the herring stocks during the 1960s and 1970s. Science eventually came up with clear-cut recommendations to ban the herring fisheries completely, but in hindsight it may be argued that it came somewhat late in the day.

For certain other stocks, such as saithe, the stock assessments may have been in the direction of overestimation, thus contributing to excessive catches. Norway pout and sand eel are important commercial species for which the population dynamics are inadequately known. And in the domain of relations and exchange mechanisms between the Skagerak/Kattegat area and the North Sea, and also between this area and the Baltic Sea, plenty of white patches remain to be explored.
But the scientific support for good fishery management in the North Sea is, as far as I can see, on the whole of better quality and organization than in any other fishing region of the world.

If we go back a few years and compare the TAC's which were actually fixed with the figures recommended by ICES, we will discover a tendency to fix quotas in excess of the scientific advice. Historically, this tendency, based on 'fishery needs' as argued from the fishing industry, has no doubt contributed considerably to the overexploitation of the fish stocks in the North Sea. This has, however, changed in the direction of TAC's being adopted in consistency with ICES recommendations.
I look upon this change as an encouraging feature. Less

encouraging is the continued tendency by political authorities to systematically go for short-term management options. This is also a practice that ICES should consider. The lesson for ICES might be to abolish or adjust its current way of presenting the recommendations, so as to give one specific advice instead of a list of options.

The really fundamental question concerning the establishment of a biologically rational exploitation of the fish stocks in the North Sea, relates to enforcement and control. This is the Achilles heel of fisheries management today. The figures I just referred from the haddock and herring fisheries argue for themselves. As a totality, the system of enforcement and control is largely inadequate in the North Sea fisheries. Given the chance, the fishing industry will cheat! I have no reason to believe that the distribution of 'dirty tricks' within Europe's fishing industry has much to do with moral qualities. The propensity to cheat is probably a constant factor, on average. The opportunity to cheat may, however, show some variation between nations and fishing ports. I will mention only a few of the multitude of tricks that the fishing industry plays on the administrations every day:

* Underreporting of catches.
* Manipulation of species-mix or flatly give a totally false species declaration, such as horse mackerel for mackerel.
* Falsify area declaration of catches, - fish in a prohibited zone and report the catch from a different zone.
* 'Double' book-keeping practices at fish auctions, only part of the landings officially registered.
* Etc.

The rules of the game are simple. If my colleague cheats, I must cheat too if I want to stay in business. If you don't help me, I'll land my catch somewhere else. And so on. Only one thing is going to help: Increase the chances of getting caught, and more severe punishment on infringements.

In addition to this, regulations should be made simpler and more effective. Take protection of juvenile fish as an example. Minimum mesh-size regulations are clearly not effective enough. A flexible policy of closing and opening areas for specific types of fishing operations has been tried with fair success in other waters, and would be worth trying in the North Sea as well. It is easy to survey from airplane, and it is considered by most skippers to be a fair, neutral regulation.

The single most powerful factor behind the fishing pressure on the North Sea fish stocks, is of course the excessive catch capacity of the fishing fleet. Everybody in the fishing industry realizes the situation, but it is not realistic to leave the process of adjustment to the industry alone. It ought to be a major issue of concern for the governments of all nations involved, from an economical as well as from a conservational point of view. It should be regarded as a resource management issue as good as any, and therefore in my opinion should be the subject of international cooperation the same way as other aspects of the management of the joint fish stocks of the North Sea. The advantages of such an approach for general acceptance internationally in the industry, seem apparent.

7. Concluding remarks.

Earlier in this intervention, I mentioned the increasing awareness in the fishing industry of questions relating to the quality and production capacity of the marine environment at large. So far, I have not come across information indicating that any of the major fish stocks in the North Sea are suffering negative influence from pollution or other man-inflicted influences other than fishing. There are, however, ample reasons for concern in relation to the effects of pollution observed locally in a number of places along the North Sea coastline, including Norway.

Until now, the concerns of the fishing industry in relation to the effects of fishery itself, have mostly been limited to the tonnage yields which could be expected next year. This has also been the focal point of most of the efforts of the science support of the fisheries. Nevertheless, it cannot be denied that the commercial fisheries have other important effects on the composition, development and quality of the marine environment that, seen from different angles and under different value criteria than the fishing industry normally adopts, have every right to be taken seriously into consideration. It is my definite impression that the fishing industry is prepared to enter into a dialogue with the advocates of these environmental interests, as long as they on their side are serious and fair.

As such, there is no reason for conflict of interests between the environmentalist movement and the fishing industry. I will venture to suggest the contrary. It might be argued that it is in the long term interests of the fishing industry to enter into some sort of structured cooperation with the personalities and the serious, representative organizations of the environmental movement. We need, for instance, the support and pressure from this movement to accelerate a development towards a more firm follow-up of the quota regulations and other regulation measures adopted to secure a biologically rational fishery.

Appendix

Reported /Actual catch.

Haddock. 1000 tons.

	1980	1981	1982	1983	1984	1985	1986	1987
Landings	104	133	174	164	133	168	168	108
Actual catch	217	207	225	232	213	250	220	175

North Sea Herring. 1000 tons.

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Reported catch	13	47	122	125	253	460	523	586	?
Actual catch	60	140	236	306	317	534	543	621	698

Source: The Directorate of Fisheries, Institute of Marine Research, Bergen.

Bottom Trawling in Strangford Lough: Problems and Policies

Dr R A Brown
Strangford Lough Wildlife Scheme, National Trust, Saintfield, Northern Ireland

The marine life of Strangford Lough, Northern Ireland is internationally noted for its richness and diversity. Reflecting this, the lough is the subject of a major Wildlife Scheme run by the National Trust, whilst a large number of areas within the lough are protected by statutory designations. Discussions aimed at the creation of a Marine Nature Reserve are taking place between the Department of the Environment (Countryside & Wildlife Branch) and the Department of Agriculture (Fisheries Division).

One of the most important benthic communities in the lough is that based on the Horse Mussel (*Modiolus modiolus L.*) which supports a very wide range of associated species, including the Queen Scallop (*Aequipecten opercularis L.*). This species has recently become the target for a bottom trawling fishery undertaken by vessels from outside the lough. The *Modiolus* population, and the associated species, are dependent on stable conditions allowing the survival of large, long lived mussels to support the community and to provide a slow recruitment of spat into the population.

Trawling for Queen Scallops in the lough entails the removal of large quantities of non-commercial species and bottom debris. In the trawled areas, the *Modiolus* community has largely been destroyed with the exception of isolated clumps and some burrowing species. The fishery continues however, at present sustained by migration of scallops from the increasingly rare undamaged areas. Recovery of a *Modiolus* community from even small scale damage is known to be a slow process; the continuation of the fishery may cause permanent damage in some areas. The implications of this for the conservation value of the lough, and for the fishery are discussed.

Introduction

Strangford Lough, Northern Ireland, is a sea lough more than 30 km in length, has recently become the target for a bottom trawland, is a sea lough more than 30 km in length, 10 km wide, connected to the Irish Sea by a channel less than 1km wide in places. The tidal currents that result from this configuration exert a profound influence on the distribution of sediments and their associated fauna (Erwin, 1977).

There is a large body of information on the lough's marine life. The first list of species was published by Dickie in 1857. Because of this early work, the lough is the type locality for a number of species, for example the sponge *Spanioplon armaturum* (Bowerbank, 1866). In 1948 the Queens University of Belfast established a marine laboratory at Portaferry near the entrance of the lough, and research there continues on the lough. In 1954, Williams listed over 2000 species of intertidal and subtidal animals occurring in the lough and on the adjacent coasts. In 1966, in recognition of the internationally important bird life, the Strangford Lough Wildlife Scheme was established under the management of the National Trust, and this now includes within its scope all aspects of the lough's wildlife. In 1977 Erwin identified twelve major benthic communities in the lough, one of the richest and most important being based upon the Horse Mussel, *Modiolus modiolus* (L.), which occurs in large beds mainly in the central area of the lough. In 1986, Erwin et al. completed, under contract to the Department of the Environment (Countryside & Wildlife Branch), a survey of the subtidal marine life of Northern Ireland. The survey showed that the lough held representatives of 72% of all the species found around the Province, and that of these 28 species had been found only within the lough (data from N Ireland Biological Data Base, held in the Ulster Museum, Belfast). The survey also highlighted the significance of the lough's *Modiolus* community.

Discussion between conservation and fishery interests continue, but appear to be impeded by major differences in the methods employed by the two interests in evaluating conditions on the lough bottom, and applying criteria aimed at successful management. These reveal significant differences in approach to the management of the lough (and possibly other onshore waters), and these are discussed in the light of current debates about the lough's future and the creation of a Marine Nature Reserve.

There is, as a result of all this work, a strong awareness of the importance of Strangford Lough, regarded as unique in the UK context (Gubbay, 1988). The history of the work undertaken to conserve the wildlife and scenery of the lough was reviewed by Boaden (1984). In addition to the protection provided by the work of the Wildlife Scheme, most of the intertidal, and a large number of coastal areas, have been designated Areas of Special Scientific Interest, and there are six National Nature Reserves. Most of the bed of the lough has no statutory designation however, and therefore what is arguably the lough's most important conservation feature remains largely unprotected, although there are three small voluntary subtidal reserves obtained by agreement with local divers.

In 1987 the Minister for the Environment, the Rt. Hon. R. Needham, initiated discussions between the Department of the Environment, Countryside & Wildlife Branch, and Department of Agriculture, Fisheries Division, consideration being 'given to declaring the entire bed of the lough as a Marine Nature Reserve' (D.O.E. Press Release, 30th October 1987). Little progress appears to have been made towards this end, although work is taking place under contract to the D.O.E., to develop a management plan for a possible Marine Nature Reserve.

The history of fisheries on the lough has been characterised by a succession of different practices during the last hundred years. The latter part of the 19th Century and the early 20th Century were dominated by a Herring Fishery, which declined during the 1930's (Department of Agriculture Report, 1938), possibly through over exploitation. Dredging, mainly for scallops (*Pecten maximus*), was apparently of little significance in the early 1950's (Williams, 1954), but by 1978 several areas were reported to have been over exploited, and one area in the south of the lough was described as having been 'permanently and adversely changed' (Report of Strangford Lough Working Group 1978). There has since been a substantial decline in the number of commercial fishing vessels fishing for *Pecten* in the lough. Currently a small part time fishery is conducted by some people potting for crabs (*Cancer pagurus, Liocarcinus puber*), lobsters (*Homarus gammarus*), and scampi(*Nephrops norvegicus*), and more importantly there is a substantial oyster farming industry (*Crassostrea gigas*), based mainly on the western shore of the lough. There is a new trial scallop farm in the south. Recent proposals for salmon farming were the subject of deep concern by both conservation and recreation interests, and applications for licences were rejected by the Minister of the Environment because he 'was not prepared to risk the possibility of spoiling this unique natural resource' (D.O.E., Press Release 30th October 1987).

Queen Scallops (*Aequipecten opercularis* L.) were first fished by Northern Ireland-based vessels in 1970, mainly from the Scottish coast. The fishery developed for about four years, and then, because of what were described as 'shortages' (Department of Agriculture Report, 1973), they dwindled rapidly thereafter (Department of Agriculture Reports 1969-1980). Although *Aequipecten* in Strangford Lough have been the subject of occasional fishing efforts for a number of years, this fishery suddenly increased in the early 1980's and still continues, conducted by vessels mainly from ports outside the lough, particularly when weather conditions in the open sea are poor. The main area of the fishery activity is in the centre of the lough, in the areas dominated by the *Modiolus* community. The Queen Scallops are not often consumed locally, but are exported to continental Europe. The fishery has given cause for concern because of its apparently unregulated nature, and because of its effects on the important *Modiolus* community, and therefore the conservation value of the lough as a whole. Discussions with Fisheries Division (Department of Agriculture) to date have revealed that they consider there is no cause for concern about adverse effects, and do not appear to have concerns for the long term sustainability of the fishery.

This paper reviews the relevant literature on (*Modiolus modiolus* L.) and its associated benthic community, and assesses the available information on the *Aequipecten* fishery. It then reports on the results of preliminary investigations conducted in 1988, on the effects of trawling on the benthic community. Finally, the various discussions and correspondence between conservation and fishery interests are summarized, and the differences in approach to the matter, and to the lough's wider conservation interests are analysed, particularly in the light of the wide body of information applicable to the sustainable integration of the lough's fishery and conservation interests.

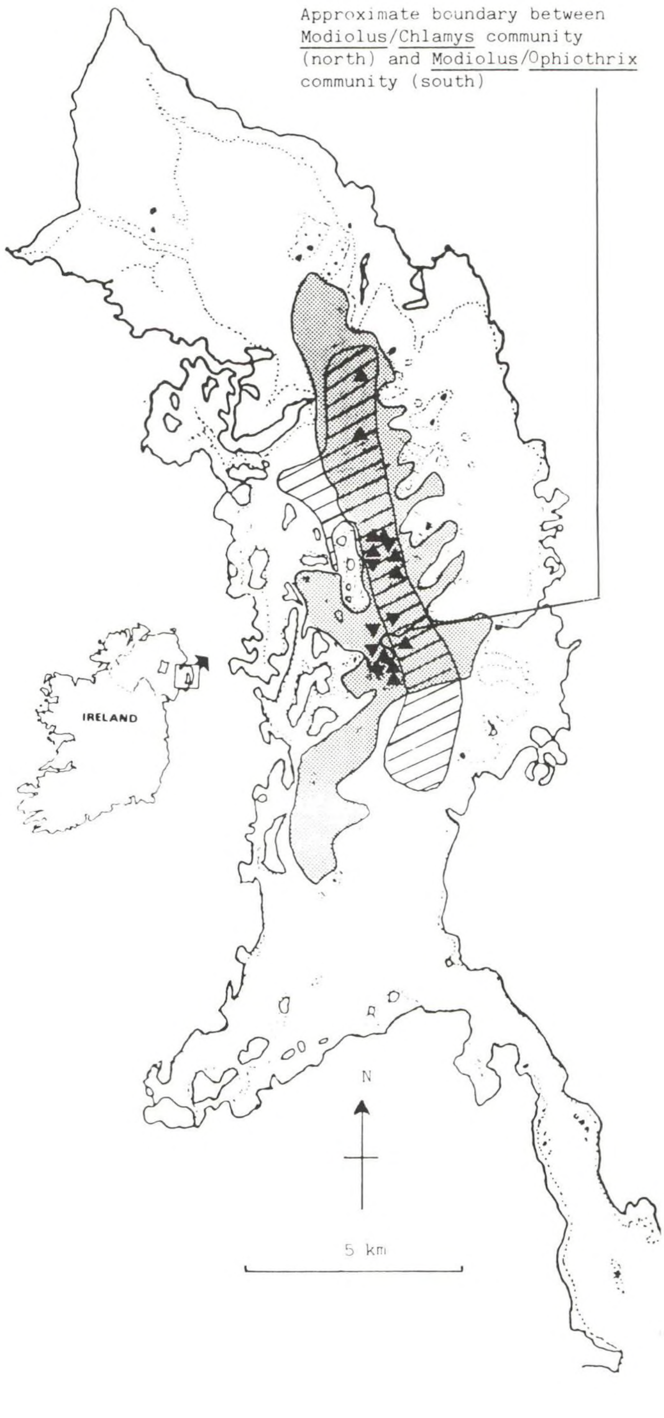


Figure 1.
The Strangford Lough area, and the dive locations referred to in the text.
Dives between 1975-1980 ( );
dives in 1988 ( ).

The Modiolius modiolus community: the information available.

Modiolus modiolus is distributed widely about Strangford Lough (fig 1) on sediments consisting largely of gravel, shell debris and fine muds (Erwin, 1977). The species colonizes these soft muds by attaching byssus threads to shell fragments and stones, tending to stabilize the substrate. The presence of *Modiolus* both living and dead, provide a dense matrix of hard surfaces for generations of mussels and epifauna to attach to (Roberts, 1975).

As a result, the *Modiolus* beds provide a habitat for a much wider range of species than would be able to colonize soft mud alone. The fauna associated with *Modiolus* is thought to constitute one of the most diverse sublittoral communities in N.W. Europe (Thorson, 1971). The Strangford Lough *Modiolus* community may be highly unusual, since *Modiolus* beds are usually associated with areas of stronger water movement (c.f. Wiborg, 1946) than those found in this part of the lough. About 90 invertebrate taxa have been found associated with the Modiolus community in the lough (Roberts, 1975), and the presence, unique in Northern Ireland (and possibly further afield), of *Chlamys* varia as a co-dominant species in the northern half of the community (Data from N.I. Biological Data Base) may reflect the unusually sheltered conditions. The Queen Scallop (*Aequipecten opercularis*) is another species closely associated with, or even dependent on, the *Modiolus* community; over 70 % of the sites in which it was present were dominated by *Modiolus*, or were adjacent to such sites.

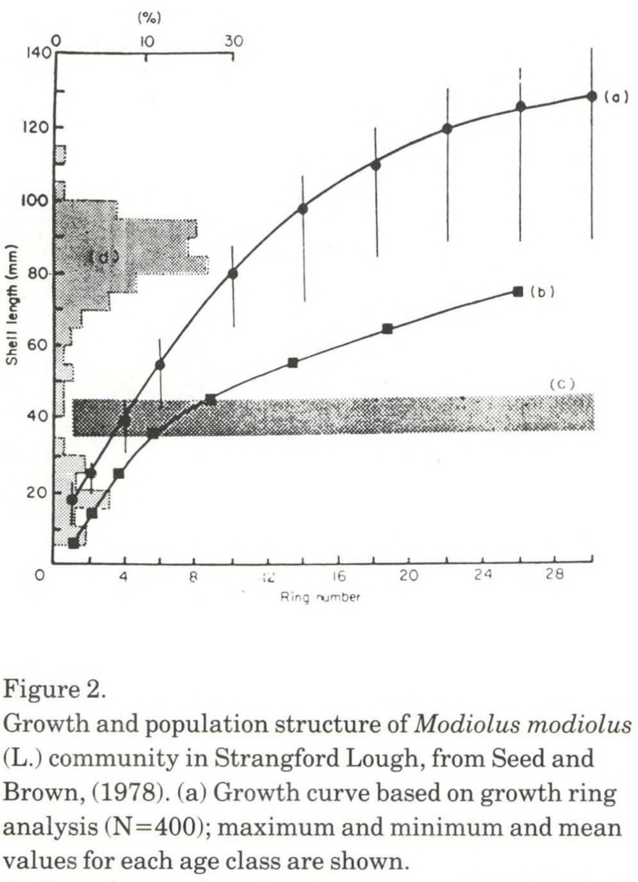


Figure 2.
Growth and population structure of *Modiolus modiolus* (L.) community in Strangford Lough, from Seed and Brown, (1978). (a) Growth curve based on growth ring analysis (N=400); maximum and minimum and mean values for each age class are shown.
(b) Growth curve based on the measurement of marked individuals in growth cages (n=81).
(c.) The shaded bar illustrates the size range at which the ' mussels become sexually mature.
(d) Typical size frequency distribution is illustrated along the vertical axis.

Detailed studies on the ecology of *Modiolus* have been conducted by Wiborg (1946, in Norway), Rowell (1967, in Canada), Brown & Seed (1976, in Strangford Lough) and Comely (1978, in Scotland). A characteristic feature of many populations is a bimodal size-frequency distribution (Seed & Brown, 1978) in which one mode is composed of variable numbers of young individuals under 30 mm in shell length, whilst the other, comprising the majority of the population, contains individuals over 60 mm in shell length, and often over 100 mm (Fig 2). Initial growth is quite rapid, young mussels growing from 5mm to 40 mm within about four years. Individuals that exceed this size become sexually mature, and thereafter the growth rate progressively declines, so that mussels of 90 mm shell length may be thirty years old, or even more, since growth ring analysis is unreliable with very slow growing shells.

This information can be interpreted in terms of the specie's reproduction and mortality. The onset of sexual maturity at about 40 mm coincides with the size at which the mussels are generally immune to attacks by crabs (*Cancer pagurus*) and starfish (mainly *Asterias rubens*) (Roberts, 1975). Predation of individuals smaller than this is heavy, but those that escape predation, and grow to sizes in excess of this threshold, generally survive for a considerable time thereafter, contributing to the larger of the two modes. They reproduce by means of a slow but continuous trickle of gametes into the water (Brown & Seed, 1976) that ensures a relatively continuous recruitment into the population. Settlement of young mussels is usually on the shells of older mussels, and it is likely that the hair-like extensions of the periostracum may attract settling spat (Comely, 1978). Later, however, they generally move down into the relative security of small crevices between the older mussels.

A number of conclusions may be derived from the available literature and data summarized above:-

a) The *Modiolus* community is one of the most diverse in the lough, and it has been identified as being of major importance to the lough's conservation interest.
b) The community is dependent on the survival of mature, long-lived mussels living together in closely knit clumps to provide a substrate for attachment of epifauna and protection for infauna.
c) The viability of the *Modiolus* population itself is dependent on slow but continuous recruitment provided by the present population, and on the physical structure of the community to provide secure sites for larval settlement and growth, so that some individuals at least, escape predation.
d) The main habitat requirement for the *Modiolus* population and its associated community is therefore the provision of undisturbed, relatively predictable conditions.

The fishery for Aequipecten opercularis

Extensive trawling for Queen Scallops is a relatively new development in Strangford Lough. Vickers (1977) reported that only 120 cwt (ca. 6000 Kg) were landed in 1976. In 1983 local attention was first drawn to increasing numbers of vessels coming into the lough to trawl for Queen Scallops, and since then the fishery appears to have developed in a largely unregulated manner, with boats frequently seen off-loading 30-40 cwt bags/boat (1 cwt = 50.4 Kg) after a single day's work. Recently, the daily landings appear to have declined to about 20 bags/boat.

There appears to be little data on the actual size of the fishery. National Trust staff have observed as many as twelve boats operating in the lough for periods of between one and three months, these boats having come from Northern Ireland fishing ports (Ardglass and Portavogie) and from Scotland and the Isle of Man. Fisheries Division acknowledge that this number have operated in the lough at times, but their statistics appear to be unreliable. In correspondence with the National Trust they considered that there was 'no significant effort' made in the fishery during 1988, whilst at the same time Trust staff were observing as many as eight vessels operating in the lough. Similarly, no *Aequipecten* were reported as being landed in Northern Ireland in 1984 and 1985 (Department of Agriculture reports, 1984 and 1985), but a number of vessels were known to have been operating in the lough at that time. It is possible that their catches may have been landed outside the Province, and therefore might not have been included in the N. Ireland Fisheries' statistics.

The fishery has mainly operated in the central portions of the lough (Fig 1) in a channel running between two lines of small islands and reefs. Occasionally there have been incursions into channels between some of the larger islands in the west of the lough. The area has been estimated by Fisheries Division to be about 7% of the total area of the lough, although it is not known how this figure was calculated. The Trust estimates that about 30% of the *Modiolus* areas have so far been subject to trawling or dredging, whilst the proportion of the unique *Modiolus/Chlamys* community subject to trawling may be as high as 40%.

The method of trawling employed is intended to catch Queen Scallops without bringing up excessive quantities of other benthic materials. As the trawl skims over the bottom, the Scallops are stimulated to swim upwards, to be caught in the net, leaving the other fauna intact below. In reality, however, the net drags along the bottom and sediments and non-commercial marine life are removed.

Opinions vary as to the amounts of non-commercial 'discard' (or by-catch) material involved, but it is clearly relevant in any assessment of the effects of the fishery on the *Modiolus* community. Fisheries Division have in the past firmly stated that the amount is relatively small because of the methods used. National Trust staff have, however, observed very large quantities of bottom sediments and benthic fauna being brought up in the nets. This latter view was eventually confirmed by a researcher from Fisheries Division who, at a meeting of the Institute of Fisheries Management in March 1988, acknowledged that large quantities of this material were brought up in trawls. In contrast with the concerns of the Trust, discussions with trawler crews indicate that they regard this as beneficial, since the 'cleaning up' of the sea bed greatly facilitates the fishing operation!

Once on board, the contents of the trawl are rapidly sorted. The Queen Scallops are stored in 1 cwt (50.4 Kg) bags and the remainder of the trawl thrown back into the sea during subsequent trawls, or on the return journey. No recording of discard materials by the crew has been seen to take place on the boats.

The Modiolus community after trawling

National Trust (RAB) and Ulster Museum (B Picton) staff examined a number of sites in the central areas of the lough in 1988, both within and outside the trawled areas (see Fig 1). Conditions were recorded by means of notes and species lists compiled during and immediately after the dives, by video sequences (F Bunker and J Woolford) and by 35 mm still photographs (B Picton). The results were compared with data from the N. Ireland Biological Data Base held in the Ulster Museum, primarily relating to survey work undertaken between 1975-1980. It must be stressed that for practical reasons the 1988 recording could not be as extensive as that of the earlier surveys, and therefore some species have probably been missed. Nonetheless, examination of the data revealed marked differences in the fauna of the different areas:

a) Untrawled areas: comparison with 1975-1980 data revealed that little change had occurred (Appendix Table 1a and 1b). The majority of the species recorded were found again in the 1988 dives, and over 80% of the sediments were covered by a dense matrix of *Modiolus/Chlamys* clumps with their associated epifauna (fig 3 - photo). In places these clumps had merged to form a firm mat-like structure overlying the surface of the sediments. In small channels between clumps, fine sediments held burrowing species like the holothurians *Thyone roscovita* and *Thyonidium commune*. Large numbers of

Aequipecten were present which were highly mobile, swimming for several metres when disturbed by the divers, and on occasions apparently in response to other stimuli.

b) Trawled areas: data from eight dives made in the period 1975-1980, before heavy trawling commenced, indicated a rich fauna comprising at least 44 species (Appendix Table 1c), usually dominated jointly by *Modiolus modiolus* and *Chlamys varia*. Many of the records specified that bivalves were particularly abundant on these sites. This data, and the species listed are largely consistent with those of the existing *Modiolus* communities in the untrawled areas. Indeed they also show strong similarities with results obtained by Dickie, collecting in the same area of the lough in 1857.

Dives conducted during 1988 revealed that marked changes had occurred (Fig 4 - photo, Appendix Table 1d). In most areas the entire *Modiolus* community was absent, and the fauna was impoverished (14 species recorded). Bottom sediments were mainly bare of epifauna (only about 5-10% cover by *Modiolus/ Chlamys* clumps), and being exposed revealed fine mud, small stones, and large quantities of dead shells and shell fragments. Some recolonization by ascidians (*Ascidiella aspersa* and *Corella paralellograma*) had occurred in a few places, mainly on broken *Modiolus* and *Chlamys* shells. A number of infaunal species were found, notably the holothurians referred to above, and the brittle star *Amphiura filiformis*. Their continuing presence is interpreted in terms of their burrowing lifestyle, and their ability to retreat below the sediment surface whilst the trawl passed over. In some places *Modiolus* clumps and patches remained, presumably having been missed by the trawl, but these rarely exceeded 1 m^2 in area. The fauna of these clumps was comparable to those of untrawled areas, and helps to confirm the nature of the original community. Although occasionally isolated living *Modiolus* individuals were found (over 60mm in shell length), there was no evidence of any recolonization of the damaged areas by *Modiolus* or *Chlamys*, and no juvenile *Modiolus* were found, although it is possible some may have been missed within the mesh of the few remaining mussel clumps. *Aequipecten* were present however, and since these were usually large adults and relatively mobile, it is considered that they had migrated in from the untrawled areas.

c) Transition zones: a number of dives were made to areas that were thought to be on or near the boundary between trawled and untrawled areas. In these zones much of the *Modiolus* community was found to be intact, but in a number of areas, patches of bare

Figure 3.
Untrawled area photographed in 1988. Note the dense cover by *Modiolus* community clumps and large quantity of epifauna (Photo - 13. Pieton).

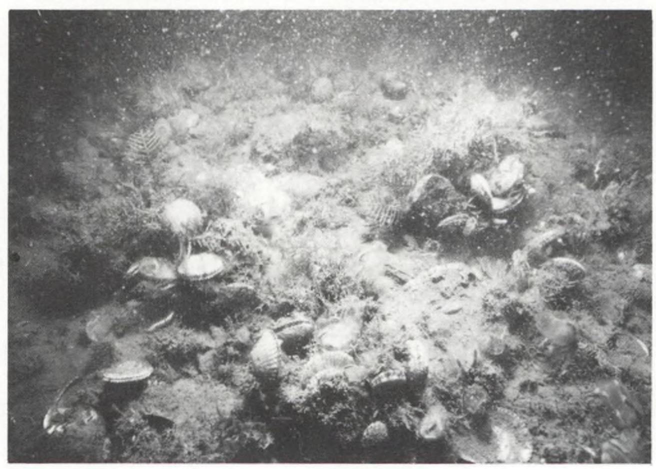


Figure 4.
Trawled area photographed in 1988. Apart from isolated individuals, sediments are bare of epifauna.

Correction:
Page 122 contains incorrect figure representations, please insert this page instead.

Aequipecten were present which were highly mobile, swimming for several metres when disturbed by the divers, and on occasions apparently in response to other stimuli.

b) Trawled areas: data from eight dives made in the period 1975-1980, before heavy trawling commenced, indicated a rich fauna comprising at least 44 species (Appendix Table 1c), usually dominated jointly by *Modiolus modiolus* and *Chlamys varia*. Many of the records specified that bivalves were particularly abundant on these sites. This data, and the species listed are largely consistent with those of the existing *Modiolus* communities in the untrawled areas. Indeed they also show strong similarities with results obtained by Dickie, collecting in the same area of the lough in 1857.

Dives conducted during 1988 revealed that marked changes had occurred (Fig 4 - photo, Appendix Table 1d). In most areas the entire *Modiolus* community was absent, and the fauna was impoverished (14 species recorded). Bottom sediments were mainly bare of epifauna (only about 5-10% cover by *Modiolus/ Chlamys* clumps), and being exposed revealed fine mud, small stones, and large quantities of dead shells and shell fragments. Some recolonization by ascidians (*Ascidiella aspersa* and *Corella paralellograma*) had occurred in a few places, mainly on broken *Modiolus* and *Chlamys* shells. A number of infaunal species were found, notably the holothurians referred to above, and the brittle star *Amphiura filiformis*. Their continuing presence is interpreted in terms of their burrowing lifestyle, and their ability to retreat below the sediment surface whilst the trawl passed over. In some places *Modiolus* clumps and patches remained, presumably having been missed by the trawl, but these rarely exceeded 1 m^2 in area. The fauna of these clumps was comparable to those of untrawled areas, and helps to confirm the nature of the original community. Although occasionally isolated living *Modiolus* individuals were found (over 60mm in shell length), there was no evidence of any recolonization of the damaged areas by *Modiolus* or *Chlamys*, and no juvenile *Modiolus* were found, although it is possible some may have been missed within the mesh of the few remaining mussel clumps. *Aequipecten* were present however, and since these were usually large adults and relatively mobile, it is considered that they had migrated in from the untrawled areas.

c) Transition zones: a number of dives were made to areas that were thought to be on or near the boundary between trawled and untrawled areas. In these zones much of the *Modiolus* community was found to be intact, but in a number of areas, patches of bare

Figure 3.
Untrawled area photographed in 1988. Note the dense cover by *Modiolus* community clumps and large quantity of epifauna (Photo - 13. Pieton).

Figure 4.
Trawled area photographed in 1988. Apart from isolated individuals, sediments are bare of epifauna.

sediment occurred. In spite of poor visibility and navigational difficulties underwater, those present during the dives agreed that in some cases these ran in approximately straight lines, whilst others did not, having a more patchy distribution. This has been interpreted as being indicative of intermittent trawling effort, where in some areas the trawl has run continuously along the bottom, whilst in others, possibly due to uneven terrain or sea conditions, the trawl had bounced along, lifting material intermittently.

The above results should only be regarded as a preliminary investigation. Clearly further research is required to determine the full extent of the changes that have occurred in the benthic communities of these areas. Nevertheless, it is the view of the National Trust, the Ulster Museum, and of the others who participated in the investigation, that major changes in the benthic communities of the central areas of the lough have occurred, to the considerable detriment of the *Modiolus* community. Furthermore, the Trust and the Museum consider that there is sufficient 'prima facie' evidence to link these changes with the onset of trawling for *Aequipecten opercularis* in the early 1980's.

The implications for the return of the damaged *Modiolus* community in the trawled areas are likely to be considerable. The literature summarised above has stressed the role of the population structure in the continuance of the community, and the importance of stable habitat conditions. Comely (1978) found that *Modiolus* less than 40 mm were seldom found away from the large animals. Loss of the original *Modiolus* community in most of the trawled areas has therefore severely reduced their attractiveness to settling *Modiolus* larvae, and those that do settle are unlikely to survive for long because of the lack of protection from predators normally obtained between the larger adults.

The poor ability of *Modiolus* to recolonize areas disrupted by fishing efforts has been documented by Wiborg (1946) who investigated the Norwegian *Modiolus* fishery (for long-line bait) which used small hand dredges and hand-operated grabs (stikkerts') in shallow water from small boats. Recovery after exploitation with this relatively small scale gear varied from between 12-15 years to much longer periods, and in some areas loss of the mussel beds was permanent. The type of equipment and larger boats used on the Strangford Lough *Modiolus* beds, and the extent of damage caused, may be expected to require a very long recovery period indeed, even assuming the trawling ceased.

Many species associated with the *Modiolus* community are likely to take a similarly long time to recover, particularly epifaunal species, and those dependent on the matrix of small cavities within the mussel clumps. Amongst the former may be included *Aequipecten*. These are dependent on other epifaunal species for settlement sites during spatfall (Brand, Paul, and Hoogesteger 1980, who also cited Eggleston 1962, and Soemodihardjo, 1974), in particular bryozoans and hydroids. Brand et al went on to state; 'it appears that both species (*Pecten maximus* and *Aequipecten opercularis*) will settle on a variety of organisms offering a clean, silt-free surface raised above the seabed...' Removal of the *Modiolus* community with its wide range of attached epifauna, leaving a bare surface or silt, stones and half buried shell debris, is therefore likely to be highly detrimental to the future of scallop settlement in the area, and therefore counter to the long term interests of a sustainable fishery.

Science and policies for management: in league or in conflict?

Apart from the recently obtained data described above, all the scientific information presented so far has been readily available to both Fisheries Division (D.O.A., Northern Ireland) and to Countryside & Wildlife Branch (D.O.E., Northern Ireland). It is available in the form of carefully reviewed publications in the literature, as reports commissioned by the Countryside & Wildlife Branch, and it is apparently available within the expertise of the field researchers of Fisheries Division. This available body of information may be summarised thus:-

a) Strangford Lough has a particularly rich marine life, the *Modiolus* community being one of its richest and most diverse communities, and probably unique, at least in a N. Ireland context.
b) It has been recommended that the entire bed of the lough be created a Marine Nature Reserve, and this view has been endorsed by the Minister for the Environment. (It may be inferred that the *Modiolus* community formed a key feature of these recommendations).
c. The *Modiolus* community remained largely unchanged between 1857 and 1980.
d) Trawling for *Aequipecten* entails the removal of large quantities of non-commercial benthic fauna. This occurs on a large proportion of the *Modiolus* beds.
e) After damage *Modiolus* beds are slow to recover, and this has adverse implications for the rich community of associated species, including those of commercial value, although *Aequipecten* may continue to migrate into the trawled zones from undamaged areas.
f) Damage to the *Modiolus* community would detrimentally affect the conservation interest of the lough, and those of the proposed Marine Nature Reserve. It would also pose a significant threat to the long term sustainability of the *Aequipecten* stocks.

Correspondence between the National Trust and Fisheries Division have revealed major differences in approach to monitoring of the trawling and its effects, and indeed to the basic biology of the benthic fauna and the proper management of the fishery. In initiating this correspondence in February 1988, the Trust expressed its concerns about trawling effects on the benthos and asked three questions:

a) What policy did Fisheries Division have for controlling damage to the bed of the lough and for maintaining sustainable natural populations?
b) What programmes had been established for monitoring the effects of the fishery?
c) What criteria were being applied to this monitoring?

Fisheries Division have not yet responded to any of these questions, but have commented that the areas of the lough subject to trawling are very small, and have been trawled and dredged since 1950. They have also stated; 'There is no evidence from catch data or discard information that the structure of the seabed and its associated communities are currently being degraded.' Their first letter on the subject concluded, 'If you have any data suggesting that the current level of fishing intensity in the lough is degrading the seabed and its associated communities we would be very interested to see them.'

This was the only item of information not already available from well established sources, and it has now been provided (by the National Trust, a voluntary, not governmental organisation) with strong evidence that since 1980 this particular fishery has caused considerable damage to the lough's marine life, and continues to do so.

A key feature of the Fisheries Division approach seems to be that fisheries in small areas are self-regulating. Over exploitation does not occur because fishing heavily reduced stocks is simply uneconomical, and therefore boats leave the area well before this situation is reached; 'Catch per unit effort data is particularly useful in small shellfish fisheries for ascertaining the health of the stocks. A fishery that is sustained over a number of years, as are these shellfish fisheries in Strangford Lough, is a good indication that neither the stocks nor the environment upon which they depend is being degraded'. This approach failed to prevent the earlier demise of the *Pecten maximus* fishery in the lough. However, from these responses, the Trust have concluded that no actual monitoring of the lough's benthic communities and their *Aequipecten* stocks is undertaken either on the benthos itself or through discard (by-catch) data from the boats, and this has recently been confirmed by officials from Fisheries Division. The Division's inference that conditions in the benthic communities have not changed, because the catch has not changed, is open to question not only because of the information provided in this paper (catches may already be starting to decline), but also because of the inaccuracies in their monitoring of fishing effort, and because of the ability of *Aequipecten* to migrate from natural communities into areas less derelict by the trawlers. The fact that 'catch per unit effort can only be sustained at economic levels for a short period each year' lends support to the latter consideration.

A number of points have emerged from the debate as it has progressed so far:-

a) Monitoring of the *Aequipecten* fishery in terms of catch data, has been wholly inadequate, and monitoring of the fishery's effects on the benthos non-existent, in spite of the conservation importance of the area and the dependance of *Aequipecten* on a viable epifauna.
b) Fisheries Division's responses appear to show a lack of awareness of the basic issues concerning the biology of benthic communities, and this may have implications for the discussions about the proposed Marine Nature Reserve.
c) The tone of the correspondence has suggested that it is the view of Fisheries Division that the National Trust should provide firm evidence that problems have occurred. The Trust has met this request but remains concerned:-
   (i) That a voluntary organisation should have to take on duties that are normally the responsibility of government, and in this case particularly that of Fisheries Division.
   (ii) That the attitude of Fisheries Division is in marked contrast to the precautionary principle (as adopted by the Council of Ministers at the 2nd Ministerial meeting on the North Sea in London in 1987), which states that operations likely to affect the quality of the sea or its marine life should not be undertaken without prior examination and evaluation of the likely effects (cf. Dethlefsen, 1986).
   (iii) That so little consideration be given to the particular requirements of an area of such high conservation interest that it is the subject of discussions between two government departments (Fisheries Division and Countryside & Wildlife Branch) concerning Marine Nature Reserve status.

A recent meeting between National Trust staff and officials from Fisheries Division and the Countryside & Wildlife Branch was held to discuss the differences in approach to the matter, and to review the evidence of the effects of trawling. As a result, both government departments have undertaken to conduct investigations in the coming summer. Countryside & Wildlife Branch have agreed to establish and survey transects across the trawled areas, and Fisheries Division have agreed to examine discard materials on the trawlers (by-catch). The Trust welcomes these undertakings. However, neither department has accepted that the concerns of the National Trust and the Ulster Museum are justified, and the trawling therefore still continues.

This paper has shown that information on the marine life of the lough, though by no means complete, is substantial, whilst the literature, reports, data and discussions concerning the *Modiolus* community are particularly extensive. Information on the *Aequipecten* fishery in the lough and its effects are apparently so sparse as to give the impression that the fishery has developed in a totally unregulated manner. Fisheries Division, in spite of requests and meetings, have still not given any indication of having a policy for either trawling, or dredging, in this internationally important area for marine life.

In all likelihood a viable co-ordination between scientific information and policy requirements could be developed for appropriate fisheries in the lough, having particular regard to the management requirements that stem from the unique conservation status of the lough. The problem is, there are no fisheries policies, and whilst the scientific information is available, it is not being applied.

Acknowledgements
This paper, and the research behind it, could not have been done without a great deal of co-operation from a large number of people. Particular thanks are due to B Picton, F Bunker and J. Woolford, who undertook the dive surveys, to Dr D Erwin and the Ulster Museum for the provision of data from the earlier surveys, and for extremely useful discussions. Thanks are due to the Strangford Lough Committee under the Chairmanship of Mr D Browne and the Wildlife Panel under the Chairmanship of Dr P J S Boaden for their encouragement, discussions and support. The work of the Wildlife Scheme is funded by the Countryside & Wildlife Branch of the D.O.E., Northern Ireland, and the diving and video work was funded by the World Wide Fund for Nature. Finally, gratitude is due to the National Trust Wardens, D Andrews and E Rainey, who ably took charge of the boating arrangements.

		A	B	C	D
Porifera	Tethy aurantium	x	x		
	Suberites carnesus	x			
	Suberites domuncula	x	x		
	Halichondria bowerbanke	x			
	Mycale macilenta	x	x		
	Myxilla fimbriata	x			
	Myxilla rosacea	x			
	Myxilla incrustans			x	
	Spaniopion armaturum	x	x		
	Hemimycal columella	x	x		
	Haliclona sp.	x			
	Haliclona fistulosa	x			
	Haliclona viscosa	x			
	Amphilectus fucorum	x	x	x	
	Dysidea fragilis	x	x		
	Aplysilla rosea	x			
	Clione cellata	x	x		
Cnidaria	Sagartia elegans			x	
	Hydrallmania falcata		x		
	Ceriantuhus lloydii			x	
	Alcynium digitatum	x	x	x	
	Kirchenpaueria pinnata	x	x	x	
	Nemertesia ramosa	x	x	x	
	Nemertesia abietina		x		
	Abietinaria filicula	x			
	Sertularella polyzonias		x		
	Sertularia argentea	x			
	Halecium halecinum		x	x	
Annelida	Myxicola infundibulum			x	
	Sabella pavonia	x	x	x	
	Amphitrite sp.	x	x	x	
	Harmothoe extenuata	x			
	Branchiomma bombyx	x	x		
Crustacea	Balanus balanus	x	x		
	Paragurus bernhardus	x	x	x	x
	Inarchus dorsettensis	x	x	x	
	Macropodia rostrata	x	x	x	
	Hyas areneus		x	x	
	Hyas coarcatatus	x		x	
	Liocarcinus depurator	x	x	x	x
	Carcinus maenas	x	x	x	x
	Cancer pagurus	x	x		
	Galathea intermedia			x	
	Munida rugosa			x	
	Perrierela audouniana	x			
	Tritaeta gibbosa	x			

		A	B	C	D
Mollusca	Buccinum undatum	x	x	x	x
	Leptochiton asellus	x			
	Emarginula sp.	x			
	Gibbuia cineraria		x		
	Calliostoma zizyphimum	x	x	x	x
	Dato dunnei	x			
	Dota coronata			x	
	Modiolus modiolus	x	x	x	x
	Astaire sulcata			x	
	Paphia rhomboides	x	x	x	
	Chlamys varia	x	x	x	
	Aequipecten opercularis	x	x	x	x
	Parvicardium ovale			x	
	Eubranchus tricolor	x	x	x	
	Nucula nucleus	x			
	Abra sp.,	x			
	Hiatella arctica	x			
	Cadlina laevis				
Bryozoa	Alcyonidium diaphanum	x	x		
	Cellepora pumicosa	x	x		
	Snupocellaria sp.		x		
	Bugula sp.	x			
Echino-dermata	Antedon birida	x	x	x	
	Ophiothrix fragilis	x	x	x	
	Ophiocomina nigra	x	x	x	
	Amphiura filiformis				x
	Asterias rubens	x		x	x
	Henricia oculata	x	x	x	
	Leptasterias mulleri	x			
	Crossaster papposus	x	x	x	
	Echinus esculentus	x	x	x	x
	Psammechinus miliaris			x	
	Paracucumaris hyndman	x			
	Thyone poscovia	x	x		
	Thyone rusus	x	x	x	x
	Thyonidium commune	x	x	x	x
	Labidoplax sp.	x			
Tunicata	Dendrodoa grossularia	x	x		
	Corella parellelograma	x	x	x	x
	Clavelina lepadiformis	x		x	
	Ascidiella aspersa	x	x	x	x
	Ascidiella scabra			x	
	Boltenia echinata	x			
	Pyura microcosmus	x	x		
	Polycarpa rustica			x	

Tabel 1 Species recorded by the Ulster Museum Sublittoral Survey of Strangford Lough 1975-1980 (data held on N. Ireland Biological databas) and the National Trust co-ordinated dives of 1988.

A 3 sites - Species recorded by the Ulster Museum (pre 1980) in sites that subsequently remained untrawled.
B 3 sites - Species recorded by the National Trust 1988 dives on untrawled sites.
C 3 sites - Species recorded by the Ulster Museum (pre 1980) on sites that were subsequently trawled.
D 3 sites - Species recorded by the National Trust 1988 dives on trawled sites (data excludes species found in remnant Modiolus clumps).

References

Boaden, P.J.S., 1984. Strangford Lough - a conservation history.
In: Jeffrey, D.W. (Ed). Nature Conservation in Ireland, Progress and problems. pp 57-66. Royal Irish Academy, Dublin.

Bowerbank, J.S., 1886. A monograph of the British Spongidae. Ray Society, London.

Brand, A.R., Paul, J.D., Hoogesteger, J.N., 1980. Spat settlement of the Scallops *Chlamys opercularis* (L.) and *Pecten maximus* (L.) on artificial collectors. Journal of Marine Biological Association, UK. 60: 379-390.

Brown, R.A. and Seed, R., 1976. *Modiolus modiolus* (L.) - an autecological study. Biology of Benthic Organisms. 11th European Symposium on Marine Biology, ed. B.F. Keegan, P. O'Ceidigh, P.J.S. Boaden. Pergamon Press. pp 93-100.

Comely, C.A., 1978. *Modiolus modiolus* (L.) from the Scottish West Coast. 1. Biology. Ophelia, 17(2): 167-193

Department of Agriculture, N.I. Reports on Sea and Inland Fisheries of N. Ireland, 1935-1987.

Dethlefsen, V., 1986. Marine pollution mismanagement: towards the precautionary concept. Marine Pollution Bulletin, 17(2):54-57.

Dickie, G., 1857. Report on the Marine Zoology of Strangford Lough, County Down, and corresponding part of the Irish Channel. Report to the British Association for the Advancement of Science, 104-112.

Eggleston, D., 1962. Spat of the Scallop (*Pecten maximus* L.) from off Port Erin, Isle of Man. Report of the Marine/ Biological Station, Port Erin. No 74: 29-32.

Erwin, D.G., 1977. A diving survey of Strangford Lough, the Benthic Communities and their relation to substrate. Biology of Benthic Organisms. 11th Symposium on Marine Biology, ed. B.F. Keegan, P. O'Ceidigh, P.J.S. Boaden. Pergamon Press 215-224.

Erwin, D.G., Picton,B.E., Connor, D.W., Howson, C.M., Gilleece, P., Bogues, M.J., 1986. The Northern Ireland Sublittoral Survey Report by Ulster Museum, Belfast.

Gubbay, S., 1988. Coastal Directory for Marine Nature Conservation. Marine Conservation Society, 319 pp.

Roberts, C.D., 1975. Investigations into a *Modiolus modiolus* (L.), Mollusca: Bivalvia community in Strangford Lough, N. Ireland. Reports to the Underwater Association. 1. (N.S.) 27-49

Rowell, T.W., 1967. Some aspects of the ecology, growth and reproduction of the Horse Mussel *Modiolus modiolus* Ph. D. Thesis, unpublished. Queen's University, Ontario, Canada.

Seed, R., and Brown, R.A., 1978. Growth as a strategy of survival in two marine bivalves, *Cerastoderma edule* and *Modiolus modiolus*.
Journal of Animal Ecology. 47:: 283-292.

Soemodihardjo, S., 1974. Aspects of the Biology of *Chlamys opercularis* (L.) (Bivalvia) with comparative notes on four allied species. Ph.D. Thesis, University of Liverpool.

Strangford Lough Working Group, 1978. Report to the Department of the Environment, Conservation Branch. 16 pp.

Thorson, G., 1971. Life in the Sea. 256 pp. World University Press.

Vickers, K.U., 1977. Strangford Lough Fisheries. Submission to the Strangford Lough Working Group. 1 p.

Wiborg, K.F., 1946. Undersøkelser over oskjellet (*Modiolus modiolus* L.). Alminnelig biologi, vekst og økonomisk betydning. Fiskeridirektoratets Skrifter VIII No 5.

Williams, G., 1954. Fauna of Strangford Lough and Neighbouring Coasts. Proceedings of the Royal Irish Academy. 56 B (3): 29-133.

Discussion

Rapporteur:
Anke van Spaendonk,
Delta Institute for Hydrobiology

Chairman: Mr van der Meer
Members of panel:
Dr Earll, Mr Holden, Prof. McGlade, Mr Munkejord,

Mr Wellershaus (North Sea Action conference, Bremen) opens the discussion by stating that it is difficult for scientists to present their results according to the requirements of policy-makers. Politicians are not dependent on science, but on politics, on power-play. Scientists who are concerned have to play an active role in policy and become political. He would like a comment on this statement from mrs McGlade en mr Holden.
Ms McGlade disagrees. Scientists have an independent status which is their strength. The active role has to be played, not by the scientists, but by the NGOs. It is their duty to make the large public aware of the situation. She agrees that scientists present their results often in an inaccessible way but states that good science can always be explained by easy simple language.
Mr Holden agrees with mrs McGlade. If scientists become political they betray the scientific ethic and no notice will be taken of what they are saying; even NGOs are already running that risk. Although scientists must remain independent, they have an educational role. Politicians should be taught how to evaluate scientific information, and how to take action in an area of uncertainty.

Mr Kooiman (Public administration and policy making, Erasmus University Rotterdam) adresses mr Holden. In his opinion there has to be interaction between fields of sciences and policy; the definition of the common problem is left open.
He also refers to the problem of simplicity. Civil servants have an interactive role between policy and science. Public administrators should not aim at simplifying, but at indicating the relevance, as politicians need relevant information. Civil servants have an important role as communicators between the scientific en political world.
Mr Holden agrees with such role of communicator for civil servants. In general public administrators do not remain in their post long enough to become good transmitters of information. Probably their key role is to facilitate the access of the scientist to the politician.
Mr van der Meer wishes to comment on mr Kooiman's question. In his view, the research world is far too fragmented. The disciplines involved in a particular problem have to be integrated. For a real achievement, the whole research field has to be reorganised, and maybe in the end also the whole political decision making machine. In the actual situation it is difficult for policy makers to present a proper and balanced solution, because they can not overview the entire field, which can result in frustrations about certain decisions.

Mr Roos (secretary of the Fishery Centre for the Dutch fishing industry) wonders why in the preceding lectures and discussions the executors, the fishing industry, are left out. His experience in the last years is, that policy is unlikely to be successful, if there is no direct communication between scientists and the fishing industry. He would like a reaction of the forum members.
Mr Holden agrees, but indicates a problem. The fishing industry is a very fragmentated industry. When trying to solve this by installing a consultative committee with representatives of the fishing industry the interests of the representatives are so much in conflict that no agreed objectives are formulated. In order to overcome this particular problem the fishing industry should try and put its own house in order and draw up a common plan of campaign of the joint fishing industry of all the coastal states.
Mr Earll (Marine Conservation Society) argues that the fisherman's independence is a major block to effective communication. He also states that the fisherman's interests should be incorporated far more effectively into the olicy processes. The system of communication should have a high level of compliance.
Mr Munkejord adds that confidence and trust between the scientific world and the fishing industry is important. In the Norwegian Board of Regulation the government, the scientists and a delegation of the fishing industry are participants. This board decides upon regulation measures to be adopted in Norway. He recommends to organise the communication and cooperation between the fishermen, the scientific authorities, and the administrative authorities.

According to ms McGLADE it is possible to join representatives of the fishing industry in a union, which tends to result in redirected mistrust as the representatives become suspect. Besides, each meeting conflicts with the fishermen's objective to earn money by fishing. She stresses the need to impose regimes under which people, in particular the fishermen, are willing to cooperate on a long term incentive.

Ms Dubsky (Coast Watch Europe) wonders about the role of the scientists in interaction. Scientists have the moral duty to give raw data to the NGOs, and to inform the public in an early state. Their responsibility does not end by informing the government so that they can go back to their cocoon.
Ms McGLADE replies that scientists have to remain independent, otherwise they become open to manipulation. Money should be put into this argument at NGO level, because they have the potential to pressure the government. In an early phase scientists have to make a considered and relevant interim statement, but scientists should not become alarmists.
Ms Dubsky points out that the NGOs do not have the methods to receive information from scientists. In mrs McGlade's opinion NGOs have to act as pressure groups to make the government aware of their responsibility to provide information. She stresses the need for a fundamental discussion at the point at which people get access to data.
Mr Bannink (Rijkswaterstaat the Netherlands) raises the problem of the nature of the observations involved in issues such as discussed here. Observations by scientists make scientific sense, observations by

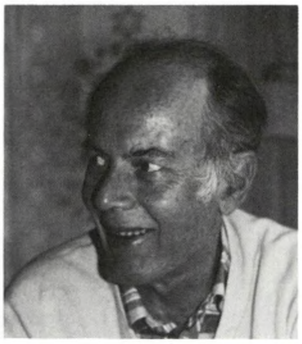
politicians make political sense. We all observe that the sea gets more and more empty and that ecosystems are changing. It is common sense knowledge. When people only aim at their primary aims in their actions their considerations are very narrow. He hopes that scientists will provide information based on common sense and that the policy of the administrators does make sense.

Mr Holden does not think that the majority use common sense, whether fishermen, administrators or politicians, we all look at our immediate, short term objectives. He argues that there is no such thing as simple common sense and that common sense on the short term and on the long term may be conflicting. Decisions are made on the basis of a large number of factors.
Mr EARL mentions that politicians and scientists, humans as they are, represent a spectrum of views; expecting scientists to be more perfect is expecting too much.

Ms Stefels would like to return to the role of scientists in politics. She thinks it misleading to call scientists independent. The impact of scientific information can not be improved by a better communication between scientists and NGOs only. Scientist should also do the necessary research. Until now research is founded by institutes or government who have a particular interest in the work done. Scientists should be persuaded to do more independent research. She asks for a reaction from mr. Holden and ms McGlade.
Mr Holden agrees with the statement. The environment in which scientists work dictates the direction of their research. Clearly, there is a limit to the amount of money. Inevitably there has to be direction in science. In the U.K. the government research institutes and organizations do not attempt to hide the results. Results are openly published and free for everybody to see.
Ms Stefels will not challenge what mr Holden is saying. She states that research should be performed out of scientific curiosity and not be directed by what the fishing industry or the government wants.
Mr Holden replies to this by saying that at universities and other institutes research is performed which is totally free of governmental pressure, notwithstanding the dependency on government resources. They cover the field out of free curiosity.
Ms McGlade states that scientists who work in governmental institutions are equipped to do research on what their policy machinery ask them to do. Although the results are free, no appreciation of an independent witness is available.
Mr Earll wants to add that there are major political differences between the handling of scientific data and the collecting and dissemination of the information, depending on the issues.

Session IIC

Policies for Offshore Activities



Chairman
Dr Lange

Norwegian Offshore Environmental Policies. Integration with Science.

Mr J. H. Koefoed
Head of division Oil Pollution Control Department
State Pollution Control Authority, Norway

The offshore oil and gas industry is a 'new' industry in Norway. Offshore drilling for oil and gas first started in 1966, and production started in 1971 (Ekofisk). As with all new industries, the environmental aspects of this industry were not fully recognized in the beginning. The possibilities of harmful discharges and negative consequences were discussed, but not until after the blow-out in 1977 on the Bravo-platform at Ekofisk, did the environmental aspects receive proper recognition. This accident focused the attention on the environmental costs of this particular industry.

As a direct follow-up of this accident the scientific community stressed the need for scientific participation in the decision-making processes; a research-programme on the effects of oil in the marine environment was established.

The offshore industry is relatively well controlled as to the scientific aspects of its effects on the environment as compared to land-based industry. This is both because it is such recent development and because international control mechanisms came in at an early stage.

Science plays an important part in several ways in managing the environmental aspects of the offshore industry. In all stages of today's management of offshore industry, from opening up of new offshore areas, through exploration and to exploitation, scientists and scientific institutions are involved, both by law (through the regulatory process), through industry (as consultants) and through other interests (fishery, wildlife, Non Governmental Organizations (NGOs)).

In Norway the offshore industry is controlled by several laws and

Introduction

Before going into detail on offshore environmental policy questions a short introduction into the history of the Norwegian Offshore Industries will be useful (OED, 1987).

Norway proclaimed sovereignty over her continental shelf with regard to exploration and development of mineral resources on May 31, 1963. This gives a total time span for the development of a Norwegian offshore oil and gas industry of less than 30 years.

Preliminary surveys were permitted in 1963 and the first round of licensing was announced April 13, 1965.

The first (dry) exploration well was drilled in 1966.

The first oil fields were discovered and proven of considerable interest in the period 1968-1971.

The first oil field came on stream in 1971 (EKOFISK). Later the surrounding fields in that area were connected to the 'Ekofisk Centre'.

During the 70s and the 80s the oil exploration and exploitation activity has spread along the Norwegian continental shelf.

Several fields are by now (and after parliamentary approval) under development.

North of the North Sea (north of 62 degrees north), the activity started in 1980. Fifty-six wells have so far been drilled between 62 and 70 degrees north (for exploration purposes). The Norwegian government has recently decided to open up the southern part of the Barents Sea for petroleum activities and other Norwegian offshore areas are currently under discussion.

According to our Ministry for Oil and Energy, most of the

regulations. The most important regulatory framework in this context is The Norwegian 'Pollution Control Act'. Offshore activities are regulated by this law through the general provisions of the law, and because discharge-permits are necessary for all activities leading to discharges for any length of time.
For the time being three aspects are of prime concern: the opening up of new areas on the Norwegian continental shelf for petroleum activities, the discharges of drilling cuttings contaminated with oil based muds, and the discharges of chemicals in connection with drilling and exploitation. Both pollution and conflicts with other legitimate uses of the sea are regarded as primary issues in the environmental regulation of the Norwegian offshore industry.

With free access to money I would have established an ongoing education and research programme for graduate and post-graduate students, educating scientists and bureaucrats by giving them the opportunity to study offshore matters in depth. In this way we would have been in the forefront of the industry. The students should have been environmentalists, geologists and chemists, as well as engineers, who together would be able to review all aspects of offshore industry, identifying problems at the earliest possible stage, so that the Precautionary Principle could be applied with more force.

The conclusion I can see: possibilities for better integration of science in policy-making than there is at present. In Norway this is generally followed up by active participation, for example, in the work carried out by the North Sea Task Force. More specifically major research-programmes on the effects of the oil industry

discovered resources of oil will be under development by the end of the century. If no new oil fields are discovered, the activity of the offshore industry will slow down by the year 2000, even though production etc. will take place for another 100 years.

The Context
As a starting point for this paper, the basic paper and some questions raised by the organizers of this seminar have been used. Let me to clarify which environmental conflicts we are dealing with by giving a brief version of the problem:

1) Catastrophical and other acute discharges:
During exploration and exploitation there are several incidents which may lead to accidental discharges. The best known is the Blow-Out situation which involves massive discharges of oil or gas (Examples from the North Sea are the Ekofisk blow out, the Piper Alpha accident, etc.). Other such massive discharges can result from rupturing tanks (storing tanks etc), from accidents during shipping, or from ruptured pipelines. Less well known and appreciated are the relatively minor acute discharges which occur as a result of incidents caused by malfunctioning equipment or unsafe working procedures.

The most conspicuous accidental discharge of oil on the Norwegian continental shelf was the Ekofisk blow out (22.4-1977, at the Ekofisk Bravo platform). Since then no oil blow outs have occurred on the Norwegian shelf.

2) Discharges as a consequence of drilling/production.
During normal operations discharges to the environment also occur. During drilling operations, cuttings and associated drilling chemicals (water based or oil based muds), are discharged. Moreover drainage water from the platform itself, from cleaning operations etc., and contaminated water from the engine-room area, is discharged. During production, water is produced in association with the oil. This so called produced water is separated from the oil in adequate facilities on the platform and discharged into the sea. Also (on platforms loading ships) there is displacement-water which is discharged during periods when the production is directed to the on-board oil tanks.

There are a great number of production chemicals used offshore, which are also in varying degree discharged into the sea.

In addition to discharges into the sea, dangerous wastes are also produced on the platforms which would be discharged into the sea but for the regulations.

There are also discharges into the air from the offshore

have been carried out in the marine environment, concentrating for the time being on the arctic environment.

A further concluding remark is that the future should be different. All parties involved should take the responsibility of managing the environmental problems caused by their activity more seriously. In the future, agencies like mine should revise the policies of industry and the energy authorities rather than regulate the industry directly. The industry should be educated to regard environmentally based costs as production costs, not as a kind of governmentally imposed burden. Science should in that framework give independent advice to industry as well as to the government.

industry, because of flaring operations (NO_x, SO_2, probably VOC) in connection with the incineration of wastes, and in connection with the fire-fighting equipment, air-conditioning, food-storage etc. (CFCs, Halons).

The Norwegian industry is subject to the provisions of The Norwegian Pollution Control Act, under governmental environmental control. This also holds for the offshore industry.

In addition to national laws and regulations the offshore industry is under international consideration, especially in the context of the Paris Convention (concerning discharges from land based sources covering the North East Atlantic). Under this convention there is a Group of experts on Oil Pollution (GOP) which on a yearly basis discusses (amongst other questions) the environmental aspects of the offshore oil and gas industry.

The most important questions discussed in GOP regarding the offshore industry are at present: Discharges of oil contaminated cuttings, and international controls over offshore discharges of chemicals. The environmental aspects of the offshore industry is also discussed in the context of the Ministerial Conferences for the Protection of the North Sea, which will next be held in the Netherlands in the coming year.

Currently the questions related to opening up of new offshore areas for exploration and exploitation are heavily debated in Norway. This was recently actualized by the Exxon Valdez accident and the obvious problems of combatting oil spills in Arctic conditions.

The discharges of oil based muds, and the discharges of chemicals offshore are also matters of concern. The discharges of oil based muds are at present, subject to national and international control, only allowed from the lower parts of the wells, and only when the concentration of base oil on cuttings is less than 100 grammes of oil per kilogramme of dry cutting.

The Use of Science in the Management of the Offshore Industry with Reference to Norway

The 1977 blow-out on the Ekofisk field was a major trigger for increased scientific interest in the environmental effects of the growing oil industry.

After 1977 the scientific community together with the government identified a growing demand for research in this field, and for the education of competent environmental scientists. This resulted in the research programme: The Norwegian Marine Pollution Research and Monitoring Programme (FOH), studying the fate of oil and its effects in the sea.

The role of science in the environmental management of the offshore industry is an integrated part of the management system. As an example, the interfaces between policy-makers and science will be described for an imaginary oil field situated in an as yet un-opened area of the Norwegian shelf.

* Before a 'new area' is opened for offshore oil and gas exploration, the Norwegian ministry for Oil and Energy, according to The Act on Petroleum Activities has to perform an Environmental Impact Assessment. This analysis is supervised by an interdepartmental steering committee. The analysis must include detailed studies of the possible negative effects of offshore activities on the environment, and 'for other legitimate uses of the sea', as well as socio-economic aspects of the activity. The end-product is scrutinized by competent central and local authorities, environmental groups, other interest groups, scientists and industry etc.

* If the Environmental Impact Assessment has shortcomings which affect our ability to decide on conditions for discharge permits or oil spill contingency demands, we can demand further analyses on the grounds of the Norwegian Pollution Act. These analyses will usually be demanded from the appointed operator In those cases the operator shall choose expertise which can be regarded as independent of the operator.

* Before exploitation starts at a specific site, the operator must develop and bring into action a monitoring programme for the area, currently in accordance with the agreed Paris Commission Guidelines (Paris commission (1988)), specifying that the monitoring shall be carried out by independent expertise (universities or scientific consultants). The monitoring shall be performed throughout the lifetime of the oil field and has a base line investigation as a 'starter'. In this connection the following throws further light on the question on using science in policy-making:

A recent example of the use of science in the environmental management of the offshore industry is the history of the discussions of the effects of oil based muds around the platforms. Those discharges are under strict control as mentioned. The environment around the discharge points are monitored regularly. The monitoring results for 1986 showed increased changes in the benthic communities, especially around one field.

These effects were causally linked to possible effects of the oil based muds discharged in that area. After publication of those data, the oil companies have queried the interpretation, assisted by other scientists than those involved in the interpretation of the data.

There have been extensive scientific debates around the effects of oil based muds in the vicinity of the platforms. The scientific community has sometimes been on the government's side and sometimes on the industry's side. This debate is still continuing and points out many interesting basic questions in connection with the use of science in policy-making, and the relations between scientists, policy-makers, and industry. In our opinion the effects observed around platforms discharging oil based muds (as expressed in the results of the monitoring programmes carried out by the operators, and interpreted by scientists), should point to a policy change regarding those discharges. It is our further view that this is a very good example on how to use scientific data for management purposes.
(See for reference: Reiersen et al (1989) and the discussion in Marine Pollution Bulletin (Gray (1988), Engelhardt & Gray (1989) and Gray (1989))

* Before exploitation starts, the operator must also obtain a discharge permit. In the application, all planned discharges must be described. The scientific community (or a part of it) will have the opportunity to comment on the planned discharges.

* During exploitation, and if new drilling muds are introduced regardless of the nature of the operation, the operator must have special permits to discharge those substances. Such permits are granted by the State Pollution Control Authority, when appropriate information is submitted, either by the operator if adequate data exists, or through our toxicity-test system if adequate information does not exist.

* As for chemicals, the main discharge permit does not cover details of those discharges. This is because in the early stages the industry is not able to decide in any detail which chemicals are going to be used. At present all planned chemical discharges are therefore treated separately as soon as the operators know which chemicals they will use. The interface with science in this aspect is mostly on the data quality side, and in some cases on toxicity testing.

* If a blow-out or another incident leads to a major discharge of oil, the scientific community will be asked to form task-forces to register damage and to give advice on the clean up operations, use of dispersants etc. At present no permanent task force is set up.

In conclusion this shows that science is integrated in the day to day management of the offshore industry.

Fields for Improvements

There are fields for possible improvement regarding the relation between science and the government according to the author.

1) When we are asking questions which we want the scientific community to answer, we must improve our way of formulating those questions in such a way that scientists can answer them with minimum uncertainty.

This means that we, the civil service, need trained scientist within our ranks, or that our staff should be trained to communicate with scientists in the best possible way.

2) As mentioned in the basic paper for this seminar the offshore industry is treated individually, in bits and pieces. This is also the case regarding scientific advice. We need a more integrated approach regarding the effect of the offshore industry on the marine environment. How this should be achieved is at present an unresolved question.

With more Resources...

The authors were asked to give their view on how to improve the situation if a certain sum of money were made available (10 million Dutch guilders).

With that amount of money an ongoing research programme could be established in cooperation with universities and research institutions, educating post-graduate students in environmental aspects of the offshore industry, and opening up communication and an exchange of personnel between ourselves and the programme. This programme could then provide government and industry with skilled personnel capable of treating the environmental questions skillfully. Such a programme should be open and multidisciplinary in its approach, integrating natural sciences and engineers.

The programme should be headed by an advisory board from both government and science, in order to identify new problems at the earliest possible stage, and direct the research programme in the best possible way. This advisory board could also advise the government in questions related to pollution from the offshore industry.

The programme should be conducted in close coordination with the ongoing activities in the North Sea Task Force.

Improvements in the Near Future

Internationally and broadly speaking there are some possible improvements under way. The 2. Ministerial Conference for the Protection of the North Sea (London 1987) called amongst other things for greater scientific knowledge and understanding of the North Sea environment, and the establishment of a North Sea Task Force. This group was assigned several tasks, resulting from the preparation of the Quality Synthesis Report (a report by the scientific and technical working group preparing the conference). Its most important task is to prepare quality status reports in which scientists are asked to give their view on how to improve the North Sea environment.

The Task Force is organized as a joint group by ICES (The international council for the exploration of the sea) and the Oslo and Paris Commission (The secretariat of the regional conventions for the north east Atlantic covering land-based discharges and dumping).

The members of the Task Force are senior scientists and policy-makers able to direct their countries resources towards the most important interests of the Task Force, thus enabling the international scientific and policy-making society to have access to the enhanced scientific knowledge and understanding asked for in the London declaration.

If the national delegations to the Task Force are carefully put together, they in themselves are interesting forums for exchange of ideas between science and policy-making at a national level.

The Task Force model is not directly applicable to the management of the offshore industry, but will, through the Paris Commission Expert Group (GOP), raise questions about the overall effects of the offshore industry.

Summing up:

In summing up, I dare say that the management of the environmental aspects of the North Sea offshore industry and its connection with science generally speaking, and speaking for Norway in particular, is not bad. There is scientific input at all levels of the decision-making process. Both national and international bodies concerned underline the importance of a scientifically based management of these complex questions.

Having said this, room for improvement does exist. Both Government and (presumably) Science can improve communication.

By allocating more time to cooperation we could probably integrate science better into the policy-making process.

The Future

As a further concluding remark, taking into account the conclusions from the World Commission on Environment and Development, I must say that the future could be different. All parties involved should gradually take more environmental responsibility. The costs of running an environmentally safe industry would then be seen as a part of the production costs, rather than just an administrative burden.

Our role as policy-makers in that scenario should be to revise the environmental policy concerning the offshore industry, on the basis of scientific and technical information made available both by science and industry. These revisions could have detailed effect on the operating companies' policy to ensure that the environment is adequately taken care of.

The scientific community in that scenario ideally plays an independent advisory role. The communication between science and policy-makers could be taken care of by ongoing policy discussions at national and international levels.

The resources needed in this scenario will partly be provided by the general funding of research by government, partly through the environmental authorities' budgets. Furthermore, the industry will provide funding for monitoring, toxicity testing etc.

It is essential, now as it will be in the future, to keep scientific advice independent from industrial and political interests. In the same context it will also be necessary to choose the best available advise from the different answers usually presented by scientists to each question raised by us.

This can and must be provided by the education of scientists, by strong and independent non governmental organizations (NGOs) and by an educated and concerned society.

References

Reiersen et al (1989), Monitoring in the marine environment of oil and gas platforms; results from the Norwegian sector of the North Sea and recommended methods for forthcoming surveillance. In 1988 International Conference on drilling wastes. F. R. Engelhardt et al. (eds.) Elsevier Applied Science Publishers ltd, Amsterdam.

and the following discussion in Marine Pollution Bulletin, by:
Gray, J. S. 1988 in Marine Pollution Bulletin 1988: 19(11)
and
F. R. Engelhardt & J.S. Gray and J. S. Gray alone in Marine Pollution Bulletin 1989: 20(1).Discussion

Discussion

Mr Lankester asks whether an environmental impact analysis (EIA) is performed in such way that constructions can be re-designed according to environmental requirements, or whether the EIA only examines the effect of the existing design on the environment.
Mr Koefoed answers that the area is studied before activities are started without knowing the working gear. Floating rigs sometimes used at the exploration site differ from the working rig. The EIA report has no obligatory implication for the design, it is left to industry to use this or former EIA's when designing new platforms.

Defining environmental politics for offshore activities - A review from science

Martin Scholten, Henk van het Groenewoud and Tim Bowmer
TNO-Laboratory for Applied Marine Research,
The Netherlands

The offshore exploration of gas and oil wells in the North Sea has resulted in an extended network of drilling and production platforms. The implementation of waste treatment technologies can reduce the release of contaminants, but there is still some loss of oil compounds from the rigs into the marine environment.
The Dutch State Supervision of Mines (Min. of Economic Affairs) estimated that approximately 30,000 tons of oil (about one-third of the total North Sea oil pollution load) is released from oil rigs each year. About 95% of this amount is related to discharges of oil-based muds from drilling platforms. The remainder is due to discharges of formation water from production platforms.

Marine scientists from all North Sea countries have been involved in environmental monitoring studies, to determine the (chemical) distribution of the discharged oil and the (biological) consequences for marine life. The scientific information of these field studies are reviewed in the presentation. There is good general agreement between the results of various programs. In the immediate vicinity of drilling locations strong biological effects have been observed, whereas some perturbations of the benthic community are generally found up to a distance of 1 km from the drilling site, depending on local hydrographic conditions. However, the interpretation of these scientific findings is still a point of debate.

Scientists should prevent inappropriate generalizations being made from single observations. Because marine conditions are spatially variable, consideration of specific conditions at each drilling location is essential. Scientists need the opportunity to gather reliable data in order to produce a well considered and unbiased

1 The current scale of North Sea offshore activities

Exploitation of gas and oil on the continental shelf (CS) of the North Sea started in the early 1960s and early 1970s, respectively. Oil production is concentrated in the East Shetland Basin in waters of up to 200 m deep, in the UK, Norwegian and Danish sector of the CS. Gas production on the other hand, is concentrated in the Southern Bight of the North Sea, in depths of less than 50 m, primarily in the UK and Dutch sectors of the CS.

U.K.	92 platforms
Netherlands	36 platforms
Norway	14 platforms
Denmark	6 platforms
F.R.G.	1 platform

About 8.000 km of pipelines have been laid in the North Sea for transportation of oil and gas to onshore processing installations. To date, a total of 75 billion US dollars has been invested and some 50,000 people earn a direct living from the offshore industry. About 30% of the energy demand of the North Sea countries can be met by its own oil and gas production, but as yet only 20% of the estimated, recoverable reserves of the North Sea have been exploited.

The operation of such a large offshore industry requires a high technological effort in terms of safety and environmental control. The North Sea offshore industry has assumed a leading role in applying advanced technological developments in this respect. Although the offshore industry has significantly reduced the release of contaminants in this way, there are still some inputs of oil and other chemicals from the platforms into the marine environment, as a result of both accidental and operational discharges.

In the light of the principle of precautionary action, agreed in the ministerial declaration arising from the

assessment of the environmental impacts of various offshore activities, based upon sufficient field studies. Monitoring should be aimed at evaluating whether applied waste treatment techniques actually reduce environmental impacts to an acceptable level, rather than simply demonstrating environmental effects regardless of their significance.
A good understanding of cause-effect relationships through experimentation is necessary to discuss monitoring results adequately. Specific conditions at the drilling locations and reference sites have to be considered, because the environmental conditions are rarely the same at all sites.

Without a reliable scientific input, environmental issues concerning regulation of offshore activities will continue to stir up controversy.

2nd International Conference on the Protection of the North Sea have been exploited.

The operation of such a large offshore industry requires a high technological effort in terms of safety and environmental control. The North Sea offshore industry has assumed a leading role in applying advanced technological developments in this respect. Although the offshore industry has significantly reduced the release of contaminants in this way, there are still some inputs of oil and other chemicals from the platforms into the marine environment, as a result of both accidental and operational discharges.

In the light of the principle of precautionary action, agreed in the ministerial declaration arising from the 2nd International Conference on the Protection of the North Sea (1987), it now has to be considered whether these discharges indeed pose no risk to the marine environment.

Marine scientists from all North Sea countries have been involved in environmental monitoring studies to determine the (physical) distribution of the discharged oil or other chemicals, and the (biological) consequences for marine life. Such monitoring studies should be aimed at evaluating whether applied waste treatment techniques actually reduce environmental impacts to a (politically agreed) acceptable level, rather than simply demonstrating any environmental effects regardless of their significance.

2 Discharges from the offshore industry
The main categories of operational discharges from offshore platforms are:

a Drill cuttings contaminated with oil based drilling muds.

b Oil contaminated production water.

Additional chemicals used in drilling and production operations can be found in both types of discharges.

However, accidental spills of muds or production water can happen during the operating life of a platform. Most of these spills are relatively small, but more serious accidents happen occasionally, e.g. the Bravo blow-out in 1977, the leakage of Occidental's Piper/Claymore pipeline in 1986 and the gas explosion on the Piper Alpha platform in 1988.

There is some controversy in the estimation of the amount of oil discharged from the platforms. The best consensus exists for the estimation of operational discharges, i.e. about 19,000t released with cuttings from oil-based muds and 3,000t with production water in 1986 for the whole North Sea. There is no consensus on the amount of oil pollution via accidental spills. In 1987 the Department of Energy of the U.K. recorded 254 spills with a total amount of 516t of oil, compiled from official reports of the offshore industry. An increase of the number of spills reported seemed to be caused by a more accurate reporting as a consequence of improved aerial surveillance in comparison to earlier years. The overall amount spilled did not however increase in comparison to earlier years. On the evidence of four surveillance flights, the Dutch Ministry of Transport and Public Works suspect the number of spills and the amount of oil released to be much higher.

Depending on these different assessments, it is estimated that between 20 and 30% of the total input of oil into the North Sea is related to offshore activities. In 1980 Read and Blackman estimated the contribution of the offshore industry to the total oil pollution of the North Sea to be less than 2%. However, Bedborough and Blackman et al. (1987) re-estimated this between 14 and 21%.

It was estimated that in 1986 approximately 4,700t of oil was released by the offshore industry on the Dutch continental shelf, which is 20% of the total oil input in the Dutch sector. For Norway this was estimated to be 3.300 t and for the U.K. 20,000 t in 1986.

Since January 1988, Dutch governmental regulations require that cuttings be cleaned to a level of less than 10% oil on a dry weight basis, and production water be cleaned to a level of 40 mg oil per litre. These regulations will be evaluated when the Environmental Impact Assessment procedure is concluded in 1990.

In 1987 the discharge of oiled cuttings declined in the Dutch Continental Shelf. A further decline was seen in 1988, partly as a result of the Dutch regulations. The amount of oil discharges from rigs in the Dutch CS has thus been reduced by 75% to approximately 1,200t in 1988. This is mainly due to the cleaning of cuttings with shale-shakers, hydrocyclones, washing or thermal treatment and reduced use of oil based muds. The discharge of oil in production water has not been reduced however. A slight reduction in the concentration did not compensate for the increase in the amount of production water. At present, 33 of the 34 gas production platforms in the Dutch CS do not meet the 40 mg.1-1 standard, due to technical problems in the cleaning procedures. Centrifugation and membrane filtration are reported to give better separation, with levels below 40 mg.1-1 in the effluent. However, treatment capacity and available space form severe limitations when using this type of technology offshore.

Little is known about the discharges of additional chemicals, such as weighing agents, gelling products, viscosifiers, surfactants, detergents, de-foamers, biocides, corrosion inhibitors, lubricants, oxygen scavengers, emulsifiers, dispersants etc. The quantities of these chemicals in operational discharges on the U.K. CS were reported by Bedborough et al. 1987. For the Dutch offshore industry, reliable discharge figures are not available, although an inventory is underway. There are also no effective regulations for discharges of these chemicals from offshore platforms at the moment.

Determining whether these discharges, irrespective of their size, can cause detrimental effects on marine life is equally important as knowing the exact amount of oil released. This will be discussed in Section 3. Scientists must provide data on the basis of which current policy and regulations can be evaluated. It is essential to know whether discharge regulations are too strict or too lax, with respect to the potential environmental harm. Given the enormous commercial and national interests involved, and the ever-growing pressure from the public to maintain the North Sea in a healthy state, the above rather pragmatic approach is the only option available.

3 Environmental impacts

It is very difficult to define unambiguous dose-effect responses concerning the various types of oil and chemicals spilled under different circumstances in the North Sea. Different oil types vary in their chemical composition and so does their potential toxicity. Soluble aromatic derivatives are presumed to be the most toxic oil compounds in the short term and polycyclic aromatics over the longer term. A knowledge of the fate of discharged oil is essential in estimating the potential effects (Scholten & Kuiper, 1987).

Oil contaminated drill-cuttings mainly affects the sediment and accumulate in the sea bed, where they cause prolonged exposure to benthic infauna and other bottom dwelling organisms. Discharged production water on the other hand, mainly dissolves in the water column, causing exposures to plankton species. In the case of larger spills floating oil slicks are usually formed, which can threaten birds.

Since the late 1970s marine scientists from the U.K., Norway, The Netherlands and Denmark have been involved in environmental monitoring studies. Some excellent reviews of these monitoring studies, mainly focussed on the impact of oil-based muds on the benthic fauna, have been released since then. For the British sector, the situation was reviewed by Davies et al. in 1981 en 1984, and more recently by Bedborough et al. (1987) and Kingston (1987).

Reiersen et al. (1988) presented a review of the Norwegian studies at the 1988 International Conference on Drilling Wastes. Unfortunately this scientific presentation was later to stir up political controversy (Gray, 1988). A review of the Dutch studies are presented in a poster at the present 3rd North Sea Seminar (Zevenboom et al. 1989).

There is good general agreement between the results of various national programmes with respect to the environmental effects of the discharge of drill-cuttings contaminated with oil based muds. The scientific data therefore, laid the basis for joint conclusions on these environmental effects by experts of the Paris Commission and the Oil Industry International E&P forum, the so-called agreed facts.

In general, most of the oil is physically bound to the cuttings and stays on the sea-bed in the vicinity of the well site. Near platforms levels up to 10,000 times background were found (Reiersen et al., 1988; Davies et al., 1984; Van het Groenewoud et al. 1988). However, resuspension and transport of oiled sediment may occur, especially in shallow areas where sediments are subjected to dispersion by wind induced turbulence alone, or in interaction with the hydrodynamic disturbance peculiar to the platform legs.

There are gradients of elevated oil and barium concentrations in the sediments found at distances of up to 1000 m from the platform. In the direction of the prevailing currents, elevated oil levels were found at up to 2000 m (Davies et al., 1981; Davies et al., 1984; Kuiper & Van het Groenewoud, 1986; Van het Groenewoud et al., 1988). Elevated sedimentary concentrations have been occasionally found at up to 5000 m distance from a platform (Reiersen et al., 1988).

In some oil fields in the East Shetland Basin, general background levels of oil in the sediment (2-10 ppm: Reiersen et al., 1988; Matheson et al., 1986) exceed the background level of the North Sea (0.4-2.0 ppm: Law and Fileman, 1985). In the Dutch CS these background levels are slightly elevated and range from 1 to 4 ppm (Van het Groenewoud et al., 1988).

In the immediate vinicity of drilling locations strong biological effects have been observed. Beneath the platform, little or no benthic fauna remain, due both to high oil concentrations and the smothering effects of cuttings. Within a radius of 500 m (an area of ca. 0.78 km^2), the benthic community is impoverished, highly modified and dominated by opportunistic species. The recovery rate in this zone is likely to be slow. Significant effects on species density and population dynamics have been observed at distances of up to 1000 m (a further area of ca. 2.4 km^2). Finally, between 1,000 m and 2,500 m, minor perturbations of the benthic community are sometimes found (encompassing a further possible area of ca. 16.5 km2), depending on the local hydrographic conditions. Such a pattern of perturbation of the benthic community was described by several authors (Davies et al., 1984; Addy et al., 1984; Mair et al., 1987; Mulder et al., 1987; Mulder et al., 1988; Matheson et al., 1986; Hannam et al., 1987; Kingston, 1987; Dicks et al., 1986; Reiersen et al., 1988). At one oil field (Stanford C) in the Norwegian CS, perturbation of the benthic community was still found at a distance of 5000 m (Reiersen et al., 1988). However, the interpretation of this finding is still a point of debate (Gray, 1988). It has been suggested that significant benthic impact occurs at sedimentary oil concentrations of 25-100 ppm (Davies et al., 1984; Reiersen et al., 1988).

Dicks et al. (1986) estimated the total North Sea area that has been biologically impacted by offshore discharges to be ca. 0.1%. Zevenboom et al. (1989) estimated the chemically polluted area to lie between 0.4 and 5% for the Dutch CS. This is an area comparable to 1 to 20 times the island of Texel. It should be stressed that most monitoring studies have been carried out around wells with large discharges of oil contaminated cuttings. At minor wells the effects may be comparable, but the spatial extent will generally be reduced (cf. Addy, 1987).

Oil in surface sediments and resuspended particles is subjected to microbial breakdown. However, in deep anaerobic sediments the degradation rate is very slow. Depending on the dynamics of sedimentation and resuspension of cuttings, the environmental effects may last a long time. In the Dutch CS, no decline of oil concentrations or recovery of benthic fauna was found in a dynamic sedimentation area, 5 years after cessation of cuttings discharges (Zevenboom et al., 1989). UK studies show up to a 60% decline of oil concentrations after 4 years.

Despite the 10-100 times lower acute toxicity of so called low-tox muds (<5% aromatics) compared to diesel muds (60% aromatics), as measured in standard laboratory experiments for aquatic organisms (Blackman et al., 1983), the long term environmental effects in the field do not differ between cuttings contaminated with these muds (Dow, 1984; Dixon, 1987; Kingston, 1987; Matheson et al., 1986; Reiersen et al., 1988). Bakke et al. (1986a) reported increased toxicity of the lowtox cuttings after an exposure on the sea bed for nine months; whereas, with the diesel cuttings toxicity declined by more than an order of magnitude.

In another field experiment reported by Bakke et al. (1986b), low aromatic cuttings showed only a temporary improvement above diesel cuttings with respect to benthic colonization. These findings raise doubts on the standard toxicity tests used for approval of drilling muds. More realistic sediment tests are now under development in The Netherlands, both in the laboratory (Adema, 1986) and under semi-field conditions in bioassays with the help of boxcores.

The concentration of hydrocarbons in fish is only elevated when the exposure to oil exceeds the metabolization rate of the MFO (Mixed Function Oxidase) system. Elevated concentrations are therefore only rarely observed, i.e. in the case of chronic exposure. Some studies indicate elevation of oil concentrations in bottom dwelling fish (Reiersen et al., 1988; Vogt et al., 1988) that might result in a slight and hardly observable tainting (Randlov & Poulsen, 1986).
Increased MFO activity in fish caught in the vicinity of oil platforms indicate a chronic exposure to oil (Davies & Bell, 1984; Payne et al., 1985).

Such an exposure may have toxic consequences, and higher MFO activity may inevitably lead to metabolic stress in fish, especially for a species like dab which can stay for relatively long periods at one location.

Another aspect of the presence of platforms is the settlement of fouling organisms on the underwater structures, so forming an artificial reef (Wolfson et al., 1979), which may serve to attract fish to feed (Dicks et al., 1986), a fact of which offshore fishermen are well aware. Such an attraction may ensure the exposure of fish.

Direct measurements of oil in the water column have not demonstrated significantly elevated concentrations. However, active biological monitoring using mussels has demonstrated elevated oil concentrations in the water during drilling operations, at distances of up to 5.000 m from the platform. After the drilling had stopped, elevated levels in mussels were only detected at up to 500 m (Van het Groenewoud et al., 1988). In the U.K. CS, mussels showed a 6 to 10 times elevation of accumulated oil concentrations at up to 6.000 m from a production platform (Sommerville et al., 1987). The concentrations alongside the platform were 10 times higher again. This was related to the remains of oil based muds in the sea bed and not to discharges of production water.
Tibbetts et al. (1982) could not determine production water related oil components being accumulated by mussels exposed in the vicinity of an oil platform. A general appreciation of the situation is given by the fact that background levels of hydrocarbons in mussels from the Dutch part of the North Sea were higher (80-100 ppm) than those found in the Wadden Sea or Eastern Schelde (50 ppm, see table below).

	sediments	mussels
Wadden Sea/ Eastern Schelde	0.1 - 0.5 ppm	50 ppm
North Sea	1 - 4 ppm	80 - 110 ppm
Platform	300 - 8000 ppm	240 - 360 ppm

Information on the environmental impact of production water or additional chemicals in the field is still lacking. Further studies to check whether current discharges of these chemicals have no significant impact on marine life are needed.
For the effects of production water it is argued that dilution prevents aquatic organisms becoming exposed to acutely toxic levels. However, most toxicity data are derived from laboratory studies, with limited value for meaningful extrapolation to the field situation, as was also demonstrated for drilling muds. LC_{50} data for production water of a common North Sea crude ranged from 100 $ug \cdot 1^{-1}$ for larval crustacea to 100 $mg \cdot 1^{-1}$ for adult brown shrimp (Read & Blackman, 1980).
Somerville et al. (1987) report LC_{50} values for production water from a U.K. rig of 1 (oyster larvae) to 4 (adult trout) $mg \cdot 1^{-1}$.

The NAM (1988) reported an LC_{50} value for Chaetogammarus of 0.8% production water (ca. 330 $ug.1^{-1}$, where the NOEC, No Observed Effect Concentration, is ca. 230 $ug \cdot 1^{-1}$). Experimental studies with natural plankton communities have shown that production water from oil platforms containing 5-15 $ug \cdot 1^{-1}$ of oil can have effects on zooplankton. This is a 2,500 to 8,000 times lower concentration than allowed in discharged production water.
Calculated dilution factors ranged from 100 at 50 m to 2,800 at 1,000 m from the platform (Sommerville et al., 1987).
Calculations for other conditions by the NOGEPA (1987) diverge widely from the foregoing, indicating a 10,000 fold dilution within less than 100 m. Visible damage to biofouling organisms from production water is restricted to less than 10 m (Middleditch, 1984; sommerville et al., 1987). However, it is the firm opinion of the authors of the present article that the spread and dilution of discharged production water can better be monitored with the aid of mussels. Fingerprints of the oil accumulated by mussels can now be used to distinguish between oil from production water and oil from drilling muds.

Accidental spills, resulting in floating oil layers, must be prevented by safer operation procedures. It is generally accepted that even small spills create a risk of significant effects among seabirds. Studies on seabird population dynamics and distribution can be used to assess the risks of offshore spills. However, the number of oil spills from ships exceed those from offshore platforms. For the Dutch sector alone, more than 10,000 oil slicks occur annually.

4 Scientific studies required

More than a decade of monitoring studies has resulted in a massive amount of scientific information on the environmental effects of drill cuttings. Scientists need to summarize this information so that decision makers can use it adequately, e.g. in an environmental risk analysis framework, in order to evaluate the regulations concerning offshore activities, on a primarily ecological basis. Such a risk analysis should not be based on mathematical calculations of predicted environmental concentrations, generated for comparison with LC50 values from laboratory studies. It should focus on ecological end-effects that can be observed in the field, bearing in mind that these may appear in the longer term (many months or years) and at a greater distance than predicted up until very recently by laboratory toxicity studies. A prototype risk analysis method linking these ecological end-effects with discharges or activities and including calculation of the risk of end-effects, is now available (cf. Scholten et al., 1989; Bowmer et al., 1989). The concept of the AMOEBA model (Dutch Ministry for Transport and Public Works) can be used as a reference for defining end-effects.

Such a risk analysis can now be set up for discharges of drill cuttings containing oil based mud remainders. Similar information needs to be gathered for environmental impacts of production water and additional chemicals from experimental field studies, for eventually use in risk analysis assessments.

The operation of an extensive North Sea, offshore industry requires governmental supervision of good house keeping among the offshore companies with respect to the protection of marine life from operational and accidental discharges.
So far only 20% of the recoverable reserves have been extracted. The remainder will be exploited in the future, probably using more wells and production sites as the reserves decline and interest moves to smaller hydrocarbon finds. This predicted increase in activity (viz. production of cuttings and formation water) must be attended by environmental control, so that the reserves can be produced without causing further damage to the marine environment.

Scientifically based monitoring studies are needed to ensure the absence of detrimental environmental effects as a result of offshore activities. These monitoring studies should be aimed at an overall evaluation of environmental quality.
Besides monitoring the impact of cuttings on benthic fauna, the following studie sare recommended:

1. the sublethal effects of cutting discharges on benthic fauna and bottom dwelling fish;
2. bioaccumulation and biological effects studies of oil in the water phase (mussels and zooplankton) as a result of production water and drilling muds;
3. bioaccumulation and effects studies of additional chemicals.

It is essential to standardise monitoring procedures internationally (Reiersen et al., 1988) to ensure reliable comparison in time and space, both between platforms, and between the national sectors as a whole. It is also necessary to have access to figures of actual emissions, for each drilling location or production platform. In this context, guidelines for monitoring have already been established within the group of oil pollution experts (GOP) of the Paris Commission.

A good understanding of cause-effect relationships through experimentation is necessary to discuss monitoring results adequately (Dicks et al., 1986). These additional studies should include bioassays with contaminated sediments and an experimental programme with production water, with both aimed at macrobenthic fauna, benthic fish eggs and larvae, ichtyoplankton and plankton communities.

In The Netherlands mesocosm studies are currently undertaken to study sublethal effects on benthic fauna, to assess relevant dose-effect relationships and to select suitable test species as indicators for active biological monitoring of sediments in the field.

The monitoring and mesocosm studies should be conducted by independent, approved consultant companies with proper expertise, equipment and experience for sampling, as well as the necessary analytical and data processing backup. Such studies should be jointly funded by responsible offshore companies and governmental agencies.

In order to gain a better understanding of the general levels of oil pollution in the North Sea, a coordinated approach to monitor actual concentrations of hydrocarbons in sediments and exposed mussels (water) over a grid of the entire North Sea is highly recommended.

5 Political use of scientific information

Scientists need the opportunity to gather reliable data and to come up with well-considered and unbiased assessments of the environmental impacts of offshore activities, without having a certain interpretation of the data forced upon them. The interpretation of these scientific findings needs a continuous and open discussion amongst scientists and experts from governmental bodies and offshore industries. Scientists have to prevent inappropriate generalizations being made from single observations, either by advocates or opponents of strong regulations for offshore activities. Because marine conditions are spatially variable, consideration of specific conditions at each drilling location is essential.

The scientific data of the studies should ultimately be applied in the environmental risk analysis in order to evaluate whether specific regulations governing offshore activities remain necessary, meaningful or effective. Regulation has to be based on actual, demonstrated or likely risks. Without a reliable scientific input, environmental risks cannot be assessed adequately, so that environmental issues concerning regulation of offshore activities will continue to stir up controversy in the future.

6 References

Addy, J.M. (1987). Environmental monitoring of the Beatrice oilfield development. Phil. Trans. R. Soc. Lond. B. 316: 655-668.

Addy, J.M., J.P. Hartley and P.J.C. Tibbets (1984). Ecological effect of low toxicity oil-based mud drilling in the Beatrice oilfield. Mar. Pollut. Bull. 15: 429-436.

Adema, D.M.M. (1986). Ontwikkeling van toetsmethoden ter vaststelling van de schadelijkheid voor het mariene milieu van spoelingen op oliebasis. TNO report R86/189 Delft NL.

Bakke, T., R.A.A. Blackman, H. Hovude, E. Kjorsvik, S. Norland, K. Ormerad and K. Ostgaard (1986a). Drill cuttings on the sea bed. Toxicity testing of cuttings before and after exposure on the sea floor for 9 months. In: Proceedings of the symposium on oil based drilling fluids, cleaning and environmental effects of oil contaminated drill cuttings. Trondheim, Norway. 514-539.

Bakke, T., N.W. Green, K. Naes and A. Pedersen (1986b). Drill cuttings on the sea bed, phase 1 and 2. Field experiment on benthic recolonisation and chemical changes in response to various types and amount of cuttings. In: Proceedings of the symposium on oil based drilling cleaning and environmental effects of oil drill cuttings. Trondheim, Norway. 17-31.

Bedrough, D.R., R.A.A. Blackman and R.J. Law (1987). A survey of inputs to the North Sea resulting from oil and gas developments
Phil-Trans. R. Soc. Lond. B. 316: 495-509.

Blackman, R.A.A., T.W. Fileman and R.J. Law (1983). The toxicity of alternative base-oils and drill-muds for use in the North Sea. ICES, CM 1983/E11.

Bowmer, C.T., M.C.T. Scholten, M. Molag, M. Roemer, M. van Veen, W.Chr. de Kock, C.J.M. Kramer, P. Leendertse, H. van het Groenewoud and L. van der Vlies (1989). The environmental risk created by six industrial waste dumpings and two hypothetical wast releases in the North Sea, as calculated with 'REFEREE' TNO report No. 89/088 Delft NL.

Davies, J.M. and J.S. Bell (1984). A comparison of the levels of hepatic aryl hydrocarbon hydroxylase in fish caught close to and distant from North Sea oil fields. Marine Environ. Res. 14: 23-45.

Davies, J.M., J.M. Addy, R.A. Blackman, J.R. Blanchard, J.E. Ferbranche, D.C. Moore, H.J. Sommerville, A. Whitehead and T. wilkinson (1984). Environmental effects of the use of oil-based drilling muds in the North Sea. Mar. Pollut. Bull. 15: 363-369.

Davies, J.M., R. Hardy and A.D. McIntyre (1981). Environmental effects of North Sea oil operations. Mar. Pollut. Bull. 12: 412-416.

Dicks, B., T. Bakke and I.M.T. Dixon (1986). Oil exploiration and production: impact on the North Sea. Oil and chemical Pollution 3: 289-306.

Dixon, M.T. (1987). Experimental application of oil based muds and cuttings to seabed sediments. In: J. Kuiper and W.J. van den Brink (eds.). Fate and effects of oil in marine ecosystems. Nijhoff, Amsterdam, 135-150.

Dow, F.K. (1984). Studies on the environmental effects of production water and drilling cuttings from North Sea offshore oil installations. Ph.D. Thesis, University of Aberdeen.

Gray, J.S. (1988). Environmental politics and monitoring ground oil platforms. Mar. Pollut. Bull. 19: 549-550.

Van het Groenewoud, H., L. van der Vlies, G. Hoornsman and T. Bowmer (1988). A comparative study of monitoring techniques to establish distribution and biological effects of drilling muds around off-shore installations on the Dutch continental shelf (1986). TNO report R88/405 Delft.

Hannam, M.D., J.M. Abby and B. Dicks (1987). Ecological monitoring of drill cuttings discharges to the seabed in the Thistle oilfield. Int. Conf. on Oil. Pollution. Amsterdam.

Kingston, P.F. (1989). Field effects of platform discharges on benthic macrofauna. Phil. Trans. R. Soc. Lond. B. 316: 545-565.

Kuiper, J. and H. van het Groenewoud (1986). Monitoren van de verspreiding en de biologische effecten van olie rond platforms op de Noordzee. TNO report R85/350a Delft.

Law, R.J. and T.W. Fileman (1985). The distribution of hydrocarbons in surficial sediments from the central North Sea. Mar. Pollut. Bull. 16: 335-337.

Mair, J.Mc.D., I. Matheson and J.F. Appelbee (1987). Offshore macrobenthic recovery in the Murchinson field following the termination of drill-cuttings discharges. Mar. Pollut. Bull 18: 628-633.

Metheson, I., P.F. Kingston, C.S. Johnston and M.J. Gibson (1986). Statfjord field environmental study. In: Proceedings of the symposium on oil based drilling fluids, cleaning and environmental effects of oil contaminated drill cuttings. Trondheim, Norway: 1-16.

Middleditch, B.S. (1984). Ecological effects of produced watereffluents from offshore oil and gas production platforms. Ocean Management 9: 191-316.

Mulder, M., W.E. Lewis and M.A. van Arkel (1987). Effecten van oliehoudend boorgruis op de benthische fauna rond mijnbouwinstallaties op het Nederlands Continental plat. NIOZ-report 1987-3. Texel NL.

Mulder, M., W.E. Lewis and M.A. van Arkel (1988). Biological effects of the discharges of contaminated drill-cuttings and water-based drilling fluids in the North Sea. NIOZ-report 1988-3. Texel NL.

NAM (1988). Determination of some chemical and ecotoxicological properties of effluent discharged from the gas/condensate platform Kly-FA-1. NAM report No. 15-207. Assen NL.

NOGEPA (1987). Environmental impact assessment of effluents discharged from gas/condensate platforms. NOGEPA report No. 6. Den Haag.

Payne, J.F., L. Fancey, J. Kiceniuk, U. Williams, J. Osborne and A. Rahimtula (1985). Mixed-Function Oxidase as biological monitors around petroleum by hydrocarbon development sites: potential for induction by diesel and other drilling mud base oils containing reduced levels of polycyclic aromatic hydrocarbons. Marine Environm. Res. 17: 328-332.

Randlov, A. and E. Poulsen (1986). Environmental impact of low-toxic oil-based drilling-muds. Taint in fish and possibilities of reduction the impact. COWI consult, Maersk olie gas a.s.

Read, A.D. and R.A.A. Blackman (1980). Oily water discharges from offshore North Sea installations: a perspective. Mar. Poll. Bull. 11: 44-47.

Reiersen, L.O., J.S. Gray, K.H. Palmork and R. Lange (1988). Monitoring in the vicinity of oil gas platforms: results from the Norwegian sector of the North Sea and recommended methods for forthcoming surveillance. In F.R. Engelhardt, J.P. Ray and A.H. Gillam (eds). Drilling Wastes; Proceedings 1988 Int. Conf. on Drilling wastes, Calcary CAN; Elsevier Applied Science. London.

Scholten, M. and J. Kuiper (1987). An environmental impact assessment of oil pollution in the North Sea. In: P.J. Newman and A.R. Agg (eds.). Environmental protection of the North Sea. Heinemann, Oxford.

Scholten, M.C.T., C.T. Bowmer, J.M.A. Janssen, W.Chr. de Kock, M. Molag, G.J. Vink and M.P. van Veen (1989). An appraisal of marine waste dumping criteria based on risk analysis and ecological effects. TNO report No. 89/034. Delft NL.

Sommerville, H.J., D. Bennett, J.I.V. Davenport, M.S. Holt, A.Lynes, A. Mahieu, B.Mc. Court, J.G. Parker, R.R. Stephenson, R.J. Watkinson and T.G. Wilkinson (1987). Environmental effect of produced water from North Sea oil operations. Mar. Pollut. Bull. 18: 549-558.

Tibetts, P.J.C., S.J. Rowland, L.L. Tovey and R. Large (1982). Investigation of the sources of aliphatic hydrocarbons in the mussel Mytilus edulis from North Sea oil production platforms by capillary GLC and CGCMS. Toxicological and Environmental Chemistry 5: 177-193.

Vogt, N.B., N.B. Davidsen and C.E. Soegren (1988). Di- and Triaromatic hydrocarbons in fish liver from the North Sea: multivariate and statistical analysis. Oil and Chemical Pollution 4: 217-242.

Wolfson, A., G. van Blaricom and G.S. Lewbel (1979). The marine life of an offshore oil platform. Mar. Ecol. Prog. Ser. 1: 81-89.

Zevenboom, W., M. Mulder, M.A. van Arkel and H. van het Groenewoud (1989). Effects of discharged offshore mining drilling waste on benthic fauna, sediment and test-mussels on the Dutch continental shelf, 1985-1987. RWS North Sea Directorate report No. NZ-N-89-01. Rijswijk NL.

Discussion

Mr Henriquez gives the exact numbers of the recent 75% reduction of oil in oil-based mud cuttings where 35% was due to cutting cleaning, and 20-30% to good housekeeping on the rigs. He mentions studies on production water effects monitoring where mussels were found to accumulate oil up to 10,000 m from the emission site (Shell-UK, november 1988).
Mr Scholten points out that the latter studies referred to oil-based muds, not production water, and that the distance found was 6,000 m. He also explains MFO-activity in fish being Mixed Function Oxydase system, i.e. an enzyme system which fish use when breaking down oil; hence the amount of MFO is a measure of exposure to oil.

Equitability, the Bridge over Troubled Waters

Dutch environmental policy has generally been equitable: in the policy-making process the different interests (environmental vs. economic) have been reasonably balanced. Quantitative data have generally been the basis for this approach. It should also be possible, using proper 'scientific' methodology, to estimate the long-term/indirect consequences of the offshore discharges on the ecosystem and, if relevant, to include these in the policy-making.

The introduction of the Precautionary Principle has caused a regulatory chaos. It is proposed - under the Precautionary Principle - to return to balanced regulations under the aegis of the current Environmental Impact Statement process (initiated by the Minister in 1987).

Dr.Ir. J.Ph. Poley
NOGEPA The Hague and E & P FORUM London

1.1. The making of Dutch environmental policy

Government policies as laid down in the relevant laws embody specific objectives, together with any relevant criteria, norms or standards, and the instruments (ways and means) with which to achieve and enforce these objectives.
Policy proposals are in general drafted by the authorities, and amended/approved by Parliament into actual law.
Any dispute regarding the resulting legislation can be settled in the (independent) courts of law.
This procedure with checks and balances is intended to result in a balanced, 'equitable' legislation. It should provide citizens and their groups/organisations (the aged, the employees, industry) with some protection against abuse of power or against arbitrariness.

The keyword in the policy-making process is 'equitability' or 'balance'. It is particularly important in environmental legislation. It means weighing environmental benefits against technological achievability and economic costs.
It also calls for realistic and achievable objectives, realistic standards and well-considered ways and means. Even the battle-cry 'reduction of pollution' needs qualification!
As early as ten years ago the chairman of the E&P International Forum, mr F. Hughes, in his address to an international meeting of government, industry and the public called for 'cooperative stewardship'. In such a joint effort all interested parties would cooperate in providing the information needed to arrive at realistic regulations. In several cases such cooperation has indeed developed. Consultation on environmental matters has always been extremely open between oil companies, never hindered by any 'company-confidentiality'.
But even between the international oil companies' representation (E&P Forum) and responsible international agencies such as IMO, UNEP and PARCOM an effective consultation has developed over the years. It has led to a better appreciation of the

requirements of the marine environment and of the technological, scientific and operational data. It has also resulted in mutual respect for each other's integrity.
A recent illustration of this is found in the 1988 joint PARCOM/ industry statement of 'Agreed Facts' on the environmental effects of discharges of OBM cuttings from offshore drilling units (see Appendix I).

Dutch environmental policy embodies several objectives and many norms, standards, ways and means.
In the 'Nota Milieuhygienische Normen' (NMN) or in the successive 'Indicatief Meerjaren Programma's' (IMP's) we find for instance:

Objectives:
'stand-still': environmental quality shall not deteriorate (EEC): reduce total volume of pollution, keep clean what is relatively clean (IMP-Water, p.36)
'control at the source': manage environmental quality by setting emission norms (IMP 1987-1991, p.9)
'well-considered restriction of environmental impact of new projects' (MER, 1986)

Standards, ways and means:
- Setting of norms and standards - minimum or target values (for emissions, component concentrations etc.) (NMN, 1976, p.58 ff)
- Application of Best Practicable Techniques (BPT)*) (NMN, p.36)
  or: Best Available Techniques (BAT)*) (NMN, p.37)
- Design specifications for process control
- Procedures for (effluent, quality) monitoring, reporting and for inspection and enforcement of compliance
- etc.

*) BPT: Those techniques which result in the largest reduction of pollution against a capital investment that is acceptable to a paying concern.
BAT: Those techniques which can result in a still larger reduction of pollution, and of which at least one is working under operational conditions.

It is useful to note how careful the law aims at 'equitability', the weighing of various interests against each other, so that fairness will prevail in society.
The 1986 Law on Environmental Impact Statements for large new projects is a recent case in point.
From the outset, the law is explicit about the objective: to flag any expected important negative environmental consequences, in order to be able to weigh the environmental consequences against 'other' consequences (State Gazette, v.211, 23 April 1986, preamble; Publ. VROM, 1986, no. 60812/10-86)

1.2. The role of science in the policy-making process
Cornerstones in achieving 'equitability' for all interests involved in the environmental case are, for instance, quantitative data.
In the traditional view this is the 'scientific' approach.
It includes, for instance:
- well-defined parameters, units etc.
- well-defined measuring or monitoring techniques
- well-described analytical models, procedures or methods
- experimental data, field data, operational data
- inclusion of all known related/dependent factors

The aim of this approach is - in order to make the required weighing of interests possible - to obtain a dispassionate, 'objective' overview of contributing factors. Any interested party would have access to this information, and any interested party should (under comparable circumstances) be able to essentially reproduce the data.
Taking as an example the environmental impact of discharges from offshore platforms, such a data set would include (amongst others):

- source:
  · perational discharge data (incl. variations in volume, rate)
  · composition of discharge (incl. variations)
  · exhaust module (type, location etc.)

- receiving environment:
  · physical data of receiving waters (tidal currents, speeds and patterns, depths, turbulence, waves etc.)
  · dispersion/dilution process: model/data
  · natural background levels of discharge components (with variations due to seasons, rain run-off etc.)

- suffering species:
  · toxicity levels or concentration thresholds
  · mobility
  · season
  · ambient natural diversity, and frequency of occurrence interdependence of species within the ecosystem

An excellent outline of the approach is the classic paper by Read and Blackman (2) 'Oily water discharges from offshore North Sea installations; a perspective'.
A comprehensive field study of the environmental effects of OBM cuttings discharges is given in the 1983 report of a British joint working group of government and industry experts, from which Figures 1 and 2 are taken.
A 1983 overview of North Sea field data (3) 'Environmental impact of OBM cuttings discharges - a North Sea perspective' is included as Appendix II.
This evidence is essentially confirmed by the data from a

continuing Dutch monitoring field study, as reported (4) to PARCOM (GOP, Feb. 1989) and others.
An assessment of the expected ranges of environmental impact of 'aromatic' discharges from gas platforms is found in the 1987 NOGEPA report no. 6 (5) (available on request).
The inherent strength of such studies is that any shortcomings can be identified and rationally discussed, and the field work can be adapted accordingly.

In the final 'weighing' process the environmental gains (a specific reduction of impact zone, a specific increase in 'survivors' etc.) must be weighed against the costs involved for the clean-up.
This will, in the end, be a political decision between government experts. Industry can only wait along the side-line for the decision.
But at least the parameters in this process are known. Each party is well aware of the law of diminishing returns, and the reasons for the accepted limits can be given afterwards.

1.3. Predicting the future environmental quality

Long-term or indirect environmental consequences of discharges are difficult to predict in the above approach. To estimate such long-term/indirect consequences one could envisage that factors should be included such as:
- total volume of effluent discharged vs. capacity of receiving environmental compartment
- natural clean-up of North Sea by influx of Atlantic water
- fate of the discharged components, incl. natural bio-degradation
- natural restoration of habitat and rejuvenation of population
- development of new populations of resistant benthos and water-column species
- inter-dependence of species within the ecosystem
- etc.

Some of these factors can be taken into account quantitatively. Several of them, in particular those relating to the inter-dependence within the ecosystem, are largely unknown. Here marine biologists may provide relevant qualitative eco-relations.

The organisers of this Seminar would like to include such 'information' in the policy-making process.
How does one deal with situations where data are lacking, and where, nevertheless, such an estimate of the future environmental quality is required?
Essentially this calls for environmental decision-making under uncertainty. Industry often has to make such decisions, and its experience suggests a way to deal with it.

One possible approach would be: have marine biological experts develop several possible ecosystem-interaction scenarios of varying environmental impacts. These scenarios should then be applied to a discharged volume of which the polluting mass as a function of time is known.
To arrive at such scenarios one might use a Delphi exercise on the ecosystem interdependence between (independent) marine biological experts.
The advantage of this approach is that one is not faced with emotive arguments, like 'concern', 'suspect', 'could influence', 'might reduce reproductivity' etc., but with a procedure whichcan be discussed step-by-step between the experts.

2.1. The Precautionary Principle, a new regime

Over the past few years the policy-situation has changed radically.
During the last decade the use/abuse of the North Sea as an 'ultimate receiver of human waste' has received increasing attention.
Concern for 'the potential decline' of the 'quality' of the marine environment, and for any related 'deterioration of the ecosystem' has recently gained more public support.
At the 1984 Bremen Conference of Ministers of North Sea nations the Precautionary Principle was introduced:
'... because possible adverse effects of discharges and dumpings into the marine environment can not be predicted with the existing state of knowledge of the marine ecosystem. Strict discharge limits must be set, even for substances which are only suspect in being harmful to the marine environment.'
(Basic Papers 3rd North Sea Seminar, p.5)

The second North Sea Conference of Ministers (London, 1987) accepted this policy principle.
We quote the Dutch Minister of Transport and Public Works (responsible for coordinating North Sea affairs) in her 9 February 1989 address to NOGEPA:
'The cornerstone of these international agreements on the North Sea is the Precautionary Principle . In conjunction with the generally valid Stand-Still Principle it permits far-reaching measures to reduce or end pollution, without the need for conclusive evidence of the negative consequences of this pollution.
Armed with this principle, and taking into account other social interests, such as the necessity of certain activities, a wide variety of measures has been taken, ranging from gradual reduction of environmental pollution via the application of the best practicable or best available means to the complete prohibition of discharges and dumping...
In short, a clean-up process is being organised, implemented and strengthened...'

With the acceptance of the 'prevention' as a policy, the 'equitability' in the policy-making process has disappeared. Weighing and balancing different interests as fairly as possible as a way to achieve an objective has been replaced by the unqualified goal of 'reduction of discharges into the North Sea'.

2.2. The consequences of the Precautionary Principle for the offshore industry

The consequences of this new regime for the offshore industry became evident fairly soon.
In the frequent consultations between company and government officials the proclamation 'reduce your discharges' has become dominant. Likewise, officials are now pushing rather indiscriminatively towards the best available technology. Attempts to obtain 'scientific', technical or operational justification for a newly set norm have failed.

Two Dutch examples may suffice:

a. The decree of the Minister of Economic Affairs of 27 August
1987 regarding discharges of OBM cuttings from drilling units permits such discharges if the average oil content is less than 100 g/kg dry weight.
Consultations between State Supervision of Mines (responsible for the enforcement of the decree) and the oil companies about actual amounts of oil discharged and how to best achieve the limit, about effectiveness of clean-up techniques, about measuring, monitoring and reporting procedures were soon in full swing.
Then, December 1987, government officials warned the industry that the 100 g/kg must be seen only as a temporary limit, that in the near future the limit would be lowered step-wise, in order to achieve a new objective: reduction of discharges that pollute the North Sea.

b. The Minister of Economic Affairs has, in accordance with the 1986 Law on Environmental Impact Statements, announced the initiation of a process for a (generic) E.I.S. for offshore drilling and production units (State Gazette of 25 June 1987).
As quoted above in section 1.1. such an E.I.S. aims at balanced regulations by weighing the various interests against each other. In the process several technical alternatives for the proposed activity should be considered, together with their economic and environmental consequences.
One of the alternatives is the situation as is, the zero-alternative, i.e. the set of regulations which are operative today.
The 1986 Law thus allows for the possibility that the present regulatory situation might result in an acceptable North Sea environmental quality.
In spite of this, following the lead of the 'Commissie voor de M.E.R.', the 'Start-notitie' mentions as its policy frame- work the objective of reducing the pollution of the marine environment to an 'acceptable' level (Start-notitie MER, 1988, p. 1+10).
The Precautionary Principle thus excludes the possibility that the actual situation might be acceptable.
Also, there is no specification of what the 'acceptable' level might be.

Without a target norm towards which to orient its future planning of operations, the industry is in a heads-I-lose, tails-you-win situation.

The pressure to reduce pollution is also affecting the possibilities for a reasonable consultation between government and industry regarding procedures.
The government's approach to discharges from unmanned gas platforms illustrates this.
The Ministerial decree of 27 August 1987 calls for sixteen samples per month to be taken from all production discharges.
This presents a major problem for the unmanned platforms. They have been designed to operate without supervision on the platform, and are visited for inspection and maintenance some four times per month.
During these visits the production-discharge samples are taken.
Legislation, however, requires the twelve extra helicopter flights (necessary only to take the twelve remaining samples), even for an unmanned platform which is known to discharge well below the 40 ppm limit.
To the present regime the taking of these twelve extra samples per month is more important than the unnecessary safety risks or the expenses incurred in the extra flights.

2.3. MER as a tool for improved procedures

The present regulatory chaos makes it difficult to arrive at the most effective technology for further reduction of pollution.
To be able to plan and to manage industrial environmental control effectively it is necessary that the operational requirements (effluent limits, acceptable technology etc.) are known.

Even under the Precautionary Principle this can still be achieved in a responsible way as follows:

Government, industry and public organisations could agree that their pace be set by the initiated Ministerial Environmental Impact Statement process for offshore activities, and to let regulatory process run its prescribed course.
This will provide several proposed technological alternatives, each carrying its recommended discharge

activities, and to let regulatory process run its prescribed course.
This will provide several proposed technological alternatives, each carrying its recommended discharge limits, its corresponding technology and costs, and its environmental consequences.
This would then be the basis for an equitable (political) decision: with a specified technology (properly costed) a specified pollution reduction will be achieved.
In this way, instead of arbitrariness, fairness and logic would prevail.

References

(1) Hughes, F., 'Management of the Environment...', Proc. Petromar 1980, Monaco, p.55-66

(2) Read, A.D. and R.A.A. Blackman, Marine Pollution Bulletin, v.11, 1981, p.44-47

(3) Poley, J.Ph. and T.G. Wilkinson, 'Environmental impact of OBM cuttings discharges - a North Sea perspective', Paper at 1983 IADC/SPE Drilling Conference, New Orleans

(4) Zevenboom, W., 'Effects of discharged offshore mining drilling waste on benthic fauna, sediment and test-mussels on the Dutch continental shelf, 1985-1987, RWS-North Sea Directorate report NZ-N-89.01

(5) NOGEPA, 'Environmental impact assessment of effluents discharged from gas/condensate platforms', report no. 6, December 1987Discussion

Discussion

Mr Lees finds the partnership between government and industry rather exclusive, where information is shared by the two parties who agree on the issues, and asks whether the speaker assumes that only these select few are equipped to pass the delicate judgments concerned.

Mr Poley answers that he did not intend to suggest such exclusivity. Since 11 years, data from government laboratories and about 15 oil companies have been exchanged in the Paris Commission. Data were also published openly in the scientific press. He wants to stress that his paper is part of a fact-finding exercise, not of an interpretative one.
The chairman expresses his surprise about the degree of harmony between science leaders and industry and welcomes 'turbulence' at a later stage.

Appendix I

Agreed facts on environmental implications of the use of oil based muds: conclusions of the 1988 meeting with the E&P forum

1. Discharges of cutting from oil based drilling muds have an effect on the seabed biological community. beneath and in the immediate vicinity of the platform, this is partly due to physical burial of the natural sediment and partly to organic enrichment and toxic effects of the hydrocarbons and additives in the mud.

2. The types of effects found in benthos are changes in diversity (number of species and distribution of individuals in a community) and changes in biological community structure on the seabed.

3. In addition to changes in the benthic communities, accumulation of hydrocarbons from base oils have been discovered in fish. The effects have been observed in fish living near the seabed (such as cod), but not in the more pelagic living species (such as saithe). Elevated concentrations of oil may be found both in the liver and in the tissues.

4. The spread of cuttings from oil based muds is greatly influenced by their particle size and the prevailing current regime. Unlike oil discharged in liquid effluents, most of the oil discharged with cuttings is physically bound, to a greater or lesser extent, to the rock particles.

5. Significant effects will be observed around the installations in general out to 1000 m of the platforms, but significant effects have also been found as far as 5000 m from platforms along the prevailing current.

6. Surrounding the area of major impact is a transition zone in which lesser significant biological effects are detected. Environmental surveys round platforms show that elevated values of hydrocarbons in the sediments are likely to be found as far as 2000 m in any direction from the platform where oil based muds have been used, and may in some cases be found as far as 12000 m from the platform along the predominant current direction (which until now has been the station of reference)

7. The shape and extent of the affected zone is variable, and is largely determined by the current regime and the scope of the drilling operation. There are indication that resuspension and transport of the sediment material away from the area occur.

8. There is a clear relationship between the amounts of oil contaminated cuttings discharged and the area of

seabed affected, but more information is needed to compare biological affects of single well drilling to the drilling of several wells.

9. Seabed recovery is likely to be a long process. OIl in the cuttings pile will be potentially available to the environment in the long-term, and probably in a modified or degraded form. The biological effects of any degraded or partially degraded oil components are not known. There are, however, signs that following cessation of drilling activities degradation of oil has occurred and the benthic communities show signs of recovery. The degree of degradation seems to correlate to the concentrations of hydrocarbon originally in the sediment.

10. It is not possible from the monitoring data around the platforms available at present to distinguish between the ecological effects of diesel based muds and so-called low toxic oil based muds.
11. Cutting discharges may result in a transit sheen on the sea surface, but this has not proven to pose a significant hazard to the sea.
12. Loss of oil from cuttings to the water column is not considered to be a major problem.

Appendix II

IADC/SPE

IADC/SPE 11400

Environmental Impact of Oil-Base Mud Cuttings Discharges—A North Sea Perspective

by J.P. Poley, *Shell Internationale Petroleum Maatschappij*, and T.G. Wilkinson, *Shell UK Exploration & Production*

ABSTRACT

Discharges of Oil-Based Mud Cuttings have an environmental impact which is limited in time and in volume/area. North Sea field data (1979-1982) indicates that beyond the immediate neighbourhood of the discharge, the hydrocarbon concentrations in the water column are effectively at ambient levels and environmental impact, if any, is difficult to establish.

Regarding the sea-bottom ecology the data shows the existence of three different zones:

a) A proximal zone, extending about 300-700 m from the platform, where cuttings form a surface deposit (thickest at the source and quickly thinning outward). Anaerobic conditions exist with associated H_2S and biodegradation will be slow. Environmental impact will be most significant in the immediate neighbourhood of the source; any recovery will be slow.
b) A distal zone, reaching beyond the proximal zone out to roughly 1500-5000 m, where cuttings may be found as thin patchy deposits of tiny particles, where aerobic conditions exist, and where biodegradation can readily take place. Environmental impact, if any, will be light, and recovery quick.
c) The far zone, beyond some 1500-5000 m, where no environmental impact can be identified.

Local circumstances will determine the actual conditions around each source.

INTRODUCTION

The relatively large water depths (100-150 m) in the N. North Sea require multi-well facilities and deviated drilling to be economical. Typical examples are the Statfjord field (at present 32-well platforms, deviations average 45°, maximum 60°), the Brent field (four 30-40-well platforms, deviations average 40°, maximum 65°).

References and illustrations at end of paper.

Oil-Base Mud (OBM) drilling is necessary to cope with the operational problems of deviated drilling. To reduce the impact of the cutting discharges, the use of OBM is mostly restricted to the critical depth-sections of the well. The volume of the oiled cutting discharges depends on the hole diameter; typical values are: for a 12 1/4 in. hole about 7.6 m^3/100 m, and for a 9 5/8 in. hole about 4.7 m^3/100 m.

As the possible environmental impact of OBM cuttings has caused concern, both oil industry and government agencies have carried out extensive field investigations to establish the extent of any problem.

DEPOSITION OF CUTTINGS

For all the vocal environmental concern, one would almost forget that the settling of drill-cuttings in a steady flow is a straightforward physical phenomenon. Its extent and rate can be estimated with fairly simple formulae. The main parameters are: height of discharge point above the sea bottom, directionality and flow velocity of the local current, density and size-distribution of the cutting particles.

The particle parameters vary, dependent on the drilled rock formations. Porous sandstone may show sizes ranging up to some 10 millimetres, with a bulk density around 2.2 (g/cm^3); shale may disintegrate, particle sizes from millimetres down, density around 2.0 (g/cm^3). The order of magnitude of the sea-water settling velocity can be estimated from formulae as given in ref. 1.

The time to reach the bottom will depend upon the height of the discharge point above sea bottom, but will in most cases be less than 1200 sec. The instantaneous value of the current velocity will thus determine the lateral transport during settling.

It is clear that - with the prevailing size-distribution and tidal cycle of the current flow -

a deposition of cuttings around a discharge point will show a gradient outward, both in volume and particle size. As observations in the Statfjord area [2] and the Brent area have confirmed, at times of low current velocity (< 0.1 m/sec), virtually all cuttings are deposited within 30 metres of the platform.

An estimate of expected maximum areal extent of cuttings deposition around a discharge point in Brent field ($v_{max} = 0.3$ m/sec) is given in Table 1 for several cases of density, particle size, current velocity and discharge height. From this table the importance of local parameters such as current flow velocity and discharge heights in determining areal cuttings spread will be clear. Also, an increase of volume of cuttings will increase the thickness of the deposit, and not its areal spread. Following these considerations, the design criteria for future Shell Expro platforms will place the discharge points much closer to the sea bottom, in order to reduce the area impacted.

It will be appreciated that the actual deposition is an irregular process with considerable local variations and redistribution leading to a very uneven spread around the discharge sites outside some 200 m away from the platforms. Nevertheless, extensive sampling around the North Sea platforms[2] over the last four years confirms the existence of such a thickness gradient in areal cuttings deposition. Table 2 gives some examples in the Brent/Cormorant area.

CUTTING-ENTRAINED OIL

The discharged cuttings entrain adhering oil. It is estimated, with sufficient efficiency of the platform cutting-cleaning process, that cuttings will upon discharge still retain 10-15% (wt) of oil. Ref.2 estimates that during the discharge process the cuttings lose about 20% of their oil in the chute, which would imply that about 10% (wt) of oil would be settling around the platform. This would amount to roughly (order of magnitude) about 300 l/m³ cuttings discharged.

Experiments suggest that during the journey downward from chute exit to sea bottom the cuttings lose only little 'free' oil. In fact, during OBM cutting discharges no more than shreds of sheens are visible at the surface. Most probably this is for the same reason that the effectiveness of the fluid-wash systems is so difficult to improve: the oil adheres strongly to the cuttings because the formulation of the original muds provides for an oleophilic surface of the cuttings.

Likewise, from laboratory experiments it can be calculated that about 2 g of oil per m³ of cuttings per day would leach out.

This would also imply that significantly less oil is 'available' to the marine environment than is discharged with the cuttings.

Exploratory laboratory work by MASSPEC ANALYTICAL, supported by AMOCO Europe Inc. (to be published) confirms this. Following this lead, the E & P FORUM, London, is undertaking a study of the 'available oil' concept, and is developing an analytical procedure to establish its relevance to marine pollution, and to determine its magnitude in field cases. The consequence would be that relatively little adhering oil (probably an order of magnitude less than the total volume of oil entrained) would be available to 'pollute' the environment.

ENVIRONMENTAL OBSERVATIONS

a. Water Column

Extensive surveys around several North Sea platforms have shown enhanced hydrocarbon levels around these platforms, increasing over the years during which drilling took place.

Analysis by government laboratories has shown[4,5] the type of ambient hydrocarbons to be related to the diesel-base of the muds. Although hydrocarbon levels could be measured, no gradient away from the platform could be established in any case. Table 3 summarises such data. As a comparison, data from Auk and Piper (which were drilled with water-base mud) are included. Similar data are available for Brent and Cormorant fields.

Background concentration data provided by Law[6] and Grahl-Nielson[2] indicates ambient values roughly between 1 and 3 µg/l in the North Sea (1978-1980).

Studies of the environmental vulnerability of the water column ecology to hydrocarbons suggest that threshold values can be recognised [7,8]. Sensitive marine species (larvae, crustacea) under a continuous exposure during 96 hours to an oil-in-seawater concentration of about 1 mg/l show a survival rate of only 50%.

Behavioural effects on adult organisms and zoo plankton may occur under continuous exposure to total hydrocarbon concentrations of 60-100 µg/l.

Comparison of the average observed water-column concentrations away, say, more than 500 m from the platforms, with these thresholds show that actual values are probably still an order of magnitude below any critical exposure level.

A different sensitive test, the bio-accumulation of diesel-based hydrocarbons in mussels, was carried out in the Brent field by one of the authors (T.G.W.) in 1981 and 1982. The results show that the concentrations accumulated in 9 weeks downstream in the main direction of the local current, beyond some 5 miles were only slightly higher than the clear-water controls. Diesel oil is clearly detected in the immediate neighbourhood of the platform, but is not identifiable at the following measuring site (2400 m away). See Table 4 and Figs. 1 and 2, which illustrate the 1981 measurements.

b. Sediments

Similar extensive studies [2,4,5,9] have been carried out out assessing the hydrocarbon contents of the sediment near platforms where OBM cuttings were discharged. Table 5 summarises some of these results, while Table 6 provides 1981 data from Brent and Cormorant fields.

A thorough benthic survey in March 1982 around Brent-Alpha indicated severely disturbed benthic communities within 300 m, dominated by abundant opportunistic species. At 500 m distance the community structure was slightly altered (measured by abundance and diversity of species). At 1000 and 2000 m distance benthic communities were undisturbed.

In the above studies, particular attention was also given to naphthalenes, because of their persistence and hence potential longer-term effects on benthic population. Relevant values are included in Table 5.

A study by Armstrong et al.[10] indicates that naphthalene levels of about 2 µg/g wet weight in sediment could be expected to restrict the benthos activity. Comparison of the above sample data with such a threshold would suggest that at present levels (i.e. after termination of drilling activity), beyond some 2.5 miles from Beryl no restriction on benthic life would occur. For Thistle and Statfjord fields similar considerations would indicate the local 'impact' zone to be considerably less than 0.5 miles. See also ref. 11. Around Cormorant-A such trace contamination was only observed at distances greater than 500 m.

Specific laboratory experiments reported by Blackman and Law[3] who exposed Scrobicularia Plana to a single dose of mud solids containing 12.7% diesel to give a layer $\leq$ 1 mm thick, indicate that, after an initial behavioural shock, the "normal feeding and burrowing activity was resumed within 24 hours". After an initial strong intake/concentration, the tissues lost the accumulated hydrocarbons within a few weeks. No extra mortality was observed over that of the control set.

It will be appreciated that in general it is very difficult to establish the relevance of laboratory data to actual field conditions. Actual sea-bottom exposure (time and concentration) as well as target organisms will be essentially different from the aquarium tests. Also the actual cause of death must be identified (i.e. smothering, H_2S-poisoning, etc.).

BIODEGRADATION

a. Close to the platform

The local rate of biodegradation of the discharged oil will depend on its availability to bacteria, and on the presence of sufficient oxygen. The nature of the depositional process, with high rates of deposition in the immediated neighbourhood of the platform, leads to thick layers of cuttings in that area, with little access for oxygen, i.e. strongly anaerobic conditions. In that limited zone the conditions will probably be fatal for local benthos, and will be conducive to the generation of sulphate-reducing bacteria (SRB's) and of layers of sulphide. To investigate the extent of this problem, a special investigaton was made during the summer of 1981 around the Cormorant-Alpha platforms[12]. It showed a cuttings deposit of 2 m thickness on top of the storage cell. Table 7 summarises the results at various distances away from the platforms. Under the then prevailing circumstances the anaerobic conditions are seen not to extend beyond about 250 m away from the platform. Samples from distances of more than 500 m were similar to those of uncontaminated sites. A thorough benthic bottom survey carried out in March 1982 jointly by the Institute of Offshore Engineering, Edinburgh and Shell Expro, Aberdeen (T.G.W.) around Brent-Alpha platform essentially confirmed these conclusions. See Table 8.

Recent observations[2,5] close to other platforms (Statfjord, Beryl) suggest similar conditions.

It is interesting to note that recent results obtained around gas and oil platforms drilled with water-base muds indicate similar anaerobic zone limits (about 250 m).

b. Larger distances from the platforms

At larger distances from the platform the amount of cuttings deposited and also the absolute amount of oil on the sediment, is considerably less and probably readily available to biodegradation. Field data on progressive degradation of the oil components and on recovery of the ambiente are, however, still lacking, and the relevance of laboratory degradation data[13] to the field situation is disputed[5].

ALTERNATIVE BASE-OILS

One of the major environmental concerns is the impact that the aromatic oil-components may have on the marine fauna.

They rank higher in acute toxicity than many other oil components, but are most times also easily degradable. There is yet hardly any field data on their environmental impact on, say, benthos. Comparative aquarium data suggest for polychaetes a 50% mortality at a continuous exposure of 96 hours to concentrations of 0.1-4 ppm of naphthalene or phenanthrenes, as compared to some 10 ppm for similar tests with crude oil.

To meet the existing concerns, nevertheless, oil industries have supplied 'low-toxic' alternative base-oils: refined (white mineral) oils with most of the aromatics removed.

Tests done in several U.K. Laboratories of several alternative base-oils have shown[13] that their relative acute toxicity is considerably lower than that of diesel oil. It is interesting, however, that at the very low aromatic content of all but one base-oil there seems to be little correlation between acute toxicity and the measured total aromatic

content of the mud.
Their performance as a drilling mud in several recent North Sea wells has been quite satisfactory. For further detail we would refer to ref. 15.

REGULATORY ASPECTS

The legal requirements of the Marine Pollution Convention and Protocol (1973/78) and the 1972 London Dumping Convention do not apply to (OBM) cutting discharges. Both conventions explicitly exclude "release of harmful substances directly arising from the exploration, exploitation and associated offshore processing of sea-bed mineral resources...".
(Mar. Pol. Conv., Art. 2(3)(b), London Dumping Conv., Art. III, 1(c)).

On the other hand, the regional North Sea pollution conventions, 1974 Paris Convention (against pollution from land-based resources), and the 1972 Oslo Convention (against pollution of the North Sea), concern themselves also with discharges from E&P installations. They acknowledge the national jurisdiction over a certain installation, but attempt to harmonise the regulatory requirements.

The use of OBM and discharge of cuttings have - up till now - essentially been accepted on the basis of the assumption that the expected damage and load on the local environment around the platform in the local circumstances was acceptable. In Norway, regular monitoring of environmental parameters is generally included as a requirement, to ensure that this basic assumption is not invalidated in the course of the drilling activity. In the UK no such requirement exists.

These 'environmental quality considerations' have given the UK regulatory agencies the flexibility to accept (after due testing) the alternative base-oils in preference to diesel in OBM drilling. The acceptance criterion is that their (laboratory) 96 hour LC 50 must be at least 5 times greater than that of the reference diesel-based equivalent[14]. Further surveying will be necessary to substantiate any (expected) difference/reduction in impact.

Similar ad hoc acceptance is found in drilling activities in the Danish waters.

CONCLUSIONS

1. OBM cuttings have a restricted environmental impact, limited in time and volume/area.

2. Data suggest that - due to the strong adhesion of the oil to the cuttings - much less oil might be available to pollute the environment than would follow from volume estimates.

3. Field observations in the water column indicate that outside the immediate neighbourhood of the discharge, the relevant hydrocarbon concentrations are almost at ambient levels, and environmental impact, if any, is difficult to establish.

4. For bottom sediments, the field observations indicate that for environmental purposes three zones can be distinguished:
   a) The proximal zone, extending about 300-700 m from the platform, where cuttings form a surface deposit (thickest at the source, and quickly thinning towards the zone limits), where anaerobic conditions exist (with associated H_2S) and where biodegradation will be slow. Environmental impact will be significant, and any recovery will be slow.
   b) The distal zone, reaching beyond the proximal zone out to some 1500-5000 m, where cuttings may be found as thin patchy deposits of tiny particles, where aerobic conditions exist and biodegradation can readily take place. Environmental impact, if any, will be light, and recovery quick.
   c) The far zone, beyond some 1500-5000 m, where no environmental impact can be identified. The benthos is 'normal' and can be compared from one area to another.

   Local circumstances will determine the actual field limits of these zones.

5. Regulation of OBM drilling by Environmental Quality criteria allows for a flexible operating regime in which economic, technological and environmental considerations can be adequately balanced.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the permission given by R.A.A. Blackman and R.J. Law to include results from their extensive field surveys which have not yet been formally published.
To retain authenticity for all quoted data the original units (m, miles, μg/l, ppm, etc.) have been maintained throughout this overview.

REFERENCES

1. Fair, G.M., Geyer, J.C. and Okun, D.A.: Elements of Water Supply and Waste Disposal, 2nd ed., Wiley, New York, 1971, 369.

2. Grahl-Nielson, O., Sundby, S., Westrheim, K. and Wilhelmsen, S., 1980: "Petroleum Hydrocarbons in Sediment Resulting from Drilling Discharges from a Production Platform in the North Sea", Proc. Symp. Research on Env. Fate and Effects of Drilling Fluids and Cuttings, vol. I, pp. 541-561.

3. Blackman, R.A.A. and Law, R.J.: "The Oil Content of Discharged Drill Cuttings and its Availability to Benthos", ICES paper CM 1981/E:23, 15 pp.

4. Law, R.J. and Blackman, R.A.A.: "Hydrocarbons in Water and Sediments from Oil-Producing Areas of the North Sea", ICES paper CM 1981/E:16, 20 pp.

5. Law, R.J., Blackman, R.A.A. and Fileman, T.W.: "Surveys of Hydrocarbon Levels around Five North Sea Oil Production Platforms in 1981", ICES paper CM 1982/E:14, 18 pp.

6. Law, R.J.: "Hydrocarbon Concentrations in Water and Sediments from UK Marine Waters", Marine Pollution Bulletin, vol. 12, May 1981, pp. 153-157.

7. Read, A.D. and Blackman, R.A.A.: "Oily Water Discharges from Offshore North Sea Installations: a Perspective", Marine Pollution Bulletin, vol. 11, Feb. 1980, pp. 44-47.

8. Baker, J.M.: "The Environmental Impact of Refinery Effluents", Part III, CONCAWE Report No. 5 (1979) pp. 16, 41-53.

9. Davies, J.M., Hardy, R. and McIntyre, A.D.: "Environmental Effects of North Sea Oil Operations", Marine Pollution Bulletin, vol. 12, Dec. 1981, pp. 412-416.

10. Armstrong, H.W., Fusik, H., Anderson, J.W. and Neff, J.M.: "Effects of Oil Field Brine Effluent on Sediments and Benthic Organisms in Trinity Bay, Texas", Marine Environmental Res., vol. 2, 1979, pp. 55-69.

11. Bakke, T.: "The 1980 Survey for Benthic Fauna in the Statfjord area", Publ. Instit. for Marine Research, Bergen, Norway, 1981

12. Wilkinson, T.G.: "The Role of Natural Sciences in Developing an Environmental Programme for Offshore Operations", Chemistry and Industry, Feb. 20, 1982, pp. 115-123.

13. Saltzmann, H.A.: "An Investigation of the Rates of Biodegradation of Aromatic Hydrocarbons in Marine Sediments, and the Application of this Approach to a Survey of Three North Sea Oil Fields", ICES paper CM 1981/E:45, 16 pp.; cited in ref. 5.

14. Blackman, R.A.A., Fileman, T.W. and Law, R.J.: "Oil-Based Drill Muds in the North Sea - the Use of Alternative Base-Oils", ICES paper CM 1982/E:13, 15 pp.

15. Thoresen, K.M. and Hinds, A.A.: "A Review of the Environmental Acceptability and the Toxicity of Diesel-Oil Substitutes in Drilling Fluid Systems", 1983 IADC/SPE Drilling Conference paper.

TABLE 1
Estimated areal spread of cuttings in Brent area for various bulk densities, current velocities and discharge heights

	Bulk Density (g/cm^3)	Discharge Height above Sea Bed (m)	Average Particle Size (mm)	Max. Areal Cuttings Spread (m)	Current Velocity
Cuttings	1.7	150	1.7	300	full cycle
	1.7	150	0.75	1200	full cycle
	2.45	150	1.7	160	full cycle
	2.45	150	0.75	1000	full cycle
Sand	2.65	150	2.0	90	full cycle
	2.65	150	0.6	1800	full cycle
Cuttings	1.7	150	0-2	20	0.03 m/sec
	2.45	150	0-2	20	0.03 m/sec
Sand	2.65	150	0-2	20	0.03 m/sec
Cuttings	1.7	150	0-2	300	full cycle
	1.7	30	0-2	60	full cycle
	1.7	15	0-2	30	full cycle

TABLE 2
Thickness of cuttings layer (in cm) around platforms in the Brent/Cormorant area (1981)

Platform	Distance (m) 75	150	200	250	450
Brent/ Cormorant A	15-20	0.5	0.1	n.m.	n.m.

TABLE 3
Total hydrocarbon contents in the water column around North Sea platforms

	Beryl 4,5		Montrose 5	Thistle 5	Auk 4	Piper 5
	1981	1982	1982	1982	1981	1982
Mean Total Hydrocarbon Content (μg/l)	1.0	3.0	4.2	3.0	1.0	1.7
Range of distances of sampling stations (miles)	1-20	.5-7.1	.5-5	.5-5	1-20	.5-5

TABLE 4
Hydrocarbon accumulation in mussels, Brent field, 15 m depth, exposure time 9 weeks (1981)

Location	Distance (km)	Mean hydrocarbon concentration μg/g (wet weight)	Diesel oil detectable
MA (Treasure Finder)	0	1300	+
MB (Vent)	6 km S.E.	70	-
MC	10 km S.E.	30	-
MD	25 km S.E.	20	-
Unexposed Control (1981)		6 - 15	

TABLE 5

Sediment concentrations of total hydrocarbons (in μg/g) and of naphthalenes (in ng/g), resp. naphthalenes, phenantrenes, dibenzothiophenes (NPD, in μg/g wet sediment) in several North Sea fields, 1979-1981

Beryl[5]

Distance (mi)	THC	ΣN
0.5	700-1100	74,700
1	130-220	4,819
2	44-71	2,013
3	19-28	78
4	12-14	149
5	7-11	31

Thistle[5]

Distance (mi)	THC	ΣN
5	60	811
1	33	215
2	11	13
3	9.7	87
5	8.0	21

Statfjord[2]

Distance (mi)	THC	ΣNPD
0.15	1768	32
0.3	147	0.6
0.4	89	0.7
0.75	36	0.35
1.1	20	0.10
1.45	4	0.02
2.0	6	0.03
3.0	5	0.01

TABLE 6
Sediment concentrations of total hydrocarbons (in ppm) in Brent/Cormorant area (1981)

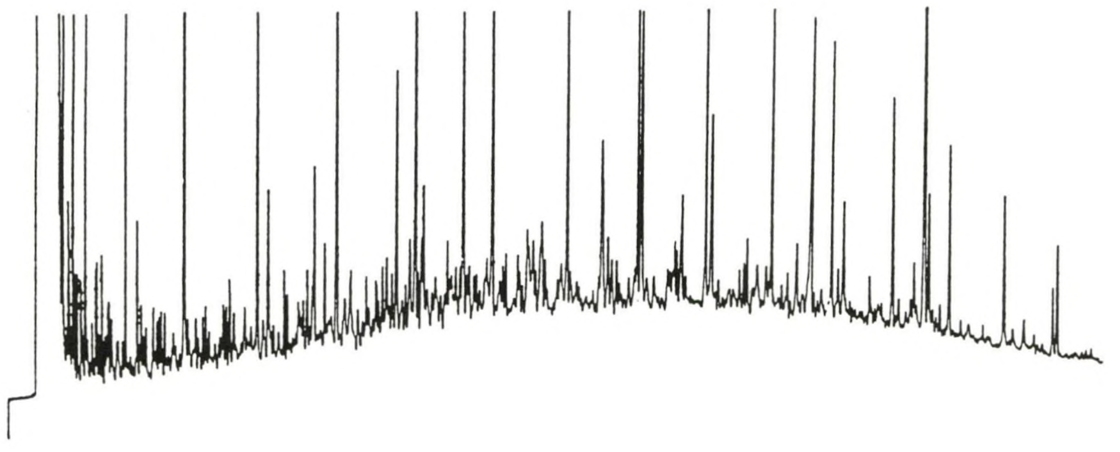
BRENT - ALPHA Distance (m)	THC	BRENT - DELTA Distance (m)	THC	CORMORANT - ALPHA Distance (m)	THC
200	2000	200	200	75	3500-4000
300	33	300	144	150	600-800
500	20	500	40	200	150-200
1000	20			250	50
2000	20	2000	20	450	50

TABLE 7
Sediment investigation around Cormorant-Alpha (June 1981)

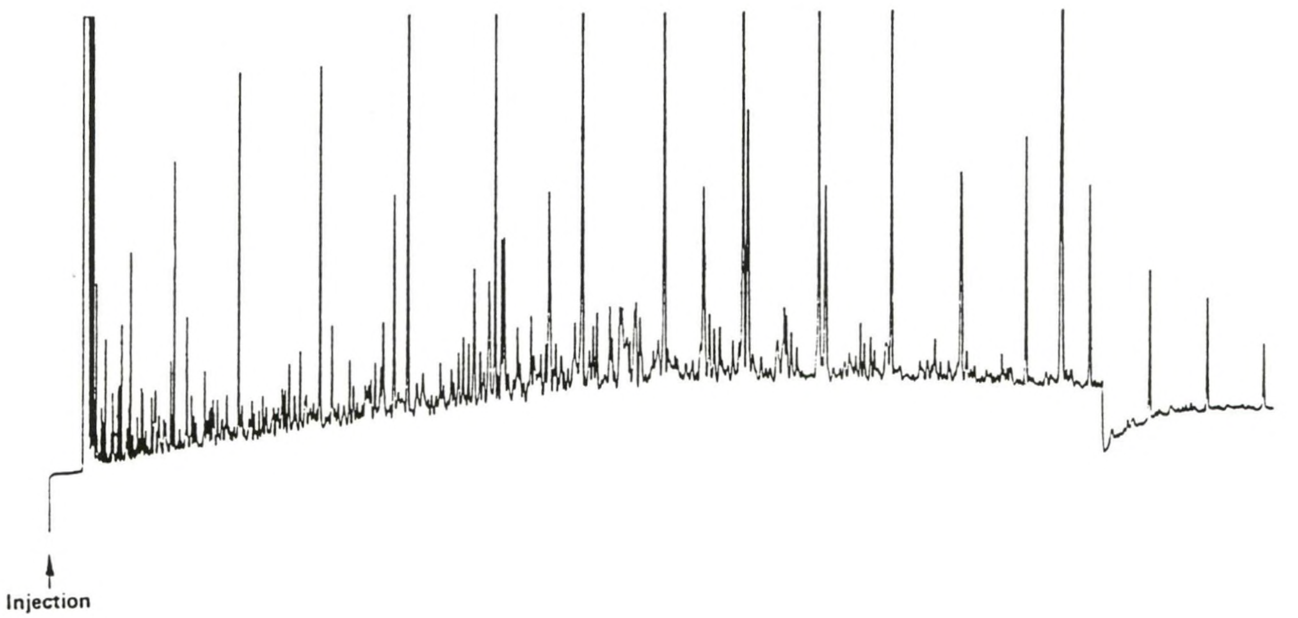
	DISTANCE (m) 75	150	200	250	450
Cuttings depth (cm)	15-20	0.5	TRACE	0	0
Total Hydrocarbon Content (μg/g)	4000	600	200	ambient	ambient
Thickness of sulphide layer (cm)	20	10	STREAKS	0	0
SRB's (no/ml)	10^4	10^4	10^4	10^1	10^1

TABLE 8
Sediment investigation around Brent-Alpha (March 1982)

	DISTANCE (m) 200	300	500	1000	2000
Total Hydrocarbon Content (μg/g)	2000	33	22	15	19
SRB's (no/ml)	10^4	10^2	10^2	10	10



Exposed mussel extract (MA 15.3, 1981)



Diesel oil

Fig. 1—Mussel hydrocarbons GC tests. Diesel oil vs. Mussel extract at source (MA).

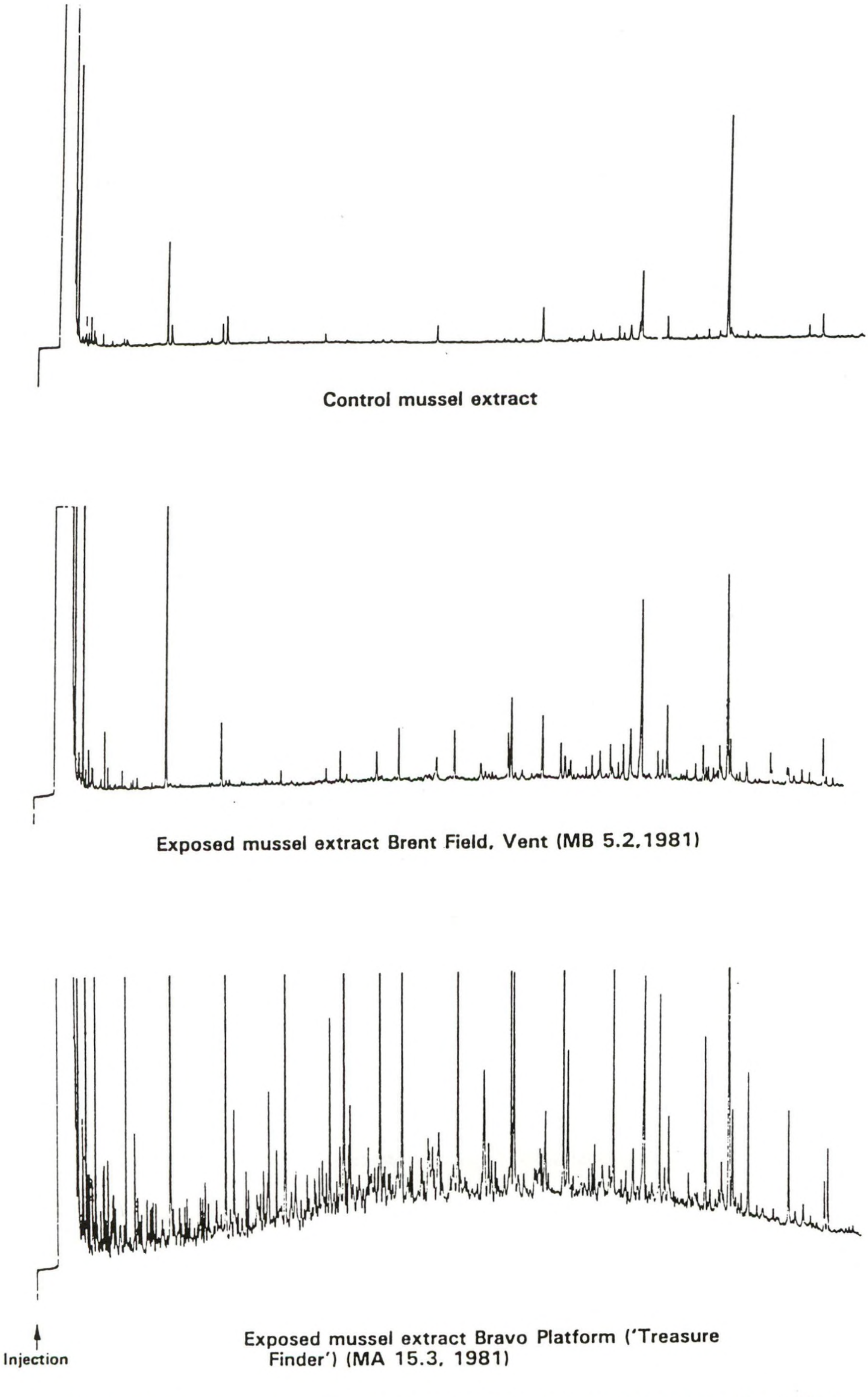
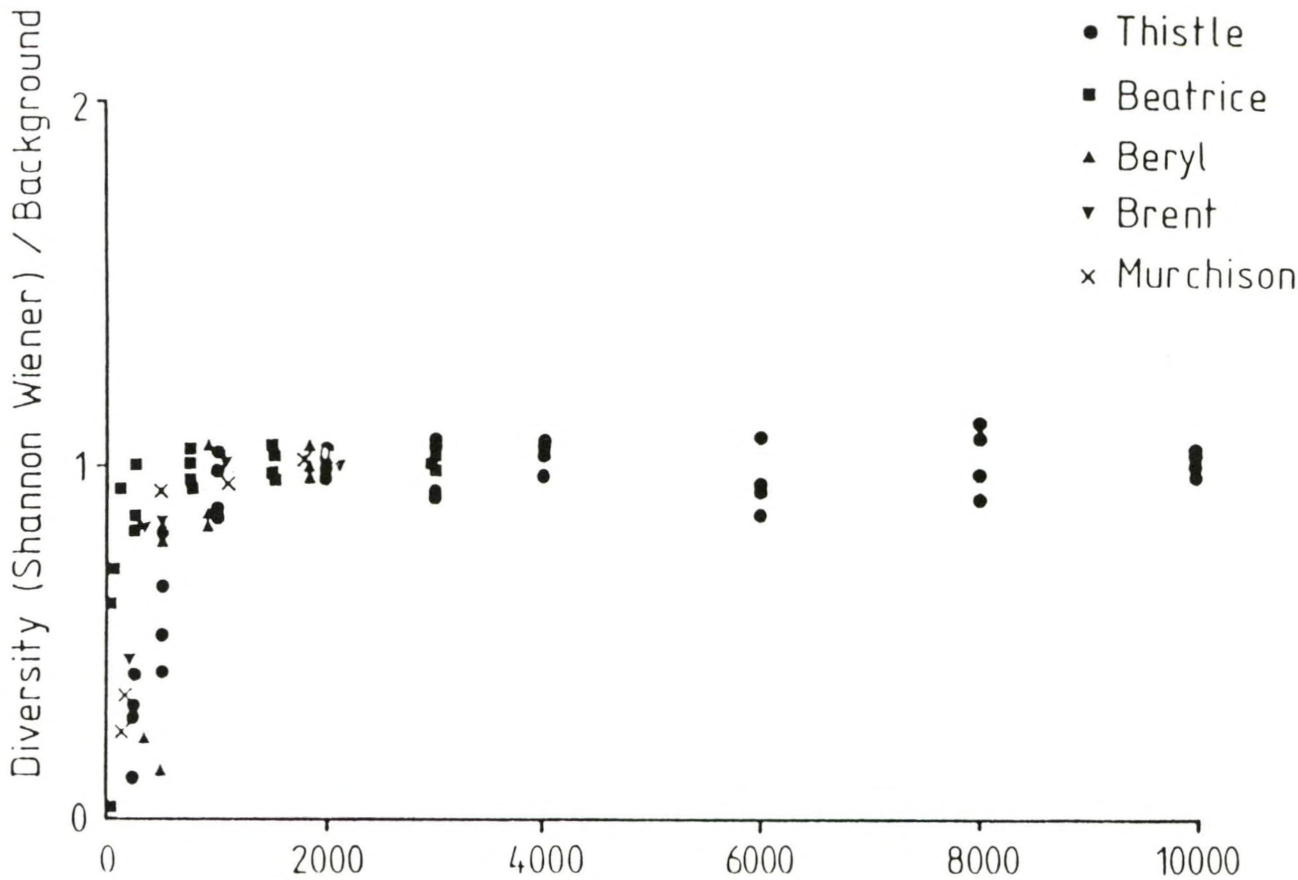
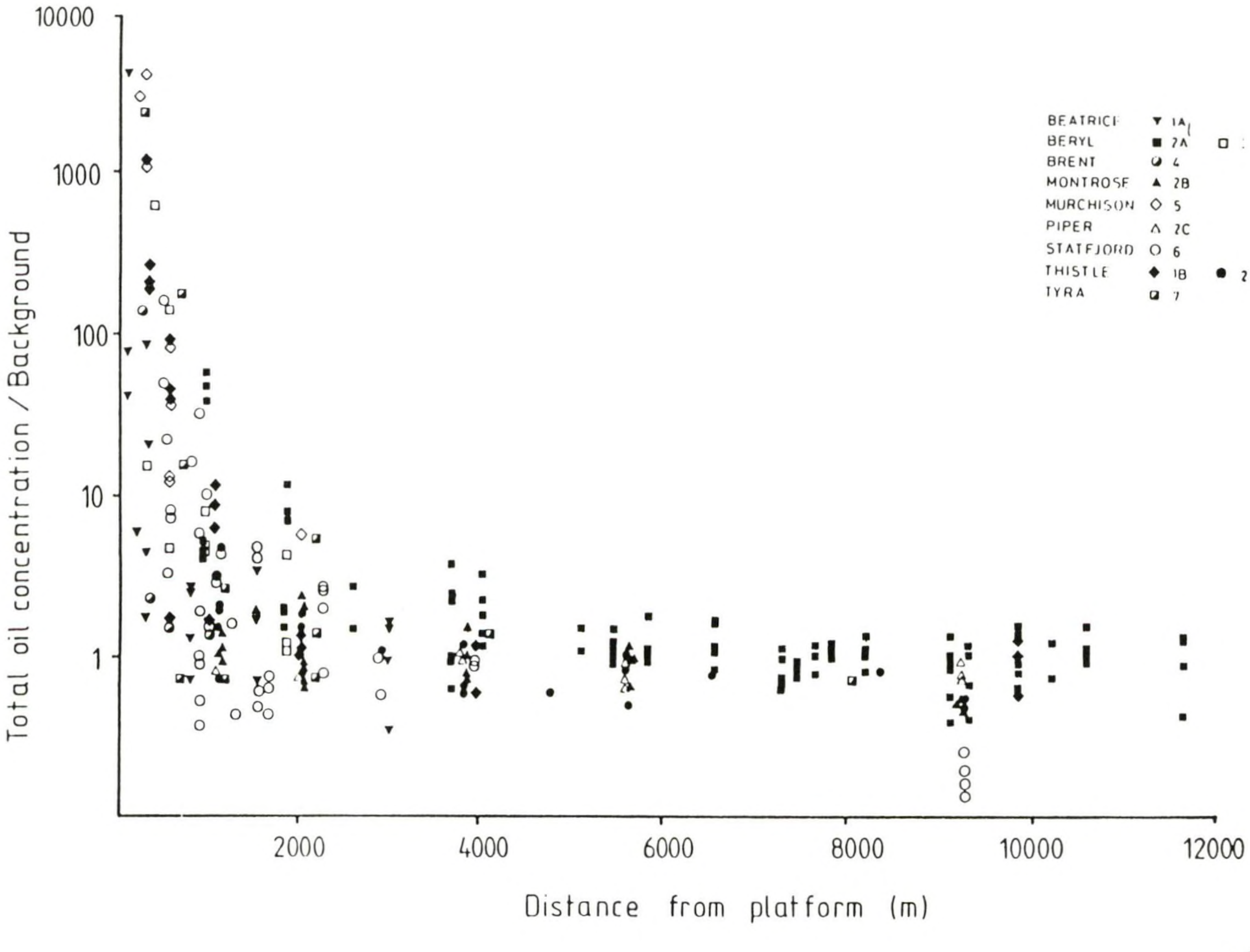


Fig. 2—Mussel hydrocarbons GC tests. Mussel extracts at source (MA) and at 6.0 km (MB) vs. control.



Thistle
Beatrice
Beryl
Brent
Murchison
Diversity (Shannon Wiener) / Background
0
1
2
0
2000
4000
6000
8000
10000
Distance from platform (m)

Figure 1



BEATRICE 1A
BERYL 2A
BRENT 4
MONTROSE 2B
MURCHISON 5
PIPER 2C
STATFJORD 6
THISTLE 1B 2
TYRA 7
Total oil concentration / Background
10000
1000
100
10
1
2000
4000
6000
8000
10000
12000
Distance from platform (m)

The Role of Science in Policy Decisions Regarding Offshore Oil and Gas Development in the United States: The Environmental Perspective

Ms L Speer,
Natural Resources Defense Council, New York

Environmental problems related to offshore oil and gas activities include oil spills; chronic pollution resulting from routine discharges of drilling fluids and produced (formation) water; disturbance effects on birds and marine mammals; and onshore impacts associated with industrial facilities necessary to support offshore oil activities.

Despite the very substantial impacts of offshore oil development, policy decisions in the U.S. regarding where to drill are rarely driven by scientific information regarding such impacts. Instead, decisions on where to drill are driven largely by the potential for economic gain to the industry and the federal government. From the environmental perspective, this is due to several forces at work.

First, the offshore oil development program in the U.S. is controlled by an agency (the Minerals Management Service, or 'MMS') that has a much stronger interest in oil development than it has in environmental protection. Agencies whose primary missions are to conserve and protect marine biological resources do not have a meaningful role in decisions regarding where to drill. As a result, scientific information and expertise on environmental impacts are not effectively incorporated into drilling decisions.

A second problem is that the funding and direction of environmental impact studies are largely controlled by the oil industry or MMS, whose missions are to maximize offshore oil exploration and development. This has created a situation where independent scientific investigations are hard to come by.

A third problem relates to the tendency of the oil industry and MMS to equate failure of science

Introduction

Environmental problems related to offshore oil and gas are many and can be quite severe. In the U.S., scientific studies of environmental impacts have not played an important role in policy decisions regarding where to drill and under what regulatory restrictions. This paper attempts to enumerate some of the reasons why science is not used effectively in offshore policy decisions from an environmental perspective, and to offer a few possible solutions.

A. Differences Between Offshore Development in the U.S. and the North Sea

Before proceeding, it is important to briefly review some of the differences between offshore oil and gas development in the U.S. and the North Sea. These differences influence the scientific, social and political atmosphere in which offshore policy decisions are made.

First, offshore development in the U.S. is not restricted to one relatively limited geographical region as it is in the North Sea, but instead takes place in many different areas off all coasts. More than a billion acres of offshore federal lands are potentially available for oil development. That is an area equivalent to about one-half the land mass of the continental U.S.

While development in the past has focused on the Gulf of Mexico, which lies off the southern coast of the U.S., industry interest has increasingly spread to other areas, especially offshore California and Alaska. Development there is taking place very rapidly, and with the recent recovery of oil prices, interest is reviving in areas off the east coast as well.

Second, the focus of offshore development in the U.S. is much more coastal than it is in the North Sea. While most North Sea development has taken place in the open ocean, most offshore development in the U.S. has been located in coastal and nearshore waters. As a result of this nearshore focus, a much broader range of

to detect environmental impacts with the absence of such impacts. This approach fails to take into account the extremely limited ability of marine science to detect change in the marine environment and to separate man-induced changes from natural ones. However, simply because science does not detect an acute impact does not mean there are not chronic, low-level but cumulatively important impacts occurring that could together spell disaster for sensitive marine resources.

A final problem is the generally poor state of communication and interaction between scientists on the one hand and policy makers and the public on the other hand. This is a longstanding problem, and one that affects every aspect of environmental policy, not just marine affairs.

constituencies are potentially affected by, and concerned with, offshore activities, including real estate developers, those whose livelihoods depend on coastal tourism, and others whose businesses rely upon a healthy, unpolluted coastal environment. Offshore oil is thus not just an environmental issue in many areas of the U.S., but a major economic and political one as well. The political clout of offshore opponents is such that the U.S. Congress has repeatedly intervened in the federal offshore program to put very large areas of the continental shelf off-limits to the oil industry.

Third, some of the environmental controls on offshore development in the U.S. are apparently somewhat more stringent than they are in the North Sea. For example, the discharge of cuttings contaminated with oil-based muds is prohibited in the U.S
Similarly, the discharge of diesel oil, even when it is used as a pill to free stuck pipe in water-based muds, is strictly forbidden.
Despite these and other differences, there are many similarities.
Like the North Sea, most oil industry waste generated by offshore activities in the U.S. is permitted to be discharged, not because such waste is harmless, but because other options like complete recycling are not as economically attractive to the oil industry. Also like the North Sea, little is known about the individual and cumulative impacts of all discharges from offshore activities; still less is known about the effects of such discharges in combination with other effluents from other industries impacting the same region.

B. Environmental Concerns

The coastal and nearshore focus of much of the offshore development in the U.S. has heightened concerns about certain environmental impacts, as discussed below.

Spills

For example, oil spilled in coastal environments can have devastating impacts. Particularly when spilled near sheltered environments such as coastal wetlands, oil may persist in sediments for decades where it can continue to exert effects on benthic organisms. Many of the coastal and nearshore areas proposed for oil development in the U.S. are extraordinarily sensitive to oil. A good example is the area off the Florida Keys, which is thickly populated with tropical corals, seagrasses and other live bottom species. A 1964 spill of only 500 gallons near the Dry Tortugas caused long term and probable permanent damage to the corals there. A major oil spill on such an environment would obviously cause untold destruction, but even small routine spills can cause major ecological damage.

As the Exxon Valdez disaster in Prince William Sound so dramatically illustrated, the ability of industry and the federal government to respond to spills is extremely limited. Indeed, containment and cleanup operations in the U.S. average only 5-15% recovery of spilled oil.[1] The proximity of oil development to the coast makes even small spills of very significant concern.

Routine Discharges

In addition to spills, there is very great concern about the impacts of the vast quantities of waste materials generated by offshore activity. Each time a well is drilled offshore in the U.S. an average of 1500 to 2000 tons of drilling mud and cuttings are generated and must be disposed of,[2] usually by dumping over the side of the platform. The federal government estimates that roughly 6,000 offshore wells will be drilled in the period 1987-1992[3] – this means that more than 10 million tons of muds and cuttings will be generated and disposed of in U.S. offshore waters.

Although oil-based muds may not be discharged, drilling fluids and associated cuttings nevertheless typically contain substantial amounts of toxic metals, including cadmium, copper, arsenic, lead and mercury. The discharge of 10 million tons of drilling fluids will mean that as much as 7,500 tons of listed toxic metals will be dumped into the ocean as a result of offshore activities for the 5-year period 1987 - 1992.[4] Prohibiting the discharge of oil-based mud thus does not eliminate concerns about drilling muds.

Produced water is another waste stream of concern. The oil industry has estimated that over 1.5 million barrels of produced water are discharged each day into the Gulf of Mexico.[5] The toxic pollutants found in produced water include cadmium, lead, benzene, naphthalene, zinc, and toluene.[6] Add to that the biocides, coagulants, corrosion inhibitors and other additives and the result can be very toxic.

Oil and grease in produced water are also quite significant. For example, the discharge of 1.5 million barrels of produced water per day into the Gulf of Mexico means that 25,000 barrels of oil and grease are permitted to be dumped into the Gulf each year.[7] By way of comparison, the federal government characterizes oil spills involving 1,000 barrels or more as 'major spill events.'[8] So produced water annually contributes the equivalent of 25 major oil spills each year, year in, year out.

Recent concerns have been raised about radioactivity in produced water as well. Studies by the Louisiana Department of Environmental Quality indicate that produced water often contains levels of radioactivity above that which can legally be discharged from a nuclear power plant.[9]

Finally, the biochemical oxygen demand (BOD) of both drilling waste and produced water can be quite high. The federal Environmental Protection Agency estimates that BOD from ocean discharged muds and cuttings is more than six times the total BOD of all municipal sewage sludge disposed of in the ocean.[10]
Again, much of that BOD is discharged into nearshore and coastal waters, many of which already suffer from oxygen depletion resulting from other sources of pollution.

In addition to spills and discharges, helicopters, seismic exploration activities, vessel traffic and drilling operations can disturb birds, whales and other animals, causing them to avoid areas where the disturbance occurs. For example, helicopter and other air traffic to and from OCS operations in the St. George Basin in Alaska's Bering Sea resulted in severe disturbance of waterfowl in the Izembek Lagoon National Wildlife Refuge in Alaska.[11] As another example, research in the Beaufort Sea has recently indicated that endangered bowhead whales avoid drilling and/or seismic activities.[12] The ultimate effect of this avoidance behavior is unknown, but the National Marine Fisheries Service has concluded that operations in certain areas of the Beaufort Sea are likely to jeopardize the continued existence of bowhead whales, due in part to the fact that disturbance may 'block or seriously disrupt' the whales' spring migration.[13]

Onshore impacts

A last category of impacts that have been quite serious in the U.S. are onshore impacts of offshore development. Canals and pipeline construction in support of offshore oil have destroyed vast areas of extremely productive coastal wetlands along the Gulf coast. In addition, construction of onshore support bases, transportation facilities, pipelines, storage tanks, processing facilities, housing, roads, etc. have caused major impacts. Particularly in undeveloped areas where little infrastructure presently exists, as in Northern California, the Florida Keys and most of Alaska, onshore industrialization accompanying offshore oil can result in serious and long term impacts on coastal habitats.

The aesthetic impacts of heavy offshore development close to shore are a great concern in many parts of the U.S., particularly where the beauty and undeveloped character of the coast is a valued commodity. While perhaps not ecologically significant, aesthetic impacts are socially and politically very significant in such areas.

C. The Role of Scientific Impact Information in Decisions on Offshore Oil.

Despite the very substantial impacts of offshore oil development, policy decisions regarding where to drill are rarely driven by scientific information regarding such impacts. Instead, such decisions are driven largely by the potential for economic gain to the industry and the federal government. From the environmental perspective, this is due to several forces at work.

The Minerals Management Service (MMS) is the Agency within the U.S. Department of the Interior that is responsible for leasing onshore and offshore federal lands to various industries, including the mining industry and the oil and gas industry. MMS' primary mission is to maximize resource extraction activities that contribute revenues to the federal treasury, and it is staffed principally by miners, petroleum geologists and other experts in resource extraction.

Unfortunately from our perspective, Minerals Management has almost exclusive legal authority over decisions on where to drill. The federal agencies with more direct responsibility for environmental protection are not given a meaningful role in such decisions, and indeed their recommendations are routinely ignored.

For example, the National Marine Fisheries Service is the federal agency charged with managing offshore fisheries and marine mammals. The Fisheries Service has repeatedly recommended that certain areas off Alaska not be leased for oil development due to the likelihood that such development would jeopardize the continued survival of several species of endangered whale, and would endanger other important biological resources. These repeated recommendations, based on the Fisheries Service's scientific studies and expertise, are routinely ignored by MMS, as have similar recommendations made by other environmental protection agencies.

Even worse, scientific and policy advice against offshore drilling given by expert resource agencies is sometimes suppressed in the interests of facilitating offshore development.

For example, draft comments highly critical of an upcoming offshore lease sale off California submitted by the U.S. Fish and Wildlife Service were suppressed after internal political pressure was brought to bear by Minerals Management. The Fish and Wildlife Service resubmitted its comments with all critical remarks removed. There have been numerous similar incidences of suppression of scientific and policy advice of expert agencies in the interests of facilitating oil development. This was a particular problem during the pro-development Reagan Administration, but there is evidence that it is continuing.

So one major problem is the fact that the offshore oil development program in the U.S. is controlled by an agency that has a much stronger interest in development than it has in protection of the environment. Agencies whose primary functions are to conserve and protect marine biological resources do not have a meaningful role in decisions regarding where to drill. As a result, scientific information and expertise in environmental impacts are not effectively incorporated into drilling decisions.

A second problem is that the funding and direction of environmental impact studies are largely controlled by the oil industry or the Minerals Management Service, whose missions are to maximize offshore oil exploration and development. This has created a situation where independent scientific investigations are hard to come by. A related issue is that there are few scientists with expertise in offshore oil and gas who are not connected financially or otherwise with the Minerals Management Service or the oil industry. This makes it very difficult for the environmental community and even the environmental protection agencies to find experts who are willing and able to critically and credibly evaluate technically complex industry and government studies.

A third problem relates to the tendency of the oil industry and the Minerals Management Service to equate failure of science to detect environmental impacts with the absence of such impacts.
This approach fails to take into account the extremely limited ability of marine science to detect change in the marine environment and to separate man-induced changes from natural ones. The marine environment is complex and variable. Detecting significant changes before they have occurred is frequently extremely difficult. Science has often failed to pick up major environmental problems until such problems reach potentially disastrous proportions, for example DDT in raptor eggs, or until such problems are obvious to ordinary citizens on the scene (for example, massive fishkills due to low dissolved oxygen in the New York Bight). When government or industry studies do not reveal detectible changes in the marine environment as a result of spills, discharges or disturbance effects, they often conclude that no problem exists.
Environmentalists counter that simply because science does not detect an acute impact does not mean there are not chronic, low-level but cumulatively important impacts occurring that could together spell disaster for sensitive marine resources.

A final problem is the generally poor state of communication and interaction between scientists on the one hand and policy makers and the public on the other hand. This is a longstanding problem, and one that affects every aspect of environmental policy, not just marine affairs.

So how do we improve the interaction between science and policy? First, it is far from clear that throwing 10 million guilders at the problem is going to solve it, and the likelihood of such a sum appearing is small. There are some things that can be done without spending vast sums.

First, jurisdiction over the decision 'where to drill' should be shared among the federal and state agencies with an interest in the resources potentially affected. In the U.S., this would mean making agencies like the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency and the National Marine Fisheries Service, and State resource protection agencies, equal partners with the Minerals Management Service in decision making. This would help ensure that all relevant scientific evidence and expertise on environmental impacts are integrated in decisions regarding where to drill.

Second, the same agencies that participate in the drilling decision should share control over the funding and direction of environmental impact studies financed by the federal government
Giving funding and substantive control over environmental studies to a broad range of agencies may help encourage scientists with a broader range of perspectives to participate in this type of research.

Third, thoughtful criteria need to be developed governing the application of the precautionary principle to oil activities in particularly sensitive areas. At present the precautionary principle is applied not on scientific grounds, but on the basis of the political power of opponents of offshore oil. In other words, because their Congressional delegations are large and powerful, much of the offshore area off Florida and California have been placed off limits to the oil industry. Other similarly sensitive areas have not received the same protection, not because they do not need it, but because they lack political clout. The development of thoughtful, rational criteria to govern the precautionary principle will not eliminate politics from the process, but will help make political choices more informed ones.

Fourth, communication between scientists and the public needs improvement. Expecting the public and policy makers to become educated about science in any detailed or thoughtful way is probably unrealistic. Politicians tend to think in 10 minute time horizons, and unless the issue is on the front page of the New York Times , very few of them are likely to take the time to learn the scientific underpinnings of most marine issues. The same goes for the public.

But improvements can be made in the education of scientists. It is obvious that science does not occur in a vacuum; much of its has social and political relevance. Academic programs that address social and political issues could help scientists integrate their work more successfully into policy debates.

Another area where improvements would be useful is in the establishment of formal, routine feedback loops between scientists, policy makers and the public. Institutional mechanisms for regular communication between scientists and decision makers can help establish lines of communication and understanding. Examples include frequent public hearings, established science advisory boards, and other routine and formal mechanisms.

Finally, scientific information is all too rarely translated into information that is useful, understandable and relevant to decision makers and the public. Particularly when scientific studies are highly relevant to public policy decisions, formal mechanisms for communicating results to the public should be routinely incorporated. This is in the best interests of scientists themselves in that the public is more likely to support the allocation of research dollars if they understand why such research is important and relevant.

Undertaking these and other recommendations made at this conference could go a long way toward maximizing the effective use of environmental information into policy making.

Footnotes

1 Draft Environmental Impact Statement, OCS Lease Sale 97 at IV-A-15; Final Environmental Impact Statement, OCS Lease Sales 94, 98, 102 at 240.

2 National academy of Sciences, 1983. Drilling Discharges in the Marine Environment at 16.

3 Final Enviromental Impact Statement, 5-Year OCS Leasing Program, §table IV.A.1-1.

4 Average toxic metal content of muds derived from industry data provided in U.S. Environmental Protection Agency, 1985. Assessment of Environmental Fate and Effects from Offshore Oil and Gas Operations, at 2-35.

5 50 Federal Register at 34598.

6 Id.

7 Current U.S. Environmental Protection Agency limits on oil and grease in discharged produced water are 48 mg/l as a monthly average and 72 mg/l as a daily maximum; taking the lower of these two numbers, the discharge of 1.5 million barrels per day of produced water means that 24,745 barrels of oil and grease per year are dumped into the Gulf of Mexico.

8 Final Environmental Impact Statement, OCS Lease Sales 94, 98 and 102 at 226.

9 Environment Reporter , February 3, 1989 at 2073.

10 U.S. Environmental Protection Agency, 1985 supra.

11 Final Environmental Impact Statement, OCS Lease Sale 89 at IV-50.

12 Minerals Management Service, 1987. Prediction of Drilling Site Specific Interaction of Industrial Acoustic Stimuli and Endangered Whales in the Alaskan Beaufort Sea. Final Report, November 1987, OCS Study MMS 87-0084.

13 Final Environmental Impact Statement, OCS Lease Sale 97 (Beaufort Sea), Vol. II, Appendix J.

Discussion

Rapporteur:
Piet Hein Nelissen

Chairman: Dr Lange
Members of panel:
Dr Koefoed, Dr Scholten, Dr Poley, and Ms Speer

Mr Lankester (North Sea Working Group East Anglia) asks where the wisdom is when designing the rigs. Governments, in order to follow the rapid developments, have to act swiftly. Scientists tend to act reactive instead of proactive, after a disaster has occurred, while the oil industry gets the blame. A company such as Shell-UK, carried out extensive environmental analysis and uses considerable technology in their designs to prevent marine pollution. Engineers, whilst designing, would benefit from a timely published 'What if...'- set of data, to give insight in the effects of their activities.
Mr Poley explains that the oil companies house proactive science. In discharging oil-based mud-cuttings the cuttings-exhaust can be located higher up, causing the cuttings to spread, which results in a lesser burden locally, but in a larger area and patchy. Local influence can be diminished, as some bottom organisms can move away from a certain amount of cuttings. The burden can also be lowered by drilling with larger cuttings and so reduce the area burdened. Different engineering possibilities can comply with policy requirements.

Ms McGlade, relating to Speers paper mentions her recent visit to the site of the Exxon Valdez disaster. In the aftermath the news media showed how people, traditionally involved in fishing, now had been deployed into the clean-up operation. Also the fears about large losses in the fishery were swept aside as fishery was very succesful this year, where outsiders had to join in catching the fish, since locals were re-deployed in the cleaning up. She asks the Natural Resources Defense Council and similar groups for more long-term information, which could demonstrate the complexity of the situation clearly and would prevent the oil industry from quickly forgetting its foibles and its woes, and wishes to add a nuance the recent message that everything is rosy up there and the fish are doing fine, neglecting even the future prospect for the fishermen once the clean-up has been done. She hopes the NGOs aim at informing the public about the long-term damage as well as giving the pungent messages.
Ms Speer agrees with McGlade. The herring fishery was closed completely, as were parts of the salmon fishery, inflicting severe damage on the fishermen. The long-term concern focuses on subsequent year classes, which may be affected by the high levels of oil in the water in parts of Prince William Sound. She points out that once the oil stops floating on the water, people tend to neglect the problems, although it is well known that the problems last, particularly in areas such as Prince William Sound which has many wetlands and coastal quiet water areas, where the oil can become entrained in the sediments and continue to exert effects on benthic organisms for many many decades. The NRDC will continue to focus on that by watching long-term studies and will ensure that such information does not get lost.

Mr Horsman (Seas at Risk) wishes to defend the Precautionary Principle, as this emerged because previous principles have failed. The equitability or balance which Poley mentioned, depends entirely on one's standpoint, whereas the Precautionary Principle redresses the balance in favour of the environment, and appears more scientifically justified than aiming at definite scientific statements. Terms like 'concern', 'maybe' or 'possibly' enable scientists better to present realistic statements about environmental vulnerability than others did.
Mr Poley would welcome it if the Precautionary Principle would allow scientists to present more solid arguments instead of 'concern' and 'suggest', so items can be discussed, allowing for a step-by-step approach to render well considered alternatives and decisions in an EIA procedure.

Mr de Jong mentions that, when collecting data on the use of chemicals other than oil in offshore operations, he found that amounts of biocides on the UK continental shelf had increased from 180 tons in 1982 to 500 tons in 1984. He asks why, after 20 years of industrial practice, so little is known about the amounts discharged and about the effects of these biocides and other chemicals used and discharged. Only now the Paris Commission summarizes data on the use of chemicals by the offshore industry from Norway, the UK and the Netherlands.
Mr Koefoed answers that industrial developments grow fast, causing governments to lag behind, as is exemplified by the initiative of the ParCom countries for coordinated collecting of data on chemicals 3 years ago. Although chemical discharges of individual compounds, or discharges involving those, are controlled by the pollution control law, the total overview is lacking, as the emission of chemicals other than oil is still not effectively controlled. He urges for good governmental and international control for their use and discharges.
Mr Scholten explains the lack of data on the environmental effects of these additional chemicals. In almost 30 years of offshore industry, accompanying environmental effect studies only started in the late seventies in the UK, and in the eighties in the Netherlands and Norway. Studies on the effects of these discharges depend on the information on discharges from the offshore industry. TNO's first monitoring studies focused on oil-based mud cuttings and production water as these were the main pollution sources. Our recent awareness of chemicals used on platforms does not include knowledge about the exact discharge volumes. Such an inventory of what is being used is necessary for estimating the impact of the chemicals. We hope to know more within one or two years.
Mr de Jong replies that evidently both authorities and scientists lag behind on industry. Contrary to Mr POLEY's remark he thinks that industry has power at present, which the Precautionary Principle might shift somewhat in the other direction.

Mr Wellershous (AKN) asks ms Speer what happens when similar toxic persistent substances are used on land. Do heavy metals, radioactive substances, oil that is burned, drilling muds used on land, oil products used in chemical processes, not end up in the sea, as well? Ms Speer agrees that impacts similar to those offshore also occur on shore; impacts may be more severe in the coastal wetlands of Louisiana and on Alaska's North slope, Prudhoe Bay. Drilling and production discharge products leaked from platforms into surrounding waters sometimes contaminate ground waters considerably. The oil and gas industry has a very substantial impact on shore as well as offshore.

Mr Henriquez shares mr Poley's frustration about government regulations which can not be interpreted clearly. He adds that, since there were no Dutch laws controlling discharges before 1988, any discharges of oil mixtures were prohibited. The industry worked with covenants.
Although he agrees that any regulation requires facts in advance, he questions whether producing facts, killing 50% of populations is not too far fetched. In the Softenon case a set of LC50 values would have killed many babies before the required data were produced. Besides lethal, also the harmful sublethal effects are important.
The Precautionary Principle is based on uncertainties. Similarly as the oil industry based its economy in for example 1973 without knowing the development of the oil price, we cannot predict the environmental situation in 2000 or 2050. The oil industry is managing its economic uncertainties without having hard facts; the Precautionary Principle has to be considered accordingly.
Mr Poley answers that from 31-8-1987 to around 20-12-1987 the oil industry had to comply with a clear limit of 100 g per kg dry weight. In December 1987 the Dutch regulatory authorities introduced the Precautionary Principle in their discussions with the oil industry setting 'reduced pollution' with lower limits, which were not yet set but to be expected. This made realistic planning difficult.

Mr McGarvin (Greenpeace consultant) remarks to mr Poley that the agreement of '50% reductions by 1995' (an example implementation of the Precautionary Principle) gives a clear time-scale for planning operations.
The potential of a toxic substance to kill populations is an area of uncertainty for scientists, while an 'agreed list of certainty' or whatever, from ParCom, requires that the acceptable data are absolutely proven. When managing the Precautionary Principle the first aim should be clean technologies. For managing the still existing waste one should aim at a reduced number of substances discharged, with industrial processes converging on an agreed list of substances, and thereby influence which products are made.
To proceed towards such list of 'agreed dischargeables' literature should first be reviewed for possible damaging effects of the substance, after which industry should have the opportunity to present contrary evidence. In the absence of such evidence after the agreed period, the substance will be considered dangerous.
Mr Poley wishes to suggest an alternative proposal, but first wants to answer mr. Enriquez. The industry after 1973 worked with scenarios. Five scenarios, ranging from a best-case to a worst-case scenario were presented to the top management, which consequently decided on 'Muddling through': an option which worked, balanced by the forces in society.
This alternative proposal for application of the Precautionary Principle shows the same balance. Let marine biologists perform a 'Delphi exercise' examining the consequences of the death of a specific type of benthos, in view of the ecosystem interdependence. Both industry and policy-makers have to be guided by the judgment of the experts. In order to achieve such advice, convergence among experts about their common opinion and advice has to be organized in a way proven effective in other fields. In a first meeting a draft is conceived, which is consequently commented upon by the individual scientists. The commented draft is discussed in a following meeting, and in three to four of such steps a common advice is produced, thus structuring the non-quantitative contribution to decision-making, rather than depending on emotive arguments which cannot be discussed. Poley argues that scientists should be able to reach such consensus and a judgment on the repercussion for the ecosystem within about 3 months, and, if not, they maybe never will, so the government could assume that science cannot contribute in qualitative aspects, while sufficient quantitative material exists. He agrees with the organizers of the Seminar that many qualitative arguments exist which refer to the interdependence within the ecosystem, but argues that they should be accessible to policy makers.

The AMOEBA has taught that ecological end effects are most often to be expected at a large distance - both in space and in time! - from the activity or discharge at the beginning of the 'chain of events'.

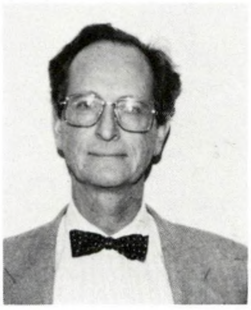
Mr Earl (Marine Conservation Society) comments on the striking difference between knowledge of information on some major discharges in America and in Europe. Such information should be transferred between organizations.

Ms Zevenboom (North Sea Directorate, Rijkswaterstaat) asks mr Poley whether he assumes that the quality and the quantity of the information about emissions (annual totals), which scientists receive as the basis for research and monitoring projects is sufficient. The complex ecosystem is matched by a complex emission system, and reasonable balance requires complete information on both. She asks industry to improve, where relevant, the information about emissions, by adding totals per drilling site, and giving exact amounts discharged additional to concentrations.
Mr Poley promises that such data, if specified, can be provided by NOGEPA. It would need some time to collect all data required.
Ms Zevenboom comments that, as environmental scientists should be able to present an answer within 3 months, it would be fair to present all detailed emission answers also within 3 months.

Mr Stebbing proposes to have a formal debate about the Precautionary Principle and the concept of 'Assimilative Capacity', which have been set in opposition throughout this seminar. Such a debate, with one speaker for the Precautionary Principle, and another for the other concept, may reveal which of the two is the more practicable, and so preferable. He offers to speak for the concept of Assimilative Capacity.
Mr de Jong supports the proposal because the Precautionary Principle, although not the main subject of the seminar, is still a key subject; a debate can elucidate the position of the concepts.
Mr Lees (Foe UK) suggests adding another common theme: access to, and freedom of, information. Also, he suggests, since the Precautionary Principle presumes the burden of proof in favour of the environment, that this could be translated into 'absolute producer liability', a way to increase the incentive for industry to implement the Precautionary Principle.
Lord Cranbrook announces that the debate on the two principles can be included in the discussions of the final session.

Session III

Co-operation between policy and science

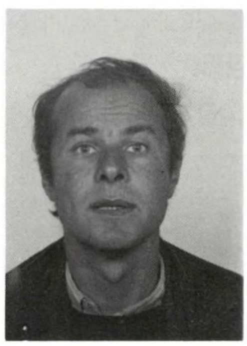


Chairman
Lord Cranbrook

Science and North Sea policy-making: Organization and Communication

Dr J. Wettestad
Dr S. Andresen
The Fridtjof Nansen Institute, Lysaker, Norway

The general focus in this article is on the communication process between politics and science in the North Sea environmental regime. More specifically, being political scientists, we take a special interest in the *institutional* and *political* aspects of this communication process. Hence we raise the following three main questions: first, which are the main necessary institutional conditions for a well-functioning dialogue between science and policy-makers in environmental policy-making? Here our suggested key-words are 'coordination', 'separation', 'communication', and 'co-operation'. Second, what (or which) main approach(es) concerrning the dialogue between science and policy-makers can be discerned in the North Sea context – in other words: how is cooperation organized and in which forums? Third, and most important, how well do the more fundamental institutional questions seem to have been handled in the current approaches?



1. Assessing the Dialogue between Science and Policy-makers: Institutional Aspects

Introduction

It has been maintained that 'scientific research is an integral part, a prerequisite even, of environmental policy.Without science, environmental policy would be dependent on the intuitively obvious' (1).

At an international symposium during the fall of 1988 in connection with the 30th anniversary of the Fridtjof Nansen Institute, the relation between science and politics in international resource management was more broadly discussed (2). Not surprisingly, one of the main conclusions was that the actual influence of science in the decision-making process tended to be quite marginal, especially when strong national and economic interests were involved. However, also in cases where science might have had a role to play, the scientific message was often ignored. One example which was offered was the process in connection with the writing of the report from the World Commission on Environment and Development (3). One main reason for the lack of scientific input was the malfunctioning of the *communication process* between policy makers and the scientific community.

Thus this is part of the reason why in this paper we find it interesting to focus on the communication process between politics and science in the North Sea environmental regime. More specifically, being political scientists, we take a special interest in the *institutional* and *political* aspects of this communication process. Hence, we raise the following three main questions: first, which are the main necessary institutional conditions for a well-functioning dialogue between science and policy-makers in environmental policy-making?
Second, what (or which) main approach(es) concerning the dialogue between science and policy-makers can be discerned in the North Sea context - in other words: how is cooperation organized and in which forums?

Third, and most important, how well do the more fundamental institutional questions seem to have been handled in the current approaches?

However, in order to be able to identify important fundamental institutional challenges within this context,some of the more basic concepts and relationships have to be defined and discussed. For instance, 'science' is here mainly understood as 'knowledge on inputs, concentrations and effects of contaminating substances' - thus mainly referring to knowledge produced by the natural sciences. However, we will come back to the role of social science - and especially political science - later in this first section. Moreover, we think it is useful to distinguish between two different societal roles which science can play: on the one hand, as a 'tool' - giving matter-of-fact scientific advice necessary for accurately 'diagnosing' problems as well as for prescribing effective 'therapies'. On the other hand, as a 'whistle-blower' - emphasizing possible problems and consequences of current policies, with information and general heightening of public attention as main objective(4). In the following we will concentrate on the 'tool'perspective.

Is it obvious, then, that scientific research can legitimately claim a major role in environmental management? According to one analyst, knowledge - in the form of theoretical understanding of cause-effect relationships as well as descriptive information about relevant variables and parameters - is a *necessary* condition for rational resource management (5). Scientific research is the major - but not the only - supplier of such knowledge. However, although being a necessary input, science does not constitute a *sufficient* basis for rational management.
Sound management policies cannot simply be derived from the findings or hypotheses of scientific research. And precautionary management may often have to proceed without any conclusive evidence. Still, unless luck is an unfailing part of management, there has to be a link between basic knowledge and political decisions. This has been clearly recognized in the different international resource regimes which have been set up; for instance in the Paris Convention it is said that 'the Contracting Parties shall endeavour to improve progressively techniques for gathering ...information which can contribute to the revision of the pollution reduction programmes drawn up...' (article 17).

Analytical perspective

Thus, as a point of departure there is agreement between analysts and practitioners alike, that scientific knowledge has an important role to play, together with several other types of 'legitimate' premises. The more difficult and intriguing question is *under what conditions can science make an 'optimal' contribution to the policy-making process?* Here, three main types of factors likely to influence the impact of science on management decisions have been suggested(6).
First, there are factors pertaining to the *nature and quality of the scientific input.* The degree of scientific uncertainty - especially concerning cause-effect relationships - is of course important. The more tentative and contested a hypothesis appears, the more easily it can be disregarded. Moreover, scientific input identifying some feasible 'cure' will probably seem more interesting than a contribution merely describing and 'diagnosing' a problem.

Second, several factors connected to the *substantive 'content' of message* can be identified. Research that is relevant for topical and pressing issues for the policy-makers - perhaps with an aroused and critical mass public demanding action - stands a good chance of being considered. Besides, the more the problem affects the 'social centre' of society, the more intellectual resources are likely to be mobilized in search for a solution.

Third, and most relevant for this paper, factors connected to the *political and institutional setting* are discussed. Political conflicts tend to disturb the development of consensual knowledge as well as the rational utilization of research findings. An institutional framework providing a firm basis for so-called iterative decision-making seems to create favorable conditions for establishing a constructive dialogue between scientists and policy-makers. In practice, this might mean specific procedures or institutions dedicated more or less solely to communication.
Moreover, the political use of research findings often seem to depend on some kind of 'mediating agent' or 'amplifier' other than the scientists or policy-makers themselves.

Before going into these institutional and political aspects more closely, it is probably wise to elaborate a little on the question of what is *gained* and what is easily *lost* by choosing an institutional perspective. Starting on a positive note, we feel that an explicit discussion of institutional aspects is one of the most constructive and 'positive' contributions political scientists can make. Although providing firm pieces of 'political technology' -i.e. knowledge on 'how structures and procedures affect actor behaviour, interaction processes and decision outputs' (7) - might be a tall order for political scientists, it is still a job that needs to be done. Moreover, it can be argued that knowledge about systems of human activities can be as critical to environmental management as is knowledge about the state and dynamics of ecological or technical systems.

On the other hand, the *institutional* focus means that very many other important aspects and factors are more or less neglected. For instance in connection with the question of 'what persuades policy-makers of the need to change policies in more environmental protectionist directions', it is very probable that discussing and improving organizational aspects of the communication process between scientists and policy-makers is much less important than for instance the different governments' perceived economic gains and losses by policy changes. As indicated at the outset, national and economic interests set the stage or the frame of reference for any international resource regime. Tracing actor interests and preferences in this setting have made one political scientist formulate' the *law of the least ambitious program*, meaning that collective action will be limited to those measures acceptable to the least enthusiastic party(8). This rather pessimistic thesis is probably valid in most cases (9). However, in this situation, the most constructive contribution from political scientists may be to focus on improving the role of knowledge, communication and organizational design. It may be one small piece of 'political engineering' contributing to 'softening' some of these somehow more 'fundamental' economic and political conflicts. With this caveat, we can proceed.

Preconditions for interaction between science and policy.

We propose to distinguish between four fundamental and basic functions which are preconditions for an effective and productive interaction between the science and the policy-making side in an international resource management context. The first function may be termed COORDINATION. The need for international management and cooperation stems from some kind of international environmental problem, trans-boundary or concerning a shared common resource (or both). In order to be able to assess (at least roughly) the origins and extent of this environmental problem, there is obviously a need for data and assessments of data from all or at least most of the cooperating countries.
Thus, the first basic question refers to whether the necessary basic data exists at the national level.
Next, whether they exist in such a form that they are *usable* in drawing up a national 'pollution profile' which in the ultimate end can be combined with similar data from other countries to get a clear picture of the overall status of the 'patient'.

Coordination

As a point of departure, there is probably scant reason to be optimistic on this account. The environmental research challenge is of an *interdisciplinary* nature. Although research councils and politicians alike underline the importance of interdisciplinary research to get answers to complex but inter-linked problems, everyone who has done research knows what kind of challenges this poses, even at the national level. Although there is a distinct tendency towards increase in the 'research family' dealing with environmental issues and marine sciences, a number of analysts have demonstrated severe problems of coordination and communication between natural scientists due to, for instance differences in training and education (10). The addition of social scientists does not make coordination any easier (11). To the extent that coordination is attained at the national level, researchers and public officials in the different countries will probably first and foremost collect data that are 'nationally' interesting - either relevant for more or less independent research projects or for some political controversial issue. Getting to the international level we also know that research methodologies and analytical concepts vary somewhat from country to country - even within the natural sciences (12).

Given that the target for protection is an international ecosystem, all this points to the *need* for rather stringent international research coordination - in order to provide (comparable) parts that ideally fit together like a puzzle, and ensure that all the parts are produced.

Separation

The next function may be termed SEPARATION. What we are hinting at here, is that it is necessary to respect and strengthen the basic *distinction* between science and politics, both nationally and in connection with the institutional structure of international cooperation. The reason for this is simple: politicized science gives decision-makers skewed signals, leading to more or less irrational policies. This has been a subject of much controversy, for instance in connection with the work of the International Whaling Commission (IWC) and the issue of dumping of low-radioactive waste in the London Dumping Convention (LDC) (13).

It may of course be tempting for the various cooperating participants to use budgetary tactics and informal pressure to make it more probable that their respective scientists come up with conclusions that support the national positions taken in international negotiations. Another, more 'understandable' complication is that participants in scientific international working groups are often (at least) headed by national civil servants. Although many of these civil servants may have a very distinguished scientific background, they are also in a sense 'scientific diplomats' and administrators, not always up to date with recent basic research. Their loyalties may also to some extent be split between scientific 'truth' and 'national interest'. In a more comprehensive and rational perspective, this might lead to both short-term and long-term 'contortions' in political attention and in policies adopted (14). This principal caveat does not, however, reduce the seemingly general value of having separate scientific and political working groups in the preparatory work for more high-level international meetings - as such a separation might contribute to more 'constructive' and less polarized meetings. First and foremost, it points to the necessity of making the separation as factual as possible.

Communication

Let us now turn to the COMMUNICATION factor. Rather cursorily, one could say that it grows naturally out of a happy solution of the separation problem: the more distinct the spheres, the greater the differences in language and mode of thinking. More fundamentally, science and policy-making are in many ways widely differing activities. Differences can be noted in time horizon, language, fundamental loyalties, peer group - to mention some of the most obvious aspects. To accentuate the matter: policy-makers want *definite* answers to complicated questions by the end of the week in order to satisfy superiors and calm public opinion - while scientists can deliver *tentative* conclusions next year, if their report is not totally 'massacred' by fellow scientists in the coming issue of 'Science'. One effect of the need for immediate answers may be that basic, long-term research is neglected by the politicians while 'consultancy research', more ready to provide quick (but expensive) answers will be given priority.

According to Division Chief Leif Christoffersen in the World Bank, '..scientists as well as policy makers and economic decision makers need to speak the same language, and also need to refer to data bases that have common credibility in order for... interaction to take place. Today this is rarely the case' (15). This points to the necessity of giving priority to the communication process. The aim of this process is not a blurring or merge of roles, but it intends to clarify and discuss the differences in approach and not least the strengths and weaknesses inherent in these differences. An important question could be: is it possible to make science more politically 'relevant' without losing its comparative advantage in the form of independence and integrity? Speaking in terms of organization, giving priority to communication might mean separate bodies or forums but not necessarily. Whether there is any room left on the agenda of the existing institutions will make a difference in this respect. It is easy to envisage a situation where the handling of urgent and practical day-to-day matters is given priority at the expense of more long term and abstract communication issues.

Co-optation

Fourth, there is the question of CO-OPTATION. By the inclusion of this concept, we wish to throw some light upon the important but difficult process of *mediation* and 'political translation' of research findings. It is obvious that scientists themselves have a responsibility to communicate their findings, both to policy-makers and to a wider audience. However, there is no *a priori* correlation between a scientist's ability to solve scientific problems and his ability to communicate his findings. Also, informing politicians, the media and the concerned public is also very time-consuming and quite a few scientists prefer the laboratories to the public debates (16). On the other hand, conclusions from scientific research usually do not in themselves have any clear cut policy implications. Scientists can always more or less explicitly 'add' a policy component to their work, but at the risk of compromising their credibility as scientists in the process.

This points to the need for *supplementary* mediating actors in the game of resource politics. As a point of departure the most obvious actors here are the national and international non-governmental organizations (concerned with the environment). These organizations have the potential of contributing substantially to the process of amplifying and 'translating' scientific research into premises and demands for new policy proposals. Some of the first environmental organizations (like the International Union for the Conservation of Nature (IUCN), and, with the North Sea as its concern the North Sea Working Group, had very close links with scientists who were concerned about this translation process. Today the picture seems somewhat more nuanced. At least quite a few scientists seem to feel that some environmental groups are more concerned with media attention and action than with scientific input (17). Thus, some degree of 'distortion' is probably unavoidable. However, we think that by discussing and creating appropriate routines of mutual information and participation, distortion can at least be reduced.

Relation between these functions

Finally: how is the relationship between these functions - is it for instance possible to maximize all of them at the same time? Yes - we think so, more or less. The most apparent contradiction might be between research coordination and 'separation'. The main point here must be that coordination in any case must imply the use of positive, general incentives (for instance funding of studies covering certain areas, substances etc.) within a broad, explicit 'master-plan', and not detailed day-to-day interference from the political side. The perspective must be long-term, i.e. at least 5 - 10 years. The possibility that the pollution problems will fade away in the meantime is very unlikely, we gather. The relation between 'co-optation' and 'separation' may also be somewhat problematic. It is not *a priori* given that the NGOs provide a 'neutral' and 'factual' translation of science in their lobbying activity. Thus, the process of 'political translation' may contribute to a blurring of the lines between science and politics.

2. Integrating Science in Policy-making:
A Description of the Scientific-Political Complex in the North Sea (18)

It should be noted here that the use of the term 'scientific-political complex' is rather loose and unpretentious, merely meant to indicate to the reader that the described bodies and organizations are at least formally and ideally connected. Moreover, it must be admitted that we have more detailed knowledge of the Paris Commission complex than the Oslo Commission complex (19).

We will not go into detailed description of this complex, partly due to obvious space limitations, but chiefly because the main features of these bodies and organizations have already been outlined at this seminar. However, we have seen how experienced civil servants scratch their head and ask questions like 'what is really the task of TWG?' Hence, a short description of formal mandates and functions may still be useful.

Starting at the scientific end of the institutional continuum, the basic ingredients in marine scientific research in the North Sea are of course the various national laboratories and research institutes. However, since fish migrate and ocean currents disperse pollutants over wide areas, international scientific collaboration is an absolute necessity. Such collaboration takes place within several, partly interconnected, institutional settings.

International Council for the Exploration of the Sea (ICES)

ICES - the International Council for the Exploration of the Sea - is in many ways a natural point of departure in this connection, as it is the oldest inter-governmental organization concerned with marine and fishery sciences (established in 1902). The Council has 18 member countries on both sides of the Atlantic.
It is involved with various aspects of oceanographic and marine biological research. Research concerning marine pollution began in the mid-1960s and is thus a comparatively new aspect of ICES's activity. Efforts have been made to determine the geographical distribution of various contaminants of the marine environment in living organisms, sea water, and sediments.

Contaminants investigated include various trace metals such as mercury, cadmium, lead, copper, and zinc, and synthetic organic chemicals such as PCBs and DDT and other pesticides, and petroleum hydrocarbons. With regard to the external advisory function, the main body within the ICES structure is the *Advisory Committee on Marine Pollution* (ACMP), established at an ICES Statutory Meeting in 1972. ACMP has the task of formulating scientific advice on marine pollution and its effects on living resources to the Member Governments and to Regulatory Commissions. The Committee considers, among other things, the results of work carried out in relevant ICES working groups (these groups also report to their respective Standing Committees during the annual Statutory Meetings). At its 1988 meeting, the ACMP reviewed the most recent reports of 17 such working groups. The ACMP is composed of: '...a number of scientists acting - when they work as Committee members - in their personal capacity as scientists, responsible only to the Council...The members do not act as national representatives'. The composition of the Committee is split between 'ex-officio' members (sub-committee chairmen) and 'co-opted' members (specific scientists chosen so that the ACMP may be able to cover different aspects of pollution problems)
In recent years, there have been 3 - 4 ex-officio members and 9 - 12 co-opted members. The corresponding fishery advice committee (ACFM) is differently composed, consisting solely of nationally nominated members. A proposition to constitute the ACMP along the same lines as the ACFM is currently being discussed within the ICES organization.

Oslo and Paris Commission: Joint Monitoring Group

When the Oslo Commission which deals with regulation of dumping and the Paris Commission were established in the early 1970s, they set up their own scientific/technical programmes and institutional structures. First, a *Joint Monitoring Group/Program* (JMG/JMP) was established as the main body which should provide a basis for the assessment of '...the existing level of marine pollution' and '...the effectiveness of measures for the reduction of marine pollution taken under the terms of the present Convention' (from article 11 in the Paris Convention). Several principles for the programme were formulated: it was to be based on the national programmes of the Contracting Parties; in order to ensure that the results obtained were comparable, the various laboratories responsible for analysis should calibrate their methods, usually under the auspices of an ICES inter-calibration exercise; methods to achieve these aims were to be established. The Programme covers 60 areas, chosen by the participating states themselves. Two main marine compartments are focused on: marine organisms and sea water. In some of the participating countries, JMG meetings are attended by civil servants as well as representatives of ocean research institutes, while other countries have a more strictly scientific representation. However, it should be noted that JMG participants are explicitly national representatives whereas ICES claims to be composed of independent scientists. To some extent, this indicates the main differences between ICES and the JMG - with ICES being the more scientific, 'internationalist' and 'methodological tool-developing' organization, and the

JMG more a forum for 'national practitioners' in the field of monitoring. The reports of the work carried out in the JMG are presented at meetings of the TWG (see below) and also at the annual Joint Meeting of the Commissions.

Technical Working Groups
As their name indicates, the *Technical Working Groups* ('Technical Working Group' - TWG - connected to the Paris Commission work; 'Standing Advisory Committee for Scientific Advice' - SACSA - connected to the Oslo Commission work) were created as forums for the discussion of questions concerning possible practical and technical solutions to pollution problems identified by marine scientific research. Thus, reports from ICES and the JMG are always reviewed as part of the agenda of TWG meetings. The groups give recommendations to the Oslo and Paris Commissions on questions of a technical nature. The groups also deal with questions concerning practical implementation of measures decided upon by the Commissions. They are intended to represent a politically neutral forum for discussions. National representatives to the groups are mostly civil servants with a background in the natural sciences. The groups now meet annually.
In connection with the North Sea Conferences, specific *Scientific and Technical Working Groups* have been established. The work of these groups has been largely based on reports and information gained through bodies like JMP and ICES. However, compared to the work of the TWG, the reports of the STWGs seem far more scientifically than technically oriented.

North Sea Conferences
Within this structure, the main political bodies are the Oslo and Paris Commission Meetings and the North Sea Conferences. The Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft was signed in 1972 and entered into force in 1974. The Paris Convention for the Prevention of Marine Pollution from Land-based Sources was signed in 1974 and came into force in 1978. Specific articles of the Conventions establish Commissions composed of representatives of each of the contracting parties to the Convention. The main duties of the Commissions are to review the condition of the seas within the area to which the Convention applies, to draw up programmes and measures for eliminating or reducing pollution from land-based sources, and to evaluate the effectiveness of the control measures adopted and the need for any additional measures. The Commissions are also to receive and assess information from the member states according to a standard procedure concerning the substances listed in the annexes to the Conventions. Programmes and regulation measures adopted by the Commissions are legally binding in the member states. The Commissions meet once a year. Continuity in work is guaranteed by a permanent joint Secretariat which organizes and prepares the meetings of the Commissions and other bodies, and distributes documentation.

Supplementing the work of the Commission, two ministerial-level *North Sea Conferences* have been held: in Bremen (1984) and in London (1987). The agendas of these Conferences include major issues covered by both the Oslo and Paris Conventions. The national delegations are headed by the respective environment ministers.

3. Strengths and Weaknesses of the Scientific- Political Complex
Now, then, how to assess this emerging scientific-political 'puzzle'? Let us go through our four suggested analytical 'check-points'.

Coordination
First: has adequate coordination been achieved so far? A rough yardstick in this connection is the quality of the end product: a comprehensive description and analysis of the North Sea ecosystem. If judged by the quality of the STWG report produced in connection with the Second North Sea Conference, the answer to the coordination question must be negative. Although the STWG report clearly was a step forward compared to earlier efforts, the report contains plenty of references to lacking and incomparable data, both regarding inputs, concentrations and effects. Thus, when it comes to the final 'assessment of the status of the North Sea'-section, the report notes that 'problems arise because of the variable quality of scientific evidence'
If we look at the most 'elementary' research problem, the input of contaminants, hardly any information is available on substances like DDT and PCB (Table 1 in the STWG report). The countries also 'score' quite differently as to information provided. Looking at River Inputs (Table 2), the United Kingdom produces the most extensive information (data is given for 12 of 14 substances). With the other countries evenly scattered, Norway is at the other end of the spectrum (info. on 4 of 14 substances). Here, information gathering coordination is obviously scarce, something which in turn raises problems with regard to policy coordination (20).

However, the report should be given credit for explicitly acknowledging these flaws in the existing knowledge. Also, the compilation of these data at the regional level is in itself a start for (hopefully) later coordination at a 'higher' level. Moreover, although deficiencies are easily detected, the 'reasons for concern' in the STWG report were still an important point of departure for the ensuing negotiations and the output of the Conference. Admittedly, the report is at some points rather crude and vague, but maybe the politicians have not yet been ready to digest and respond to more precise advice? We will return to this question in the final section of this paper.

But why such a flawed end product? Is it only due to incomplete knowledge or are also other forces at work? In order to answer this question, we think it is necessary to look into the scientific-political system more closely, taking the national level as point of departure. On the one hand, we would tend to argue that a well-functioning national scientific-political system is a necessary, but not a sufficient condition for smooth and coordinated international effort. On the other hand, it should be acknowledged that there is also probably a kind of feed-back relationship between the national and international level: discussions and decisions taken in international forums form some of the background and framework for national organization and coordination.

With regard to the question of national coordination, we must admit that we have only more or less scattered pieces of evidence, and we hope that other participants at the seminar will help us out here in the following discussions. Nonetheless, we will at least offer you some ideas about the state of affairs in Norway. On the whole, we think it is fair to say that ocean research coordination in Norway seems somewhat haphazard.
Coordination is high in short, all-out efforts leading up to international conferences, and more dormant in the periods in-between. Clearly, the North Sea Conferences have been an important impetus towards increased research effort and coordination in Norway. However, interest seems to fade when the necessary documents are provided for (21). Moreover, links to the international research and monitoring networks are split between the State Pollution Control Authority and the Ocean Research Institute, to mention some of the most important networks. Problems have been witnessed concerning the coordination of these external links (22).

Our very crude impression is that coordination is somewhat better handled in, for instance the UK and the Netherlands. One indication is that British delegations to the different international organizations concerning the North Sea seem extremely well prepared (an evaluation also shared by those not very favorable towards UK policy) and they score high on the information indicator (23). In the Netherlands, the BEON programme seems to be a central mechanism for securing coordination and communication between the scientific and the political side. Also, the coordinated effort of the marine sciences through the Netherlands Marine Research Foundation seems interesting in this perspective. However, although coordination may be improving, civil servants in the Netherlands have indicated that the lack of scientific coordination is a very real problem which is to be solved if the necessary data for the North Sea is to be provided (24).

We would once again like to stress that it may be that coordination seems better in these other countries simply because we know very little about it. Thus, on the whole, it is not possible for us to draw a sweeping conclusion concerning the state of national coordination.

As to the international level, it seems reasonable to distinguish between the situation concerning research (i.e. predictive hazard assessment) and the state of affairs with regard to monitoring (retrospective hazard assessment) (25). If we start with research, where our knowledge is most limited, representatives of the OsParCom Secretariat expressed dissatisfaction with the progress witnessed in connection with the Oslo Convention work already back in 1984. More recently, the call for better coordination of research was sounded in the policy paper on enhancement of scientific knowledge and understanding in connection with the London North Sea Conference.
As far as we can see, ICES must here be the primary organization to focus on. However, it is probably fair to say that the research emphasis within ICES so far has been more on the fishery side than on the pollution side.

With regard to monitoring and data gathering, the picture has so far been rather bleak. The OsParCom Joint Monitoring Programme has been characterized by experienced participants in the work of the Programme as a 'complete failure'. Indeed, this has recently been more or less acknowledged also by the Parcom Secretariat.
Compared to the ideal picture of what might be achieved by implementing the Commissions' monitoring programmes, '...for the time being, however, it must be admitted that there is still a long way to go'. The Secretariat identifies several 'disadvantages' of the current JMP: on the one hand, it covers only the major estuaries and coastal zones of the participating states and no open sea sites. On the other hand, it is based on the already existing monitoring programmes of the states and little mutual 'adaption' seems to have taken place. This has made the programme 'heterogeneous' and comparative assessments difficult (26).
Several reasons may be cited for this lack of progress: first, an experienced participant in international marine scientific cooperation has pointed to '...a lack of an ability to encourage or coerce participants to follow internationally agreed guidelines instead of the national ones'. According to this observer, states often submit data to international sampling programs that have been collected for a totally different purpose. This might have something to do with the lack of a clear North Sea

assessment mandate, as the Oslo and Paris Conventions cover far wider areas than the North Sea only.

Second, others have pointed to the fact that necessary, but time-consuming methodological discussions have dominated the agenda of the JMG. These discussions have quite understandably hampered the dynamic dimension of the group's activity (we will come back to this question under the discussion of 'communication') (27).

Third, it must be recognized that it is not until quite recently (cf. the algae and seal 'incidents') that the health of the North Sea has been alarmingly focused on, despite several years of Commission meetings and North Sea Conferences. The urgency and drive to know 'what is really going on' have been lacking.

A fourth (admittedly more speculative) factor - which may shed some light on the inaction of seemingly 'impatient' and 'result-seeking' nations (at least in most cases) like the Nordic countries, the Netherlands and Federal Republic of Germany - may be that the strictly 'scientific' way of arguing in these matters has been closely linked to an actor that many have regarded as a political 'stumbling-block' within this cooperation: namely Great Britain (28).

Separation

Let us now turn to the question of separation, and ask: has the necessary separation between the scientific and the political sphere been achieved so far? Concerning the rather sensitive and difficult question of the degree of national politicization of marine science, it has for instance been maintained in connection with the case of Great Britain that: '...the study of marine pollution remains the task of underfunded scientists employed less to protect the sea than to defend existing government policy' (29). As this question is quite 'touchy' we do not know how much we can rely upon answers given by those involved in the North Sea environmental regime. At face value, however, it seems that the general impression is that in most countries at least, there is no strong government pressure upon scientists to produce 'loyal' science: they are free to voice their own opinions. Although there might be exceptions, it does not seem that the politicization of science has reached the North Sea in any manner comparable to for example the IWC or the LDC (low radio-active waste). Another matter may be that it has been documented that similar data are interpreted quite differently by scientists from different countries (30). It cannot be 'proven' however, whether this is due to government pressure. Due to among other things, severe methodological problems, we leave the further 'sociology of science' to the sociologists.

Instead, we will focus on some more tangible aspects of the scientific preparatory work for the North Sea Conferences. To start on a positive note, a seemingly conscious separation trend concerning the more overall relationship between scientific and political aspects of cooperation may be noted. With regard to the preparatory work for the Bremen Conference, the scientific status report was finished just before the Conference itself. According to Norwegian observers, this meant that some of the attention and time of the Conference had to be devoted to clarification and discussion of the scientific background material. In connection with the London Conference, things were organized differently. On the one hand, the Scientific and Technical Working Group completed its work well in advance of the Conference itself. On the other hand, a separate Policy Working Group was established, and was able to use the STWG report as a point of departure for its own clarification and mediation efforts. We find it reasonable to assume that this institutional separation may have been one reason for the comparatively 'successful' course of the Conference itself.

However, while not reducing the value of the above-mentioned trend, the legitimacy of the scientific report produced can be questioned somewhat. The members of the group may definitely be characterized as experienced and able participants in the previous Commission work, and also as representing a considerable scientific expertise between them. Nevertheless, at least half of the group must be characterized rather as civil servants than as scientists. Thus, it is not surprising that the STWG report has been characterized as 'negotiated science'. For instance, it has been maintained that '...there was a measure of compromise between different views, say between British and German scientists' (31). Moreover, others have pointed out that compromises were struck with regard to the 'assessment' part of the report.

Now, several other more independent scientists and scientific institutions participated of course in the national preparatory processes. But given that civil servants really believe in the value of *independent* scientific advice, it is somewhat puzzling that the contribution of the 'independents' had to be filtered and controlled - as reflected in the composition of the international working group. Such a filtering procedure may be a *practical* routine and perfectly understandable, but a somewhat stronger position on the part of the traditional 'independent' (university) scientists may be worth considering. For example, in Norway there seems to be limited direct contact between these scientists and the Ministry of the Environment. Communication is mainly channelled through the State Pollution Control Authority. Criticism have been voiced that there is a tendency to make use of the same international 'scientific bureaucracy' too often, at the expense of scientists doing basic research (32). With regard to the specific STWG report, we are not saying that a different composition would necessarily have mattered much in terms of conclusions reached, but it would have enhanced the legitimacy of these conclusions and might have served as a symbolically and fundamentally important gesture.

Communication

Third, there is the equally important question of communication. In a science-politics perspective, we think it is possible to regard the current structure as a kind of mediation chain or continuum. In the one end, you have the national scientists and national scientific programs, partly connected to each other through the ICES international network. On the other (receiving) end, you have the yearly Commission meetings. In between you have potentially important mediation 'agents' - and these are first the Joint Monitoring Group and then the technical working groups. Now, the crucial question is: do these groups fulfill their mediating role effectively?

Let us first focus the JMG more closely. This group was initially established in order to provide a basis for the assessment of '...the existing level of marine pollution' and '...the effectiveness of measures for the reduction of marine pollution taken under the terms of the present Convention' (from article 11 in the Paris Convention). As indicated in the coordination section, the progress concerning studies of the level of marine pollution has not been satisfactory. Moreover, this means that scientific input from JMG into the activity of the technical working groups has not functioned as assumed in the original institutional design. If we quite roughly differentiate between the action-initiating (on the advice of JMG) and the action-initiated (by the work of and decisions taken by the Commissions) role of the technical working groups, much more weight seems to have been given to the latter role than was initially supposed. We think it is important to point out that this might have something to do with the malfunctioning of the JMG. Nevertheless, this development implies at the next turn that the Commission meetings have received weaker scientific impulses than initially assumed, and a weakening of this particular dynamic dimension of the cooperation.

More generally, it is our impression that the Commission meetings have given very little priority to more basic and long-term strategic discussions concerning scientific development, communication of existing knowledge etc. To accentuate somewhat: even if the dynamic scientific impulse might have been more or less absent, it does not seem to have been missed much at the meetings (33). Some of the reason for this is of course that the Commission agendas gradually - as the cooperation has developed and widened - have been filled up with necessary, but time-consuming discussions of commitments already taken on.

On the one hand, this indicates that it might be interesting to study more closely the organizational experiences gathered in connection with the London North Sea Conference. In connection with this Conference, a special Policy Working Group discussed important policy matters before the Conference was held, with the scientific status report as point of departure. As indicated earlier, this design probably contributed to the constructive outcome of the Conference. Despite obvious differences between the Commission and Conference approach, a similar design might have something to offer also within the Commission approach. By expanding the existing preparatory CVC-mechanism or even establishing a new Policy Group, one could either relieve Commission meetings of some of the more routine matters and allow these meetings to discuss long-term communication issues more adequately, or let the CVC/ Policy Group meetings function as a more evaluative think-tank.

On the other hand, it might be that there is something fundamentally wrong with the communication chain - in a sense, it might be 'too long' (34). An indication pointing in this direction is that the information and advice provided by the comparatively most 'pure' scientific element in the system - ICES - have to pass through two 'filters' mostly composed of civil servants before eventually being considered by the meeting of policy-makers. Although a 'translation' and simplification is of course to some degree necessary, one might wonder whether a more direct and 'pure' scientific input is possible. However, this would undoubtedly lay the heavy burden upon the scientists to translate their scientific message into lay-talk. In connection with the preparatory work to the London Conference, civil servants complained that some of the scientific work being produced was not readable (and consequently not usable) for non-scientists. A stronger scientific component may aggravate this problem if the scientists fail to take this criticism seriously. It should be possible to formulate complex relations in a form which can be put to practical use. Moreover, if the scientists are concerned with getting their message through in the wake of the adoption of the Precautionary Principle, maybe they should be more concerned with environmental *risks*; what consequences will it have *if they are wrong*? (35). Thus, both policy-makers and scientists face challenges here.

Co-optation

Finally, there is the question of co-optation (36). This is - and perhaps in more than one sense - a more unorthodox dimension. Basically, the challenge has two aspects: on the one hand to utilize information and knowledge outside the traditional scientific community.
On the other hand, to bring out information to, and involve, the wider public opinion - in order to secure support for, and infuse 'political energy', into the continuing cooperation. Let us begin then by formulating some more specific questions for exploration. In connection with the environmental non-governmental organizations, we think it is interesting to focus the aspects of *'knowledge basis'* and *'role consciousness'*. With regard to knowledge basis, important questions are: to what extent do the organizations have 'private' research activities going on? How do they regard the present communication with the established scientific community? Do they feel that their knowledge is adequately utilized by the policy-makers? Concerning role consciousness, interesting questions are: to what extent do they consciously regard themselves as mediating agents to the public opinion? Are they aware of the dangers of 'media contortion'; of attention drawn away from less conspicuous, but ecologically vital issues?

First to the question of *knowledge basis*. Not surprisingly all representatives of the environmental organizations claimed that knowledge was the very basis for their work concerning the North Sea (as well as elsewhere). Their main source of information was derived from science, from personal contacts with scientists or via published scientific information. Over the last few years, however, some large NGOs like Greenpeace have commissioned research on the North Sea. This opens up for an additional stream of scientific input, making some resourceful NGOs less dependent on the regular scientific sources. By and large, however, the environmental organizations base their work upon the same sources of information as the civil servants and the politicians.

Generally, the NGOs claim that *enough* is known about the health of the North Sea to adopt more 'strict' measures than are presently agreed upon. The environmentalists are impatient: 'Action Now' (before it is too late) is a common slogan. This hints at a communication problem between the NGOs and the habitually cautious scientists. In fact the difference in time horizon, language etc may be more significant between scientists and environmentalists than between scientists and politicians.

The communication between the scientific community and the NGOs will be affected by their different roles. However, it is hardly feasible to give a general answer to how communication is functioning between these two groups. They are both quite heterogeneous. As for the scientists, some are in a sense quite 'elitist' - confident in their 'ivory-towers' - shunning the media as well as 'ignorant' representatives of NGOs, tending to disregard any potential policy implications of their research.

At the other end of the spectrum there are the 'pro-environmental' scientists, often participating actively in political debates and/or being members of NGOs - which raises difficult questions of their scientific credibility. The majority of scientists, however, probably belong somewhere in between these two extremes. Differences exist between environmental organizations as well. On the one hand the more 'peaceful' *lobbying* groups with traditionally fairly strong ties to the scientific community. On the other hand the more *action-oriented* groups, with (seemingly) somewhat looser links to science.

Needless to say communication between the pro-environmental scientists and the NGOs is in general very good, while there is often mutual distrust and poor communication, especially between action-oriented NGOs and the elitist scientists. It is our impression, however, that communication between 'main-stream' scientists as well as 'main-stream' NGOs is reasonably good, giving these NGOs an important mediating function.

As to the question of whether their knowledge is adequately utilized by the policy-makers, the environmental organizations all feel that North Sea environmental politics is moving in the 'right' direction, although many are skeptical as regards the actual implementation of the agreed principles. They claim some of the credit for this development, while they do not think that changed scientific input has mattered much for the apparent change in policy. Generally, the environmental organizations do not seem to feel that faulty communication is the main reason for their not getting through with their suggestions but rather the lack of political will on the part of the policy-makers.

The *chain of communication* between the NGOs and the policy-makers, however, takes different routes for the action-oriented and the lobbying environmental organizations. This brings us to the point of *'role consciousness'*. Although direct appeals through the media to the public may be used to some extent by most environmental organizations, this seems to be the main strategy for the actionists. An organization like Greenpeace has highly professional PR people and close ties with important news media. Through extensive use of pictures and direct actions, they often appeal very directly to people's emotions and at the same time fulfill the criteria for being defined as 'good news material' and thus making the headlines. In a sense the actionists try to influence the policy-makers by means of 'arousing' the public via the media, well aware that the politicians realize that votes decide at the next election. Although more 'normal' lobbying work is also carried out by the actionists, this strategy seems to be more subordinate.

While the actionists as a point of departure prefer 'separation' from the formal decision-making process (maybe in order to avoid the 'hostage-function'), the lobbyists rely more heavily upon 'integration' in the decision making process. They have established close contacts especially with civil servants and try to influence policy more through 'silent diplomacy' than through actions.

Both strategies are of course legitimate as means of exerting influence and in a sense they complement each other. However, there seems to be an inherent danger of 'media contortion' in the actionist strategy. One illustration may be the strong - and successful - campaigning and media attention focused on incineration at sea. Although very visible and consequently a good campaigning target, most available evidence suggest that the negative ecological impact is quite modest. Such actions may contribute to direct attention away from other more serious, long term but less visible ecological problems.

Undoubtedly the NGOs regard themselves as mediating agents to the public opinion but it is debatable whether NG's using actions as main strategy can justifiably be regarded as mediators of scientific knowledge. The degree of simplification and differences in methods and approach may be too fundamentally disparate. This is not to say that they do not have an important part to play within the environmental North Sea regime. However, our impression is that the media-contortion dimension has been somewhat neglected in their - at least public - thinking.

Everybody concerned with the environment is happy about the increased public attention directed toward this issue. However, marine ecology is a complex field and the most rational policy is not necessarily the one corresponding to the daily agenda of the national and international news media. Not least due to the environmental organizations, the environment has achieved a prominent place on the political agenda, and rightly so. Now may be the time for at least some of these NGOs to sit down and re-think what strategies are needed in this new situation. The right strategy for *getting* an issue on the agenda is not necessarily identical with the right strategy for *keeping* it there and for contributing to solving complex problems. There may also be a need for some re-allocation of resources by one of the other new key players, the media. Most countries have some very capable journalists covering the traditional 'high politics' issues like security and economy, but in most countries there are very few 'environmental journalists', and they are essential if the media are to play a constructive role in this dialogue too.

4. Some concluding Thoughts.

As briefly summarized in section 2, a compound international scientific-political complex has evolved within the North Sea cooperation. As witnessed in connection with the production of the STWG report before the second North Sea Conference,this complex is capable of coming up with fairly usable knowledge on the state of the North Sea. In our identification and discussion of possible institutional shortcomings and deficiencies, this achievement should not be forgotten.

On the other hand, having said this, our main conclusion is of course that several institutional deficiencies can be identified: coordination of research and monitoring is flawed; the awareness of the importance of a clear distinction between science and politics is too low; policy-makers and scientists speak different languages and translation of the scientific message is often sparse - to mention some important points.

Rather implicitly, thus, we voice a call for *more* and *improved* knowledge - a call which is not particularly fresh or original. But is it so obvious that imperfect knowledge has been an impediment in policy-making so far - and that future improvements are really necessary? It is probably useful to think in terms of *stages* here (37). In the initial phase of cooperation, the precision of the information is less important. Rather crude pieces of knowledge are probably enough to warrant the formulation of general reduction programmes. Precise knowledge in this phase is necessary first and foremost with the objective of establishing a firm basis for future progress assessments. In the later, more advanced phases of cooperation, where 'fine-tuning' and corrections of earlier policies are crucial, the need for precise and comprehensive knowledge for policy-making purposes is more urgent and obvious.

In the North Sea context, we think that we are right now in a transition period - having been through an initial phase and moving towards a more advanced and complicated stage. This stage may for instance imply fine-tuning of the percentage reduction aims agreed to at the second North Sea Conference and even perhaps the development of a more nuanced system, with the largest reductions where it counts most environmentally. Perhaps the basic rationale for an intensified research and monitoring effort is that we have so far not fully established the firm basis for progress assessments which such policy development is dependent upon - and as can be recalled, was originally called for in the Paris Convention text. In such a perspective, institutional deficiencies in the scientific-political complex may be far more crippling in the coming years than they have been up to now.

Notes

* The main background material for this article is threefold: general books and articles on North Sea environmental cooperation; archive material in the Norwegian Ministry of Environment; interviews with civil servants, scientists and environmental organizations in Norway, Denmark, the Netherlands, Belgium, Federal Republic of Germany and Great Britain. Main background publications published by the authors are:
Steinar Andresen. 'The Environmental North Sea Regime: A Successful Regional Approach?', Ocean Yearbook 8, 1989a);
Jorgen Wettestad. 'Uncertain Science and Matching Policies Science, Politics and the Organization of North Sea: Cooperation', The Fridtjof Nansen Institute, 1989.

1. Moltke, Konrad von. 1984. 'Needs and Action: Obstacles to International Policies', World Resources Institute Journal 84, Washington 1984.

2. 'The Management of International Resources: Scientific Input and the Role of Scientific Cooperation'. In 'International Resources Management: The Role of Science and Politics', Belhaven Press, 1989. S. Andresen & W. Oestreng (eds).

3. Timberlake, Lloyd. 1989. 'The Role of Scientific Knowledge in Drawing Up the Brundtland Report' (chapter in the book referred to above under 2.).

4. We owe this distinction to Arild Underdal. 1989. 'The Politics of Science in International Resource Management: A Summary' (chapter in the symposium book, Ref 2.), and
Nils Roll-Hansen. 1986. 'Sur nedbor - et storprosjekt i norsk miljoforskning', Oslo, NAVF, especially pp. 11 - 16.

5. Underdal, ibid.

6. It should be noted that our theoretical perspective is heavily indebted to Underdal (especially the symposium book chapter).

7. Underdal, A. 1983. 'Causes of Negotiation 'Failure'', European Journal of Political Research, 11, p. 193.

8. Underdal, A. 1980. 'The Politics of International Fisheries Management', Oslo.

9. It is for instance supported by the findings of Sunneva Saetevik. 1988. 'Environmental Cooperation between the North Sea States', London.

10. Wooster, W. 1986. 'Immiscible Investigators: Oceanographers, Meteorologists and Fishery Scientists', in Miles, E. and Stokes, R. (eds.) 'Natural Resource Economics and Policy Applications', University of Washington Press, Seatttle and London, pp.374-387

11. Huppert, D. 1988. 'Comments on the Role of Objectives in Fisheries Management', in Wooster, W. (ed) 'Fishery Science and Management: Objectives and Limitations', Springer Verlag, and
Jacobsen, H. and Kay, D. (eds.) 1983. 'Environmental Protection: The International Dimension'

12. Moltke, op.cit.

13. Andresen, S. 1989 (b). 'Science and Politics in the International Management of Whales', Marine Policy, No.2, 1989, pp. 99-117.
For a discussion of the LDC in this perspective, see Miles, E. 1989. 'Scientific and Technical Knowledge and International Cooperation in Resource Management' (chapter in symposium book, Ref 2.).

14. This is pointed out in Viktor Sebek's article 'Bridging the Gap Between Environmental Science and Policy-making: Why Public Policy Often Fails to Reflect Current Scientific Knowledge', Ambio, vol. 12, no. 2, 1983.

15. Christoffersen, L. 1989. 'Global Environment Monitoring and Information Systems : An Operational Perspective' (chapter in the symposium book, Ref. 2.).

16. Andresen, S. 1989 c). 'Increased Public Attention: Communication and Polarization' (chapter in the symposium book, Ref 2.).

17. Expressed in interviews by some scientists. See also, Phillip, D. 1986. 'Are Environmental Conservation Organizations Necessary?' Marine Pollution Bulletin, Vol.17, No 9, pp. 387-388.

18. This is a somewhat shorter version of chapter 3 in Wettestad, op. cit., 1989.

19. Much due to the work of Saetevik, op.cit.

20. This is further discussed in Andresen, S. 1989 a).

21. Interview with a Norwegian senior scientist.

22. See Andresen/Floistad 1984. 'Overvaaking av forurensningssituasjonen i norske havomraader: vektlegging, organisasjon, samordning', The Fridtjof Nansen Institute, especially pp.89 - 91.

23. See Saetevik, S., 1988. This attitude was confirmed and strengthened in interviews made in connection with this article.

24. Interview with Dutch scientist/civil servant.

25. This distinction is taken from : Persoone, G. 1987. 'Hazard Prediction and Relevance of Laboratory-Scale Studies', paper 34 at the International Conference on Environmental Protection of the North Sea, London, March 1987.

26. 'Measurement Campaigns of the Oslo and Paris Commissions', paper produced by the OsParcom Secretariat to the first meeting of the Task Force, Hague 7 - 9 December 1988.

27. Interview with a Norwegian senior civil servant.

28. For a discussion of the role of the UK within the North Sea Cooperation, see Saetevik, op. cit. and Andresen a), op.cit.

29. Quote from Sonia Boehmer-Christiansen : 'The Role of Science in the International Regulation of Pollution' (chapter in the symposium book).

30. de Jong, F. 1987. 'The quality of the North Sea; national points of view', in Proceedings of the 2nd North Sea Seminar, Reasons for Concern, Vol 1, pp. 39-54.

31. Quote from Daily Telegraph Weekend Magazine October 8 1988. 'North Sea or Dead Sea? The rising tide of pollution' (special feature).

32. Interview with Norwegian senior scientist.

33. Interview with Norwegian civil servant.

34. Interview with Norwegian senior scientist.

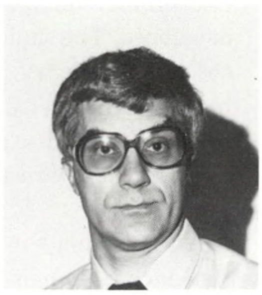
35. This was pointed out by a Norwegian civil servant.

36. The question of co-optation is primarily based upon interviews with the following environmental organization in the Netherlands: Friends of the Earth, Greenpeace, IUCN, NorthSeaWorking Group and Seas at Risk. We have also interviewed a researcher working for Greenpeace and a representative of Greenpeace, Norway. We base this section of the paper on interviews with scientists as well, see *, Introduction to the Notes.

37. We owe the general idea here to Arild Underdal.

How is scientific knowledge incorporated into North Sea Conference decisions?

Dr R Ferm,
Director, Environment Protection Agency, Solna, Sweden



The paper starts out from the 60s when the research on mercury and its potential hazards led to almost world-wide acceptance of the necessity to reduce discharges of mercury. Another example of a similar decision situation, referring to PCBs, is also given. The examples are based on often extensive research efforts over many years, international action plans, for instance within the framework of the Paris Commission, included in annexes these types of substances as prime targets.

Today's situation is quite the opposite. At the Second North Sea Conference ministers for the environment took the decision to reduce inputs of persistent substances which are toxic and liable to accumulate, by 50% before 1995. This decision is not based on detailed scientific research with respect to each individual compound concerned. It rather expresses a general anxiety, among scientists and politicians, as well as among the public in general, with regard to the use of man-made, non-natural organic compounds in today's society.

Yet another type of sequences of events resulting in environmental decisions is given by the nutrient case. During the 50s and 60s it was possible to develop the so called Vollenweider model to prognosticate the effects of a specified reduction of nutrient inputs on fresh water eutrophication. The recent decisions by the environmental ministers at the North Sea Conference to reduce inputs of nutrients by 50% is, however, based more on a general assessment of the eutrophication situation in the sea at a time in the past when inputs were about 50% lower than today. This is, in other words, a type of retrospective analysis. In order to finally cope with sea eutrophication, it will be necessary to develop models

Introduction

In this presentation, I describe three cases where different types of polluting agents are dealt with within the framework of international conventions. The presentation will not describe the individual cases in any great detail but concentrates on a discussion about the interrelation between scientific knowledge and the decision-making process. For those who are more interested in the individual cases, I refer to an abundance of scientific literature, as well as to annual reports and other publications from the international conventions and the North Sea Conferences.

The first case describes mercury pollution, where decision-makers since long have been in an implementation phase. The scientific background for the decisions now taken has been available for over two decades.

The second case regards eutrophication, where actions are presently being taken or planned. There are, however, a number of specific questions that need to be answered in order to obtain a sufficient scientific basis for further decisions.

And last but not least, I will talk about the situation as regards pollution of the seas by stable and man-made organic substances. Here, certain general decisions have already been taken, but it will be necessary in the near future, to develop significantly the scientific basis for further decisions.

Mercury

As early as during the 1960s, scientific research had shown that the use of organic mercury compounds as seed dressing and as a preservative in the paper producing industry caused enhanced levels of mercury in fish flesh in the receiving bodies of water. A little later it became abundantly clear that also inorganic mercury caused the same types of effects, although not as strongly. The

for the sea of a similar character as the one mentioned above.

The paper ends by discussing the potential role of scientific data and judgments in tomorrows environmental decisions, and proposes that the task to explain frontier-line scientific results in terms that can be understood by politicians and decision-makers and, not least, by the public in general will become increasingly important.

Minamata incident in Japan added a lot of knowledge, and so did other serious accidents of a similar nature. Although the mechanisms involved were not completely understood, there was a clear relation between the use or discharges of mercury on the one hand, and the observed effects on the other.

Basing themselves upon these results, many countries began to take action both with regard to product control, and with regard to discharge reductions from industries. Acceptable substitutes for use as seed dressing have been developed. The same is the case for the preservatives in the paper industry. Many mercury discharging industries have either changed their processes in order to avoid mercury discharges altogether, or have substantially reduced their discharges of mercury.

As a consequence of all this knowledge, mercury was on the black list when several of the marine conventions were drawn up during the 1970s. The technical discussions in working groups started almost immediately and a number of decisions have now been taken to protect our seas from discharges of different forms of mercury.

Although scientific evidence is quite clear, it should be noted that different countries have reacted quite differently as regards the action programmes which they have designed. Some countries have reduced their direct emissions to water by more than 90 per cent during the last two decades. Other countries have only taken a few preliminary steps to reduce such emissions, and are still in the process of preparing the more far-reaching reduction programmes necessary.

This situation is especially clear for the chlor-alkali industry but is in principle the same for a number of other types of industries, as well as for the use of mercury containing products. Why is it that some countries are working very hard to diminish the use of mercury in all sectors of society (such as in dentistry or the use of hospital thermometers), whilst other countries, though subscribing to the same general principles, are making very little or no progress in this field?

The answer is, of course, partly due to different interpretations of the scientific results. But equally important are the differing administrative structures, and the economic capabilities of the countries concerned. Some countries still lack the powerful administration needed to launch sufficiently rigorous abatement programmes. Some countries have an economical situation that does not allow environmental authorities to act as decisively as they might wish to. As a generalization, it can be concluded that the most advanced countries as regards abatement of mercury contamination are between ten and twenty years ahead of those countries lagging behind.

All countries are striving in the same direction, however, and will reach the desired goal, although at different points in time. I believe that we will be able to see a marked improvement in all countries around the turn of the century, and in many cases the situation will be, almost at least, under control. Ten years from now, all North Sea and Paris Convention States will have developed rigorous action programmes both for their industrial discharges and for their product controls.

In the mercury case, it is therefore the duty of scientists to increase the pressure for remedial measures in those countries lagging behind.

It will also be necessary to monitor the effects of the discharge reductions in order to be able to adjust our priorities in the future, as regards which sources are the most important ones. And finally, since mercury is a substance occurring naturally, it is clearly necessary to devote more research into what may be acceptable levels of inputs of mercury to the seas. What is the natural transport, due to geological processes, of mercury to the marine environment? Is an antropogenic addition of 10 per cent over and above that background transport level acceptable? Or is the acceptable addition lower or higher than that? As the national programmes to reduce mercury pollution are coming closer to completion, it will be more and more urgent to be able to set the right priorities as regards the remaining sources.

Eutrophication

Although eutrophication of inland waters has long been a familiar phenomenon, it has only in the relatively recent past been demonstrated that at least parts of our neighbouring seas are also threatened by eutrophication. In some coastal areas, the eutrophication is so obvious that almost no-one today questions the need to take action against the input of nutrients to these areas. There is still a debate as to whether or not the open sea areas in the Baltic and in the North Sea are effected by eutrophication today. There is also a debate about the relative role of nitrogen and phosphorous as limiting factors for eutrophication.

Primarily in view of the situation in many coastal areas, the environment ministers of the North Sea states took a decision at the Second North Sea Conference to reduce inputs of nutrients to the North Sea by 50%. Discussions at a technical level are going on, both in the preparations for the Third North Sea Conference and in the Paris Commission (in particular in its Nutrient Working Group). Measures considered in these discussions cover both point sources such as certain industrial sectors and municipal discharges, and agricultural practices which give rise to a diffuse but large source of input of nutrients to the sea.

The response from decision-makers has been remarkably rapid as regards marine eutrophication. A relatively short time has elapsed between the realisation of the problems and the first decisions on an international scale to reduce inputs. This is probably in part due to the fact that many countries already had experience from their inland waters on how to combat eutrophication. Also, the effects of eutrophication is such that everyone can see it. Excessive algal blooms and oxygen depletion in bottom waters leading to the death of marine organisms occur every summer. The decision-makers have in this case reacted rapidly (although some may consider not rapidly enough).

In contrast to the mercury case, much basic knowledge is still needed as regards eutrophication and its causes. The decisions taken so far primarily indicate an awareness of the problem and a willingness to break the trends of increased nutrient inputs, and decrease them with approximately a 50 per cent reduction as a goal. Already before this goal is to be achieved, i.e. in 1995, it will be extremely important to have a much more sophisticated basis, derived from scientific research and monitoring programmes, to aid the decision-makers in future decision processes.

Among the important questions are the following: Are nitrogen and phosphorous going to be reduced in parallel? This is the philosophy of the decisions taken so far. But what are the scientific justifications for such a parallel reduction? Is perhaps one of the two nutrients more important as a limiting factor? Are there other growth factors which may be dealt with on a technical level as well, e.g. silicon compounds? How is the distribution of the nutrients around the North Sea, with the sea currents? What role does the atmospheric input have? What importance have the denitrification processes that occur naturally in the seas? How important in the influx of nutrients from the Atlantic into the North Sea?

It is easy to see that we must increase our knowledge of the underlying mechanisms that stimulate eutrophication. We must also devote considerable research towards the input side of the problem, i.e. the variability in the inputs over the year, and the relative importance of the different types of input.

Stable man-made organic substances

In the case of stable and man-made organic substances as a potential source of pollution of the seas, it is evident that the decision-makers have reacted even more rapidly upon scientific signals than in the two cases described earlier.

Although work has been going on against specific organic substances for a long time (DDT and PCB, amongst others, are on the black lists of the conventions), it should be noted that the decision making situation for these two compounds, as well as for others of a similar type, is more like the one described above for mercury. A lot of scientific evidence has been available, and the basic decisions to start reducing inputs were normally taken long ago. We are in the final stages of an implementation process.

The decision by the North Sea environmental ministers to reduce by the order of 50 per cent the inputs of stable organic substances which are toxic and liable to bioaccumulate is of an entirely different nature than the earlier decisions regarding selected individual compounds. As long as an organic substance fulfills the criteria mentioned above, it will fall under the general demand for reductive measures. Since we do not know the chemical identity of more than a fraction of all man-made organic substances which are released into our environment, and in particular into our seas, it might be advocated that in this case, the decision-makers are even ahead of the scientists. The process to reduce inputs is already under way, and it will be for scientists to develop the principles for how best to set out to fulfill the task set by our ministers.

Since we do not know the chemical nature of all the compounds concerned, it is obviously impossible to reduce each one of them by 50 per cent. And even if we did know the chemical nature, it is highly unlikely that such a procedure would be optimal.

Furthermore, the assimilative capacity for stable man-made organic compounds is in principle zero. Dioxins have taught us that we can get negative environmental effects at extremely low concentrations. We do not know where, or if, there is a safe level of contamination for such substances. And thus the precautionary principle calls for special care as regards these compounds which are alien to the environment.

In this case, it is very clear that a lot of basic scientific knowledge required for the successful implementation of the ministerial decision, is still lacking. There is a need to develop a much sounder basis as regards the phenomenon of persistence itself. How persistent is persistent? Which ones of the prevailing distribution mechanisms in the environment are the crucial ones? Is it possible to find a relatively limited number of common ecotoxicological mechanisms through which the stable organic substances act upon organisms. If so, is this an enzymatic response, or perhaps a hormonal one, or perhaps a combination?

Furthermore, the monitoring systems must be considerably improved. How does one monitor for a substance? Also for this purpose, more general knowledge on how these compounds cause a negative environmental effect is required.

General conclusions

It is of course difficult to draw general conclusions in this matter, since the need for, and type of, interrelation between scientists and decision-makers will vary, according to the type of pollution in question, and also according to the individual circumstances in each country. It is my personal opinion that we talk too little to each other.

The decision-makers ought to be more concerned and better informed of what happens in the research field. They should take greater interest than they do now in how and where research money is allocated. On the other hand, scientists ought to have easier access to the ears of political and technical decision-makers.

It would probably be an improvement of the situation if we had more industrialists and politicians in the committees and councils granting research money. And on the other hand it would be advantageous, to have joint seminars between the technical staff and environmental scientists more often in early stages of the development of technical processes or products.

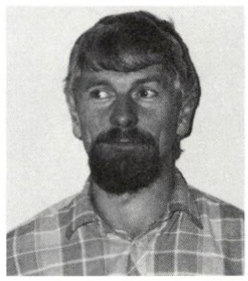
And finally, it will be increasingly necessary to improve the communication between decision-makers and scientists. We cannot expect to have all the answers available when we have to take our decisions. Thus, research efforts must, at least partly, concentrate on those questions to which the decision-makers most urgently need answers. It cannot be left, however, to the decision-makers themselves to define what those questions are.
This must be done by co-operation between scientists and decision-makers. And this in turn leads to a need for increased mutual trust between those two parties. The situation today, where scientists often mistrust the motives of the decision-makers and where decision-makers find it very difficult to transform the warnings from scientists into concrete actions, will have to change.

We experience at present several dangerous threats to our marine environment. In spite of that, I am looking forward towards the future with both faith and hope. The international conventions established, as well as the North Sea Conferences, provide excellent forums for remedying the situation, although it will require a long

time and a lot of patience. Many important decisions have been taken already, and all countries concerned agree upon the necessity to do even more in the future. The problem is as usual lack of money, knowledge and time.
Environmental scientists can do relatively little as regards the lack of money, but they can do very much to increase the knowledge needed and to provide a sounder basis for the setting of priorities.

Last year I participated in several meetings with the North Sea Task-Force. After a slow start, which is only natural, the Task-Force is picking up speed, and had an excellent meeting in the U.K. in April this year. It is an opinion which I share with many others, that an especially encouraging aspect on the Task-Force is the good interaction between scientists and decision-makers which is developing in the group. I believe that the Task-Force will increase significantly in importance in the future and will develop into perhaps one of the most important groups for the protection of the North Sea.

Co-operation of Policy and Science. Viewpoint of a Scientist.



Dr A. Jensen,
Danish Isotope Centre, Copenhagen, Denmark

During the last ten years the general public has shown a growing interest in environmental matters. The question is how this interest has influenced scientific research and political decision-making. An interesting example concerns eutrophication problems in Denmark. Extensive scientific discussions were followed by extensive discussions among the policy-makers. At the end political decisions were made which were not solely based on scientific evidence.

I intend to give a critical review of the work performed within the different international organisations working in the North Sea Area and how this information has influenced political decisions taken in relation to the environment of the North Sea. The discussion also shows how the different scientific and political environmental viewpoints among the different North Sea countries have influenced decisions taken for improving the health of the North Sea.

It is, I think, very difficult to obtain big improvements in environmental matters solely on scientific evidence. Strong pressure is also needed from environmental groups. This pressure, together with the scientific evidence, exerts influence on the political system. Improvements can also be obtained if there are substantial economic interests in better environmental condition. This will be exemplified by the French and British ban on TBT-antifouling paints for pleasure boats.

Introduction

During the last ten years there has been a growing interest among the public in environmental matters. Every day environmental matters are mentioned in the newspapers and on television. Politicians show also a more pronounced interest in environmental matters. Is this caused by a real interest in these matters and a concern for the health of the ecosystem or is it caused by short-sighted interest in a more popular public profile, in order to get a better chance in the next election? What is the role of the scientific community in this respect, placed in the conflict zone between the public and the politicians? Is there good communication between the politicians and the scientists so that relevant, long-planned environmental research is performed?
In my paper I will try to answer some of these questions, starting with an example from Denmark concerning marine research and political decisions about eutrophication problems.

Danish Eutrophication Problem

In the early 1970s it became evident that the current knowledge of the exchange of water and material in Danish marine waters was insufficient to work out a detailed programme for monitoring and the abatement of marine pollution. After the establishment of the Danish National Agency of Environmental Protection in 1972 it was realized that a five year investigation with the purpose of improving the knowledge of the water exchange and eutrophication levels in Danish marine waters should be carried out as a first step.

The programme started in 1973 and in one of the evaluation reports after the end of the programme (Ærtebjerg Nielsen et al., 1981) it was concluded:
'The water exchange of the Danish waters is very intensive. The dilution rate is therefore high, and the possibilities for decomposition of discharged substances are good. In areas heavily loaded with nutrients an increase in the concentration of phosphorus and nitrogen as well as the plankton algae production has taken place

over the last 30 year period. In the open Danish waters this increase is, however, not reflected by increased turbidity or decreased oxygen concentration. Therefore, it can be concluded that problems related to eutrophication do not occur in open Danish waters.'

In the autumn of 1981, the same year as the publication of the above mentioned report, big areas of Kattegat, the Belt Sea and the Danish and German part of the North Sea suffered from oxygen deficiency. This alarming situation caused a lot of debate among the public, scientists and politicians. A scientific evaluation of the reasons for this oxygen deficiency was performed and published in January 1984. During the preparation of this report new areas with oxygen deficiency were reported in 1982 in the Danish areas in the Belt Sea as well as in the North Sea along the Danish Coast (Fig. 1a). Also in 1983 the oxygen content was low in Kattegat and the North Sea (Fig. 1b). However, an autumn with a lot of stormy weather prevented a new disaster.

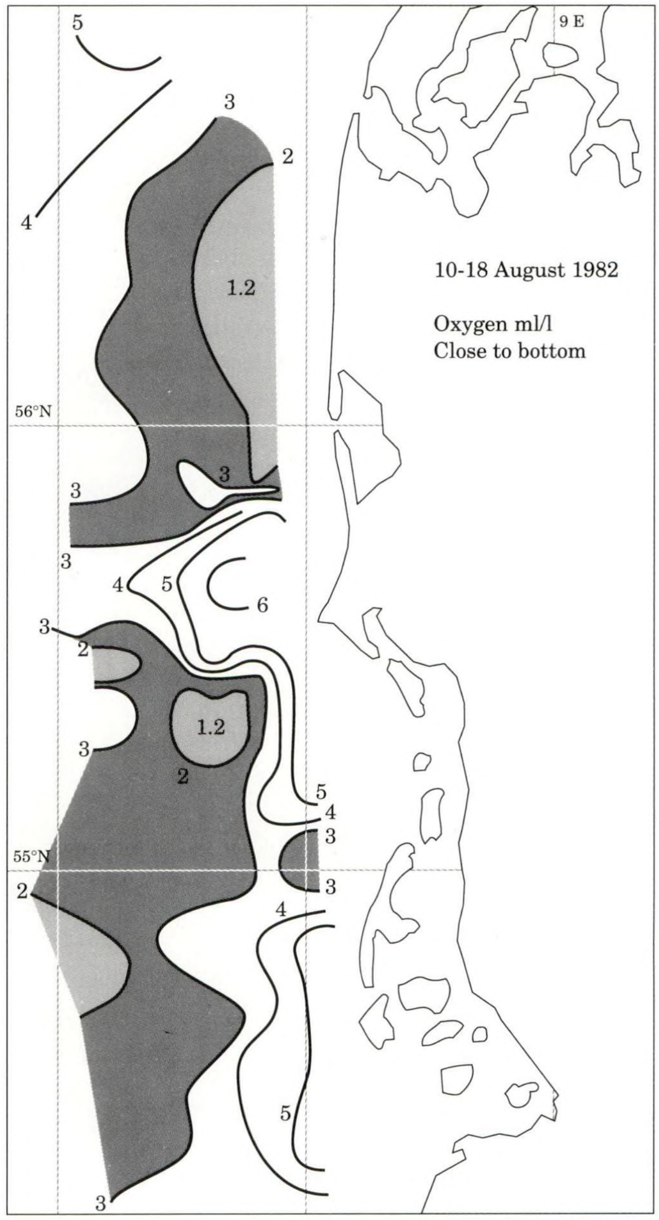


Fig. 1a.

On the basis of this and other reports, including a report about the input of phosphorus, nitrogen and organic matter to the sea, the government proposed a plan for reduction of the inputs of nutrients and organic matter to the Danish environment in 1984. Because it was a minority government it had to accept a number of modifications to the plan before it was accepted by Parliament in May 1985. The final plan was better for the environment.

In the autumn 1986 large areas in the Kattegat were affected by oxygen deficiency. Because of cooperation between marine scientists and the news in Danish Television a lot of publicity was created, starting with pictures of many dead Norway lobsters shown by a biologist from the Marine Pollution Laboratory of the Danish Agency of Environmental Protection. This cooperation was accepted by the Agency because it was of the opinion that the present restrictions on nutrients, especially the restrictions on farming activities, were not sufficient for improving the eutrophication problem. This started an enormous debate in Danish society and a majority in the Parliament tried to press the government to suggest new, more stringent laws for reducing the inputs of nutrients to the Danish environment.

The 'green organisations' also tried to press the government. A six-point action plan: 'Save the sea around Denmark' proposed by the Danish Society for Nature, which is a 'green organisation', received so much support from the general public that the minority government proposed a nearly identical action plan. The final action plan was strengthened by Parliament. It intended to give 50% and 80% reductions of the total inputs of nitrogen and phosphorus respectively into the Danish environment over a five year period.

These decisions caused a complete change in Danish effluent policy, which previously had been based on quality objectives for grey-list substances and nutrients, to uniform emission standards for most substances. For the black-list substances, Danish policy has always been to use strict emission standards based upon best available technology.

Among marine scientists there is still a debate as to whether the Danish reductions in nutrient discharges will substantially reduce the eutrophication problems in the open Danish sea areas, e.g. the Kattegat. It is generally accepted that international agreements on reductions of nutrient inputs to the marine areas are necessary to achieve further improvement in the Danish North sea area and the Kattegat.

This case study has shown the need for cooperation among scientists and politicians. It further demonstrates the difficulty in predicting the possible effects when using quality objectives for the marine environment and it proves that even by extensive scientific research and monitoring over several years it is very difficult to predict when the marine system is overloaded with, e.g. nutrients, or is not in an equilibrium state. It further supports the view from the Second International Conference of the Protection of North Sea (Anon, 1988a) that a precautionary approach is necessary which may require action to control inputs of substances even before a causal link has been established by wholly scientific evidence.

International Organisations working in the North Sea Area

In the North Sea area, prior to the first North Sea Conference in Bremen in 1984, there were four organisations working internationally with environmental problems of the North Sea: The International Council for the Exploration of the Sea (ICES), Oslo and Paris Commissions (OSCOM and PARCOM) and EEC. In addition to these four, after the Second North Sea Conference in London in 1987 a new organisational entity was established with the formation of the North Sea Task Force (NSTF), which is run by PARCOM and ICES in cooperation.

ICES - The most Scientific and Least Political Organisation?

The organisation of the ICES working groups and hierarchy of ICES is shown partly in Fig. 2. The members of the working groups (WGM) are scientists appointed by the national governments. WGM are working in their capacity as scientists generating scientific discussions.

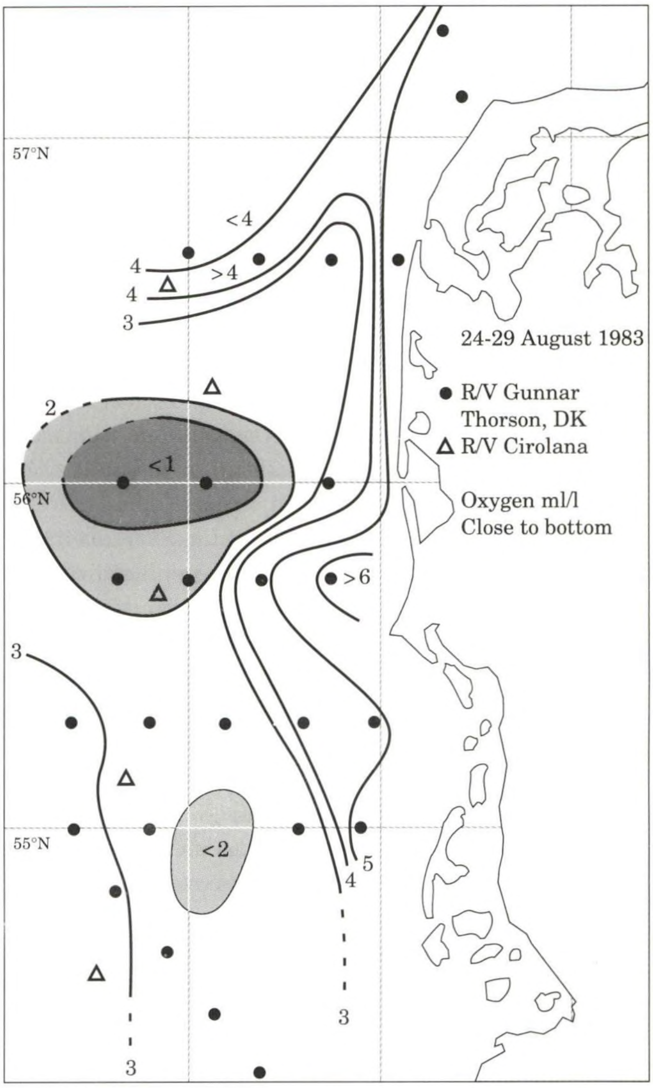


Fig. 1b.

WGM present and discuss the different scientific questions in relation to marine problems. All the work is done on a voluntary basis and is based on the professional interests of WGM.

The reports from WGs have to be accepted by the Advisory Committee of Marine Pollution (ACMP) where the members are appointed because they have a position within the ICES hierarchy, or because of their scientific capacity.

ICES WGs have carried out a great deal of relevant scientific work in relation to the North Sea environment. The marine chemistry WG (Fig. 2) has contributed to the improvement of the comparability of sampling techniques and analytical results for trace metals in particular (e.g. Berman and Boyko, 1989). ICES WGs have also worked on the monitoring of contaminants in seawater and biota.

In my opinion WGM are only a little influenced by their political system at home. Of course they can not work completely independently of the environmental view in their home country; but generally the work is performed in a scientific way, especially in WGs. ICES has the advantage that the membership also covers Canada, United States and the Baltic countries including The DDR, Poland and Russia. This gives a broader scientific view on the different matters and the advantage of inputs from countries outside the area around the North Sea.

Oslo and Paris Commission - Less Scientific and More Political Organisations?

The main organisation of Oslo and Paris Commissions is shown schematically in Fig. 3. As shown in Fig. 3 the two organisations have a Joint Monitoring Group (JMG) which is responsible for performing and evaluating the joint monitoring programme for the whole OSCOM and PARCOM area.

As the JMG has an advisory role in relation to the Commission, it can in principle work on a completely scientific basis and does mostly that. However, the members of the JMG are delegates of the national governments and as such they are slightly influenced by the policy of their government.

During its 12 years of existence the JMG has gradually improved the performance of its work. During the first years the main problem, were the establishment of the joint monitoring programme and the strengthening of the different laboratories so that comparable data could be obtained. This has been achieved in close cooperation with ICES WGs. This has also been mirrored in the membership of JMG because earlier several of JMG representatives also were members of ICES WGs.

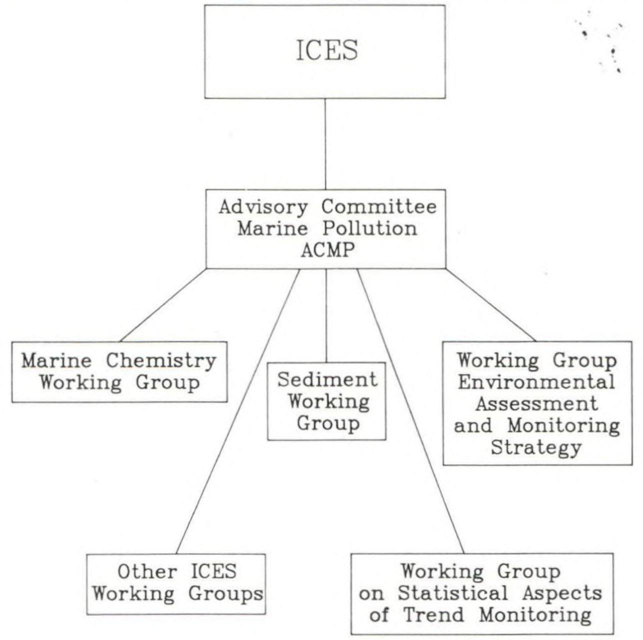


Fig. 2 Simplified Organizational Chart of ICES = International Council for the Exploration of the Sea

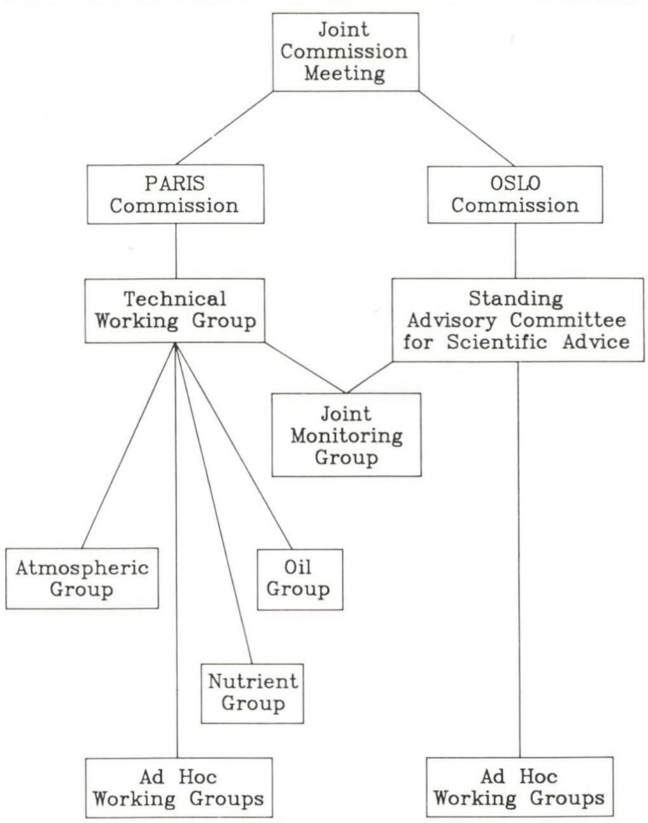


Fig. 3. Organizational Chart of OSLO and PARIS Commissions

During the last years the JMG has changed its work more in the direction of doing its work either independently of ICES WGs or in cooperation with ICES WGs. An example is the '1985 Baseline Study of contaminants in fish and shellfish' (ANON., 1988b) which was carried out in cooperation between ICES, OSCOM, PARCOM and HELCOM (Helsinki Commission).

The weakness of the JMG in relation to the North Sea is the broad membership where perhaps countries like France, Spain and Portugal will not carry out monitoring programmes on the same scale as the North Sea countries.

Going up in the hierarchy of OSCOM and PARCOM we find SACSA (Standing Advisory Committee for Scientific Advice) and TWG (Technical Working Group) respectively, as shown in Fig. 3. The members are mostly government officials and are therefore more influenced by the policy of the different governments. An example of the work of TWG is presented in Annex 1. It shows that the work is mostly directed at reviewing statistical and scientific data presented by the different governments and suggesting guidelines and restrictions for relevant parameters. The work is more administrative in nature and does not involve much scientific research. SACSA and TWG are the place where scientific work can be discussed among administrative representatives because the majority of the members do have a scientific background. However, the decisions taken are influenced by the policies of the governments.

The highest level in OSCOM and PARCOM is the yearly Commission meeting most of whose members are very close to the political system in their home country. In principle all decisions taken at the lower levels have to be confirmed by the Commission meeting. Often there is a large communication gap, especially between the scientific discussions at the lower levels such as the JMG, and the discussions in the Commission. There is no doubt that better communication is essential between the scientific groups and the more political groups within OSPAR and PARCOM. It has been improving over the last few years and must be further improved. In my opinion it is essential that scientists present their views at the more political levels in order to minimise the communication gap. This also means that scientists have to present their results in a manner which can be understood by politicians.

Because of the Danish eutrophication problems the Danish Agency of Environmental Protection in 1985 convened a meeting under OSPAR with the objective of securing a Cooperation Agreement among the North Sea States which border the Southern and Eastern North Sea and the Skagerrak and Kattegat as regards measures to assess the input and effects of nutrient loads from land-based sources. The Danish initiative resulted in the formation of a nutrient group within PARCOM. The members of this group are a mixture of scientists and administrators. Because of the implication of the decisions taken in this group there are great differences in the opinions among the scientists and the more policy-oriented members of the group. Generally it can be said that the different viewpoints relate mainly to the different national backgrounds and that even the viewpoints of scientists are influenced by official policies.

In a overview paper on the monitoring of nutrients within the JMG prepared in 1989 by prof. S. Gerlach, Federal Republic of Germany, after a request the from JMG, quite different opinions were expressed as to whether nutrients are a problem for the marine environment. Taking the North Sea area, it was the general opinion that nutrients have caused some problems in the Eastern part of the North Sea, although there was no agreement on the severity of the problem. Despite considerable research effort there are still difficulties in proving causality between the increase in nutrient concentrations and the increase in phytoplankton. Concerning the UK area the UK recognizes in principle the unwanted effects of increased nutrient concentration and of nutrient inputs to coastal waters, but still has no proof that such effects occur off the British North Sea Coast.

EEC - The Least Scientific and The Most Political Organisation?

The EEC sets directives for the marine environment which also influence the North Sea environment. The EEC has its scientific advisory committees which in principle should work under scientific conditions, since most of the members are scientists appointed as experts. However, when agreements on directives have to be achieved in the Council it is at least my experience that in the end a political compromise decides the content of the directive, which is not always to the benefit of the environment.

Two examples are the directives on mercury, 82/176/EEC, and cadmium, 83/513/EEC, where the quality objectives set for mercury and cadmium in both fresh and sea water are much higher than concentrations ever found in any natural area. In my opinion these quality criteria were a political compromise. However, in my opinion, the criteria suggested by one of the EEC members at least was based on faulty scientific information, in which the most recent scientific data was not included.
It is very difficult to change a directive even though the scientific evidence today proves that the quality

objectives set for mercury and cadmium are far too high and will not protect the marine environment.

The North Sea Task Force - The Ideal Combination of Science and Policy?

At the 1987 Ministerial Conference in London it was agreed that a North Sea Task Force should be established. After OSPAR, PARCOM and ICES accepted the mandate of the Task Force, it held its first meeting in December 1988 where the following objectives were agreed:

- to provide an organisational framework for discussion and exchange of views between policy makers and scientists, with the aim of attaining the respective aims of the two groups;

- to screen and co-ordinate the scientific work carried out within the framework of OSPARCOM and ICES;

- to provide interim reports on selected subjects as and when necessary to the Commissions, to ICES, and to the North Sea Conference;

- to produce a new assessment of the North Sea in 1993;

- to fill the gaps in knowledge identified by the previous Quality Status Report and the London Declaration.

It was further agreed that policy makers had an important role to play in the Task Force, especially in the beginning and at the end of its existence. Under certain circumstances it would be essential to convene scientifically oriented meetings to discuss matters of more scientific nature.

If these objectives are followed the ideal forum for exchange of views among policy makers and scientists will have been established. As the Task Force has only held two meetings, it is premature to predict whether it will achieve its objectives and be a success, thus contributing to the benefit of the health of the North Sea.

Is the Co-operation between Science and Policy sufficient?

During the last years the co-operation between science and policy-making has increased, presumably because environmental questions have received much more attention from the public. However, it has to be further improved in the future because it is vital to improve communication between environmental scientists and policy-makers. Whether this can be achieved by the organisations mentioned above will be for the future to demonstrate.

In my opinion it is important to have excellent co-operation between environmental scientists and policy-makers, equally excellent co-operation between environmental scientists and the 'green' environmental groups. If the 'green organisations' want to have political influence they have to work together with environmental scientists to give a reliable impression. This co-operation has been demonstrated by the case history of the Danish eutrophication problem. It is very important for the pressure which environmental groups can put on policy-makers, because scientific proof of a causal relationship is very difficult to obtain with great security.

Some of the goals set up at the London Conference in 1987 were, I believe, partly caused by the pressure from environmental groups and by pressure from the more progressive governments in environmental questions. The acceptance of the precautionary principle was a big step forward because it is very difficult, as demonstrated by the Danish eutrophication problems, to predict when the marine environment is not in a steady state.

There are very few cases where it has been possible to demonstrate a clear causal link between the input and effect of a contaminant. This was clearly shown by the relation between inputs to the marine environment of tributyltin from antifouling paints and the effects on oysters in France and UK (Alzieu et al., 1986). In this case a close co-operation was established between scientists and politicians and in both countries a ban on the use of antifouling paints with tributyltin on pleasure boats less than 25 meters came into force. A similar ban has also been proposed by EEC and in this case there is a general, positive support for a directive.

However, in both countries the oyster production is an important business. What would happen if a similar causal link was demonstrated for another contaminant where economic interests were insignificant? Would it be as easy to get a ban?

What to do with a Grant of 10 Million Guilders?

How would I use the grant to obtain the maximum cooperation between scientific knowledge and the political decision-making process with respect to the North Sea? I would use it for the establishment of a international, environmental North Sea Research Institute whose main task should be:

- establishment of cooperation between marine research institutes around the North Sea;

- performing its own research, especially in relation to the understanding of the ecosystem of the North Sea;

- performing the more scientific tasks of the North Sea Task Force;

- providing members for the more scientific groups mentioned above.

Once a strong scientific institute in relation to environmental matters of the North Sea is established, there will automatically be cooperation with policy-makers.

Conclusion

In the paper it is demonstrated how scientific results have been used by policy-makers and environmental groups to press the Danish minority government to accept more stringent restrictions than they would have proposed themselves on the basis of the scientific evidence.

The paper also shows that it is necessary to have better co-operation between policy and science in order to obtain the necessary improvement in the health of the North Sea. In this context the precautionary principle is an important step towards an improvement in the health of the North Sea.

It is further postulated that environmental groups are important factors in the decision-making process because it is very difficult to demonstrate with scientific evidence a causal link between input of contaminants and their effects. It is very seldom possible to get improvements in the health of the environment because of economical reasons without strong pressure from scientists, environmental groups and the public. This co-operation sometimes also involves the government.

References

Alzieu, C., Sanjuan, J., Deltreil, J.P. and Borel, M., 1986. Tin contamination in Arcachon Bay: Effects on oyster shell abnormalies. Mar. Pollut. Bull. 17, 494-498.

Anon., 1988a. Ministerial declarations. Second International Conference on the Protection of the North Sea. London, 24-25 November 1987. Department of the Environment, London.

Anon., 1988b. Results of 1985 baseline study of contaminants in fish and shellfish. Coop. Res. Rep. 151.

Berman, S.S. and Boyko, V.J., 1989. ICES seventh round intercalibration for trace metals in biological tissues. Part two. Coop. Res. Rep. In press.

Cadmium. Council directive of 26 September 1983. Limit values and quality objectives for emission of cadmium. 83/513/EEC.

Gerlach, S.A., 1989. The monitoring of nutrients. Internal paper from Fourteenth Meeting of JMG.

Mercury. Council directive of 22 March 1982. Limit values and quality objectives for emission of mercury from chloralkali plants. 82/176/EEC.

Ærtebjerg Nielsen, G., Jacobsen, T.S., Gargas, E. and Buch, E., 1981. Evaluation of the physical, chemical and biological measurement. The Belt Project. National Agency of Environmental Protection. Copenhagen.

Annex 1. Headlines of the work of TWG meeting in 1988.

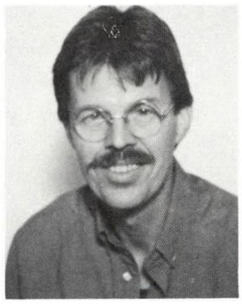
1. Waste stream approach and low waste technology.
2. Mercury pollution.
3. Reduction programmes for grey list substances.
4. Tributyl-tin compounds.
5. Cadmium pollution.
6. Discharges: Licensing procedures and charging systems.
7. Report of the working group of atmospheric inputs of pollutants to convention waters.
8. Report of the working group of input data.
9. Pollution by PCBs.
10. Report of the working group of oil pollution.
11. Monitoring to assess compliance with the Paris Commision's environmental quality objectives for mercury and cadmium.
12. Nutrients.

New Perspectives

The actual setting of priorities by politicians in the different uses of the marine environment and in marine research has been steered more by disasters, such as the wreckage of oil tankers, the Minemata disease, the declining populations of seals and other animals with publicity value, than by results from systematic and well-coordinated scientific research. The North Sea environment is no exception to this rule.

At first this approach was useful to bring the marine environment to the attention of politicians, but disasters form an uncertain, by definition not preventive, and too temporary basis for decisions.

In our paper two questions will be addressed. First we analyse how the relation between politics and science functions in practice, and then we discuss how the quality of this relation can be improved. Secondly we discuss how the public interest and consequently the political interest in marine environmental topics can be maintained and intensified in the future in order to ensure that the political basis for the conservation of the North Sea is strengthened.



Jan Kuiper,
EcoMare, Wadden and North Sea Centre, De Koog, Texel
Wanda Zevenboom,
Rijkswaterstaat North Sea Directorate, Rijswijk
Ben ten Brink,
Rijkswaterstaat, DGW, Den Haag

Introduction

In this paper we will explore some aspects of the relation between policy and science in the context of the environmental problems of the North Sea. Primary aim of the authors is to make a contribution to the conservation and rehabilitation of ecosystems in the North Sea. The central aim for policy and science (for us) is to obtain, sustain and guarantee a healthy marine environment and to explore and use the potentials of the North Sea in an environmental acceptable way, i.e. ecological sustainable development and exploitation.

At the 2nd North Sea Seminar in 1987 it has been made clear that there are sufficient "reasons for concern". In the past years this concern has not diminished. Fortunately in the last few years there have been signs of a growing awareness of environmental problems. The Brundtland report appeared with its notion of global ecological sustainable growth, queens and princes expressed their concern and also the Council on Social Economic Affairs (SER) in the Netherlands stated in March of this year that 'the aim of maintaining balance in the ecological system is of a higher order than five (other) objectives of social-economic policy'.
Also the awareness of environmental problems encountered in the North Sea has increased during recent years. This awareness was given expression at the 2nd North Sea Ministerial Conference by adoption of the precautionary principle.

For a long time the sheer expanse of the sea may have given the impression that there is sufficient room for everything. And indeed, a number of activities take place: the sea is used as a medium for shipping, fishing, military activity, as a rich resource (fish, oil, gas, sand, gravel) and last (but unfortunately not least) as an unlimited garbage dumping place: directly from ships, pipes, etc, or indirectly via polluted rivers and the atmosphere. Many of these uses have in one way or another serious impacts on the marine environment of the North Sea, although not so often (even in this relatively well investigated sea) clear cause-effect relations are for 100 % scientifically sound and proven. Being aware of the serious situation of the ecosystems of the North Sea is one thing, finding a solution to ensure ecological sustainable growth and exploitation is another. The answer must be given by science and policy, working in close cooperation.

In the present paper we describe our society as a web (figure 1), a network in which science and policy have their place. We try to point to those relations in this web which have to be strengthened in order to achieve our goal for the North Sea as described above.

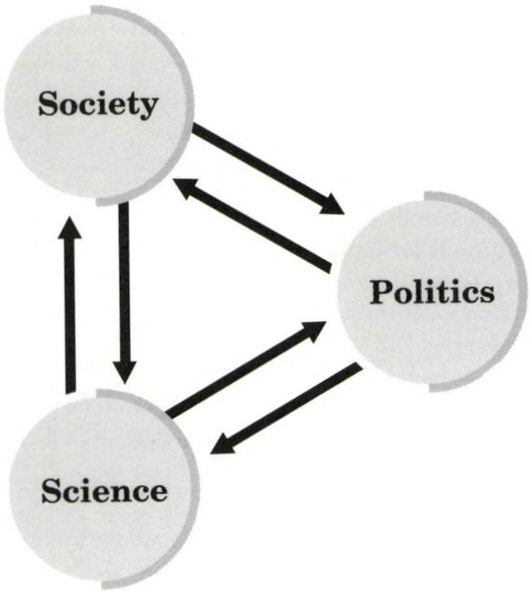


Fig. 1.

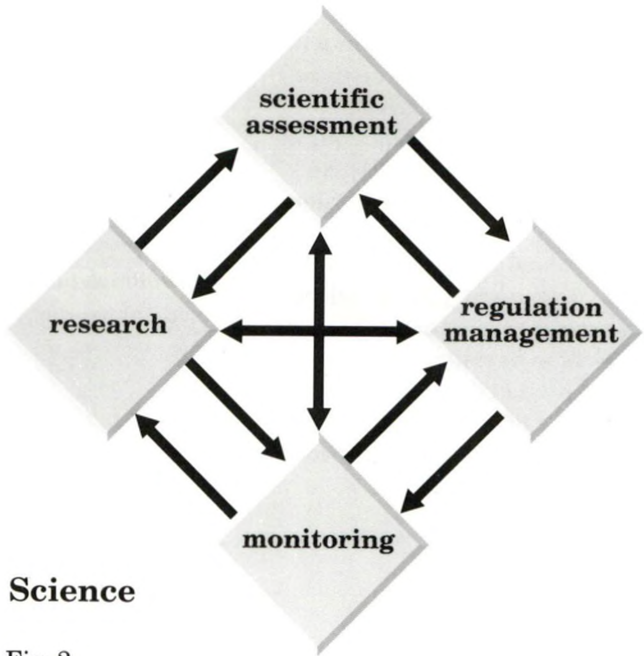


Fig. 2.

Relations between policy and science.
Using science as an objective and generally accepted method, scientists try to find answers to questions which are formulated by themselves and others. Policy-makers, whom we can divide in politicians and civil servants, active in the implementation of policy, have a large influence on the process taking place in scientific circles. First policy-makers have a large influence on the questions asked in science, directly by funding some research projects and disregarding others. Secondly policy-makers decide if and how answers given by scientists are used and incorporated in regulations, etc., and by doing so are indirectly steering future questions posed to and by scientists.

In practice the majority of measures taken by policy-makers regarding the different uses of the marine environment and in setting priorities in marine research was triggered more by disasters, such as the wreckage of oil tankers, Minemata disease, declining populations of seals and other animals with publicity value, than by results from systematic and coordinated scientific research. The North Sea environment forms no exception to this rule.

As a first phase this approach has been useful to bring the marine environment to the attention of politicians, but disasters form an uncertain, and too temporary basis for decisions, and they are by definition not preventive.

What one expects is that science and politics play the following roles :

- scientists formulate problems encountered in the North Sea and come up with alternative solutions
- politicians study these alternatives, relate them to other interests and take decisions.

In practice this process of cooperation between science and politics has not functioned too well in the past.

Many measures taken by policy makers, and in fact also the steering of applied marine research were triggered by the occurrence of environmental disasters. Though this 'management by accident', environmental disasters take the role of science, and scientists follow instead of lead the way. Many examples can be given illustrating this phenomenon :

PCB intoxication in Japan - ban on PCB's
Mercury poisoning (Minemata disease) - mercury on the black list
Cadmium poisoning - cadmium on the black list
Mortality of eiders and terns in Wadden Sea - ban on dumping of drins
Oxygen problems in German Bight (increased toxic algal blooms fish kills) - 50% reduction of nitrogen and phosphorus input in the North Sea
Steady increase of various toxic substances (grey list compounds) - 50% input reduction

The latter two cases may illustrate a subtle change in the policy approach : the target is set for 1995, the intensity of action is set on a 50% reduction, without awaiting further scientific evidence for identifying the exact level of target or intensity of action. These latter two examples are interesting cases of the application of the precautionary principle, a concept adopted and agreed upon by the 2nd North Sea Ministerial Conference (1987).

It is, however, not systematic scientific research, but the occurrence of disasters which seems to have the greatest influence on the policies adopted. This is a kind of troubleshooting management, policy-makers act in good agreement with this precautionary principle, following the direction set by science, but unable to fine-tune decisions due to lack of scientific advice. There exists an imbalance between policy questions and scientific answers.

One of the causes of this phenomenon is that the worlds of science and politics are wide apart and are ruled by different laws. In politics people have to act quickly, are only interested in main outlines, and not interested in details; they accept and sell simple messages and are happy with a 60% precision or probability of predictions. Traditionally scientists work along a slow process of acquiring knowledge, are interested in details, investigate problems from different angles, and are content only if predictions have a 90% precision or probability or higher still.

Moreover many scientists wait for the policy-maker to tell them what is important to investigate, the policy-maker waits for the scientist to tell him which aspects are important enough to incorporate in regulations and laws.

A solution to this problem would be different attitudes of scientists and policy-makers towards environmental sciences. Predictions must not be seen as 'The Truth' or 'The Final Answer', but as the latest step in an iterative process which, step by step, brings us a little further in the direction of how ecosystems function (figure 2). This means that a scientist must be willing to respond more quickly to questions asked, accepting a higher uncertainty, and that the scientist must not be blamed but on the contrary be stimulated to re-answer questions which could be reformulated and more precisely after the latest answer. On the other hand this attitude means that the policy-maker must accept that scientists can only give a 'best professional judgement', just as he must accept from environmental scientists like ecologists, environmental chemists, ecotoxicologists the same level of uncertainty as is accepted in meteorology or economy. The meteorologist is also not crucified if the weather of today is somewhat (or totally!) different from what he predicted the day before. It is generally accepted as his best professional judgement of yesterday.

Scientists do play a political role, whether they want to or not. It is important that scientists are aware of this political role. Some scientists help those groups in society, who have no priority for the conservation of our ecosystems (but are more interested in short-term money-making), and by continuously stressing the uncertainty of many scientific predictions, by stressing that more research must be done before anything can be said. Scientists must not be afraid to make 'mistakes' in the necessary 'best professional judgements'.

It is very important in this respect that scientists are allowed to operate in relative independence. An essential condition for achieving this is the availability of long term guarantees for the financing of pure scientific research, pure science as the source of new ideas, concepts, theories. Also the financing of applied science must have a long-term character. Only short term investigations, using widely accepted methodology (e.g. routine toxicity tests), can be financed on a more short-term basis.

Apart from the willingness of scientists to express their best professional judgements and the acceptance by policy-makers of relative uncertainty of these judgements and predictions, another important aspect occurs in the relation between science and policy.
It is very important that the different actors in this process can find one another in common goals. Since the

last North Sea ministers' conference these common objectives can be described as: to obtain, sustain and guarantee a healthy marine environment and to explore and use its potentials in an environmentally acceptable way (ecological sustainable growth and exploitation). In other words all (short term) human interferences in the North Sea ecosystems are evaluated in the light of the (long term) functioning of the ecosystems. Thereby the apparent contradiction between ecological and economic activities disappears. It is ecology which sets the boundaries for economic activities.

These objectives are of course nice formulations, but they have the disadvantage that they are still vague, very general and difficult to evaluate. There is a need to specify the goals more precisely so that the effect of regulation and management measures, based on scientific research, can be evaluated in the light of the predetermined goals set out before.

A second important aspect that comes into focus is that scientists must be willing to communicate their knowledge on a more integrated level to the policy makers. Both aspects, integrated presentation of scientific knowledge and more precise formulation of goals, will be illustrated with an example, derived from a recent Dutch plan for organising research in the North Sea (the AMOEBA approach).

One way to bridge the gap between science and politics is the introduction of environmental reference values for all kind of parameters relevant to the structure and functioning of the ecosystems of the North Sea. These environmental reference values, derived from a relatively 'undisturbed' reference period, are by no means environmental standards. They are useful tools in the assessment of the present state (the 'health') of the marine environment. For the North Sea a set of 30 parameters has been chosen. The reference situation, in time located at 1930, can be visualized by a circle, all reference values being equalized to the radius of the circle.

Comparison of the situation at present with the reference values can be conveniently displayed in an AMOEBA shaped figure (figure 3). Some species like Phaeocystis have showed an overwhelming increase since 1930, others, such as the common seal, have become nearly extinct. From all the chosen species the analysis of all available information on population numbers, distribution, demands on the environment, sensitivity to stress factors, etc. is collected in ecoprofiles. By the simple amoeba presentation problems of eutrophication, pollution, overfishing, public works like polders and dikes, etc. are presented in a simplified and clear way. But the interrelation of various factors can also be

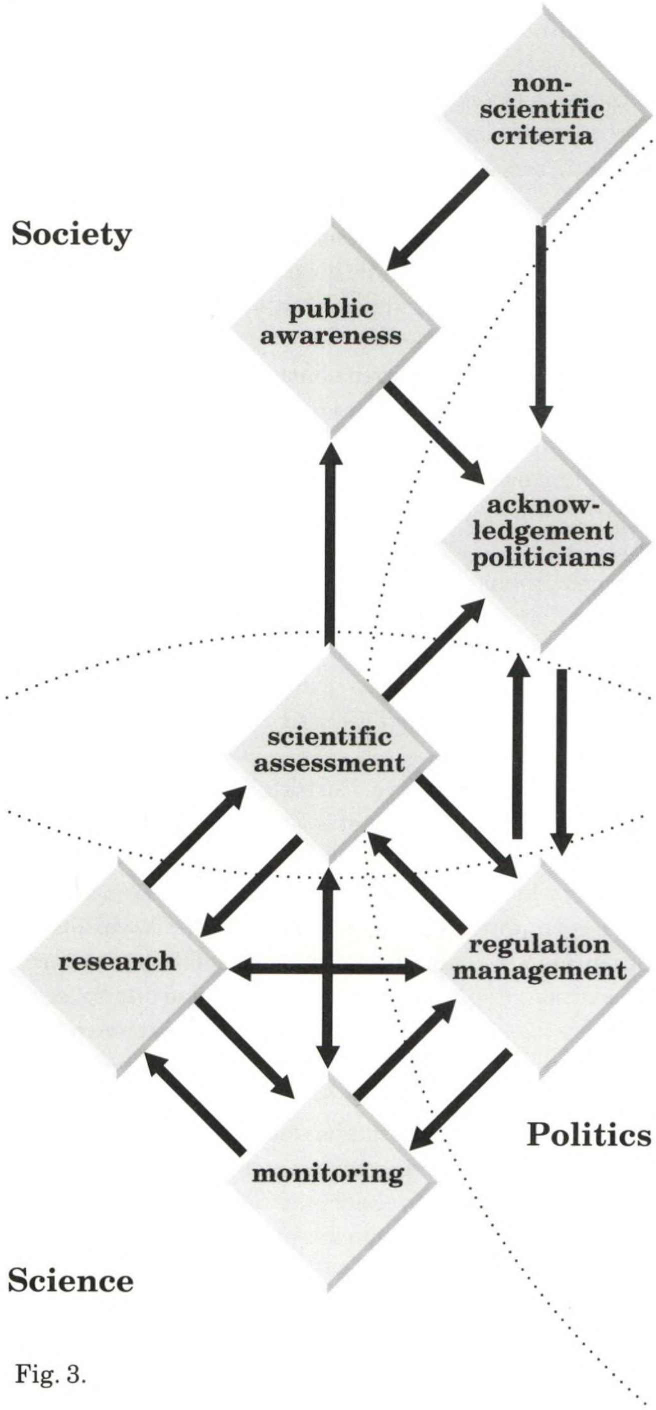


Fig. 3.

shown. Measures taken at one sector (e.g. fisheries) and in another (e.g. eutrophication or pollution with organic micropollutants) both have effects on the shape of the amoeba.

The goals for the future can be formulated quite precisely by setting the maximum deviation of the reference circle. Effects of measures can be shown in a way which can be understood by the layman.

That sometimes a successful relation could be built up between scientists and policy-makers in the past is illustrated by the Dutch OPEX (Oil Pollution EXperiment). In this project scientists and policy-makers together formulated questions in relation to the optimal combat techniques and management of oil spills in the Wadden Sea. Research showed that the application of chemical dispersants intensified the effects of oil. Scientists stated that the application of chemicals was a bad measure, policy-makers adopted this prediction and abolished the application of chemicals as one of the first tools in oil spill management.

Relation scientists - the public at large in relation to policy-makers

In fact the relation between science and politics described above is concerned mainly with the relation between scientists and civil servants policy-makers (figure 4). Before they can start their work or expand their activities, funds must be made available by politics. This means that politicians should be interested in the subjects with which the above mentioned scientists and public servants are busy. Politicians can be motivated to come into action if the public and/or strong lobby groups ask them to do so.

Politicians and their decisions on environmental affairs are not only influenced by the results of scientific research, but also by other factors from all types of groups. The mechanism described before, by which policy-making was in the past more governed by the occurrence of disasters than by the results of scientific research, clearly points to the importance of the public at large in this respect.

In the case of the North Sea many different pressure groups are lobbying to ensure maximum attention to their interests.

Different beneficiaries of the richness of the sea (e.g. fisheries, offshore activities, shipping) often tend to look at short-term interests which not necessarily coincide with long term ecological sustainable growth. Nature conservationists embrace long-term processes and sometimes overlook the short term problems some users have in surviving. Scientists and public servants policy-

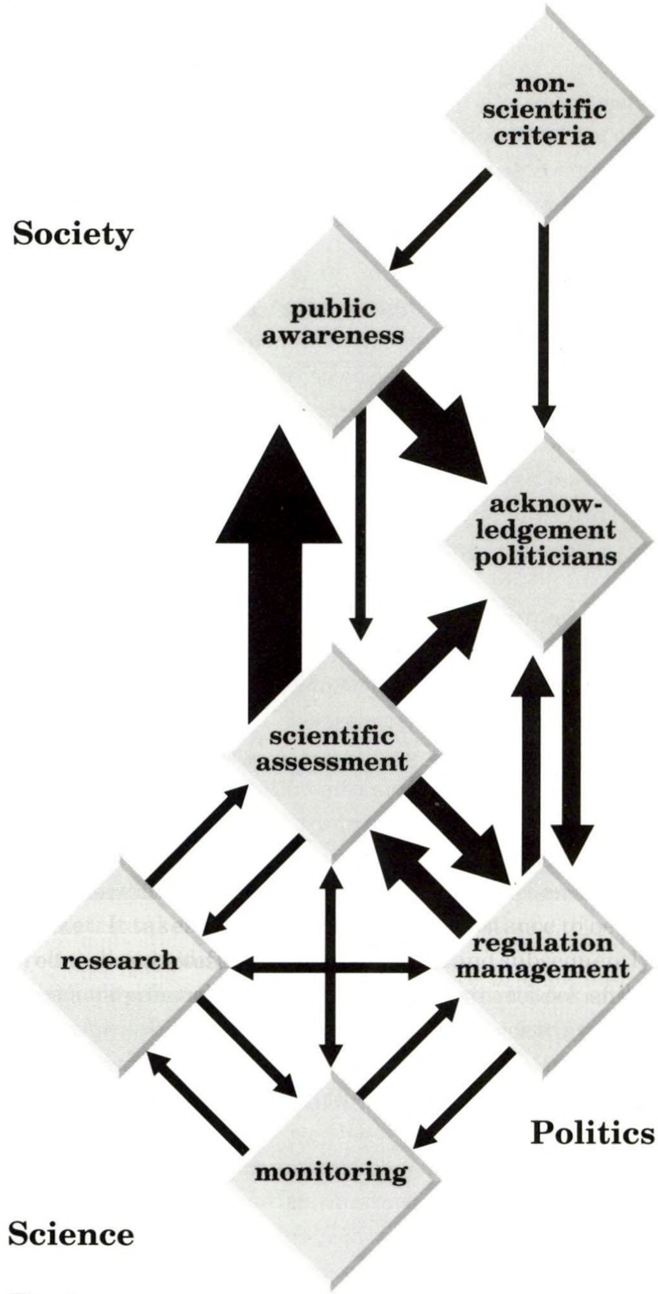


Fig. 4.

makers play a special role. In principle they (only) carry out work, but in practice they have considerable influence on the questions asked and how answers to these questions are used. Scientists should also focus on the long-term effects on ecosystems. The relation between nature conservation and science must be strengthened.

The relation of the public, different pressure groups and lobbies inside this conglomerate with politicians is important. For groups active in conservation and rehabilitation of North Sea ecosystems it is very important to organize and strengthen an effective lobby. For scientists and policy-makers who work along similar lines and have similar goals as these groups, it is important to support these lobby groups and feed them with subsidies and information.

The short-term 'users' of the sea are generally organized in strong, professionally organized lobbies. To gain more power the nature conservation lobby needs to improve its professionalism and strength.

Scientists and policy-makers both have a strong responsibility to present information on which long-term policy can be founded to the public. If the public is aware of the seriousness of the situation in our ecosystems, including those of the North Sea, there is a chance that a political basis can develop to support the necessary measures. Measures in terms of financial support for the necessary scientific investigations, and measures taken by the governments to ensure the ecological sustainable growth and maintenance of the North Sea ecosystems.

In practice this statement means that the government should invest in the communication process between policy-makers and the public, explaining the background of plans and measures, and should also invest in the communication process between science and the public, explaining new findings, new theories, backgrounds of phenomena in specific ecosystems, explaining how and where these ecosystems are threatened, what can be done to prevent further deterioration of these systems, etc.

The political readiness of the public to make (short-term) economic sacrifices to enable the (long-term) survival of ecosystems must be based on knowledge. This means that the communication between science and policy-makers has to contain "true" information. The information may be simplified but must never turn into propaganda. Of course we know that knowledge alone is not enough to raise the necessary readiness, but without it, measures have no basis in the public and can be easily turned back in future (if taken at all).

What type of contributions to this communication process between government, public, science and the public can be made? In the first place environmental education should be incorporated into all levels of education, starting at primary school and going up to universities and other forms of adult education. This environmental education should not be presented as a 'nice extra' in the programm, but as an integrated and essential part. In the framework of environmental education attention should be paid to the marine environment in general and the North Sea in particular.

In the second place development of means of information and education of different groups of the general public should have priority. The role of the media is important in this respect. Much attention should be given to information at various levels via newspapers, radio, tv and (video)film. But also other means of education must be exploited and developed. An important method could be the setting up of transfer-points of knowledge in the form of science parks, science centres, etc. The communication between North Sea scientists and the public can also go via existing natural history museums, visitors' centres along the coasts, and short, general courses on the ecology of the sea and the coast, etc. Various methods may be used to inform different groups to satisfy their questions and aims. Essential is that a frame work of educational facilities exists so that people can take part at their own level of interest and background knowledge.

Centres like EcoMare should form a chain along the coasts of Europe exchanging techniques and information, setting up an international network for public information and education on the marine environment. The recent example of the 'Coastwatch' project shows that international educational projects on the marine environment are feasible. In October 1988 thousands of schoolchildren in many different countries in Europe studied in october 1988 the situation of European coastal waters and made this knowledge available to each other by using personal computers. An example worth following up with other projects.

Conclusions

We discussed various aspects of the relation between science and politics and indicated that to achieve the central aim (ecologically sustainable growth and development of North Sea ecosystems), the general public should also be activated.
The conclusions can be summarized by stating that the processes indicated in figure 5 by thick arrows need to be intensified.

This means that better cooperation between policy-makers and scientists is necessary and possible. Scientists as well as policy-makers have to accept uncertainties in the predictions of environmental science of today (as they are accepted in economy or meteorology). Not 'The Truth' but a cyclic process leading to increased understanding and better predictions of the ecosystem behaviour is the primary goal of environmental sciences.

To structure discussions on measures and the direction of future applied environmental research it is important that the vague general goals are translated in specific and verifiable objectives (e.g. AMOEBA approach).

It is acknowledged that the conservation of (marine) ecosystems is only politically interesting if supported by the general public. Therefore priority should be given to the improvement of the information and education of the public. This can happen in two ways: by incorporating environmental education in the usual education programmes from primary schools to universities, or by improving the information of the general public through the media (newspapers, magazines, tv, etc), science transfer points, visitors centres, museums, information centres, etc. Formation of an internationally oriented network of such centres is one way to improve the quality of the information flow.

Finally the relation between the public and politics can be improved. The nature conservation lobby must be organized with great professionalism if they wish to form an effective counterweight against the strong lobbies of the "short-term users" of the North Sea ecosystems.

Policy-makers must accept that scientists can only give a 'best professional judgement', and they must accept from environmental scientists like ecologists, environmental chemists, and ecotoxicologists the same level of uncertainty as is accepted in meteorology or economy.

Discussion

Rapporteur:
Cees Camphuysen

Chairman: Lord Cranbrook
Members of panel:
Dr Wettestad & Dr Andresen, Dr Ferm, Dr Jensen, Dr Kuiper

Mr Lankester (North Sea Working Group) asks who would be the main target for education, and wonders if environmental scientists should not explain the urge for a precautionary approach when actually designing industrial processes which will influence the environment.
Mr Kuiper does not think that education should aim at one specific group. From primary school level onwards people's basic attitude towards the environment should be educated, as basic as the training in reading and arithmatic. The group mentioned is just one of the many specific groups.

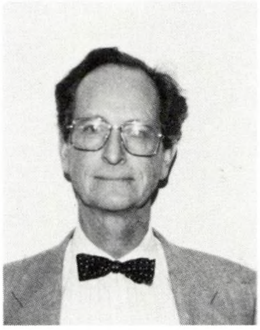
Lord Cranbrook would like to give his personal view, from his expertise in advising industrial groups. When considering the precautionary principle he believes industrial exercises already exist, and are practiced; it is extremely important to transfer these from industry to the environmental scene. Industry has developed several processes, called 'worst case analysis' or 'risk analysis', some of which are now standard processes in industrial analysis and environmental impact assessment. They imagine the worst possible cases, and investigate which precautions need to be taken then, quite a sophisticated process, which as yet has not been firmly transferred to the environmental field. For an effective anticipatory policy, it is incumbent on environmental scientists to evolve similar processes. Although worst risk analysis, or worst case analysis, will not necessarily predict all hazards - such as in the eutrophication hazard in Denmark -, if it is done properly every possibility is considered. He suggests evolving such processes for the environment. If the anticipatory principle is to be something more than a just flag which you wave at people, and say that they are not using or doing it, it must be defined in such terms. Every possible hazard, including those that seem to be rather improbable must be very firmly explored, and steps to provide the appropriate remedy or to take the appropriate precaution must be devised.
Mr Ferm states that such an approach would hold in an ideal world, where these instruments could be used, exact predictions be made, based on all available knowledge and where also a risk assessment could be made to estimate the risk to make a decision error. Not living in an ideal world, sooner or later someone will make an arbitrary decision. However, this does not argue against developing such a 'worst case assessment', as more background means that the odds are smaller for pure guessing or operating in an opportunistic way. In a society where children from primary school on have been taught some basic ecology, which is continued at higher levels, higher education should aim rather at giving an ecological background to important groups in political decision making, as well as to people with an industry career ahead, which means both engineers and economists, as the latter become managing directors of industry. Higher up one needs more specialised education, including knowledge about how to use the models discussed.

Mr Eikelenboom would like to know why the human being is not included in the 30 species taken for the amoeba?
Mr Kuiper points out that the amoeba only describes the situation of species living in the North Sea. The strength of this amoeba approach - and which species to select is still open for further discussion - is that it tries to choose indicator species which give information about other processes in the ecosystem.
Mr Eikelenboom thinks that the human species is part of the whole, and as such the role of the human species in the North Sea cannot be neglected.

Mr Gravenberg (S.L.O.) would like to come back to education. It seems very important to give people particular expert knowledge in order to be able to handle environmental problems. The general public seems to be poorly informed about the kind of knowledge and the potential of science to deal with problems. Youngsters now at school are the new generation which has to take the action tomorrow. He would like to respond to the question where to spend money and indicates that this should be in the direction of education because then a new generation may be raised which could help to close the gap between rational knowledge and the awareness that action can be taken.

Mr Jensen has a general comment referring to the Marine Pollution Laboratory, where several scientists raised publicity by presenting their views on the oxygen depletion at different meetings with the general public, a successful activity, which also raised publicity for the Marine Pollution Laboratory. However, last year the environmental research at the Danish Research Institute was evaluated by international experts, and one of their criticisms was that scientists at the Marine Pollution Laboratory spent too much time on raising publicity and trying to communicate their scientific results to the public. They should have used more of their time for scientific publishing instead. The urge for scientists to publish in the international papers and on the other hand the demands to inform the public about what is going on seem to be contradictive to some extent.
Mr Kuiper argues that translating the results of scientific investigations to the large public is a job on its own, which may be in better hands with people specially skilled to do so. Such work is too important to remain just a side road. Unfortunately, scientists tend to present their results after a disaster has occurred. A more general ecological background presented to the young (such as does exist for simple economics), may enable people to know what to do or not to do; it will also make ecology an intrinsic part of themselves.

Session IV
Forum



Chairman
Lord Cranbrook

Forum Report

Rapporteurs:
Christien Absil & Rob Alkemade
(Delta Institute for Hydrobiology)
Winfried Gieskes (Department of Marine Biology, University of Groningen)

Chairman: The Earl of Cranbrook

Members of Panel:
Mr H. Muntingh (European Parliament, socialist fraction)
Mr P. Horsman (Seas at Risk Federation)
Prof. Dr R. Clark (U.K.)
Dr H.P. Poley

Summaries on the items by Lord Cranbrook, Salomons, van der Meer, and Lange

Introduction by Mr H Muntingh

North Sea policy decision issues are based on considerable scientific information. Quality Status Reports have been prepared for the Bremen and the London Conferences; in Germany the Rat von Sachverständigen fuer Umweltfragen published an extensive report in 1980, and the Netherlands Water Quality Plan of 1985 is based on various quality reports derived from scientific data and publications. Important and useful information was also brought together in the Proceedings of the two previous Seminars of the Werkgroep Noordzee in 1979 and 1986. As a politician I feel that most of the information is accessible.

Nevertheless, the information also reveals that many questions remain unresolved, partly because scientists are always hesitant to express themselves clearly. Yet, although information is insufficient - and will probably always be so - a politician has to decide on the basis of available information, although a lack of information is often used as an excuse to defer political decisions. According to Mrs Smit-Kroes, politicians can only act on clear scientific information which is made accessible to politicians. Other speakers have argued that politicians should try to understand scientific information as it is presented by scientists. I agree that scientific information is normally available and that politicians should make an effort. The AMOEBA model could help here to bridge the gap between science and policy making.

The individual politician often acts differently from the 'general politician' in handling information. Many politicians do in fact not really care for the environment and some tend to use the argument of a lack of (easily digestible) scientific data to shy away from making difficult decisions, or even as an argument to avoid certain decisions. If the incorporation of scientific knowledge into political decision making is insufficient, it is the politicians who are to blame for that.
It is my opinion that the Precautionary Principle is a practical guide for making decisions. I have no objection to use the concept of Assimilative Capacity as well, provided it is embedded in a precautionary approach. I believe that objections to the Precautionary Principle may be guided by its tendency to result in unpleasant decisions.

The problem of insufficient information may have different causes. One is that the information exists, but is not available. Such secrecy of information can be a danger to the environment as it might have helped in solving certain environmental problems. Information can be withheld by governments, by industry, or by scientists who could find themselves in a position where giving free information may have adverse consequences for themselves. Freedom of information is essential to the protection of the environment. For example, the problems of the river Rhine could have been solved much earlier if the necessary information, available to governments institutions, had been freely accessible early on. Even now the NGOs have to do research from their own ships to find the emission data themselves. On such a basis, where information is made accessible only to a select group, politicians cannot act adequately.

Decisions should profit from more and better information. Politicians should therefore stimulate scientific research. With that objective the European Community is making considerable investments in cooperative research programmes.

What kind of science is needed? I would plead for some shift in emphasis. Monitoring should continue as a source for the essential distress signals, but more effort should be invested in preventing distress signals from arising at all by stimulating prevention, in a policy based on a precautionary approach.
More effort should be put in evaluating new industrial products and processes for environmental safety before products are put on the market, or before projects are carried out; environmental impact assessment for both products and projects should be expanded. Integrated research which includes social aspects and interdisciplinary approaches should be encouraged.

And how to spend 10 million guilders? I suggest bringing together a team of people to help politicians to collect and use more profitably the scientific information which scientists produce and translate that into political proposals, so facilitating the translation of scientific information into policy making.
Another way to spend part of it may be to organize an intensive course to educate those who believe that the precautionary principle is impracticable in how to make it practicable.

Introduction by Mr P V Horsman

Do you find the incorporation of scientific knowledge in the polical decision making process sufficient, effective and succesful?

The answer to the question above is simple and short - no. In this discussion I shall try to give reasons and provide some ideas where the situation can be improved.

1 Is There Sufficient Science?

How much science is sufficient? It was stated earlier in the conference that the North Sea is the most studied sea in the world, yet we are still saying that we do not have sufficient knowledge or information about the environment. This begs the question - will we ever have sufficient knowledge?

But sufficient science for what? What is it that we (society) are asking science to do? Obviously there is not one voice in society - politicians ask for one thing; industry for another and perhaps the general public asks for a third. The title of the conference includes 'Distress Signals'. There still remains doubt about what distress signals there are. Algal blooms, the seal viral epidemic, the failure of seabird colonies in the north, increased eutrophication in parts of the North Sea. These are all obvious, visible signals but, as was said earlier, there are many other signals not so obvious that can be seen by science. So one reason why we need science is to detect these distress signals. And the one thing the signals have revealed is our lack of knowledge about the environment. Science requires sufficient data which is available quickly, but also the existing knowledge should be put to better use.

But the answers that science comes up with depends on the questions asked. It was said earlier in the conference that if we stopped dumping or disposing of our waste in the sea that research would stop. Research should not be driven by our need to use the environment. This is the wrong standpoint from which to start. Politicians can - and do - ask for scientific data to justify and defend the continued use of the environment for waste disposal. A further pressure is that politicians hold the purse strings and when they are pulled tight the independence of science is called into question. Policy can and does force science to maintain the status quo and, as was said earlier in the conference, policy is based on economic or, worse, political compromise. Thus for example in the UK the Water Authorities have relaxed the discharge consents on over 1000 sewage treatment works prior to their privatisation. This information researched and released by Friends of the Earth, UK also provides a further example of how non-governmental organisations (NGOs) can be instrumental in spreading information. The options provided to scientists and the general public are those that politicians and industry want to sell to society - not necessarily all the options that are available.

It was said earlier in the conference that from an environmental view the whole question of waste disposal should be addressed. This is true, there is no point in stopping the inputs to one media and creating problems for another. This has been addressed for years by environmental NGOs. At least over the last ten years and longer, we have campaigned for the need to recycle and re-use materials, for reducing waste at source, for clean technologies and waste minimisation techniques. Such technologies are now firmly on the agenda, but while there are cheap waste disposal, 'end of pipe' technologies, the incentive will not be there for industry to reduce the waste it is producing.

The costs to industry and governments were also talked about and addressed. It appears that when government and industry do not want to do something about an issue like environmental protection there is a 'knee-jerk' response that any extra measures will have too many extra costs and jobs will be lost. While not wishing to diminish these effects, they work in the opposite way to that generally put out. Pollution control creates jobs and costs are insignificant. But in fact government and industry will pay for what they want or are pushed to - or rather they will get us to pay. The Water Authorities Association in the UK have spent 3 millions in the last three or four months on advertising (more than Pepsi) in the current run up to privatisation, and this is all paid by the water rates. The electric industry in the UK force consumers to pay extra for uneconomical nuclear power generation because the government want to keep and protect this part of their industry. But what costs can be put on the environment? Who is going to do it? Should a price be put on environment? And what of the costs of cleaning up the environment - usually not borne by industry?

2 Is Science Effective?

A fisheries scientist said earlier in the conference that the scientific data does not lead to good policy decisions and gave a whole range of reasons for this. Another statement earlier was that the politicians do not take the time to understand the science. But this is obviously a problem when someone can be an environment minister this week, defence minister next week and perhaps prime minister the week after! (Although in Europe, only one environment minister ever made prime minister and this is Mrs. Gr. Harlem Brundtland of Norway, well known for her efforts in environmental protection.) But science does not communicate well. Effort should be put in this direction. But, I hear people say, there are conferences, publications etc. Unfortunately in many cases these pay lip service to the principle of communication. Conferences organised with registration costs of 300 or 400 £ excludes a whole section of the environmental debate - the NGOs. Publications from research establishments are expensive and at best come out long after the work has been done. So government and industry scientists finish up talking among themselves in an elite club and pretend they are communicating. Contrast this with environmental NGOs where publications are fast and cheap which disseminates information far and wide and everyone can afford to come and contribute to conferences such as this.

In this light I welcomed this morning's paper which discussed the incorporation of environmental NGOs and following this line I would propose that such representatives are invited as observers on the North Sea Task Force.

3 What Can Be Done To Make Science Sufficient, Effective and Successful?

Firstly to make science sufficient there is a desperate need for resources and, as was noted earlier, it is the resources for looking at the wider environment that are lacking. We know more of the workings of atoms, molecules and organs than we do know about how communities and ecosystems work. This imbalance should be redressed.

Secondly effective and successful science is taken to mean having an effect on the policy makers such that the environment is protected. To make science effective and successful firstly, communication is needed which includes freedom of information for all interested parties and open decision making. We heard earlier in this meeting about the real decisions that are taken in the 'back room' and parties should be included in these. Environmental NGOs should be considered as part of the decision-making process.

A further requirement is a higher priority for government environmental departments. At present in most administrations the environment department is low in the 'pecking order'. This imbalance leads to the exploitative ministries gaining the benefit wherever they conflict with environmental requirements. This is certainly the situation in the UK and we heard earlier in the conference of the conflict of interests with the US Minerals Management and the Department of Fisheries and Wildlife and the Minerals Management 'won' the debate.

Scientific independence is also needed - independent from both government and industry. The question of how to fund such science arises but perhaps all industry and government should contribute to a large pool for providing funding for frontier research and the baseline work. This does not remove the need for dependent research such as Environmental Impact Assessment (which also needs an independent base) and monitoring that should be funded by industry on the polluter pays principle.

'Courage' has been said in three or four separate papers during the conference. Scientists need the courage to admit when they don't know exactly and because we do not know then we should not be carrying out any disposal activity - the precautionary approach. This principle gives science and scientists this option and is in fact more scientifically justified and correct. In the current climate of strangled resources for science, the scientists also need courage to speak out. Increasingly in the environmental movement we are seeing this as the number of letters, and phone calls from concerned individuals, sometimes anonymously, increases.

4 The Precautionary Principle

This principle involves three main elements:

- the reversal of the burden of proof, that is it is up to industry to show that what they are doing is safe and not up to the environmentalist to show environmental damage;
- erring on the side of precaution, which could be interpreted as 'giving the environment the benefit of the doubt' where debate exists as to the environmental effects;
- freedom of information including open decision making.

The second North Sea Ministerial Conference agreed to the precautionary principle; the third conference should not simply re-iterate this but should go further and stipulate steps for implementing it and statements from this conference should reflect this.

The assimilative capacity has been discussed in opposition to the precautionary principle, or sometimes in conjunction with it. But the assimilative capacity is a theoretical notion - a nice idea, but in practice it has not worked, and there are several examples where the capacity has been exceeded. This principle (similar to the permissive principle?) also relies on knowing what the capacity of the environment is and this becomes a subjective value judgement based on the amount of damage that can be recorded (for this is the way to measure how the assimilative capacity is working) and accepted.

The precautionary principle gives us the means to protect the environment without having to prove damage.

5 The Question of Money

The final question asked is what could I do with 10 million guilders (£3 million). As was said earlier in terms of government and industry this amount of money is minute. It is equivalent to about 1 hours spending on defence in the UK and one tenth the cost of a tornado aircraft. But who would make the best use of this relatively small amount of money? Who would turn out effective publications and organise successful conferences to disseminate information? And who desperately needs the money? The answer to all the questions is the environmental NGOs.

Finally I want to turn to the myth of scientific objectivity. Scientists are human subject to views, human failings, pressures both personal and professional. Government scientists have to watch their sovereign view; industrial scientists their shareholders. Who or what is driving force behind the environmentalist? Our only objective is the protection of the environment - it is certainly not the money we earn, or the acceptability among the scientific establishment that we crave (although our science is good and getting better). Simple defence of nature is our aim and there is no better starting point.

Debate on Assimilative Capacity and the Precautionary Principle

Dr Ard Stebbing (Plymouth Marine Laboratory, UK) speaks on behalf of the Assimilative Capacity, Dr B Bannink (Rijkswaterstaat, the Netherlands) on behalf of the Precautionary Principle.

Stebbing suggested that the Precautionary Principle needs to be stated more clearly and expresses the hope that this debate will open a discussion to enable both concepts to be examined more thoroughly than before. The assimilative capacity concept (Cairns, 1977) was considered by GESAMP as a property of the environment, defined as its ability to accommodate a particular activity without unacceptable impact. The concept is based on three premises:

- that a certain level of some contaminants may not produce any undesirable effect
- that each environment has a finite capacity to accommodate some wastes without unacceptable impact
- that this capacity can be quantified and utilized

In the environment dilution (most contaminants can be reduced to non-toxic concentrations) and degradation (which usually makes contaminants less toxic) occur, and organisms have a capacity to detoxify, sequester and respond homeostatically and effectively to toxic contaminants.

How can this concept be used?
Scientific understanding needs to be used to predict the assimilative capacity for a waste or contaminant in advance of release. Simulation models, such as the one for TBT, can help calculate assimilative capacity. Assessing the assimilative capacity of the environment by actually using it is unacceptable, nor is the concept a 'polluters charter'. It could equally well be interpreted as a 'charter for a sustainable environment' because if it is overloaded and there is reduction in biological diversity, this will reduce its capacity to assimilate.

The concept itself is essentially neutral, but it is the way it has been used that makes it a target for the NGOs. Stebbing understands the precautionary principle responds to the fear that the absence of evidence of toxic effects does not prove their absence in the marine environment, and is both a spur to caution and to the scientific community of ecotoxicologists.
In his view one can exercise all the caution that is required to achieve environmental protection within the concept of assimilative capacity. For some contaminants there is no assimilative capacity, while for some others the environmental capacity is already being exceeded.

The concepts of assimilative capacity and the precautionary principle are not actually mutually exclusive. They are in fact quite compatible and Stebbing believes it was a mistake in the 'basis papers' to set them in apposition.

He wholeheartedly supports the recognition of the difficulties of establishing causality, as set out in the Ministerial Declaration by adoption of the precautionary principle (Second International Conference on the Protection of the North Sea).
A research objective of his group at the Plymouth Marine Laboratory is to develop techniques that can establish causal links between contaminants and their biological effects.
Of course caution is needed! But wastes do exist and there is an immediacy in the need to deal with them. The creation of waste continues, and the problem is global. The precautionary principle should not be operated in the marine environment by using the assimilative capacity of another environment. The assimilative capacity concept appears to provide a neutral and rigorous framework to operate in both 'anticipatory' and 'retrospective' ways to achieve protection of the North Sea with an appropriate balance between preservation and utilization of the marine environment.

Bannink drew attention to the almost repetitive course of events that takes place when a new product enters the market. It takes time for a product or substance to be produced, to be distributed, to be in use and subsequently to become discarded: time in which a certain stock of the product has already been produced. It further takes additional time for wastes to build up in the environment to levels high enough to cause effects and even more time to build up a reasonable chance for these effects to be noticed. Production, use and discharges of wastes of these products continue during the subsequent time that elapses between the first observation of an effect and the production of sufficient evidence to regard the suspected product as the causing agent, let alone the additional time needed to complete regulation/legislation to limit or to end its waste releases or its very production. Thus substantial stocks of products are manufactured and demand their application and 'phasing out'. When substances are shown to cause detrimental effects, the assimilative capacity in all instances gets overdrawn. Only if effects can be predicted (or if substances are not too persistent) there is a chance that this capacity is not usurped. PCBs illustrate the aforementioned chain of events, as may many a xeno-biotic (man-made substance, not occurring in biological systems and hence alien to them).
The policy not to discharge certain substances unless it is shown that no harm is involved results from what is called the 'precautionary principle'. This principle should be used with priority for xeno-biotics and

especially for those that bioaccumulate, are persistent and are screened to be toxic or are to be produced in bulk quantities.

The unknown assimilative capacity for these substances is the very reason of existence for the precautionary principle. It has taken life millions of years to adapt (to) its surroundings: life to an extent has grown to depend on the predictability of substances. So far, science has shown interferences of xeno-biotics with life's processes on the level of enzyme, hormone, and DNA itself. But science is by far not advanced enough to be able to predict ecological effects of substances before they occur. The complexity of these processes and of processes at higher aggregated levels (up to ecosystem interactions) makes scientists humble - at least enough so to prevent them to facilitate society with soothing guarantees.
The economic use of new substances bears a resemblance with the use of drugs: these substances induce a quick (economic) arousal, their use becomes (economically) addictive and their (environmental) consequences are devastating and linger long after the thrills have worn off. The existence of such risks to life calls for a precautionary principle to be applied rigorously.
This debate is, according to Bannink, not a debate with a winner or a loser. The crux is to prevent life from becoming the loser.

Continuing the debate from the floor

Mr Newman (Water Authority Board, U.K.) wants to contradict mr Horsman and states that there certainly is no conspiracy of symposium organizers against environmentalists: they are often invited as speakers and sometimes offered reduced fees.

Mr Jensen argues that the principle of assimilative capacity did not prevent 10 years of unnoticed harm by TBT. He explains why the Danish government has changed to a precautionary approach completely, after over 10 years of policy based on an assimilative capacity which resulted in inadequate protection; a policy which Sweden has adopted also.

Mr Muntingh (European Parliament) asks for further research on synergistics, since so many different chemicals are entering the sea.
Mr Stebbing answers by referring to his paper, where the key element was to advocate biological effects monitoring techniques as an indicator for the total index of combined chemical effects and interactions, an approach which integrates natural factors as well. He mentions a workshop, to be held in the North Sea next year in order to do such integrated research.

Mr Carlyle (North Sea Task Force) wishes to respond to the proposal to have a representative of environmental NGOs attending the North Sea Task Force. This proposal will be seriously considered by the Task Force, and an answer will follow. He adds that the first reports are going to be published at the end of this year, and that the Task Force also plans to give seminars to a wider audience.

The discussion on principles then addresses the implementation of the assimilative capacity principle in policy, exemplified by legislation in the Paris Commission where the application of this principle resulted in environmental quality standards for a xenobiotic substance such as lindane, a definitive life affecting substance of which the assimilativity can be questioned.
Mr Bosch (North Sea Directorate, Rijkswaterstaat, the Netherlands) stresses that the assimilative capacity principle should never be used in a retrospective way, i.e. to use the environment to test out what the ultimate level of that capacity is. However, since we have to deal with the 'real world', the assimilative capacity may be used in a predictive way, e.g. to establish the critical levels of wastes which can be processed by the marine ecosystem and metabolized into natural products. The effect of certain wastes could be assessed in a predictive way by giving a quantitative relationship between the waste input and their final effects in the marine environment. Development of such predictive instruments has already started, such as risk analysis and therefore assimilative capacity can be used. However, we should have the courage to say no to the use or disposal of wastes which have a persistent character or about which we do not yet 'know' enough.

Mr Muntingh comments that industrial standards are unnecessarily low, and he questions the sense of responsibility of the industry for the environment. He illustrates this with several examples where, notwithstanding the availability of information or sufficient technology, effective measures were not taken, as such measures were not enforced by the government, nor initiated by the industries.
Mr Poley claims that in the offshore industry the best available techniques are normally used to protect the environment as well as possible, and that the industry gives an impetus to develop sufficient technology to comply with low emission standards.
Mr van der Voet (Dutch chemical industry) states that the industry does its utmost best to keep emissions down. Putting new techniques into practice needs time, and it also requires governmental support by defining clear and uniform limits.
Lord Cranbrook remarks that this seminar is trying to help eight or nine governments, which is perhaps grander than just trying to help one government.

The meeting then proceeds with the final statement.

Statement

Introduction

1. Following the decision to hold a 3rd North Sea Interministerial Conference in 1990, Werkgroep Noordzee resolved to hold a seminar to focus attention on the relationship between science and policy-making in the process of developing effective protection for the North Sea. The aims of this seminar were set by the Basis Papers (refer). It was not intended to bring out new evidence on the state of the North Sea environment (as was done in the 2nd North Sea seminar), although the 1988 algal bloom and the epidemic among seals were mentioned in the forefront of peoples mind.

2. The seminar was reminded that in the past environmental management had developed in response to crises (e.g. the collapse of the herring fishery, the Ekofisk disaster). Decisions made at the 1987 Interministerial Conference were intended to improve procedures to safeguard the North Sea Environment. Central to these was the adoption of the Precautionary Principle and the decision to reduce urgently and drastically the total quantity of substances that are persistent, toxic and liable to bio-accumulate reaching the aquatic environment of the North Sea. It was also agreed that scientific input needed to be improved and for this purpose a Task Force was set up to coordinate scientific research.

3. The seminar was opened by Ms J. Stefels, Chairman of Werkgroep Noordzee, who invited speakers to express an opinion on the proposition that, 'In today's environmental policy, the guiding role of science is close to nil'. She also asked (i) whether science is indeed capable of playing a role in policy making; 'if not, has this to do with the character of science and its performers or with its social and political position', and (ii) 'whether politicians are able to use scientific information adequately'.

A. Summary of Seminar Presentations

Session I
Science as a basis for political decision-making and the basic concepts in policy

Lord Cranbrook

4. Netherlands Minister of Transport and Public Works, Mrs N. Smit-Kroes opened by noting the uncertainties

faced both by scientists and by politicians in interpreting environmental data: 'doubts are a luxury', undermining political confidence. She called on scientists to make the best use of available information, to respond more promptly and place less emphasis on gaps in knowledge, and on policy-makers to be clear on the type of information they require. She endorsed the concept of sustainable use, determined by three criteria: (i) maintenance of production capacity, (ii) preservation of biotic diversity and (iii) the ability of the sea to regulate itself. She favoured the AMOEBA diagram as a means of expressing biotic status and an 'ecological Dow-Jones index' as a tools for political decisions. Dr J. Stel emphasised the need for strong relations between science and policy, requiring that policy-makers formulate the right questions and that scientists address their research with appropriate and sophisticated technology. He proposed new institutions to tackle the task of appraisal and review. Mr A. P. Barisich noted the impetus to policy formation resulting from the North Sea conferences. Although science may be the basis of policy decisions, he recognised that politicians will tend to use scientists and scientific argument to justify their own objectives, necessarily involving socio-economic factors on an equal basis. The decision-making process must take account of the aspirations of the public; scientists must review their accountability, and must include NGOs in the debate. Prof. R. B. Clark illustrated the scientific dilemma by reference to the exponential curve of the costs of effluent treatment; politicians, not scientists, have to decide where on this curve the level of pollution control must be set. He doubted that there was ever a purely scientific basis for any decision and believed that policy decisions direct science to certain ends and hence pre-judge scientific issues. Finally, Lord Cranbrook illustrated the practical effects of decisions taken at the 1987 North Sea conference by reference to Anglian Waterôs North Sea Action Plan, itemising the work that had to be done, the judgments made and the costs involved.

Session IIA
Policies for effluent waters

Prof. Förstner/Dr Salomons

5. The session centered on four themes:
Legislation
Available technology for control
Achievements of present control strategies
Monitoring techniques

A major impetus for this session is the decision taken at the 2nd ministerial conference to reduce river inputs of dangerous substances by 50%. This decision includes nutrient inputs.
Prof. Förstner draws attention to the present levels of technology for these objectives. Different levels of technology are needed for different substances. While phosphate removal is a feasible option, nitrate will require further development of technology to achieve efficient de-nitrification. While metal pollution has significantly decreased, this is not valid to the same extent for organic micro-pollutants.

Dr Bennett (policy) presented an overview of the existing legislation aimed at protection of the North Sea, i.e. the EEC legislation, the Rhine Treaty and the Paris and Oslo conventions. Only three countries had signed all treaties involved in protecting the North Sea, some countries had only signed one or two treaties. Dr Bennett therefore argued that a far greater integration in international environmental policy making is needed for effective protection of the North Sea.

Irrespective of which principle is embraced, environmental quality assessment is a pre-requisite for effective control. Even on behalf of the precautionary principle most decisions will be made on a cause-effect basis. In his presentation on monitoring strategies Dr Stebbing (science) stressed the advantage of biological methods over chemical ones, as the former are integrating effects of different contaminants. The use of environmental bio-assays is also motivated because the criteria for environmental quality are ultimately biological. The use of biological monitoring techniques is not advocated as an alternative to chemical techniques, but as its complement, which enables chemical analytical resources to be used more efficiently.

Dr Pearce (industry) showed the efforts of the tin dioxide industry in complying with environmental legislation. He argued that legislation which aimed at reducing acid inputs did not address the real issue of the environmental impact of tin dioxide wastes, which are the heavy metals. Dr Pearce stressed that industry must recognize and accept its responsibility for the protection of the environment. Governments and society expect industry to give signals of responsibility in showing a positive way ahead. This should be achieved by a more open debate and increased mutual trust. A holistic approach to the environment in general is advocated. The present impression is that the expectation about the environment and the legislation are driven by community issues. It is not possible to address the physical environment without involving and educating the public.

Mr de Jong's (environment) presentation highlighted the confusion caused by the different lists of dangerous substances adopted by various countries, including the new red list from the UK. This pertains in particular to the black listed (exempted) substances from the EEC directive of 1976, which are at present again considered to be suitable for 50% reduction.

The discussion of the session addressed the notion that not too much attention should be given to any specific substance, but that rather a general approach to assessment of toxicity for related compounds should be found. In this context the recently introduced substitutes for PCBs were mentioned, which have similar toxicological properties, but which are not covered by existing legislation. And although EEC directives do exist, the implementation is still difficult, as is evident from the numerous discharges and spillages reported. The issue of freedom of information, which was already discussed extensively in the first session, was addressed again in this session. Discussions centered on the need for freedom of information, but no solution for this problem was given, nor were ways or means indicated to protect such freedom. Dissemination of information was also seen as an issue which needed improvement.

Specific conclusions from this session were:
a. The wordings of the precautionary principle are vague and they should be revised and be made more concrete.

b. In order to implement the precautionary principle science should emphasize the anticipatory approach.

c. The time-lag between development of new technology for effluent control and their implementation should be reduced.

d. Industry itself should also implement the precautionary principle.

e. Environmental groups have an important task in creating environmental awareness both with the public and with industries.

Session IIB
Policies for Fisheries

Mr van der Meer

6. In fisheries biological research results play an important role in the political decision making process. Politicians, however, do not always follow scientific biological advice, as in final decision-making socio-economic factors are taken into account as well. Fishing policy does not explicitly include environmental goals. Views were expressed, however, that when the objectives of the fishing policy were really to be made effective, important environmental objectives would implicitly be met at the same time. It was recognized that the fisheries activity at sea can cause changes in the marine environment.

As to the quality of scientific advice in fisheries the view was expressed that improvements should be made to the effect that economic, resource-use factors and socio-cultural factors should also be included.

On the role which scientists have to play it was felt that science should be independent and not be made a part of the political power-play. It was questioned, however, in how far this is the situation in practice. Views were expressed that the accessibility of science should also be improved.

It was recognized that - since there is a great deal of interaction between different scientific disciplines - science should be organized in a more integrated way.

Views were expressed that the role of administrators should be strengthened as intermediaries between science and politics and that NGOs can have an important role in presenting policy alternatives and in stimulating public awareness.

Session IIC
Policies for Off-shore Activities

Dr Lange

7. The main topic of this Session regarded the offshore industry and its possible environmental impact, and in particular the question was discussed whether communication and cooperation between science and authorities were satisfactory or not.

Mr. Koefoed (authorities) answered the question with yes in his lecture. He exemplified this by explaining the Norwegian system for environmental control of the offshore industry. This includes cooperation between scientists and authorities right from the beginning. Thus, before an area of the continental shelf is opened for offshore activities, the authorities will perform an environmental impact assessment. We have cases which show that these studies have led to the conclusion not to open a particular area for offshore activities. In most cases, however, areas have been opened, and in these cases the oil companies will be responsible for undertaking more in-depth studies with regard to the specific field. The results of these comprehensive environmental studies, together with the results of socio-economic studies, constitute important parts of the documentation on which the authorities will base their decision whether or not a permit for the development of the particular oil field will be issued. Moreover, when a platform enters the production stage, the oil company has to apply for discharge permits in all cases. They are also obliged to carry out pollution monitoring studies in the vicinities of the platforms. With regard to the latter studies, these have to be undertaken according to 'Guidelines' issued by the Paris Commission. They have to apply forr permits for use of different chemicals and in this process, too, scientists are taking part in the assessments. It should be mentioned that the guidelines themselves are the result of cooperation between science and authorities. Thus, all the way, cooperation between scientists and the authorities takes place.

The next two speakers, Dr Scholten (science) and Dr Poley (industry), also were satisfied with the cooperation between science and the authorities. In my view the first three speakers' presentations did in fact more or less mirror each other. Dr Poley drew also attention to discharges of liquid effluents (produced water) and how the industry is trying to minimize the impact on the environment, e.g. by constructing the outlet pipe in a way which at least secure that dilution of the liquid occurs quickly.

Lisa Speer, U.S.A., representing the environmental organizations based her views on experiences from North America. In contrast to the earlier speakers from Europe, Lisa Speer was embarrassed by the fact that the US authorities pay very little attention to the environmental quuestion, and that it appears that it is much easier for an oil company to obtain a drilling permit on the US coast line than it is in Europe. She gave a number of examples.

In the discussion a number of questions were raised to the lecturers, two of which may be of special interest.

The first question regards the accessibility of information. The freedom of information was thus questioned. Secondly Mr de Jong wanted to emphasize that the time was ripe to discuss other chemicals than just those applied in drilling activities, and he also stressed the time-lag between the introduction of these chemicals offshore and the appearance of the information about their use. No general answer to these questions could be given as conditions differ in different countries. In my view, however, Dr Poley's positive answer to the question whether he was willing to make this type of information available, might also be extended to show the willingness in this respect in most of the North Sea countries.

Session III

Co-operation between policy and science

Lord Cranbrook

8. The session was opened by Dr Wettestad, who said that knowledge is a necessary component for science management policy, but scientific research is essential though not sufficient.

Four fundamental functions are needed for an effective transfer of scientific input:

- Coordination of research and monitoring
- Separation between science and policy-making
- Communication between science and policy-makers
- Co-optation, that is to say politicization of research findings.

Obvious deficiencies in all four regimes where identified in the present North Sea programme which is still in a transitional stage.

He was followed by mr Ferm who illustrated three case studies.

For mercury there have been disparate national programmes, but reduction and elimination are been achieved.

For marine eutrophication outstanding crucial questions are: Which is the limiting factor: nitrogen or phosphorous? Therefore should one concentrate on controlling one or both of these substances? Are other growth factors as important as are nitrogen and phosphorus? Have the input sources been identified?

For stable organic substances basic research is needed. Resistance is inadequately defined. Chemical monitoring for unknown chemical substances is problematical. Monitoring for biological effects is inadequate. And safe contamination levels, if any, are unknown.

Dr Jensen followed.

He first reviewed eutrophication incidence in Danish coastal waters and the Kattegat and the political response, which was to apply emission reductions of 50% for nitrogen and 80% for phosphates.

He then discussed the relative balance of science and politics in ICES, OsCom ParCom, the EEC and the North Sea task force. He called for close cooperation between science and policy-makers and between science and the non-governmental (green) organizations.

And finally Dr Kuiper reviewed environmental disasters experience in the North Sea and the urgency of preventative action in the way meteorologists must accept an element of prediction and the iterative process of their profession.

...

Regulatory regimes can be evaluated by effectiveness. The use of the 'Amoeba' model to define reference values was recommended.

The nature conservation lobby need to improve its professionalism and strength.

The discussion was necessarily brief, but concluded that environmental education was important to all ages and all social and occupational levels.

Addition to the summary on friday morning:

Dr. Jensen: Relations of cooperation between science and policymakers. I also mentioned the other way: between scientists and the non- governmental (green) organizations.

B. Conclusions

a) Precautionary Principle

9. As initial steps to the implementation of the Precautionary Principle, Ministers at the 1987 Conference agreed on time-tables for the end of incineration of wastes at sea, sea dumping of industrial wastes, and for a substantial reduction (in the order of 50%) of inputs to the sea by rivers, by direct discharge, of substances that are toxic, persistent and bio-accumulative.

Separate initiatives have since been taken by North Sea country governments to produce lists of substances for the reduction regime; these all include the 12 agreed EC black list substances but otherwise vary in composition. Besides the existing pre-manufacturing schemes for new chemicals, no substantial new reduction schemes have been proposed for the remaining 60 - 100,000 compounds already in use in European countries. The effectiveness of the (operation in practice of the) schemes has been questioned.

10. For agreed black list substances, it is clear that emission reductions of 50% may not meet standards already adopted by the EC; for Community member countries, this interpretation of the 1987 North Sea Interministerial Conference declaration may therefore contravene existing legal obligations. If the Precautionary Principle is to serve as a pointer to appropriate control levels for other inputs and as a clear guide to policy for environmental protection of the North Sea, it must be refined and made more explicit.

There was a body of opinion which concluded that a refinement of the precautionary principle should include:

- reverse of burden of proof
- giving the environment the benefit of the doubt
- open decision-making

11. It was the opinion of some members of the seminar that the anticipatory approach is an integral part of the Precautionary Principle. It is self-evident that xenobiotics qualifying by virtue of toxicity, persistence and liability for bio-accumulation demand especial caution; some, such as DDT, have already been abolished from use by common consent. But experience (e.g., eutrophication of Danish seas) has shown how suddenly critical loads of familiar, assimilative substances such as nutrients can be exceeded and self-regulation can collapse, overturning accepted assumptions. Prognostic methods such as risk analysis, worst case hypotheses or HAZOP, which are familiar in industry, may possibly be applied to natural systems in the environment for guidance for anticipatory actions. Developments in biological sampling now provide extremely sensitive methods for identifying sublethal deleterious effects and point to likely productive lines of action. The deployment of biological effects techniques in monitoring programmes is important because of their unique ability to integrate the effects of the multitude of contaminants present in the marine environment. They provide the possibility of measuring the totality of environmental quality and focussing the efforts of environmental chemists on times and places where there are demonstrable problems.

(b) Scientists and policy-making

12. There was no challenge to the definition of science as the objective and verifiable study of the natural world, yielding hypotheses that are susceptible to practical test and verification. It was agreed that science is a logical process, and need not be incomprehensible to the layman, but that improvement in the presentation and interpretation of scientific results is often necessary. Science should not, however, be oversimplified and inherent uncertainties through natural variability should not be disguised.

13. Scientists must be able to keep their professional independence. The presentation of scientific results should be independent from the political processes. Scientists should also seek to participate in the international community, especially considering the international nature of the North Sea.

14. All scientific information, new data gathered in North Sea research programmes, proceedings of the Preparatory Working Groups (PWG) and the North Sea Task Force should be freely available. Scientists should be prepared to expose their science. Participants in this seminar felt that a representative of environmental NGOs should be invited to have observer status in the North Sea Task Force.

15. Scientists should minimise jargon and avoid obscurity in presenting results. They should take initiatives to explain their science and to educate the wider community in the interpretation of scientific results. Modern technology provides many aids for public communication which should be utilised to the full.

16. There is also an important place for intermediaries between scientists and policy-makers and the public, serving as 'translators' of scientific results. This should improve communication between science and the general public (and via public opinion to the politician). Funds must be made available to set up information centres where science is translated into everyday language. Consistency should be sought through an international

(European) network of such public information centres. Within the public service, governments should be adequately equipped with scientific advisers. The media should also invest in the training of journalists to increase their understanding of environmental issues and to improve the reporting of these issues

17. Steps should be taken to co-ordinate scientific efforts, which are at present too scattered. It is regretted that there are instances of failure to communicate and exchange scientific information between disciplines, between official departments or ministries and between national and/or regional organisations. In particular, an overall international programme of environmental research is needed, incorporating fisheries research, emissions into the marine environment, and research in offshore development activities. This could be based on existing infrastructures, but effective implementation requires political decision.

18. There should be a biennial report on the state of the environment of the North Sea, taking into account the indicators of sustainable use, i.e. the maintenance of productive capacity, the preservation of biotic diversity and the capacity for self-regulation. All North Sea States should have statutory responsibility to provide contemporary biological and chemical records.

19. At the seminar the Amoeba
The AMOEBA approach is explained in appendix 3.
approach was introduced, a concept for policy use of scientific information newly developed by the Tidal Waters Division of the Rijkswaterstaat (DGW). This graphic model aims to communicate information to politicians and other groups on the current biotic status of the North Sea in relation to a reference status (chosen to be the year 1930)
This can also be used to predict the future situation. It was recommended that the concept should be developed by all North Sea States in close co-operation.

(d) The role of environmental NGOs
20. Environmental NGOs should be strong and independent. They have an important role to play in the dissemination and public understanding of scientific results. NGOs need to relate to scientists to ensure that the scientific results are not misunderstood.

21. Environmental NGOs also have an important role as pressure groups and representatives of public opinion, and in impressing scientific information on governments and ensuring that there is an urgent action programme to conserve the North Sea environment.

Acknowledgements

The organisation of the 3rd North Sea Seminar and the publication of the Proceedings were made possible by the support of the following persons:

The Earl of Cranbrook - chairman of the Seminar
Dr C. C. ten Hallers-Tjabbes (Cato Marine Ecosystems Research and Management Studies) - general coordination
C. van der Venne, P. Huesman, W.J. de Rijk, M. Vink, I. de Maaker - administration
J. Vijfvinkel - publicity
C. van der Venne, J. Vijfvinkel, M. Vink, I. Hopkes, R. Veeningen, I. de Maaker, S. Brodie Cooper, N. Gijzen, M.J. Stoop, F. Hart, S. Meinzen - assistance during Seminar

Proceedings:
C. C. ten Hallers, A. Bijlsma - editors

Appendix I

Delegates 3rd International North Sea Seminar

Absil, Christien
Delta Institute for Hydrobiology, Nl

Akkerman, Ir J.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Al, J.P.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Alkemade, Rob van
Delta Institute for Hydrobiology, Nl

Andersen, Steinar
Fridtjof Nansen Institute, Nw

Ast, Mr J.A. van
Erasmus Studiecentrum voor Milieukunde, Nl

Ausems, J.A.
State Supervision of Mines, Nl

Bannink, B.A.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Barisich, Mr A.
Comm of European Communities, DG XI

Bennett, Dr Graham
Institute for European Environmental Policy, Nl

Bijlsma, Drs A.
Stichting Onderzoek der Zee (SOZ), Nl

Bijnsdorp, Rob
VARA, Nl

Birch, T.S.
Greenpeace

Bjordal, Hävard
Norges Naturvernforbund-Nordsjöutvalget, Nw

Bockholts, P.
TNO-Hoofdafdeling MT, Nl

Booker, D.I.J.
Thames Water Authority, UK

Bos, H.R.
Rijkswaterstaat, Directie Noordzee, Nl

Bosch, Luuk
Rijkswaterstaat, Directie Noordzee, Nl

Braak, Kees
Werkgroep Noordzee, Nl

Brederode, Ms L.E. van
St. IUCN-ledencontact, Nl

Brink, Drs Ben ten
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Brodie Cooper, S.
Marine Forum, UK

Bruijn, Th. de
3th North Sea Conference Secretariat, Nl

Buuren, J.T. van
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Camphuysen, Cees
Werkgroep Noordzee, Nl

Carlyle, Stefan
Oslo-Paris Commission

Cerutti, M.F.A.
Rijkswaterstaat Dienst Binnenwateren/RIZA, Nl

Clark, Prof. Dr A.B.
Department of Zoology, U. Newcastle, UK

Colijn, F.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Cooper, V.A.
WRC, UK

D'Hondt, Philippe
Ministry of the Environment, Be

Dekker, R.H.
Rijkswaterstaat, Dienst Binnewateren/RIZA, Nl

Delbeke, Katrien
Vrije Universiteit Brussel, Be

Diermes, Lars
Danish Society for the Conservation of Nature, Dk

Droop, Rob
VROM, Directoraat-Generaal Milieuhygiene, Nl

Dubsky, Karin
SAR

Earll, Bob
National Trust, Marine Warden Area, UK

Eikelenboom, Dr E.

Ende, K. v.d.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Evans, S.M.
Dove Marine Laboratory, UK

Feddema, P.
Secr. Provisionary Waddensea
Advisory Council, Nl

Fegan, Loraine
Comm. of European Communities DGX II

Ferm, Dr R.
Nat. Environment Protection Board, Sw

Förstner, Prof. Dr Ulrich
Arbeitsb. Umweltschutztechniek, FRG

Fosk, Mr
Norges Fiskarlag, Nw

Franeker, Jan Andries van
Werkgroep Noordzee/RIN, Nl

Gieskes, Dr Winfried
Dept. Mariene Biologie RUG, Nl

Gijzen, N.M.

Glas, P.C.G.
Delft Hydraulics, Nl

Glegg, Dr G.A.
Greenpeace

Gravenberch, F.L.
S.L.O., Nl

Haer, P.M. van der
Rijkswaterstaat, Nl

Hallers-Tjabbes, Dr Cato C. ten
C.M.E., Nl

Ham, P.J.M. van der
Min. van Economische Zaken, Nl

Harder, G.A.
Rijkswaterstaat, Nl

Hart, Frank
stagaire Werkgroep Noordzee, Nl

Hartog, J.J.
SIPM, Nl

Hey, E.
Rijkswaterstaat, Nl

Hindriks, D.V.

Holden, Dr Michael
DG XIV, BI

Hoorn, Ir. H.
ICONA, Nl

Hopkes, Inez
Werkgroep Noordzee, Nl

Horsman, Paul
SAR

Houtsma, W.H.
Quod Novum (Universiteitsblad Erasmus U)

IJlstra, A.H.
Werkgroep Noordzee, Nl

Jager, Z.
Ecotec Resource b.v.

Jaspers, E.
Institute for Marine Scientific Research, IZWO

Jensen, Dr A.
Danisch Isotope Centre,
Academy of Technical Science, Dk

Johnston, E.
Albright and Wilson Ltd, UK

Jones, N.V.
Institute of Estuarine & Coastal Studies, UK

Jones, P.J.
Institute of Offshore Engineering, UK

Jong, Folkert de
SAR

Jonge, J. de
Rijkswaterstaat, Nl

Jörgensen, Henning Mörk
DNF, Dk

Kersten, H.
Greenpeace Netherlands

Klos, H.S.
Schuttevaer Pers, NL

Knoester, Dr M.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Kooiman, J.
Erasmus Univ. Rotterdam, Nl

Korup, Yvonne
County of Funen, Environmental Dept., Dk

Koten, M. van
Raad voor het Milieu-en Natuuronderzoek, NL

Kouwenaar, Th. A.
Ministry of Foreign Affairs, Nl

Kramer, Kees J. M.
Lab. for Marine Res. MT-TNO, Nl

Krog, Carsten
Danisch Seafishery Association, Dk

Kuiper, Dr J.
Ecomare, NL

Kuiper, F.

Lange, Dr Rolf
CMS, Nw

Lankester , R.R.
North Sea Work Group, UK

Lees, A.J.
Friends of the Earth Ltd, UK

Linley, El Anne
M.E.S. Ltd, UK

Lutter, Stephan
WWF-Germany, FRG

Maaker, Iris de
Werkgroep Noordzee, Nl

Mac Garvin, Dr M.
Strawberry Research, UK

Mac Gillavray, E.
NAM

McGlade, Prof. Dr J.
Department of Zoology, U. Cambridge, UK

Meer, Mr B.B. van der
RIVO, NL

Meerter
Rijkswaterstaat, Nl

Meintser, Sylvia
Werkgroep Noordzee, NL

Metselaar, K.
Environment Dept.

Meyer, Kees
VROM (Directoraat-Generaal Milieuhygiene), Nl

Milne, Roger
New Scientist, UK

Munkejord, Svein
Fiskeridirektoratet, Nw

Nelissen, Piet-Hein
Werkgroep Noordzee, Nl

Newman, Dr P.J.
WRC (European Studies), UK

Nielsen, Else
Danish Inst. for Fisheries and Marine Research, Dk

Olsthoorn, Hans
Werkgroep Noordzee, Nl

Pagee, J.A. van
Delft Hydraulics, Nl

Paget, S.E.W.
Greenpeace International

Pearce, Dr Derek
Tioxide Group PLC, UK

Peet, Gerard
Stichting S.E.A., Nl

Petersen, Verner Hastrup
County of Funen, Environmental Dept., Nl

Pierrot-Bults, Dr A.C.
Ned Oceanografen Club, Nl

Poley, Dr Ir J.P.
NOGEPA

Postma, Renske
University of Utrecht, Nl

Reid, P.C.
Dept. of the Environment, UK

Reineking, Bettina
Common Wadden Sea Secretariat

Revier, J.M.
Waddenvereniging, Nl

Ridder, Maj E.
Int. Environment reporter

Riet, Mr van
Ministerie van Verkeer en Waterstaat, Nl

Rietman, Ferdinand
ICWS Centre of Water Studies

Rietveld, M.J.
Ministerie van Onderwijs en Wetenschappen, Nl

Ringers, J.N.
NOGEPA

Ritterhoff, Juergen
WWF-Germany, FRG

Roos, A.N.
Prod van Vis en Visprod., Nl

Rothwell, P.I.
R.S.P.B., UK

Ruiter, Ben
Rijkswaterstaat, Nl

Salomons, W.
Inst. for Soil Fertility, Nl

Sayers, D.R.
Anglian Water, UK

Scholten, Dr Martin
TNO, Nl

Schoot-Uiterkamp, Dr A.J.M.
TNO, Nl

Schutzgemeinschaft Deutsche
Nordseeküste e.v., FRG

Siemelink, M.E.
Ministerie van Landbouw en Visserij, Nl

Smies, M.
Shell International Petroleum Mij. BV

Souster, M.
The Times, UK

Spaendonk, Anke v.
Delta Institute for Hydrobiology, Nl

Speer, Lisa
Staff Scientist
Natural Resources Defense Council, USA

Stebbing, Dr A.R.D.
Inst.for Marine Research, UK

Stefels, Jacqueline
Werkgroep Noordzee, Nl

Stel, Dr J.
Stichting Onderzoek der Zee SOZ, Nl

Stoop, Ir J.A.
Ministerie van Landbouw en Visserij, Nl

Stoop, Marie-Jose
Werkgroep Noordzee, Stagiaire, Nl

Stutterheim, E.
Rijkswaterstaat, Dienst Getijdenwateren, Nl

Trommel, J. van
S.L.O., Nl

Tromp, D.
Rijkswaterstaat Hoofddirectie, Nl

Turkstra. E.
Rijkswaterstaat, Nl

Tydeman, C.F.
WWF-UK, UK

Van de Wetering, B.
3th North Sea Conf. Secr.

Veeningen, Roelof
Werkgroep Noordzee, Nl

Velde, Onno v.d.
Rijkswaterstaat, Nl

Venne, Corrie van der
Werkgroep Noordzee, Nl

Verheij, F.J.
Directoraat-Generaal Scheepvaart en Maritieme Zaken, Nl

Vijfvinkel, Johan
Werkgroep Noordzee, Nl

Vink, Martin
Werkgroep Noordzee, Nl

Vliet, Jan van
VROM, Directoraat-Generaal Milieuhygiene, Nl

Voet, Ir C.G. van der
Staff member Environment & Safety, Nl

Vries, J.W. de
KNMI, Nl

Warren, L.M.
WWF-UK, UK

Wellershaus, Stefan
Aktionskonferenz Nordsee, FRG

Wettestad, Jörgen
Fridtjof Nansen Institute, Nw

Wieriks, J.P.
Rijkswaterstaat, Nl

Zevenboom, Dr W.
Rijkswaterstaat-Directie Noordzee, Nl

Appendix II

AMOEBA Approach, a method for the description and assessment of ecosystems.

Towards 'sustainable development'

The water management plan describes how the Netherlands will be managing its rivers, lakes, estuaries, and sea in the next five years. The purpose of this plan is optimum and permanent use, and a sustainable preservation of the ecological functions of these waters. It is based on the concept of 'sustainable development' from the Brundtland commission.

Ecological objectives: Seals or Algae?

The present Dutch objectives for the North Sea are: 'The maintainment and the attainment of a water quality level to preserve the ecological values in relation to the desired functions.' These objectives, however, are difficult to quantify and to verify. Which ecological values need to be preserved: algae or seals? The difference between the two choices is tremendous. How can we achieve verifiable ecological objectives? The Tidal Waters Division of Rijkswaterstaat has developed a method for this purpose, named AMOEBA.

In Dutch AMOEBA is an acronym for 'general method for ecosystem description and assessment.'

Species as subject for ecological objectives

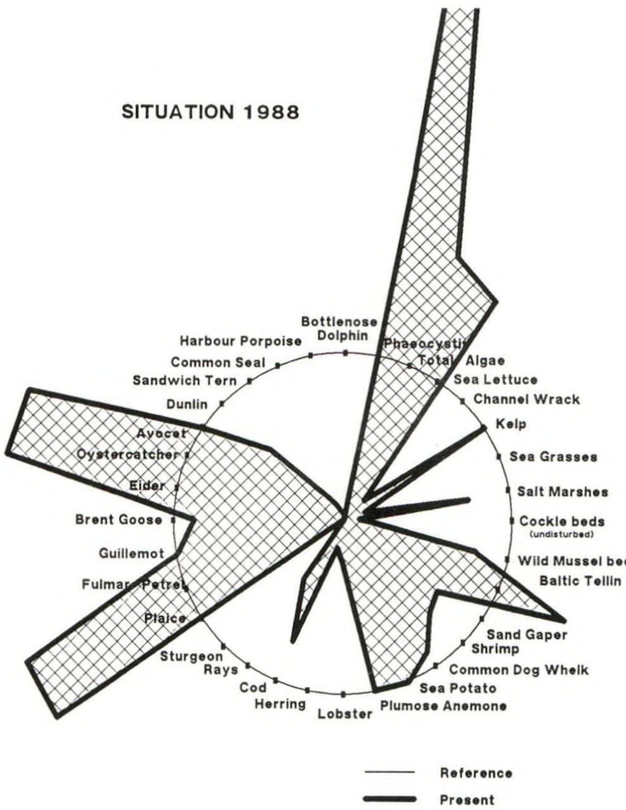
For the realization of ecological objectives, only plants and animals have been taken into consideration. The physical and chemical components of the ecosystem are considered here as means to reach the ecological objectives. The most fundamental values attributed by society to plant- and animal life are: diversity, self regulation, and production and harvesting.

Which type of ecosystem and kinds of measures provide guarantees for the sustainable preservation of these fundamental values? Surely not a radioactive or a heavily polluted system. Different opinions exist about the sustainability of the present North Sea. It is assumed that the ecosystem which is not or hardly manipulated, offers the best guarantee for the preservation of these fundamental values; such an ideal ecosystem is the point of reference.

The closer one gets to the point of reference, the larger the guarantee of sustainability. Society chooses her objectives, somewhere between zero and the point of reference. This is, in essence, weighing of the direct costs of measures against the loss of guarantees for sustainability in the long term.
The ecological objective of the North Sea can then be described as: the maximum acceptable distance to the point of reference.

AMOEBA as a description of the ecosystem
How can the present ecosystem of the North Sea be compared to the reference? For this purpose an estimate has been made for the numbers of 32 plant and animal species in the Dutch part of the Continental Shelf. These 32 species form insofar as possible a cross section of the entire system. The present and the reference numbers of each species are presented visually by a figure resembling an amoeba. The year 1930 has been chosen as the year of reference, because data were available and the impact of man was limited. The present displacement of the numbers of the species in relation to the reference numbers (1930) is striking. A shift from long living species (i.e.mammals) to short living species (i.e. algae) is observed.

Fig. AMOEBA
The distance from the centre to the circle represents the reference numbers (for example: 4000 - 9000 seals). The present numbers have been entered. To obtain a visual impression, the species numbers have been connected by a line. The circle is the reference, the amoeba-resembling figure represents present numbers.



Basis papers
3rd North Sea Seminar

Contents

Introduction to the Basis papers

The theme of the 3rd North Sea Seminar, a scientific understanding of signals from the environment as a decision basis for political decision-making for the North Sea, is elucidated in a series of basis papers.
The papers will briefly address the use of science as a basis for political decision making regarding the North Sea in general. The developments in these fields, and in their relevant policies, as well as an identification of the problems which occur, will be specifically highlighted.

The basis papers were a starting out point in which Werkgroep Noordzee presented background material for the seminar.

Cato ten Hallers,
Editor.

General policies and scientific support

Cato ten Hallers

The North Sea has always traditionally been heavily exploited by man. The activities had a profound impact on the environment, an impact which has expanded and intensified during the last decades. Shipping, fisheries, military activities, mineral extraction and the use of the sea as an ultimate waste receiver have all left their marks on the marine environment. The most visible signals of an affected environment have been the result of spilled and dumped wastes, which wash ashore or are found floating at sea. The more hidden signals, dealing with the deterioration of the ecosystem can only be detected by scientific research. Actually marine scientists were among the first to word their concern for the North Sea environment. They indicated the potential decline in the quality of the marine environment and tried to communicate their concern to the public. Concern about the North Sea environment, although existent in former times, has recently gained more public support. This has resulted in a policy commitment to actively protect the marine environment.

Policy makers, confronted with a general concern about the state of the environment, took steps to control the human impact on the marine environment. Both national and international approaches were developed. The national approaches often related to an international acknowledgement of specific problems. For example most North Sea states have reduced and eventually stopped their discharges of sewage and sewage sludge into the North Sea. Inputs from industrial discharges could be legislated in the jurisdiction zones; for shipping, international approaches are being negotiated.

Most of the North Sea is international water, and therefore not subject to national legislation and enforcement. International treaties and directives were developed as a base for regulations, concerning activities which could threaten the marine environment. The EEC adopted a series of Directives which are directly applicable to member states. The first was Directive 76/464/EEC referring to pollution caused by dangerous substances, including a list of such substances (1976) followed by Directives for specific substances (1982, 1983, 1984). The Conventions of Oslo (1974) and Paris (1978) and the London Dumping Convention (1975) refer to discharges from land based sources and dumping at sea, the Marpol Treaty (1973/78) refers to pollution from shipping and the Continental Shelf Treaty (1958) refers to mineral extraction. The international agreements and their implementation had to be structured and administered. Institutions started to develop, the Oslo and Paris Conventions were administered through a joint secretariat. Marpol was administered by the Marine Environmental Protection Committee of the IMO. The treaties, conventions and directives are in the course of being implemented in the national legal frameworks and administration procedures.

In 1984 all North Sea states had their ministers, who were responsible for the North Sea Environment, meet in the International Conference for the Protection of the North Sea Environment, in Bremen. A second Conference was held in London in 1987, and a third one will take place in the Netherlands in 1990.

Policy agreements and the drawing up of regulations were negotiated in such bodies, and in politics in general. In the course of such developments scientific information was included. The weighing and balancing of different interests was often more crucial to the accomplished decisions than the presented scientific information. If scientific information were to be included, the character of the information tended to be quantitative and with reference to cause-effect relations. The information presented scientifically is often of a different nature than that which can be used in policy-making. Information of a qualitative character has been difficult to incorporate in policy. This has resulted in a wide gap forming between policy use of scientific information such as numerical data and the potentially available information about the quality of the ecosystem which could be presented by scientists. Policy-makers have been reluctant to use scientific information of the latter character as a basis for decision-making. Most information on the ecosystem level has therefore never made it into the decision-making processes. Only when the deleterious impact could be related to a cause were subsequent measures taken. one example of this was when it became evident that the tern, a predatory bird,became badly affected by pesticide drins which had accumulated through the food web; the production of such drins was consequently effectively discouraged.

Science has in fact been asked to predict the future condition of the ecosystem as a basis for policy making. Predicting future conditions of life systems is rather difficult, even if ample research has been done as is the case in the medical sciences. For marine ecosystems, which as yet have not been amply investigated, impact has to be demonstrated with less available knowledge. And yet if there should be any factual basis to the decision-making processes it has to be based on such science. Apart from the character of the research, which is often qualitative but not quantitative, the position of science in policies for the protection of the North Sea environment may be affected by differences in perception and position between policy makers and scientists. Science operates in a different framework than policy making, the two being motivated by different objectives and guiding principles. Both the development of policies and the testing of the efficacy of policies are subject to political and social conditions.

Such conditions can influence the weight attributed to information and the framework used for the exchange of information. For example the perspective as seen from an economic viewpoint differs from the environmental perspective. It is a political decision as to how to weigh the economic data versus the ecotoxicological data. In order to be able to attribute a realistic value to the data, the policy maker has to understand what the data represent. Also the scientist has to understand which topic to select as a key to environmental conditions.

Differences in basic policy principles and in scientific views can result in differing policy concepts incorporating science.
Such different concepts are 'Environmental Capacity' and 'Precautionary Principle'. The Environmental Capacity concept assumes a measurable capacity of the ecosystem to accommodate the effects resulting from human activities, and therefore assumes that sufficient scientific knowledge is available or can be generated within the necessary short notice. The Precautionary Principle assumes that whenever it is uncertain as to whether long-lasting harm to the ecosystem may occur, policy should take the utmost care. This concept is based on the understanding that more complex and indirect ecosystem effects are hardly known, and, when investigated, tend to be more severe than shown in single and direct effect studies.

The differences in policy concepts will result in different questions asked to science and a different use of information. An example of the different conditions between policy and science is the understanding of the notion 'long term', which can considerably differ between policy and science. Understanding between policy makers and scientists is more often hampered by a lack of insight into each others position. This is a disadvantage when evaluating the ecosystem conditions based on the available knowledge. It also impedes a proper evaluation of the potentially available knowledge, of the options for exchange, and of existing gaps. An understanding of the ecosystem in policy is apt to have undefined elements. The definition of 'a Healthy Ecosystem' is not unequivocal; the ambiguous understanding of a healthy ecosystem and the predictions in view of that are mirrored in their application in policy.

The objective of the 3rd North Sea Seminar is to stimulate an open and independent discussion about the policies needed for the protection of the North Sea environment and the role of science, based on a presentation of views and criteria from policy makers and scientists as well as from representatives of interest organizations, on the state and position of policy and science and of the interaction between the two. We wish to encourage that attention be paid to the present situation of existing platforms for an exchange between policy and science. In view of effective and consistent policies needed for the protection of the marine environment we welcome ideas and suggestions about potentially new perspectives and what may be expected from them in view of a better co-operation between science and policy.

The 3rd North Sea Seminar invites scientists, politicians and interest organizations to share their views on the state of the North Sea environmental policies and the underlying policy concepts.

Policies for effluent waters

Jennie Simons & Folkert de Jong

History

Discharges of effluent waters from Northwest European industries, agriculture and urban settlements into rivers, canals and estuaries are, and have long since been, one of the major sources of North Sea pollution. In the 1970's the increasing awareness of the chemical pollution of rivers, estuaries and coastal waters led to the adoption of a number of international regulations aiming at the reduction of the pollution of the fresh and salt water ecosystems of Northwest Europe. In 1974 the countries bordering the Northwest Atlantic Ocean signed The Convention for the prevention of marine pollution from land-based sources (Paris Convention). In 1976 the Rhine Chemical Treaty and the EEC Directive on the chemical pollution of the aquatic environment of the EEC (Directive 76/464) came into force.

The above mentioned legal instruments all contain lists of substances and catagories of substances for which discharge limits must be set. The substances concerned are placed on either a black or a grey list. The discharges of black-list substances must be terminated; the discharges of those that are placed on the grey list must be reduced. The black and grey lists of the different conventions and Directives vary, although black lists have much in common. The setting of discharge limits for substances and categories of substances, be it on a national or international level, for a certain type of industry or in general, is called the uniform emission approach. Both the Paris Convention and the EEC 76/464 Directive are also based on the principle of environmental capacity. This is primarily due to the different view of the United Kingdom with regard to waste management.

This different view has been incorporated in the 76/464 Directive as follows: "a member of the EEC does not have to comply with limit values for discharges if this member-state can prove that the quality objectives for the substances concerned in the geographical area that is under the jurisdiction of this member state are not exceeded". Therefore all executive Directives, which resulted from the 76/464 framework Directive, also contain quality objectives for fresh water, estuaries and territorial waters. The quality objectives of the Directives, being concentration values for salt water, are based on the toxicity, bio-accumulation and persistence characteristics of the substances concerned.

The precautionary principle

The predictive value of EQS's for the whole North Sea ecosystem has been the subject of heavy debates between the UK and some continental North Sea countries. At the first Ministerial Conference on the protection of the North Sea (Bremen, 1984) the Precautionary or preventive principle was introduced. The North Sea riparian countries should adhere to this principle because possible adverse effects of discharges and dumpings into the marine environment can not be predicted with the existing state of knowledge of the marine ecosystem. Strict discharge limits must be set, even for substances which are only suspect in being harmful to the marine environment. The UK, however, persisted with its policy of environmental capacity and derived EQS's. At the Bremen meeting it was decided to elaborate a combination of the two approaches. On the second North Sea Conference (London 1987) an important shift in the UK policy for effluent waters was reached: the UK accepted the precautionary approach and agreed on the future elimination of dumping of industrial waste and the reduction of discharges into rivers and atmosphere.

Future policy

At present a mixture of policy approaches is used in practice: in some situations Quality Objectives (i.e. bathing water), in others Emission Standards. Both types of standards differ, on a national as well as on an international level: there are different emission standards and quality objectives in the various European countries, there are also differences between the US, the EEC and Japan. There is however one clear point in this confusing situation: neither emission standards, nor quality objectives have primarily been derived from ecosystem standards. Emission standards are the result of political negotiations which primarily take into account the cost of introducing new technologies; the availability of that technology is also taken into consideration. EQO's are generally based on toxicity tests which have limited predictive value for the marine ecosystem of the North Sea. Moreover they only apply for separate substances; in view of the mixed contaminant streams entering the North Sea this is a serious limitation to the practical value of EQS's. Another disadvantage of the EQS approach is that it only applies to a limited area, not taking into account the factor of dispersion, and eventual deposition in other geographical areas.

The decision, taken at the 2nd Ministerial North Sea

Conference, to reduce riverine inputs of dangerous substances by 50% between 1985 and 1995, seems like a clear step towards a general Emission Standard approach. However, together with this decision some other problems have been confronted: which substances must be reduced by 50%, and will 50% within 10 years be sufficient for a lasting protection of the North Sea ecosystem? The decision was clearly a political one; the question as to whether what would be best for the ecosystem at this moment has not been raised.

Are, on the other hand, marine scientists able to provide officials and politicians with this kind of information; and, still more important, do scientists present their information in such a way that it can be used by policy makers? But also, do policy makers ask the right questions? And if so, will they use the information, as presented by science, for the development and the execution of policies for the protection of fresh and salt water ecosystems, even if the information is politically inconvenient? Can we learn something from the way in which available scientific information has been used in policy in the past?

Long term

In the Netherlands so called reference values for the marine ecosystem have been developed. These concentration values are based on computations made of the "natural" situation in the 1930's. Should these reference values be used in long term future water quality management? Will they guarantee a rich, lasting, well balanced ecosystem, such as climatic and physical conditions allow for; an ecosystem that does not suffer from frequent disasters as is the case with the North Sea ecosystem at present. Political choices must be made as to whether such a rich and well-balanced marine ecosystem is the preferred choice. Policy should also decide as to whether the protection of the ecosystem should have priority over other uses, i.e. shipping, offshore activities fisheries, dumping and discharges. To date these other uses have been given highest priority. If this situation continues in the future, can a lasting, well balanced marine ecosystem still be guaranteed? It will certainly mean large investments in clean technologies for the reduction of discharges, the prevention of risks and, most of all the enforcement of legal instruments.

The third North Sea Seminar will address and hopefully elucidate some of the questions that have been raised above.

Policies for fisheries

Jacqueline Stefels

Fishery is one of the earliest activities of mankind in the North Sea. For ages the fish resources of the North Sea were considered to be inexhaustible and the environmental impact to be of no significance. The fisherman claimed that they knew how to 'leave the capital and yield the interest' as they were the ones especially acquainted with the environment and its features; fisheries science was then still in its childhood. This point of view, which has developed through the ages, is understandable and might serve as an explanation for the stubbornness of fishermen in view of rules and regulations.

Impact on the North Sea environment

The vast increase in the fisheries efforts during the past decades has, however, led to an increased political awareness of the possible environmental effects thus created. From 1 million tons a year at the beginning of this century, the total North Sea fish catch increased to 2 million tons in 1956, and, after a few years, to around 3 million tons in the late sixties and early seventies. In more recent years the annual catch has been brought back to around 2.5 million tons.

Since the late sixties the proportion of demersal, pelagic and industrial fisheries has changed remarkably; a dramatic decline of pelagic fisheries, and to a lesser extent of demersal fisheries was largely compensated for by a vast increase in industrial fisheries. This mirrored the change in the balance between the stocks of different types of fish. For example the overfishing of herring and mackerel caused a decline in the stocks of these species. As herring and mackerel feed on the young fish of other species; such species, now being less preyed upon, were able to increase in number. Other complicated mechanisms, such as those relating to the balances between species, and chain reactions in ecosystem interactions caused by sudden changes, may have played a role here as well. In the late sixties and early seventies a dramatic change in stock composition took place.

The herring catches tumbled down from over 1 million tons a year in 1965 to 0.3 million tons in 1975. In 1977, a total ban on herring catches was subsequently issued in order to save the remaining stock. Since their predator, the herring, had almost disappeared, the stock of sandeel, a species which is fished commercially, increased dramatically. In 1980 industrial fisheries, in which sandeel is important species, covered 60 % of the total catch. In the eighties symptoms of overfishing were also recorded for cod, plaice, and sole. Apart from these direct effects of overfishing on the commercial fish stock, other environmental effects are likely to occur. Scientific research on the latter subject has seldom been accomplished and communication between fisheries scientists and scientists on other aspects of the marine environment is limited. Some indirect effects have been documented, although again they concern the commercial species, rather than other constituents of the ecosystem.

The decrease in herring stock appeared to affect the tuna stock. Tuna, which feeds on herring, was confronted with a decrease in its main food source, and consequently disappeared from the North Sea. Yet another signal came from the Shetlands' sea bird population. After first having increased in population in response to the increase of sandeel, their population tumbled down rapidly in 1988. Their breeding success has diminished to a disastrous level and there is good evidence to prove that this results from the severe reduction in their main food source, the sandeel. Although the situation may be much more complicated than just simply the problem related to the overfishing of the primary food source, such indirect effects of overfishing, resulting in changed species composition, can be of great significance. Not only are fish and birds subject to the impact of overfishing; it is clear that there is an urgent need for a better understanding of the interactions taking place within the ecosystem.

Lately environmental problems concerning fish farms have risen. The organic waste from the pens can seriously eutrophicate the environment; in several instances having changed the underlying sediment in an anoxic one, from which macrofauna has disappeared. Another problem is formed by antibiotics used for treatment of fish diseases. Organic waste containing antibiotics will precipitate and may cause resistance in the bacterial flora in the sediment. Antibiotics may also accumulate in the wild fauna.

Fisheries policy and the precautionary principle

The increased awareness of the need for the conservation of commercial fish stocks has roused the impetus to forming the Common Fisheries Policy of the European Community (1983); in this policy control systems as formulated by the North East Atlantic Fisheries Commission were adopted and extended. It regulates matters such as the minimum fish and mesh sizes, closed areas and seasons, by-catch levels, and total allowable catches, the latter being shared between member states as national quotas.

Total allowable catches (TACs) are based on individual stocks, and set by the fisheries scientists of the International Council for the Exploration of the Sea (ICES). They advise the European Commission. Although TACs are assessed on biological considerations, quota are decided upon on political considerations, hence the connection between the two being a political one. The decisions are subject to pressure by the member states, on behalf of their fisheries interest. It should be stressed that the only reason for setting quota is economic efficiency; quota are solely based on the preservation of commercial fish stocks. No pressure of environmental interest is represented in the quota decision process.

The European Economics Community (EEC) now plays a leading role in the field of fisheries, especially since the EEC member states transferred to it their competence in this field. In addition to this the EEC since the adoption of the 1st Environmental Action Programme in 1973, developed an environmental policy, which was confirmed in the single European Act in 1986, and reaffirmed in the Declaration of the Council Meeting of Rhodos in 1988. "It is essential to increase efforts to protect the environment directly and also to ensure that such protection becomes an integral component of other policies"[1]. Hence the EEC now is responsible for the environmental dimension of the Common Fisheries Policy (CFP). However, since the second programme the CFP as the object of environmental protection has disappeared from the Environmental Action programme. The insertion of the CFP as the object of environmental protection should be pursued.

The current quota system can be regarded as an expression of a policy in which the environmental capacity concept sets the stage. Suitable measures are taken as a result of the observed decline in stock, but no attention has been paid to the environmental problems except to those which directly effect the fisheries. This contrasts strongly with the precautionary principle, as proclaimed by the North Sea Ministers who assembled in London, in 1987. Ministers will have to decide upon the basic conception to be used in fisheries policy.

Future policy and research

Besides the problem that the current quota policy does not take into account environmental considerations other than those directly related to the fisheries, implementation and enforcement of the quota causes problems. In coming to a compromise, practical aspects such as enforcement tend to be overlooked. For example, a fundamental problem in quota management and restricted license situations is that they regulate single species catches, while in most fisheries a mixture of species is caught. It is very difficult to prove that the fisherman willfully intended to fish for a particular species, instead of being so 'unlucky' to catch it along with non restricted species. The current situation is far too complicated and full of loopholes. Enforcement as well as environmental considerations should, therefore, be main points in a new quota system.

The question posed to scientists now is whether they are able to provide the appropriate knowledge needed to construct such a system (for example a combined license covering a group of fish species, or a total abandoning of fish quota replaced by quota for fishing efforts). The question to policy makers is whether they are prepared to develop such systems, and base them on factual knowledge and scientific information. Will fisheries scientists, often associated with institutes under the responsibility of governmental fisheries departments, join hands with other marine scientists? Policy makers will have to stimulate research on the effects of different fishing techniques. At the moment one can only guess at the consequences when yet again a beam-trawl with 12 or more heavy tickler chains sweeps the area. Policy makers should also have the courage to stimulate alternative methods such as highly selective and passive gear.

The industrial fisheries also deserve attention. The massive amounts of fish which are caught and without selectivity, form a serious threat to the environment. Isn't it time, in the overcrowded world we live in, with resources which are becoming more and more scarce, to re-consider the usefulness of these fisheries? Is the use of fishmeal and cheap fuel oil not an exuberant waste of organic material?

During the last decades it has become increasingly clear that the fisheries have had a tremendous impact on the North Sea ecosystem; probably more so than the total flow of effluents into the North Sea has ever shown. It is a challenge for the 3rd NSS to bring about a change in the attitudes of policy makers in which there should be more room to consider environmental conservation, and to give a better insight in the research which has been done and should still be done to improve management.

[1] Declaration European Summit Rhodos, 3-4 December 1988, Annex I.

Policies for offshore activities

Jan Andries van Franeker

Earlier decisions on the exploitation of North Sea oil and gas supplies were based solely on economic considerations. The environmental impact from offshore activities, and various conflicts with other types of uses of the North Sea have increasingly gained more attention in recent policy-making. They nevertheless, still seem to be considered of secondary importance compared to economical advantages gained by governments as well as companies. In certain areas, high risks (environmental and other) may have induced tougher demands on technology and safety, but have never seem to lead to the decision not to drill. Offshore activities are officially allowed to take place in shipping lanes, in areas of high fish production, in areas where the ecosystem is vulnerable and in military shooting ranges. In other words, is there any 'risk level' at which policy makers could decide that the precautionary principle prohibits offshore exploitation? If so, what are the criteria?

In this paper we will concentrate on the offshore oil and gas extraction, although another offshore mining activity - the rapidly increasing sand and gravel extraction - constitutes a serious threat to the marine environment, requiring carefully developed policies.

Evidently, the question 'to drill or not to drill' is not the only one to be considered. Where offshore activities are allowed, policy has to decide on the intensity of exploitation, and on the framework of environmental and safety regulations. Oil and gas platforms produce large quantities of drill cuttings and fluid containing a wide variety of chemical substances. Large volumes of oil-bearing cleaning and production water have to be discharged; the quantity of production water increasing as the field grows older and the mineral resource becoming more difficult to extract.

Biocides are used as a preventive against corrosion. Accidents, large and small,inevitably occur on a regular basis. So, even with strict environmental regulations, a growth in offshore industry is bound to result in an increase in pollution. Environmental policy for discharges of the above mentioned substances seems to be rather undeveloped. There is a regulation that the oil-content of discharged production water must be 40 ppm or less, but up until now there has been no policy for the quantity of production water discharged per platform or per area. Almost all discharges into the sea from drill cuttings and fluid are permitted. The reason for this is not that the substances involved are harmless, but the fact that the transport to, and waste management on land are too problematic and costly. A policy for the overall permissible discharges has yet to be developed. The offshore industry uses, and discharges, many other compounds which can have an adverse effect on the environment. Little is known about the impact made by such compounds, neither singly or as a combination. No policy is as yet being developed to manage these compounds in view of the protection of the marine environment.

Part of the problem of the inadequacy of environmental regulations for offshore industry may be caused by the fact that political decisions are hampered by highly conflicting sources of information on environmental impacts. Oil companies emphasize that they cannot find direct deleterious effects of their activities to the water or sea bottom beyond that within the immediate vicinity of discharging platforms. This has been disputed by the Dutch Ministry of Transport and Shipping in statements on the occurrence of large "dead" sea bottom areas surrounding the platforms. Irrespective of such a disagreement, the environmental organizations keep stressing that acute toxicity of discharges is hardly relevant. In their view, the primary criterion on offshore permits and regulations should be the long term, cumulative effects on the ecosystem of all offshore discharges combined. Scientists are confronted with the nearly impossible task of assessing the overall ecological effects from offshore activities. Inevitably, the conclusions from their studies usually cover only a part of the problem, the rest has to be based on assumption. Such conclusions are not easily translated into policy decisions. Nevertheless, there is a definite feeling that the knowledge available is not always fully utilized in policy-making. The problems in assessing the 'environmental capacity' of the North Sea should not obscure the need for regulations based on the 'precautionary principle'.

The third North Sea Seminar which is going to be organized by Werkgroep Noordzee Foundation in the spring of 1989 will focus its attention on the relationship between policy makers and scientists in the process of developing an effective policy for the protection of the North Sea. The impact from offshore activities made on the marine ecosystem will be one of the case studies at this Seminar.