Marine Habitat Committee **ICES CM 2001/E:08**
Ref.: ACME

REPORT OF THE

BENTHOS ECOLOGY WORKING GROUP

Wimereux, France
17–21 April, 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

1 OPENING OF THE MEETING

The Benthos Ecology Working Group (BEWG) met at the Station Marine in Wimereux, France. The group was welcomed by the Chair, K. Essink and by resident scientist, N. Desroy, who informed the group of the regrettable absence of local colleague and organiser, J.-M. Dewarumez, who was taken ill a few days before the start of the meeting.

The list of participants for the meeting is appended as Annex 1.

2 APPOINTMENT OF THE RAPPORTEUR

Due to the unfortunate absence of J.-M. Dewarumez, three rapporteurs were appointed, J. van Dalfsen (NL), H. Rees (UK) and H. Hillewaert (B). A contribution from every member to drafting the text of the report was, as ever, greatly appreciated.

3 TERMS OF REFERENCE

The terms of reference (ToR) for the 2001 meeting of the Benthos Ecology Working Group (C. Res. 2000/2E09) were to:

a) finalise guidance to ACME on quality assurance (QA) procedures for benthic studies [OSPAR 2001/1.1];
b) report on progress of integration of national benthos surveys in the North Sea in relation to the ICES North Sea Benthos Survey;
c) review the impact on the marine benthic system in the ICES area from:
    i) the dumping of fish offal and fish discards,
    ii) the dumping of invertebrate discards,
    iii) the damage in the trawl path due to bottom trawling gear;
d) produce guidelines for epibenthos sampling and community description for publication in the ICES TIMES series
e) provide guidance to habitat mapping and habitat description of benthic communities, and in this connection, contribute to the verification of the EUNIS classification together with WGMHM and WGEXT.

The Chair noted that BEWG would report by 4 May for the attention of the Marine Habitat and Oceanography Committees and the ACME.

4 ADOPTION OF THE AGENDA

The agenda was reviewed and duly adopted. It can be found at Annex 2.

The status of several attendees in relation to the official membership list for the BEWG, as supplied to the Chair by ICES, is currently unclear. It was therefore decided to review and update the existing list of members of this Working Group.

5 REPORT ON THE ICES ANNUAL SCIENCE CONFERENCE (BRUGES, BELGIUM, 2000)

H. Rumohr and H. Rees reported briefly on some of the scientific Theme Sessions with contributions regarding benthic issues. In the Mini-symposium on Defining the role of ICES in supporting biodiversity conservation [Mini] there were interesting contributions by C. Frid *et al.* on ecological reference points for North Sea benthos and on development of new indices of ecosystem health. There was strong agreement that ICES must give more prominence to biodiversity both in its science and advisory activities. The Theme Session on Marine biological invasions [U] looked back at past patterns of exotic species invasions (including benthic species) and towards future movements and management. Both short-term and long-term studies were recommended in order to understand the role of exotic species invasions in impacting the economy and the environment. In the Theme Session on Marine habitat classification and mapping [T] it was stated that habitat mapping is an important tool for management and conservation of marine areas and marine resources. Further standardisation of methods was recommended. An internationally accepted classification to a certain level of detail was considered essential for communication, both among scientists and with politicians and managers.

The report of this meeting is now available as ICES Annual Report for 2000, Part 1 (February 2001).

6 REPORT ON THE ACME MEETING AND OTHER MEETINGS OF INTEREST

6.1 Advisory Committee on The Marine Environment (ACME)

K. Essink gave a short account of BEWG issues dealt with in the meeting of the Advisory Committee on the Marine Environment (ACME) in 2000. The report on this meeting (ICES Coop. Res. Rep. No. 241, Nov. 2000) mentions the following issues relevant to the BEWG. Reference is made to the development by the BEWG of guidelines for the study of epibiota as part of continuing ICES work to improve and harmonise methodology for marine biological monitoring. Also the work of the ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements related to Eutrophication Effects (SGQAE) is reviewed. The BEWG contributed to both subjects, in 2000, and there are further addenda below.

An extensive overview is given of the amount of discards and fish offal in the Baltic Sea and the potential effects. The BEWG contributed to this at the 2000 meeting. Although a simple carbon budget shows that the contribution by offal to the total oxygen consumption in the Baltic Sea is insignificant (0.05 %), the ACME recommended a more quantitative assessment of the amount of discards and offal, and of the effects on the Baltic ecosystem. Benthic ecologists are encouraged to undertake research programmes on the possible secondary effects on benthos in the Baltic Sea.

6.2 Marine Habitat Committee (MHC) (September 2000, Bruges, Belgium)

K. Essink and H. Rumohr reported on the Marine Habitat Committee, which met on 25 and 29 September 2000 with Astrid Jarre as Chair. For the first time a peer review of Working/Study Group reports was executed. With respect to these reports it was agreed that the ICES Secretariat will make the reports available on the Website immediately after having received them. With respect to the role of ICES in supporting biodiversity conservation there was concern about the availability of good taxonomic knowledge. Dr Paul Keizer (Canada) was elected as Chair for the next three years. Reference: ICES Annual Report for 2000, Part 2 (February 2001).

6.3 Working Group on Marine Habitat Mapping (WGMHM)

S. Degraer informed the BEWG about the meeting of WGMHM in Galway on 2–6 April 2001. During the meeting, two major topics, classification and habitat mapping, were dealt with.

Several discussion sessions addressed the classification of the pelagic habitat employing EUNIS (the European Nature Information System). At this stage in its development the participants felt confident with the EUNIS classification at level 3. It was decided that the EUNIS classification should now be more thoroughly tested and evaluated. The comments or remarks should be sent to the European Environment Agency (EEA) for consideration in a revised EUNIS classification.

Several presentations about ongoing habitat projects were given. Most of these presentations dealt with the use of remote sensing techniques (e.g., side-scan sonar, RoxAnn, QTC) in surveying the benthic habitats. It was proposed to apply for EU funding of a Concerted Action to create a benthic habitat map of the North Sea to the EUNIS level 3. A subgroup dealing with the development of this research proposal was established.

It was felt that the proposed concerted action should be closely linked to the BEWG initiative on the North Sea Benthos Project. Close interaction between both working groups is strongly advised.

6.4 Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT)

J. van Dalfsen and H. Hillewaert, who participated in the meeting of WEGXT on the Orkneys, 3–7 April 2001, reported the following to the BEWG:

a) Members of WGEXT reported on the status of marine extraction, development of seabed resource mapping, legal frameworks and approaches to environmental impact assessments in the various participating countries. The Group also agreed on a standard input format for reporting these data.

b) An ICES Code of Practice for the Commercial Extraction of Marine Sediments (including minerals and aggregates) and guidelines for the preparation of an Environmental Impact Assessment evaluating the effects of seabed aggregate extraction on the marine environment were finalised.

c) Capabilities of Acoustic Ground Discrimination Systems (AGDS) for detecting and delineating biological communities were discussed. Particular attention was given to Synthetic Aperture Sonar (SAS), a novel acoustic technique.

d) Completion of the monitoring of the Øresund Fixed Link was reviewed. The temporary biological impacts during construction were generally shown to have been very small and even less than predicted in the environmental impact assessment. This resulted from the careful planning and strict environmental management during the construction.

WGEXT brought forward a request to BEWG for information on large-scale general trends in marine benthos in the North Sea area as a means for referencing influences by extraction activities. BEWG referred to existing information already presented in its reports to ICES, but is prepared to address specific questions from WGEXT.

6.5 EuroGOOS

H. Rumohr reported on a EuroGOOS meeting in The Hague (6–8 April 2000) of which a report has been published: "Biological Observations in Observational Oceanography". At this meeting H. Rumohr gave an outline on common benthos sampling methodology in European waters:

Monitoring the fauna of the sea floor is one of the most reliable means to determine environmental quality since the stationary benthos integrates changes of the marine environment over time and shows effects even when the actual causal event could not be measured. Benthos sampling methods have always been very conservative and little was changed after the first quantitative attempts by C.G. Joh. Petersen in 1909. Grabs have replaced dredges, which nonetheless still give valuable information on rare and larger species. Coring devices are the most popular technology in recent deep-sea and general research activities. Newly designed special gear to collect the "overlooked fauna", i.e., rare and large epi- and infauna gave a new momentum to the sampling activities. Much has been done to make data from various benthos samplers more reliable and comparable, particularly with respect to the fact that data are restored in international data banks and are used by people other than the data originators (intercalibrations, intercomparisons, ring tests, quality assurance). There have been several attempts to overcome the shortcomings of traditional sampling. These methods are destructive and do not allow repetitive information retrieval from the same spot. Imaging methods (photo, video, sonar) have gained more importance since they are non-destructive and cover various scales from mm to tens of metres. However, they need traditional samples for verification and groundtruthing. New approaches include the use of echo signals for larger-scale mapping and classification of the sea floor. The combination of traditional and modern methods provides new types of data which allow us to judge the environmental quality status of the seafloor and its fauna with more precision and spatial validity.

7 REPORT OF COOPERATIVE STUDIES AND OTHER STUDIES RELEVANT TO ICES

7.1 Methodology and Monitoring Programmes

M. Zettler reported on the mapping of benthos in German waters of the Baltic Sea. This study aims to give an overview of the macrozoobenthos of the Mecklenburg Bight (Western Baltic Sea) with emphasis on water depths between 5 m and 29.5 m. The data result from several research cruises in 1999 and 2000. This was the first time that such an extensive investigation of macrozoobenthos has been carried out.

The study is focused on biology and recent distribution of the macrozoobenthos. Therefore, population dynamics of species and their variability in time and space are only included for some dominant species in order to follow their long-term development. Particularly for long-living bivalves (*Arctica islandica* and *Astarte borealis*) morphological and population characteristics were recorded. In addition, some other dominant species, such as the polychaete worm *Scoloplos armiger* and the crustacean *Diastylis rathkei*, are examined in more detail.

A list of the taxa has been compiled consisting of all data on macrozoobenthos available for the inner and outer coastal waters of the Mecklenburg Bight since 1995. In total, 240 taxa were observed in this area. The greatest number of species (about 140) was found in the depth zone between 15 m and 20 m. The highest abundance and biomass were detected in the more shallow waters between 5 m and 10 m. Several species (29 taxa) occurred only in the inner coastal waters (e.g., Salzhaff, Pötenitzer Wiek, Breitling) or in the shallow parts of the shoreline (< 1 m). Both habitats are characterised by the occurrence of boulders, stones, phytal or groyne piles.

The data obtained in 1999 and 2000 were compared with historical data from the literature (starting with the beginning of research on macrozoobenthos in the Baltic in the 1870s) covering the past 130 years. This comparison showed that the abundance and distribution of several species (e.g., the polychaete worms *Pygospio elegans* and *Nephtys hombergii*)

increased during the last decades. 23 species became extinct or disappeared during this period of time. When taking into account all the historical and recent data, about 263 taxa were described for the Mecklenburg Bight.

Reference:

Zettler, M. L., Bönsch, R. and Gosselck, F. 2000. Verbreitung des Makrozoobenthos in der Mecklenburger Bucht (südliche Ostsee) – rezent und im historischen Vergleich, IOW, Marine Science Reports No. 42.

J. Kotta reported on the national benthic monitoring in Estonia. Macrozoobenthos is currently included in three different national monitoring programmes in Estonia:

a) Coastal-water monitoring

limited to soft bottoms, minimum depth 5 m, covers the major bays and deeps around Estonian coastal waters, yearly monitored since 1993.

b) Hot spot areas

including Tallinn, Narva and Pärnu bays, all areas receiving strong municipal load. The sampling is carried out along transects (two stations in a bay, one reference station). Samples have been collected twice per month during the ice-free season since 1997.

c) Phytobenthos monitoring

consisting of sampling along 6 different transects around the Estonian coastal sea, including both soft and hard bottoms, from seashore to 15(20) m depth. Zoobenthos is sampled within the vegetation and from unvegetated substratum.

Besides these major programmes, sampling is carried out elsewhere, but less regularly and at longer time intervals, *viz.* in the Väinameri Archipelago Sea (mapping of a unique loose-lying red algal community), in the vicinity of harbours, etc.

The methods employed in these sampling programmes are partly comparable. The methods recommended by HELCOM are largely followed in programmes 1 and 2. When mapping the zoobenthos of hard substrata the methods of the Swedish national phytobenthos monitoring are used, with some modifications. Due to the low species diversity and a high risk of the introductions of aliens, workshops on invertebrate taxonomy are very beneficial for the scientists involved in zoobenthos monitoring in Estonia.

S. Dahle gave a presentation on the environmental status of Norway's Continental Shelf based upon the Petroleum Regional Monitoring Programme, 1996–1998. A report is available which gives a compilation of surveys and research prepared for the Norwegian Oil Industry Association (OLF). The presentation was based upon a report made by Akvaplan-NIVA, DNV and Unilab Analyse, on contract to the Norwegian Oil Industry Association and the Norwegian State Pollution Control Authority.

Monitoring of the sea floor environment in the vicinity of offshore oil and gas platforms has been undertaken since the start of oil exploration in the Norwegian sector of the North Sea. Since 1988 the environmental monitoring has been carried out in accordance with national and OSPAR guidelines, and includes analyses of benthic communities as well as sampling of sediments for measuring of physical characteristics and concentrations of oil-related contaminants (oil hydrocarbons, certain chemicals and metals). Each year 300–500 stations are sampled by a 0.1 m^2 van Veen grab (at depths of more than 500 m, by a 0.5 m^2 box-corer). The monitoring was originally concentrated around individual oil fields. In 1996 the Norwegian offshore sector was divided into monitoring regions, and these are intended to be sampled every 3 years. The regional monitoring introduced regional reference stations in addition to the field specific reference stations, in such a way that the "background" levels of benthic communities and contaminants could be established.

The regional monitoring gives a better set of data for assessments of wider environmental quality arising from the impacts of oil and gas operations, both the discharges from the drilling activities and the operational discharges during production. Impacted areas of the sea floor can be calculated at each field. Contaminated areas are defined as those areas having significantly higher concentrations of the given contaminants than the reference stations, and areas with disturbed benthic communities are calculated based upon standard univariate and multivariate analyses and the existence/non-existence of indicator species. In general the area of the Norwegian sector impacted by the petroleum industry has been reduced since 1994, and this is more pronounced for the chemical contamination than the for benthic communities. The reduction may be explained by the prohibition of the discharge of oil-based drilling mud in 1993,

which used to be the main source of contamination from the offshore oil industry. The monitoring shows a rapid reduction in the area of chemical contamination; in many fields the affected area has reduced by 50 % in just 4–5 years. The area with disturbed benthic communities is also reducing, but at a much slower rate. In the Ekofisk region, where oil exploration has taken place since the mid-1960s, and which is the region mostly affected by petroleum activities, the area of the sea floor affected by chemical contamination amounts to 0.03 % of the regions total area, and the biologically affected area amounts to 0.02 %. These figures are calculated on the basis of the monitoring carried out in 1996.

The seafloor monitoring programme in the Norwegian sector has been carried out by standardised procedures since 1988, and most stations are sampled every third year. The monitoring activity therefore provides a large data pool both in time and space, which may contribute to the general mapping and analyses of the North Sea benthic communities.

P. Kingston (by correspondence) reported on the ongoing Firth of Forth Project. About half of the sample stations have been worked up, the results of which will be reported at the forthcoming international Polychaete conference in Iceland. This year a RoxAnn survey was carried out covering the inner part of the Firth to map the distribution of sediments in the area and relate acoustic information to the physical information obtained from the previous year's sampling programme.

H. Rumohr reported on an EU-funded *Spisula solida* research programme PESCA. In this programme, observations are made on *Spisula solida* as well as on *Ensis directus* using grab samples and video recordings along the German coast. The data will be a prerequisite for a decision on whether *Spisula* dredging should be allowed in the German coastal waters. Samples are taken in three regions, of which one is a closed area for the shellfish fishery (*Spisula* research area). Main targets/goals within the programme are:

1) Avoiding overfishing of parent stock;

2) Reduction of impact on food resources for diving ducks;

3) Protection of undersized *Spisula;*

4) Duration of physical impact of the dredging tracks;

5) Avoidance of high by-catch mortality.

A report will be available at the end of 2001.

J. Craeymeersch noted that effects of shellfish fisheries on the benthic environment will depend on the sediment characteristics, the local hydrodynamic situation, the target species, the fishery intensity and the fishery technique used. Fisheries for, e.g., *Ensis* spp. require disturbance to a greater depth in the sediment than fisheries for species living near the surface of the seabed (e.g., *Spisula subtruncata*). In all cases sediment will be disturbed at least temporarily. In highly dynamic situations, the visual effects have been noticed for up to 40 days (Hall *et al.*, 1990; Tuck *et al.*, 2000).

It is also evident that the fishery will change the population structure of the target species: the larger, older individuals are targeted. Whether or not this could result in a long-term effect on the population structure depends on the maximum age, the age at maturity and the spat fall success. For species reaching their marketable size at older ages (e.g., 8 years for *Ensis arcuatus*), and for species becoming adult after a few years (e.g., 3 years for *Ensis siliqua*) new recruitment will – after fishing activities - depend on a small part of the population (Robinson and Richardson, 1998). For shorter-lived species (e.g., *Spisula subtruncata* or *Ensis directus*), this effect can be expected to be lower. The removal of adults could also result in local changes in the spat fall. First, competition between adults and larvae might become lower, resulting in a higher recruitment success. On the other hand, adults could also be a positive cue for settlement of larvae. Thirdly, positive or negative effects might result from active selection or avoidance of disturbed sediments by the larval or post-larval stages (Peterson *et al*., 1987).

There is almost no knowledge on the direct mortality in the trawl path or the by-catch of shellfish fisheries. McKay (1992) and Tuck *et al.* (2000) found damages of 10 % (larger bivalves such as *Arctica islandica*) to 30 % (*Echinocardium cordatum*) after fishing for *Ensis*. Motile species were caught but were apparently undamaged, probably due to the low fishing speed.

There are a few published studies on the effects on benthic communities. Immediately after commercial fishing for *Ensis*, Hall *et al.* (1990) and Tuck *et al.* (2000) noticed a numerical reduction of many benthic species. However, after 5 – 40 days, effects were no longer detectable.

With respect to commercial exploitation of bivalve species, the BEWG noted that a sustainable use of bivalve populations needs to take into consideration (1) their ecological functioning (e.g., serve as food for diving birds, play a role in sediment dynamics), and (2) the reproductive biology and capacity of the populations. The BEWG, therefore, stresses the need for research on the population dynamics of potential commercially exploitable bivalve species. This knowledge is essential for a sustainable fishery.

7.2 Long-term Benthic Studies

Ingrid Kröncke reported on long-term variability in macrofauna species composition off the island of Norderney (East Frisia). Macrofaunal samples were collected quarterly from 1978 to 1999. Abundance, biomass and species numbers of single species or taxonomic groups showed different long-term variability. Different patterns were found over time according to different zoogeographical distribution or feeding mode. Temperature seemed to be a major factor structuring the community. Cold winters in 1978/1979 and 1995/1996 had severe negative effects on the community. A clear shift in community structure has become obvious since 1988, which occurred in direct connection with an increasing North Atlantic Oscillation Index (NAOI). The mediator between the NAOI and the benthos seems to be the sea-surface temperature. But also increasing storm frequency since the late 1980s changed the hydrodynamics of the area and led to higher resuspension of sediments and organic matter. This changed the food availability for macrofauna species as well as sediment stability. The results are similar to others observed in long-term studies in the North Sea and indicate a system shift at the end of the 1980s.

Ingrid Kröncke also reported on decadal changes in macrofauna communities on the Dogger Bank caused by large-scale climate variability. In the frame of a long-term comparison between 1985–1987 and 1996–1998, Wieking and Kröncke (2001) found marked changes in macrobenthic communities of the Dogger Bank (central North Sea) as a result of the rise in the NAO. Due to an increase in bottom temperatures, southern species such as the amphipod *Megaluropus agilis* and the ophiurid *Amphiura brachiata* increased in abundance on top of the Dogger Bank and on the southern slope, and occurred even in the deeper parts in 1996–1998. In contrast, abundance of northern species (e.g., *Corophium crassicorne*, *Siphonocoetes kroyeranus* [Amphipoda], *Nuculoma tenuis* [Bivalvia]) decreased on top, and to the south of the Dogger Bank. The additional increase in abundance of interface-feeding species such as the polychaete *Spiophanes bombyx* coincided with a higher primary production in the central North Sea.

Benthic communities along the northern slope of the Dogger Bank were strongly affected by increasing wind stress and stronger currents at the northern slope of the Dogger Bank. These factors are also associated with a positive NAO index during the 1990s. Changes in larval supply, food availability and sediment composition caused by resuspension of fine material led to a decrease in species occurring on fine sand (*Ophelia borealis* [Polychaeta]) compared to the 1980s, whereas abundance and total number of species preferring coarser and unstable sediment (e.g., *Echinocyamus pusillus* [Echinodermata]) increased in the 1990s. The decrease of total abundance, changes in trophic structure such as the increase in hyperbenthic predators (*Cerianthus lloydii* [Anthozoa], *Corymorpha nutans* [Hydrozoa]) and the higher diversity of feeding types, as well as the increase of total number of northern species, were related to a stronger inflow of northern water masses and a connected decrease in food quantity and quality. These changes resulted in a pronounced separation of northern and southern macrofauna communities along the northern slope of the Dogger Bank during the positive NAO index period in the 1990s.

H. Hummel gave a presentation regarding the monitoring of macrozoobenthos in the SW Netherlands, commissioned by the Dutch Rijkswaterstaat authority. He drew attention to problems that may arise after storage of the monitoring data in large databases, developed by this authority and others. He had encountered problems in retrieving the data from the Rijkswaterstaat database to be used for further analysis. He also noted that there was little organised effort in the evaluation of the monitoring data to support the understanding of developments in coastal waters, which might provide the basis for effective management. An analysis of macrozoobenthos data from the saline lake Grevelingen revealed significant declines in the abundance of bivalves and gastropods, and an increase of polychaetes in the mid-1980s. This result, indicating a major change in the Grevelingen system, had not yet been brought to the attention of the authorities directly responsible for the management of the lake. Dr Hummel expressed his concern that this may be an example of a more widely occurring shortcoming in the process of evaluation of monitoring data and in the communication of the results among the responsible authorities. Dr Hummel further stated that development of a Benthos Information System, like the one developed by his institute, might offer a solution to this problem. The option may be valuable, given the current tendency of some authorities to contract out monitoring work.

W. Sistermans presented a Benthos Information System as developed by the NIOO-CEMO, showing a system for data management. The program is still under development but when completed will allow queries according to user demands. The presentation of the Benthos Information System is available on CD-ROM.

H. Rumohr presented information on long-term benthos studies in Kiel Bay (Western Baltic). An overall positive linear trend was observed from 1953–1998 in macrofauna abundance and species richness. Even in this rather impoverished area, an increase in the number of grab samples collected led to a significant increase in the number of species encountered, which continued even after 65 samples. A paper on this is currently in press in MEPS.

Also, long-term trends in a number of species were presented (1968–1998). These were similar among species, and explanations might be sought in extreme ice winters, which were found to influence the fauna in the Kiel Bay down to at least 24 m depth, as well as increasing frequency of anoxic episodes. Another explanation may be found in correlations with the NAO (a publication is in preparation). Finally, the Baltic Sea is reliant on periodic inflows of new marine water masses from the Kattegat/Skagerrak. The last major event of this kind was observed in 1993.

S. Smith presented results from Kjell Leonardsson regarding long-term monitoring in the two northernmost basins of the Baltic. Over time, the variations in total abundance and biomass were small and also similar in coastal as well as offshore areas in the Bothnian Sea (southern basin). In the Gulf of Bothnia (northern basin), the offshore areas deviated from those found in the coastal areas.

The life span of the amphipod *Monoporeia affinis* is longer in the far north (3 years) and gradually diminishes further south (1 year in the Baltic proper) due to a slower growth. Food availability controls their growth and in order to reach maturity they have to reach a minimum size. After reproduction they die. The changes in mean body weight are well synchronised between the sampling areas in each of the different subareas, except for the offshore areas in the Bothnian Sea. The abundance of *M. affinis* has been fluctuating more or less cyclically since 1983, but in the spring of 2000 there was a severe decline in the Norrby area that is situated between the two basins. It was argued that the cause of this dip was a low algal productivity for some previous years.

Rather close by in the area of Holm islands, the introduced species *Marenzelleria* cf. *viridis* has reached an all-time high of 1 000 individuals/m² in the year 2000. However, further south, the increase in numbers seems to have proceeded much more slowly. In the same year a southern relic species *Halicryptus spinulosus* also arrived in the area. Both these incidents coincided with a temporary influx of more saline water.

7.3 Biodiversity Research

H. Hummel informed the BEWG about an EU concerted action entitled MARine BIOdiversity research in Europe that was started in November 2000. The action aims at establishing an infrastructure and conditions required for marine biodiversity research at a European scale.

A more detailed account of BIOMARE can be found at Annex 3.

7.4 Effects of Anthropogenic Perturbations

H. Rees reported on studies in connection with dredged material relocation and aggregate extraction in the UK. A detailed report can be found at Annex 4.

7.5 North Sea Benthos Studies

G. Duineveld reported on the benthic fauna of the Frisian front, an enriched zone north of Texel, which has been monitored since the 1980s. The area is characterised by a strong gradient in sediment grain size, depth, current speed and food input. The benthic fauna shows a zonation in accordance with the gradient in abiotic conditions. The dominating species in the zone with highest food input was the brittle star *Amphiura filiformis* which reached densities up to 2000 ind. m^{-2}. After a stable period of about 10 years, *Amphiura* densities began to drop in the early 1990s down to 200 ind. m^{-2}. Associated species like the bivalve *Mysella bidentata* displayed a similar decline. By contrast, species like the burrowing ghost shrimp *Callianassa* increased in abundance. Causes for the shift in dominance are unknown. In order to gain a more fundamental understanding of the population dynamics of the species living at the Frisian Front, a programme was started to study their reproduction, larval supply and recruitment. The first step in this programme was the construction of a submersible pump that autonomously takes samples of pelagic larvae over longer time intervals (months). In this way it is possible to bridge the gaps between observations that commonly arise when one is fully dependent on (expensive) ship time. The pump consists of a 25-litre barrel that is closed at pre-programmed times. A

plunger built in the barrel top displaces the water and its larval contents through one of the 12 sieves (100 µm sieve size). The contents of the sieve are subsequently preserved with formalin. All actions of the pump are driven by hydraulics. NIOZ have opted for a barrel capturing a volume of water that is subsequently driven through a sieve because this set-up is independent of the current speed and consumes relatively little energy. Initial results of a short-term deployment of the pump were presented at the BEWG meeting.

R. Zühlke gave a presentation of results on North Sea epibenthos obtained in 1999 in the framework of the EC Project 98/021 "Monitoring Biodiversity of Epibenthos and Demersal Fish in the North Sea and Skagerrak". Using the third quarter "International Bottom Trawl Survey" of five European countries, over 240 stations were sampled in 1999 and 2000 covering around 150 ICES rectangles.

The objectives of the project were:

i) to analyse epibenthic diversity patterns in the North Sea;

ii) to identify the spatial distribution of faunal communities; and

iii) to relate environmental factors as well as fishing effort to species diversity.

A detailed summary of results obtained in 1999 can be found at Annex 5.

J. van Dalfsen informed the members of the BEWG about a project started by TNO on ecotope mapping of the Dutch Continental Shelf (North Sea). The project started in 2001 and will end in 2003. There has been an increase in human activities and use of the North Sea, and future developments will further extend the pressure on the ecosystem. Presently, there is a mismatch between the knowledge on spatial and temporal scales of the marine benthic biota and the scales needed to assess the effects of the various uses of the North Sea. The project aims to integrate knowledge on the benthos, seabed morphology, and hydrodynamics through the preparation of detailed GIS maps for the use of environmental managers (government and authorities) and others (e.g., offshore oil and gas, fishery and dredging industries).

7.6 Benthos Studies in Southern Europe

S. Parra gave an overview of current benthic studies in Spain.

Galician waters (NW Spain)

In La Coruña Bay, long-term variations of benthic infauna at two stations have been studied since 1982. One of the stations is located in muddy, hypoxic sediments of the harbour area, where harbour dredging was carried out in 1982. Following a relatively quick recovery after dredging operations, the infaunal community did not vary much with time, in spite of frequent sediment disturbances. The bivalve *Thyasira flexuosa* and opportunistic polychaetes are the dominant organisms. The high stability of this community is related to the dominance of opportunists, who have short life cycles, and are thus well adapted to environmental disturbances. The other station is located in a relatively clean, fine sand area of the bay, and the community is dominated by species having longer life cycles, such as *Tellina fabula* and *Paradoneis armata*. This community shows a wider temporal variation, both seasonally and interannually. Species composition has remained very stable throughout this time at both stations, although the relative dominance of main species may change. The *Aegean Sea* oil spill (3 December 1992) affected the communities for a few years after the spill, causing a decrease in amphipods and some bivalves and a dramatic increase of opportunistic polychaetes.

In Ferrol Bay, spatial and temporal variations of the subtidal infauna are being investigated. Here the port authority is going to build a big external commercial port, and the impact of this construction on the natural environment of the bay has to be assessed.

A new project was recently set up to study the hyperbenthos of the La Coruña Bay. A new hyperbenthic sledge is being designed to study the small motile fauna living in the near-bottom zone. It is fitted with two nets (0.5 mm mesh size) and an opening-closing system working on the seabed. It samples quantitatively water layers from 0 cm to 50 cm and from 50 cm to 75 cm above the sea floor.

In the south of Galicia (IEO, Vigo), the team of Dr Nélida Pérez is working on the impacts of the fisheries. They are studying the dumping of discards by the Spanish fleet in the ICES area.

In the south of Galicia, the benthos team of the University of Santiago is carrying out associated benthos studies. Dr Pita and collaborators are studying the polychaete communities that live in maerl beds in Vigo Bay; Drs Gómez-Gesteira and Fraga, in the Ares-Betanzos Bay, are studying the taxonomic level and sample size that are sufficient for assessing pollution impacts by hydrocarbons on the subtidal macrobenthos.

Dr Gómez-Gesteira also has carried out investigations relating to the *Aegean Sea* oil spill and he proposed the amphipod group as a bioindicator to detect the impact of oil pollution rather than using opportunistic polychaetes, because the recovery rate of the amphipods was slow but progressive.

Cantabrian Sea (N. Spain)

Dr García Castrillo, from the Natural History Museum of Santander, has started a study on the preliminary quantitative evaluation of the impact of beam trawling (particularly looking at megafauna) on the continental shelf of the Cantabrian Sea.

Drs Sáiz-Salinas and Pagola-Carte, from the University of the Basque Country, work on monitoring programmes for zoobenthos communities on the rocky shores (e.g., looking for indicator species for monitoring) They recommend monitoring rocky substrates by using more extensive biomass sampling surveys of subtidal areas followed by a less time-consuming treatment of the samples (identification of higher taxonomic groups or by trophic levels). They are also working on long-term variation of zoobenthos communities on the rocky shores of Abra de Bilbao (Bay of Biscay).

Atlantic Ocean (S. Spain)

The benthos team of the University of Sevilla is working in the Algeciras Bay (Southern Spain). Dr García-Gómez and collaborators are studying the effects of organic effluents (urban sewage disposal) on the infaunal subtidal communities and the temporal evolution of this community in two areas. They observed that the poorly treated urban effluents that discharge into areas with reduced hydrodynamics affect much larger areas than discharges in hydrodynamically energetic zones, where their effects are much more rapidly dispersed. Additionally, this team is investigating the effect of thermal pollution on benthic infaunal communities in an area influenced by a coastal power station in the Algeciras Bay.

A. Borja (by correspondence) informed the meeting about monitoring programmes for benthic communities on soft bottoms carried out by his team at AZTI (Institute for Fisheries and Food, Pasaia, Spain). This monitoring programme includes 12 estuaries and the continental shelf of the Basque Country (Cantabrian Sea). The studies started in 1995, with annual surveys. The focus of these studies is on the development of benthic communities due to the sewage treatment and discharge processes in that coastal area. Recently, a Biotic Index for the European coasts was developed, permitting the calculation of environmental impacts on communities.

Benthic studies in Greece/Crete

H. Rumohr reported on a Greek-German cooperative project between the Institut für Meereskunde in Kiel and the Institute of Marine Biology of Crete (IMBC). The project is coming to the end of the second funding period and is mainly concerned with the transfer of knowledge about sediment profile photography and side-scan sonar applications to Greece. The cooperation resulted in a series of common publications and also provided insight into the various Greek research projects which are currently being conducted. Within the Department of Marine Ecology and Biodiversity under Chris Smith, staff work on a variety of EU-funded projects such as assessing the by-catch of marine turtles by drifting longlines and by the trawl fishery, and determination of the growth and natural mortality of *Nephrops norvegicus* in relation to creeling in Greek waters. Other projects centre around the use of ROVs and the development of advanced packages for automatic inspection of sediments (ARAMIS) and advanced manipulation of deep-water sampling (AMADEUS). Other projects deal with the regulation and the monitoring of marine aquaculture (MARAQUA) and the effects of trawling on the environment and on the productivity of fishing grounds off Crete (NATO and DG XIV Study Project 98/013). Additional information can be found on their well-maintained web page http://www.imbc.gr.

7.7 Other Studies

H. Rumohr reported on a study and PhD project in the Western Baltic concerned with the benthos of Fehmarn Belt, one of the major straits between the marine Skagerrak/Kattegat system and the brackish/estuarine Baltic. The study (by Monika Kock, Kiel) is based on grab and dredge sampling in the years 1997 to 1999, accompanied by video and REMOTS recordings. The data allow a classification into a deep *Abra alba*/*Arctica islandica* community (20–29 m) and

intermediate *Macoma* dominated assemblages on either side of the strait, both being different however. Biomass and abundance data over 3 years showed the high variability in the system, which is however remarkably stable over the long term (>30 yrs). The study has been carried out partly in anticipation of the planned crossing of the Belt by either a bridge or a tunnel and may serve as background information for the evaluation and assessment of possible effects during construction and afterwards.

8 NORTH SEA BENTHOS PROJECT [TOR: B]

Since the last BEWG meeting, an intersessional meeting was held among participating institutes during the North Sea symposium held at Wilhelmshaven in early May 2000. At this meeting possibilities of harmonisation of sampling were discussed. Also, end products of the North Sea Benthos Project were agreed upon.

8.1 Review of Field Work Carried Out

The progress made in separate national benthic surveys in the North Sea was reviewed. In general, a significant sampling effort had been realised by the different North Sea countries. Due to the much regretted absence of J-M. Dewarumez and some other representatives, information on progress is incomplete for some sampling programmes carried out by France, Germany, Denmark and Scotland. An overview of the present state of coverage of the North Sea is presented at Annex 6. The majority of the samples have already been analysed. Samples obtained focus mainly on macrozoobenthos, but supporting and additional sampling was carried out including sediment type, contaminant levels in sediment, epifauna and meiofauna.

It was concluded that a major part of the North Sea has already been sampled. Care was taken to ensure re-visiting the 1986 ICES North Sea Benthos Survey stations, as far as possible.

8.2 Field Work in 2001

In the year 2001 continued sampling will be done in order to cover areas not yet sampled in 2000. These areas include the Borkum Riff and Amrum Bank area (Germany), parts of the Belgian Continental Shelf, and areas off the English east coast.

P. Kingston (by correspondence) informed the BEWG that initially the United Kingdom Offshore Operators Association (UKOOA) were intending to mount some offshore surveys. This is not now taking place as an industry-driven initiative, but has been superseded by a new programme being funded by the UK Department of Trade and Industry (DTI). This programme has been inspired by the EC Habitats Directive and is aimed at identifying areas that might be of special conservation interest on the UK Continental Shelf (UKCS) to enable the UK Government to produce a “Strategic Environmental Assessment”. It covers the North Sea, Irish Sea, SW approaches and the area west of Shetland. The programme is not centred on the offshore oil and gas industry, but aims to cover any area of the UKCS where there is a perceived lack of information on the nature and status of the marine environment. There is an annual budget of about £1.4 million and this will be used on targeted surveys over the next few years. This year (2001) there is a plan for two surveys in the North Sea, one to survey the sand banks of the southern North Sea and the other to survey the “pock-marks” of the central and northern North Sea. The project is being managed by a Consultancy, Geotek, based in Southampton, run by an oceanographer, Quentin Hugget. A planning meeting for the first phase of the work took place in February. P. Kingston has been in touch with the DTI and Geotek over the programme and has suggested that it should be coordinated with the activities of the BEWG. The new programme is quite flexible and will continue to represent the interests of the BEWG.

8.3 Arrangements on Data Handling

J. Mees of the Flemish Marine Institute offered his services to collate and store the data from the project and to provide logistical support in the data analysis. H. Rees emphasised the importance of sound quality assurance applied to the process of data collation and storage, a matter which was supported by members.

H. Hummel gave an overview on data handling as performed at his institute, and pointed out the possibilities of EU funding on database infrastructure management in the years to come. The data handling of the North Sea Benthos Project might benefit from this development. H. Rees expressed his concern that separate construction of a new database to handle data from the NSBS should not proceed in isolation from the development of a new biological database at ICES, which is designed to service future ICES and OSPAR needs. After all, the North Sea Benthos Project is under the umbrella of ICES. The BEWG participants supported this view, but agreed that for this project a benthos

database should primarily serve a practical use. Additionally, the same data could also be reported to, e.g., ICES and OSPAR.

The BEWG concluded that it is of the utmost importance to further liaise with the ICES WG on Marine Data Management to discuss the possibilities of an adequate input of the data into the ICES Database. S. Dahle also stressed the importance of liaising with the oil and gas industry as owners of extensive monitoring data.

After further discussion, it was decided to follow two lines of approach. Firstly, it was agreed to accept the offer of J. Mees. He will prepare a proposal shortly and communicate on this with the Chair. This proposal will include a time schedule on the setting up of the data format and the organisation of a workshop in the autumn of 2001 in Oostende to discuss the treatment of differences in data sets from the different countries. This workshop has to produce a proposal of a final format for the input of data. A second workshop is planned in 2002 to discuss and carry out the data analysis. E. Rachor has offered to host this workshop at AWI-Bremerhaven. In the process of data analysis, quality checks should be incorporated.

The second line to follow is the EU funding on database infrastructure management as pursued by H. Hummel at NIOO-CEMO. At a later stage both lines may converge, offering mutual benefit for project work. In the meantime, H. Hummel and his group are willing to offer any cooperation with the people at J. Mees' institute. J. Craeymeersch offered to assist from his experience with the 1986 NSBS database.

8.4 Reporting Goals

The Chair reminded the BEWG of the goals and end products as formulated intersessionally at the Wilhelmshaven meeting (May 2000). These were:

- Goals:

1) *ICES Cooperative Research Report* Nr. xxx
2) Publication(s) in *ICES Journal of Marine Science*

- End products:

1) An overall comparison with the results from the 1986 NSBS; also, an indication of the limitations of comparison due to differences in approach.
2) Comparison of 1986–2000 data in relation to the North Atlantic Oscillation and other environmental influences (e.g., input of nutrients).
3) Testing of the applicability of the EUNIS habitat classification system as developed by the European Environmental Agency.
4) Investigation of the relationship between the benthos (large and long-lived species) and bottom trawling intensity. This will be dependent on the degree of detail available on fishing intensity. A similar approach is being followed in the CEFAS-coordinated North Sea epibenthos surveys.

The BEWG agreed that there was no need to further specify the end products at this stage. It was agreed that these end products should be reconsidered during the workshops to be held under the coordination of the Flemish Marine Institute. Finally, it was concluded that progress made will be reported at the 2002 meeting of the BEWG.

9 IMPACT ON THE MARINE BENTHIC SYSTEM FROM FISHERIES [TOR: C]

During this meeting, the BEWG reviewed the impact of trawling on the North Sea and Northeast Atlantic benthic system, i.e., from dumping of fish offal and fish discards, the dumping of invertebrate discards, and the damage and direct mortality in the trawl path due to bottom trawling gear. Information was extracted from, e.g., the IMPACT II report and from the EU REDUCE project. An overview of the EU REDUCE study is given at Annex 7.

9.1 Discards

In addition to target species, fishing activities also result in the capture of non-target species (fish and invertebrates) and undersized individuals of target species. A large proportion of this by-catch is discarded as dead organic matter. Part of

the discards is consumed by birds at the sea surface. Another part might be consumed by mid-water scavengers, but this is probably negligible. Finally, at the seabed the remaining part is consumed by benthic predators and scavengers.

The amounts of the discarded by-catch can be considerable. In the Baltic Sea about 14 950 tonnes of discards and offal are produced annually (ICES, 2000). Table 9.1.1 gives estimates by Camphuysen *et al.* (1993) for the whole North Sea, while Table 9.1.2 gives estimations by Garthe *et al.* (1996) for the North Sea and Northeast Atlantic. The table of Camphuysen has been split up into a northern part (offal and roundfish) and a southern part (flatfish and benthic invertebrates, both caught by bottom trawling). The latter agrees with data reported by Groenewold and Fonds (2000) on the Dutch Continental Shelf: 275 000 tonnes discarded, of which 195 000 tonnes reach the bottom.

Table 9.1.1. Annual amounts of fish offal and discards for the North Sea (Camphuysen *et al.* 1993).

	Annual amount (tonnes)	**Consumed by birds**	**Available in mid-water and at seabed (tonnes)**
Northern North Sea			
fish offal	838,700	90 % (95 %)*	8,370
discards - roundfish	146,000	80 %	49,200
Total			**57,570**
Southern North Sea			
discards - flatfish	148,000	20 %	118,400
discards - benthic invertebrates	100,000	10 %	90,000
Total			**208,400**

* according to Camphuysen *et al.*, 1995.

Table 9.1.2. Annual amounts of fish offal and discards for the North Sea and NE Atlantic (Garthe *et al.*, 1996).

	Annual amount (tonnes)	**Consumed by birds (tonnes)**
Fish offal	62,800	55,000
Discards - roundfish	262,200	206,000
Discards - flatfish	299,300	38,000
Discards - benthic invertebrates	149,700	9,000
Discards - elasmobranches	15,000	2,000
Total	**789,000**	**310,000**

9.2 Direct Mortality on the Sea Floor

Damage also occurs to animals that are hit by the bottom trawl but not retained by the nets. Because commercial trawls generally show low catch efficiency for invertebrates, mortality in the trawl track is far more important than discard mortality (Bergman and van Santbrink, 2000). Flatfish fisheries mainly occur in the southern North Sea. Thus, mortality in the trawl path is only important in this particular area. As an example, Table 9.2.1 gives the estimated fishing mortality exerted by trawl fisheries on megafaunal populations in the Dutch sector in 1994. The fishing mortality varied from 5 % to 39 %.

Table 9.2.1. Fishing mortality (%) in invertebrate megafaunal populations in the Dutch sector by the commercial fleets (4-m and 12-m tickler chain fleet, 4-m chainmat fleet, otter trawl fleet) (Bergman and van Santbrink, 2000).

	Length (cm)	Fishing mortality %
All sediments		
Chamelea gallina	<2	5
Chamelea gallina	>2	24
Corystes cassivelaunus ?	>1.5*	18
Corystes cassivelaunus ?	>1.5*	28
Echinocardium cordatum	>3	24
Ensis spp.	>10	11
Mactra corallina	>1	15
Phaxas pellucidus	>1.5	17
Sandy sediments		
Lunatia catena	<1.5	39
Ophiura texturata	>0.5**	7
Spisula solida	>1	24
Spisula subtruncata	>1	19
Thia scutellata	>0.5*	19
Silty sediments		
Abra alba	>0.5	25
Aphrodita aculeata	>7	21
Arctica islandica	>8	11
Astropecten irregularis	>2.5	14
Corystes cassivelaunus juv.	<1.5*	30
Dosinia lupinus	>0.5	26
Gari fervensis	>2.5	35
Pelonaia corrugata	>1	14
Turritella communis	>1.5	13

*carapax width; **disc diameter

9.3 Reaction of Benthos to Discards to the Seabed

A review of the instantaneous reactions of "marine carrion and scavengers" has been made by Britton and Morton (1994). Their main conclusions were:

- In the marine environment there are more facultative than obligate scavengers.
- Lysianassid amphipods and nassariid gastropods are near to "real" scavengers. *Orchomene nanus* and *Scopelochirus hopi* were found to feed mainly on crustacean carrion (Groenewold and Fonds, 2000).
- Human-generated carrion (e.g., fish discards) provides a significant food source for a variety of opportunistic scavengers, e.g., buccinid whelks and portunid crabs. Fonds and Groenewold (2000) calculated that the additional energy generated by fishing activities is only enough to provide 7 % of the maximum food demand of the entire scavenger population, both fish and invertebrates, in the Dutch sector of the southern North Sea. The importance may be relatively greater for fish than for invertebrates. It is suggested that beam trawling leads to shortcuts in trophic relationships and therefore may enhance secondary production.
- Among the polychaetes, there are omnivorous and detrivorous species which, at least in part, rely on either carrion or animal detritus.
- Macrophagous scavenging is a principal feeding habit of the gastropod families Buccinidae, Melongidae and especially Nassariidae.
- Among the arthropods, the isopod families Cirolanidae and Idoteidae include many fish predators, but also carrion-feeders; amphipods also, scavenge. More recently, Groenewold and Fonds (2000) found *Liocarcinus holsatus*, *Pagurus bernhardus*, *Asterias rubens* and ophiuroids to be the main active scavengers attracted to different kinds of bait in the southern North Sea.

Comparison of historical benthos data from the beginning of the last century with the data of the North Sea Benthos Survey in 1986 indicated that scavenger and predator species are more frequently observed at present (Rumohr and Kujawski, 2000). However, as the total amount of carrion produced by fishing activities only accounts for less than 10 % of food consumption by scavenger populations in the benthic community, Lindeboom and de Groot argue that it is unlikely that fishing activities could lead to larger populations of scavenging species.

9.4 Contribution to Total Oxygen Consumption

Based on the total amounts of discards and offal as given in the tables above, the additional flux of carbon to the seabed can be estimated at about 0.02 g C/m^2/year in the northern North Sea, and 0.35 g C/m^2/year in the southern North Sea. The community carbon demand (estimated from oxygen consumption) in both areas is respectively 10 and 60 g C/m^2/year. Thus, the supply from discards and offal is insignificant: 0.2–0.5 % of the community demand. The same applies to the effect on oxygen consumption. The same conclusion has been made for the Baltic Sea (ICES, 2000): dumping of fish offal contributes 0.05 % to the total oxygen consumption.

Direct mortality in the trawl path also plays an insignificant role in the total oxygen consumption, as all moribund invertebrates are consumed within a few days (Groenewold and Fonds, 2000).

9.5 Recommendations for Future Research

Possible effects of bottom trawling on benthic communities, either proven or not proven, have been summarised in the 1999 WGECO report as follows:

Table 9.5.1. Effects of bottom trawling.

	Gears, fleets and physical impacts	Direct mortality	Comparison of disturbed and undisturbed areas	Long-term studies
A) HABITATS				
Bottom trawls can remove some physical features	YES	N/A	YES	YES
Bottom trawling can cause a reduction in structural biota	YES	N/A	YES	YES
Bottom trawling can cause a reduction in complexity	YES	N/A	YES	NO
Bottom trawling can cause a reduction in the physical structure of the sea floor	YES	N/A	YES	NO
B) SPECIES				
Bottom trawling can cause a reduction in the geographical range of a species	N/A	N/A	NO	YES
Bottom trawling can cause a decrease in populations which have low rates of turnover	N/A	NO*	YES	YES
Bottom trawling is patchy and can cause fragmentation of populations	N/A	N/A	YES	NO
The relative abundance of species is altered by bottom trawling	N/A	YES	YES	YES
Fragile species are more affected by bottom trawling than robust species	N/A	YES	YES	NO
Surface-living species are more affected by bottom trawling than deep-burrowing species	N/A	YES	NO	NO
Bottom trawling can have sub-lethal effects on individuals	N/A	YES	YES	YES
Bottom trawling can cause an increase in populations which have high rates of turnover	N/A	NO*	NO	YES
Bottom trawling favours populations of scavenging species	N/A	YES	YES	YES

N/A: indicated these effects are not applicable to this study type
NO: no evidence was found during the review of IMPACT and other studies
YES: evidence was found during the review of IMPACT and other studies

The BEWG makes the following amendments/comments:

- The direct mortality studies were not designed to give answers about longer-term trawling impact on populations with low or high rates of turnover, so NO in the table above should be N/A (see *).
- The accumulated evidence on direct mortality and indications for long-term changes in species composition and distribution offer sufficient grounds for concern on the sustainability of the benthic system.
- It is proposed to add sediment resuspension to the list of effects of bottom trawling. Field observations by BEWG members showed otter trawling to cause significant turbidity in deeper waters of the northern North Sea. Possible effects could be the clogging of the filter-feeding apparatus or enhanced turnover and release of nutrients.
- It is recognised that there is a lack of hard evidence for many of the supposed long-term effects of bottom trawling. Due to the present extent and intensity of bottom trawling in the southern North Sea, studies other than ones focusing on direct effects are difficult or impossible to accomplish. The BEWG, therefore, recommends the designation of a closed study area—the dimensions to be further negotiated—devoted to measuring long-term effects.
- The initiation is recommended of autecological studies on the life history (reproduction, recruitment, growth) of species that are likely to be affected by bottom trawling.
- Initiatives are recommended towards modelling of long-term effects of bottom trawling using life history information.

References

Bergman, M.J.N. & J.W. van Santbrink, 2000. Mortality in megafaunal benthic populations caused by trawl fisheries on the Dutch continental shelf in the North Sea in 1994. ICES J. Mar. Sci. 57: 1321–1331.

Britton J.C. & B. Morton, 1994. Marine carrion and scavengers. Oceanogr. Mar. Biol. Ann. Rev. 32: 369–434.

Camphuysen, C.J., K. Ensor, R.W. Furness, S. Garthe, O. Hüppop, G. Leaper, H. Offringa & M.L. Tasker, 1993. Seabirds feeding on discards in winter in the North Sea. EC DG XII research contract 92/3505. NIOZ Rapport 1993–8, Netherlands Institute for Sea Research, Texel. 140 pp.

Camphuysen, C.J. *et al.*, 1995. Consumption of discards by seabirds in the North Sea. EC DG XIV research contract 92/3505. Final report.

Fonds, M. & S. Groenewold, 2000. Food subsidies generated by the beam-trawl fishery in the southern North Sea. In: Kaiser, M.J. & S.J. de Groot (eds.). Effects of fishing on non-target species and habitats. Biological, conservation and socio-economic issues. Blackwell Science, pp. 130–150.

Garthe, S., K. Camphuysen, R.W. Furness, 1996. Amounts of discards by commercial fisheries and their significance as food for seabirds in the North Sea. Mar. Ecol. Progr. Ser. 136: 1–11.

Groenewold, S. & M. Fonds, 2000. Effects on benthic scavengers of discards and damaged benthos produced by the beam-trawl fishery in the southern North Sea. ICES J. Mar. Sci. 57: 1395–1406.

ICES 2000. Report of the ICES Advisory Committee on the Marine Environment, 2000. ICES Cooperative Research Report, 241: 91–95.

Lindeboom, H.J & S.J. de Groot. IMPACT-II. The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. NIOZ-Rapport 1998–1 / RIVO-DLO Report C003/98.

Rumohr, H. & T. Kujawski, 2000. The impact of trawl fishery on the epifauna of the southern North Sea. ICES J. Mar. Sci. 57: 1389–1394.

10 ADVICE ON QUALITY ASSURANCE PROCEDURES FOR BENTHOS STUDIES [TOR: A]

10.1 Report of the ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements in the NE Atlantic Area (SGQAE)

H. Rees updated the BEWG on the meeting of the SGQAE in February 2001 in Copenhagen.

Themes of special importance included:

- Setting the agenda for future SGQAE activity;
- Seeking to establish an effective merger with SGQAB on matters of common interest;
- Considering means to enhance its influence (to practical effect) both in relation to ICES/OSPAR and the wider European context;
- Producing a final draft of QA guidelines.

These were all issues of high priority, but special attention was given to the last item.

10.2 Review of Final Draft of General Guidelines for QA for Biological Monitoring in the OSPAR Area

The available final draft provides general guidelines. The BEWG felt that there was no need for significant additions. Further comments, if any, on the draft QA guidelines from BEWG members are invited and should be sent to H. Rees before November 2001.

BEWG members also provided useful comments on a draft questionnaire concerning QA/AQC activities in the ICES/OSPAR area, which is to be circulated by SGQAE later in 2001.

10.3 Related Matters

H. Rumohr reported on the results of the BEQUALM macrobenthos ring test in 2000. The data are now ready for a final report that will be distributed to the participants before summer 2001. The results show different outcomes for the sorting efficiency of the 17 labs (19 participants), and significant variability in the success of identification at the species level. However, most laboratories correctly identified specimens at the genus level. The results are, however, in good agreement with similar results from a NMBAQC study from the UK. Since most of the participants were from German labs, the issues arising from the ring test will be discussed at a workshop in Berlin in autumn 2001 that will be hosted by the German authority responsible for organising a national ring test in 2001. BEQUALM ring test participants from other countries will also be invited to take part, to plan future activities.

M. de Kluijver reported on the progress of the ETI CD-ROM series for identification of benthic species, which is under development. The CD-ROMs facilitate the identification of macrobenthic organisms (1 mm and larger) in the North Sea (to a depth of 100 m). Currently, Volume I – Keys to Mollusca and Brachiopoda (525 species) and Volume II – Keys to Polychaeta, Nemertina, Sipuncula, Platyhelminthes and miscellaneous worm-like groups (651 species) are available. Besides pictorial keys, these CD-ROMs contain introductions to different taxa, hyperlinked glossaries, illustrated species descriptions, synonyms, literature and taxonomic sections. In addition, the Mollusca contain a “MapIt” (a modified GIS) module, while for the Polychaeta a text key and an “Identify it” to higher taxa is given.

The volumes on Crustacea and remaining animal groups are scheduled for the end of 2001. For the algae only a checklist with all synonyms is being prepared at this moment.

In a parallel project, two CD-ROMs—one dealing with the zooplankton and the second with the phytoplankton of the North Sea—are under development. In total, this series will cover 4500–5000 North Sea species.

The CD-ROM series will be used as a validation tool for the North Sea Information System (NIS), which is being developed. This system is a joint action of ETI and AquaSense (both in Amsterdam) and is server based. ETI is responsible for the biological part and AquaSense for the software development. This system enables the storage of large sets of biotic and abiotic data. The user will be able to select a subset of the data and import new data. After validation of the species names of the added data, the sets will be merged and stored to a temporary file. This file can be exported or used for statistical analyses. After an inverse analysis, the results will be displayed in a visualisation model.

11 GUIDELINES FOR SAMPLING AND DESCRIPTION OF EPIBIOTA, INCLUDING QUALITY ASSURANCE

A sub-group was set up to discuss and work on the guidelines. The contents of the draft guidelines are given at Annex 7.

H. Rees will circulate an updated draft to contributors, for further intersessional work. The BEWG will discuss progress at its 2002 meeting, and intends to produce a final draft by then to be published in the ICES TIMES series. H. Rees will contact ICES with respect to procedures regarding the publication of a TIMES report.

12 HABITAT MAPPING AND HABITAT DESCRIPTION OF BENTHIC COMMUNITIES, AND VERIFICATION OF THE EUNIS CLASSIFICATION [TOR: E]

The BEWG was asked to provide guidance on habitat mapping and the description of benthic communities and, in this connection, to contribute to the verification of the EUNIS habitat classification, together with the ICES Working Groups on Marine Habitat Mapping (WGMHM) and on Effects of Extraction of Marine Sediments (WGEXT). The BEWG considered it appropriate to provide comments on the ongoing development of EUNIS (the European Environment Agency's European Nature Information System) and the work on habitat mapping by WGMHM from the perspective of benthic community information and in relation to activities within BEWG, particularly the North Sea Benthos Project.

The latest proposals for the EUNIS marine habitat classification developed by the European Environment Agency were made available to the BEWG (Davies and Moss, 2000; paper presented to WGMHM, Galway, April 2001) for evaluation. David Connor explained the background and current status of development of the classification:

- The EUNIS classification (http://mrw.wallonie.be/dgrne/sibw/eunis/home.html [codeword EUNIS]) aimed to provide a comprehensive classification of habitats for European waters (together with a classification of terrestrial and freshwater habitats). The classification is presented in a hierarchical scheme of five levels from very broad (e.g., subtidal sediments) to much finer detail (e.g., particular seagrass communities).
- The EUNIS classification has been developed from the BioMar classification for Britain and Ireland (www.jncc.gov.uk/mermaid), the Barcelona Convention classification for the Mediterranean, and the HELCOM (Helsinki Convention) classification for the Baltic. It has been further refined through expert input at two OSPAR/ICES/EEA workshops, in Oban in 1999 (IMPACT 99/4/Info.2) and Southampton in 2000 (BDC 00/6/Info.1). The results of the Southampton workshop were now reflected in the EUNIS paper presented to WGMHM in Galway.
- Progress in development of the classification system was reported to the OSPAR Biodiversity Committee in November 2000 (BDC 00/6/4), at which it was recognised that the classification needed further refinement (particularly at levels 4 and 5) to ensure that it could be used in a fully operational way. OSPAR agreed to undertake a detailed review of scientific literature to provide the necessary detail. Contracting Parties to OSPAR will undertake this review over the coming year, with a view to integrating the information and further refining the EUNIS classification. It was noted that the BioMar classification had been developed through the detailed multivariate analyses of a large data set of biological samples, but that such an approach was currently considered unachievable at an OSPAR scale. In addition, OSPAR recognised the need for, and encouraged the development of, habitat maps to facilitate improved management of the marine ecosystem.

Although BEWG was able to only briefly examine the proposed EUNIS classification, it reiterated the value of developing such a classification scheme for marine habitats. In particular:

- The classification provided a means of consistently interpreting benthic sample data from different institutes and across different countries in the ICES area. This was particularly important in projects such as the North Sea Benthos Project.
- By integrating benthic community data with environmental factors (e.g., depth, substratum, currents), the classification provided an opportunity to improve our understanding of marine ecosystems.
- The development of a hierarchical classification was valuable in facilitating the integration of detailed biological data at the lower levels in the classification with broader habitat data from remote survey techniques at the higher levels in the classification. Additionally, the hierarchy facilitated communication of scientific information in a readily understandable manner to environmental managers.

After consideration of the current status of the EUNIS classification and of habitat mapping proposals with WGMHM, BEWG recommended the following:

- Further refinement of the EUNIS classification should be encouraged, and could be facilitated by testing of the classification in the North Sea benthos project.
- The integration of data from infaunal samples (e.g., from grabs) and epibiota samples (e.g., from video and trawls) remains a significant issue to be addressed in developing a satisfactory classification of sediment communities. More studies are required where data from the two perspectives (sampling approaches) are collected at the same sites to develop a better understanding of their interrelationship.
- The integration of benthic sample data with that from acoustic seabed surveys, seabed geology, bathymetry and hydrography in GIS systems should be pursued, both to develop marine habitat maps and to facilitate the spatial analysis of the different data sets.
- The strong temporal variation (related to, for example, changes in climate or human impact) of some benthic habitats and hence benthic communities needs to be considered when elaborating the lower levels of the EUNIS habitat classification. Such temporal variation, together with the limitations of performing large-scale mapping studies, suggests that the classification units should not be too specific. Maps demonstrating the "potential communities" within a particular habitat may be preferable to presenting very refined maps that represent specific communities valid only at one point in time (i.e., from one sampling event).
- Additionally, there is a need to specify those habitats which are regularly disturbed (e.g., estuaries occasionally receiving huge amounts of sediment from freshwater runoff; habitats that are periodically deoxygenated) and to distinguish these from similar habitats that remain more stable over time. The former will support more opportunistic communities compared with more stable habitats.
- To integrate data sets of different kinds (infaunal/epifaunal), different methods (acoustic/visual) and different approaches (biological/physical/geological), procedures (or guidelines) need to be developed. Furthermore, the scaling of different data sets should be taken into account. At an early stage the sampling techniques of institutions (countries) supplying such data sets should be proofed and only data sets with comparable methods should be selected. GIS should be the usual instrument (or tool) to join the data sets mentioned above. Correlations between biotic and abiotic factors and the identification of indicator species (*sensu* characteristic species for communities or impacts) should be carried out using multivariate statistical techniques.
- The ICES/OSPAR and ICES HELCOM Steering Groups on Quality Assurance of biological community measurements, along with the ICES Working Group on Marine Data Management, were identified as important sources of advice on the application of sound QA/QC procedures to data sets prior to their amalgamation. These groups may also provide a route for harmonisation of procedures with EC activities, especially in connection with the Water Framework Directive.
- H. Hillewaert expressed the concern of the WGEXT, who re-iterated that the proposed EUNIS classification system to level 3 required some alteration to make it consistent with the present understanding of geological environments, processes and seabed dynamics, and current terminology in use by the geological community. Remarks on this were made at the WGEXT meeting in April 2001 and recommendations on this matter were included in its annual report.

BEWG acknowledges the usefulness of work within WGMHM in producing a North Sea habitat map, as presented at Galway in April 2001, and advises WGMHM to take advantage of ongoing relevant initiatives on mapping and monitoring of North Sea benthic communities, in order to verify and improve the habitat map and the proposed classification.

The North Sea Benthos Project, currently being undertaken by a number of institutes, will provide a description of the benthic communities of southern and central parts of the North Sea by 2002. A workshop will be organised in Ostende in autumn 2001. The data source for the North Sea Habitat Map can be further expanded by taking into account the results from the long-term monitoring programmes of offshore petroleum activities, both in the British (UKOOA) and the Norwegian sectors of the North Sea.

References

Davies, C., & Moss, D. (2000). EUNIS habitat classification. Suggested implementation of proposals made at Southampton, September 2000. Centre for Hydrology and Ecology, Monks Wood, UK (Paper to ICES WGMHM, Galway, 3–6 April 2001. Version Feb01v3).

OSPAR (1999). OSPAR/ICES/EEA Workshop on Habitat Classification and Biogeographic Regions (Oban, 6–10 September 1999). OSPAR Commission, London (IMPACT 99/4/Info.2).

OSPAR (2000). Progress and future work on habitat classification and mapping. OSPAR Commission, London (BDC 00/6/4).

OSPAR (2000). Second OSPAR/ICES/EEA Workshop on Marine Habitat Classification (Southampton, 18–22 September 2000): Summary Record. OSPAR Commission, London (BDC 00/6/Info.1).

13 ANY OTHER BUSINESS

13.1 A.G. Huntsman Award in Marine Science

In his capacity as Chair of the A.G. Huntsman Foundation (based at the Bedford Institute of Oceanography, Dartmouth, Canada), BEWG member Dr D. Gordon had approached some senior members of BEWG for nominations for the annual A.G. Huntsman Award. This year the award is in the category of Biological Oceanography, which includes all aspects of marine science dealing with plankton, benthos, fish, marine mammals and ecosystems.

The BEWG unanimously agreed upon the nomination of Dr Tom Pearson of Seas Ltd., Oban, UK for the 2001 Huntsman Award in Marine Science because of his lifetime contribution to the fundamental and applied research on marine benthos. It was agreed that the Chair will forward the nomination by 30 April 2001.

13.2 Ecological Quality Objectives for Benthos

K. Essink informed the BEWG about a report "Towards Ecological Quality Objectives for North Sea Benthic Communities", which was produced recently by de Boer, Daniels and Essink (2001). The OSPAR Convention Annex V states the necessity to implement Ecological Quality Objectives (EcoQOs) for the protection and conservation of the ecosystems and the biodiversity in the marine waters of the OSPAR area. Related to this, at a workshop held at Scheveningen, The Netherlands, 1–3 September 1999, it was decided to develop EcoQOs on 10 issues. With a view to showing progress at the 2002 North Sea Conference, the Institute of Marine Research (Bergen, Norway) and the National Institute for Coastal and Marine Management/RIKZ (The Netherlands) took the initiative to work on EcoQOs regarding the following four issues:

- Benthic communities;
- Habitats;
- Reference points for commercial fish species;
- Threatened and declining species.

In January 2001 K. Essink was charged with the issue of Benthic Communities. The actual work was contracted out to an ecological research and consultancy firm, and had to be completed by 5 April. Because of the very tight time schedule it was decided to restrict the work to readily available publications and to involve a number of external specialists, among which members of the BEWG, for consultation. The responsible Steering Group had requested ICES to have the BEWG consider the report on EcoQOs for benthic communities, and to receive advice from ACME on all four issue-reports.

The BEWG took notice of the report by de Boer, Daniels and Essink, and made the following comments:

- Considering the limited time available, there was appreciation for the amount of literature information dealt with.
- Application of EcoQOs should be done rather on a local or regional scale than on a large spatial scale. This is especially relevant to situations of localised human influence, where the Ecological Quality Reference should relate to a reference situation outside the sphere of influence.
- In EcoQOs natural temporal dynamics should be taken into account.
- In this report, there seems to be an overemphasis of the impacts of fisheries activities. The output of contaminants from industrial developments and activities in general need more attention. Because in the field situation effects of separate contaminant compounds are hard to find, generic models for the effects of groups of contaminants need to be developed further, similar to the organic enrichment model for benthos developed by Pearson and Rosenberg.
- When considering benthic communities, one must realise that nowhere will single effects be operative. The integrated response of the communities will have value as an indicator of ecological quality, but when considering EcoQOs this will have its operational limitations.
- This report deals with the "health" of benthic communities, but pays no attention to the significance of quality of benthic communities in relation to being a food source for, e.g., fish and mankind. Contaminant levels in benthos may provide good indicators of environmental quality.

S. Dahle further commented that the oil industry is much more interested in the environmental impact factor of any component of contaminants released by their activities.

There was difference of opinion on the potential of using indices based on occurrence of functional groups in benthic communities. On the one hand side, it was argued that functional group composition may be independent of habitat. This may be true in cases of organic enrichment, and time series at local situations. On the other hand, it was stated that diversity of feeding types is strictly related to the nature of the habitat.

It was concluded that the report by de Boer *et al.* was a valuable contribution towards the development of EcoQOs, but that there exists a huge literature to be further consulted. Also, consultation and (re)analysis of large data sets will be necessary to bring this issue further.

13.3 Theme Session at the 2002/2003 ASC

The BEWG discussed the possibility of having a theme session (or mini-symposium) on benthic issues at a future Annual Science Conference. Agreement was reached on a theme with the provisional title of "The role of benthos as indicator of environmental quality". One element of justification is the use of benthos in relation to the further development and application of Ecological Quality Objectives. This proposal will be taken further at the Marine Habitat Committee (September 2001) and will be elaborated further at the 2002 meeting of the BEWG.

13.4 Publications of Interest

S. Smith informed the meeting of the publication of the "The 2000 Red List of Swedish Species". This report is issued simultaneously in Swedish and English and currently includes—next to terrestrial species—echinoderms, molluscs and larger crustaceans. In a next edition (in 6 years), polychaetes will also be included, hereby completing the project. The Red List can be ordered from SLU Publikationstjänst, Box 7075, 750 07 Uppsala (Fax + 46 18 672854; Tel. + 46 18 671100; e-mail: publikationstjanst@service.slu.se).

M. Zettler informed the BEWG on the Revision of *Marenzelleria* by Bick, Sikorsky and Bastrop at the moment in press. On the basis of both morphological and genetic characteristics 5 species are being described.

M. Zettler also referred to a book on "Aquatic Invasions in Europe" to be published by Kluwer Acad. Publ, and edited by Leppakoski, Olenin and Gollasch. One chapter in this book will give an update on European occurrence of the polychaete *Marenzelleria*.

13.5 Forthcoming Meetings

Attention was drawn to the following meetings of interest:

- Conference on drifting algal mats, Gothenburg, 7 May 2001 (info: Susan Smith)
- European Marine Biology Symposium, Menorca, September 2001
- ICES 2001 Annual Science Conference, Oslo, 26–29 September 2001. Submission of abstracts before 7 May 2001
- Food for thought: structuring factors of shallow marine coastal communities, NIOZ, Texel, 29–30 November 2001

13.6 Miscellaneous

H. Rumohr informed the group about increasing frustrations within the Baltic benthos research community about a perceived imbalance in the representation of Baltic affairs at BEWG. This was communicated to him by colleagues from Sweden and Lithuania. The Baltic colleagues plan to meet during a BMB conference in Stockholm in November 2001 to discuss further activities to foster the Baltic group connections. H. Rumohr will inform the Baltic colleagues about the BEWG meeting in Wimereux via an internet Forum that will be temporarily moderated by himself [hrumohr@ifm.un-kiel.de]. Information and comments are welcomed. Baltic benthos affairs were an important part of earlier BEWG work and effort was required to ensure that current activities were adequately represented. Discussions are needed on how to achieve this goal.

M. de Kluijver asked the BEWG members to send him species lists of ongoing research projects, to test the validation tools of the North Sea Information System presently being developed.

14 REPORT OF THE MEETING

14.1 Executive Summary

The Benthos Ecology Working Group (BEWG) met at Wimereux, France, from 17–21 April 2001. There were 25 participants representing Norway, Sweden, Germany, Estonia, The Netherlands, Belgium, France, United Kingdom and Spain. The following issues were covered.

North Sea Benthos Project

The progress of this project was reported. During 2000 various national surveys of benthos and epibenthos have covered a large proportion of the North Sea. In these surveys many of the stations of the 1986 ICES North Sea Benthos Survey were revisited. A few gaps will be filled in by sampling during 2001. Agreement was reached regarding the Flemish Marine Institute at Oostende to coordinate the collation of data and data management, including quality assurance routines. In autumn 2001 a meeting will be convened in Oostende to discuss details of data management, quality assurance, and data analysis.

Impact on the marine benthic system from fisheries (discards, offal, damage in the trawl path)

The BEWG reviewed the impact of trawling on the marine benthic system, i.e., from dumping of fish offal and fish discards, the dumping of invertebrate discards, and the damage and direct mortality in the trawl path due to bottom trawling gear. Information was extracted from, e.g., the IMPACT II report and from the EU REDUCE project.

Published data on annual production of fish offal and discards (fish and invertebrates) in the North Sea and NE Atlantic are not consistent. Roughly estimated 880—1200 tonnes of dead organic matter is discharged of which 200—450 tonnes reach the seabed. Especially for invertebrates, mortality in the trawl path is more important than the amounts discarded. This relates to the southern North Sea where flatfish fisheries are concentrated.

It was calculated that the extra input of dead organic matter to the seabed would make up 0.2–0.5 % of the total oxygen consumption by the benthic system, which is considered to be insignificant. A similar conclusion was reached for the Baltic Sea where the dumping of fish offal and discards contributes 0.05 % to the total oxygen consumption.

Also insignificant with respect to the total oxygen consumption is the direct mortality of invertebrates in the trawl path, as all moribund invertebrates are consumed by scavengers within a few days.

Quality assurance for benthos studies

The BEWG reviewed the final draft of General Guidelines on Quality Assurance for Biological Monitoring in the OSPAR Area, and felt that there was no need for significant additions. This was a request from the ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements in the NE Atlantic Area (SGQAE).

In the framework of the EU BEQUALM project a ring test on macrozoobenthos sorting and identification was held in 2000. The results were reviewed, and show good agreement with results from a NMBAQC study from the UK.

Progress was reported on the further development by ETI (Amsterdam) of CD-ROMs for the identification of benthic species from the North Sea.

Guidelines for sampling and description of epibiota

Intersessionally, as well as during the meeting, progress was made with actual writing of text for this report on sampling and community description of subtidal epifauna, including quality assurance. Intersessional work will be continued to produce a final draft in one year's time. The report will be published in the *ICES Techniques in Marine Environmental Sciences* (TIMES) series.

Marine habitat mapping, and verification of the EUNIS classification

The BEWG were asked to provide guidance on habitat mapping and the description of benthic communities, and in this connection, to contribute to the verification of the EUNIS habitat classification, together with the ICES Working Groups on Marine Habitat Mapping (WGMHM) and on Effects of Extraction of Marine Sediments (WGEXT).

The BEWG reiterated the value in developing the EUNIS classification for marine habitats. The classification provides a means of consistently interpreting benthic sample data from different institutes and across different countries in the ICES area. The hierarchical classification was found valuable in facilitating the integration of detailed biological data at the lower levels in the classification with broader habitat data from remote survey techniques at the higher levels in the classification. Additionally, the hierarchy facilitated communication of scientific information in a readily understandable manner to environmental managers.

The BEWG recommended further refinement of the EUNIS classification, integration of data from infaunal samples (e.g., from grabs) and epibiota samples (e.g., from video and trawls), integration of benthic sample data with that from acoustic seabed surveys, seabed geology, bathymetry and hydrography in GIS systems. The importance of strong temporal variation of some benthic habitats and hence benthic communities needs to be considered when elaborating the lower levels of the EUNIS habitat classification.

The BEWG acknowledges the usefulness of work within the WGMHM in producing a North Sea habitat map, and advises the WGMHM to take advantage of ongoing initiatives on mapping and monitoring of North Sea benthic communities, in order to verify and improve the habitat map and the proposed classification. The data that are being produced by the North Sea Benthos will expand the data source for the North Sea Habitat Map.

14.1.1 A.G. Huntsman Award in Marine Science

The BEWG unanimously nominated Dr Tom Pearson of Seas Ltd., Oban, UK for the 2001 Huntsman Award in Marine Science (Biological Oceanography) because of his lifetime contribution to the fundamental and applied research on marine benthos.

Ecological Quality Objectives for Benthos

The BEWG commented on a Dutch report "Towards Ecological Quality Objectives for North Sea Benthic Communities", which was based on readily available literature and was prepared for the North Sea Conference 2002. It was concluded that application of Ecological Quality Objectives (EcoQOs) should be done rather on a local or regional scale than on a larger spatial scale. Also natural temporal dynamics should be included in EcoQOs. Although nowhere will single human effects be operative on benthic communities, the integrated response of communities will have value as indicators of environmental quality, but this will have its operational limitations when considering EcoQOs.

14.2 Action List

1) Magda Bergman to report on further results from the EU Reduce project.

2) Gerard Duineveld to report on further results on studies on transport and settlement of larvae.

3) Jonne Kotta to report on benthic studies in Estonian waters, including effects of NAO and alien species.

4) Michael Zettler to report on benthos mapping and alien species in German Baltic waters.

5) Heye Rumohr to report on the outcome of the EU BEQUALM project and other QA matters.

6) Susan Smith to report on Swedish benthic research.

7) Ruth Zühlke/Jon Alvsvåg/Ingeborg de Boois to report on results of the North Sea epibenthos project.

8) Hubert Rees to report on the outcome of the SGQAE meeting.

9) Heye Rumohr to report on the outcome of the SGQAB meeting.

10) Hubert Rees to contribute on the use of time series for environmental impact assessment.

11) Santiago Parra to report on results of benthic studies in Ferrol Bay.

12) Salve Dahle to report on Norwegian/Russian studies near Franz Jozefland.

13) Torleif Brattegaard to report on results of mapping benthos along the Norwegian coast.

14) Salve Dahle/Sabine Cochrane to report on studies in Spitzbergen fjord.

15) Paul Kingston/Salve Dahle to report on studies regarding oil pollution and benthos.

16) Eivind Ough to report on effects of PAHs from Al-smelters on benthic communities.

17) Tom Gullikson to report on long-term changes in hard-bottom communities.

18) Mario de Kluijver to report on progress in CD-ROMs as an identification aid.

19) Ingrid Kröncke to report on investigations in the high Arctic deep sea.

20) Ingrid Kröncke to report on community relationships near Spiekeroog (Wadden Sea).

21) Jan Helge Fosså to report on Lophelia reefs: succession and conservation.

22) Heye Rumohr to report on the outcome of the Spisula project (EU PESCA).

23) Jan van Dalfsen to report on progress in ecotope mapping and on long-term recovery of benthos from sand extraction.

24) Hans Hillewaert to report on monitoring studies in Belgian waters.

25) Jan van Dalfsen/Hans Hillewaert to report from the WGEXT meeting.

26) Heye Rumohr/David Connor to report from the WGMHM meeting.

27) Michaela Aschan to report on long-term effects of scallop dredging in the Barents Sea.

28) Eike Rachor/Naumov to report on studies in the White Sea.

29) David Connor to report on further developments in habitat mapping.

30) Les Watling to report on US benthic studies.

31) Don Gordon c.s. to report on Canadian benthic studies.

32) Herman Hummel to report on achievements in the BIOMARE project.

33) Jean-Marie Dewarumez c.s. to report on French benthic research.

35) Jan Warzocha to report on further results of long-term data analysis in the southern Baltic.

36) Sigmar Steingrimsson to report on Icelandic benthic research.

37) Chris Smith to report on benthic research in Greece.

38) Members from Portugal, Lithuania, Latvia, Finland, Far-Oer to report on benthic research in their countries.

14.3 Recommendations for the 2002 Meeting

The Benthos Ecology Working Group (BEWG) recommended that it meet in Tromsø, Norway, from 24–27 April 2002 to:

a) produce a final draft of guidelines for epibenthos sampling and community description for publication in the ICES TIMES series;

b) report on the progress in the North Sea Benthos Project, including first results of data analysis;

c) review studies in northern seas in comparison with, e.g., the Baltic Sea and North Sea, with a view to gaining insights into ecosystem functioning, human impacts, and gaps in knowledge;

d) make preparations for a future theme session or mini-symposium at the ICES Annual Science Conference in 2003 or 2004, focusing on the role of benthic communities as indicators of marine environmental quality;

e) review further needs for quality assurance in benthic monitoring and research.

Justifications

a) this will conclude a BEWG activity of the past years;

b) the further guidance of the BEWG is needed for the continuation of the North Sea Benthos Project under the ICES umbrella. This work will contribute valuable validation of the EUNIS habitat classification;

c) a perspective on the benthic ecology of northern seas deserves more attention, e.g., in order to strengthen the advisory role of ICES. The review will also be relevant to OSPAR, ICES and EEA in relation to the extension of habitat mapping towards northern waters. The comparative nature of the review should allow wider appreciation of the influence of climate change in benthic communities;

d) a theme session (or mini-symposium) on this subject will allow the synthesis of state-of-the-art knowledge, which will contribute to the further development of operational ecological quality objectives for marine benthic communities [relevant to OSPAR];

e) It is necessary to build on

   i) the results of the BEQUALM project, as well as on national QA/QC programmes;

   ii) the experiences in integrating national surveys, especially in connection with the North Sea Benthos Project;

   iii) new developments in computer-based taxonomic identification aids, including the Web.

15 DATE AND PLACE OF NEXT MEETING

After having considered two options the BEWG proposed to have its 2002 meeting in Tromsø (Norway) from 24–27 April. The meeting will be held in the facilities of the Polar Environmental Centre. The availability of these facilities was checked during the meeting and confirmed. Effort will be made to attract more scientists working in Baltic and more northern waters.

16 CLOSING OF THE MEETING

K. Essink formally closed the meeting on 21 April at 12.15 hours, and expressed his thanks and appreciation to the staff of the Marine Station at Wimereux. The work of the three co-rapporteurs was acknowledged. K. Essink wished J.-M. Dewarumez a quick dismissal from hospital and subsequent further recovery. The meeting was concluded with an enjoyable excursion to the Cap Griz Nez - Cap Blanc area and a visit to the Nausica Marine Centre in Boulogne/Mer. Here, a delicious seafood meal was served, demonstrating excellent marine benthos quality.

ANNEX 1: LIST OF PARTICIPANTS

Name	Address	Telephone	Telefax	E-mail
Magda Bergman	Netherlands Institute for Sea Research (NIOZ) PO Box 59 1970 AB Den Burg-Texel The Netherlands	+ 31 222 369474	+ 31 222 319674	magda@nioz.nl
Ingeborg de Boois	Netherlands Institute for Fisheries Research (RIVO) PO Box 68, 1970 AB IJmuiden, The Netherlands	+ 31 255 564660	+ 31 255 564644	i.j.deboois@rivo.wag-ur.nl
David Connor	Joint Nature Conservation Committee, Monkstone House, City Road, Peterborough PE1 1JY UK	+ 44 1733 866837	+ 44 1733 555948	david-connor@jncc.gov.uk
Johan Craeymeersch	Netherlands Institute for Fisheries Research (RIVO-CSO) PO Box 77, 4400 AB Yerseke The Netherlands	+ 31 113 672306	+ 31 113 573477	j.a.craeymeersch@rivo.wag-ur.nl
Salve Dahle	Akvaplan-niva Polar Environmental Centre 9296 Tromsø Norway	+ 47 777 50300	+ 47 777 50301	salve dahle@akvaplan.niva.no
Jan van Dalfsen	TNO-MEP PO Box 57 1780 AB Den Helder The Netherlands	+ 31 223 638808	+31.223.630687	j.vandalfsen@mep.tno.nl
Jean-Claude Dauvin	Station Marine Université de Lille 1 28 avenue Foch 62930 Wimereux France		+ 33 321 992901	jean-claude.dauvin@univ-lille1.fr
Steven Degraer	University of Gent Dept. of Biology Marine Biology Section K.L. Ledeganckstraat 35 B-9000 Gent Belgium	+ 32 9 2465252	+ 32 9 2645344	steven.degraer@rug.ac.be
Nicolas Desroy	Station Marine Université de Lille 1 28 avenue Foch 62930 Wimereux France		+ 33 321 992901	nicolas.desroy@univ-lille1.fr

Name	Address	Telephone	Telefax	E-mail
Gerard Duineveld	Netherlands Institute for Sea Research (NIOZ) PO Box 59 1970 AB Den Burg-Texel The Netherlands	+ 31 222 369528	+ 31 222 319674	duin@nioz.nl
Karel Essink (Chair)	Rijkswaterstaat/RIKZ PO Box 207 NL-9750 AE Haren The Netherlands	+ 31 50 5331 373	+ 31 50 5340 772	k.essink@minvenw.rikz.nl
Hans Hillewaert	Sea Fisheries Department Ankerstraat 1 B-8400 Ostende Belgium	+ 32 59 342259	+ 32 59 330629	hhillewaert@unicall.be http://www.dvz.yucom.be
Herman Hummel	NIOO-CEMO PO Box 140 4410NT Yerseke Netherlands	+ 31 113 577484 + 31 113 577300	+ 31 113 573616	hummel@cemo.nioo.knaw.nl
Mario de Kluijver	ISP/ETI University of Amsterdam PO Box 49766, NL-1090 GT Amsterdam, The Netherlands	+31 20 525 6905	+31 20 525 5402	kluijver@science.uva.nl
Jonne Kotta	Estonian Marine Institute Marja 4d 10617 Tallinn Estonia	+ 372 6112949	+ 372 6112934	jonne@klab.envir.ee
Ingrid Kröncke	Forschungsinstitut Senckenberg Schleusenstrasse 39a D-26382 Wilhelmshaven Germany	+ 49 4421 947 532	+ 49 4421 947 550	ingrid.kroencke@sam.terramare.de
Jan Mees	Vlaams Instituut voor de Zee Victorialaan 3 B-8400 Oostende Belgium	+ 32 59 342130	+ 32 59 342131	jan.mees@vliz.be
Santiago Parra	Instituto Español de Oceanografia Centro Oceanográfico La Coruña Muelle de Ánimas s/n Apdo. 130 15001 La Coruña Spain	+ 34 981 205 362	+ 34 981 229 077	santiago.parra@co.ieo.es
Hubert Rees	Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Burnham Laboratory Remembrance Av. Burnham-on-Crouch Essex CMO 8HA UK	+44 1621 787200	+44 1621 784989	h.l.rees@cefas.co.uk
Heye Rumohr	Institut für Meereskunde Düsternbrooker Weg 20 D-24105 Kiel Germany	+49 431 597 3957	+49 431 597 3994	hrumohr@ifm.uni-kiel.de

Name	Address	Telephone	Telefax	E-mail
Wil Sistermans	NIOO-CEMO PO Box 140 4410NT Yerseke Netherlands	+ 31 113 577300	+ 31 113 573616	sistermans@cemo.nioo.knaw.nl
Susan Smith	National Board of Fisheries Dept. of Coastal and Freshwater Resources PO Box 423 S-401 26 Gothenburg Sweden	+ 46 31 743 0362	+ 46 31 743 04 44	susan.smith@fiskeriverket.se
Magda Vincx	University of Gent Dept. of Biology Marine Biology Section K.L. Ledeganckstraat 35 B-9000 Gent Belgium	+ 32 9 2645210	+ 32 9 2645344	magda.vincx@rug.ac.be
Michael Zettler	Institut für Ostseeforschung/ Baltic Research Institute Seestrasse 15 D-18119 Rostock Germany	+ 49 381 5197 236	`+ 49 381 5197 440	michael.zettler@io-warnemuende.de
Ruth Zühlke	School of Biological Sciences University of Wales Swansea Singleton Park Swansea SA2 8PP UK	+ 44 1792 295 448		bdzuhlke@swansea.ac.uk

ANNEX 2: AGENDA

1. Opening and Local Organisation
2. Appointment of Rapporteur
3. Terms of Reference
4. Adoption of Agenda
5. Report on ICES 2000 Annual Science Conference (Bruges, Belgium)
6. Report on meeting of ACME, and other meetings of interest
7. Report of cooperative studies and other studies relevant to ICES (including Action List of 2000 BEWG-meeting)
8. North Sea Benthos Project [ToR: b]
9. Review of the Impact on the Marine Benthic System in the ICES Area from:
   i) The dumping of fish offal and fish discards;
   ii) The dumping of invertebrate discards;
   iii) The damage in the trawl path due to bottom trawling gear [ToR: c]
10. Advice on Quality Assurance procedures for benthos studies [ToR: a]
11. Guidelines for epibenthos sampling and community description for publication in the ICES TIMES series [ToR: d]
12. Guidance to habitat mapping and habitat description of benthic communities, and verification of the EUNIS habitat classification [ToR: e]
13. Any other business
14. Report of the Meeting, Recommendations and Action List
15. Date and Place of next meeting
16. Closing of the meeting

ANNEX 3: BIOMARE: IMPLEMENTATION AND NETWORKING OF LARGE-SCALE LONG-TERM MARINE BIODIVERSITY RESEARCH IN EUROPE.

By Herman Hummel and Carlo Heip

Centre for Estuarine and Coastal Ecology, Netherlands Institute of Ecology (NIOO-CEMO)
Royal Netherlands Academy of Arts and Sciences
Korringaweg 7, 4401 NT Yerseke

Phone: +31–113–577484 (577300), fax: +31–113–573616
E-mail: hummel@cemo.nioo.knaw.nl

The EC concerted action (CA)(5th FW, theme 4 "Energy, Environment and Sustainable Development") BIOMARE was started in November 2000 to establish the infrastructure and conditions required for marine biodiversity research at a European scale. It will last 2 years and includes 21 actively participating European institutes.

Consensus had grown that concertation and coordination at European scale is urgently required to implement long-term and large-scale marine biodiversity research and to plan the adequate use of the European research infrastructure. Many research questions cannot be addressed at local scales and require cooperation and the establishment of a committed network of scientists and institutes. There is no agreed common methodology for many aspects of biodiversity research; this needs careful preparation.

The objectives of the Concerted Action are to achieve a European consensus on the selection and implementation of:

1. A network of Reference Sites as the basis for long-term and large-scale marine biodiversity research in Europe,
2. Internationally agreed standardised and normalised measures and indicators for (the degree of) biodiversity,
3. Facilities for capacity building, dissemination and networking of marine biodiversity research, by a) workshops, b) improving training and mobility, c) an internet website including an overview of ongoing research programmes and existing infrastructure for marine biodiversity research in Europe, d) a database on reviewed and evaluated, available data, aiming at employing data for socio-economic questions such as the impact of fisheries or tourism.

The objectives will be complemented through 3 Workpackages, consisting of a series of evaluations, recommendations, regional meetings and joint workshops.

The methodology in each of the Workpackages is similar, following a sequence of:

1. Inventories and reviews made by Workpackage leaders consulting all members,
2. Regional meetings and a general workshop to discuss drafts and recommendations,
3. Reports and implementation.

The inventories, meetings and reports will focus on:

1. Expanding the existing networks of marine biodiversity research organisations,
2. Establishing a rationale and recommendations for selection of reference sites for marine biodiversity research,
3. Establishing a series of methodologies, protocols, and putative indicators of marine biodiversity in Europe,
4. Publishing an annotated checklist of available long term data sets, species diversity lists, and associated publications,
5. Initialising a Euroconference on marine biodiversity,
6. Establishing a website for dissemination of European marine biodiversity information to scientists, administrators and the public at large,
7. Indicating data available to end-users, suitable for integration with socio-economic questions.

The Concerted Action will enhance Marine Biodiversity Research in Europe through a network of marine institutes establishing an agreed series of reference stations and indicators. This allows inter-site comparisons and long term surveys, maximises the integration of efforts in marine biodiversity research at pan-European scale for students, researchers and managers dealing with socio-economic questions, and increases the awareness of the public.

ANNEX 4: UK STUDIES IN CONNECTION WITH DREDGED MATERIAL RELOCATION AND AGGREGATE EXTRACTION

by Hubert Rees (CEFAS)

1 Dredged material

Licenses for the disposal of wastes to sea from ships are issued by the UK Ministry of Agriculture, Fisheries and Food under the Food and Environment Protection Act (1985). The role of the Centre for Environment, Fisheries and Food (CEFAS) is to provide scientific advice to MAFF on the suitability of the material for sea disposal at the application stage and, once a licence is granted, to check that licence conditions are met and that no unexpected effects occur.

There are over 100 sites licensed for sea disposal around the England and Wales coastline, and the approach to field evaluation has been to target a small suite of larger arisings which are considered to be representative of the wider activity, although surveys at sites of special concern are periodically conducted, irrespective of the amounts disposed of. The outcome of surveys to date has been reported in a variety of publications. A multidisciplinary approach is adopted, and a survey typically involves acoustic methods for ground discrimination (especially sidescan sonar and precision bathymetry) accompanied by grab sampling for later analyses of the physico-chemical properties of sediments, and the macrofaunal and (more recently) the meiofaunal component of the benthos.

The Roughs Tower disposal site in the outer Thames estuary provides a good example of the above approach. This site consists of a complex of locations which have been designated over the years to deal with dredged material from various sources, and in varying quantities and nature. Over the last 15 years, annual quantities have fluctuated about a mean of 3.25 million wet tonnes. Regular input of maintenance dredgings has periodically been augmented by capital arisings from port developments at Harwich and Felixstowe on the English east coast, especially in 1994 and, most recently, in the 1999/2000 period, when over 10 million tonnes were deposited (see below). Until 1996, the site was also used for the disposal of sewage sludge.

The disposal site is located in shallow water (10–20 m depth) and is characterised by moderately strong tidal currents (>2 knots on springs) and periodic exposure to the influence of wave action at the seabed. From time to time, concerns have been expressed about the dispersive capacity of the site, especially in relation to the larger capital arisings, and also about the settlement of finer material in the vicinity. This has been a particular concern for commercial fishermen engaged in potting for shellfish in the vicinity. As a result, the large capital disposal operation in 1999/2000 was followed by effective closure of the site, with a new one to seaward opened for ongoing disposal of maintenance dredgings.

The 1999/2000 operation involved the controlled disposal of material within the confines of the site, aided by the initial construction of a bund to limit erosion. A sidescan sonar survey in 2000 indicated that the bulk of the material had remained on site in the immediate aftermath of disposal. The final part of the operation involved the sprinkling of a gravel layer to enhance the prospects for its use as a lobster habitat, and evaluation of the success of this aspect of the scheme is being conducted under the auspices of shellfish scientists at CEFAS.

Periodic grid surveys of the concentrations of trace metals (including TBT) in sediments have revealed occasional elevations in the vicinity of disposal but levels are much below those which would give rise to environmental concerns. This broadly conforms with expectation, given the relatively clean nature of the arisings, especially from capital works involving the dredging of underlying geological strata. (Higher concentrations of TBT have been found elsewhere, in association with the disposal of maintenance dredging from certain urbanised estuaries, and field and laboratory responses of the benthic macrofauna and meiofauna are the subject of a separate study.)

Sediments in the sampling area are typically heterogeneous in nature, with significant quantities of coarser material which are not well suited to sampling by Day grab. Recently, we have employed a Hamon grab along a transect through the disposal site, in order to determine the nature of impacts at and near to disposal, and to provide a reference point for events after the effective cessation of disposal activity. Initial findings conform with predictions concerning the effects of the disposal of relatively uncontaminated sediments. Aside from reductions in response to the smothering of the benthic fauna, the newly deposited material confers no special advantage to new colonisers, and there is no evidence of peripheral enhancement in opportunistic species. Demonstrable effects on the benthic fauna are confined to within and immediately adjacent to the disposal site, but no azoic sediments were encountered on this occasion. This transect has been repeated at intervals, most recently in June 2000, and will provide useful insights into any recovery process, as well as the stability of the material in the longer term. A comparison between 1995 and 1999 data shows a strong element of consistency in the pattern of response to disposal.

"BENEFICIAL USE" OF DREDGED MATERIAL

The scope of MAFF-funded work by CEFAS in this area is defined by the title of the project, namely "Implications of the nature and quality of dredged material for its beneficial placement in the coastal environment". Its aims are not only to provide new insights into the consequences of a variety of "beneficial use" schemes in the UK, but also to define a context for this activity in the wider domain of dredged material relocation. Thus the activity, whether directed at estuarine restoration schemes or to conventional sea disposal routes, may be viewed along a continuum of environmental costs and benefits. It may therefore be as unreasonable to assume that the former are necessarily in all cases "beneficial", as it would be to dismiss all conventional sea disposal activity as "adverse". The recent Roughs Tower activity (above) may yet provide a useful exemplar of an enlightened ("beneficial") offshore route, and hence contribute to a more rounded or "holistic" approach to the decision-making process.

During the first year of the project, CEFAS has initiated research reviews to better define a framework for the scientific testing of hypotheses for environmental change through field and laboratory study. A series of site visits to existing and planned estuarine "beneficial use" schemes have also been carried out, in close liaison with the Environment Agency which, in England and Wales, also has extensive interests in this activity, both from an environmental and flood defence perspective. CEFAS has also commenced a nation-wide survey of the physical characteristics and organic content of dredged material at source, to improve the capability to predict environmental consequences.

CEFAS are also in the process of identifying data sets, especially from UK sources but more widely if readily accessible, with a view to a combined analysis of benthic responses to dredged material disposal, in collaboration with the Plymouth Marine Laboratory. Plans are also being developed for complementary (CEFAS and Hull University) field and laboratory evaluations of the responses of the benthic macrofauna and meiofauna to dredged material deposition, again with the aim of enhancing predictive capability. Finally, a web site is under construction, in order to provide a forum for scientific exchange among the many UK organisations with an interest in this topic (entitled DECODE: "Determination of the Environmental Consequences of Dredged Material Emplacement").

2. Aggregate extraction

The extraction of marine aggregates (sand and gravel) provides a significant source of material for the construction industry in the UK, as well as servicing a variety of sea defence initiatives (e.g., beach replenishment). To date, extraction licences have centred mainly on locations along the English east and south coasts where significant reserves of material have been identified. This has given rise to increasing levels of concerns over environmental and fisheries impacts, and applications for new licences are now routinely accompanied by formal Environmental Statements. An important driver for recent scientific studies is also provided by the imminent implementation of a new statutory framework for the regulation of the activity by the UK Department of the Environment.

CEFAS scientists have been engaged in studies at aggregate extraction sites for a number of years. Recently, these have included:

a) Evaluation of cumulative impacts. This study (funded by the UK Ministry of Agriculture, Fisheries and Food and the Crown Estates Commission, who own the coastal seabed) has concentrated on field surveys of the benthic fauna, sediments and fish-feeding activities at two contrasting locations off the English east and south coasts which are notable for the occurrence of clusters of licensed sites which yield significant quantities of material for the industry. Accompanying this fieldwork has been an appraisal of the interaction of an array of other factors (natural and man-made) which, in combination, have the potential to lead to environmental effects arising from aggregate extraction which are greater than the sum of the individual sources of impacts. The work therefore addresses a wider policy need for the adoption of an integrated approach to the regulation of coastal developments.

b) Determination of the "rehabilitation" of seabed sediments following the cessation of aggregate dredging. Earlier CEFAS work provided useful information on the progress of "recovery" of a dredged location following controlled experimental dredging off the English east coast. However, little information is available on the "reality" of conditions after the event of several years of commercial extraction at various sites around the UK coast. Such information should provide the ultimate test of the acceptability and longevity of environmental impacts arising from the activity, as well as an indication of appropriate measures which might be taken to mitigate any adverse consequences. As a result, a project (funded by the UK Department of the Environment and the Ministry of Agriculture, Fisheries and Food) has commenced on an examination of target locations which represent different effective dates of cessation of dredging. The recent advent of Electronic Monitoring Systems ("Black Boxes") aboard dredgers allows relatively precise targeting of historical dredging activity within licensed areas and hence facilitates field evaluations of environmental effects (see below). However, prior to this, the information is less reliable but improved by the cooperation of dredging firms, including the provision of results from resource surveys before and after the event of dredging.

During the first year of the project, CEFAS has drafted a research review for publication, covering the biological effects of aggregate dredging. This has provided a hypothesis-testing framework for field sampling activity in 2001 and beyond, and a variety of sites have been targeted for investigation. The results from preliminary sampling indicate that, depending on location and intensity, the effects on the benthic fauna arising from dredging activity may be longer than might have been anticipated from earlier experimental work. More extensive sampling activity will be necessary in order to confirm this initial finding.

c) Habitat mapping as a tool in the evaluation of coarse substrata and the associated biota. This MAFF-funded project involved the assessment of a variety of acoustic and visual methods for ground discrimination, along with extensive "groundtruthing" of sediments and the associated benthic fauna, using conventional sampling techniques. The study addressed the efficiency with which wider areas of seabed may be characterised on the basis of this combination of survey methodology, and particular attention was paid to the implications of spatial scale and patchiness in the investigated areas, principally along the English south coast. A GIS is under construction, incorporating the results from this study, along with other information, including that from geological and commercial fish population surveys. The study has recently been extended to allow an evaluation of the effects of man-made disturbances, including those arising from aggregate extraction, dredged material disposal and demersal fishing activity.

d) Guidelines for the conduct of benthic surveys at aggregate extraction sites. This project (funded by the UK Department of the Environment) arose from the need to provide written guidance to the industry and their consultants on current approaches to the conduct of surveys in areas of coarse substrata, so as to improve the quality of scientific work carried out in connection with the production of Environmental Statements. The guidelines should also have a more general value in providing a summary of current practices, and likely future developments, for the benefit of other scientists engaged in R&D and regulatory monitoring activities. A draft has been produced and is under review, prior to publication.

ANNEX 5: HITCHHIKING ON INTERNATIONAL BOTTOM TRAWL SURVEYS IN THE NORTH SEA: A EUROPEAN EPIBENTHIC MONITORING PROJECT

Ruth Zühlke[1,2], John Alvsvåg[4], Ingeborg de Boois[5], John Cotter[1], Hilmar Hinz[3], Simon Jennings[1], Ingrid Kröncke[3], John Lancaster[2], Gerjan Piet[5], Philip Prince[6]

[1] CEFAS, Lowestoft, England, [2] University Wales Swansea, [3] Forschungsinstitut Senckenberg, Germany, [4] IMR, Bergen, Norway, [5] RIVO, IJmuiden, Netherlands, [6] DIFR, Hirtshals, Denmark

From 1995 to 1998 methods to systematically survey the epibenthos of the North Sea using 3rd quarter International Bottom Trawl Surveys were developed in the framework of a EU project. In 1999 and 2000 these methods were applied by five European countries and epibenthic samples were taken at about 250 stations each year covering 140 ICES rectangles.

Effects of sieve mesh-size

With increasing time and financial pressure benthic surveys demand a sampling design that is efficient without compromising the scientific objectives. One method to speed sample processing is to increase the sieve mesh-size.

The objective of this study was to identify the effects of different sieve mesh-sizes on processing time, the number of species retained, diversity measures and multivariate community analysis. Samples were collected at 63 sites throughout the North Sea and washed through two successive sieves, the first with 10 mm and the second with 5 mm mesh.

Processing time for whole samples (5 mm and 10 mm fractions) took 91±25 minutes compared with 55±16 minutes for the 10-mm mesh fraction. Altogether, 40 % of free-living species and 9 % of attached species were recorded solely in the 5 mm fraction. However, spatial gradients of species diversity and community structure were almost identical, independent of the mesh-size used.

We conclude that the use of coarser sieving mesh would save time and money, if the aims of a North Sea epibenthos survey were to describe broad patterns of community structure and relative diversity. It would be possible to process approximately 50 % more samples, if the time saved with 10-mm mesh were allocated to additional sampling. However, if information on individual species is desired, then sorting with the finer sieve mesh will yield crucial information. It was decided to employ a 5 mm mesh for epibenthic samples of the North Sea.

Epibenthic fauna in the North Sea (1999 and 2000)

Epibenthic fauna was clearly divided between the southern North Sea and the central-northern North Sea, roughly along the 50 m depth line. The separation was based on an overall higher number of species in the central and northern North Sea and a change in the species composition from north to south.

Sessile fauna including erect, branching species like bryozoans and hydrozoans were particularly diverse along a corridor in the central-northern North Sea between 56°N and 58°N, coinciding with the area between the 50 m and 100 m depth line. Cluster analysis, based on the structure of the community, confirmed the north-south gradient found for species diversity. Separation of clusters was driven to a great extent by species occurring predominantly or exclusively north of the 50 m contour line. Few species were exclusive to the south, but a number of scavenging species were found here more frequently and in higher numbers.

Depth was positively correlated with the community structure, whereas the type of sediment showed no significant relationship with variations in the epibenthic community structure or numbers of species. Beam trawling effort was negatively correlated with the diversity of sessile fauna.

ANNEX 6: NORTH SEA BENTHOS PROJECT 2000/2001

Institute/persons	Programme in 2000	2001 + comments
1 AWI/Senckenberg (Rachor/Kröncke)	Area: German sector of North Sea +Dogger Bank Period: June 2000 Stations: 120 (van Veen) + 96 (box core) Gear: Van Veen, Box Core Sieve: 1 + 0.5 mm Extra: 2 m beam trawl (5 mm mesh in the cod-end) Sediment: Extra survey in 2001 + video/still photos (in stony areas)	Additional sampling at Borkum Riff and Amrum Bank
2 Rijkswaterstaat (Essink *et al.*)	Area: Dutch Continental Shelf Period: April–May 2000 Stations: 125 (one core per station) Gear: Box Core (NIOZ) Sieve: 1 mm Extra: sediment samples	Extra ICES stations possible in 2001 by TNO??
3 NIOZ, Texel (Bergman *et al.*)	Area: Frisean Front Period: 2000 Stations: …….. Gear: Box Core Sieve: 1 mm Extra: sediment samples triple-D and beam trawl?	
4 Fisheries Research Station (Hillewaert)	Area: Belgian Continental Shelf Period: March 2000 Stations: 20 (10 replica/station) Gear: Van Veen (0.1m²) Sieve: 1 mm Extra: Sediment, epibenthos (8 m beam trawl with 22 mm mesh in cod-end)	Repeated sampling in March 2001
5 University Gent (Degraer, Vincx)	Area: Belgian Contin. Shelf/Sandbanks Period: February/March 1997–1999 Stations: 700 (in total) Gear: Van Veen (1 replicate/station) Sieve: 1 mm Extra: Sediment, org. matter, STDC meio/epi/hyperbenthos	
6 Station Marine de Wimereux (Dewarumez/Dauvin)	Area: Coastal zone + grid in eastern Channel Period: March 2001 Stations: 80 + 140 (2 replicates) Gear: Hamon / Van Veen Sieve: 1 mm Extra: Sediment (+ beam trawl ?)	Extra samples in 2001?
7 France (rv "Thalassa")	Area: Southern North Sea Period: February 2001 Extra: Benthos (during night)	Benthos samples taken during the International Bottom Trawl Survey (IBTS)
8 CEFAS, B-o-C (Rees *et al.*)	Area: English waters in North Sea up to Scottish boarder Period: May/June 2000 Stations …… Gear: Day grab or Box Core Sieve: 1 mm Extra: Sediment, meiofauna, beam trawl?	To be completed in May–June 2001
9 CEFAS, Swansea (Zühlke *et al.*) + N-UK-D-NL-DK	Area: North Sea (E. Channel - N. Shetland) Period: July–October 2000 Stations: 250 in 140 ICES rectangles Gear: 2-m beam trawl, 4 mm mesh in cod-end Sieve: 5 mm Extra: 5 fixed stations with 6 replicates within 1 square mile	Programme on epifauna Same sations also sampled in 1999
10 BfG-Koblenz (Nehring/Leuchs)	Area: German North Sea estuaries Period: October annually Stations: 26 (along salinity gradient) Gear: Van Veen, 6 replicates/station Sieve: 0.5 mm option: 1 mm at outer stations	

Institute/persons	Programme in 2000	2001 + comments
	Extra: Kieler Kinderwagen dredge sediment samples	
11 Bund-Länder Messprogramm	Area: Coastal area Sylt (W.Armonies) Stations: …….. Gear: …….. Sieve: …….. Extra: ……..	
12 Geotek (Kingston/Hugget)	Area: North Sea c.a.	New programme
13 Akvaplan-niva (S. Dahle)	Area: Norwegian sector North Sea Period: Since 1989 Stations: 350 (around oil platforms; 5 replicates/ station) Gear: Van Veen Sieve: 1 mm Extra: Sediment, TOC, contaminants	
14 Denmark	Area: …….. Period: …….. Stations: ……. Gear: …….. Sieve: …….. Extra: ……..	No information on Danish programme(s)

ANNEX 7: OVERVIEW OF THE EU-REDUCE PROJECT: REDUCTION OF ADVERSE ENVIRONMENTAL IMPACT OF DEMERSAL TRAWLS

Contract no. FAIR PL 97 3809 (1998–2001)

by Magda Bergman (NIOZ)

1. Objectives and methods

The **objectives** for this project are to develop alternative designs for the standard beam trawls (tickler chain and chain matrix beam trawls) that catch acceptable amounts of commercially sized fish and generate less mortality in invertebrate communities.

Alternative designs for the tickler chain beam trawl were

i) The electro beam trawl and

ii) The longitudinal chains beam trawl.

In both designs the tickler chains were taken away. As alternative for the standard chain matrix beam trawl, an escape window with large square meshes was inserted in the belly of the net just before the cod-end.

Comparative field studies were carried out in which alternative gears were tested against standard gears for

i) Catch composition,

ii) Catch efficiency for invertebrates,

iii) Discard mortality of invertebrates, and

iv) Direct mortality of invertebrates.

2. Evaluation of results

- Commercial catches were acceptable in electro beam trawls (although lower catches of plaice were registered) and in window chain matrix beam trawls.
- Higher investment costs and complex handling in case of electro beam trawls are foreseen, whereas the window is a cheap, and easy-to-install alternative.
- Reduced catch efficiency for a number of invertebrate species was found in the electro and longitudinal chains beam trawl as well as in the window alternative, all compared with their standards.
- Mortality among a number of invertebrate species caught as discards in the electro and the longitudinal chains beam trawl was lower than in the standard, whereas the window did not lead to any reduction in discard mortality.
- Electro beam trawls caused lower changes in community structure than standards, and lower median and single species mortality, while there where no indications for an enhanced delayed mortality.
- Longitudinal chains beam trawls caused larger changes in community structure than the standard gear, and higher median and single species mortalities.
- Trawling with window chain matrix led to smaller changes in community structure, and lower median and single species mortality than the standard trawl.

3. Recommendations

The development of trawls rigged with a combination of optimised electro stimulation and square meshed windows is recommended, since electro stimulation reduces direct mortality of invertebrates (also catch efficiency) and window zones generate smaller catches (also of invertebrates) and thus higher fish quality. It must be stressed that the electro window beam trawl will cause substantial mortality in infauna and epifauna due to the presence of a groundrope.

ANNEX 8: GUIDELINES FOR THE STUDY OF THE EPIBIOTA OF SUBTIDAL ENVIRONMENTS

Contents