

THE NORTH SEA BENTHOS PROJECT: PLANNING, MANAGEMENT AND OBJECTIVES

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Census of Marine Life: Turning Concepts into Reality (Session L)

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ABSTRACT

The ICES Benthos Ecology Working Group is integrating recent macrobenthic infaunal data (1999-2001) available from various sources, including national monitoring surveys, in North Sea soft bottom sediments. It is expected to cover most of the North Sea. The main goal is an overall comparison with the North Sea Benthos Survey data of 1986, in order to determine whether there have been any significant changes and, if so, what may be the causal influences (e.g., climate change, fishing impacts). The work will contribute valuable information on several other topics such as habitat classification and the distribution of endangered species.

Therefore, in addition to physico-chemical measurements of sediments samples alongside the benthic fauna, information on water depths, temperature, water quality and salinity will be incorporated in the analysis of species and community distributions. Also, we will use existing ecological and hydrographical models for currents, bottom shear stress and carbon input, along with information on the distribution of habitat types, to explain the observed distribution patterns.

At the ASC, an overview of the data available will be presented as well as the anticipated outcomes, and the first steps taken to deal with taxonomic differences and other issues affecting the capability to integrate submitted information.

Keywords: *macrobenthos; infauna; North Sea; community; habitat classification*

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INTRODUCTION

Macrobenthic infaunal communities are especially suited for long-term comparative investigations since many of the constituent species are of low mobility, relatively long lived and integrate effects of environmental changes over time. Further, the macrobenthos of the North Sea has been well studied on localized scales over the last hundred years. The sampling and analytical methodology is well established and so is the theoretical framework within benthic ecology. The macrobenthos is relatively easy to sample quantitatively and is of great importance for environmental surveillance for of the above reasons. It is in fact the main component of biological trend monitoring programmes aimed at evaluating the status of benthic ecosystems. However, the initiative to conduct a synoptic sampling exercise for the North Sea benthos was only taken in 1986, under ICES auspices (*e.g.*, Heip & Craeymeersch, 1995; Heip *et al.*, 1992; Künitzer *et al.*, 1992; Craeymeersch *et al.*, 1997). This involved collaboration between five countries (Belgium, the Netherlands, Germany, France and UK) in the sampling of the entire southern part in April 1986. The data were supplemented by an earlier extensive grid survey of the northern part conducted by Scotland (see, *e.g.*, Eleftheriou and Basford, 1989). In addition to analysis of the benthic macrofauna from grabs, data were also generated on the physico-chemical status of sediments (Basford *et al.*, 1993;

Irion & Müller, 1987), on the meiofauna (principally copepods: see Huys *et al.*, 1992) and the epifauna from small trawls or dredges (*e.g.*, Duineveld *et al.*, 1991).

Following the success of this work, the ICES Benthos Ecology Working Group recommended that a repeat survey should be conducted after more than 10 years had elapsed, in order to evaluate any changes to the status of assemblages identified in 1986, in relation to natural or human influences. A decision was therefore made to promote national effort towards the re-sampling of stations from the 1986 North Sea Benthos Survey or, alternatively, to seek contributions from ongoing national research and monitoring effort that might, collectively, allow a comparable holistic assessment to that achieved in 1986.

This paper reports on the outcome of progress to date, and identifies priorities for future evaluation of the combined data set in order to address important issues of contemporary relevance.

OBJECTIVES OF THE NORTH SEA BENTHOS PROJECT (NSBP 2000)

The objectives of NSBP 2000 are:

- i. to re-visit several stations sampled during the 1986 ICES North Sea Benthos Survey;
- ii. to augment the NSBP 2000 data with information from other sources (principally from the period 1999 – 2001) in order to maximise coverage of the North Sea area;
- iii. to establish a new NSBP data-base at the Flanders Marine Institute;
- iv. to work by correspondence, in Workshops and *via* the ICES Benthos Ecology Working Group to resolve problems affecting the compatibility of data sets from different sources;
- v. to determine patterns in contemporary North Sea benthic assemblages and the causal influences, by reference to supporting environmental data from the NSBP 2000 and other sources;
- vi. to compare the outcome of the NSBP 2000 with that of 1986 and to postulate causes for any observed differences, with reference to information on temporal changes in biotic and environmental factors, including human influences;
- vii. to report findings to ICES and to produce publications;
- viii. to provide a strategic evaluation of the utility of the collaborative exercise for sea-wide quality assessments, and to make recommendations for the timing and co-ordination of any future work.

SOURCES OF DATA

Data for the North Sea Benthos Project were provided by the Netherlands Institute for Sea Research, Rijkswaterstaat Haren, TNO, the Alfred Wegener Institute for Polar and Marine Research, the Senckenberg Institute Wilhelmshaven, the University of Kiel, the

Bundesanstalt für Gewässerkunde, the Marine Station - University of Lille, Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Marine Biology section - University of Gent, Sea Fisheries Department Oostende, FRS Marine Laboratory Aberdeen, Akvaplan NIVA Tromso, NIVA.

Sampling occurred mainly in spring and early summer of 2000 and covered almost the whole North Sea from the English Channel to about 60°N. The Norwegian data set contains information mainly from studies associated with oil and gas platforms. Figure 1 illustrates the sampling locations.

Most of the sampling in 2000 was conducted with a 0.1 m² van Veen grab and samples were sieved over a 1 mm mesh. Two to three replicates per station were taken. Dutch samples were obtained with a box corer, British ones with a 0.1m² Day or Hamon grab depending on the sediment type.

Biomass was estimated by most of the laboratories, ranging from wet weight to ash free dry weight. Conversion factors can be used to standardize biomass for all data sets. AFDW and wet weight data are available from NIOZ and Wimereux to calculate conversion factors; conversions by Rumohr *et al.* (1987) are also commonly used.

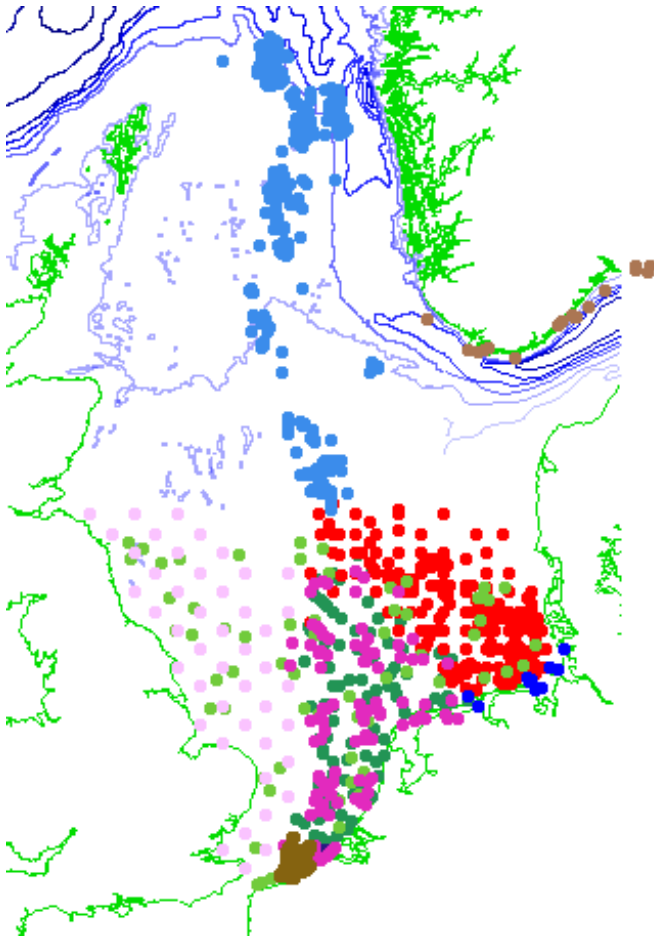


Figure 1. Positions of the sampling locations. Colours correspond to different sources of data. Additional samples, off the coast of Scotland, are not shown.

Samples for sediment composition and contaminants were taken by most participants, either from extra grabs or from the same grab as used for faunal analysis. Samples for analysis of meiofauna were taken only by CEFAS.

TAXONOMIC PROBLEMS

After excluding spelling variations, the database contained 1426 taxonomic entities, of which 814 (57%) are unique to individual datasets.. However, the incidence of species found only once within any individual dataset is much smaller, *e.g.*, for Akvaplan NIVA: 110 from a total of 629, for NIOZ: 56/218 and for the ICES North Sea Benthos Survey conducted in 1986: 201/1004. The high incidence of occurrences unique to individual datasets indicates that there could be differences in interpretation of the taxonomic literature between the different data contributors.

Taxonomic names were checked using the database Integrated Taxonomic Information System (ITIS – <http://www.itis.org>). It was found that only 5 of the 233 genera and 208 of the 1173 species in the NSBP list were not listed in ITIS. So, clearly, the problems described above seem to come from inconsistencies in the identification of species, rather than problems with nomenclature *per se*.

Taxonomic problems were addressed during a Workshop held at AWI, Bremerhaven (9-11 September 2002). The result was a significant reduction of errors in the taxa list. The outcome of the discussion will be passed on to ITIS, for updating their database.

DATA MANAGEMENT

Data received from the project participants were uploaded into a central database. The database itself is an MS SQL server database, with a front-end developed in MS Access. For the taxonomy/species lists, no separate database was developed, but the existing species register at the Flanders Marine Institute (VLIZ) was used.

The structure of the samples database was discussed first at the NSBP workshop in Oostende in January, 2002, and later altered according to discussions held at the second workshop in Bremerhaven. An overview of the database structure is presented in Figure 2. A more detailed description will be published later.

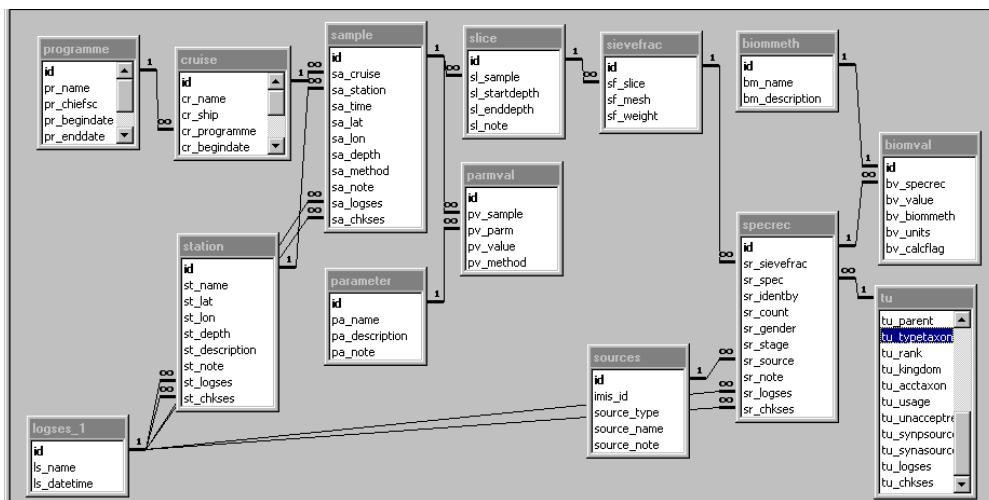


Figure 2. Structure of the information on sampling for NSBP.

The structure for the taxonomic information was adapted from the structure of the ITIS database. The taxonomic hierarchy is implemented as an open-ended hierarchy, where every taxonomic name or name part is stored in a single record, together with a pointer to a 'parent' record. In contrast to the ITIS structure, this open-ended hierarchy is consistently implemented for all taxonomic ranks - in ITIS, name parts for everything below genus are stored in a single record, with a maximum of four name parts per record. The structure of the database is illustrated in Figure 3.

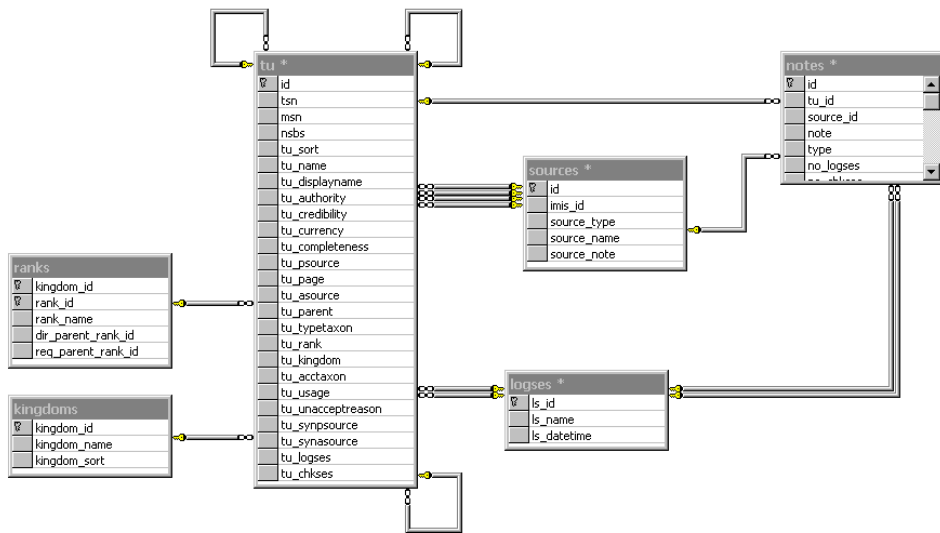


Figure 3. Structure of the taxonomic part of the database.

Data were sent to VLIZ either as Excel sheets, or as structured text or Word documents. Information was then first converted into separate Access mdb databases. After an initial quality check the data were then uploaded in the central database described above.

All taxonomic names were checked against the VLIZ taxonomic register, and where necessary an entry created in this register. As a quality-control procedure, all names were checked against the ITIS database.

PLANS FOR FUTURE DATA ANALYSIS

The status of the macrobenthic fauna in 2000 will be analyzed by univariate and multivariate methods (*e.g.*, CANOCO, PRIMER), aimed at a description of community structure and its attributes, such as biodiversity. Spatial distribution patterns will be analyzed for their relationship with environmental parameters. These include physico-chemical measurements of sediment samples (grain size, organic content, contaminants), depth, information on the annual cycle of the temperature of the bottom water, and water quality (*e.g.*, turbidity, salinity). Additionally, we will use existing ecological and hydrographical models (*e.g.*, the European Regional Seas Ecosystem Model: ERSEM) to obtain information on bottom currents, bottom shear stress and carbon input. We will also attempt to include spatial differences in fishing effort.

A subset of the 2000 data will be used for comparison with the 1986 ICES North Sea Benthos Survey. The data will be analyzed for possible changes in the distribution of assemblages and different species, changes in density and biomass of species, phyla and trophic guilds. These changes will be discussed in the light of environmental fluctuations in the North Sea recorded by other studies. One example is the outcome from the

Continuous Plankton Recorder programme, which shows changes in the algal biomass since the 1980s.

EXPECTED SCIENTIFIC OUTPUTS

The main aim of the survey is a descriptive evaluation of the macrozoobenthos communities in the North Sea in the year 2000, about 15 years after the first co-ordinated survey under the auspices of the ICES Benthos Ecology Working Group. Accordingly, an overall comparison with the results of the 1986 ICES North Sea Benthos Survey will be made, considering distribution patterns of the main benthic communities and of indicator species. To enable such comparison and to identify the causative factors involved in possible changes, long-term observation data from other sources (*e.g.*, monitoring-type studies, meteorological/hydrological series, CPR data) will be included in the analyses. The planned publications will provide valuable material for forthcoming quality status assessments of the North Sea and also for measures to be taken for the protection of marine biodiversity and ecosystem functioning. Moreover, as several new uses and intensifications of existing ones are planned for North Sea waters (*e.g.*, wind energy farms, sand and gravel extraction), co-ordinated spatial planning is required, for which benthos data are a fundamental requirement.

Possible changes according to climatic trends (including the North Atlantic Oscillation) will be analysed. Principally, a shift of distribution patterns of species (and communities) that benefit or suffer from warming in the North Sea south of the Dogger Bank, may be expected (see, *e.g.*, Wiekling & Kröncke, 2001).

Considering the ongoing intensive bottom trawl fisheries in large areas of the North Sea, investigations will be made of the relationship between the benthos (mainly large and long-lived and fragile species) and bottom trawling intensities.

Together with sediment distribution data, results from the epifaunal studies performed during the NSBP (either by trawling and dredging or by imaging) and morphological features (*e.g.*, depth contours) identified from sea charts, a contribution will be made to the efforts to classify and describe habitats in the North Sea. This may serve as a basis for nature protection measures (*e.g.*, through the EU 'Habitats' Directive, OSPAR activities and as compensation measures for localized human impacts) and for spatial planning in general (see above). Since new data on the relevant communities and characterising species of specific habitats will be provided by the NSBP, the task of habitat classification should therefore be greatly facilitated.

Through a combination of the intended analyses and publications it will also be possible to provide a strategic evaluation of the utility of our collaborative exercise for sea-wide quality assessments, including recommendations for the timing and coordination of any future work.

SUMMARY AND RECOMMENDATIONS

1. The combination of new sampling effort at a proportion of the 1986 ICES North Sea Benthos stations, along with contributions of data from several other sources (including ongoing national monitoring programmes) has yielded a large amount of information which provides good coverage of the North Sea, especially of the southern part. Coverage of the northern part is more limited, but efforts are being made to address this deficiency, notably *via* survey work conducted recently by the Marine Laboratory, Aberdeen.
2. A state-of-the-art database dedicated to the NSBP 2000 has been constructed at the Flanders Marine Institute, which will serve the needs of the present collaborative assessment, as well as acting as a future repository for relevant biological and supporting environmental data.
3. Effort has commenced on the harmonisation of data sets on the macrobenthic infauna from different sources, including significant progress at a second NSBP 2000 Workshop held in Bremerhaven (9-11 September 2002), a report of which is in preparation. This involved desk-based evaluation of combined species lists and laboratory work to resolve identification problems.
4. Consideration has been given to appropriate analytical methods for exploring data structure in relation to the core objectives of NSBP 2000, with initial outputs expected in Spring, 2003.
5. There are grounds for considerable optimism regarding the strategic value of the eventual output, especially in the light of contemporary requirements for sea-wide assessments of quality status to meet international obligations, such as those under OSPAR. Presently, the ICES NSBP 2000 activity is being co-ordinated by a Steering Group comprising six members of the ICES Benthos Ecology Working Group. The Steering Group considers that there would be significant advantages to operating within the formal framework of an ICES Study Group of finite duration, which may be further strengthened by establishing a collaborative link with OSPAR. These matters are presently being explored through the appropriate channels.

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