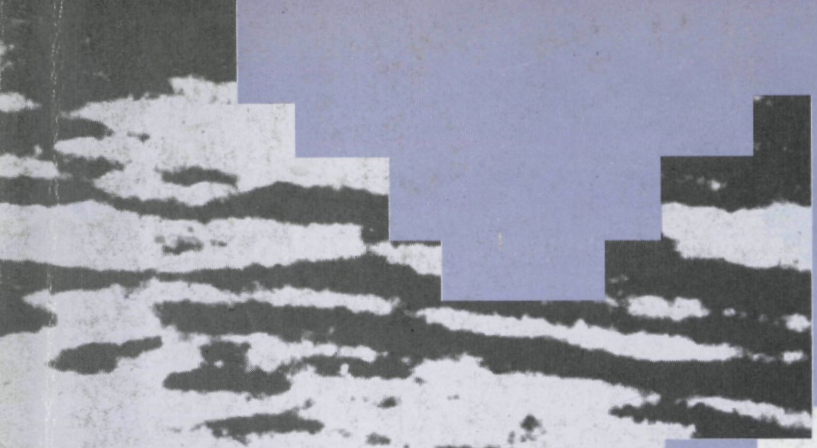


The distribution of benthic macrofauna in the Dutch sector of the North Sea in relation to the micro distribution of beam trawling

Final report 1998

Beleidsgericht ecologisch onderzoek van de Noordzee/Waddenzee

BEON

NIOZ
NIOO-CEMO
RIVO-DLO
NITG-TNO
RWS-DNZ

The distribution of benthic macrofauna in the Dutch sector of the North Sea in relation to the micro distribution of beam trawling

Final report 1998

761

M.J.N. Bergman (NIOZ)
J.W. van Santbrink (NIOZ)

J. Buijs (NIOO-CEMO)
J.A. Craeymeersch (NIOO-CEMO)

G.J. Piet (RIVO-DLO)
A.D. Rijnsdorp (RIVO-DLO)

C. Laban (NITG-TNO)

W. Zevenboom (RWS-DNZ)

Oktober 1998

BEON Rapport nr. 98-2

BEON project NIOZ 96 V 26

ISSN 0924-6576

M.J.N. Bergman, J.W. van Santbrink
Netherlands Institute for Sea Research (NIOZ)
P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands

J. Buijs, J.A. Craeymeersch
Netherlands Institute of Ecology - Centre for Estuarine and Coastal Ecology (NIOO-CEMO)
P.O. Box 140, 4400 AC Yerseke, The Netherlands

G.J. Piet, A.D. Rijnsdorp
Netherlands Institute for Fisheries Research (RIVO-DLO)
P.O. Box 68, 1970 AB IJmuiden, The Netherlands

C. Laban
Netherlands Institute of Applied Geoscience (NITG-TNO)
P.O. Box 157, 2011 AD Haarlem, The Netherlands

W. Zevenboom
Rijkswaterstaat - North Sea Directorate (RWS-DNZ)
P.O. Box 5807, 2280 HV Rijswijk, The Netherlands

CONTENTS

Summary 1

Subproject 1. A quantitative evaluation of the impact of beam trawl fishery on benthic fauna in the southern North Sea 5
G.J. Piet, A.D. Rijnsdorp, M.J.N. Bergman, J.W. van Santbrink, J.A. Craeymeersch, J. Buijs

Subproject 2. Abundantie en soortsamenstelling van het macrobenthos in relatie tot de intensiteit van de boomkorvisserij 17
J.A. Craeymeersch, J. Buijs, G.J. Piet, A.D. Rijnsdorp

Subproject 3. De epifauna in de zuidelijke Noordzee: veranderingen door het instellen van de scholbox? 29
J.A. Craeymeersch, J. Buijs, G.J. Piet, A.D. Rijnsdorp

Subproject 4. Abundance and species composition of larger sized invertebrate species (megafauna) in relation to beam trawl effort 37
M.J.N. Bergman, J.W. van Santbrink, G.J. Piet, A.D. Rijnsdorp

Subproject 5. Distribution of larger sized invertebrate species (megafauna) in the Dutch sector of the North Sea 55
M.J.N. Bergman, J.W. van Santbrink

EXECUTIVE SUMMARY

Relevance

This report presents the results of an integrated study of the relationship between the spatial distribution of benthic invertebrate fauna and the distribution of beam trawling. The background of the study is the concern raised about the effects of beam trawling on the benthic fauna. In a series of field studies from the fifties up to the recent EU project IMPACT-II, direct mortality due to trawling is observed in many invertebrate species. Indications are found that the benthic invertebrate fauna has changed in areas that are trawled frequently, like the southern North Sea. The IMPACT-II studies point to an increase in abundance of small opportunistic species and a decrease in larger, longer lived, species in several areas in the North Sea and Irish Sea. In this BEON-project the annual fishing mortality in the fauna populations is calculated and the following hypothesis is tested: the species composition of the benthic ecosystem of the southern North Sea reflects the trawling intensity.

Layout of the project

The relation between the benthos assemblages and beam trawling is studied by linking the densities of invertebrates in various subregio's of the Dutch sector to the spatial micro-distribution of the Dutch beam trawl fleet. The patchiness in the distribution of fishing effort as well as the distribution of benthic invertebrates is taken into account. Therefore, high resolution (1x1 nautical mile) data were used to estimate the spatial distribution of the fishing activities of the Dutch beam trawl fleet.

This report consists of five subprojects. In subproject 1 the frequency of annual trawling intensity is calculated for eight ecotopes and the annual fishing mortality in invertebrate megafauna species is estimated that is generated by beam trawling in the Dutch sector. In subproject 2 the correlation is analysed between species assemblages of small sized macrofauna and annual trawling intensity. Subproject 3 compares the changes in epifauna assemblages in the Plaice Box (in which trawling with trawlers >300 hp is prohibited) with the trends observed in a normally trawled reference area. Subproject 4 analyses the correlation between the species composition of megafauna species and annual trawling intensity. Subproject 5 provides the spatial distribution of megafauna species in the Dutch sector of the North Sea, a basic data set for subproject 1.

Results of subprojects

In the first subproject, the trawl frequency of beam trawl vessels larger than 300 hp within different benthic ecotopes on the Dutch sector of the North Sea (NCP) is analysed for a 4-year period. Benthic ecotopes are defined by the water depth and the grain size of the sediment at a resolution of 1x1 Nm. For eight ecotopes the frequency distribution of annual trawling intensity is estimated. It is shown that different types of ecotopes are trawled at different intensities, and of all ecotopes, only a part (40-65%) is trawled more than once a year, whereas the other part is trawled less intensively.

The subproject further explores a method to link the high resolution effort data with the spatial distribution of a selection of larger sized (>1 cm) benthic species (megafauna) to estimate the average level of annual fishing mortality generated by beam trawling in the populations in the Dutch continental shelf. Fishing mortality is determined by the overlap in the spatial distribution between a species and the fishery, and the direct mortality rate inflicted by one fishing event (the passage of a trawl). The latter has recently been estimated for the selected species in the IMPACT-II project. To calculate the spatial distribution of megafauna a predictive model was build based on the measured densities in 67 stations of the Dutch continental shelf (see subproject 5) and expected relations between densities and latitude, depth and sediment characteristics. These predicted abundance patterns were linked

to the beam trawl frequency on a 1x1 Nm resolution. The preliminary analysis suggests annual fishing mortality rates between 12% and 75%, depending on the species.

In the second subproject, the high resolution beam trawl distribution data were linked to a data set of small sized infauna to study the relationship between the species composition and the beam trawl intensity. Because benthic assemblages are strongly determined by abiotic factors such as sediment type (grain size, silt fraction) and depth, two more or less homogeneous areas were selected a priori: an offshore area and the Oystergrounds. Despite this selection, the variation in species composition and density within each area was still significantly related to subtle variations in sediment type, depth and latitude. Beam trawl intensity, though significant, explained in most cases a smaller fraction of the variation in the benthic assemblage than the other environmental variables. Examination of individual species revealed that Spionidae, a family of opportunistic annelids, showed a significant positive relationship with beam trawl intensity, if studied on a 1x1 Nm resolution in both the offshore area and the Oysterground. Among the other species showing a relation with beam trawl intensity, only the bivalve *Arctica islandica* and the crustacean *Ampelisca brevicornis* have ecological charateristics that make them sensitive for effects of beam trawling. Hence, their lower abundances in the more heavily trawled stations may be due to beam trawling. For the other species, however, this is less likely given their ecological charateristics and the relationship may be due to other environmental variable(s) than beam trawl intensity.

In the third subproject, changes in the epibenthos assemblage were examined between 1985 and 1996 in relation to the establishment of a protected area in the southeastern North Sea ("the plaice box"). In this area, beam trawling with vessels over 300 hp was initially restricted during the second and third quarter, and since 1994, totally forbidden. The beam trawl intensity was therefore substantially reduced since 1989 and in particular since 1994. Substantial changes in the epibenthic assemblage were detected after the establishment of the "plaice box". Changes, however, occurred in the references areas as well (although in other species), and were also observed in the demersal fish assemblage, suggesting that other unknown environmental variables may have been involved.

The fourth subproject presents the results of a field study of the distribution and abundance of larger sized benthic invertebrates (infauna and epifauna), carried out in 1996 and 1997. The objective of the study was to test the difference in megabenthos assemblage between areas trawled at different intensities. The 1996 study attempted to utilise the difference in trawling intensity in areas inside and outside the "plaice box". This study was unsuccessfull because the differences in benthic assemblage were greatly correlated with the environmental gradients across the border of the "plaice box". The 1997 study was carried out in a more homogeneous area (Oysterground) and applied a sampling grid comprising of a mosaic of heavily and lightly trawled stations. Variation in benthos was mainly explained by variations in water depth, sediment characteristics and latitude. Beam trawl intensity explained a relatively small though statistically significant proportion of the variance in species abundances. Single species analysis showed a significant positive correlation between abundance and beam trawl intensity for *Upogebia spp.*, *Pectinaria spp.* and *Ophiura albida*. For *Upogebia* this relationship was probably related to another environmental variable. For *Pectinaria spp.* the correlations may be spurious because they were mainly determined by some stations with an exceptional high abundance and coincided with a high beam trawl intensity. It is interesting, though, that these three species form important items in the diet of both plaice and sole which are the target species of the beam trawl fishery. Clear negative correlations between abundance and beam trawl effort were not detected. The most negative correlations (for species like *Chamelea gallina*, *Acanthocardia echinata*, *Echinocardium cordatum* and *Turritella communis*) were found to be not significant. The strongest indication for the effect of beam trawling was found when younger and older age classes were distinguished. For many species, the older age classes are more negatively correlated with beam trawl intensity than younger age classes of the same species.

The fifth subproject presents the results of a first field study on the distribution and abundance of megafauna (the larger size invertebrate species) in the Dutch sector of the North Sea. For many species the spatial distributions appear to be related to environmental gradients, e.g. type of sediments, coastal or offshore areas, and latitude. Densities of a selection of these species were used in subproject 1 to model the spatial distribution of the megafauna.

Synthesis and conclusions

The study showed that the variation in the benthic assemblage was mainly determined by environmental variables such as water depth, sediment type (grain size, silt content) and latitude, and to a lesser extent by beam trawl effort. Support for the hypothesis that beam trawling affects the benthic assemblage was found in the negative correlations between the abundance of some of the more sensitive species (e.g. juvenile *Arctica islandica*, *Ampelisca brevicornis*). Also the observed positive correlation between the abundance of some opportunistic species (Spionidae) and beam trawl intensity is in line with this hypothesis. The strongest support for a direct effect of beam trawling on the benthic assemblage stems from the observation that the negative correlation between abundance and beam trawl intensity was stronger for older (larger) specimens than for younger (smaller) specimens.

On the other hand, the distribution of beam trawling will be influenced by the benthic assemblage through its effect on the availability of suitable benthic food for sole and plaice, the main target species of the beam trawl fisheries. Flatfish will concentrate in areas with a high biomass of small species. Thus, the correlation in distribution of beam trawling and benthos is likely to be determined by a two way interaction of the direct effect of beam trawling on benthos and the effect of benthos on beam trawl distribution.

The BEON project supports the estimation of the annual fishing mortality for the different non-target invertebrate megafauna species in the IMPACT-II project (12 - 75% and 7 - 48% respectively). Also the hypothesis is supported that beamtrawling affects the benthic assemblages by enhancing opportunistic benthic species and reducing low productive and vulnerable species.

Recommendations

- The study of the impact of beam trawling on benthos may be pursued further using the modelling approach in which the micro-distribution of beam trawling is linked to the micro-distribution of particular benthic organisms to estimate the fishing mortality generated by fishing. This annual fishing mortality rate can then be incorporated in a spatial population dynamic model of species to explore the level of beam trawl effort at which the resilience with respect to natural disturbances (*e.g.* severe winters) is not affected significantly, and at which the populations can sustain in the long term. In conjunction with monitoring programmes on the micro-distribution of beam trawl effort and the distribution and abundance of invertebrate benthos, in particular the more vulnerable megafauna, this approach may form a basis to quantify more exactly the impact of beam trawling on the benthos necessary to explore the consequences of area closures for the benthic ecosystem.
- Experimental studies to disentangle fisheries effect from effects of other environmental factors on the benthos assemblages are important to generate quantitative information on the dominant ecological processes affecting the population dynamics. This information can be used in the modelling approach.
- A review of the life history characteristics of benthic invertebrate species is needed to interpret the observed patterns and changes in benthic assemblages in relation to trawling.
- Research into alternative fishing methods to reduce the impact on the benthic ecosystem should be encouraged.

A QUANTITATIVE EVALUATION OF THE IMPACT OF BEAM TRAWL FISHERY ON BENTHIC FAUNA IN THE SOUTHERN NORTH SEA

33998

G.J. Piet, A.D. Rijnsdorp (RIVO-DLO)
M.J.N. Bergman, J.W. van Santbrink (NIOZ)
J.A. Craeymeersch, J. Buijs (NIOO-CEMO)

Introduction

There is a growing concern about the effects of fishing activities on the marine ecosystem (ICES 1988). The increase since the 1960s in trawling fleets with regard to number of vessels, motor power, weight of gear and fishing speed gave rise to this concern, and studies on the impact of beam trawling on the benthic fauna were initiated (IMPACT-1 1994, IMPACT-II 1998). In these studies, the beam trawling was shown to cause a direct mortality in some non-target fish and benthic invertebrates. The long term impact will be related to the mortality generated by the fisheries and the life history parameters of the organisms which determine the level of additional mortality the populations can sustain.

All mobile bottom gears scrape the surface of, or dig into, the seabed to varying degrees. The penetration depth largely depends on the nature of the seabed (Margetts & Bridger 1971, Bridger 1972, BEON 1991). Benthic invertebrate species, or life-history stages of a particular species, often differ in their vertical position in the substratum. Therefore some benthic species or life-history stages are more vulnerable to trawling than others (Houghton et al. 1971, Bergman & Hup 1992, IMPACT-II 1998) and this vulnerability may depend to some degree on the nature of the sediment. The direct mortality of various benthic organisms, taking account of the integrated effects of the vulnerability and vertical distribution, were estimated by experimental trawling in the southern North Sea (Bergman & Santbrink 1994, Santbrink & Bergman 1994, Bergman et al. 1998a).

This fishing mortality generated by a fishery will not only depend on the direct mortality rate generated at each fishing event, but also by the overlap in horizontal distribution between the species and the fishing effort. Duineveld et al. (1991) showed that the horizontal distribution in the southern North Sea of benthic invertebrates was related to sediment characteristics and water depth. The horizontal distribution of beam trawling will be affected by the local concentrations of target fish, by the suitability of the seabed (stones, muddy areas) for beamtrawling, and by the occurrence of physical obstacles such as wrecks and oil rigs and of shipping lanes. In a study of the micro-distribution of a sample of 25 beam trawl vessels Rijnsdorp et al. (1996) showed that beam trawling was highly patchy. Only at a resolution of 1x1 Nm squares the distribution became random. It was further shown that after extrapolating the micro-distribution of the sampled vessels to the total Dutch fleet, 10% of the surface area in eight of the most heavily fished ICES rectangles of the North Sea was trawled less than once in five years and 33% less than once in a year. The surface area that was trawled more than 10 times in a year was estimated at 3%.

In the present study the micro-distribution of Dutch beam trawling in the Dutch sector of the North Sea will be analysed at a resolution of 1x1 Nm. The micro-distribution will be related to environmental parameters (depth, sediment charateristic and latitude) that are relevant in determining the distribution of benthos. Furthermore, fishing mortality rates will be estimated for

a selection of invertebrate megafauna species for which data on direct mortality due to a single fishing event and horizontal distribution is available.

Material and methods

Beam trawl effort

The DAFIST database contains beam trawl effort data of the Dutch fleet on a spatial scale of 30x30 Nm (ICES rectangles) based on EC-logbook forms. For determination of the effort two classes of ships were distinguished based on their engine power: Hp-class 1 (≤300 Hp), Hp-class 2 (>300 Hp). Ships of Hp-class 1 are rigged with two 4 m wide beam trawls and fishing speed is 4.3 $Nm.hr^{-1}$. Ships of Hp-class 2 are rigged with two 12m wide beam trawls and fishing speed is 6 $Nm.hr^{-1}$. The average effort by ICES rectangle was determined for a four year period (1-1-1993 until 31-12-1996).

The micro-distribution of beam trawling was studied since 1993 in a sample of 24 beam trawl vessels of Hp-class 2 (13% of the Dutch fleet) and one vessel of Hp-class 1 using an automated position recording system for details. In 1996, the sampling was extended and now comprises one additional Hp-class 2 vessel (n=25) of 5 additional vessels of Hp-class 1 (n=6). Fishing positions are recorded every 6 minutes at an accuracy of 180 m (see Rijnsdorp et al. 1994, 1996). The HP-class 2 APR data only comprise of beam trawl effort. However, the smaller vessels (HP-class 1) may use different gear types during the year. Hence the APR data base also contains fishing registrations of shrimp trawl and otter trawls.

Trawling frequency

The frequency of the beam trawl fishery was based on Automatic Position Registration (APR) and the DAFIST data base as described in Rijnsdorp et al. (1996). This approach raises the observed micro-distribution within each ICES rectangle to the total fishing effort of the Dutch fleet as given by the DAFIST data base. The annual frequency with which a 1x1 Nm square was trawled was calculated as follows:

$$F = \frac{R/_{10} * TV/_{TR} * S * 2 * W * FH * 1852}{4 * 1852^2 * 2\cos(\pi * N1 / 180) * \cos(\pi * N2 / 180)}$$

Where R= total number of APR registrations in an ICES rectangle of the sampled vessels, TV = total number of fishing hours of the Dutch fleet in the 4-year period in an ICES rectangle, TR = total number of fishing hours of the sampled vessels in the 4-year period in an ICES rectangle, FH = number of fishing hours per day absence from port, S = trawling speed, W = width of the beam trawl, N1 and N2 = upper and lower latitudinal positions of the 1x1 Nm square. For the present study the APR data recorded during a 4-year period (1-4-1993 until 31-3-1997) were used, and the DAFIST data for TBB for the years 1993 - 1996.

Environmental data

Data on the grain size distribution of the sediment in the Dutch sector of the North Sea were obtained from the TNO Department of Geology (NITG-TNO). Four grain size classes were distinguished according to the Wentworth scale (gsc0: >0.5 mm; gsc1: 0.25-0.5 mm; gsc2: 0.125-0.25 mm; gsc3: <0.125 mm). Data on the depth distribution were obtained from RWS North Sea Directorate. Eleven 5 m depth-classes were distinguished (0-5, 5-10,..., >50 m). Data of both datasets were transformed to the 1x1 Nm resolution by determining the grain size or water depth at the center of each square and using this for the entire square.

Benthic invertebrates

Larger sized in- and epifauna species (>1 cm) were sampled at 67 stations spread out over the Dutch sector (see subproject 5). At each of these stations the abundance was determined. Sediment characteristics for 1996 were given by Holtman et al. (in press). Water depth at each sampling station was derived from the water depth dataset.

The effect of water depth and seabed sediment on the beam trawl effort was tested for each Hp-class seperately using a two-way ANOVA with the number of registrations as the dependent variable. Direct mortality estimates due to a single experimental trawling (fishing event) were available for 16 invertebrate species (Bergman et al. 1998a, Table 1). For some organisms two estimates of direct mortality were available, one for sandy (grainsize >0.175 mm) and one for silty sediment (grainsize <0,175 mm). For some species a distinction was made between larger and smaller specimens (*Chamelea gallina*) or between juveniles, males and females (*Corystes cassivelaunus*). The direct mortality estimates as percentage of the initial density in the sea floor, reflect the mortality generated by one fishing event, or, in other words, by one passage of a beam trawl.

The abundance of each species was estimated by a GLM model that explained the observed numerical abundance as a function of sediment type (grainsize), depth and latitudinal position (see above). As for each 1x1 Nm square in the Dutch sector grainsize, depth and latitudinal position were known, the abundance of each species could be calculated.

For a number of species direct mortality estimates were available for soft and sandy sediments. The distinction between the sandy and soft sediments was made at a grainsize of 0.175 mm. This distinction differed from the classification of the Wentworth scale that used borders at 0.125 mm and 0.250 mm. Therefore, two fishing mortality estimates were derived for these by applying the direct mortality estimates to sediment classes of <0.125 mm and <0.250 mm, respectively.

Fishing mortality estimates

Fishing mortality estimates of the selection of benthic invertebrates on the Dutch sector of the North Sea were determined from the horizontal distribution of the species, the direct mortality estimate due to a single fishing event and the distribution of total beam trawl effort (combined for both Hp-classes) on a 1x1 Nm spatial resolution. First the fishing mortality (Fi) was estimated at each spatial window (for instance a 1x1 Nm square):

$$F_i = 100 * \left[1 - 1 * ((100 - M)/100)^{T_i}\right]$$

where M= direct mortality after one fising event (Table 1) and Ti = trawling frequency (yr^{-1}) in window i. The fishing mortality F over the entire area (NCP) was than calculated by averaging the Fi values over the numerical abundance of the species in window I:

$$F = \frac{\sum_i F_i * N_i}{\sum_i N_i}$$

where Ni = the numerical abundance in window i.

Results

Distribution beam trawl effort

The distributions of APR-recordings over the various depth-sediment classes is given in Table 2. A two-way ANOVA shows that depth and sediment, as well as the interaction term (depth*sediment) were statistically significant ($p<0.01$). The distribution of the beam trawl effort on a 1x1 Nm resolution clearly differs between Hp-classes. The smaller vessels generally fish in the coastal waters, whereas the larger ones fish in offshore waters and along the borders of the 12 Nm zone and plaice box. The small vessels mainly fish in waters below 15-19 m depth and in coarser sediment (grain size >0.25 mm). The larger vessels mainly fish in waters between 25 m and 45 m and sediments with a grain size of 0.125 mm - 0.5 mm. The depthzone beyond 45 m is hardly represented in the Dutch sector of the North Sea.

The frequency distribution of beam trawl intensity estimated at a resolution of 1x1 Nm is shown for 8 sediment/depth strata (Fig. 1). The cumulative frequency distributions shows that within each stratum beam trawl intensity was not distributed homogeneously. For example 53% of the surface of stratum 6 was trawled less than once a year by trawlers of Hp-class 2 whereas 30% and 37% of the surface of strata 3 and 5, respectively, were trawled less than once a year.

Distribution of benthic invertebrates

The distributions of most species was significantly determined by sediment grain size, depth and latitudinal position (Table 3) for most species. Only for *Chamelea gallina* larger than 2 cm, *Spisula solida* and *Pelonaia* spp. the model was not significant at the 0.05 level. However, for all of the species except for *Pelonaia* spp. the model explained more than 50% of the variation. The estimated abundance per species per sediment/depth stratum is shown in Table 4.

Fishing mortality estimates

The overall fishing mortality estimated for the various species was hardly affected by the assumed distinction between sandy and silty sediments (Table 5). Only species with marked differences in direct mortality in sandy and silty sediments, and which occurred in both sediment types, were affected differently. For species with a higher direct mortality estimate in soft sediments than in sandy sediments, such as *Chamelea gallina* (>2 cm), and *Mactra corallina*, the fisheries-induced mortality was higher when the threshold was at the 0.25 mm level instead of the 0.125 mm level.

Discussion

The abundance and distribution of benthic invertebrates has been shown to be highly dependent on the characteristics of the sediment (grainsize, siltcontent) and other environmental variables such as water depth and temperature (Duineveld et al. 1991; subproject 2, 4 and 5). The environmental variables available to us on the 1x1 Nm scale were restricted to depth and grain size. Hence, the model employed in the present paper should be considered as a first approximation.

The mortality estimates were calculated from the micro-distribution data of the sampled vessels of ²300 hp and >300 hp raised to the total number of fishing days of the Dutch fleet in the period 1993 - 1996. The sampled vessels for the micro-distribution of the fleet of ≤300 hp, however, was restricted to one vessel. Only in the course of 1996, the number of HP-class 1 vessels sampled was increased to 6 vessels. Another complication arise from the fact that these vessels may use a variety of fishing gears during the year. The micro distribution, therefore,

includes fishing positions of the fishery for shrimps and roundfish. The observed distribution, therefore, cannot be considered to be representative for the distribution of beam trawling.

The overall fishing mortality rates estimated in this study at a resolution of 1x1 Nm squares showed values between 12% and almost 75%. These rates should be considered maximum estimates. In comparison, the fishing mortality estimates of the same species in the IMPACT-II project (7 - 48%; Bergman et al. 1998b) were lower than those estimated in the present study. The difference between the two studies may be due to the different assumptions made in both studies. Estimates of fishing mortality in the present study might be slightly overestimated because of the assumption with regard to the proportion of a day at sea which is spent fishing. We assumed that each fishing day comprised 20 fishing hours ignoring the time needed to steam between the harbour to the fishing grounds.

For most species the observed estimates of fishing mortality were hardly affected by the method applied to link the direct mortalities determined for the "soft" and "sand" sediments to the sediment classification applied in this study. Only for three species that showed substantial differences in the direct mortality estimate in relation to sediment type (*e.g.* large striped venus, razor shell and rayed through shell), a substantial effect was observed. It was observed, however, that the estimates of fishing mortality depended to a considerable extent on the model used to estimate the spatial distribution of the benthic species.

Direct mortality estimates for some species (*Abra, Arctica, Ensis* and *Mactra*) were less accurate because of the low initial densities in the experimental areas. Hence the fishing mortality estimates of these species will be less accurate as well. The direct mortality estimates may be overestimated for all megafauna species, and especially for the largest infauna species, because these were obtained in fishing experiments in which the seabed was trawled on average 1.5 times during a short time period. This overestimation is caused by an additional mortality due to the second passage of the trawl, especially in species that are (partly) dug out of the sediment during the first passage. If the direct mortality generated by one fishing event increases at a second fishing event shortly following the first, the direct mortality estimate may be overestimated. Although no data are available on the time interval between successive trawling events in the North Sea, the information from the fishery suggests that a skipper tries to fish close to previous fishing positions, but also tries to avoid fishing exactly the same position. Therefore, it seems unlikely that this interval will be less than the time needed by the organism to reposition itself in the sediment.

The direct mortality estimates may be overestimated if part of the population was distributed below the depth of the sampling gear employed. This sampling error, however, can be neglected in the species concerned. Finally, the vertical distribution of benthic animals may change seasonally due to spawning and feeding cycles, making the animals more or less susceptible to a fishing event in dependence of the time of year. To minimise this potential error, direct mortalities were obtained from experiments in April-June and in September.

Because of the reasons given above, the fishing mortality estimates should be considered to be preliminairy. This applies in particular to the estimates made for benthic invertebrates inhabiting the shallower waters where the fleet of smaller vessels mainly operate.

Mortality generated by beam trawling above the mortality generated by natural causes (predation, disease, *etc*) will reduce the standing stock. The opportunities for invertebrate populations to survive in the Dutch sector of the North Sea will not only depend on the average level of fishing mortality, but also on the spatial differences in the beam trawl intensities over the distribution area of the species and of the life history characteristics of the species (*e.g.* age and size at first reproduction, reproductive rate, longevity). The cumulative frequency plots showed that substantial parts of all strata were fished less than once every year. In these parts the mortality generated by beam trawling will be less that the presented fisheries mortality values presented in Table 5, whereas in other parts the mortality will be higher. A crucial question which remains to

be answered is whether these less trawled areas will provide sufficient opportunities for the longterm survival of populations of vulnerable benthic species. Rumohr et al. (1998) showed that the distribution area of several bivalve species at present is smaller than in the 1920s. The next step in this study will be to build quantitative spatial population models of typical benthic invertebrate species and explore the effect of different levels of beam trawling on the spatial distribution and population abundance. The results of these simulations can be compared to known distribution patterns.

References

Bergman M.J.N. & Hup M. 1992. Direct effects of beam trawling on macrofauna in a sandy sediment in the southern North Sea. ICES J. Mar. Sci. 49: 5-11.

Bergman M.J.N. & van Santbrink J.W. 1994a. Direct effects of beam trawling on macrofauna in a soft bottom are in the southern North Sea. In: Environmental impact of bottom gears on benthic fauna in relation to natural resources management and protection of the North Sea. S.J. de Groot & H.J. Lindeboom (eds.) pp. 179-208.

Bergman M.J.N. & van Santbrink J.W. 1994b. A new benthos dredge (TRIPLE-D) for quantitative sampling of infauna species of low abundance. Netherlands Journal of Sea Research 33:129-133.

Bergman M.J.N., B. Ball, C. Bijleveld, J.A. Craeymeersch, B.W. Munday, H. Rumohr and J.W. van Santbrink, 1998a. Direct mortality due to trawling. In: H.J.Lindeboom & S.J. de Groot (eds.). 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: 167-185.

Bergman M.J.N. , Craeymeersch J.A., Polet, H. & van Santbrink J.W. 1998b. Fishing mortality in invertebrate populations due to different types of trawl fisheries in the Dutch sector of the North Sea in 1994. In: The effects of different types of fisheries on the North Sea and Irisch Sea benthic ecosystems. H.J. Lindeboom & S.J. de Groot (eds.). NIOZ-Rapport 1998-1, RIVO-DLO Report C003/98: 353-358.

Bridger J.P. 1972. Some observations on the penetration into the sea bed of tickler chains on a beam trawl. ICES CM 1972/B:7. 9 pp.

Craeymeersch J.A. Buijs J.,Piet G.J. & Rijnsdorp A.D. 1997. Abundantie en soortensamenstelling van het macrobenthos in relatie tot de intensiteit van de bodemvisserij. BEON rapport. 13 pp.

Duineveld G.C.A, Kunitzer A.,Niermann U., de Wilde P.A.W.J. & Gray J.S. 1991. The macrobenthos of the North Sea. Netherlands Journal of Sea Research 28: 53-65.

Groot de S.J. 1972. Some further experiments on the influence of the beam trawl on the bottom fauna. ICES CM 1972/B:6. 7 pp.

Houghton R.G., Williams T. & Blacker R.W. 1971. Some effects of double beam trawling. ICES CM 1971/B:5. 16 pp.

ICES. 1988. Report of the study group on the effects of bottom trawling. ICES CM 1988/B:56. 30pp.

IMPACT-I. 1994. Environmental impact of bottom gears on benthic fauna in relation to natural resources management and protection of the North Sea. S.J. de Groot & H.J. Lindeboom & (eds.) NIOZ-Rapport 1994 - 11, RIVO-DLO Report C026/94. 257 pp.

IMPACT-II. 1998. The effects of different types of fisheries on the North Sea and Irisch Sea benthic ecosystems. H.J. Lindeboom & S.J. de Groot (eds.). NIOZ-Rapport 1998-1, RIVO-DLO Report C003/98: 404 pp.

Margetts A.R. & Bridger J.P. 1971. The effect of a beam trawl on the sea bed. ICES CM 1971/B:8. 9 pp.

Rijnsdorp A.D., Buijs A.M., Storbeck F. & Visser E. 1996. Micro-scale distribution of beam trawl effort in the southern North Sea between 1993 and 1996 in relation to trawling frequency of the sea bed and the impact on benthic organisms. ICES CM 1996/Mini 11. 16 pp.

Rumohr, H., S. Ehrich, R. Knust, T. Kujawski, C.J.M. Philippart & A. Schroeder, 1998. Long term trends in demersal fish and benthic invertebrates. In: H.J. Lindeboom & S.J. de Groot (Eds.). 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: 280-353.

Santbrink J.W. van & Bergman M.J.N. 1994. Direct effects of beam trawling on macrofauna in a soft bottom are in the southern North Sea. In: Environmental impact of bottom gears on benthic fauna in relation to natural resources management and protection of the North Sea. S.J. de Groot & H.J. Lindeboom (eds.) pp. 147-179.

TABLE 1

List of invertebrate species studied and the direct mortality estimate due to a single fishing event (passage of a beam trawl). Data based on Bergman et al. (1998a). Also indicated are the species abbreviations used throughout the document. Direct mortality estimates of species indicated with an asterisk are less reliable because these species had low initial densities.

Scientific name	English name	Abbreviation	Direct mortality (%) sand	soft
*Abra alba**	-	abral	39	39
Aphrodita aculeata	sea mouse	aphac	38	38
*Arctica islandica**	quahog	arcis	16	16
Astropecten irregularis	burrowing starfish	astir	45	22
Chamelea gallina	striped venus>2 cm	chagag	7	40
Chamelea gallina	striped venus<2 cm	chagal	7	6
Corystes cassivelaunus	masked crab juvenile	corcaj	63	63
Corystes cassivelaunus	masked crab male	corcam	48	27
Corystes cassivelaunus	masked crab female	corcaf	22	26
Dosinia lupinus	smooth artemis	doslu	44	44
Ensis spp*.	razor shells	enssp	13	3
Euspira catena	large necklace shell	eusca	61	61
Gari fervensis	sunset shell	garfe	81	81
Mactra corallina	rayed through shell	macco	11	28
Ophiura texturata	a brittle star	ophte	6	6
Pelonaia corrugata	-	pelco	18	18
Phaxas pellucidus	-	phape	15	38
Spisula solida	thick through shell	spiso	31	31
Spisula subtruncata	cut through shell	spisu	21	21
Thia scutellata	thumb-nail crab	thisc	22	22
Turritella communis	tower shell	turco	14	14

TABLE 2

Percentage of APR-recordings in relation to depth (5m class) and sediment (grain size) in the 4 year study period 1-4-1993 to 31-3-1997 for the sampled vessels of <=300hp (upper) and >300hp (lower).

HP-class 1 <=300pk

Depth (m)	GRAINSIZE			
	≤0.125 mm	0.125-0.25 mm	0.25-0.5 mm	>0.5 mm
5	0	2.8	.3	19.9
10	4.8	5.5	6.0	11.9
15	3.6	5.5	4.9	6.5
20	3.5	1.9	1.5	2.2
25	1.6	2.8	1.3	1.1
30	1.3	1.0	0.6	1.2
35	0.0	1.5	0.4	0.4
40	0.0	0.3	0.2	0.4
45	0.1	0.5	0.3	0.3
>50	0	0.7	0.4	0.6

HP-class 2 >300pk

Depth (m)	GRAINSIZE			
	≤0.125 mm	0.125-0.25 mm	0.25-0.5 mm	>0.5 mm
5	0.0	0.0	2.3	0.0
10	0.1	1.2	0.7	0.0
15	0.5	3.1	0.5	0.1
20	0.1	3.4	0.2	0.0
25	1.9	8.8	5.8	0.1
30	0.0	6.4	6.1	6.6
35	2.2	6.4	3.7	4.0
40	5.8	4.0	3.4	3.5
45	1.8	3.3	3.8	2.5
>50	0.0	1.8	3.2	2.7

TABLE 3

Results of the GLM analysis of the numerical abundance (Y) of invertebrate benthic species in relation to environmental variables. The table gives the percentage of the total variance explained by each (co-)variable or factor against the full model. S=sediment type, D=depth, L=latitude. For species abbreviations see Table 1. The model analysed was: Y = S + D + L + interaction terms.

	abral	aphac	arcis	astir	chagag	chagal	corcaj	corcam	corcav	doslu	enssp
R^2	0.79	0.45	0.54	0.65	0.5	0.3	0.73	0.46	0.56	0.45	0.93
p	0.00	0.01	0.01	0	0	0.44	0	0.01	0	0.01	0
S	15	1	0	16	1	4	10	2	2	18	0
D	14	38	43	11	48	27	19	24	20	27	41
S*D	15	11	7	14	1	17	18	23	26	3	9
L	12	1	1	17	0	1	7	1	4	7	0
L*S	15	1	0	16	1	5	10	2	2	18	0
L*D	14	38	42	11	47	28	19	23	20	24	41
L*S*D	15	11	7	14	1	17	18	23	26	3	8

	eusca	garfe	macco	ophte	pelco	phape	spiso	spisu	thisc	turco
R^2	0.44	0.63	0.5	0.25	0.19	0.92	0.27	1	0.67	0.52
p	0	0	0	1	0.96	0	0.61	0	0	0
S	6	10	0	10	2	13	0	0	14	7
D	26	31	49	34	16	15	24	50	10	35
S*D	17	10	1	7	32	15	23	0	25	8
L	0	0	0	1	0	12	0	1	0	0
L*S	6	9	0	9	2	14	0	0	15	7
L*D	27	31	48	32	16	15	27	49	10	34
L*S*D	17	9	1	7	32	15	26	0	25	8

TABLE 4

Estimated density (N/100m^2) of invertebrate species from the model given in Table 3.
Grain size classes: gsc 1: 0.25-0.5 mm; gsc 2: 0.125-0.25 mm; gsc 3: <0.125 mm

gr. size	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3
depth(m)	20	25	30	35	5	10	15	20	25	30	35	40	45	50	40	45	50
abral	0	0	0	2	0	0	0	0	0	0	2	5	1	2	86	3	3
aphac	0	0	0	0	0	0	8	5	0	0	0	7	8	2	23	4	13
arcis	1	0	0	0	0	0	0	0	0	0	2	5	4	9	0	5	13
astir	0	0	0	0	0	0	6	3	5	8	33	48	31	51	390	82	38
chagag	0	1	0	0	0	0	5	1	0	17	35	62	41	32	17	22	14
chagal	0	1	0	0	0	0	0	0	10	18	26	25	17	17	1	6	11
corcaj	0	0	0	5	0	0	1	0	0	2	7	11	14	9	0	25	7
corcam	4	1	0	15	0	0	0	0	0	15	21	21	20	23	0	16	6
corcav	0	3	3	31	0	0	0	0	5	35	52	63	63	58	31	89	37
doslu	1	0	0	0	0	0	0	0	0	1	6	35	34	38	12	17	14
enssp	245	147	19	43	1297	403	1303	403	382	41	97	20	1	2	0	2	0
eusca	0	0	0	0	0	0	0	0	112	55	3	1	0	0	0	0	0
garfe	1	0	0	0	0	0	1	0	0	1	19	2	2	0	0	0	0
macco	0	0	0	0	0	5	0	0	0	1	1	0	0	0	0	0	0
ophte	0	5	16	6	0	2	25	174	19	77	62	3	5	5	43	4	8
pelco	1	0	0	0	0	0	0	0	0	0	0	2	4	8	0	6	12
phape	0	0	0	0	0	0	1	0	0	0	3	4	3	10	372	3	4
spiso	0	25	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
spisu	485	66	0	0	1538	1835	20148	151500	106	0	4	1	0	0	25	0	1
thisc	12	42	22	108	0	5	0	0	0	2	15	0	0	0	0	0	0
turco	72	0	1	0	0	0	0	0	3	0	2	276	112	315	646	39	71

Table 5. Fishing mortality (% of the population per year) estimated for the Dutch sector of the North Sea from the direct mortality caused by at a single fishing event and the overlap between the horizontal distribution of the species and of the Dutch beam trawl fishery (≤300 pk and >300 pk). Fishing mortality estimates are given for two levels of distinction between coarse and soft sediment (grain size of 0.25 mm and 0.125 mm).

Species	Fishing mortality	
	0.125mm	0.25mm
abral	44	44
aphac	42	42
arcis	27	27
astir	32	27
chagag	27	59
chagal	17	15
corcaj	72	72
corcam	60	48
corcaf	39	42
doslu	54	54
enssp	26	12
eusca	75	75
garfe	75	75
macco	27	49
ophte	17	17
pelco	25	25
phape	37	38
spiso	70	70
spisu	16	16
thisc	57	57
turco	25	25

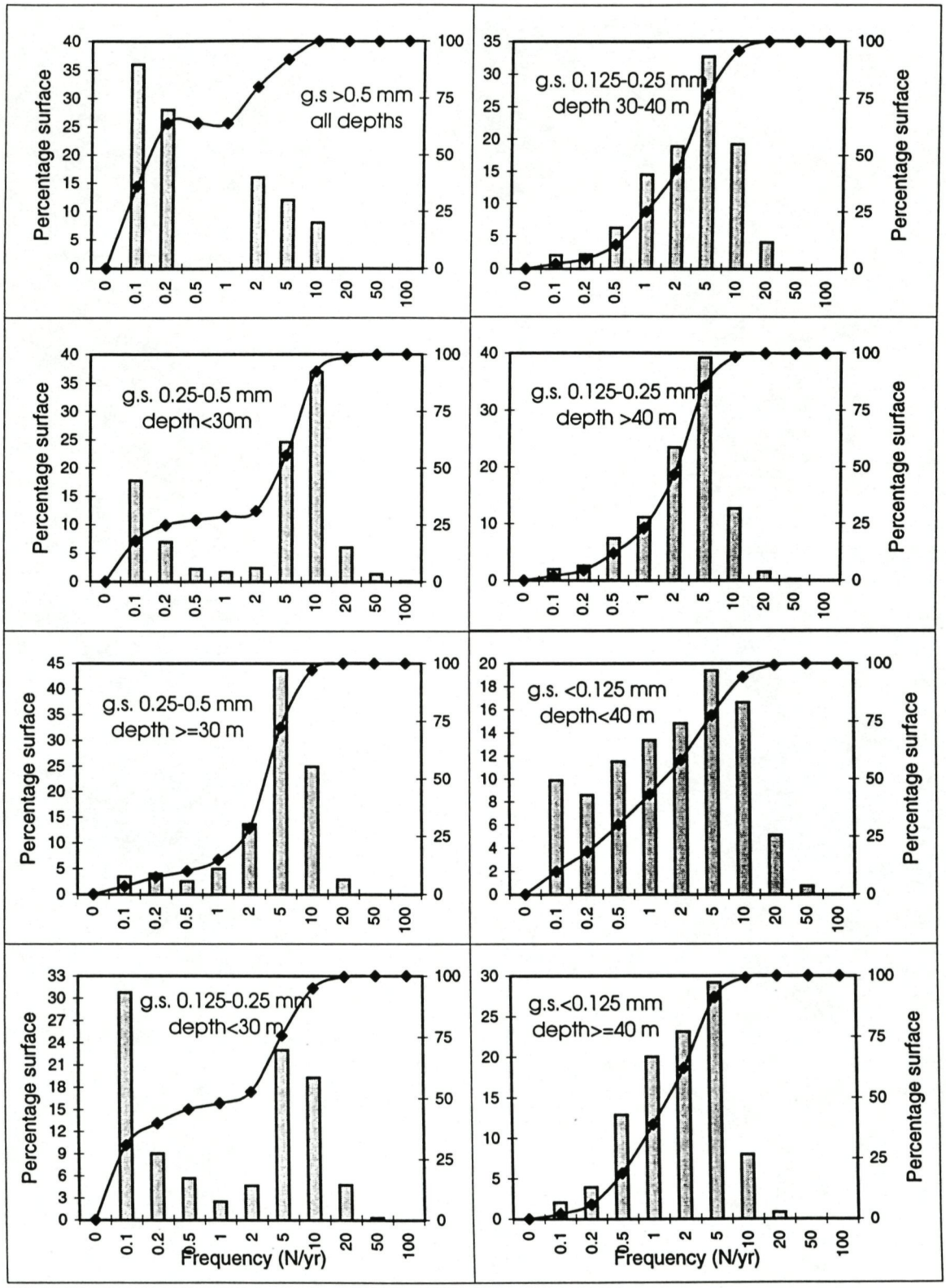


Fig. 1. Beam trawl frequency of Dutch fleet >300 hp within eight ecotopes based on sediment grain-size (g.s.) and depth. Left y-axis is for the absolute proportion of the surface (bars), right y-axis for the cumulative proportion of the surface (lines).

ABUNDANTIE EN SOORTENSAMENSTELLING VAN HET MACROBENTHOS IN RELATIE TOT DE INTENSITEIT VAN DE BOOMKORVISSERIJ

34000

J.A. Craeymeersch, J. Buijs (NIOO-CEMO)
G.J. Piet, A.D. Rijnsdorp (RIVO-DLO)

Inleiding

Voor een kwantitatieve evaluatie van het effekt van de boomkorvisserij op de bodemfauna zijn gegevens over de ruimtelijke verspreiding van de bodemfauna en een gedetailleerde kennis over de ruimtelijke verspreiding van de boomkorvisserij vereist. Wat de bodemfauna betreft, zijn op het Nederlands Continentaal Plat gegevens beschikbaar over de ruimtelijke verspreiding van de in de bodem levende soorten bemonsterd met een boxcorer (zie Holtmann et al. 1996b). Onderzoek naar de ruimtelijke verspreiding van de boomkorvisserij met behulp van automatische positieregistratie-apparatuur heeft aangetoond dat er binnen de intensief beviste zuid-zuidoostelijke Noordzee gebieden voorkomen die minder dan eenmaal per jaar worden bevist. Daarnaast zijn er gebieden die zeer intensief (meerdere malen per jaar) worden bevist.

In dit rapport wordt nagegaan of er verschillen gevonden kunnen worden in de bodemdiersamenstelling van intensief en weinig intensief beviste gebieden.

Materiaal en methoden

Bodemdieren en visserij-intensiteit: gegevens

Gegevens over de infauna (in de bodem levende invertebraten) zijn het laatste decennium beschikbaar gekomen via verschillende onderzoeksprojekten: VOORDELTA, MILZON, BIOMON, de ICES North Sea Benthos Survey (1986) en het MMP (Master Monitoring Plan, 1990). Deze gegevens vormden de basis voor een recent verschenen atlas van het zoöbenthos op het Nederlands Continentaal Plat (Holtmann et al. 1996b). De gegevens zijn samengebracht in een relationeel gegevensbestand, beheerd op het NIOO-CEMO.

De data voor de visserij-intensiteit zijn verkregen in het kader van onderzoek naar de microverspreiding van de Nederlandse boomkorvisserij. Dit onderzoek loopt sinds 1993 (Rijnsdorp et al. 1994). De visserij-intensiteit werd uitgedrukt in de bevissingsintensiteit, dit is het aantal keer dat binnen een vak van 1x1 of 3x3 mijl een vierkante meter van de zeebodem door een boomkor wordt bevist. Voor dit onderzoek waren gegevens beschikbaar vanaf 1-4-1993 tot en met 1-4-1997. Het betreft een totale bevissingsintensiteit over deze periode berekend per 1x1 mijl vak en 3x3 mijl vak. Er is uitgegaan van een homogene visserij binnen een vak, en er is aangenomen dat de steekproef van 13% van de schepen representatief is voor de gehele boomkorvisserij. Ook is aangenomen dat deze verspreiding van de visserij ook gold in de periode waarin de bodemdiergegevens verzameld zijn (1986-1993).

Alle voor het benthos bemonsterde stations zijn via hun positie gekoppeld aan het dichtstbijzijnde vak van 1x1 mijl en 3x3 mijl waarvoor bevissingsintensiteit gegevens beschikbaar waren. Naast visserij-intensiteit zijn voor iedere lokatie ook de diepte, het slibgehalte en de mediane korrelgrootte van het sediment bekend. Voor de Milzon-gegevens uit 1988 is de diepte niet bekend. De diepte lag echter tussen de 20 en 30 m, en in de dataset zijn deze ontbrekende waarden op 25 m gezet.

Vaststellen van voor het benthos homogene gebieden

De verdere analyses zijn uitgevoerd in twee voor het zoöbenthos vrij homogene gebieden. Als homogene gebieden zijn de levensgemeenschappen zoals vastgesteld in Holtmann et al. (1996a, b) gekozen. Nagegaan is waar ook voldoende gegevens over de visserij-intensiteit beschikbaar waren (bijv. niet in het kustgebied), en waar voldoende verschillen in visserij-intensiteit bestonden. Uiteindelijk zijn volgende gebieden geselecteerd:

- een uit de kust gelegen gebied in de ICES-kwadranten 34F3 en 35F3, verder OFFSHORE genoemd. In dit gebied zijn gegevens voorhanden van 61 stations.
- een gebied in de ICES-kwadranten 36F3, 36F4, 37F3, 37F4 en 37F5, het OESTER-GRONDEN gebied. Hier zijn gegevens over 81 stations bekend.

Figuren 2.1 en 2.2 geven de ligging van de lokaties en een overzicht over de verschillen in visserij-intensiteit tussen en binnen de gekozen gebieden.

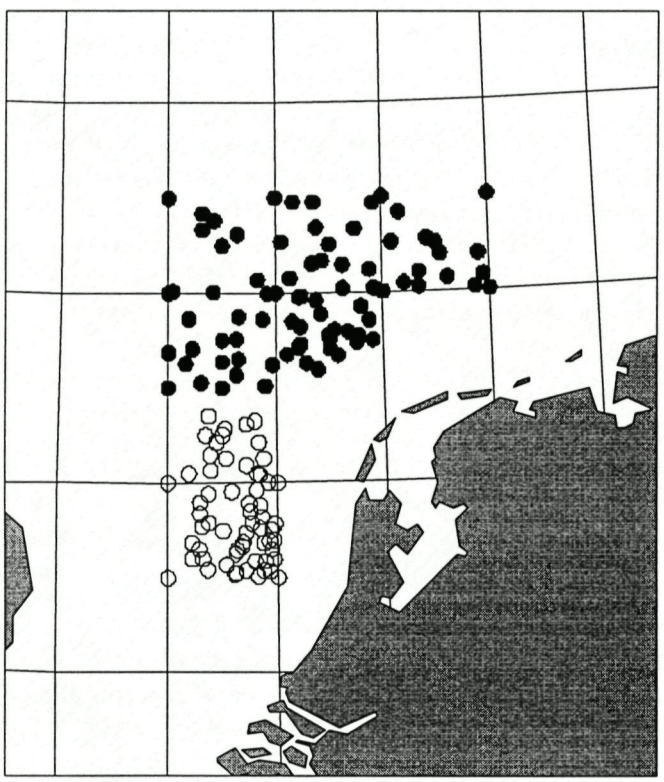


Fig. 2.1. Onderzoeksgebieden in deze studie (open cirkels: offshore; gesloten cirkels: oestergronden).

Analyses

Verschillen in de soortensamenstelling binnen ieder homogeen gebied (OFFSHORE en OYSTERGROUND) zijn nader geanalyseerd met ordinatie-technieken. De ordinaties zijn uitgevoerd met behulp van het programma CANOCO (ter Braak 1988) en als ordenings-methode zijn CCA (canonical correspondence analysis) en RDA (redundancy analysis) gekozen. RDA gaat uit van een lineaire respons van de soorten op de omgevingsvariabelen, CCA gaat ervan uit dat de soorten bij benadering volgens een Gauss-kromme op de omgevingsvariabelen reageren (Jongman et al. 1987).

Bij de analyses zijn naast de visserij-intensiteit ook diepte, slibgehalte en mediane korrelgrootte als omgevingsvariabelen meegegenomen. Het effekt van deze variabelen (in dit geval covariabelen) is ook eerst uit de analyse geëlimineerd, waarna nagegaan wordt in hoeverre een deel van de resterende variantie verklaard kan worden aan de hand van verschillen in visserij-intensiteit. Voor de gekozen gebieden zijn afzonderlijke analyses uitgevoerd. Een apart analyse is uitgevoerd met de visserij-intensiteit berekend per vak van 1x1 mijl, en per vak van 3x3 mijl.

Uitsluitend soorten die in meer dan 10% van alle monsters voorkwamen, zijn in de analyses meegenomen (zie appendices 1 en 2). De gegevens zijn logaritmisch getransformeerd.

Daarnaast is afzonderlijk aandacht besteed aan één familie, de Spionidae. Spioniden behoren tot de borstelwormen en zijn veelal opportunistische soorten met een lage reproduktieleeftijd, een korte levensduur en een hoge produktiviteit (zie o.a. Gudmundsson 1985). Via lineaire regressie is de totale dichtheid (log-getransformeerd) en de visserij-intensiteit vergeleken.

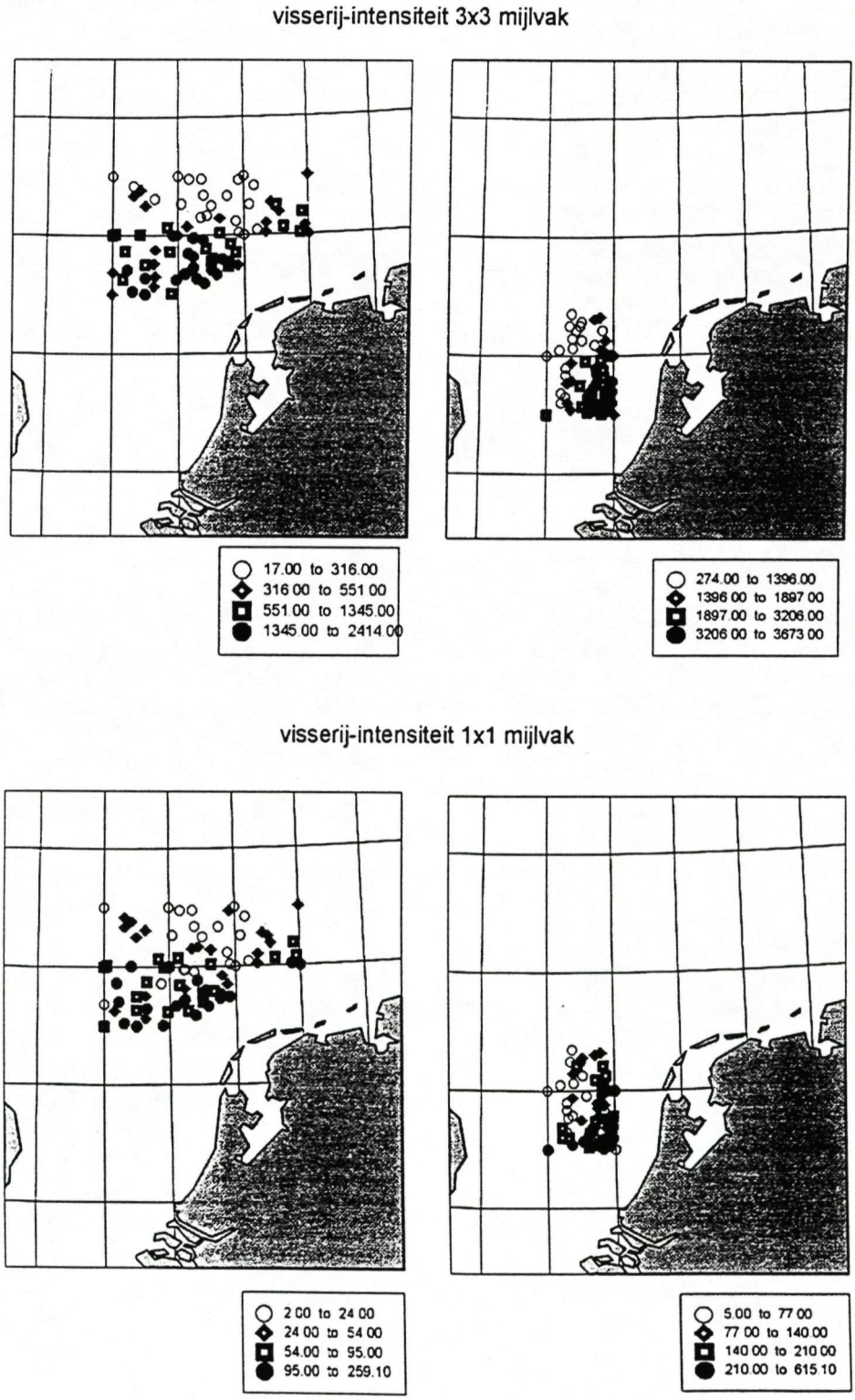


Fig. 2.2. Microverspreiding van de visserij-intensiteit in de twee onderzoeksgebieden.

Resultaten

Offshore

Soortensamenstelling

De volgende tabel geeft een overzicht van CCA's waarbij diepte, slibgehalte, mediane korrelgrootte of één van beide visserij-intensiteiten (1x1 mijl- en 3x3 mijlvakken) als omgevingsvariabele gebruikt is. De positie langs de eerste as (gekozen in funktie van de betreffende omgevingsvariabele) is met een Monte Carlo-permutatietest getest (999 permutaties).

Omgevingsvariabele	% door as 1 verklaard	p (Monte Carlo-permutatietest)
diepte	3.1	0.01
slibgehalte	4.6	0.02
mediane korrelgrootte	2.5	0.01
visserij-intensiteit (1x1 mijl)	1.7	0.06
visserij-intensiteit (3x3 mijl)	3.3	0.00

Het is duidelijk dat, ook al hebben we met 'homogene' gebieden te maken, een deel van de variantie in de soortensamenstelling te verklaren is door verschillen in diepte en sedimentsamenstelling.

Analyses waarbij diepte en sedimentsamenstelling als covariabelen meegenomen worden (en het effekt van deze variabelen dus geëlimineerd wordt), geven de volgende resultaten:

Ordeningsmethode	Visserij-intensiteit	% door as 1 verklaard	p (permutatietest)
CCA	1x1 mijl	2.2	0.01
	3x3 mijl	3.5	0.07
RDA	1x1 mijl	2.0	0.00
	3x3 mijl	3.4	0.00

Uit de ordinatie-diagrammen van de vier analyses (niet afgebeeld) blijkt dat de volgende 20 soorten gemiddeld meer of juist minder voorkomen op lokaties met een hogere visserij-intensiteit (zie appendix 1 voor de codes):

	RDA		CCA	
	1x1 mijl	3x3 mijl	1x1 mijl	3x3 mijl
minder	PONT ALTA	Luna poli	ETEO FOLI	EUMI SANG
	SCOL ARMI	NEPH HOMB	SCOL ARMI	PSEU LONG
	NEME RTIN	STHE LIMI	OPHE LIMA	PONT ALTA
	BATH ELEG	ETEO FOLI	PSEU SIM	SIGA MATH
	ETEO FOLI	OPHE LIMA	PONT ALTA	NEPH HOMB
	ECHI PUSI	Fabu fabu	DIAS BRAD	STHE LIMI
	OPHE LIMA	MYSE BIDE	SCOL BONN	OPHE LIMA
	UROT BREV	PONT ALTA	ECHI PUSI	ETEO FOLI
	PSEU LONG	SPIO FILI	UROT BREV	OPHI SPEC
	SCOL BONN	PSEU LONG	PSEU LONG	MYSE BIDE
meer	SIGA MATH	BATH GUIL	THIA SCUT	NEPH CAEC
	ANAI GROE	ARIC MINU	PERI LONG	TRAV FORB
	PERI LONG	TRAV FORB	NEPH HOMB	OPHE BOR
	GAST SPIN	NEPH CAEC	GAST SPIN	ATYL SWAM
	MAGE PAPI	OPHE BOR	Tell ferr	DIAS BRAD
	Tell ferr	SCOL SQUA	ANAI GROE	THIA SCUT
	SCOL SQUA	THIA SCUT	SCOL SQUA	ANAI GROE
	HARM LUNU	ATYL SWAM	SIGA MATH	SCOL SQUA
	BATH GUIL	NEPH CIRR	HARM LUNU	PSEU SIM
	ATYL SWAM	LANI CONC	ATYL SWAM	BATH GUIL

Ongeacht de methode blijkt dat *Pontocrates altamarinus* (PONT ALTA), *Eteone foliosa* (ETEO FOLI), *Ophelia limacina* (OPHE LIMA) en *Pseudocuma longicornis* (PSEU LONG) minder voor te komen op lokaties met een hogere visserij-intensiteit, *Scolelepis squamata* (SCOL SQUA) en *Atylus swammerdami* (ATYL SWAM) meer op lokaties met een hoge visserij-intensiteit.

Spionidae

De visserij-intensiteit blijkt een signifikant deel van de variantie in de (log getransformeerde) totale dichtheid van de spioniden te verklaren:

Visserij-intensiteit	p
1x1 mijl	0.006
3x3 mijl	0.045

Op lokaties met een hogere bevissingsintensiteit komen Spionidae in hogere dichtheden voor dan op lokaites met een lagere bevissingsintensiteit.

Oestergronden

Soortensamenstelling

Volgende tabel geeft een overzicht van CCA's waarbij diepte, slibgehalte, mediane korrelgrootte of één van beide visserij-intensiteiten (1x1 mijl- en 3x3 mijlvakken) als omgevingsvariabele gebruikt is. De positie langs de eerste as (gekozen in funktie van de betreffende omgevingsvariabele) is met een Monte Carlo-permutatietest getest (999 permutaties).

Omgevingsvariabele	% door as 1 verklaard	p (Monte Carlo-permutatietest)
diepte	1.9	0.01
slibgehalte	2.6	0.01
mediane korrelgrootte	3.0	0.01
visserij-intensiteit (1x1 mijl)	1.3	0.00
visserij-intensiteit (3x3 mijl)	1.3	0.00

Ook in dit gebied is een deel van de variantie in de soortensamenstelling te verklaren door verschillen in diepte en sedimentsamenstelling.

Analyses waarbij diepte en sedimentsamenstelling als covariabelen worden gekozen, geven het volgende resultaat:

Ordeningsmethode	Visserij-intensiteit	% door as 1 verklaard	p (permutatietest)
CCA	1x1 mijl	1.5	0.00
	3x3 mijl	2.3	0.00
RDA	1x1 mijl	0.9	0.00
	3x3 mijl	1.4	0.00

Uit de ordinatie-diagrammen van de vier analyses (niet afgebeeld) blijkt dat volgende 20 soorten gemiddeld meer of juist minder voorkomen op lokaties met een hogere visserij-intensiteit (zie appendix 2 voor de codes):

	RDA		CCA	
	1x1 mijl	3x3 mijl	1x1 mijl	3x3 mijl
minder	CORB GIBB	SCOL ARMI	AMPE BREV	AMPE BREV
	SIGA MATH	SIGA MATH	CORB GIBB	Arct isla
	AMPE BREV	AMPE BREV	Arct isla	DOSI LUPI
	CYLI CYL	Amph auri	NEPH CIRR	GLYC NOR
	STHE LIMI	Arct isla	SIGA MATH	Mage
	Nucu lten	Nucu lten	Nucu lten	ARGI HAMA
	Arct isla	CORB GIBB	EUDO DEF	Levi grac
	Amph auri	CYLI CYL	DOSI LUPI	EUDO DEF
	OWEN FUSI	Levi grac	AONI PAUC	SIGA MATH
	NEPH CIRR	SPIO BOMB	Levi grac	SCOL ARMI
meer	POEC SERP	STHE LIMI	POEC SERP	NERE LONG
	Gypt cape	NERE LONG	HARM LUNU	POLY SPEC
	LANI CONC	CALL SUBT	LUMB LATR	STHE LIMI
	UROT POSE	Minu cirr	ETEO LONG	Gypt cape
	OPHI FLE	Gypt cape	LANI CONC	SIPU NCUX
	Fabu fabu	SIPU NCUX	Fabu fabu	Minu cirr
	BATH ELEG	Upog delt	BATH ELEG	Upog delt
	LUMB LATR	THRA CON	UROT POSE	LUMB LATR
	SCAL INFL	LUMB LATR	SCAL INFL	THRA CON
	ECHI CARZ	MYSE BIDE	THRA PHAS	POEC SERP

Steeds blijken *Sigalion mathildae* (SIGA MATH), *Ampelisca brevicornis* (AMPE BREV) en *Arctica islandica* (ARCT ISLA) minder voor te komen op lokaties met een hogere visserij-intensiteit, *Lumbrineris latreilli* (LUMB LATR) meer op lokaties met een hoge visserij-intensiteit.

Spionidae

Slechts als de meest gedetailleerde visserij-intensiteit gebruikt wordt (1x1 mijlvakken) blijkt visserij-intensiteit een signifikant deel van de variantie in de (log getransformeerde) totale dichtheid van de spioniden te kunnen verklaren:

Visserij-intensiteit	p
1x1 mijl	0.029
3x3 mijl	0.709

Net zoals in het offshore-gebied hebben spioniden op de meest beviste lokaties een hogere dichtheid dan op minder beviste lokaties.

Discussie

Zowel in het OFFSHORE- als in het OESTERGRONDEN-gebied blijkt de fauna in de sterk beviste gebieden anders dan in de minder beviste gebieden. De multivariate analyses (ordinaties) geven verschillen aan in de aantallen *Sigalion mathildae*, *Ampelisca brevicornis*, *Arctica islandica* en *Lumbrineris latreilli* in de OESTERGRONDEN, *Pontocrates altamarinus*, *Eteone foliosa*, *Echinocardium*, *Ophelia limacina*, *Pseudocuma longicornis*, *Scolelepis squamata* en *Atylus swammerdami* in het OFFSHORE-gebied. *Scolelepis squamata*, *Atylus swammerdami*, en *Lumbrineris latreilli* komen in hogere dichtheden voor op lokaties met een hogere visserij-intensiteit, de overige soorten in lagere dichtheden.

De lagere dichtheden van *Arctica islandica* en *Ampelisca brevicornis* op intensief beviste lokaties zijn hoogstwaarschijnlijk een rechtstreeks gevolg van die visserij.

De noordkromp, *Arctica islandica*, is een filter-feeder en leeft ingegraven in de bovenlaag van het sediment. In de Noordzee komt de soort vrijwel overal voor ten noorden van de 30 m dieptelijn. Over de Noordkromp is veel bekend. Een overzicht over de auto-ecologie, verspreiding en effekten van verstoringen is te vinden in Witbaard (1995). De soort kan beschouwd worden als een typische K-strateeg. Zijn trage groei en lage recruitment maken dat de populatie zich slechts langzaam kan herstellen van verstoringen. Voor bodemvisserij blijken de dieren zeer gevoelig. Grote aantallen worden door over de bodem gesleepte vistuigen beschadigd.

Vlokreeftjes van het genus *Ampelisca* leven aan de oppervlakte van het sediment in een kokertje (zie bijv. Fig. 6.B. in Valente et al. 1992). De diertjes voeden zich met in suspensie zijnde partikels (Enequist 1949). Ze zijn in hun tweede levensjaar volwassen, en vrouwtjes planten zich eenmaal voort (Klein et al. 1975). Een grote instabiliteit van de bodem, bijv. door verstoring door visserij, zal de (blijvende) vestiging van *Ampelisca* verhinderen.

Voor een aantal soorten is een effekt van visserij op de dichtheid niet waarschijnlijk, bijv. voor het vlokreeftje *Pontocrates altamarinus*. Het diertje wordt op het Nederlands Continentaal Plat (NCP) vooral gevonden ten zuiden van de 30m isolijn. De hoogste dichtheden zijn gevonden tussen 53°30'N en 52°30' N (Holtmann et al. 1996b). De diertjes leven op en in de bovenste sedimentlaag, en leven er van het gesedimenteerd detritus (Enequist 1949). Maar ze kunnen blijkbaar ook op ander voedsel overschakelen (Beare & Moore 1994 in Holtmann et al. 1996a). Ze prefereren bodems met een laag slibgehalte (Holtmann et al. 1996b). Gezien het verspreidingspatroon op het NCP, is het feit dat het diertje praktisch niet in het zuidelijkste deel van het OFFSHORE gebied voorkomt (waar de visserij-intensiteit het hoogst is) hoogstwaarschijnlijk niet aan visserij toe te schrijven.

Voor de overige soorten is het onduidelijk hoe visserij een positief of negatief effekt kan hebben.

De borstelworm *Eteone foliosa* komt in zowat alle soorten sediment voor, en leeft op en in de bovenste centimeters van de bodem. De Phyllodocidae, de familie waartoe *E. foliosa* behoort, zijn allen carnivoor (Fauchald & Jumars 1979). De borstelworm *Sigalion mathildae* leeft iets dieper (15 tot 20 cm onder de oppervlakte van het sediment), meestal in fijn tot zeer fijn zand met een laag slibgehalte. Ook deze dieren zijn vrijlevend en carnivoor. (Holtmann et al. 1996b). Over de levenscyclus van beide soorten is verder niets bekend (Hartmann-Schröder 1996). De dieren kunnen blijkbaar niet profiteren van het extra voedselaanbod dat door bodemomwoeling aan de oppervlakte komt.

Ook van het kommakreeftje *Pseudocuma longicornis* zou verwacht kunnen worden dat het van een verhoogd voedselaanbod kan profiteren. Het kommakreeftje leeft in de bovenste sedimentlaag, maar zwemt ook vrij vaak. (Jones 1976). Kommakreeftjes leven van micro-organismen en organisch materiaal dat op de bodem gesedimenteerd is. Daarenboven hebben de dieren een korte levenscyclus: ze leven waarschijnlijk hoogstens een jaar en broeden tweemaal per jaar (Holtmann et al. 1996b).

Atylus falcatus hoort waarschijnlijk eigenlijk tot het epibenthos, maar zwemt ook dikwijls rond en wordt daarom ook steeds in het hyperbenthos gevonden (Cattrijse et al. 1993). Het diertje is dus niet zo van de bodemstabiliteit afhankelijk, en zal zeker niet negatief beïnvloed worden door bodemvisserij. Over de voedingswijze van *A. falcatus* is echter niets bekend. Misschien kan deze soort profiteren van een verhoogd voedselaanbod.

De borstelworm *Scolelepis squamata* wordt vooral ten noorden van de Waddeneilanden en uit de Hollandse kust gevonden (Holtmann et al. 1996b). De dieren hebben een sterke voorkeur voor goed gesorteerd sediment (Wolff 1973). *S. squamata* leeft tot dieptes van ongeveer 40 cm in het sediment, in verticale gangen. De dieren houden hun paar mucus afscheidende palpen (tastorganen) op zo'n manier in het water dat in suspensie zijnde voedselpartikels gevangen worden (Dauer 1983). In gebieden met een sterke golfinwerking (bijv. rond de Hinderplaat in de monding van het Haringvliet - Craeymeersch et al. 1996) kunnen ze zo zeer efficiënt de in resuspensie gebrachte partikels wegvangen.

Lumbrineris lattreilli is een borstelworm die in grote aantallen voorkomt rond het Friese Front (Holtmann et al., 1996b). De soort komt zowel voor in slibbig fijn zand als in grove zanden (Hartmann-Schröder, 1996). De dieren hebben een niet-pelagische ontwikkeling.

Ophelia limacina is een borstelworm typisch voor zuivere zanden (Bellan & Dauvin 1991, Dauvin et al. 1993). Op het NCP komt de soort vooral in het zuidelijk deel gevonden. Verder komt het dier ook ten noorden van de Waddeneilanden, op de Klaverbank en op de Doggersbank voor (Holtmann et al. 1996a). *O. limacina* is een niet selectieve deposit feeder.

Voor een aantal soorten (*Arctica islandica, Ampelisca brevicornis*) is het dus te verwachten dat ze in lagere aantallen voorkomen in de meest intensief beviste gebieden. Ook volgens verwachting is de totale dichtheid aan Spionidae het hoogst op lokaties met een hogere visserij-intensiteit. Voor andere soorten is een positieve of negatieve beïnvloeding, gezien de bestaande informatie over hun auto-ecologie, niet voor de hand liggend. Het is daarom aannemelijk dat de waargenomen verschillen tussen sterk beviste en licht beviste gebieden te wijten zijn aan verschillen in een of meerdere omgevingsvariabelen. Waarschijnlijk hebben de verschillende gebieden een andere aantrekkingskracht voor platvissen, en zijn er daarom ook verschillen in de bevissings-intensiteit (zie ook subproject 4).

Bij nader inzien blijken de homogene gebieden toch niet zo homogeen. Er zijn voldoende ruimtelijke verschillen in de bodemdiersamenstelling die niet aan visserij toegeschreven kunnen worden, zelfs na correctie voor diepte en sedimentsamenstelling. In het OESTERGRONDEN-gebied kan hierbij gedacht worden aan verschillen in de hydrodynamische omstandigheden (getijdstromen, golfinwerking), waterkolom (primaire produktie, chlorofyl) en bodem (POC, stabiliteit) gaande van het zuid (Friese Front) naar noord (zie o.a. Jenness & Duineveld 1985, de Gee et al. 1991).

Referenties

Bellan, G. and Dauvin, J.-C., 1991. Phenetic and biogeographic relationships in *Ophelia* (Polychaeta, Opheliidae). Bull. Mar. Sci., 48: 544-558.

Cattrijsse, A., Mees, J. and Hamerlynck, O., 1993. The hyperbenthic Amphipoda and Isopoda of the Voordelta and the Westerschelde estuary. Cah. Biol. Mar., 34: 187-200.

Craeymeersch, J.A., Brummelhuis, E.B.M., Dimmers, W., Schout, P., Timmermans, B. and Sistermans, W., 1996, Het macrobenthos in de Haringvlietbuitendelta in het najaar 1994, Monitoring in het kader van het evaluatie-onderzoek naar de effekten van de aanleg van de grootschalige lokatie voor de berging van baggerspecie. NIOO-CEMO. 42 pp.

Dauer, D.M., 1983. Functional morphology and feeding behavior of *Scolelepis squamata* (Polychaeta: Spionidae). Mar. Biol., 72: 279-285.

Dauvin, J.-C., Bellan-Santini, D. and Bellan, G., 1993. Les genres *Ophelia* et *Ampelisca* de la rJgion de Roscoff: exemples d'allotopie et de syntopie dans les communautJs marines de substrat meuble. Cah. Biol. Mar., 34: 1-15.

de Gee, A., Baars, M.A. and van der Veer, H.W., 1991, De ecologie van het Friese Front. Waarnemingen aan een biologisch-rijke zone in de Noordzee, gelegen tussen de Zuidelijke Bocht en de Oestergronden; Nederlands Instituut voor Onderzoek der Zee. NIOZ-Rapport 1991-2.

Enequist, P., 1949. Studies on the soft-bottom amphipods of the Skagerak. Zool. Bidr. Uppsala, 26: 297-492.

Fauchald, K. and Jumars, P.A., 1979. The diet of worms: a study of polychaete feeding guilds. Oceanogr. Mar. Biol. Ann. Rev., 17: 193-284.

Gudmundsson, H., 1985. Life history patterns of polychaete species of the family Spionidae. J. mar. Biol. Assoc. U.K., 65: 93-111.

Hartmann-Schröder, G., 1996, Annelida, Borstenwhrmer, Polychaeta [2nd ed.]: Jena, Fischer, 648 p.

Hayward, P.J. and Ryland, J.S., 1990, The marine fauna of the British Isles and north-west Europe: Oxford, Osvord Science Publications, 996 p.

Holtmann, S.E., Belgers, J.J.M., Kracht, B. and Daan, R., 1996a, The macrobenthic fauna in the Dutch sector of the North Sea in 1995 and a comparison with previous data, NIOZ-Rapport 1996-8.

Holtmann, S.E., Groenewold, A., Schrader, K.H.M., Asjes, J., Craeymeersch, J.A., Duineveld, G.C.A., van Bostelen, A.J. and van der Meer, J., 1996b, Atlas of the zoobenthos of the Dutch Continental Shelf:

Rijkswijk, Ministry of Transport, Public Works and Water Management, North Sea Directorate, 244 p.

Jenness.MI and Duineveld, G.C.A., 1985. Effects of tidal currents on chlorophyll *a* content of sandy sediments in the southern North Sea. Mar. Ecol. Prog. Ser., 21: 283-287.

Jones, N.S., 1976, British Cumaceans (Synopses of British Fauna (New Series) No. 7): London, Academic Press, 63 p.

Jongman, R.H.G., ter Braak, C.J.F. and van Tongeren, O.F.R., 1987, Data analysis in community and landscape ecology: Wageningen, Pudoc, 299 p.

Klein, G., Rachor, E. and Gerlach, S.A., 1975. Dynamics and productivity of two populations of the benthic tube-dwelling amphipod *Ampelisca brevicornis* (Costa) in Helgoland Bight. Ophelia, 14: 139-159.

Rijnsdorp, A.D., Buys, A.M., Storbeck, F. and Visser, E., 1994, De microverspreiding van de nederlandse boomkorvisserij in 1993-1994, RIVO Rapport CO 18/94.

ter Braak, C.J.F., 1988. CANOCO - an extension of DECORANA to analyze species-environment relationships. Vegetatio, 75: 159-160.

Valente, R.M., Rhoads, D.C., Germano, J.D. and Cabelli, V.J., 1992. Mapping of benthic enrichment patterns in Narragansett Bay, Rhode Island. Estuaries, 15: 1-17.

Witbaard, R., 1995, Ecoprofiel Noordkromp. Een overzicht van de ecologie en biologie van *Arctica islandica*, Nederlands Instituut voor Onderzoek der Zee, Texel.

Wolff, W.J., 1973, The estuary as a habitat. An analysis of data on the soft-bottom macrofauna of the estuarine area of the rivers Rhine, Meuse and Scheldt, No. 126 of Zoogische Verhandelingen: Leiden, Brill: 242 p.

Appendix 2.1. Soorten meegenomen in analyse van OFFSHORE gebied

Phylum	Familie	Code	Latijnse naam
Annelida	Cirratuloidea	CHAESETO	Chaetozone setosa
Annelida	Goniadidae	GONIMACU	Goniada maculata
Annelida	Magelonidae	MAGEPAPI	Magelona papillicornis
Annelida	Nephtyidae	NEPHCAEC	Nephtys caeca
Annelida	Nephtyidae	NEPHCIRR	Nephtys cirrosa
Annelida	Nephtyidae	NEPHHOMB	Nephtys hombergii
Annelida	Nephtyidae	NEPHLONG	Nephtys longosetosa
Annelida	Opheliidae	OPHE BOR	Ophelia borealis
Annelida	Opheliidae	OPHELIMA	Ophelia limacina
Annelida	Opheliidae	TRAVFORB	Travisia forbesii
Annelida	Orbiniidae	SCOLARMI	Scoloplos armiger
Annelida	Paraonidae	ARICMINU	Aricidea minuta
Annelida	Phyllodocidae	ANAIGROE	Anaitides groenlandica
Annelida	Phyllodocidae	ETEOFOLI	Eteone foliosa
Annelida	Phyllodocidae	ETEOLONG	Eteone longa
Annelida	Phyllodocidae	EUMISANG	Eumida sanguinea
Annelida	Polynoidae	HARMLUNU	Harmothoe lunulata
Annelida	Sigalionidae	SIGAMATH	Sigalion mathildae
Annelida	Sigalionidae	STHELIMI	Sthenelais limicola
Annelida	Spionidae	SCOLBONN	Scolelepis bonnieri
Annelida	Spionidae	SCOLSQUA	Scolelepis squamata
Annelida	Spionidae	SPIOBOMB	Spiophanes bombyx
Annelida	Spionidae	SPIOFILI	Spio filicornis
Annelida	Terebellidae	LANICONC	Lanice conchilega
Arthropoda	Oedicerotidae	PERILONG	Perioculodes longimanus
Arthropoda	Atylidae	ATYLSWAM	Atylus swammerdami
Arthropoda	Corystidae	CORYCASS	Corystes cassivelaunus
Arthropoda	Diastylidae	DIASBRAD	Diastylis bradyi
Arthropoda	Gammaridae	MEGAAGIL	Megaluropus agilis
Arthropoda	Haustoriidae	BATHELEG	Bathyporeia elegans
Arthropoda	Haustoriidae	BATHGUIL	Bathyporeia guilliamsoniana
Arthropoda	Haustoriidae	UROTBREV	Urothoe brevicornis
Arthropoda	Haustoriidae	UROTPOSE	Urothoe poseidonis
Arthropoda	Lysianassidae	HIPPDENT	Hippomedon denticulatus
Arthropoda	Mysidae	GASTSPIN	Gastrosaccus spinifer
Arthropoda	Oedicerotidae	PONTALTA	Pontocrates altamarinus
Arthropoda	Pseudocumidae	PSEU SIM	Pseudocuma similis
Arthropoda	Pseudocumidae	PSEULONG	Pseudocuma longicornis
Arthropoda	Thiidae	THIASCUT	Thia scutellata
Echinodermata	Fibulariidae	ECHIPUSI	Echinocyamus pusillus
Echinodermata	Ophiolepidae	OPHIALBI	Ophiura albida
Echinodermata	Ophiolepidae	OPHISPEC	Ophiura
Echinodermata	Spatangidae	ECHICORD	Echinocardium cordatum
Mollusca	Donacidae	DONAVITT	Donax vittatus
Mollusca	Montacutidae	MYSEBIDE	Mysella bidentata
Mollusca	Montacutidae	TELLFERR	Montacuta ferruginosa
Mollusca	Naticidae	LUNAPOLL	Lunatia poliana
Mollusca	Tellinidae	FABUFABU	Fabulina fabula
Nemertea	Nemertea indet.	NEMERTIN	NEMERTEA

Appendix 2.2. Soorten meegenomen in analyse van OESTERGRONDEN gebied

Phylum	Familia	Scode	Latin name
Annelida	Pectinariidae	Amphauri	Amphictene auricoma
Annelida	Phyllodocidae	ANAIROSE	Anaitides rosea
Annelida	Spionidae	AONIPAUC	Aonides paucibranchiata
Annelida	Chaetopteridae	CHAE VAR	Chaetopterus variopedatus
Annelida	Cirratuloidea	CHAESETO	Chaetozone setosa
Annelida	Flabelligeridae	DIPLGLAU	Diplocirrus glaucus
Annelida	Phyllodocidae	ETEOLONG	Eteone longa
Annelida	Aphroditidae	GATTCIRR	Gattyana cirrosa
Annelida	Goniadidae	GLYC NOR	Glycinde nordmanni
Annelida	Glyceridae	GLYC ROU	Glycera rouxi
Annelida	Goniadidae	GONIMACU	Goniada maculata
Annelida	Hesionidae	Gyptcape	Gyptis capensis
Annelida	Polynoidae	HARMGLAB	Harmothoe glabra
Annelida	Polynoidae	HARMLUNU	Harmothoe lunulata
Annelida	Pectinariidae	Lagikore	Lagis koreni
Annelida	Pectinariidae	Lagikore	Pectinaria koreni
Annelida	Terebellidae	LANICONC	Lanice conchilega
Annelida	Paraonidae	Levigrac	Levinsenia gracilis
Annelida	Lumbrineridae	LUMBLATR	Lumbrineris latreilli
Annelida	Magelonidae	Mage	Magelona
Annelida	Magelonidae	MAGEPAPI	Magelona papillicornis
Annelida	Spionidae	Minucirr	Minuspio cirrifera
Annelida	Nephtyidae	NEPHCIRR	Nephtys cirrosa
Annelida	Nephtyidae	NEPHHOMB	Nephtys hombergii
Annelida	Nephtyidae	NEPHSPEC	Nephtys
Annelida	Nereidae	NERELONG	Nereis longissima
Annelida	Capitellidae	NOTOLATE	Notomastus latericeus
Annelida	Opheliidae	Opheacum	Ophelina acuminata
Annelida	Hesionidae	OPHI FLE	Ophiodromus flexuosus
Annelida	Oweniidae	OWENFUSI	Owenia fusiformis
Annelida	Sigalionidae	PHOLMINU	Pholoe minuta
Annelida	Sigalionidae	PHOLSPEC	Pholoe
Annelida	Poecilochaetidae	POECSERP	Poecilochaetus serpens
Annelida	Spionidae	POLYSPEC	Polydora
Annelida	Scalibregmidae	SCALINFL	Scalibregma inflatum
Annelida	Orbiniidae	SCOLARMI	Scoloplos armiger
Annelida	Sigalionidae	SIGAMATH	Sigalion mathildae
Annelida	Spionidae	SPIOBOMB	Spiophanes bombyx
Annelida	Spionidae	SPIOFILI	Spio filicornis
Annelida	Sigalionidae	STHELIMI	Sthenelais limicola
Annelida	Pilargiidae	SYNE KLA	Synelmis klatti
Arthropoda	Ampeliscidae	AMPE TEN	Ampelisca tenuicornis
Arthropoda	Ampeliscidae	AMPEBREV	Ampelisca brevicornis
Arthropoda	Argissidae	ARGIHAMA	Argissa hamatipes
Arthropoda	Haustoriidae	BATHELEG	Bathyporeia elegans
Arthropoda	Haustoriidae	BATHGUIL	Bathyporeia guilliamsoniana
Arthropoda	Haustoriidae	Bathtenu	Bathyporeia tenuipes
Arthropoda	Callianassidae	CALLSUBT	Callianassa subterranea
Arthropoda	Corystidae	CORYCASS	Corystes cassivelaunus
Arthropoda	Diastylidae	DIASBRAD	Diastylis bradyi
Arthropoda	Leuconidae	EUDO DEF	Eudorellopsis deformis
Arthropoda	Leuconidae	EUDO TRU	Eudorella truncatula
Arthropoda	Phoxocephalidae	Harpante	Harpinia antennaria
Arthropoda	Lysianassidae	HIPPDENT	Hippomedon denticulatus
Arthropoda	Bopyridae	Ionethor	Ione thoracica
Arthropoda	Leucothoidae	LEUCINCI	Leucothoe incisa

Phylum	Familia	Scode	Latin name
Arthropoda	Oedicerotidae	PERILONG	Perioculodes longimanus
Arthropoda	Pseudocumidae	PSEULONG	Pseudocuma longicornis
Arthropoda	Callianassidae	Upogdelt	Upogebia deltaura
Arthropoda	Haustoriidae	UROTPOSE	Urothoe poseidonis
Cnidaria	Anthozoa indet.	ANTHOZOA	ANTHOZOA
Echinodermata	Amphiuridae	AMPH FIL	Amphiura filiformis
Echinodermata	Spatangidae	ECHICORD	Echinocardium cordatum
Echinodermata	Synaptidae	Leptinha	Leptosynapta inhaerens
Echinodermata	Ophiolepidae	OPHIALBI	Ophiura albida
Echinodermata	Ophiolepidae	OPHISPEC	Ophiura
Mollusca	Scrobiculariidae	ABRAALBA	Abra alba
Mollusca	Cyprinidae	Arctisla	Arctica islandica
Mollusca	Veneridae	Chamgall	Chamelea gallina
Mollusca	Veneridae	Chamgall	Venus striatula
Mollusca	Erodonidae	CORBGIBB	Corbula gibba
Mollusca	Cylichnidae	CYLI CYL	Cylichna cylindracea
Mollusca	Veneridae	DOSILUPI	Dosinia lupinus
Mollusca	Tellinidae	Fabufabu	Fabulina fabula
Mollusca	Iravadiidae	Hyalvitr	Cingula vitrea
Mollusca	Iravadiidae	Hyalvitr	Hyala vitrea
Mollusca	Leptonidae	Leptsqua	Lepton squamosum
Mollusca	Naticidae	Lunapoli	Lunatia poliana
Mollusca	Naticidae	Lunapoli	Natica alderi
Mollusca	Montacutidae	MYSEBIDE	Mysella bidentata
Mollusca	Petricolidae	Mysiunda	Mysia undata
Mollusca	Nuculidae	Nuculten	Nucula tenuis
Mollusca	Nuculidae	Nucuniti	Nucula nitidosa
Mollusca	Solenidae	Phaxpell	Cultellus pellucidus
Mollusca	Solenidae	Phaxpell	Phaxas pellucidus
Mollusca	Montacutidae	Tellferr	Montacuta ferruginosa
Mollusca	Thraciidae	THRA CON	Thracia convexa
Mollusca	Thraciidae	Thraphas	Thracia phaseolina
Nemertea	Nemertea indet.	NEMERTIN	NEMERTEA
Phoronida	Phoronidae	PHORINDE	Phoronidae
Sipunculida	Sipunculidae	Golfvulg	Golfingia vulgaris
Sipunculida	Sipunculidae	SIPUNCUX	Sipunculidae

DE EPIFAUNA IN DE ZUIDELIJKE NOORDZEE: VERANDERINGEN DOOR HET INSTELLEN VAN DE SCHOLBOX?

34002

J.A. Craeymeersch, J. Buijs (NIOO-CEMO)
G.J. Piet, A.D. Rijnsdorp (RIVO-DLO)

Inleiding

In 1989 is de scholbox, een voor bepaalde visserij gesloten gebied in de Noordzee, in werking gesteld (EEC Council regulation No 4193/88). Van 1 april tot en met 30 september gelden er volgende regels (Piet & Rijnsdorp 1997):

- Geen visvangst in de box binnen de 12 mijlszone door vaartuigen groter dan 8 m die boomkor en otterborden gebruiken (EEC Council regulation No 3094/86).
- Geen visvangst in de box met vaartuigen met boomkor of otterborden, en een motorvermogen groter dan 300 pk.

Andere schepen mogen in de box vissen, indien zij voldoen aan de volgende eisen:

1. aangemeld en motorvermogen niet hoger dan 300 pk (ook boomkorvisserij);
2. niet aangemeld, maar vissend op garnalen;
3. niet aangemeld, maar vissend met otterborden waarvan de netten een maaswijdte van minimaal 100mm hebben. Alle gevangen tong en schol die meer dan 5% van de totale vangst uitmaken, moeten overboord gezet worden.

Sinds 1994 is de scholbox het gehele jaar gesloten voor 12m boomkorren. Het gebied is wel het gehele jaar toegankelijk voor eurokotters met een motorvermogen < 300 pk en 4m boomkorren (BEON 1996). En waarschijnlijk is de visserij-inspanning door deze eurokotters in de scholbox zelfs toegenomen (ICES 1996).

De instelling van de scholbox heeft een invloed gehad op de commerciële vissoorten. Sinds de instelling van de scholbox worden er meer commerciële vissoorten met een lengte tussen 25 en 40 cm gevangen. Maar op andere vissoorten is geen merkbare invloed waargenomen. En ook de soortensamenstelling blijkt na de instelling niet veranderd Piet & Rijnsdorp (1997).

In dit hoofdstuk wordt nagegaan of de instelling van de scholbox in 1989 een invloed gehad heeft op de verspreiding en dichtheid van ongewervelde dieren. Hiervoor wordt gebruikt gemaakt van de gegevens uit de boomkorbestandsopnames die sinds 1985 door het RIVO-DLO uitgevoerd worden, de BTS survey.

Materiaal en methoden

BTS, Beam Trawl Survey

In 1985 werd de eerste BTS survey gehouden. De survey wordt in internationaal verband uitgevoerd, en beslaat de Noordzee, het Kanaal en de wateren ten westen van Groot-Brittanië. Er wordt zowel dichtbij als ver uit de kust gemonsterd. Het vistuig is een paar 8 m boomkorren. In de kuil was de maaswijdte 40 mm gestrekt. De boomkorren zijn verder voorzien van 8 kettingen.

Figuur 3.1. geeft de posities van alle surveys uitgevoerd in de periode 1985-1996 door het RIVO-DLO, IJmuiden. Het gebied omvat een 30-tal ICES kwadranten van 30x30 mijl in de zuidelijke en zuidoostelijke Noordzee en omvat zowel stations binnen als buiten de scholbox. In het zuidelijk deel werden bij iedere survey in augustus of september in ieder ICES-kwadrant telkens minstens 3 trekken gedaan, in het noordelijk deel slechts 1 of 2 trekken. Bij de verschillende surveys werden telkens andere lokaties bemonsterd. De vissnelheid was 4 mijl/uur, de lengte van een trek in de meeste gevallen ± 30 minuten. Er werd uitsluitend overdag gevist.

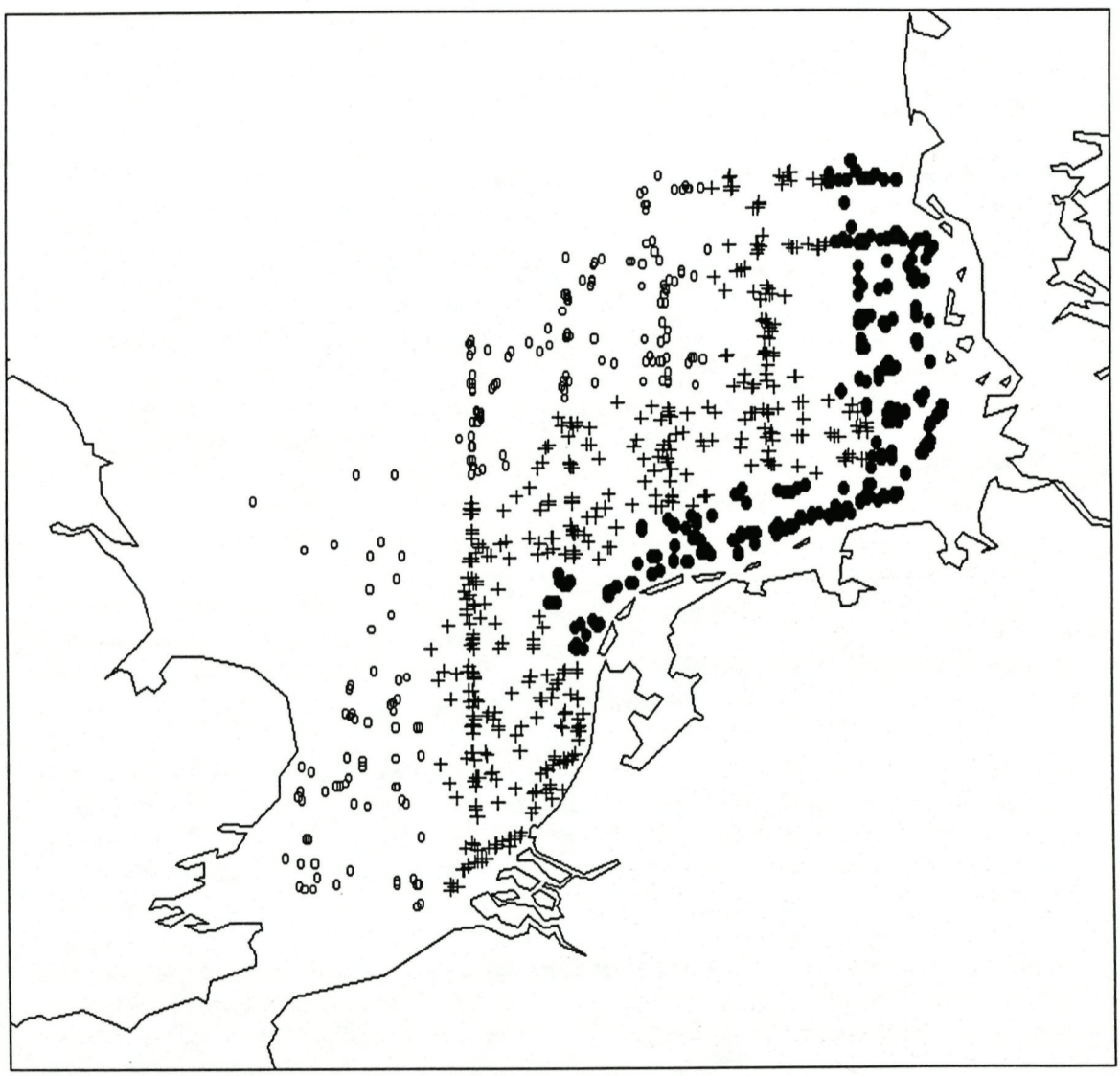


Fig. 3.1. BTS surveys 1985-1996: lokatie van alle trekken door het RIVO-DLO uitgevoerd.
(• : scholbox; + : referentiegebied; o : overige)

Vangstsamenstelling

Abundante kleinere vissoorten en bodemdieren werden in vismanden (30 l) verzameld. Drie deelmonsters genomen bij het begin, in het midden en aan het einde van het sorteren van de vangst, werden nader geanalyseerd. Bij erg grote vangsten werd slechts een deelmonster gesorteerd.

Bodemdieren

Alle gegevens zijn vanaf de originele RIVO-DLO data formulieren in een computerbestand ingevoerd. Controle van de dataset is gebeurd op gelijkwaardige wijze als bij de SNS gegevens (Sole Net Survey; Buijs et al. 1994). De gegevens zijn samengebracht met deze van de SNS survey in een relationele database. Bij de BTS survey is van de noordzeekrab *Cancer pagurus* voor een aantal surveys ook de lengte en het geslacht genoteerd en ingevoerd.

Alle aantallen zijn omgerekend naar aantal per visuur. Omdat voor 1985 de exacte tijdsduur van de trekken niet bekend was, is uitgegaan van de standaardtijd van 30 minuten. Een verdere analyse is uitgevoerd met de gegevens uit de scholbox en een referentiegebied zoals gebruikt door Piet & Rijnsdorp (1997) (Fig. 3.1). Nagegaan is of de soortensamenstelling van het epibenthos in de scholbox veranderd is na de instelling van de box, en of eventuele veranderingen in de scholbox ook optraden in het referentiegebied.

Er is veel aandacht besteed aan de betrouwbaarheid van de identificaties. Tabel 3.1 en 3.2 geven voor de jaren 1985-1996 het aantal trekken waarin iedere soort gevonden is. Uit eerder onderzoek (Buijs et al. 1994) wisten we dat er verwarring is tussen een aantal soorten. In de BTS surveys blijkt er soms verwarring geweest te zijn tussen de spinkrab *Hyas araneus* en de helmkrab *Corystes cassivelaunus*. Omdat deze laatste veel meer gevonden zijn dan de spinkrab, is in de analyses de spinkrab *Hyas araneus* veranderd in de helmkrab *Corystes cassivelaunus*. De aantallen van deze laatste zullen daardoor iets overschat zijn, terwijl de spinkrab niet meer in de analyses voorkomt (vandaar de aanduiding V in Tabellen 3.1 en 3.2).

Tot slot dient opgemerkt dat de pelikaansvoet *Aporrhais pespelecani* in de BTS surveys nooit gevonden is. In de SNS survey is de soort echter regelmatig gevonden in de jaren 1985-1991. De reden voor het ontbreken van deze soort is onduidelijk. Als de soort in de vangsten zat, was het zeker genoteerd.

Analyses

Veranderingen in de soortensamenstelling van de epibenthosgemeenschappen in de periode 1985-1996 zijn nagegaan via een ordinatie. Voor de scholbox en het referentiegebied zijn afzonderlijke analyses verricht. De ordinaties zijn uitgevoerd met behulp van het programma CANOCO (ter Braak 1988a; Jongman et al. 1987). Als ordeningsmethode is partiële canonische correspondentie analyse gebruikt (ter Braak 1988b).

Bij een ordinatie worden de lokaties (trekken) langs een aantal assen geordend, en wel op zo'n manier dat lokaties met een gelijkaardige soortensamenstelling bij elkaar komen te liggen, lokaties met een totaal verschillende soortensamenstelling liggen ver van elkaar. Bij een CCA zijn de assen gekozen in funktie van (als lineaire combinatie van) gemeten omgevingsvariabelen. Verschillen in soortensamenstelling worden aldus direkt gerelateerd aan omgevingsvariabelen. Verder wordt er bij een CCA van uitgegaan dat soorten bij benadering volgens een Gauss-kromme reageren op de omgevingsvariabelen. Bij andere ordeningsmethodes (bijv. PCA) wordt uitgegaan van lineaire verbanden. Bij een partiële ordinatie wordt het effekt van een of meer variabelen (covariabelen) geëlimineerd en wordt de residuele variantie in de soortensamenstelling verklaard aan die omgevingsvariabelen waarin men geïnteresseerd is. De positie in het ordinatie-diagram kan met een Monte Carlo-permutatietest getoetst worden.

Omdat de soortensamenstelling in de Noordzee verandert met de diepte en de lokatie (zie o.a. Künitzer et al. 1992; Holtmann et al. 1996), zijn diepte en positie (lengte en breedte) als covariabelen meegenomen. Het jaartal is als omgevingsvariabele genomen.

Bij de ordinaties werden zeldzame soorten (in Tabellen 3.1. en 3.2 aangegeven met een N) niet meegenomen.

TABEL 3.1

Scholbox. Aantal trekken per jaar waarin de genoteerde soorten gevonden zijn.

Latin name	Analyse	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Acanthocardia echinata	Y							1		1	2	1	
ACTINIARIA	Y	5	4	3	2	2	6			1	3	3	4
Alcyonium digitatum	Y				1				1	2	2		
Alloteuthis subulata	Y	1							1	2	1	5	
Aphrodita aculeata	Y	1	5	2		2	5	3	3	1	2	2	5
Arctica islandica	Y							2	1	1		1	3
ASCIDIACEA	N									1		1	1
Asterias rubens	Y	17	18	14	19	20	31	28	28	30	30	27	27
Astropecten irregularis	Y	5	2		5	7	10	12	11	11	8	9	2
Buccinum undatum	Y	10	8	2	5	5	3	6	4	3	6	7	5
Cancer pagurus	Y	7	3	8	5	3	19	24	21	26	26	24	11
Carcinus maenas	Y	5		1						2	1	7	3
CEPHALOPODA	N									1			
Chamelea gallina	N					1				1			
Corystes cassivelaunus	Y	6			3	3	5	4	8	9	10	3	
Crangon	Y	2					3	1	3	2	6	6	2
Donax	N										1		
Echinidae	Y		1		1			2		3			
Echinocardium	Y		4	1	2	4	1	6	6	3	6	4	
Echinocardium cordatum	Y	4	1	2	1		12	2	7	7	9	12	6
Ensis	Y	1	1				1	1				1	6
Hyas araneus	Y	1	1	1	1		2	3	1	2	1	3	1
Liocarcinus holsatus	Y	16	17	10	18	20	28	28	28	30	30	28	22
Liocarcinus puber	N						1						
Loligo	Y			1	1			2		2	1		
Lunatia	N										1		
Mactra stultorum	N									3		1	
Mya arenaria	N							2					
Mytilus edulis	N							1					
Ophiura	Y	8	9	4	6	13	14	19	24	21	18	9	13
Pagurus bernhardus	Y	16	11	11	17	15	20	19	19	24	20	18	21
PELECYPODA	N	2				2	3		1		2		
Psammechinus miliaris	N	1											
Sepia	N							1					
Spisula	Y							4	3	5	3	5	
Tunicata indet.	N	1											

TABEL 3.2

Referentiegebied. Aantal trekken per jaar waarin de genoteerde soorten gevonden zijn.

Latin name	Analyse	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Acanthocardia echinata	Y	3	7	4	3	5	4	9	3	3	6	4	4
ACTINIARIA	Y		2	1	2		4	2	2	2	7	2	5
Alcyonium digitatum	Y	2	3	3	1	1		4	1	4	3		3
Alloteuthis subulata	Y	1		1			1		2		4	9	
Aphrodita aculeata	Y	12	17	15	23	12	19	19	16	20	20	15	19
Arctica islandica	Y	5		1	1	3	1	3	7	4	4	3	5
ASCIDIACEA	Y								1	3	2	2	1
Asterias rubens	Y	24	31	31	36	35	42	42	34	45	40	41	42
Astropecten irregularis	Y	17	21	23	20	19	26	32	23	27	27	24	20
Buccinum undatum	Y	5	13	6	7	7	7	11	7	8	7	4	5
Cancer pagurus	Y	1	3	5	8	9	27	24	25	27	27	14	18
Carcinus maenas	N			1				1	1				
CEPHALOPODA	N								1	1			
Cerastoderma edule	N	3					1						
Chamelea gallina	N								1	3		1	
Corystes cassivelaunus	Y	17	20	19	16	10	15	17	19	25	24	24	24
Crangon	Y	1	2		1	4	2		7	4	5	8	6
Echinidae	Y		18	10	8		1		1	10			1
Echinocardium	Y	7	11	10	12	16	13	15	13	12	10	12	11
Echinocardium cordatum	Y	14	3	5	10	12	22	21	21	9	16	14	19
Ensis	Y	3	1	2	1			3	1	4	4	1	3
Epitonium (Clathrus)	Y			1	1		2	4		3		1	1
Hyas araneus	V	8	2			1	1			5	2	1	
Liocarcinus holsatus	Y	20	30	31	34	35	41	43	41	45	43	43	45
Liocarcinus puber	Y						2	1			1	1	
Loligo	Y	1				1	1	4	2	4	1		1
Lunatia	Y	2	4					2		1		2	
Macropodia rostrata	N		1								2		
Metridium senile	N							1					
Modiolus modiolus	N	1											
Mya truncata	N	1					1				1		
Nephrops norvegicus	Y	2	3	2	3	2	2	3	3	5	12	5	3
Neptunea antiqua	N	1	1										
Ophiura	Y	18	22	20	20	9	22	31	27	22	22	11	20
Pagurus bernhardus	Y	19	22	22	19	27	30	39	31	36	35	27	36
Pecten	Y	1								2	2	2	
PELECYPODA	N							1	3		1		
Petricola pholadiformis	N										1		
PORIFERA	N							1					
Psammechinus miliaris	N	4											
Sepia	Y	1			3	1	1	1	3	3	4	3	2
Spisula	Y					1		3	2	3	2	5	3
Turritella communis	N						1		1		2		

Resultaten en discussie

In de scholbox zijn in totaal in de periode 1985-1996 292 trekken uitgevoerd en geanalyseerd; in het referentiegebied 475 trekken. Algemeen werden meer soorten gevonden in het referentiegebied dan in de scholbox.

De positie van de trekken in de scholbox langs de eerste ordinatie-as was signifikant (p=0.00 bij 999 permutaties). Figuur 3.2 geeft de gemiddelde score langs de eerste as weer voor de verschillende jaren. Duidelijk is dat er omslagpunt ligt bij 1990/1991.

Gemiddeld zijn na 1989 soorten *als Arctica islandica, Acanthocardia echinata* en *Spisula* meer gevonden dan voordien, een soorten als *Buccinum undatum* werd minder gevonden.

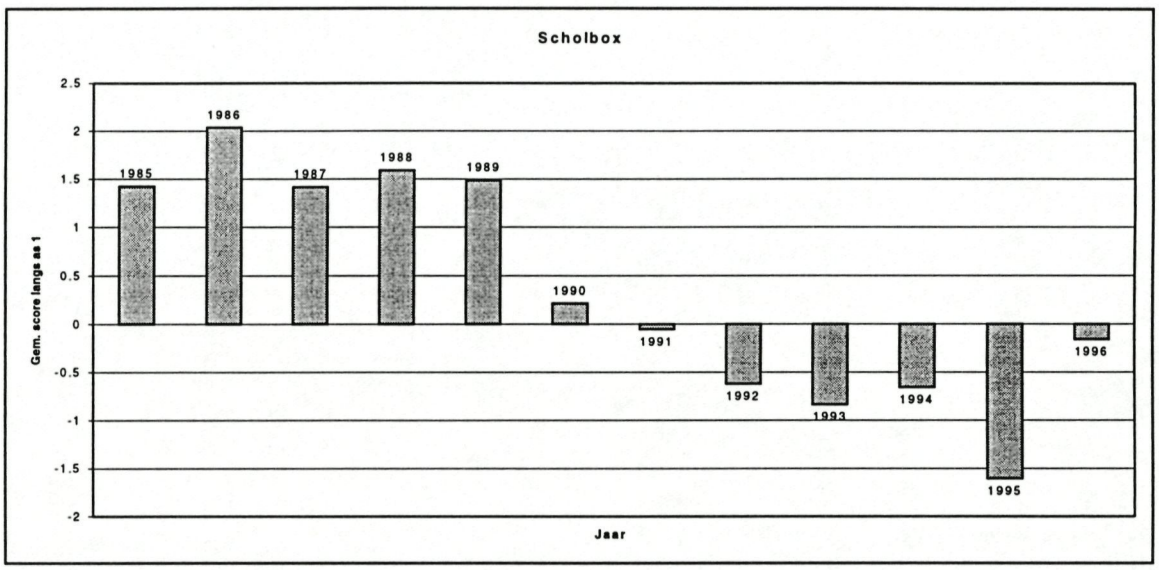


Fig. 3.2. Scholbox. Gemiddelde score per jaar langs de eerste ordinatie-as.

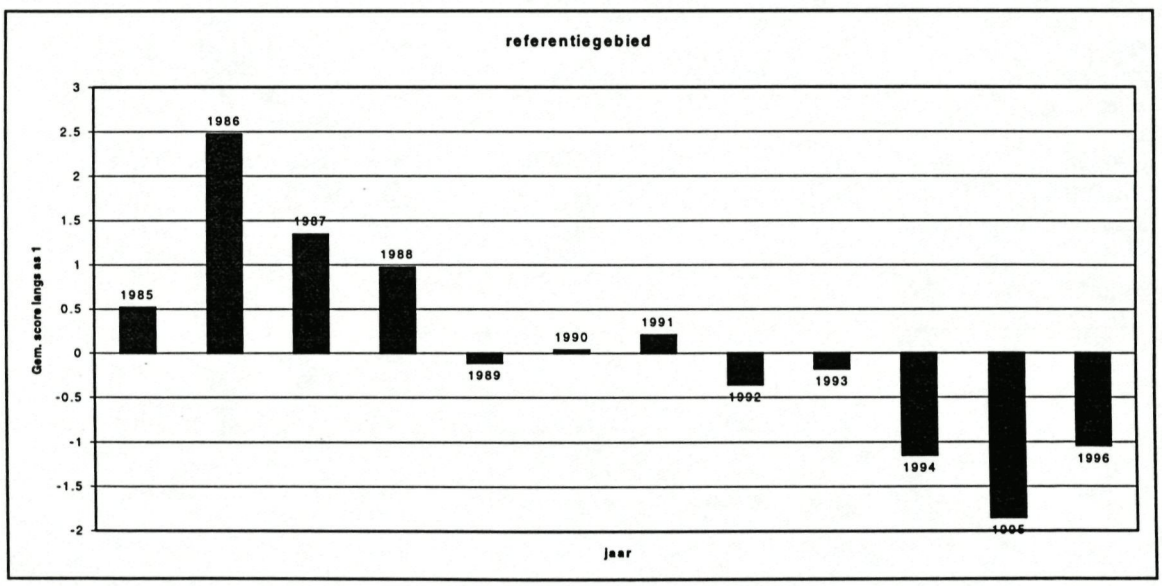


Fig. 3.3. Referentiegebied. Gemiddelde score per jaar langs de eerste ordinatie-as.

Ook in het referentiegebied blijkt de soortensamenstelling veranderd (p=0.00), waarbij het omslagpunt ongeveer gelijk valt (Fig. 3.3). Wel zou men in feite drie periodes kunnen onderscheiden: 1985-1988, 1989-1993 en 1993-1996.

Soorten als *Pecten* en *Spisula* zijn meer gevonden na 1989, *Lunatia* en Echinidae (regelmatige zeeëgels) minder.

In zowel de scholbox als het referentiegebied blijkt de soortensamenstelling dus na het instellen van de scholbox veranderd. De meest opvallende soorten zijn niet dezelfde, met uitzondering van *Spisula*. Maar dit is niet verwonderlijk gezien referentiegebied en scholbox ook in hun omgevingsvariabelen (o.a. diepte) verschillen, en bijgevolg in hun soortensamenstelling (zie bijv. ook Künitzer et al. 1992). In beide gebieden worden trouwens, behalve in 1985, na 1990 meer soorten gevonden dan voordien (Fig. 3.4; Tabellen 3.1 en 3.2). Opvallend is wel dat de scores langs de eerste ordinatie-as in 1996 weer kleiner zijn dan de voorgaande jaren, en mogelijk is er een terugkeer naar de voorgaande periode.

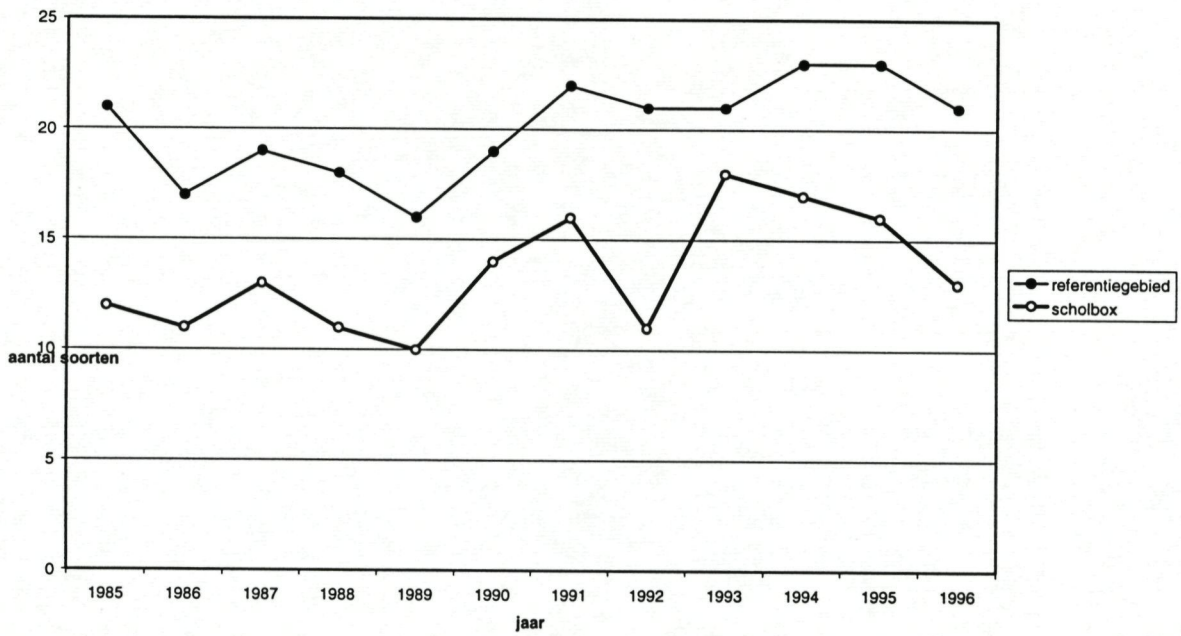


Fig. 3.3. Aantal soorten meegenomen in de analyse

Al bij al kan men concluderen dat er in het onderzochte gebied wel een verandering in soortensamenstelling is, maar dat de veranderingen niet beperkt zijn tot de scholbox. De verandering moet dan ook waarschijnlijk niet toegeschreven worden aan het instellen van de scholbox, en dus niet aan een verandering in visserij-intensiteit.

Referenties

BEON, 1996. BEON thema bijeenkomst Boomkorvistuigen, 19 januari 1996, Den Haag. BEON Rapport nr. 96-8.

Buijs, J., J.A. Craeymeersch, P. van Leeuwen en A.D. Rijnsdorp, 1994. De epi- en endofauna van de Nederlandse, Duitse en Deense kustzone: een analyse van 20 jaar bijvangstgegevens. NIOO-CEMO Rapporten en Verslagen 1994-05 / BEON Rapport nr. 94-11 / RIVO Rapport 94-010. 63 p.

Holtmann, S.E., Groenewold, A., Schrader, K.H.M., Asjes, J., Craeymeersch, J.A., Duineveld, G.C.A., van Bostelen, A.J. and van der Meer, J., 1996, Atlas of the zoobenthos of the Dutch Continental Shelf: Rijkswijk, Ministry of Transport, Public Works and Water Management, North Sea Directorate, 244 p.

ICES, 1996. Report of the working group on the assessment of demersal stocks in the North Sea and Skaggerak. ICES C.M. 1996/Assess:6.

Künitzer, A., Basford, D., Craeymeersch, J.A., Dewarumez, J.M., Dörjes, J., Duineveld, G.C.A., Eleftheriou, A., Heip, C., Herman, P., Kingston, P., Niermann, U., Rachor, E., Rumohr, H. and de Wilde, P.A.J., 1992. The benthic infauna of the North Sea: species distribution and assemblages. ICES J. mar. Sci., 49: 127-143.

Piet, G.J. & A.D. Rijnsdorp, 1997. Changes in the demersal fish assemblage in the south-eastern North Sea following the establishment of a protected area ("plaice box").

ter Braak, C.J.F., 1988a. CANOCO - an extension of DECORANA to analyze species-environment relationships. Vegetatio, 75: 159-160.

ter Braak, C.J.F., 1988b, Partial canonical correspondence analysis, *in* Bock, H.H., ed., Classification and related methods of data analysis: Amsterdam, Elsevier Science Publishers B.V., p. 551-558.

ABUNDANCE AND SPECIES COMPOSITION OF LARGER SIZED INVERTEBRATE SPECIES (MEGAFAUNA) IN RELATION TO BEAM TRAWL EFFORT

34004

M.J.N. Bergman, J.W. van Santbrink (NIOZ)
G.J. Piet, A.D. Rijnsdorp (RIVO-DLO)

Introduction

Since the sixties the North Sea trawling fleet increased enormously with regard to number of vessels, engine power, weight of gears and trawling speed. In a recent EU-project (Bergman et al. 1998) the direct mortality rate due to a single beam trawling event was estimated to vary from 10 to 50% of the initial density for various non-target invertebrate species (gastropods, starfish, crustaceans, worms) and from 30 to 80% for a number of bivalves. Fragile and superficial living species showed high mortality, robust or deeply burrowing species low or even no mortality. For all these species mortality mainly occurred in the trawl path, as a result of direct fysical damage inflicted by the passage of the trawl or indirectly from disturbance and subsequent predation.

Based on these results, the following hypothesis can be formulated: species composition of sessile and low mobile invertebrate species is related to spatial distribution of trawling effort. This hypothesis predicts that, in general, the abundance of older yearclasses of relatively vulnerable, long lived species will be higher in areas with low trawling effort, while higher densities of younger yearclasses or opportunistic species will be found in more heavily trawled areas. However, as the micro distribution of trawl fisheries is obviously determined by the presence of target fish, this hypothesis can only be tested under the assumption that the spatial distribution of target fish is not strongly correlated with the abundance or species composition of megafauna. If *e.g.* spatial distributions of fish (and thus effort) and species are positively related, higher densities of megafauna may be found in more frequently trawled areas, despite the higher fishing mortality in these areas. To test the hypothesis, the relation between species composition of sessile and low mobile megafauna (invertebrates > 1 cm) and trawling effort was determined in a number of test areas in the Dutch sector.

In 1996 the invertebrate species composition was compared at stations within and outside the western border of the Plaice-box, an area closed for beam trawlers > 300 hp since 1994. Registration of the micro distribution of trawlers showed that this area was indeed avoided by the fleet > 300 hp (Rijnsdorp et al. 1997). EURO trawlers (< 300 hp using 4m beam trawls) are allowed in the Plaice-box, and within this area regularly trawl tracks of 4m beam trawls and in some cases of 8m beam trawls were recognised on the side scan sonar recordings (BEON data report 1996). Due to time constraints only a limited number of stations (6 stations inside versus 6 outside) could be sampled. Although the test areas inside and outside the Plaice-box were selected in a way to minimise abiotic gradients (*e.g.* in sediment type) and to ensure high densities of benthos species, in practice the test areas showed a strong gradient in median grainsize, mud content and water depth with the largest grainsize and lowest mud contents within the Plaice-box. Species composition in the stations appeared to be primarily related to these abiotic gradients (BEONdata report 1996). From this pilot study it was concluded that strong hydro-sedimentological gradients and low invertebrate abundances made the coastal zone not a suitable test area for testing the hypothesis.

In 1997 the test was performed in the Oystergrounds, an area with relatively low hydro-sedimentological gradients (*e.g.* median grainsize, mud percentage and water depth)

and relatively high invertebrate abundances. In squares (1*1 mile) with different trawling efforts, the species composition of megafauna was determined. Trawling efforts for the 1*1 mile squares were given in the total number of bottom contacts of beam trawlers equipped with an Automatic Position Recording system (APR system, RIVO data, see subproject 1) in 1993-1996 and ranged from 0 to 261 times. In this paper the results of the 1997 study are presented.

Material and methods

Sampling stations and procedures

In the Oystergrounds, a fine sandy to muddy area with water depths ranging from 40 - 50 m and a relatively rich invertebrate community, 41 squares (1*1 mile) were selected to study the relation between species composition and trawling effort. The sampling program was carried out in April 1997 on board R.V. MITRA (RWS/DNZ). The squares were situated in an area from 53° 30' to 55° 30' N and from 4° to 5° E and were roughly distributed in three clusters (Fig 4.1). In each cluster, squares were selected with either low or high ARP trawling efforts, in such a way that gradients in other abiotic parameters (grainsize, mud content, water depth) were as low as possible. In the centre of each square one haul with the benthos dredge Triple-D (Bergman & van Santbrink 1994) was made to estimate the density of megafauna (invertebrate macrofauna > 1 cm). The sampling depth was 10 cm, the width of the cutting blade was 20 cm, meshsize was 1.4 cm stretched, the length of the haul was 100 m and the towing speed was 3 nautical miles per hour. Catches were sorted on board. Animals were measured in length classes. Sediment samples were collected and median grainsize and mud content were determined by NITG-TNO. Water depth was measured at each sampling station.

In subproject 5, megafauna was sampled in 67 other stations in the Dutch sector of the North Sea (survey June 1997) of which 12 stations were positioned inside the area in the Oystergrounds mentioned above. These 12 stations were included in subproject 4 as well, as the sampling procedure with the Triple-D and the sorting of the catch was similar to those in the April cruise. Grainsize and mud parameters of these stations were given for 1996 in Holtmann *et al.* (in press). Water depth was measured at each sampling station.

The positions of the 53 stations in this subproject, the median grainsize, the mud content, the water depth, and the APR trawling effort are given in Appendix 4.1. The abundances of megafauna species (both total and per length category) are given in Appendix 4.2. Species occurring in less than 10 stations were excluded. In Appendix 4.3 codes, names and size classes of species are given.

Analysis

Effects of the trawling effort and other environmental variables on megafauna composition were studied by means of ordination techniques. As migration of mobile species may trouble the relation between trawling effort and species abundance, species like shrimps, hermit crabs, swimming crabs, and starfish *Asterias rubens* were not included in the analyses. The analyses were performed in the CANOCO program (ter Braak 1988). Correspondence analysis (CA) as well as caconical correspondence analysis (CCA) were used, assuming a Gaussian respons of species to environmental variables. Effects on species composition were analysed of trawling effort (the target variable) relative to a number of other environmental variables (covariables) like median grainsize, mud content, water depth and geographical location. The percentage of variance in the species composition for which each environmental variable accounted, was calculated and tested (Monte Carlo permutation test). To assess the effect of trawling effort on the species composition, the effects of the covariables were eliminated in further CCA ordinations. Effects of trawling effort were analysed both on total abundances of megafauna species and on abundances of different age-classes of a species. Statistical significance of the correlation between the total abundances of single

species and the trawling effort was tested with a multiple regression model (General Lineair Model; $y = b_0+b_1x_1+b_2x_1^2+b_3x_2+b_4x_2^2+$effort with x_1 the first CCA-axis and x_2 de second CCA-axis); p= 0.05).

Results

The relative contributions of environmental variables to the variance in species composition
The plots in Fig. 4.2 indicate that in the study area there is no relation between the trawling effort and the other environmental variables: median grainsize, mud content, water depth and geographical location (latitude and longitude). Grainsize and mud content show a negative correlation, just like grainsize and water depth. The grainsize distribution does not show a north-south gradient.

Fig. 4.3 presents CA ordination diagrams in which the stations are positioned according to their similarity in species composition (total abundances per species per station). Stations that are positioned close together show a high degree of similarity. In each diagram, the stations are labelled with a particular environmental variable (*i.e.* trawling effort or one of the other variables); larger dots indicate higher values of that variable. The plots indicate that not only trawling effort but also the other variables are correlated with the ordination of the stations. Especially water depth, grainsize and the north-south gradient are clearly correlated with the ordination, *i.e.* affect the species composition.

In a series of CCA analyses, in which the trawling effort and each of the other variables were successively used as a single environmental variable that is related to the first axis, the percentage of variance in the megafauna composition (total abundances per species per station) was calculated for which that particular variable accounted. The statistical significance of the scores on the first axis (x-axis) was tested using a Monte Carlo permutation test (Table 4.1). Apparently trawling effort accounts for a significant, but lower percentage of the variance in the megafauna composition than each of the other variables like grainsize, water depth, geographical latitude and mud content.

CCA-ordination analyses in which trawling effort plus the other variables were used simultaneously, provided another method to estimate the relative impact of various environmental variables on species abundances. On the first axis in a CCA biplot, a lineair combination of variables was plotted that accounted for the largest percentage of variance in the species composition. The diagram displays an ordination of species (Fig. 4.4) in which the environmental variables are represented by arrows. An arrow roughly points in the direction of the maximum variance that is correlated with the corresponding variable, *e.g.* the abundances of species displayed in the lower right-hand side of the biplot in Fig. 4.4 are positively related with larger grainsize, species in the upper half of the biplot are associated with larger water depths, a more northern distribution and lower trawling efforts. The nearly opposite directions of the arrows of grain size and depth indicate that these variables are negatively correlated, as indicated in Fig. 4.2, whereas trawling effort is not clearly related with any of the other variables. The length of the arrow gives an impression of the relative contribution of that particular variable to the ordination of the species along the canonical axes. It appears that grainsize, water depth and latitude are the most closely related to the pattern of variance in species composition; trawling effort has less influence as it is represented by a relatively short arrow (this is in accordance to the conclusion drawn from Fig. 4.3).

The relation of trawling effort and species composition
The results above have made clear that next to trawling effort, a number of abiotic variables are related to the variance in species composition. To focuss more closely on the relation of trawling effort and species composition, CCA-ordinations are performed in which the calculated relations between species distribution and the other variables (median grainsize, mud content, water depth and geographical location) are eliminated. This elimination is allowed

because effort is not correlated with these covariables. The ordination of species along the first axis (which reflects the trawling effort) is given in Table 4.2. High positive scores on the x-axis indicate a positive correlation with trawling effort, whereas high negative scores indicate a negative correlation. Species with intermediate scores on the x-axis are either unaffected by trawling effort or restricted to stations with intermediate efforts. Abundances of species like *Ophiura albida, Pectinaria,* and *Upogebia* spp. are positively correlated with trawling effort, abundances of *Chamelea gallina, Acanthocardia echinata, Echinocardium cordatum* and *Turritella communis* are negatively correlated.

To interprete the CCA-results in Table 4.2, the spatial distributions of trawling effort and some of the species showing the highest correlations were plotted (Fig. 4.5), and the statistical significance of these correlations was tested using a multiple regression model (GLM). Spatial distributions of *Chamelea gallina, Acanthocardia echinata, Echinocardium cordatum* and *Turritella communis* appeared to be hardly correlated with the effort distribution (Fig. 4.5) and the relations were not significant. The correlation appeared to be significant only for *Pectinaria* spp., *Ophiura albida,* and *Upogebia* spp. ($p = 0.000, 0.001, 0.007$ respectively). For the first species, however, Fig. 4.5 shows an incidental high abundance in a high-effort station (indeed, when this outlying station is omitted, the correlation is not longer significant). For *Upogebia* spp., Fig. 4.5 shows a clustered distribution, which is probably related to other environmental parameters than trawling effort. This significance is therefore not meaningfull.

As it can be assumed that abundences of larger sized (thus older) specimens of a species are more affected by (a prolonged) trawling effort, a CCA ordination was performed in which most species were divided in two length classes (for size class limits: see Appendix 4.3). Table 4.3 shows the ordination results of these classes along the X-axis, which, like in Table 4.2, represents the correlation of these classes with trawling effort. For many species *(e.g. Abra alba, Chamelea gallina, Acanthocardia echinata, Aporrhais pespelicani, Corystes cassavilaunus, Aphrodite aculeata, Echinocardium cordatum*) abundances of older specimens are more negatively correlated with trawling effort than younger specimens.

Discussion

The fact that for almost all species in this analyses the trawling effort is not significantly correlated with abundances (GLM test) may be caused by a inherent problem in this study: areas with high benthos densities that attract more target fish will be trawled more frequently, whereas areas with low benthos densities in unattractive fishing grounds will be trawled scarsely. Because of this phenomenon, differences in species abundances between heavily and hardly trawled areas may reflect more the difference in initial densities than the densities as result of trawling. This is possibly another reason for the positive correlation of *e.g. Ophiura albida* and *Upogebia* spp., of which the latter is a major prey item for plaice, with the effort. An extra source of variance (noise) in the data-set is the random distribution of trawling effort within the 1*1 miles quadrants (see subproject 1), which causes uncertainty about the trawling effort in the 25 m^2 that is actually sampled with the Triple-D. A total number of 53 stations is rather low with respect to this uncertainty. Last but not least the extrapolation of the spatial distribution of trawling effort in the APR fleet (13% of the Dutch 12m beam trawl fleet) to the total fleet may lead to additional noise in the data-set.

Nevertheless the data-set points to a possible correlation between trawling effort and variance in species abundances, when CCA scores of younger and older age-classes of the same species are compared. The fact that older age-classes of *e.g. Abra alba, Chamelea gallina, Acanthocardia echinata, Aporrhais pespelicani, Corystes cassavilaunus, Aphrodite aculeata,* and *Echinocardium cordatum* are more negatively correlated with trawling effort than younger ones, may be explained by the longer range of years over which they have been affected by trawling. Moreover, the IMPACT-studies revealed that direct mortality rate in the

trawl path due to a single trawling event is generally lower for small individuals than for large sized ones in *e.g. Chamelea gallina, Dosinia lupinus, Mysia undata, Aphrodite aculeata* (Bergman et al. 1998).

Regarding this results, it should be stressed that the species in this analysis are still relatively common in the Oystergrounds, an area that is trawled with moderate frequency during the last decades. This means that these species are at least to some extent resistent to beam trawling (either due to a low direct mortality, or due to life history aspects such as a high rate of recruitment). Abundances of more vulnerable species, like long lived superficial burrowing bivalves, that decreased due to commercial trawling during this century (Rumohr et al, 1998), have become too rare to be involved in this analysis. It can be expected that abundances of these species would have showed strong correlations with the spatial distribution of trawling effort.

References

BEON data report, 1996. Soortsamenstelling en abundantie van de grotere (epi)benthische macrofauna in relatie met de intensiteit van boomkorvisserij in een aantal testgebieden in de zuidelijke Noordzee. M.J.N.Bergman & J.W. van Santbrink (eds.). BEON data report (NIOZ 96V): pp 5.

Bergman M.J.N. & J.W. van Santbrink, 1994. A new benthos dredge (Triple-D) for quantitative sampling of infauna species of low abundance. Neth.J. Sea Res. 33: 129-133.

Bergman M.J.N., B. Ball, C. Bijleveld, J.A. Craeymeersch, B.W. Munday, H. Rumohr and J.W. van Santbrink, 1998. Direct mortality due to trawling. In: H.J. Lindeboom & S.J. de Groot (eds.). 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: 167-185.

Braak C.J.F. ter, 1988. CANOCO - a fortran program for caconical community ordination by (partial) (detrended) (canonical) correspondence analysis, principal components analysis and redundancy analysis (version 2.1). Technical report; Wageningen; LWA 88-02: pp 95.

Rumohr, H., S. Ehrich, R. Knust, T. Kujawski, C.J.M. Philippart & A. Schroeder, 1998. Long term trends in demersal fish and benthic invertebrates. In: H.J. Lindeboom & S.J. de Groot (Eds.). 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: 280-353.

Rijnsdorp A.D., A.M. Buijs, F. Storbeek & E.Visser, 1997. De microverspreiding van de Nederlandse boomkorvisserij gedurende de periode van 1 april 1993 tot en met 31 maart 1996. RIVO-DLO rapport C006/97; pp 39.

TABLE 4.1

CCA analyses using trawling effort and the other variables successively as a single environmental variable.

Environmental variable	% variance accounted for by the first axis (x-axis)	p (Monte Carlo permutation)
trawling effort	4.2	0.037
water depth	17.6	0.001
median grainsize	19.8	0.001
mud content	12.9	0.001
longitude	6.1	0.009
latitude	19.2	0.001

TABLE 4.2

Correlation of the species abundances and trawling effort (CCA; other environmental variables are eliminated in the ordination). Values represent scores along the first axis. Higher positive values point to stronger positive correlations; lower negative values to stronger negative correlations.

Species	
Pectinaria sp. indet.	0.639
Ophiura albida	0.328
Mysia undata	0.317
Upogebia sp. indet.	0.210
Brissopsis lyrifera	0.122
Mya truncata	0.089
Pelonaia corrugata	0.086
Abra alba	0.086
Golfingia spp. indet.	0.073
Aphrodita aculeata	0.062
Phaxas pellucidus	0.044
Corystes cassivelaunus	-0.015
Anemone sp. indet	-0.021
Aporrhais pespelicani	-0.026
Corbula gibba	-0.036
Astropecten irregularis	-0.038
Dosinia lupinus	-0.044
Ophiura texturata	-0.066
Chamelea gallina	-0.073
Arctica islandica	-0.081
Nucula nitidosa	-0.090
Echinocardium cordatum	-0.094
Turritella communis	-0.117
Cucumaria elongata	-0.122
Acanthocardia echinata	-0.130

TABLE 4.3

As in Table 4.2, but a CCA is performed for separate small and large size classes (see Appendix 4.3). When a large size class scores lower than a small size class, the abundance of large specimens is more negatively (or less positively) correlated with trawling effort than the abundance of small specimens.

Species	Size class		Difference
	small	large	(small - large)
Abra alba	0.461	-0.011	0.473
Acanthocardia echinata	0.040	-0.346	0.386
Ophiura albida	0.681	0.304	0.377
Aporrhais pespelicani	0.190	-0.126	0.316
Aphrodita aculeata	0.213	0.007	0.206
Chamelea gallina	-0.025	-0.138	0.113
Corystes cassivelaunus	0.056	-0.056	0.112
Echinocardium cordatum	-0.015	-0.118	0.103
Astropecten irregularis	-0.028	-0.086	0.058
Arctica islandica	-0.051	-0.090	0.038
Turritella communis	-0.142	-0.163	0.021
Dosinia lupinus	-0.045	-0.047	0.003
Phaxas pellucidus	-0.032	0.130	-0.162
Ophiura texturata	-0.117	0.084	-0.201

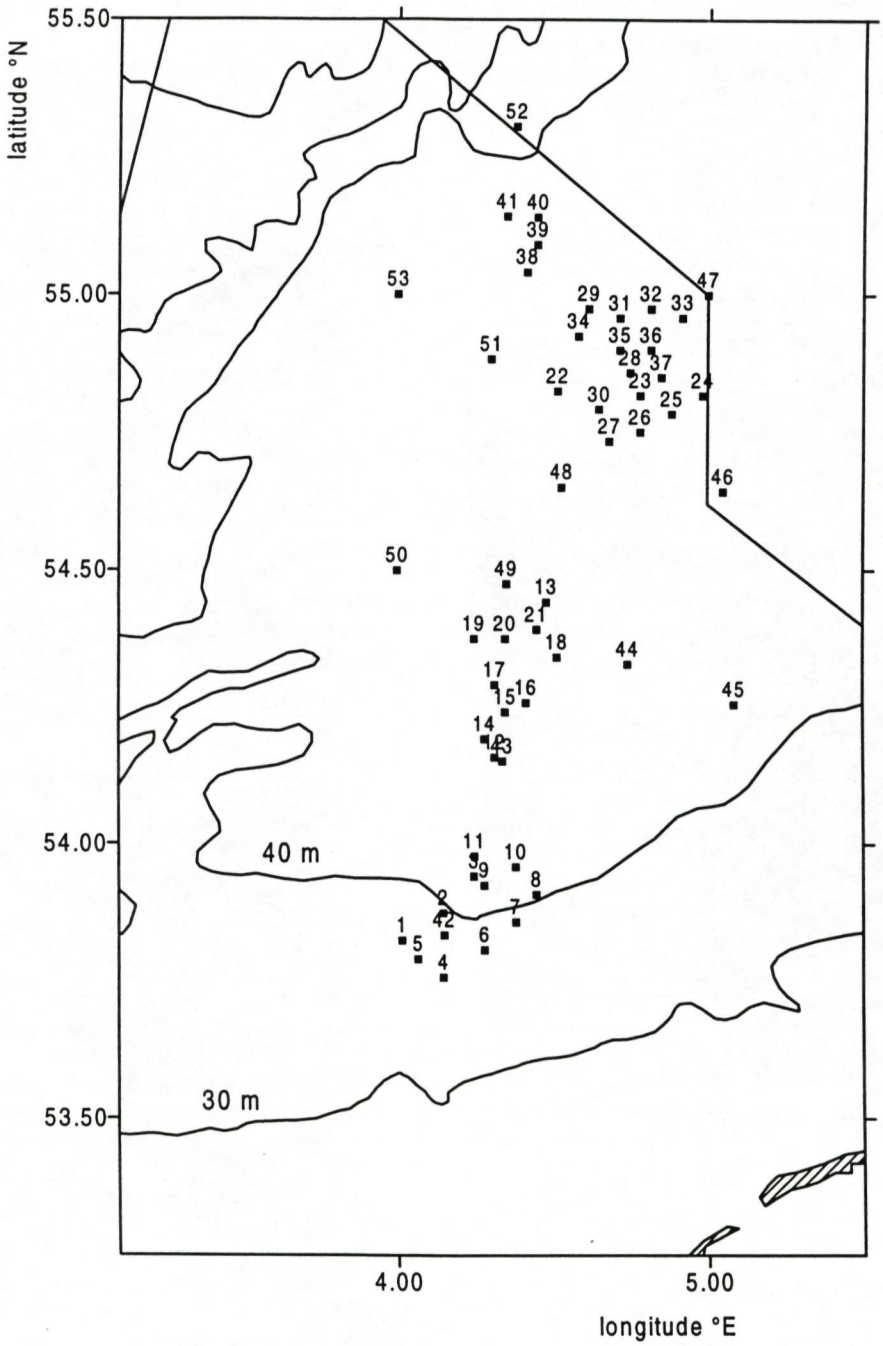


Fig. 4.1. Positions of the stations in the Oystergrounds (for details, see Appendix 4.1).

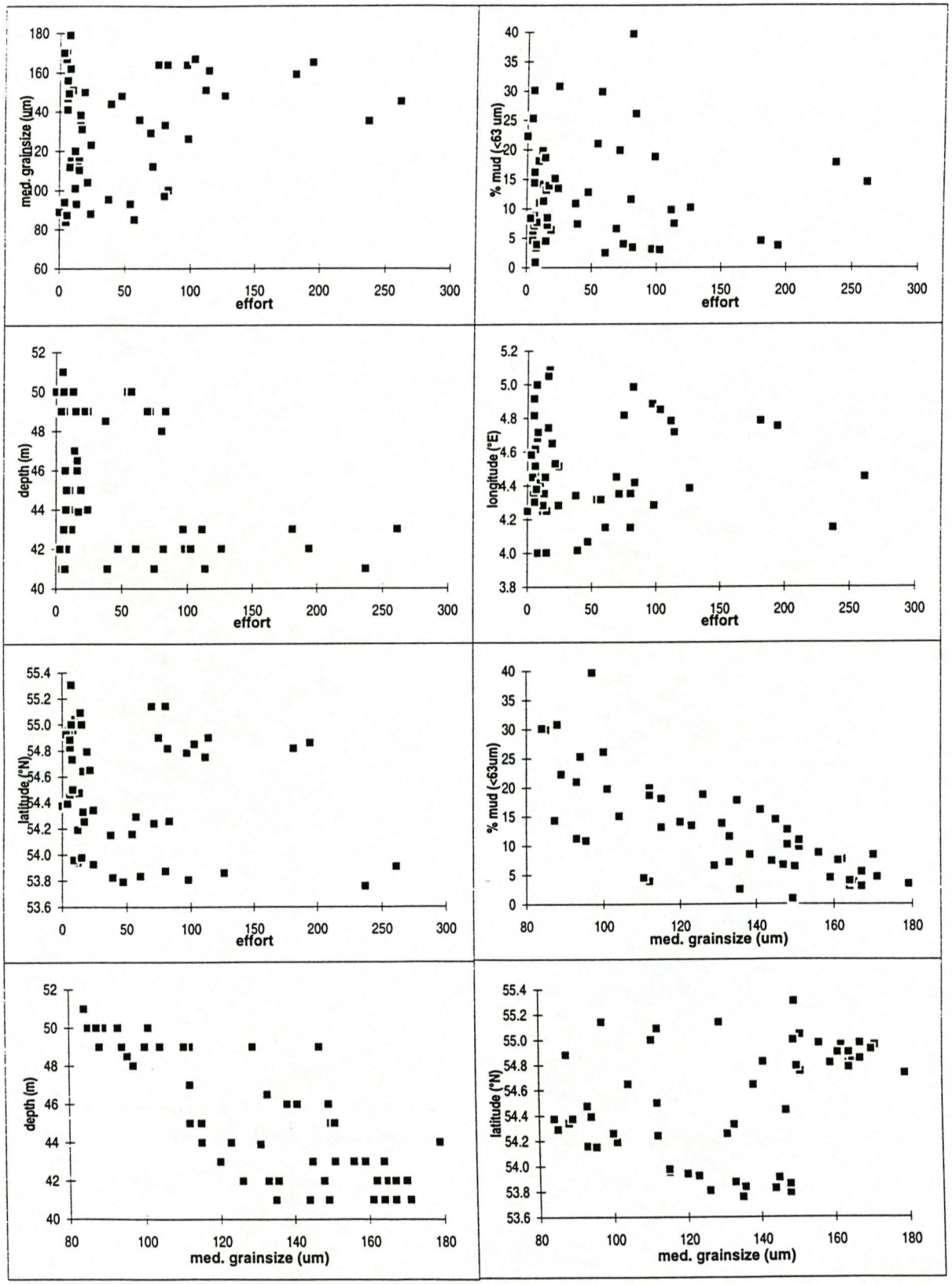


Fig. 4.2. Plots of trawling effort (APR 1993-1996; see Material & Methods) and environmental variables.

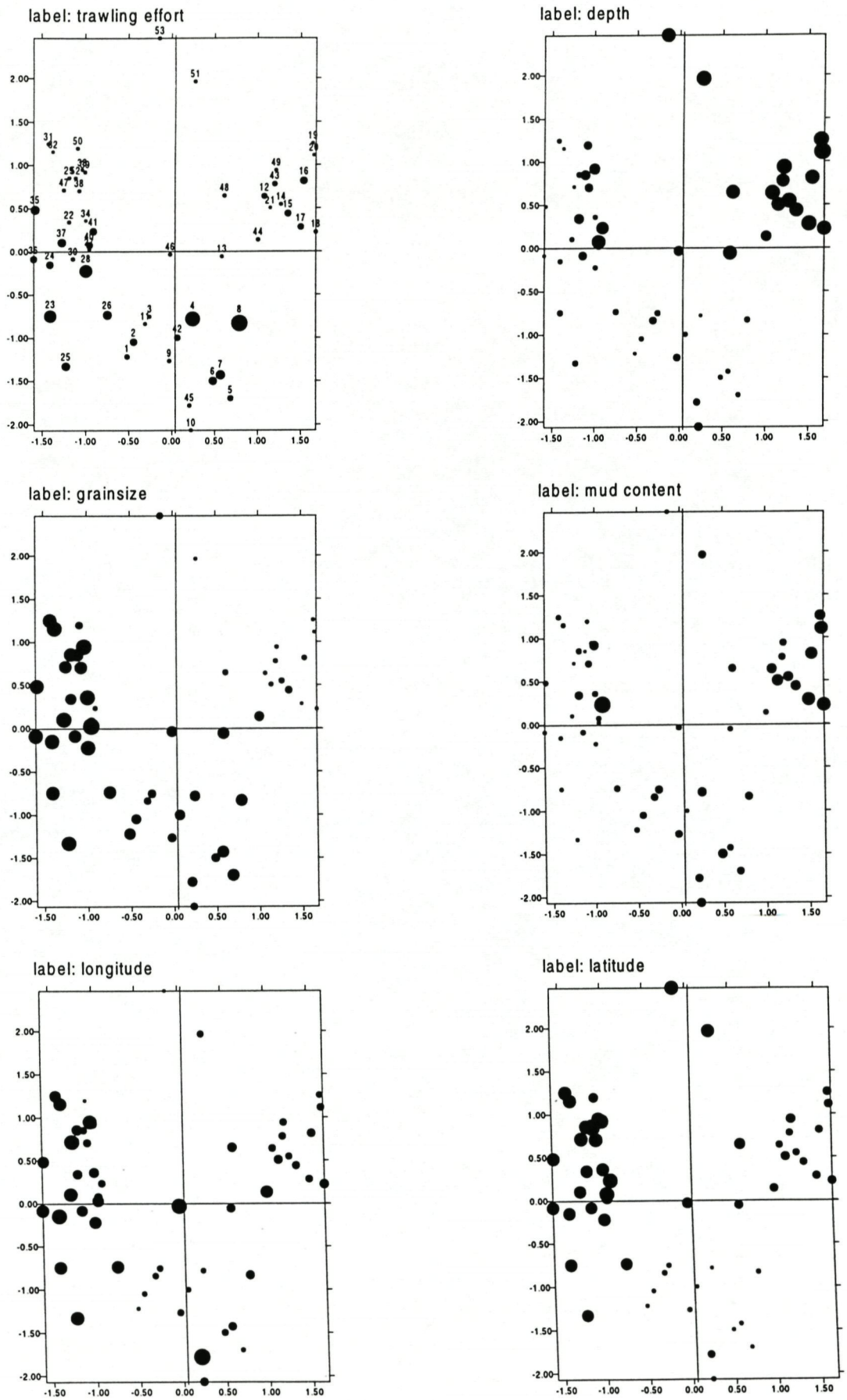


Fig. 4.3. CA-ordination of stations showint the similarity of species composition in the sampling stations. Clustered stations point to a high similarity in species composition. In each diagram the stations are labelled (size of dots) with a different environmental variable. The diagrams show the correlation between the clustering (thus species composition) and that variable.

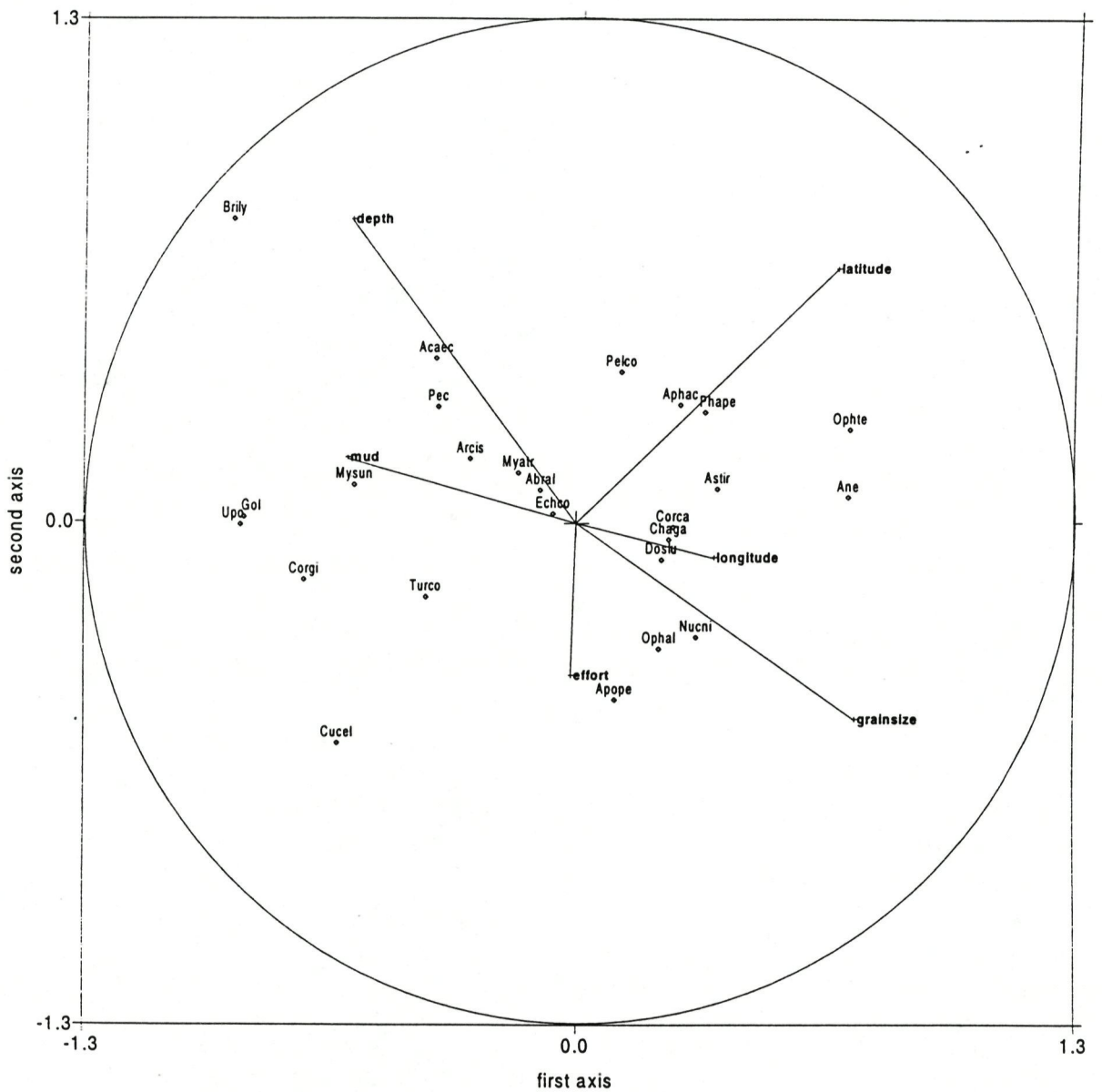


Fig. 4.4. CCA-ordination diagrams showing the correlation of species abundances with environmental variables. For species codes: see Appendix 4.3.

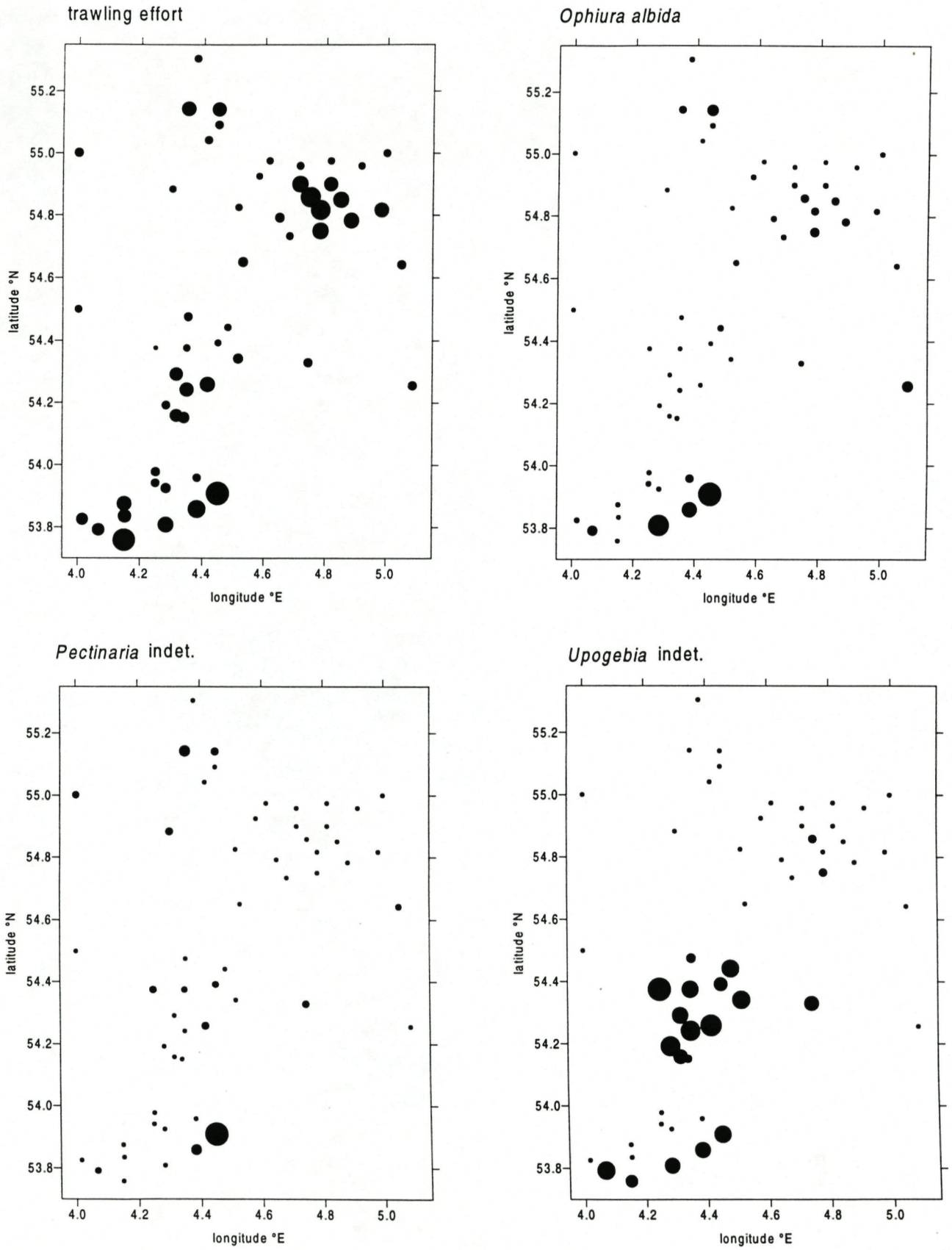


Fig. 4.5. Spatial distribution of trawling effort (first plot) and species that showed a high positive or negative correlation with trawling effort in Table 4.2. Larger dots indicate a higher trawling effort of higher species densities respectively.

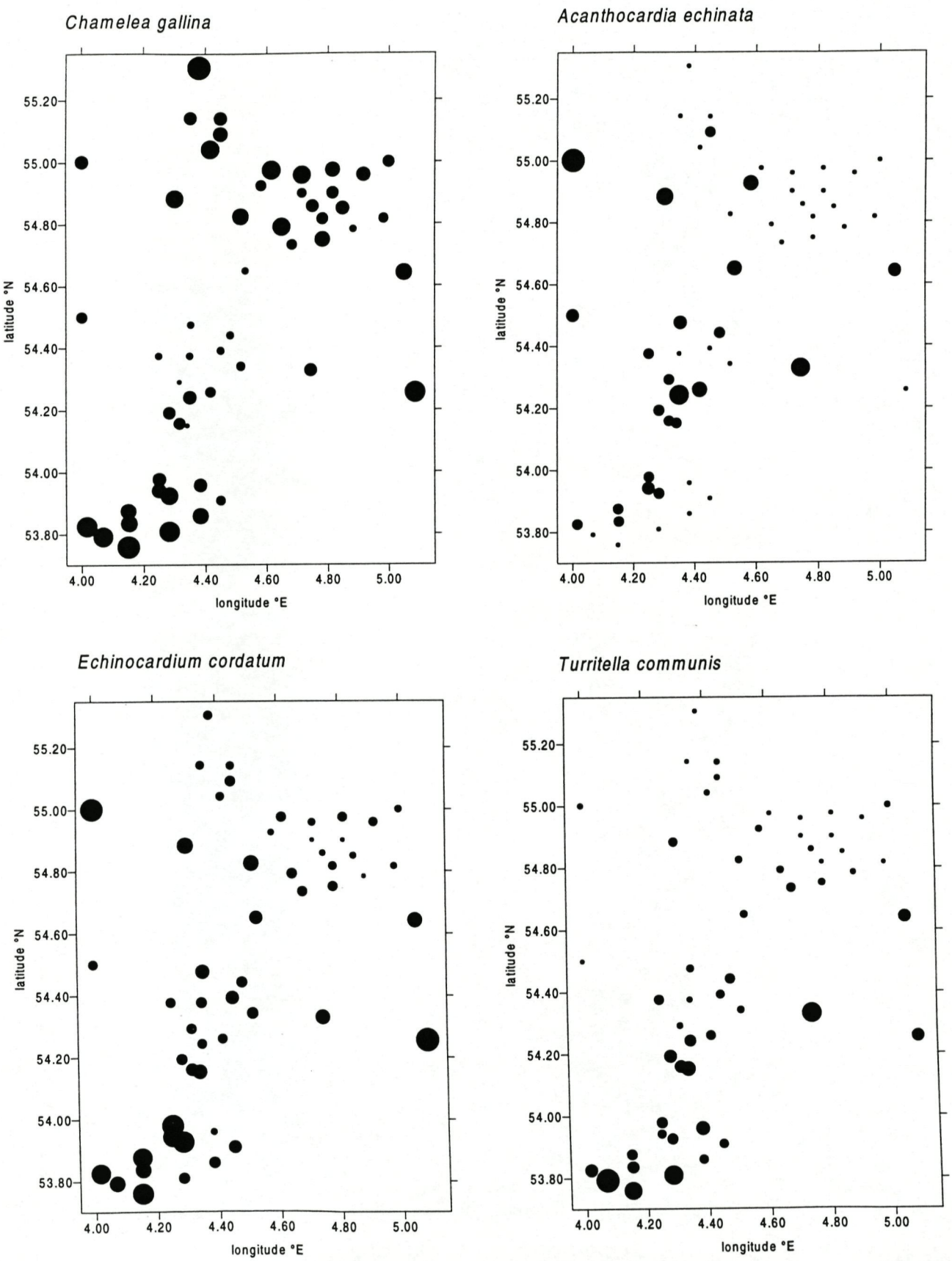


Fig. 4.5. (Continued).

APPENDIX 4.1.
Abiotic variables of the sampling stations.

nr	Station name	Position (UTM; centr.mer.=3°E) x	y	Month	Effort (APR-data)	Grainsize (D50, mu)	Mud(<63 mu) (%)	Depth (m)
1	36F41	566920	5964650	April	39	144	7	41
2	36f410	575648	5970341	April	80	133	12	42
3	36f411	582041	5977903	April	12	120	14	43
4	36f42	575829	5957360	April	237	135	18	41
5	36f43	571360	5961000	April	47	148	13	42
6	36f44	584500	5963050	April	98	126	19	42
7	36f45	590986	5968774	April	126	148	10	42
8	36f46	595270	5974432	April	261	145	15	43
9	36f47	584270	5976060	April	24	123	14	44
10	36f48	590769	5979899	April	9	115	18	45
11	36f49	581989	5981511	April	15	115	13	44
12	37f41	585989	6002058	April	54	93	21	50
13	37f410	569190	6033796	April	6	147	7	49
14	37f42	583776	6005757	April	12	101	20	50
15	37f43	587991	6011375	April	71	112	20	49
16	37f44	592325	6013336	April	83	100	26	49
17	37f45	585702	6016834	April	57	85	30	50
18	37f46	598557	6022714	April	24	88	31	49
19	37f47	581209	6026095	April	0	89	22	50
20	37f48	587700	6026211	April	5	84	30	51
21	37f49	594178	6028208	April	4	94	25	49
22	38f41	597423	6076503	April	6	141	16	46
23	38f410	614603	6075970	April	181	159	5	43
24	38f411	627469	6076345	April	82	164	3	42
25	38f412	621190	6072395	April	97	164	3	43
26	38f413	614784	6068558	April	111	151	10	43
27	38f414	608397	6066540	April	8	179	3	44
28	38f415	612350	6080566	April	194	165	4	42
29	38f416	603477	6093328	April	6	156	9	43
30	38f42	606096	6072984	April	19	150	6	45
31	38f43	609925	6091620	April	8	162	8	42
32	38f44	616268	6093630	April	5	167	6	41
33	38f45	622753	6092019	April	5	171	5	41
34	38f46	601551	6084010	April	3	170	8	42
35	38f47	610083	6085127	April	114	161	8	41
36	38f48	616497	6085307	April	75	164	4	41
37	38f49	618782	6079781	April	103	167	3	42
38	39f41	590532	6100488	April	10	151	11	45
39	39f42	592560	6106051	April	14	112	19	47
40	39f43	592444	6111645	April	69	129	7	49
41	39f44	586189	6111648	April	80	97	40	48
42	biom62	575857	5965888	June	61	135.7	3	42
43	biom77	587575	6001290	June	38	95.4	11	49
44	biom79	613431	6021592	June	16	132.9	7	47
45	biom80	635951	6014070	June	17	131	14	44
46	biom82	632298	6056975	June	16	138.3	9	46
47	biom83	627900	6096750	June	7	149.2	1	41
48	biom84	598780	6057050	June	22	104.1	15	49
49	biom85	587742	6037325	June	13	93	11	50
50	biom86	564875	6039686	June	8	111.9	4	45
51	biom87	583597	6082686	June	6	87.3	14	50
52	biom88	587581	6129750	June	7	149.4	1	46
53	biom89	564087	6095460	June	15	110.4	5	49

APPENDIX 4.2.

Species densities n/100 m²; species codes and size class limits are explained in Appendix 4.3.

Station	abral			acaec			ane	aphac			apope			arcis			astir			brily
nr	small	large	total	small	large	total	total	small	large	total	small	large	total	small	large	total	small	large	total	total
1	0.0	7.4	7.4	0.0	3.7	3.7	0.0	18.5	7.4	25.9	29.6	63.0	92.6	0.0	0.0	0.0	37.0	22.2	59.3	0.0
2	0.0	3.4	3.4	0.0	3.4	3.4	6.8	0.0	0.0	0.0	3.4	54.4	57.8	0.0	3.4	3.4	3.4	30.6	34.0	0.0
3	0.0	0.0	0.0	3.5	3.5	7.0	10.5	0.0	0.0	0.0	3.5	13.9	17.4	0.0	7.0	7.0	3.5	24.4	27.9	0.0
4	3.5	10.6	14.2	0.0	0.0	0.0	0.0	3.5	0.0	3.5	74.5	88.7	163.1	0.0	10.6	10.6	3.5	35.5	39.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0	43.5	72.5	0.0	3.6	3.6	3.6	7.2	10.9	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	7.5	3.8	15.0	18.8	15.0	18.8	33.8	0.0	3.8	3.8	7.5	11.3	18.8	3.8
7	3.8	15.0	18.8	0.0	0.0	0.0	0.0	0.0	11.3	11.3	0.0	3.8	3.8	0.0	0.0	0.0	15.0	0.0	15.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	15.1	15.1	0.0	3.8	3.8	0.0	22.7	22.7	3.8	3.8	7.6	7.6
9	0.0	3.8	3.8	0.0	3.8	3.8	0.0	0.0	0.0	0.0	3.8	15.3	19.1	0.0	0.0	0.0	7.6	42.0	49.7	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	10.9	0.0	0.0	0.0	0.0	7.3	7.3	0.0	3.6	3.6	0.0
11	3.6	3.6	7.2	0.0	3.6	3.6	0.0	0.0	18.0	18.0	0.0	3.6	3.6	0.0	3.6	3.6	0.0	36.0	36.0	0.0
12	0.0	7.4	7.4	3.7	0.0	3.7	0.0	0.0	7.4	7.4	0.0	0.0	0.0	3.7	18.4	22.1	0.0	14.7	14.7	33.2
13	0.0	7.5	7.5	3.7	0.0	3.7	11.2	0.0	3.7	3.7	0.0	7.5	7.5	7.5	0.0	7.5	29.8	0.0	29.8	11.2
14	0.0	0.0	0.0	3.7	0.0	3.7	0.0	0.0	7.5	7.5	0.0	0.0	0.0	0.0	3.7	3.7	7.5	0.0	7.5	44.8
15	0.0	3.6	3.6	21.6	0.0	21.6	0.0	3.6	0.0	3.6	0.0	0.0	0.0	7.2	14.4	21.6	0.0	0.0	0.0	36.0
16	0.0	0.0	0.0	10.7	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	10.7	14.2	7.1	0.0	7.1	32.0
17	0.0	3.6	3.6	3.6	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	18.1	21.7	0.0	3.6	3.6	25.3
18	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	3.3	3.3	3.3	0.0	3.3	3.3	26.6	29.9	0.0	0.0	0.0	53.2
19	0.0	0.0	0.0	3.5	0.0	3.5	3.5	0.0	3.5	3.5	0.0	0.0	0.0	7.1	28.3	35.4	0.0	3.5	3.5	417.6
20	0.0	3.5	3.5	0.0	0.0	0.0	0.0	0.0	3.5	3.5	0.0	0.0	0.0	10.4	20.8	31.3	3.5	0.0	3.5	83.3
21	0.0	3.9	3.9	0.0	0.0	0.0	3.9	0.0	11.6	11.6	0.0	7.7	7.7	0.0	11.6	11.6	7.7	0.0	7.7	65.6
22	0.0	7.3	7.3	0.0	0.0	0.0	22.0	3.7	22.0	25.7	0.0	11.0	11.0	0.0	0.0	0.0	47.7	11.0	58.7	0.0
23	3.7	0.0	3.7	0.0	0.0	0.0	7.3	3.7	11.0	14.6	3.7	11.0	14.6	0.0	0.0	0.0	22.0	25.6	47.6	0.0
24	3.4	0.0	3.4	0.0	0.0	0.0	13.7	0.0	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	3.4	10.3	13.7	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.6	7.2	3.6	10.7	0.0
26	0.0	3.7	3.7	0.0	0.0	0.0	14.8	0.0	7.4	7.4	7.4	0.0	7.4	0.0	0.0	0.0	11.1	11.1	22.2	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	18.7	22.5	0.0	0.0	0.0	0.0	3.7	3.7	18.7	18.7	37.5	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	7.2	7.2	18.0	25.2	3.6	0.0	3.6	0.0	0.0	0.0	18.0	25.2	43.2	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	11.0	7.3	0.0	7.3	0.0	14.7	14.7	0.0	7.3	7.3	25.7	44.0	69.7	0.0
30	0.0	3.5	3.5	0.0	0.0	0.0	3.5	0.0	7.0	7.0	0.0	3.5	3.5	0.0	0.0	0.0	27.9	41.8	69.7	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	14.5	0.0	18.1	18.1	0.0	0.0	0.0	0.0	0.0	0.0	18.1	7.2	25.3	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	11.2	0.0	7.5	7.5	0.0	0.0	0.0	0.0	0.0	0.0	22.4	14.9	37.3	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0	14.7	3.7	0.0	3.7	0.0	0.0	0.0	0.0	3.7	3.7	3.7	14.7	18.3	0.0
34	0.0	0.0	0.0	0.0	10.6	10.6	7.1	0.0	3.5	3.5	0.0	10.6	10.6	0.0	10.6	10.6	74.5	99.4	173.9	0.0
35	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	35.6	14.2	49.9	0.0
36	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	0.0	0.0	0.0	3.6	3.6	0.0	0.0	0.0	76.5	3.6	80.1	0.0
37	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	7.4	7.4	0.0	0.0	0.0	0.0	3.7	3.7	7.4	0.0	7.4	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.5	31.8	35.4	0.0	3.5	3.5	3.5	3.5	7.1	28.3	28.3	56.6	0.0
39	0.0	3.6	3.6	3.6	0.0	3.6	10.7	7.2	14.3	21.5	0.0	0.0	0.0	0.0	3.6	3.6	46.5	32.2	78.8	0.0
40	0.0	3.6	3.6	0.0	0.0	0.0	0.0	179.2	10.8	190.0	0.0	7.2	7.2	0.0	0.0	0.0	60.9	39.4	100.4	0.0
41	14.6	0.0	14.6	0.0	0.0	0.0	7.3	47.4	18.2	65.6	3.6	14.6	18.2	3.6	7.3	10.9	76.6	10.9	87.5	0.0
42	3.7	3.7	7.4	0.0	3.7	3.7	0.0	0.0	0.0	0.0	3.7	7.4	11.1	0.0	7.4	7.4	0.0	22.2	22.2	0.0
43	0.0	3.7	3.7	3.7	0.0	3.7	0.0	0.0	7.4	7.4	0.0	0.0	0.0	0.0	14.8	14.8	3.7	7.4	11.1	107.4
44	7.4	0.0	7.4	14.8	3.7	18.5	3.7	3.7	7.4	11.1	3.7	0.0	3.7	0.0	37.0	37.0	3.7	7.4	11.1	7.4
45	0.0	3.7	3.7	0.0	0.0	0.0	0.0	3.7	14.8	18.5	0.0	3.7	3.7	0.0	3.7	3.7	25.9	11.1	37.0	0.0
46	0.0	0.0	0.0	3.7	3.7	7.4	0.0	0.0	3.7	3.7	0.0	7.4	7.4	0.0	14.8	14.8	63.0	29.6	92.6	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	3.7	3.7	0.0	0.0	0.0	0.0	3.7	3.7	7.4	25.9	33.3	0.0
48	0.0	6.9	6.9	3.4	6.9	10.3	3.4	3.4	24.1	27.6	0.0	6.9	6.9	6.9	6.9	13.8	6.9	10.3	17.2	127.6
49	0.0	0.0	0.0	7.1	0.0	7.1	0.0	0.0	7.1	7.1	0.0	0.0	0.0	3.6	0.0	3.6	14.3	3.6	17.9	71.4
50	0.0	10.3	10.3	6.8	0.0	6.8	17.1	17.1	3.4	20.5	0.0	0.0	0.0	0.0	10.3	10.3	41.1	37.7	78.8	0.0
51	0.0	0.0	0.0	7.4	7.4	14.8	0.0	18.5	37.0	55.6	0.0	0.0	0.0	0.0	3.7	3.7	185.2	0.0	185.2	66.7
52	0.0	14.8	14.8	0.0	0.0	0.0	3.7	29.6	18.5	48.1	0.0	0.0	0.0	3.7	14.8	18.5	51.9	11.1	63.0	0.0
53	0.0	0.0	0.0	3.7	29.6	33.3	7.4	59.3	7.4	66.7	0.0	0.0	0.0	0.0	0.0	0.0	85.2	44.4	129.6	151.9

APPENDIX 4.2. continued.

Station		chaga			corca		corgi	cucel		doslu			echco		gol	myatr	mysun	nucni
nr	small	large	total	small	large	total	total	total	small	large	total	small	large	total	total	total	total	total
1	14.8	96.3	111.1	9.0	116.9	125.9	0.0	25.9	14.8	29.6	44.4	0.0	429.6	429.6	0.0	3.7	0.0	111.1
2	6.8	51.0	57.8	7.5	67.3	74.8	3.4	17.0	10.2	23.8	34.0	13.6	425.2	438.8	0.0	0.0	0.0	95.2
3	3.5	45.3	48.8	55.3	73.7	129.0	10.5	17.4	0.0	13.9	13.9	27.9	446.4	474.3	3.5	0.0	0.0	45.3
4	17.7	120.6	138.3	0.0	74.5	74.5	10.6	63.8	3.5	17.7	21.3	20.9	500.4	521.3	3.5	0.0	3.5	106.4
5	18.1	87.0	105.1	8.2	57.1	65.2	39.9	195.7	10.9	21.7	32.6	61.6	181.2	242.8	90.6	7.2	3.6	50.7
6	52.6	56.4	109.0	88.0	58.6	146.6	60.2	165.4	22.6	11.3	33.8	7.5	78.9	86.5	176.7	11.3	0.0	97.7
7	7.5	52.7	60.2	101.6	79.0	180.6	139.2	82.8	67.7	37.6	105.3	11.3	86.5	97.8	45.1	11.3	3.8	143.0
8	7.6	7.6	15.1	66.5	43.0	109.5	207.7	79.3	22.7	68.0	90.6	49.1	83.1	132.2	185.0	11.3	0.0	37.8
9	11.5	64.9	76.4	19.1	76.4	95.5	19.1	53.5	0.0	15.3	15.3	49.7	496.6	546.2	3.8	7.6	0.0	53.5
10	10.9	25.5	36.4	69.1	50.9	120.1	58.2	83.7	0.0	3.6	3.6	0.0	10.9	10.9	0.0	7.3	0.0	25.5
11	3.6	32.4	36.0	10.8	64.7	75.5	3.6	50.4	0.0	3.6	3.6	46.8	546.8	593.5	0.0	0.0	0.0	118.7
12	7.4	18.4	25.8	0.0	40.6	40.6	51.6	7.4	0.0	0.0	0.0	11.1	129.1	140.1	169.6	7.4	0.0	11.1
13	3.7	3.7	7.5	0.0	37.3	37.3	85.7	29.8	3.7	7.5	11.2	18.6	63.4	82.0	67.1	0.0	3.7	22.4
14	14.9	14.9	29.9	0.0	41.1	41.1	63.5	29.9	0.0	22.4	22.4	3.7	78.5	82.2	123.3	3.7	0.0	7.5
15	18.0	18.0	36.0	7.2	21.6	28.8	115.0	7.2	0.0	18.0	18.0	10.8	39.5	50.3	64.7	10.8	3.6	18.0
16	3.6	14.2	17.8	17.8	0.0	17.8	74.7	3.6	10.7	10.7	21.3	3.6	49.8	53.3	92.5	7.1	17.8	28.4
17	0.0	3.6	3.6	10.8	0.0	10.8	0.0	25.3	3.6	10.8	14.4	0.0	57.8	57.8	50.5	3.6	0.0	7.2
18	6.6	6.6	13.3	3.3	6.6	10.0	43.2	10.0	3.3	3.3	6.6	69.8	23.3	93.0	56.5	3.3	0.0	0.0
19	7.1	0.0	7.1	7.1	10.6	17.7	3.5	10.6	7.1	7.1	14.2	28.3	31.9	60.2	81.4	17.7	3.5	0.0
20	3.5	3.5	6.9	0.0	6.9	6.9	13.9	0.0	0.0	3.5	3.5	13.9	62.5	76.4	45.1	0.0	0.0	6.9
21	0.0	7.7	7.7	0.0	7.7	7.7	27.0	3.9	7.7	3.9	11.6	42.5	100.4	142.9	73.4	3.9	0.0	7.7
22	40.3	25.7	66.0	17.9	62.7	80.6	0.0	0.0	25.7	18.3	44.0	0.0	234.6	234.6	0.0	0.0	0.0	66.0
23	18.3	7.3	25.6	23.1	50.1	73.2	0.0	0.0	3.7	3.7	7.3	3.7	25.6	29.3	0.0	0.0	0.0	14.6
24	17.2	0.0	17.2	7.8	74.6	82.4	0.0	0.0	3.4	3.4	6.9	3.4	6.9	10.3	0.0	3.4	0.0	17.2
25	7.2	0.0	7.2	11.5	17.2	28.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.2
26	22.2	36.9	59.1	15.8	95.0	110.8	0.0	0.0	25.8	25.8	51.7	18.5	40.6	59.1	3.7	3.7	0.0	110.8
27	11.2	7.5	18.7	5.5	88.1	93.6	0.0	0.0	3.7	3.7	7.5	11.2	44.9	56.2	0.0	0.0	0.0	86.1
28	25.2	7.2	32.4	13.4	116.2	129.6	0.0	0.0	3.6	18.0	21.6	0.0	7.2	7.2	0.0	3.6	3.6	90.0
29	7.3	88.0	95.3	0.0	55.0	55.0	0.0	0.0	36.7	25.7	62.3	22.0	33.0	55.0	0.0	3.7	0.0	121.0
30	34.9	48.8	83.7	24.4	73.2	97.6	0.0	0.0	10.5	17.4	27.9	0.0	73.2	73.2	0.0	3.5	0.0	125.5
31	18.1	65.0	83.1	14.1	94.2	108.4	0.0	0.0	7.2	21.7	28.9	10.8	10.8	21.7	0.0	0.0	0.0	86.7
32	26.1	26.1	52.3	8.5	111.0	119.5	0.0	0.0	3.7	14.9	18.7	0.0	48.5	48.5	0.0	3.7	0.0	127.0
33	40.3	3.7	44.0	18.9	98.4	117.3	7.3	0.0	14.7	3.7	18.3	0.0	36.7	36.7	0.0	0.0	0.0	117.3
34	7.1	14.2	21.3	4.3	34.7	39.0	0.0	0.0	7.1	0.0	7.1	0.0	7.1	7.1	0.0	0.0	0.0	46.1
35	7.1	7.1	14.2	17.4	60.9	78.3	0.0	0.0	0.0	3.6	3.6	0.0	0.0	0.0	0.0	7.1	0.0	99.7
36	14.6	14.6	29.1	19.3	130.1	149.3	0.0	0.0	7.3	10.9	18.2	0.0	0.0	0.0	0.0	0.0	0.0	116.6
37	14.8	25.9	40.6	0.0	103.5	103.5	0.0	0.0	14.8	25.9	40.6	0.0	11.1	11.1	0.0	0.0	0.0	66.5
38	10.6	74.3	84.9	15.2	66.1	81.3	0.0	0.0	35.4	35.4	70.7	0.0	31.8	31.8	0.0	7.1	0.0	35.4
39	7.2	39.4	46.5	8.8	87.9	96.7	0.0	0.0	3.6	0.0	3.6	3.6	68.0	71.6	0.0	17.9	0.0	0.0
40	25.1	10.8	35.8	43.8	63.7	107.5	0.0	0.0	7.2	0.0	7.2	7.2	21.5	28.7	0.0	25.1	0.0	0.0
41	14.6	18.2	32.8	66.8	86.4	153.1	0.0	0.0	32.8	18.2	51.0	3.6	25.5	29.2	0.0	10.9	0.0	0.0
42	3.7	63.0	66.7	3.7	55.6	59.3	0.0	22.2	0.0	11.1	11.1	66.7	185.2	251.9	0.0	11.1	3.7	96.3
43	0.0	3.7	3.7	3.7	33.3	37.0	48.1	0.0	0.0	0.0	0.0	33.3	163.0	196.3	74.1	11.1	3.7	18.5
44	18.5	14.8	33.3	3.7	74.1	77.8	266.7	33.3	3.7	55.6	59.3	22.2	185.2	207.4	203.7	0.0	14.8	7.4
45	33.3	85.2	118.5	0.0	40.7	40.7	533.3	51.9	48.1	40.7	88.9	429.6	240.7	670.4	3.7	11.1	0.0	18.5
46	0.0	66.7	66.7	0.0	140.7	140.7	14.8	0.0	18.5	11.1	29.6	18.5	207.4	225.9	14.8	7.4	0.0	25.9
47	22.2	3.7	25.9	0.0	55.6	55.6	0.0	0.0	0.0	0.0	0.0	0.0	14.8	14.8	0.0	0.0	0.0	96.3
48	3.4	3.4	6.9	0.0	27.6	27.6	37.9	3.4	0.0	0.0	0.0	24.1	120.7	144.8	72.4	20.7	3.4	10.3
49	7.1	0.0	7.1	14.3	14.3	28.6	28.6	3.6	0.0	0.0	0.0	75.0	117.9	192.9	14.3	0.0	3.6	14.3
50	6.8	13.7	20.5	54.8	116.4	171.2	0.0	0.0	3.4	6.8	10.3	3.4	47.9	51.4	0.0	0.0	0.0	102.7
51	44.4	33.3	77.8	7.4	55.6	63.0	25.9	0.0	0.0	3.7	3.7	251.9	14.8	266.7	0.0	18.5	3.7	0.0
52	51.9	100.0	151.9	0.0	103.7	103.7	0.0	0.0	44.4	44.4	88.9	0.0	37.0	37.0	0.0	0.0	0.0	7.4
53	18.5	18.5	37.0	29.6	55.6	85.2	0.0	0.0	18.5	11.1	29.6	477.8	133.3	611.1	0.0	0.0	0.0	0.0

APPENDIX 4.2. continued.

Station nr	ophal small	ophal large	ophal total	ophte small	ophte large	ophte total	pec total	pelco total	phape small	phape large	phape total	turco small	turco large	turco total	upo total
1	0.0	14.8	14.8	11.1	3.7	14.8	0.0	0.0	0.0	0.0	0.0	103.7	129.6	233.3	0.0
2	0.0	3.4	3.4	10.2	6.8	17.0	0.0	0.0	0.0	0.0	0.0	44.2	81.6	125.9	0.0
3	0.0	7.0	7.0	17.4	20.9	38.4	0.0	0.0	0.0	0.0	0.0	13.9	52.3	66.3	0.0
4	0.0	0.0	0.0	3.5	0.0	3.5	0.0	3.5	17.7	3.5	21.3	312.1	241.1	553.2	17.7
5	54.3	398.6	452.9	3.6	0.0	3.6	3.6	3.6	0.0	0.0	0.0	377.4	771.2	1148.6	50.7
6	992.5	3172.9	4165.4	0.0	0.0	0.0	0.0	0.0	3.8	0.0	3.8	182.2	535.9	718.0	33.8
7	0.0	1866.1	1866.1	0.0	0.0	0.0	33.9	3.8	0.0	0.0	0.0	22.6	48.9	71.5	33.9
8	483.4	4924.5	5407.9	0.0	0.0	0.0	347.4	7.6	0.0	0.0	0.0	7.6	68.0	75.5	45.3
9	0.0	3.8	3.8	3.8	15.3	19.1	0.0	0.0	0.0	0.0	0.0	45.8	84.0	129.9	0.0
10	7.3	192.9	200.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.2	232.9	291.1	0.0
11	0.0	3.6	3.6	25.2	10.8	36.0	0.0	0.0	0.0	0.0	0.0	32.4	104.3	136.7	0.0
12	0.0	0.0	0.0	11.1	0.0	11.1	0.0	3.7	3.7	0.0	3.7	151.2	92.2	243.4	29.5
13	3.7	37.3	41.0	93.2	0.0	93.2	0.0	37.3	0.0	0.0	0.0	59.6	48.5	108.1	48.5
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	22.4	0.0	22.4	115.8	119.6	235.4	67.3
15	0.0	3.6	3.6	0.0	0.0	0.0	0.0	3.6	7.2	0.0	7.2	46.7	104.3	151.0	64.7
16	0.0	0.0	0.0	0.0	0.0	0.0	10.7	7.1	3.6	0.0	3.6	32.0	56.9	88.9	78.2
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	7.2	10.8	39.7
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	10.0	23.3	49.8
19	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.0	10.6	0.0	10.6	10.6	84.9	95.6	95.6
20	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	3.5	3.5	6.9	45.1
21	0.0	0.0	0.0	0.0	0.0	0.0	3.9	7.7	0.0	0.0	0.0	34.8	15.4	50.2	23.2
22	0.0	0.0	0.0	135.6	0.0	135.6	0.0	0.0	7.3	0.0	7.3	18.3	7.3	25.7	0.0
23	29.3	113.5	142.8	25.6	11.0	36.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	3.4	24.0	27.5	6.9	17.2	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	25.1	132.6	157.6	0.0	3.6	3.6	0.0	0.0	0.0	0.0	0.0	3.6	0.0	3.6	0.0
26	40.6	306.5	347.1	7.4	11.1	18.5	0.0	0.0	3.7	0.0	3.7	22.2	3.7	25.8	3.7
27	3.7	7.5	11.2	48.7	3.7	52.4	0.0	0.0	0.0	3.7	3.7	52.4	11.2	63.7	0.0
28	18.0	169.2	187.2	68.4	21.6	90.0	0.0	0.0	0.0	7.2	7.2	3.6	0.0	3.6	3.6
29	0.0	0.0	0.0	88.0	7.3	95.3	0.0	7.3	11.0	7.3	18.3	0.0	0.0	0.0	0.0
30	3.5	13.9	17.4	139.5	7.0	146.4	0.0	0.0	13.9	0.0	13.9	20.9	3.5	24.4	0.0
31	0.0	0.0	0.0	39.7	0.0	39.7	0.0	7.2	0.0	3.6	3.6	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	74.7	7.5	82.2	0.0	3.7	7.5	0.0	7.5	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	25.7	3.7	29.3	0.0	3.7	3.7	0.0	3.7	0.0	0.0	0.0	0.0
34	0.0	7.1	7.1	60.3	3.5	63.9	0.0	0.0	3.5	3.5	7.1	7.1	7.1	14.2	0.0
35	3.6	3.6	7.1	42.7	3.6	46.3	0.0	0.0	0.0	7.1	7.1	0.0	0.0	0.0	0.0
36	3.6	7.3	10.9	36.4	3.6	40.1	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	44.3	114.5	158.9	18.5	11.1	29.6	0.0	3.7	0.0	7.4	7.4	0.0	0.0	0.0	0.0
38	0.0	0.0	0.0	35.4	14.1	49.5	0.0	0.0	7.1	10.6	17.7	3.5	0.0	3.5	0.0
39	3.6	3.6	7.2	111.0	204.1	315.1	0.0	3.6	0.0	0.0	0.0	3.6	0.0	3.6	0.0
40	29.9	747.9	777.8	71.7	197.1	268.8	10.8	7.2	17.9	3.6	21.5	3.6	0.0	3.6	0.0
41	10.9	142.2	153.1	51.0	266.2	317.2	43.8	3.6	3.6	0.0	3.6	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.3	85.2	181.5	0.0
43	0.0	3.7	3.7	0.0	0.0	0.0	0.0	0.0	11.1	0.0	11.1	177.8	163.0	340.7	3.7
44	0.0	11.1	11.1	0.0	0.0	0.0	7.4	22.2	11.1	3.7	14.8	148.9	595.6	744.4	29.6
45	0.0	611.1	611.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	125.9	88.9	214.8	0.0
46	0.0	14.8	14.8	3.7	3.7	7.4	3.7	3.7	3.7	3.7	7.4	88.9	125.9	214.8	0.0
47	0.0	3.7	3.7	14.8	33.3	48.1	0.0	7.4	0.0	0.0	0.0	3.7	3.7	7.4	0.0
48	0.0	27.6	27.6	13.8	3.4	17.2	0.0	6.9	3.4	0.0	3.4	24.1	10.3	34.5	0.0
49	0.0	0.0	0.0	3.6	0.0	3.6	0.0	0.0	0.0	0.0	0.0	17.9	17.9	35.7	7.1
50	0.0	0.0	0.0	27.4	0.0	27.4	0.0	0.0	6.8	0.0	6.8	0.0	0.0	0.0	0.0
51	0.0	0.0	0.0	66.7	14.8	81.5	11.1	103.7	3.7	3.7	7.4	37.0	25.9	63.0	0.0
52	0.0	7.4	7.4	14.8	44.4	59.3	0.0	3.7	0.0	11.1	11.1	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	14.8	33.3	48.1	7.4	11.1	0.0	0.0	0.0	0.0	3.7	3.7	0.0

APPENDIX 4.3.
Codes and names of species used in this study

Species code	Scientific name	Common english name	Dutch name	Size-class limits* small	large
abral	*Abra alba*		witte dunschaal	≤ 2	≥ 3
acaec	*Acanthocardia echinata*	prickly cockle	gedoornde hartschelp	≤ 9	≥ 10
ane	*Anemone sp. indet.*	anemones	anemonen		
aphac	*Aphrodita aculeata*	sea mouse	zeemuis	≤ 9	≥ 10
apope	*Aporrhais pespelicani*	pelican's foot shell	pelikaansvoet	≤ 6	≥ 7
arcis	*Arctica islandica*	quahog	noordkromp	≤ 10	≥ 11
astir	*Astropecten irregularis*	burrowing starfish	kamster	≤ 9	≥ 10
brily	*Brissopsis lyrifera*				
chaga	*Chamelea gallina*	striped venus	venusschelp	≤ 3	≥ 4
corca	*Corystes cassivelaunus*	masked crab	helmkrab	≤ 2	≥ 3
corgi	*Corbula gibba*	common basket shell	korfschelp		
cucel	*Cucumaria elongata*	a sea cucumber	een zeekomkommer		
doslu	*Dosinia lupinus*	smooth artemis	lichtgestreepte artemisschelp	≤ 4	≥ 5
echco	*Echinocardium cordatum*	sea potatoe	zeeklit	≤ 5	≥ 6
gol	*Golfingia spp. indet.*				
myatr	*Mya truncata*		geknotte strandgaper		
mysun	*Mysia undata*		ronde zandschelp		
nucni	*Nucula nitidosa*	nut shell	driehoekige parelmoetneut		
ophal	*Ophiura albida*	a brittle star	kleine slangster	≤ 0	≥ 1
ophte	*Ophiura texturata*	a brittle star	gewone slangster	≤ 2	≥ 3
pec	*Pectinaria sp. indet.*		goudkammetje		
pelco	*Pelonaia corrugata*		een zakpijp		
phape	*Phaxas pellucidus*		sabelschede	≤ 5	≥ 6
turco	*Turritella communis*	tower shell	penhoren	≤ 5	≥ 6
upo	*Upogebia sp. indet.*				

* limits of small and large size classes (0.5 cm classes: 0=0-0.5 cm; 1=0.5-1 cm, etc.) that are mentioned in Appendix 4.2.

DISTRIBUTION OF LARGER SIZED INVERTEBRATE SPECIES (MEGAFAUNA) IN THE DUTCH SECTOR OF THE NORTH SEA

34005

M.J.N. Bergman, J.W. van Santbrink (NIOZ)

Introduction

In 1996 field surveys were carried out to measure the densities of larger sized (>1 cm) invertebrate species (megafauna) in a selection (n = 60) of the 100 stations in the BIOMON project (Holtmann et al. 1996). The BIOMON project aims to detect year-to-year variations in the macrobenthic community and is focused on the small sized (>1 mm) fraction of macrofauna sampled with a boxcorer. As this gear, due to its small sampling size, is not suitable to reliably estimate the densities of low abundant invertebrate megafauna, the benthos dredge Triple-D (Bergman & van Santbrink 1994), sampling size about 30 m^2, was used in the BEON field surveys. For epifauna species that are too low abundant to be sampled reliably with the Triple-D, a fine meshed 3m beam trawl was used. Demersal fish species were caught in this beam trawl as well. During the field surveys it appeared that, due to the an imperfection of the newly fitted pneumatic system, the Triple-D sampling of superficially or periodically burrowing invertebrate species (*e.g.* snails, anemones, swimming crabs) was not reliable, leading to an overestimation of abundances (BEON data report 1996). Unfortunately, these species are seriously underestimated in the fine meshed 3m beam trawl sampling. The 1996 survey therefore did not provide reliable abundances of those species. Deeper burrowing infauna species, however, were sampled reliably with the Triple-D. This also holds for epifauna and fish species sampled in the fine meshed 3m beam trawl. Abundances of species in these two categories are presented in this subproject.

In the 1997 field surveys, the sampling was repeated in the 1996-stations. In addition a number of other BIOMON-stations were sampled. In 67 stations the species composition of megafauna and fish was determined using the improved Triple-D and the fine meshed 3m beam trawl. The 1997 survey provided reliable density estimates for all categories of megafauna: infauna, superficially burrowing fauna, epifauna and fish.

In subproject 1 of this BEON project, an estimate is given for the fishing mortality, *i.e.* the mortality in the populations of some megafauna species generated by the 12m and 4m beam trawl fisheries at the Dutch continental shelf over a certain time period. This fishing mortality is calculated using three variables: (i) the trawling frequency of the beam trawl fleet in the period 1993-1996 (APR-data RIVO), (ii) the estimates of the direct mortality rate in megafauna species due to a single experimental trawling (data Bergman et al, 1998), and (iii) the spatial distribution of megafauna. Abundances in 1997 of a selection of the sessile and low mobile megafauna species were used to calculate of the fishing mortality in subproject 1. Because of the sampling problems, the 1996-data were not used in the calculations.

In this subproject the abundances of megafauna and fish in the Dutch sector are presented per sampling station and in the four main subareas of the Dutch sector (Doggerbank, Oystergrounds, offshore sandy area and coastal area). Density estimates in 1996 and 1997 are compared. For a number of species, especially those for which the fishing mortality is calculated in subproject 1, spatial distributions of abundances are depicted.

Material and methods

The sampling surveys were carried out from March to May 1996 and in June 1997, onboard RV MITRA (RWS/DNZ). The stations were a selection of the BIOMON stations, of which 60 stations were sampled in 1996 and 67 in 1997. In 1997, a few new stations were added in order to get a better coverage of the area especially in the northern part of the Doggerbank. The stations were selected more or less at random within the main subareas of the Dutch sector, *i.e* Doggerbank, Oystergrounds, offshore sandy area and coastal area. The position of the stations including the water depth, median grainsize and mud content that were determined in 1996 (Holtman et al. in press) are given in Fig. 5.1. In each station one haul was made with the benthos dredge Triple-D about 25 m south from the BIOMON station (haul length *circa* 150 m; sampling depth 10 cm (12.5 cm in Oystergrounds in 1997); sampling width 20 cm; mesh size 1.4 cm stretched; fishing speed 3 nM/h). In addition, one haul with the fine meshed 3m beam trawl was made about 50 m south from the BIOMON station (haul length 250 - 750 m; mesh size cod end 1 cm streched; fishing speed 3 nM/h). In the 1996 survey, the Triple-D could not be used in some soft sediment stations (*e.g.* in the Frisian Front) as the runners dug too deeply into the seabed. In 1997 the Triple-D was equipped with much broader runners and the dredge was used without problems in all stations. The catches were sorted on board and animals were measured in length classes. For specimens in length classes smaller than < 1 cm which could pass through the meshes, at least relative estimates of species densities could be made, as a standard sampling procedure was carried out.

The positions of the stations sampled in 1996 and 1997, including data on the median grainsize, mud content and water depth are given in Appendix 5.1. The total abundances of megafauna and fish in the 1996-stations (infauna based on Triple-D sampling, fish and some invertebrate epifauna species based on 3m beam trawl sampling) are given in Appendix 5.2. In 1996, abundances of superficially or periodically burrowing species (*e.g.* snailes, anemones, swimming crabs) were not estimated reliably (see Introduction) and are omitted. The total abundances of all categories megafauna and fish in the 1997-stations are given in Appendix 5.3.

Results and discussion

The mean abundances of megafauna and fish species are given for the four main subareas in the Dutch sector (Doggerbank, Oystergrounds, offshore area and coastal area) for 1996 (Table 5.1) and 1997 (Table 5.2). A comparison of the mean densities is given for the epifauna and fish species, that were sampled in the fine meshed 3m beam trawl in 1996 and 1997 (Table 5.3a). As the sampling gear and the procedure were similar, differences in mean abundances in the subareas must be considered as year to year variations in the populations. In species showing seasonal migrations, these differences may be partly due to the the different sampling periods in 1996 (March-May) and in 1997 (June). The mean densities of infauna species, sampled in the Triple-D in 1996 and 1997, are compared in Table 5b. For many bivalve species the mean densities in the subareas were estimated up to two times higher in 1996 than in 1997. This points either to decreased in abundances in 1997 or to a unexpected overestimate due to the problems with the pneumatic system in 1996. As only 1997-data were used for the calculation of fishing mortality in subproject 1, this problem has no further implications.

Little is known about the year to year, as well as longer term, variation in densities of invertebrate megafauna species in the North Sea. Previous sampling programs, in which box corers, grabs or trawls were used, did not generate abundances for the majority of megafauna species, as these were too low abundant or too deep burrowing into the seabed for these gears respectively.

In Fig. 5.2 a series of maps illustrate the spatial distributions of a number of megafauna species and fish (1997-sampling) over the Dutch sector. The distributions of species for which the fishing mortality is calculated in subproject 1 are included in this series. For many species the spatial distributions appear to be related to environmental gradients in the North Sea *i.e.* sedimentological gradients (median grainsize, mud content), hydrographical gradients (coastal versus offshore areas) and temperature gradients (northern versus southern distribution). Abundances of mobile species are also related to seasonal migration patterns. Figure 5.2 illustrates this species specific distribution.

Dab (*Limanda limanda*) and gobius (*Pomatoschistus* spp.) are (in numbers) the most common and dominant fish species. Sole (*Sole solea*) has a coastal distribution in spring and early summer due to spawning activities. Solenette (*Buglossidium luteum*) and dragonet (*Callionymus lyra*) tend to avoid silty sediments. The lesser weever (*Trachinus vipera*) shows a typical southern distribution.

The most widely distributed echinoderms are the common starfish, *Asterias rubens*, and brittlestar *Ophiura texturata*. The brittlestar *O. albida* occurs in very high densities in a number of soft bottom stations (*e.g.* the Frisian Front stations nr. 53 and 60). *Brissopsis lyrifera, Cucumaria elongata,* and *Astropecten irregularis* prefer silty bottoms. Density estimates of *Brissopsis lyrifera* and *Echinocardium cordatum* are not reliable, as these species may burrow deeper than 10 cm, and pulverise easily in the catch of the Triple-D, which makes them hard to count.

In the group of bivalves, *Chamelea gallina* occurs in all types of sediment, although the densities are much lower south of 53°N. *Spisula subtruncata* and *Ensis americanus* are typical coastal species, where they can locally reach extremely high densities. *Angulus fabulus* is restricted to sandy sediment, whereas *Mya truncata, Acanthocardia echinata* and *Dosinia lupinus* prefer silty seabeds. *Spisula solida* shows a southern preference, *Ensis siliqua* and *Gari fervensis* a northern distribution. In the group of gastropods, the large necklace shell (*Euspira catena)* is limited to sandy environments, the tower shell (*Turritella communis)* to silty areas.

In the crustaceans, the swimming crab *Liocarcinus holsatus* and the hermit crab *Eupagurus bernhardus* are the most common species. The brown shrimp *Crangon crangon* is a typical coastal species, whereas another shrimp species *C. allmani* shows an offshore distribution. The masked crab *Corystes cassivelaunus* prefers silty sediments. *Thia scutellata* shows a southern, *Ebalia* spp. a northern distribution.

The Sipunculid species *Golfingia* indet. and the seamouse *Aphrodite aculeata* (a polychaete worm) are typical inhabitants of silty sediments.

References

BEON data report, 1996.Verspreiding en abundantie van grotere (epi)benthische macrofaunasoorten op het NCP en de invloed van boomkorvisserij op de verspreiding van deze fauna. M.J.N. Bergman & J.W. van Santbrink (eds.). BEON data report (NIOZ 96V): pp 5.

Bergman, M.J.N. & J.W. van Santbrink, 1994. A new benthos dredge (Triple-D) for quantitative sampling of infauna species of low abundance. Neth. J. Sea Res. 33: 129-133.

Bergman, M.J.N., B. Ball, C. Bijleveld, J.A. Craeymeersch, B.W. Munday, H. Rumohr & J.W. van Santbrink, 1998. Direct mortality due to trawling. In: H.J.Lindeboom & S.J. de Groot (eds.). 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: 167-185.

Holtmann, S.E., J.J.M. Belgers, B. Kracht & R. Daan, 1996. The macrobenthic fauna in the Dutch sector of the North Sea in 1995 and a comparison with previous data. NIOZ Rapport 1996-8: 102 pp.

TABLE 5.1.

Mean densities (n/100 m²) of demersal fish and benthic invertebrates in four sub-areas in the Dutch sector in 1996; sandy coastal zone (n samples = 10), sandy offshore zone (n=20), silty Oystergrounds (n=30) and sandy Dogger bank (n=7). Positions of stations and boundaries of sub-area's (based on Holtman, 1996), are shown in Fig 5.1; 3mBT=3 m beam trawl; DDD = Triple-D. Only species that were sampled reliably in the trawl or in the (in 1996 not properly functioning) Triple-D are included.

	Gear	Coastal zone		Offshore zone		Oystergrounds		Dogger bank		Total	
		mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
FISH											
Agonus cataphractus	3mBT	0.26	0.39	0.07	0.13	0.02	0.03	0.04	0.05	0.08	0.19
Ammodytes spp.	3mBT	0.58	0.90	0.43	0.34	0.03	0.09	0.44	0.93	0.30	0.55
Arnoglossus laterna	3mBT	0.17	0.24	0.69	0.81	0.88	0.61	0.26	0.15	0.63	0.66
Buglossidium luteum	3mBT	1.18	1.63	5.52	5.43	3.73	3.52	2.28	1.78	3.73	4.16
Callionymus lyra	3mBT	0.22	0.32	0.54	0.62	0.37	0.29	0.10	0.08	0.37	0.44
Callionymus reticulatus	3mBT	0	0	1.63	2.01	0.01	0.04	0.03	0.08	0.55	1.38
Ciliata mustela	3mBT	0.01	0.03	0.00	0.01	0	0	0	0	0.00	0.01
Enchelyopus cimbrius	3mBT	0	0	0.00	0.02	0.15	0.29	0	0	0.06	0.19
Eutrigla gurnardus	3mBT	0.05	0.10	0.04	0.06	0.42	1.41	0.54	0.71	0.24	0.91
Gadus morhua	3mBT	0	0	0.00	0.02	0.01	0.03	0.01	0.03	0.01	0.02
Gaidropsarus vulgaris	3mBT	0	0	0	0	0.11	0.27	0	0	0.04	0.17
Hippoglossoides platessoides	3mBT	0	0	0	0	0.06	0.19	0.02	0.07	0.03	0.12
Limanda limanda	3mBT	4.84	2.32	3.55	3.08	2.10	1.28	2.32	1.73	3.06	2.41
Melanogrammus aeglefinus	3mBT	0	0	0	0	0.00	0.02	0	0	0.00	0.01
Merlangius merlangus	3mBT	0.21	0.32	1.45	5.30	0.28	0.22	0.02	0.04	0.63	3.07
Microstomus kitt	3mBT	0	0	0	0	0.01	0.02	0.03	0.04	0.01	0.02
Phrynorhombus norvegicus	3mBT	0	0	0	0	0.01	0.03	0	0	0.00	0.02
Platychthys flesus	3mBT	0.43	0.70	0.00	0.02	0	0	0	0	0.07	0.32
Pleuronectes platessa	3mBT	3.75	5.03	0.69	1.29	0.14	0.15	0.01	0.03	0.91	2.47
Pomatoschistus spp.	3mBT	17.69	20.45	6.15	5.34	1.81	3.77	2.42	1.06	5.98	10.48
Scophthalmus rhombus	3mBT	0.01	0.02	0	0	0	0	0	0	0.00	0.01
Solea solea	3mBT	0.33	0.42	0.09	0.16	0.07	0.07	0.01	0.03	0.11	0.22
Syngnathus acus	3mBT	0.03	0.08	0	0	0	0	0	0	0.00	0.03
Syngnathus rostellatus	3mBT	0.01	0.03	0.01	0.03	0.02	0.08	0	0	0.01	0.05
Trachinus vipera	3mBT	0	0	2.82	3.18	0	0	0	0	0.94	2.25
Trisopterus minutus	3mBT	0	0	0.02	0.06	0	0	0	0	0.01	0.03
ECHINODERMS											
Asterias rubens	3mBT	15.65	45.27	23.30	48.89	2.18	4.63	2.53	2.33	11.50	34.41
Brissopsis lyrifera	DDD	0	0	0	0	44.15	97.99	0	0	15.49	60.91
Echinocardium cordatum	DDD	14.84	23.25	352.77	1072.31	1323.72	2613.78	2.04	3.82	591.09	1738.62
Luidia sarsi	3mBT	0	0	0	0	0.01	0.04	0	0	0.01	0.03
Ophiotrix sp.	3mBT	0	0	0	0	0.39	0.98	0	0	0.15	0.63
Ophiura albida	3mBT	5.55	10.57	120.56	161.77	249.27	790.04	7.25	12.57	137.51	501.13
Ophiura sp.	3mBT	0	0	0.02	0.05	0	0	0	0	0.01	0.03
Ophiura texturata	3mBT	15.75	40.93	69.79	182.66	25.81	96.13	0.05	0.09	35.79	122.87
Psammechinus miliaris	3mBT	0	0	0.03	0.10	0.90	1.94	3.73	4.74	0.79	2.24
Spatangus purpureus	DDD	0	0	0.17	0.75	0	0	0	0	0.06	0.44
MOLLUSCS											
Abra alba	DDD	0	0	0.21	0.93	48.91	90.08	0	0	17.23	57.49
Abra nitida	DDD	0	0	0	0	0.82	2.09	0	0	0.29	1.28
Abra prismatica	DDD	0	0	0.45	1.10	0	0	0.95	1.63	0.27	0.90
Acanthocardia echinata	DDD	0	0	0	0	6.32	9.58	0.48	1.28	2.28	6.35
Aequipecten opercularis	3mBT	0	0	0	0	0.01	0.03	0.18	0.19	0.02	0.08
Angulus fabulus	DDD	242.05	389.55	14.32	57.54	0.77	2.41	3.31	5.73	48.17	183.55
Angulus tenuis	DDD	44.41	137.52	0	0	0	0	0	0	7.79	57.70
Arctica islandica	DDD	0	0	0	0	7.05	11.28	12.77	17.33	4.04	9.84
Astarte montagui	DDD	0	0	0	0	0	0	1.92	3.83	0.24	1.41
Chamelea gallina	DDD	3.83	5.31	9.34	16.14	190.11	281.30	12.50	8.49	72.19	186.03

TABLE 5.1 (continued)

	Gear	Coastal zone		Offshore zone		Oystergrounds		Dogger bank		Total	
		mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
MOLLUSCS, continued											
Corbula gibba	DDD	0	0	1.04	4.66	100.08	286.60	0	0	35.48	173.70
Donax vittatus	DDD	0	0	17.93	34.91	0	0	0	0	6.29	22.09
Dosinia exoleta	DDD	0	0	0.48	1.61	0	0	0	0	0.17	0.96
Dosinia lupinus	DDD	0	0	1.09	2.68	47.12	42.87	13.45	14.90	18.57	33.39
Ensis americanus	DDD	4035.24	7265.01	3.61	15.51	0	0	0	0	709.20	3298.24
Ensis arcuatus	DDD	0	0	5.56	11.84	0	0	0	0	1.95	7.40
Ensis ensis	DDD	8.47	26.78	28.33	46.48	6.05	14.65	248.44	284.76	44.06	125.14
Ensis indet.	DDD	1.70	5.38	0	0	0	0	0	0	0.30	2.25
Ensis siliqua	DDD	0	0	6.11	22.46	5.68	19.00	76.92	37.25	13.58	31.92
Ensis spp. Juv.	DDD	0	0	6.63	19.72	0	0	0	0	2.33	11.92
Gari fervensis	DDD	0	0	0	0	10.77	20.07	73.01	45.42	12.74	30.00
Laevicardium cordatum	DDD	0	0	0.30	0.93	0	0	0	0	0.11	0.56
Lucinoma borealis	DDD	0	0	0	0	0.72	2.40	10.68	14.70	1.57	6.09
Lutraria lutraria	DDD	0	0	0	0	2.32	4.00	3.02	3.66	1.18	2.92
Macoma balthica	DDD	361.43	580.57	0	0	0	0	0	0	63.41	270.93
Mactra corallina	DDD	0.34	1.07	1.17	3.94	1.22	2.31	3.87	4.87	1.37	3.29
Mya truncata	DDD	0	0	0	0	7.45	19.14	2.57	3.50	2.93	11.73
Mysia undata	DDD	0	0	0	0	3.91	7.44	3.23	3.39	1.77	4.85
Mytilus edulis	3mBT	0.03	0.07	0.02	0.08	0	0	0	0	0.01	0.06
Nucula nitidosa	DDD	0	0	8.78	33.85	714.72	1624.45	0.47	1.25	253.92	1006.25
Petricola pholadiformis	DDD	0.68	2.14	0	0	0	0	0	0	0.12	0.90
Phaxas pellucidus	DDD	0	0	0.47	1.59	37.11	51.25	5.84	7.25	13.91	34.60
Spisula elliptica	DDD	0.28	0.88	13.32	18.86	0	0	0	0	4.72	12.71
Spisula solida	DDD	0.28	0.88	6.21	17.62	0	0	0	0	2.23	10.68
Spisula subtruncata	DDD	63979.69	194967.3	1041.23	3897.82	1.63	2.81	3.73	5.72	11590.88	81907.71
Thracia convexa	DDD	0	0	0	0	0.66	1.74	0	0	0.23	1.06
Thracia papyracea	DDD	0	0	0	0	0.52	2.33	0.47	1.24	0.24	1.44
Thyasira flexuosa	DDD	0	0	0	0	0.17	0.74	0	0	0.06	0.44
Venerupis senegalensis	DDD	6.44	20.35	0.23	1.04	0	0	0	0	1.21	8.54
CRUSTACEANS											
Crangon allmani	3mBT	0.15	0.28	3.61	7.56	4.74	13.37	3.28	3.48	3.43	9.42
Crangon crangon	3mBT	78.18	101.53	9.37	8.26	0.32	0.89	0	0	16.27	48.90
Eupagurus bernhardus	3mBT	10.05	10.45	9.03	8.32	3.87	3.49	17.53	10.71	8.21	8.58
Hyas coarctatus	3mBT	0.01	0.04	0	0	0.01	0.02	0	0	0.01	0.02
Inachus dorsettensis	3mBT	0	0	0	0	0.01	0.04	0	0	0.01	0.02
Macropodia spp.	3mBT	0.01	0.03	0.15	0.32	0.03	0.05	0.05	0.13	0.07	0.20
Palaemon elegans	3mBT	0.02	0.07	0.01	0.02	0.04	0.09	0	0	0.02	0.07
Pontophilus sp.	3mBT	0	0	0.14	0.53	0.01	0.05	2.02	1.53	0.29	0.86
Processa sp.	3mBT	0	0	0.01	0.03	0.14	0.32	0.06	0.07	0.06	0.21
Thia scutellata	DDD	1.39	4.39	33.58	30.40	0	0	0	0	12.02	23.93
Upogebia sp.	DDD	0	0	0	0	18.14	49.62	0	0	6.37	30.19
OTHER GROUPS											
Alcyonium digitatum	3mBT	0	0	0	0	0.03	0.12	0	0	0.01	0.07
Pectinaria koreni	DDD	28.56	58.04	3.15	13.44	7.24	26.99	0	0	8.66	30.69
Halichondria panicea	3mBT	0	0	0	0	0.01	0.03	0	0	0.00	0.02

TABLE 5.2.

Mean densities (n/100 m²) of demersal fish and benthic invertebrates in four sub-areas in the Dutch sector in 1997; sandy coastal zone (n=11), sandy offshore zone (n=22), silty Oystergrounds (n=27) and sandy Dogger bank (n=7). Positions of stations and boundaries of sub-area's (based on Holtman, 1996), are shown in Fig 5.1; 3mBT=3 m beam trawl; DDD = Triple-D.

	Gear	Coastal zone		Offshore zone		Oystergrounds		Dogger bank		Total	
		mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
FISH											
Agonus cataphractus	3mBT	1.30	1.16	0.14	0.17	0.05	0.08	0.14	0.13	0.29	0.65
Ammodytes indet.	3mBT	0.42	0.87	1.01	1.80	0.04	0.08	1.60	3.73	0.58	1.65
Amphioxis indet.	DDD	0	0	0.17	0.79	0	0	0	0	0.06	0.45
Arnoglossus laterna	3mBT	0.42	0.52	0.38	0.34	0.28	0.36	0.13	0.07	0.32	0.37
Buglossidium luteum	3mBT	0.52	0.72	4.79	4.04	1.76	2.46	8.18	6.38	3.22	4.11
Callionymus lyra	3mBT	2.85	6.49	0.37	0.30	0.13	0.25	0.05	0.05	0.65	2.72
Callionymus reticulatus	3mBT	0	0	0.31	0.45	0	0	0	0	0.10	0.29
Ciliata mustela	3mBT	0.03	0.05	0	0	0	0	0	0	0.01	0.02
Enchelyopus cimbrius	3mBT	0	0	0	0	0.07	0.14	0	0	0.03	0.10
Entelurus aequoreus	3mBT	0.01	0.02	0	0	0	0	0	0	0.00	0.01
Eutrigla gurnardus	3mBT	0.03	0.05	0.05	0.08	0.06	0.10	0.08	0.04	0.05	0.08
Gadus morhua	3mBT	0.15	0.34	0.02	0.04	0.16	0.21	0.04	0.06	0.10	0.20
Hippoglossoides platessoides	3mBT	0	0	0	0	0.17	0.31	0.03	0.05	0.07	0.21
Hyperoplus lanceolatus	3mBT	0.01	0.02	0.01	0.02	0	0	0	0	0.00	0.02
Limanda limanda	3mBT	10.95	13.60	1.89	1.83	2.60	1.86	1.44	0.68	3.62	6.43
Liparis liparis	3mBT	0.03	0.05	0	0	0	0	0	0	0.00	0.02
Merlangius merlangus	3mBT	0.02	0.05	0.06	0.09	0.14	0.15	0.02	0.03	0.08	0.12
Merluccius merluccius	3mBT	0	0	0	0	0.00	0.01	0	0	0.00	0.01
Microstomus kitt	3mBT	0	0	0	0	0.01	0.02	0.02	0.03	0.01	0.02
Myoxocephalus scorpius	3mBT	0.31	0.38	0	0	0	0	0	0	0.05	0.19
Platichtys flesus	3mBT	0.03	0.06	0	0	0	0	0	0	0.01	0.03
Pleuronectes platessa	3mBT	5.67	4.31	0.98	1.12	0.41	0.57	0.03	0.05	1.42	2.65
Pomatoschistus indet.	3mBT	12.35	17.45	1.54	1.86	1.02	0.64	0.91	0.48	3.04	8.05
Scophthalmus maximus	3mBT	0	0	0	0	0.00	0.01	0	0	0.00	0.01
Solea solea	3mBT	2.89	3.26	0.08	0.16	0.02	0.06	0	0	0.51	1.66
Syngnathus acus	3mBT	0.01	0.04	0	0	0	0	0	0	0.00	0.02
Syngnathus rostellatus	3mBT	0.05	0.12	0	0	0.01	0.03	0.01	0.02	0.01	0.05
Trachinus vipera	3mBT	0.10	0.21	2.30	2.16	0.01	0.03	0	0	0.77	1.63
Trigla lucerna	3mBT	0.03	0.05	0	0	0.004	0.02	0	0	0.01	0.03
Trispoterus minutus	3mBT	0	0	0	0	0	0	0	0	0	0
ECHINODERMS											
Amphiura cf. Chiaje	DDD	0	0	0	0	0	0	226.59	396.43	23.67	138.43
Asterias rubens	3mBT	42.09	127.82	19.62	32.59	7.97	11.72	2.07	1.48	16.78	55.07
Astropecten irregularis	DDD	0	0	2.19	7.29	68.41	63.12	16.40	18.00	30.00	51.45
Brissopsis lyrifera	DDD	0	0	0	0	35.46	73.00	0	0	14.29	49.05
Cucumaria elongata	DDD	0	0	0	0	26.87	66.07	0	0	10.83	43.54
Echinocardium cordatum	DDD	2.02	4.49	12.12	26.49	836.37	2072.55	0	0	341.36	1363.93
Echinocyamus pusillus	DDD	0	0	8.08	15.28	0	0	0.53	1.40	2.71	9.42
Ophiotrix indet.	3mBT	0	0	0	0	0.34	0.92	0	0	0.14	0.60
Ophiura albida	3mBT	65.37	178.17	363.07	471.09	745.72	3376.17	58.28	109.15	436.55	2155.43
Ophiura texturata	3mBT	22.04	51.18	47.49	115.94	8.84	15.09	5.08	11.53	23.31	71.35
Psammechinus miliaris	3mBT	0	0	0.10	0.22	0.98	2.24	2.46	2.43	0.68	1.76
MOLLUSCS											
Abra alba	DDD	0	0	0.67	2.46	17.88	42.66	0	0	7.43	28.18
Abra nitida	DDD	0	0	0	0	6.45	32.77	0	0	2.60	20.81
Abra prismatica	DDD	0	0	2.36	6.91	0	0	0	0	0.77	4.05
Acanthocardia echinata	DDD	0	0	0	0	6.21	8.95	1.59	1.98	2.67	6.38
Aequipecten opercularis	3mBT	0	0	0.00	0.01	0.00	0.01	0.05	0.07	0.01	0.03

TABLE 5.2 (continued)

	Gear	Coastal zone		Offshore zone		Oystergrounds		Dogger bank		Total	
		mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
MOLLUSCS, continued											
Angulus fabulus	DDD	74.11	178.23	46.30	168.39	0	0	2.65	3.52	27.65	121.21
Angulus tenuis	DDD	23.30	71.00	0	0	0	0	0	0	3.83	28.97
Aporrhais pespelicani	DDD	0	0	0	0	6.98	19.66	0.53	1.40	2.87	12.81
Arctica islandica	DDD	0	0	0	0	5.64	8.79	2.65	4.64	2.55	6.29
Bela nebula	DDD	0	0	0	0	0	0	1.06	2.80	0.11	0.90
Buccinum undatum	DDD	0	0	0	0	0.54	1.32	4.23	4.98	0.66	2.13
Cerastoderma edule	DDD	0.01	0.04	0	0	0	0	0	0	0.00	0.02
Chamelea gallina	DDD	0.67	1.50	12.12	26.86	55.40	43.78	32.01	34.59	29.76	40.10
Colus gracilis	DDD	0	0	0	0	0.00	0.01	0.01	0.02	0.00	0.01
Colus jeffreysianus	DDD	0	0	0	0	0.14	0.71	0	0	0.06	0.45
Corbula gibba	DDD	0	0	0	0	41.42	113.80	0	0	16.69	74.30
Donax vittatus	DDD	0	0	36.20	70.57	0	0	0	0	11.89	43.33
Dosinia exoleta	DDD	0	0	0.17	0.79	0	0	0	0	0.06	0.45
Dosinia lupinus	DDD	0	0	0.34	1.09	17.84	25.88	9.52	9.04	8.29	18.48
Ensis americanus	DDD	661.28	529.99	6.57	23.86	0	0	0	0	110.72	321.23
Ensis arcuatus	DDD	0.34	1.12	14.14	38.30	0	0	0	0	4.70	22.61
Ensis ensis	DDD	0	0	40.74	76.42	1.49	2.91	237.30	202.56	38.77	102.92
Ensis siliqua	DDD	0	0	5.05	19.75	1.37	4.13	87.17	27.18	11.32	29.72
Epitonium clathrus	DDD	0	0	0	0	0.41	1.57	0	0	0.17	1.01
Euspira catena	DDD	2.36	6.68	29.12	80.69	0.55	1.98	8.47	8.20	11.06	47.47
Euspira poliana	DDD	14.48	39.60	22.90	72.49	2.74	7.59	19.58	37.39	13.05	46.26
Gari fervensis	DDD	0	0	0.17	0.79	1.10	3.68	41.80	29.61	4.86	15.72
Hiatella arctica	3mBT	0	0	0	0	0.01	0.02	0	0	0.00	0.01
Laevicardium crassum	DDD	0	0	0.01	0.03	0	0	0	0	0.00	0.02
Lucinoma borealis	DDD	0	0	0	0	0	0	7.94	13.60	0.83	4.77
Lutraria lutraria	DDD	0	0	0	0	0.96	2.64	3.17	3.96	0.72	2.26
Macoma balthica	DDD	247.14	421.78	0	0	0	0	0	0	40.57	188.32
Mactra corallina	DDD	1.01	3.35	0.34	1.09	0.27	0.99	2.65	2.80	0.66	1.93
Musculus niger	DDD	0	0	0	0	0.41	1.57	0	0	0.17	1.01
Mya truncata	DDD	0	0	0	0	5.97	9.10	0	0	2.41	6.43
Mysia undata	DDD	0	0	0	0	2.03	3.45	0	0	0.82	2.39
Mytilus edulis	3mBT	0.28	0.49	0	0	0.00	0.01	0	0	0.05	0.22
Neptunea antiqua	DDD	0	0	0	0	0.14	0.71	0	0	0.06	0.45
Nucula nitidosa	DDD	0	0	26.77	85.13	193.59	312.85	23.81	62.99	89.29	220.82
Nucula tenuis	DDD	0	0	0	0	0.63	2.69	0	0	0.26	1.72
Oenopota turricula	DDD	0	0	0	0	0	0	3.70	7.09	0.39	2.42
Phaxas pellucidus	DDD	0	0	0.17	0.79	12.99	43.76	0	0	5.29	28.20
Sepiola atlantica	3mBT	0	0	0.01	0.02	0	0	0	0	0.00	0.01
Spisula elliptica	DDD	0.34	1.12	52.02	104.46	0	0	0	0	17.14	63.84
Spisula solida	DDD	0	0	8.75	25.55	0	0	0	0	2.87	14.99
Spisula subtruncata	DDD	16148.48	45284.34	21.04	91.36	1.78	4.52	3.70	5.66	2659.26	18627.78
Thracia convexa	DDD	0	0	0	0	0.55	2.85	0	0	0.22	1.81
Thracia papyracea	DDD	0	0	0.34	1.09	0	0	0	0	0.11	0.64
Turritella communis	DDD	0	0	0.34	1.09	117.13	182.41	0	0	47.31	128.25
Venerupis senegalensis	DDD	0	0	0.34	1.58	0	0	0	0	0.11	0.90
CRUSTACEANS											
Callianassa spp.	DDD	0	0	3.37	14.99	3.70	17.07	0	0	2.60	13.74
Cancer pagurus	3mBT	0	0	0.003	0.02	0	0	0	0	0.00	0.01
Carcinus maenas	DDD	0	0	0.17	0.79	0	0	0	0	0.06	0.45
Cirolana borealis	DDD	0	0	0	0	3.27	7.91	0	0	1.32	5.22
Corystes cassivelaunus	DDD	0.34	1.12	18.01	30.44	93.88	45.29	87.30	72.23	52.92	57.06
Crangon allmani	3mBT	0.34	1.12	0.99	2.26	0.63	1.21	0	0	0.64	1.58
Crangon crangon	3mBT	37.33	56.24	1.39	2.40	0.04	0.14	0	0	6.60	25.88

TABLE 5.2 (continued)

	Gear	Coastal zone		Offshore zone		Oystergrounds		Dogger bank		Total	
		mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
CRUSTACEANS, continued											
Ebalia indet.	DDD	0	0	0.84	1.59	0.27	0.99	22.88	13.68	2.78	8.13
Eupagurus bernhardus	DDD	46.77	85.10	23.74	25.08	13.67	13.02	40.21	30.12	25.18	40.04
Inachus indet.	DDD	0	0	0	0	0.01	0.03	0	0	0.00	0.02
Liocarcinus arcuatus	DDD	0	0	0.67	2.18	0	0	0	0	0.22	1.27
Liocarcinus depurator	DDD	0.34	1.12	0.34	1.58	0.27	0.99	0	0	0.28	1.17
Liocarcinus holsatus	DDD	118.18	127.46	13.47	11.63	7.22	3.61	11.64	5.83	27.95	64.37
Liocarcinus marmoratus	DDD	0	0	2.19	4.80	0	0	0	0	0.72	2.90
Liocarcinus pusillus	DDD	0	0	0.00	0.01	0	0	0	0	0.00	0.01
Macropodia indet.	DDD	0	0	0.51	1.30	0.40	1.16	0	0	0.33	1.05
Necora puber	DDD	0	0	0.003	0.01	0	0	0	0	0.00	0.01
Nephrops norvegicus	DDD	0	0	0	0	0.26	0.94	0	0	0.10	0.60
Palaemon indet.	DDD	1.35	4.47	0	0	0	0	0	0	0.22	1.81
Pinnotheres pisum	3mBT	0	0	0.01	0.04	0	0	0	0	0.00	0.02
Pisidia longicornis	3mBT	0	0	0	0	0.01	0.05	0	0	0.00	0.03
Pontophilus indet.	3mBT	0.06	0.16	0.34	0.48	0	0	0.01	0.02	0.12	0.32
Processa indet.	3mBT	0	0	0	0	0.01	0.06	0	0	0.00	0.04
Thia scutellata	DDD	2.69	6.22	38.89	44.56	0	0	0	0	13.21	31.08
Upogebia indet.	DDD	0	0	0	0	13.30	35.22	0	0	5.36	23.06
OTHER GROUPS											
Alcyonium digitatum	3mBT	0	0	0	0	0.02	0.04	0	0	0.01	0.02
Alcyonidum cf. gelatinosum	3mBT	0	0	0	0	0.002	0.01	0.01	0.02	0.00	0.01
anemones. indet	DDD	239.12	576.27	38.89	94.62	8.16	10.95	8.47	22.40	56.20	245.19
Aphrodite aculeata	DDD	0	0	0.51	1.73	28.05	43.50	2.65	3.52	11.75	30.50
Halichondria panicea	3mBT	0	0	0	0	0.03	0.12	0	0	0.01	0.08
Golfingia indet.	DDD	0	0	0	0	26.94	57.61	0	0	10.86	38.53
Metridium senile	DDD	0.05	0.09	0	0	0.00	0.02	0	0	0.01	0.04
Pectinaria indet.	DDD	0.34	1.12	0.17	0.79	3.70	11.62	0	0	1.60	7.52
Pelonaia corrrugata	DDD	0	0	0	0	7.52	20.22	0.53	1.40	3.08	13.22
Urticina felina	DDD	0	0	0	0	0.005	0.02	0	0	0.00	0.01

TABLE 5.3a.

Comparison of mean densities (n/100 m²) of demersal fish and benthic invertebrates per subarea in 1996 and 1997, sampled with a 3m beam trawl. This table includes only those species that were found in both years, and were sampled reliably in this gear.

	coastal zone				offshore zone				oyster grounds				dogger bank				total			
	1996		1997		1996		1997		1996		1997		1996		1997		1996		1997	
	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
FISH																				
Agonus cataphractus	1.3	1.2	0.3	0.4	0.1	0.2	0.1	0.1	0.1	0.1	0.02	0.03	0.1	0.1	0.04	0.05	0.3	0.6	0.1	0.2
Ammodytes indet.	0.4	0.9	0.6	0.9	1.0	1.8	0.4	0.3	0.04	0.08	0.03	0.09	1.6	3.7	0.4	0.9	0.6	1.6	0.3	0.5
Arnoglossus laterna	0.4	0.5	0.2	0.2	0.4	0.3	0.7	0.8	0.3	0.4	0.9	0.6	0.1	0.1	0.3	0.1	0.3	0.4	0.6	0.7
Buglossidium luteum	0.5	0.7	1.2	1.6	4.8	4.0	5.5	5.4	1.8	2.5	3.7	3.5	8.2	6.4	2.3	1.8	3.2	4.1	3.7	4.2
Callionymus lyra	2.9	6.5	0.2	0.3	0.4	0.3	0.5	0.6	0.1	0.3	0.4	0.3	0.05	0.05	0.1	0.1	0.6	2.7	0.4	0.4
Callionymus reticulatus	0	0	0	0	0.3	0.4	1.6	2.0	0	0	0.01	0.04	0	0	0.03	0.08	0.1	0.3	0.6	1.4
Eutrigla gurnardus	0.03	0.05	0.05	0.10	0.05	0.08	0.04	0.06	0.1	0.1	0.4	1.4	0.1	0.0	0.5	0.7	0.1	0.1	0.2	0.9
Gadus morhua	0.2	0.3	0	0	0.0	0.0	0.0	0.0	0.2	0.2	0.01	0.03	0.04	0.06	0.01	0.03	0.1	0.2	0.01	0.02
Hippoglossoides platessoides	0	0	0	0	0	0	0	0	0.2	0.3	0.1	0.2	0.03	0.05	0.02	0.07	0.1	0.2	0.03	0.12
Limanda limanda	10.9	13.6	4.8	2.3	1.9	1.8	3.5	3.1	2.6	1.9	2.1	1.3	1.4	0.7	2.3	1.7	3.6	6.4	3.1	2.4
Merlangius merlangus	0.02	0.05	0.2	0.3	0.1	0.1	1.4	5.3	0.1	0.1	0.3	0.2	0.02	0.03	0.02	0.04	0.1	0.1	0.6	3.1
Microstomus kitt	0	0	0	0	0	0	0	0	0.01	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.01	0.02	0.01	0.02
Platichtys flesus	0.03	0.06	0.4	0.7	0	0	0.005	0.02	0	0	0	0	0	0	0	0	0.01	0.03	0.1	0.3
Pleuronectes platessa	5.7	4.3	3.8	5.0	1.0	1.1	0.7	1.3	0.4	0.6	0.1	0.2	0.03	0.05	0.01	0.03	1.4	2.7	0.9	2.5
Pomatoschistus indet.	12.4	17.4	17.7	20.4	1.5	1.9	6.2	5.3	1.0	0.6	1.8	3.8	0.9	0.5	2.4	1.1	3.0	8.0	6.0	10.5
Solea solea	2.9	3.3	0.3	0.4	0.1	0.2	0.1	0.2	0.02	0.06	0.1	0.1	0	0	0.01	0.03	0.5	1.7	0.1	0.2
Syngnathus acus	0.01	0.04	0.03	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.02	0.004	0.03
Syngnathus rostellatus	0.05	0.12	0.01	0.03	0	0	0.01	0.03	0.01	0.03	0.02	0.08	0.01	0.02	0	0	0.01	0.05	0.01	0.05
Trachinus vipera	0.1	0.2	0	0	2.3	2.2	2.8	3.2	0.01	0.03	0	0	0	0	0	0	0.8	1.6	0.9	2.2
ECHINODERMS																				
Asterias rubens	42.1	127.8	15.6	45.3	19.6	32.6	23.3	48.9	8.0	11.7	2.2	4.6	2.1	1.5	2.5	2.3	16.8	55.1	11.5	34.4
Ophiotrix indet.	0	0	0	0	0	0	0	0	0.3	0.9	0.4	1.0	0	0	0	0	0.1	0.6	0.1	0.6
Ophiura albida	65.4	178.2	5.6	10.6	363.1	471.1	120.6	161.8	745.7	3376.2	249.3	790.0	58.3	109.2	7.3	12.6	436.6	2155.4	137.5	501.1
Ophiura texturata	22.0	51.2	0	0	47.5	115.9	0.0	0.1	8.8	15.1	0	0	5.1	11.5	0	0	23.3	71.4	0.0	0.0
Psammechinus miliaris	0	0	0	0	0.1	0.2	0.0	0.1	1.0	2.2	0.9	1.9	2.5	2.4	3.7	4.7	0.7	1.8	0.8	2.2
MOLLUSCS																				
Aequipecten opercularis	0	0	0	0	0.003	0.01	0	0	0.003	0.01	0.01	0.03	0.1	0.1	0.2	0.2	0.01	0.03	0.02	0.08
Mytilus edulis	0.3	0.5	0.03	0.07	0	0	0.02	0.08	0.002	0.01	0	0	0	0	0	0	0.05	0.22	0.01	0.06
CRUSTACEANS																				
Crangon allmani	0.3	1.1	0.1	0.3	1.0	2.3	3.6	7.6	0.6	1.2	4.7	13.4	0	0	3.3	3.5	0.6	1.6	3.4	9.4
Crangon crangon	37.3	56.2	78.2	101.5	1.4	2.4	9.4	8.3	0.04	0.14	0.3	0.9	0	0	0	0	6.6	25.9	16.3	48.9
Pontophilus indet.	0.1	0.2	0	0	0.3	0.5	0.1	0.5	0	0	0.01	0.05	0.01	0.02	2.0	1.5	0.1	0.3	0.3	0.9
Processa indet.	0	0	0	0	0	0	0.01	0.03	0.01	0.06	0.1	0.3	0	0	0.1	0.1	0.005	0.04	0.1	0.2
OTHER GROUPS																				
Alcyonium digitatum	0	0	0	0	0	0	0	0	0.02	0.04	0.03	0.1	0	0	0	0	0.01	0.02	0.01	0.07
Halichondria panicea	0	0	0	0	0	0	0	0	0.03	0.12	0.01	0.03	0	0	0	0	0.01	0.08	0.005	0.02

TABLE 5.3b.

Comparison of mean densities (n/100 m²) of benthic invertebrates per subarea in 1996 and 1997, sampled with the Triple-D. This table includes only those species that were found in both years, and in 1996 were assumed to be sampled reliably.

	coastal zone				offshore zone				oyster grounds				dogger bank				total			
	1996		1997		1996		1997		1996		1997		1996		1997		1996		1997	
	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
ECHINODERMS																				
Brissopsis lyrifera	0	0	0	0	0	0	0	0	35.5	73.0	44.2	98.0	0	0	0	0	14.3	49.1	15.5	60.9
Echinocardium cordatum	2.0	4.5	14.8	23.2	12.1	26.5	352.8	1072.3	836.4	2072.6	1323.7	2613.8	0	0	2.0	3.8	341.4	1363.9	591.1	1738.6
MOLLUSCS																				
Abra alba	0	0	0	0	0.7	2.5	0.2	0.9	17.9	42.7	48.9	90.1	0	0	0	0	7.4	28.2	17.2	57.5
Abra nitida	0	0	0	0	0	0	0	0	6.4	32.8	0.8	2.1	0	0	0	0	2.6	20.8	0.3	1.3
Abra prismatica	0	0	0	0	2.4	6.9	0.4	1.1	0	0	0	0	0	0	1.0	1.6	0.8	4.1	0.3	0.9
Acanthocardia echinata	0	0	0	0	0	0	0	0	6.2	8.9	6.3	9.6	1.6	2.0	0.5	1.3	2.7	6.4	2.3	6.3
Angulus fabulus	74.1	178.2	242.0	389.5	46.3	168.4	14.3	57.5	0	0	0.8	2.4	2.6	3.5	3.3	5.7	27.6	121.2	48.2	183.6
Angulus tenuis	23.3	71.0	44.4	137.5	0	0	0	0	0	0	0	0	0	0	0	0	3.8	29.0	7.8	57.7
Arctica islandica	0	0	0	0	0	0	0	0	5.6	8.8	7.1	11.3	2.6	4.6	12.8	17.3	2.5	6.3	4.0	9.8
Chamelea gallina	0.7	1.5	3.8	5.3	12.1	26.9	9.3	16.1	55.4	43.8	190.1	281.3	32.0	34.6	12.5	8.5	29.8	40.1	72.2	186.0
Corbula gibba	0	0	0	0	0	0	1.0	4.7	41.4	113.8	100.1	286.6	0	0	0	0	16.7	74.3	35.5	173.7
Donax vittatus	0	0	0	0	36.2	70.6	17.9	34.9	0	0	0	0	0	0	0	0	11.9	43.3	6.3	22.1
Dosinia exoleta	0	0	0	0	0.2	0.8	0.5	1.6	0	0	0	0	0	0	0	0	0.1	0.5	0.2	1.0
Dosinia lupinus	0	0	0	0	0.3	1.1	1.1	2.7	17.8	25.9	47.1	42.9	9.5	9.0	13.5	14.9	8.3	18.5	18.6	33.4
Ensis americanus	661.3	530.0	4035.2	7265.0	6.6	23.9	3.6	15.5	0	0	0	0	0	0	0	0	110.7	321.2	709.2	3298.2
Gari fervensis	0	0	0	0	0.2	0.8	0	0	1.1	3.7	10.8	20.1	41.8	29.6	73.0	45.4	4.9	15.7	12.7	30.0
Laevicardium crassum	0	0	0	0	0.01	0.03	0.3	0.9	0	0	0	0	0	0	0	0	0.0	0.0	0.1	0.6
Lucinoma borealis	0	0	0	0	0	0	0	0	0	0	0.7	2.4	7.9	13.6	10.7	14.7	0.8	4.8	1.6	6.1
Lutraria lutraria	0	0	0	0	0	0	0	0	1.0	2.6	2.3	4.0	3.2	4.0	3.0	3.7	0.7	2.3	1.2	2.9
Macoma balthica	247.1	421.8	361.4	580.6	0	0	0	0	0	0	0	0	0	0	0	0	40.6	188.3	63.4	270.9
Mactra corallina	1.0	3.4	0.3	1.1	0.3	1.1	1.2	3.9	0.3	1.0	1.2	2.3	2.6	2.8	3.9	4.9	0.7	1.9	1.4	3.3
Mya truncata	0	0	0	0	0	0	0	0	6.0	9.1	7.4	19.1	0	0	2.6	3.5	2.4	6.4	2.9	11.7
Mysia undata	0	0	0	0	0	0	0	0	2.0	3.4	3.9	7.4	0	0	3.2	3.4	0.8	2.4	1.8	4.9
Nucula nitidosa	0	0	0	0	26.8	85.1	8.8	33.8	193.6	312.9	714.7	1624.4	23.8	63.0	0.5	1.2	89.3	220.8	253.9	1006.3
Phaxas pellucidus	0	0	0	0	0.2	0.8	0.5	1.6	13.0	43.8	37.1	51.2	0	0	5.8	7.2	5.3	28.2	13.9	34.6
Spisula elliptica	0.3	1.1	0.3	0.9	52.0	104.5	13.3	18.9	0	0	0	0	0	0	0	0	17.1	63.8	4.7	12.7
Spisula solida	0	0	0.3	0.9	8.8	25.5	6.2	17.6	0	0	0	0	0	0	0	0	2.9	15.0	2.2	10.7
Spisula subtruncata	16148.5	45284.3	63979.7	194967.3	21.0	91.4	1041.2	3897.8	1.8	4.5	1.6	2.8	3.7	5.7	3.7	5.7	2659.3	18627.8	11590.9	81907.7
Thracia convexa	0	0	0	0	0	0	0	0	0.5	2.9	0.7	1.7	0	0	0	0	0.2	1.8	0.2	1.1
Thracia papyracea	0	0	0	0	0.3	1.1	0	0	0	0	0.5	2.3	0	0	0.5	1.2	0.1	0.6	0.2	1.4
Venerupis senegalensis	0	0	6.4	20.4	0.3	1.6	0.2	1.0	0	0	0	0	0	0	0	0	0.1	0.9	1.2	8.5
CRUSTACEANS																				
Thia scutellata	2.7	6.2	1.4	4.4	38.9	44.6	33.6	30.4	0	0	0	0	0	0	0	0	13.2	31.1	12.0	23.9
Upogebia indet.	0	0	0	0	0	0	0	0	13.3	35.2	18.1	49.6	0	0	0	0	5.4	23.1	6.4	30.2
OTHER GROUPS																				
Pectinaria indet.	0.3	1.1	28.6	58.0	0.2	0.8	3.1	13.4	3.7	11.6	7.2	27.0	0	0	0	0	1.6	7.5	8.7	30.7

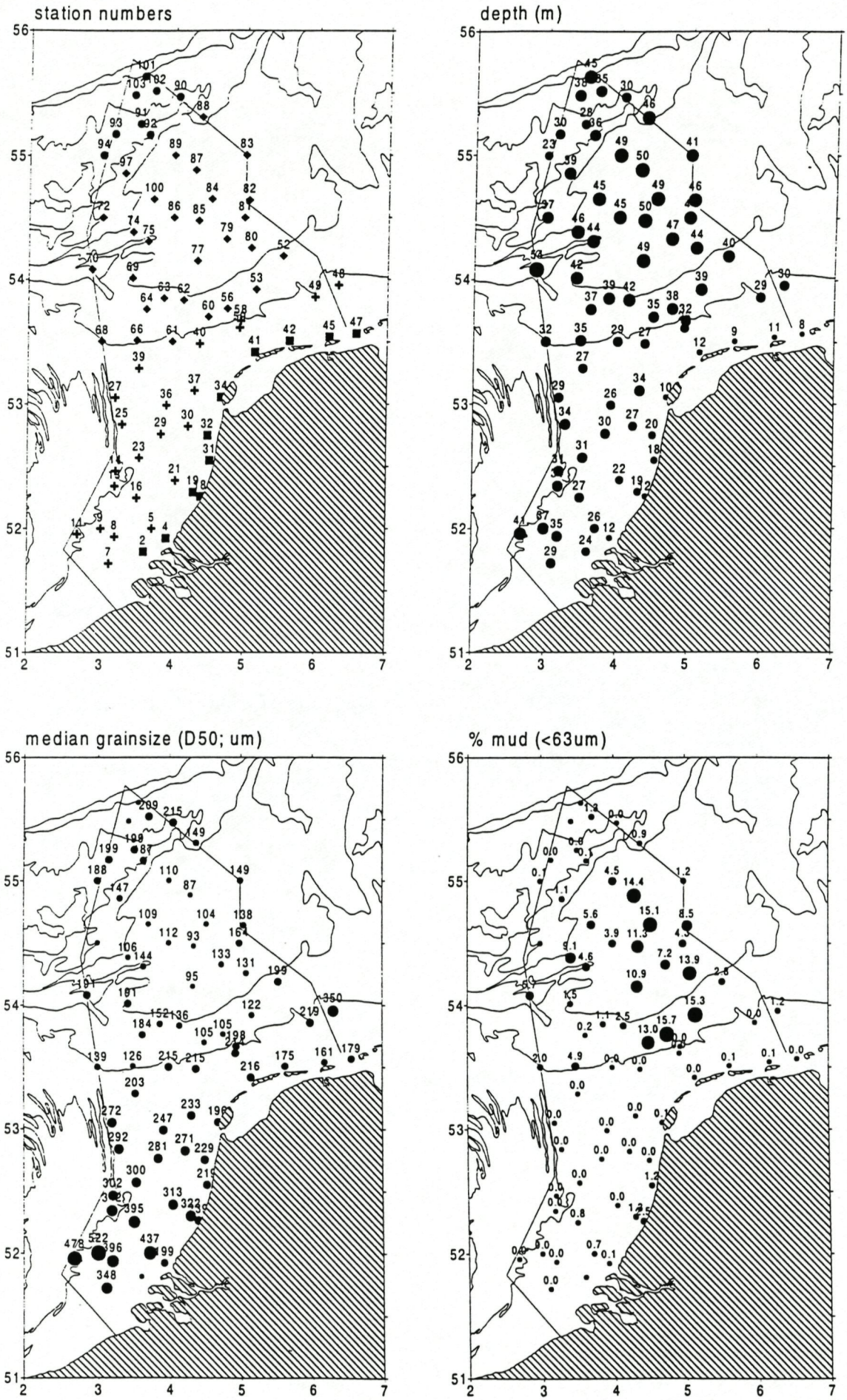


Fig. 5.1. Sampling stations and main abiotic variables (water depth, median grainsize, mud content).

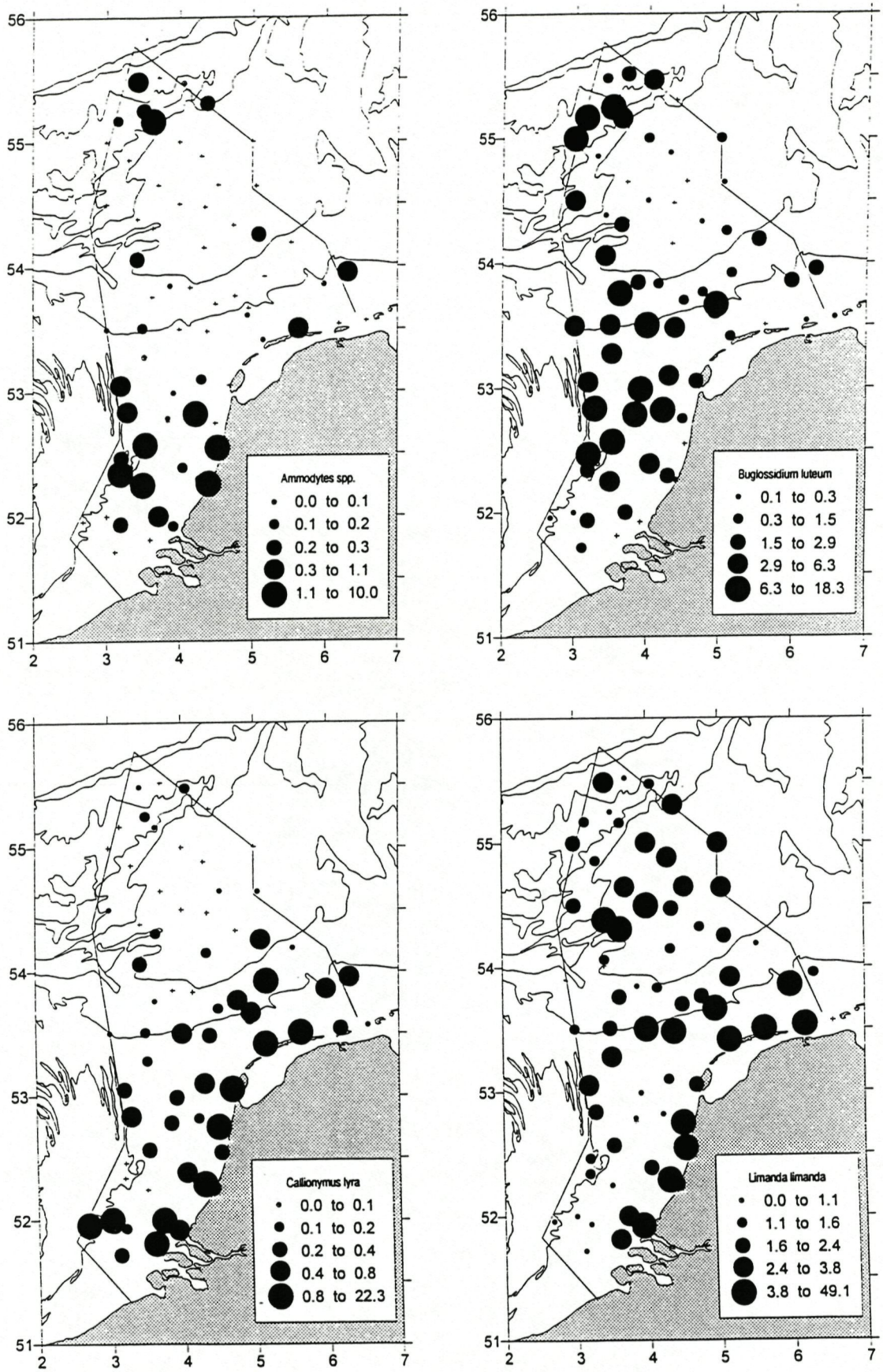
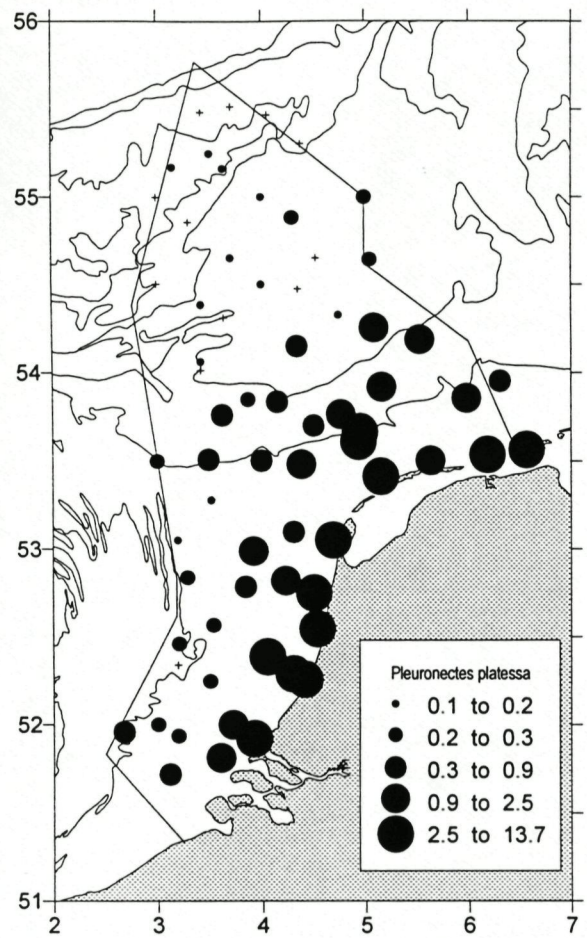
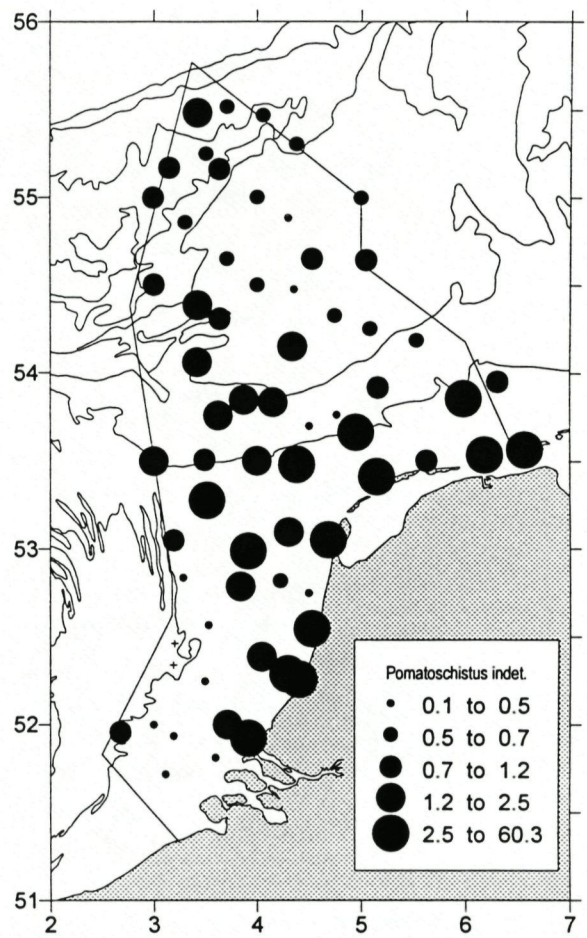
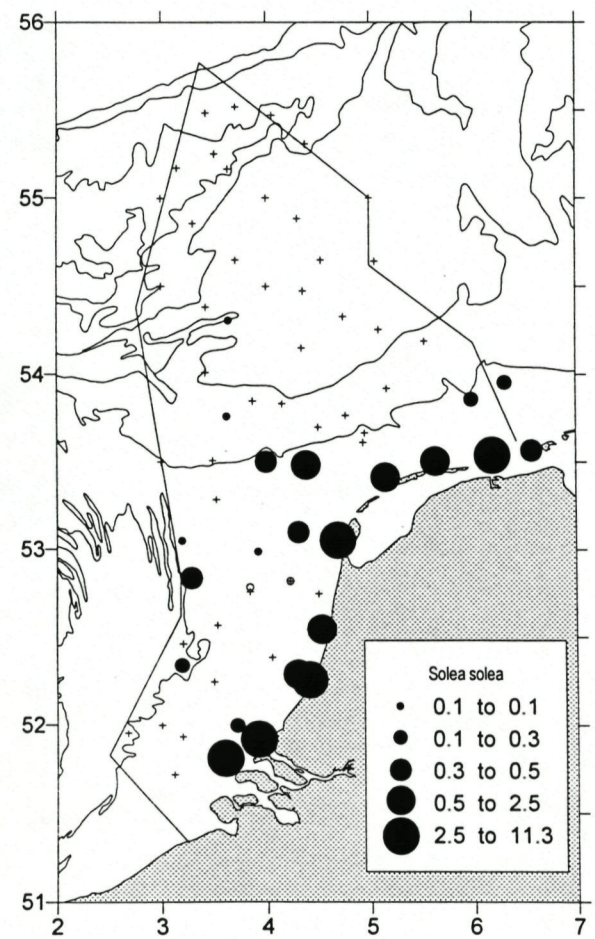
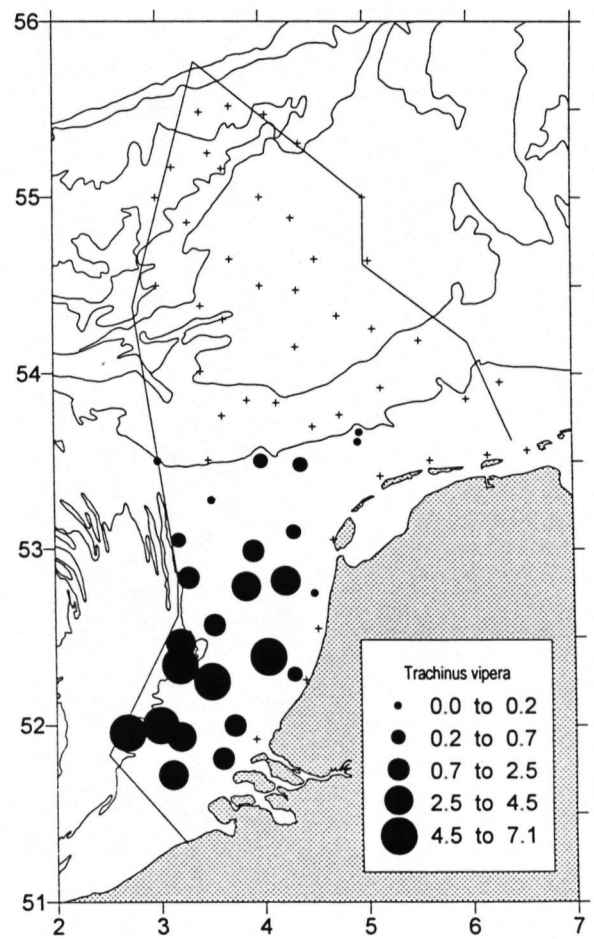


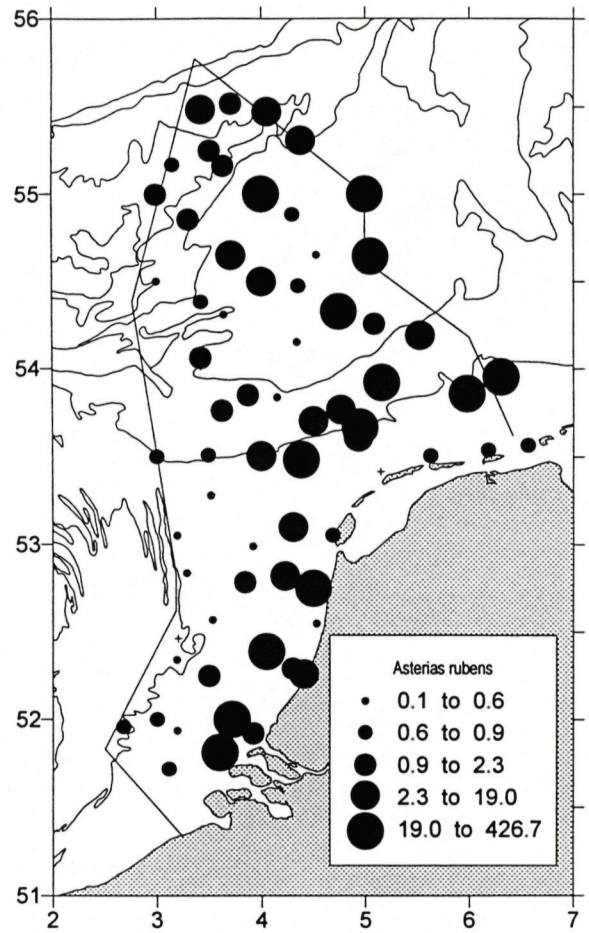
Fig 5.2. Spatial distribution (densities in n/100m²) of a number of demersal fish and benthic invertebrate megafauna (>1 cm) in June 1997. [o = present in the other sampling gear].

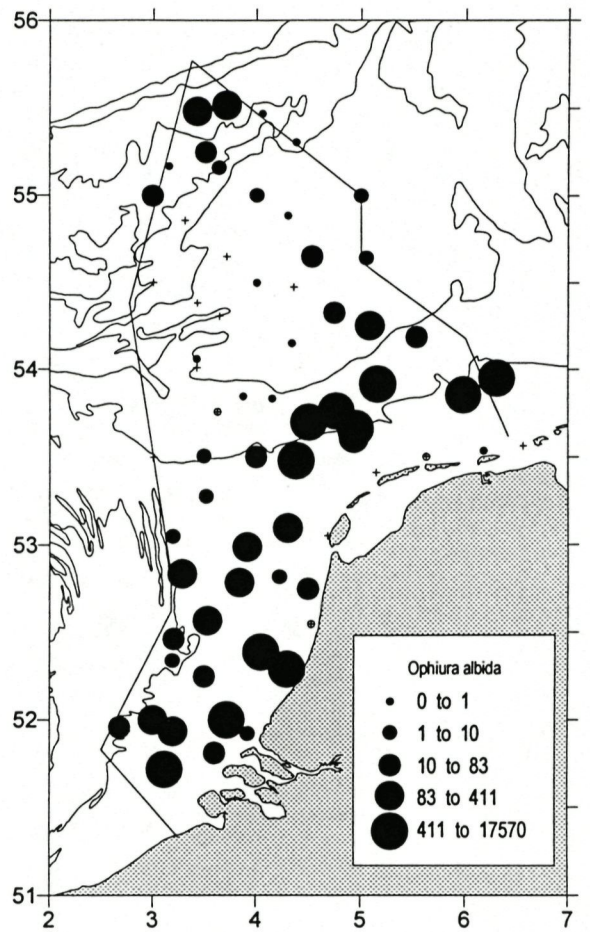

Pleuronectes platessa
0.1 to 0.2
0.2 to 0.3
0.3 to 0.9
0.9 to 2.5
2.5 to 13.7

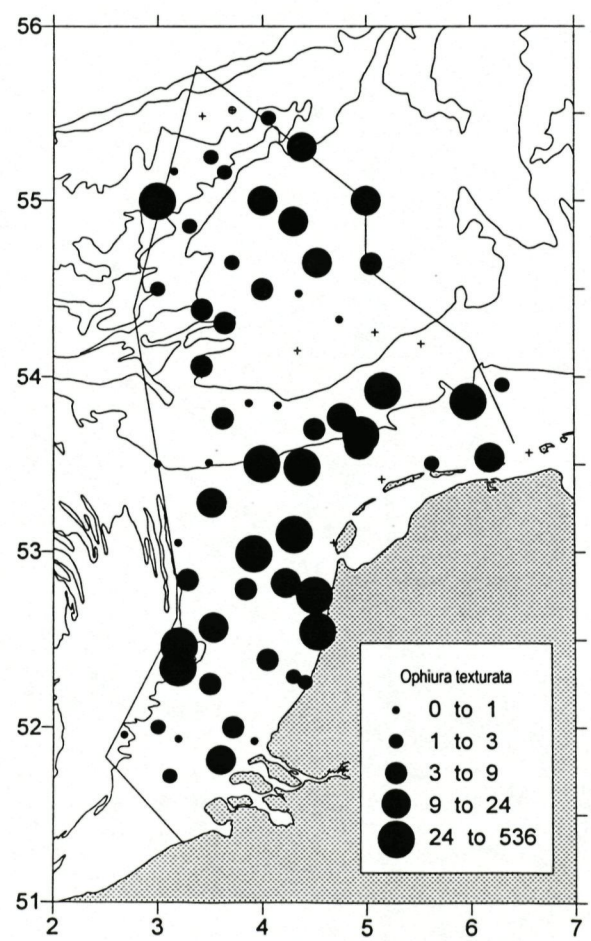

Pomatoschistus indet.
0.1 to 0.5
0.5 to 0.7
0.7 to 1.2
1.2 to 2.5
2.5 to 60.3

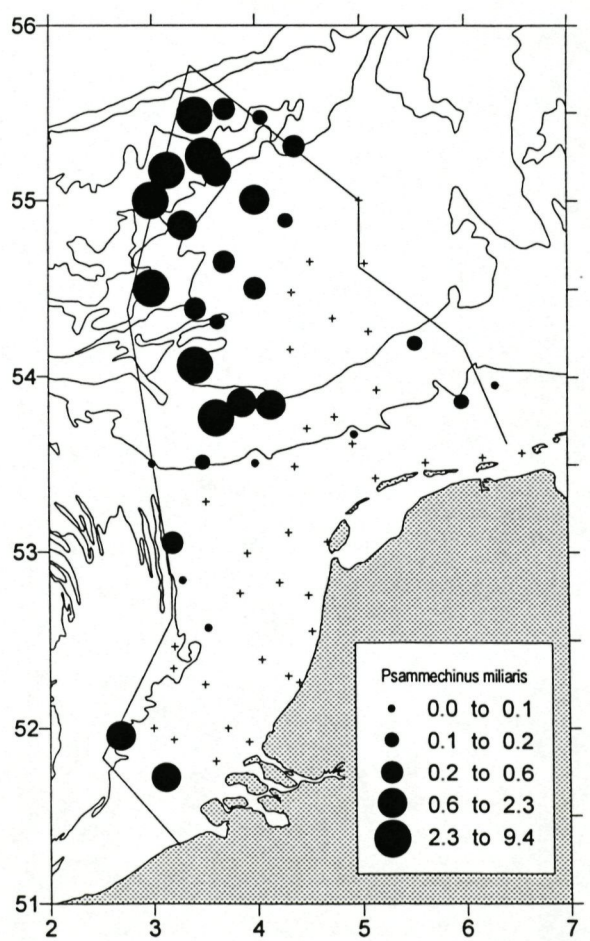

Solea solea
0.1 to 0.1
0.1 to 0.3
0.3 to 0.5
0.5 to 2.5
2.5 to 11.3

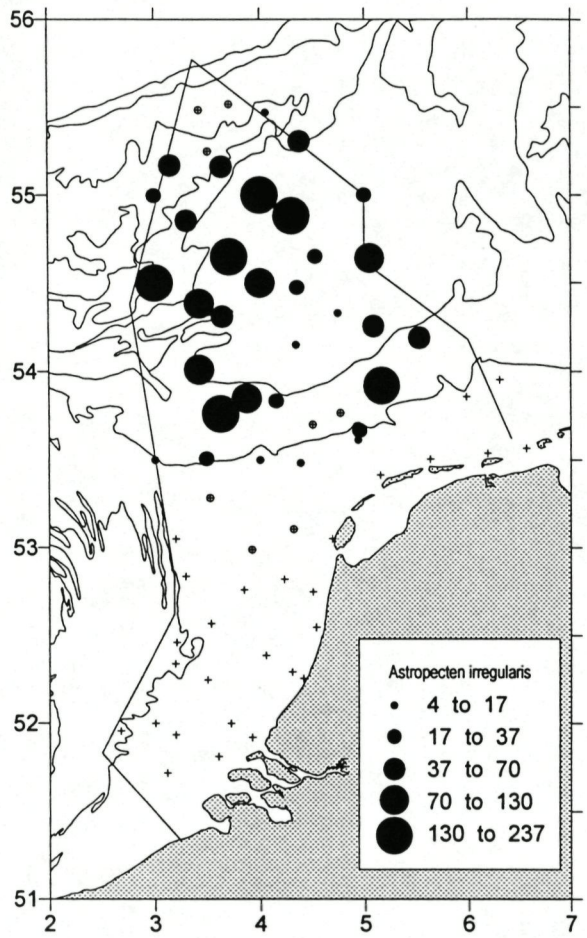

Trachinus vipera
0.0 to 0.2
0.2 to 0.7
0.7 to 2.5
2.5 to 4.5
4.5 to 7.1

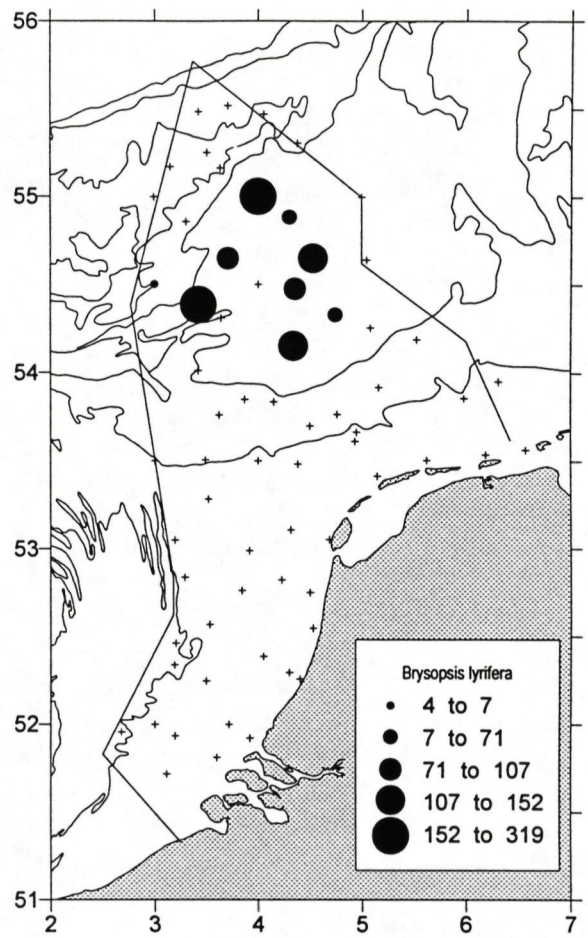

Asterias rubens
0.1 to 0.6
0.6 to 0.9
0.9 to 2.3
2.3 to 19.0
19.0 to 426.7

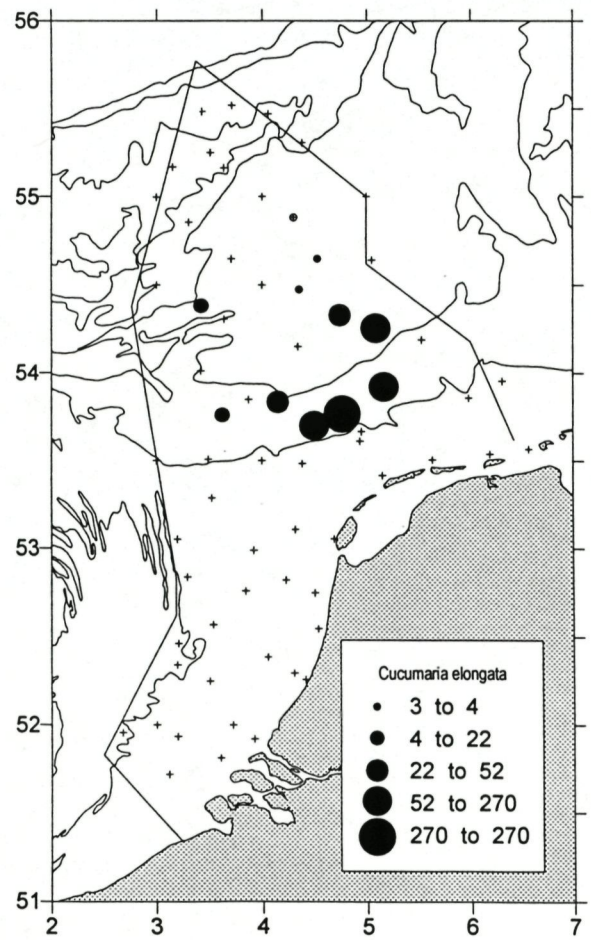

Ophiura albida
0 to 1
1 to 10
10 to 83
83 to 411
411 to 17570

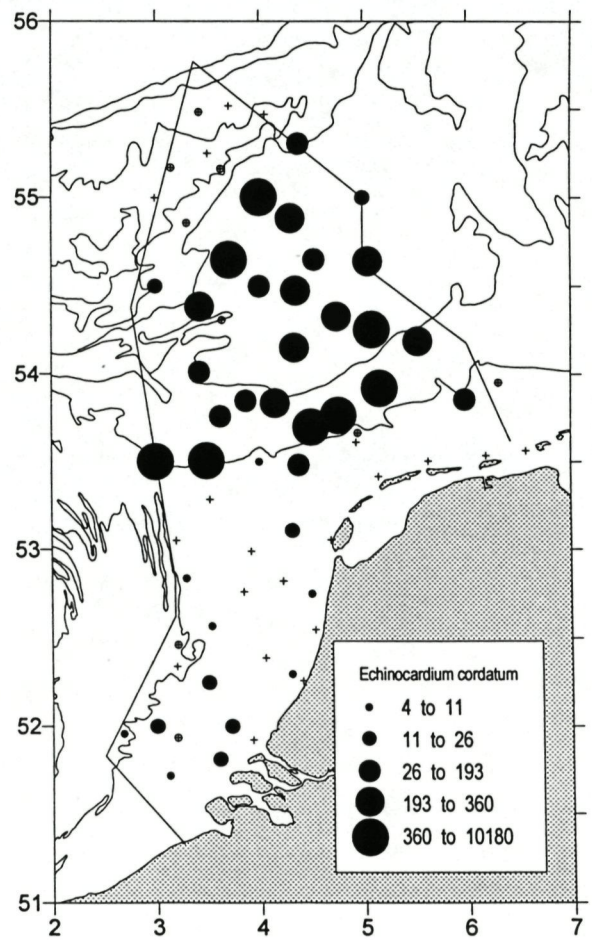

Ophiura texturata
0 to 1
1 to 3
3 to 9
9 to 24
24 to 536

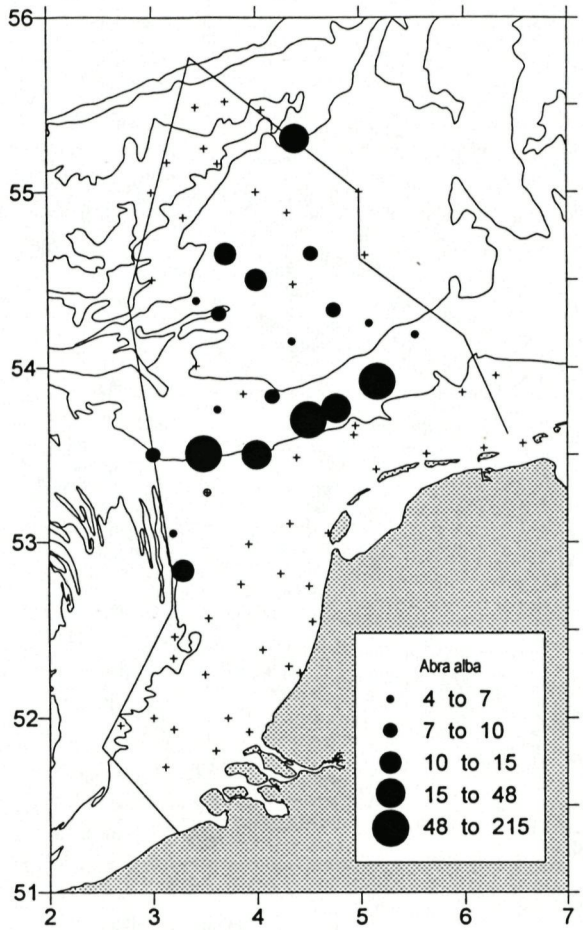

Psammechinus miliaris
0.0 to 0.1
0.1 to 0.2
0.2 to 0.6
0.6 to 2.3
2.3 to 9.4

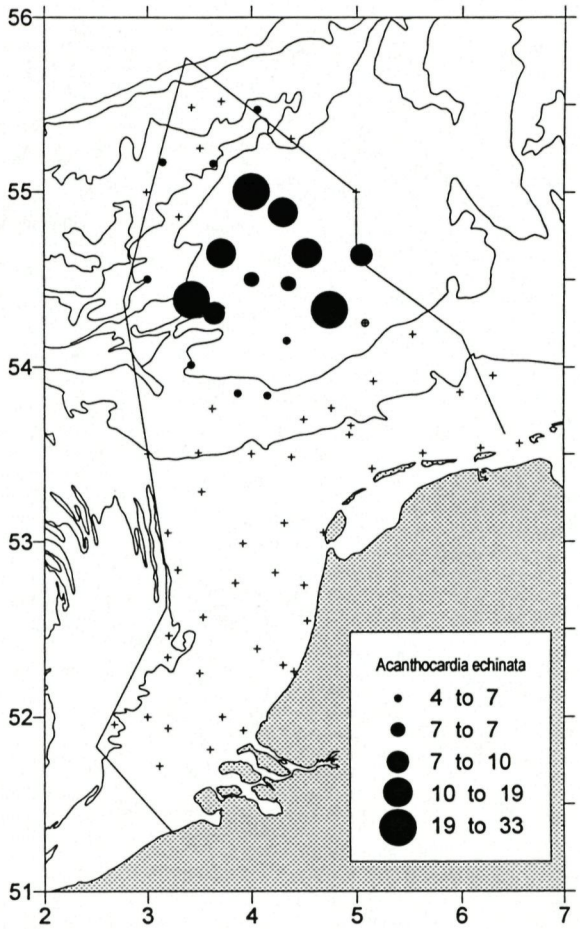

Astropecten irregularis
4 to 17
17 to 37
37 to 70
70 to 130
130 to 237

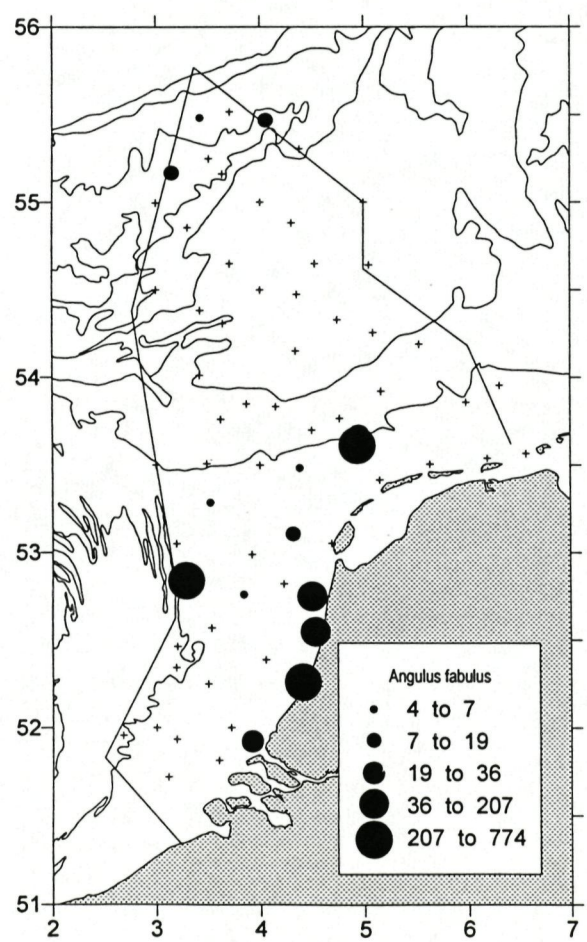

Brysopsis lyrifera
4 to 7
7 to 71
71 to 107
107 to 152
152 to 319

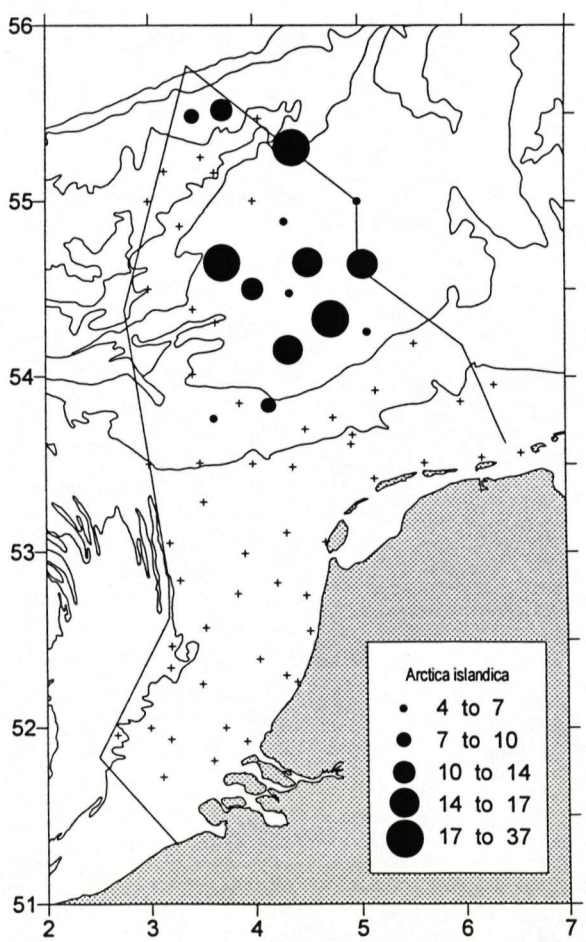

Cucumaria elongata
3 to 4
4 to 22
22 to 52
52 to 270
270 to 270

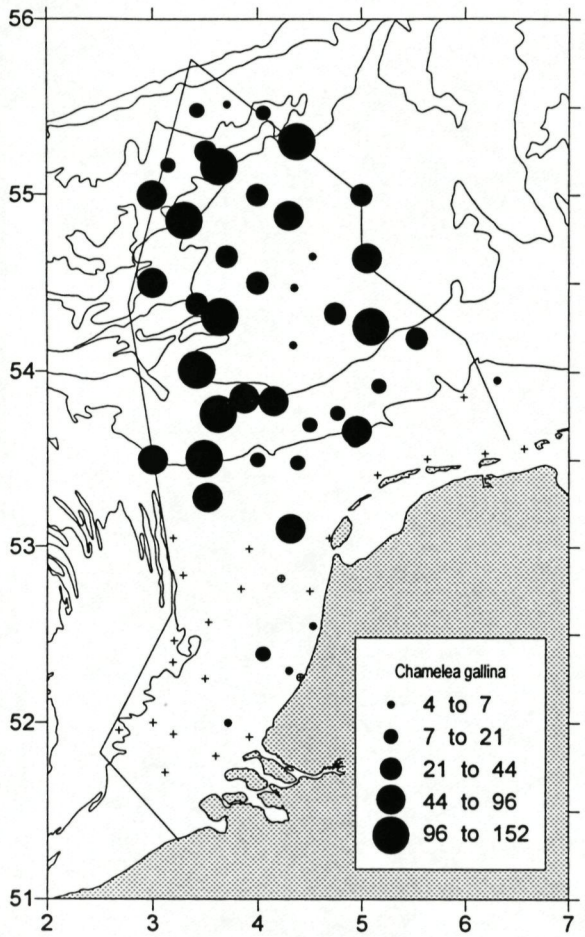

Echinocardium cordatum
4 to 11
11 to 26
26 to 193
193 to 360
360 to 10180

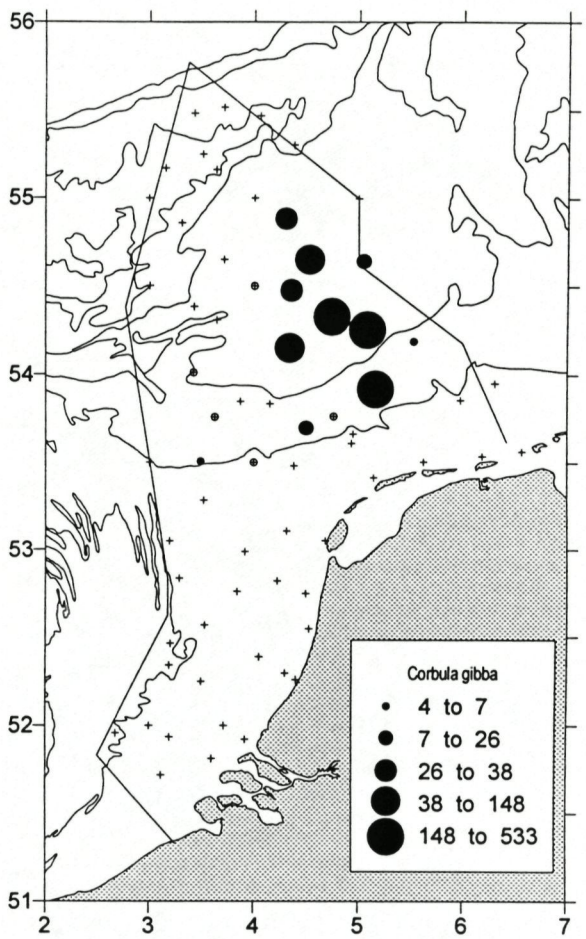

Abra alba
4 to 7
7 to 10
10 to 15
15 to 48
48 to 215

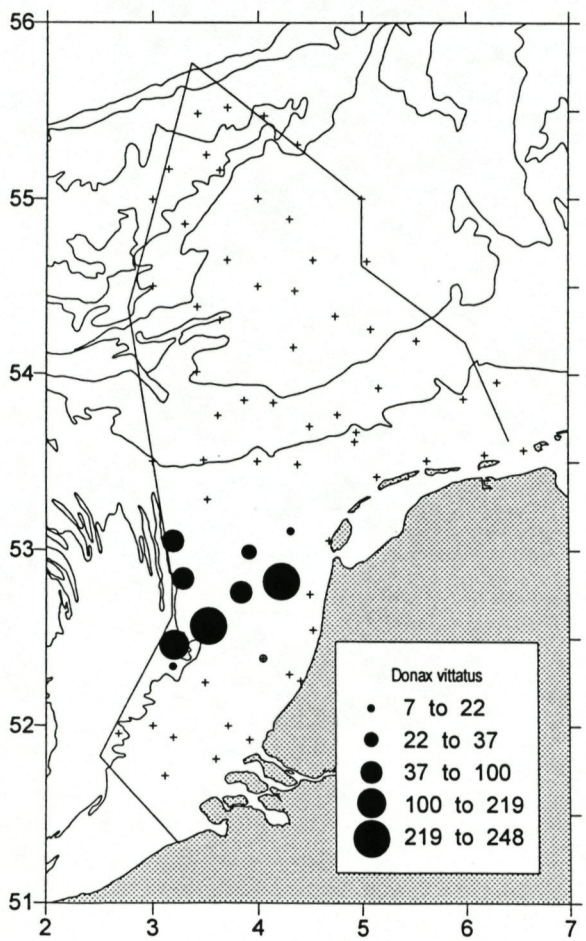

Acanthocardia echinata
4 to 7
7 to 7
7 to 10
10 to 19
19 to 33

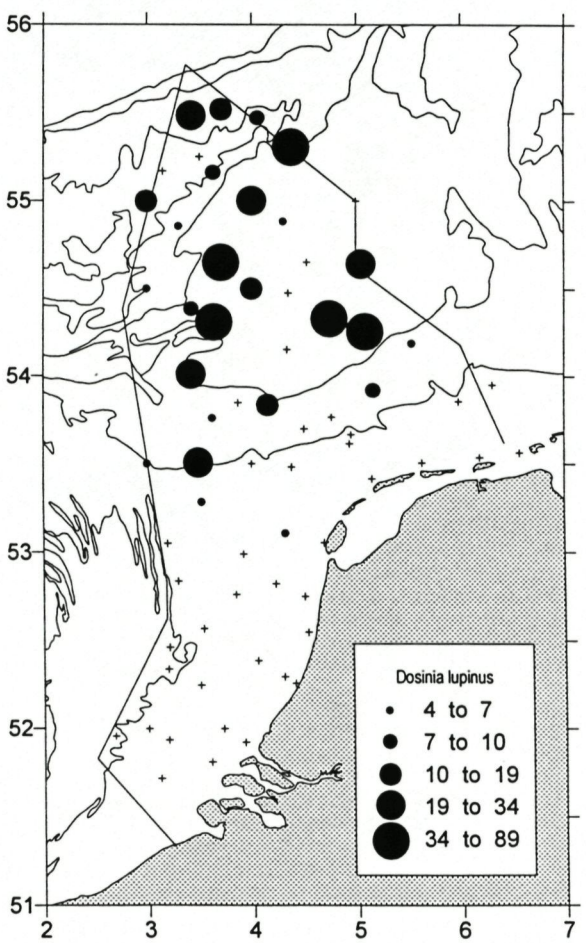

Angulus fabulus
4 to 7
7 to 19
19 to 36
36 to 207
207 to 774

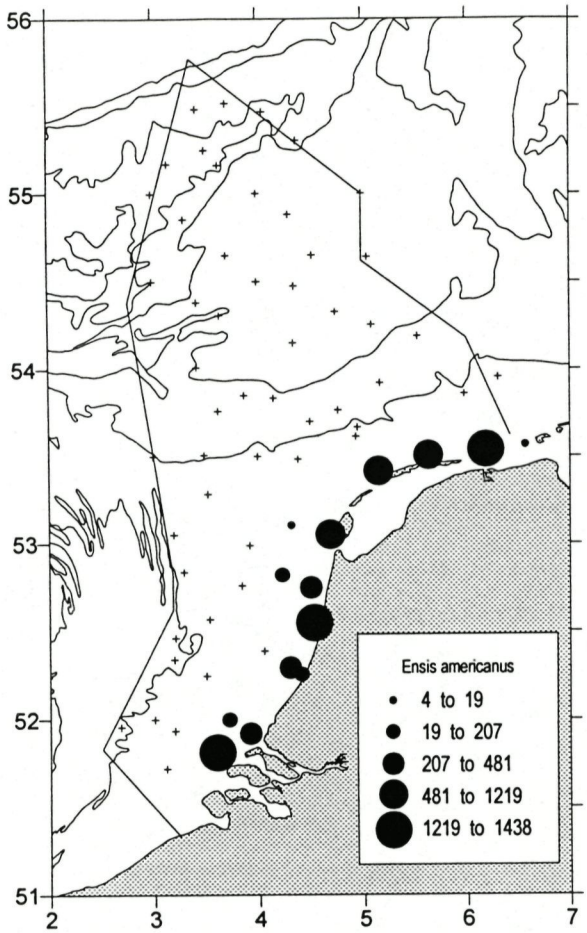

Arctica islandica
4 to 7
7 to 10
10 to 14
14 to 17
17 to 37

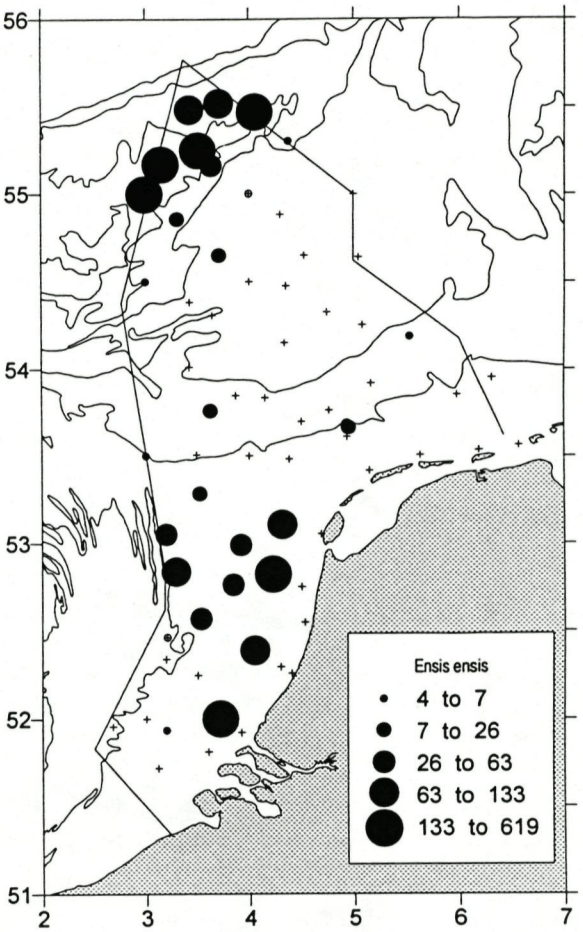

Chamelea gallina
4 to 7
7 to 21
21 to 44
44 to 96
96 to 152
56
55
54
53
52
51
2
3
4
5
6
7

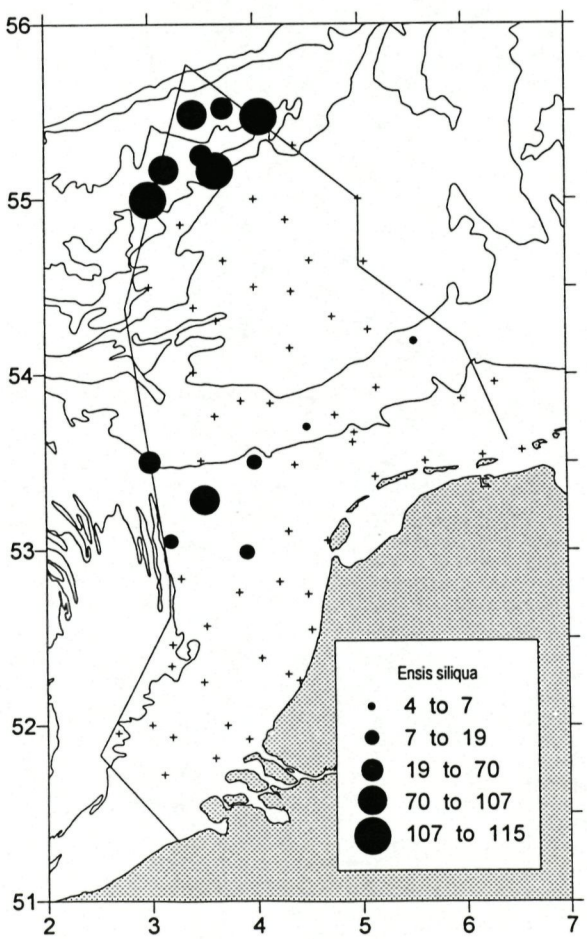

Corbula gibba
4 to 7
7 to 26
26 to 38
38 to 148
148 to 533
56
55
54
53
52
51
2
3
4
5
6
7

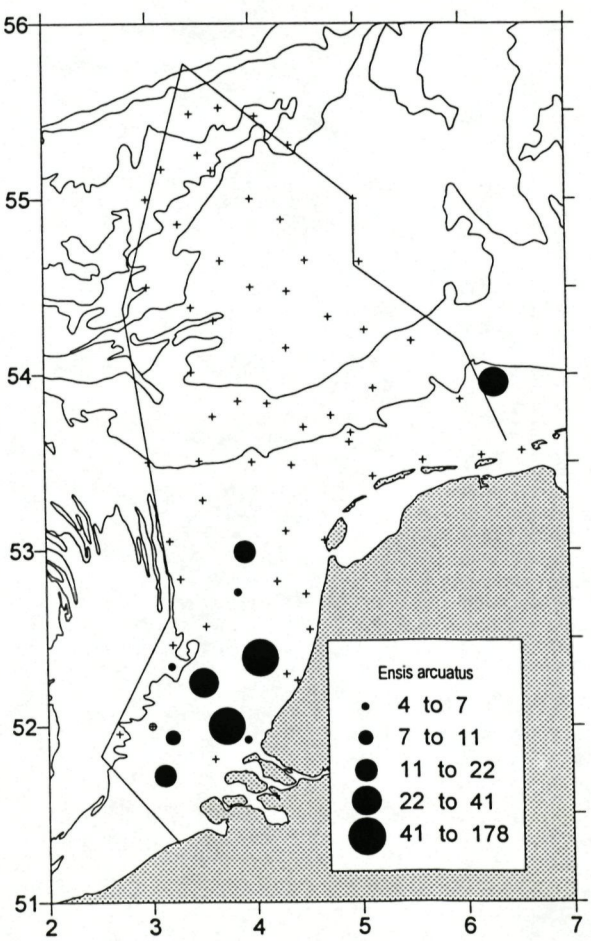

Donax vittatus
7 to 22
22 to 37
37 to 100
100 to 219
219 to 248
56
55
54
53
52
51
2
3
4
5
6
7

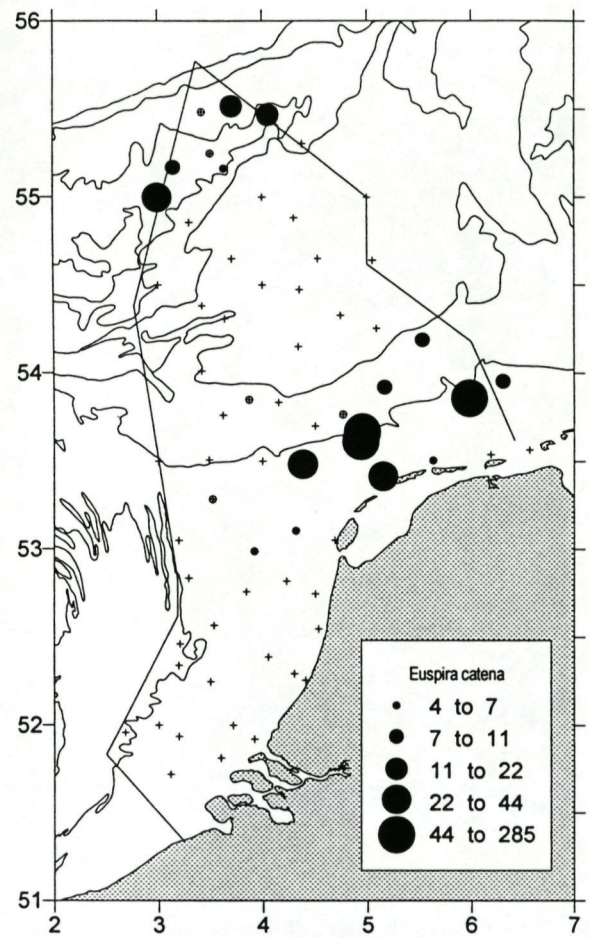

Dosinia lupinus
4 to 7
7 to 10
10 to 19
19 to 34
34 to 89
56
55
54
53
52
51
2
3
4
5
6
7

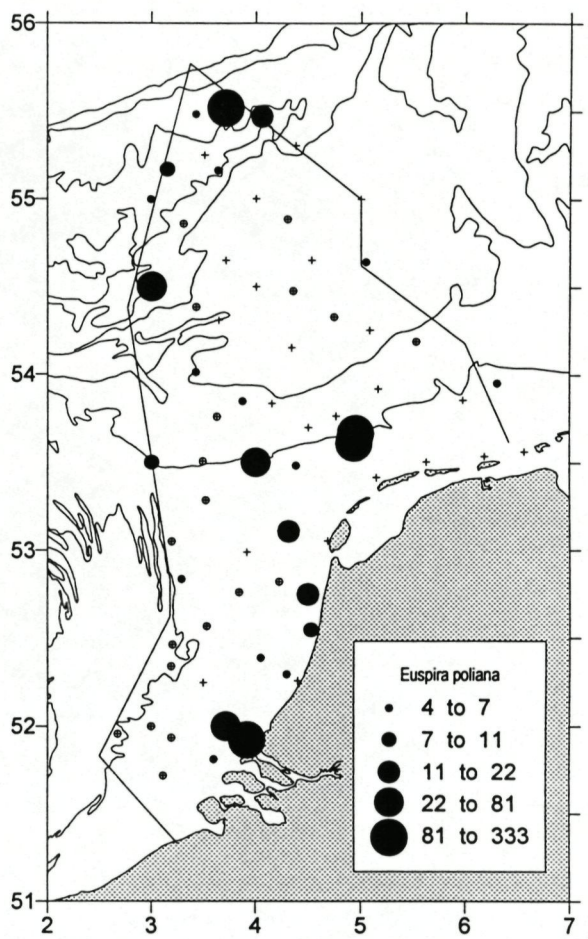

Ensis americanus
4 to 19
19 to 207
207 to 481
481 to 1219
1219 to 1438

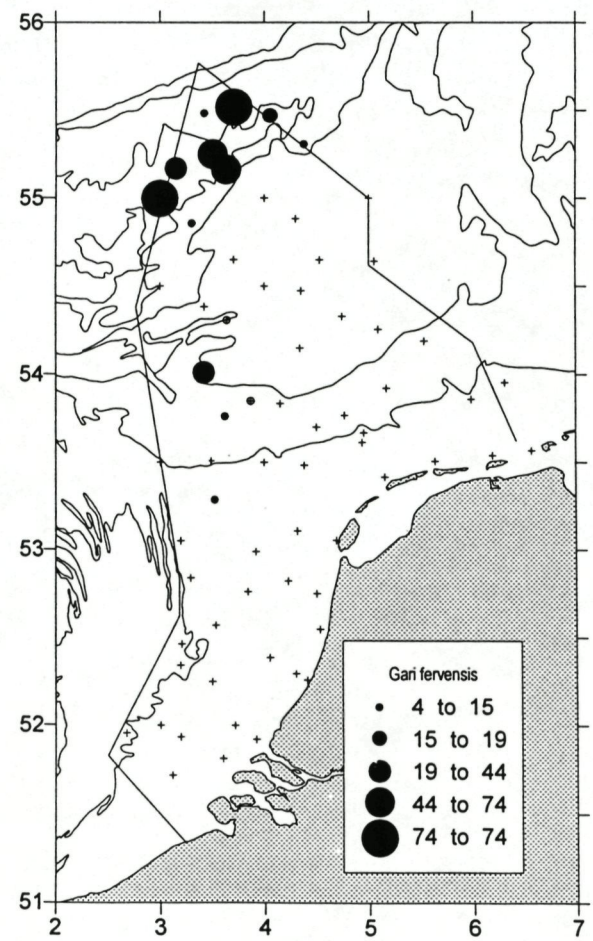

Ensis ensis
4 to 7
7 to 26
26 to 63
63 to 133
133 to 619

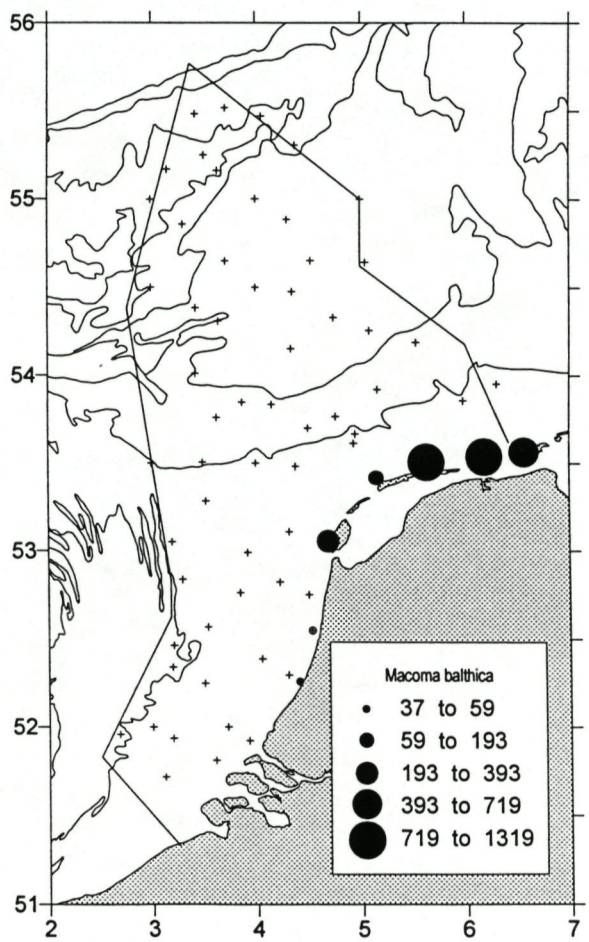

Ensis siliqua
4 to 7
7 to 19
19 to 70
70 to 107
107 to 115

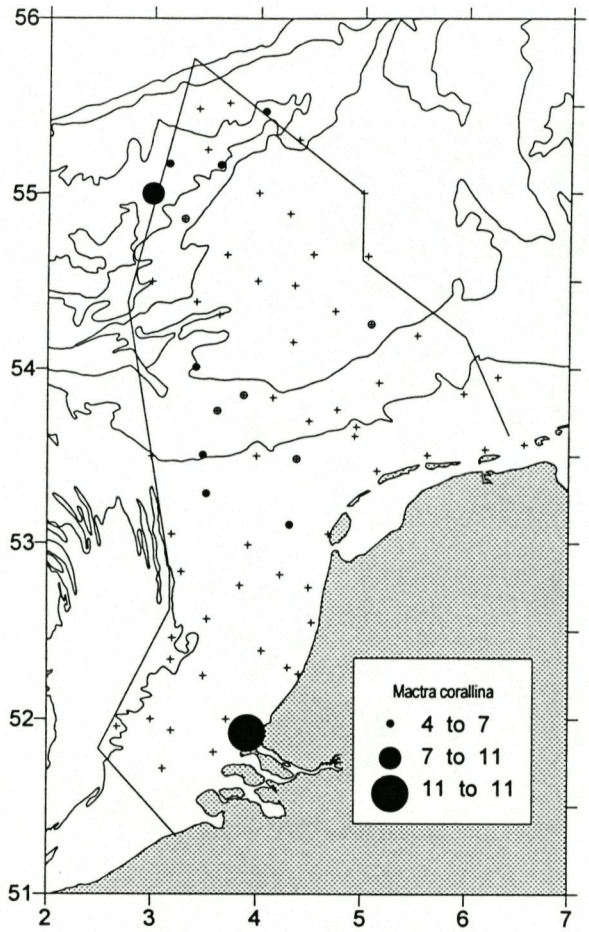

Ensis arcuatus
4 to 7
7 to 11
11 to 22
22 to 41
41 to 178

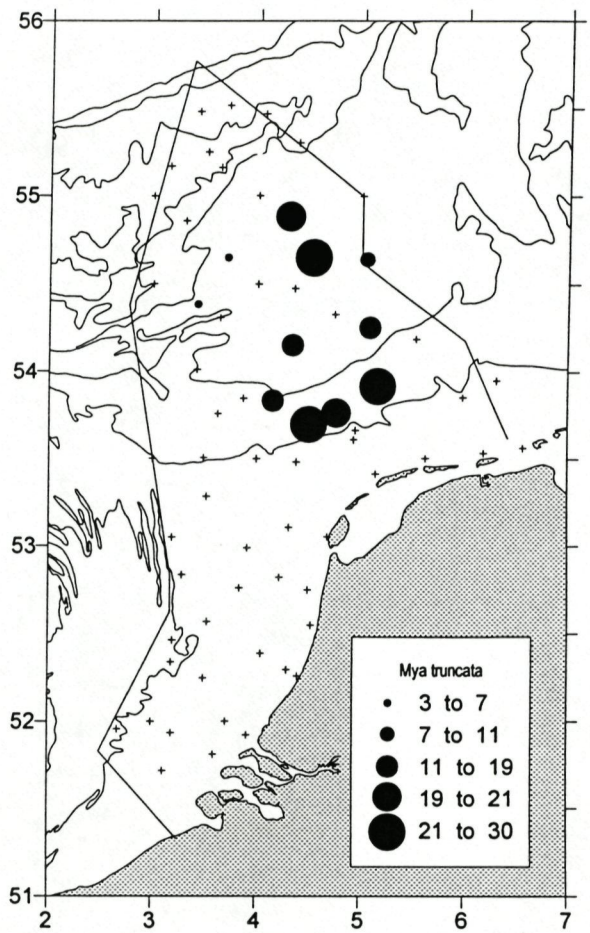

Euspira catena
4 to 7
7 to 11
11 to 22
22 to 44
44 to 285

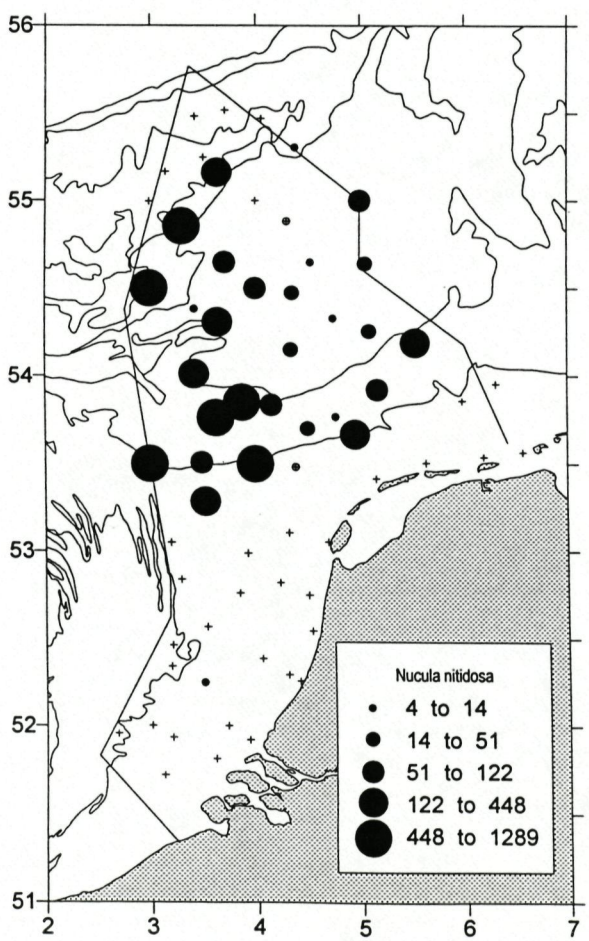

Euspira poliana
4 to 7
7 to 11
11 to 22
22 to 81
81 to 333

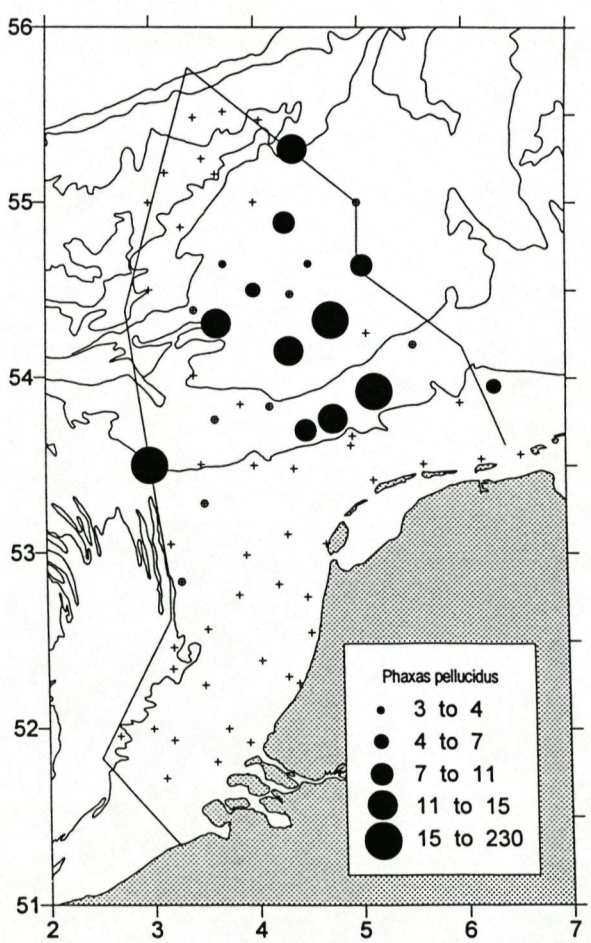

Gari fervensis
4 to 15
15 to 19
19 to 44
44 to 74
74 to 74

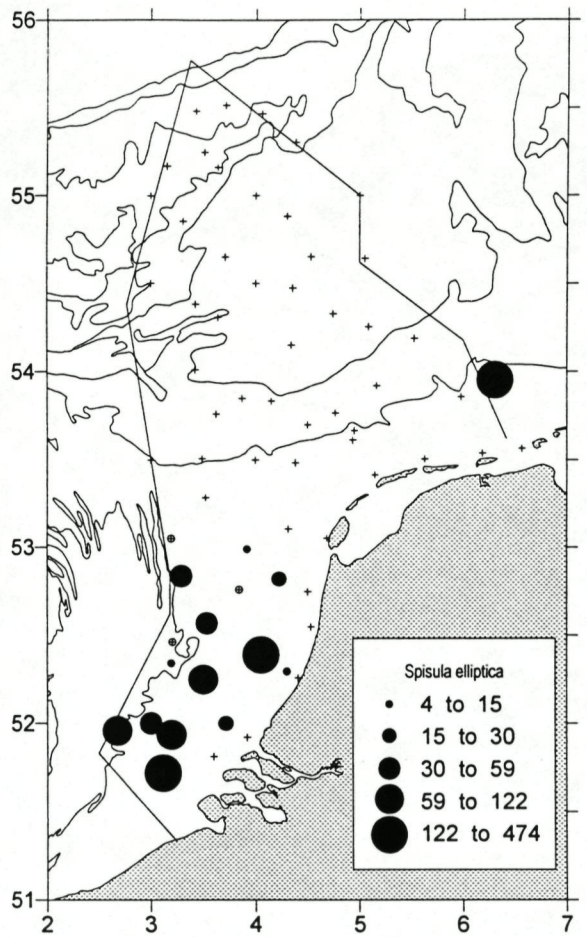

Macoma balthica
37 to 59
59 to 193
193 to 393
393 to 719
719 to 1319

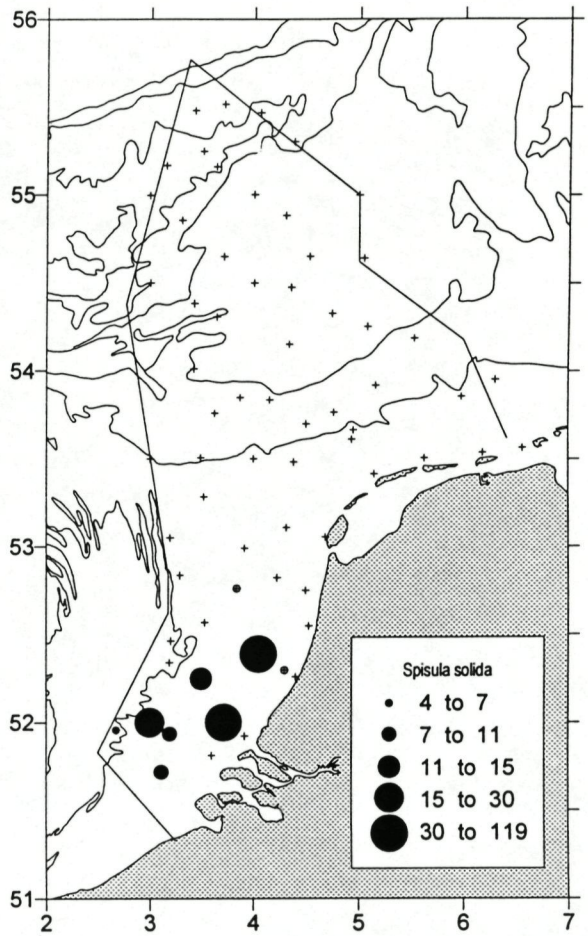

Mactra corallina
4 to 7
7 to 11
11 to 11

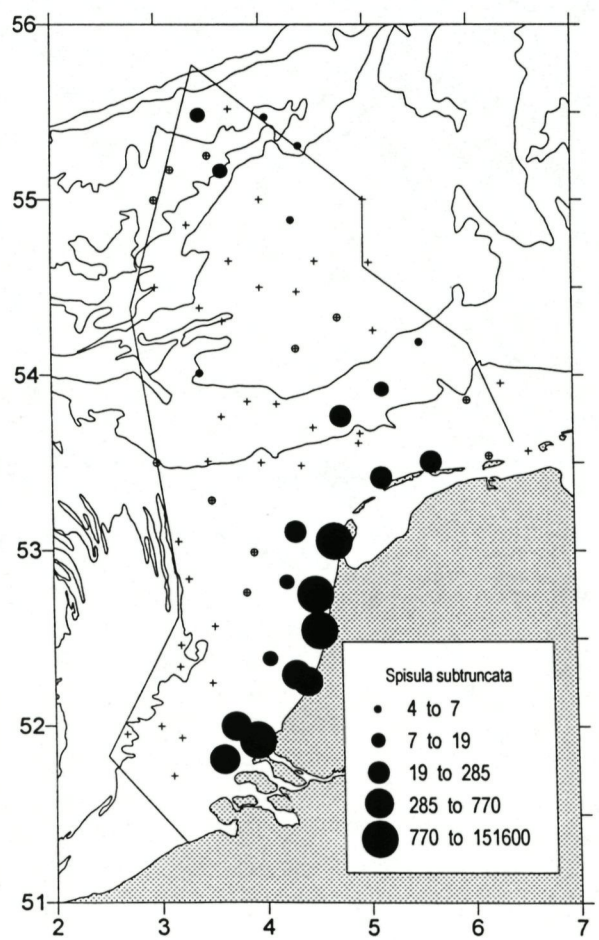

Mya truncata
3 to 7
7 to 11
11 to 19
19 to 21
21 to 30

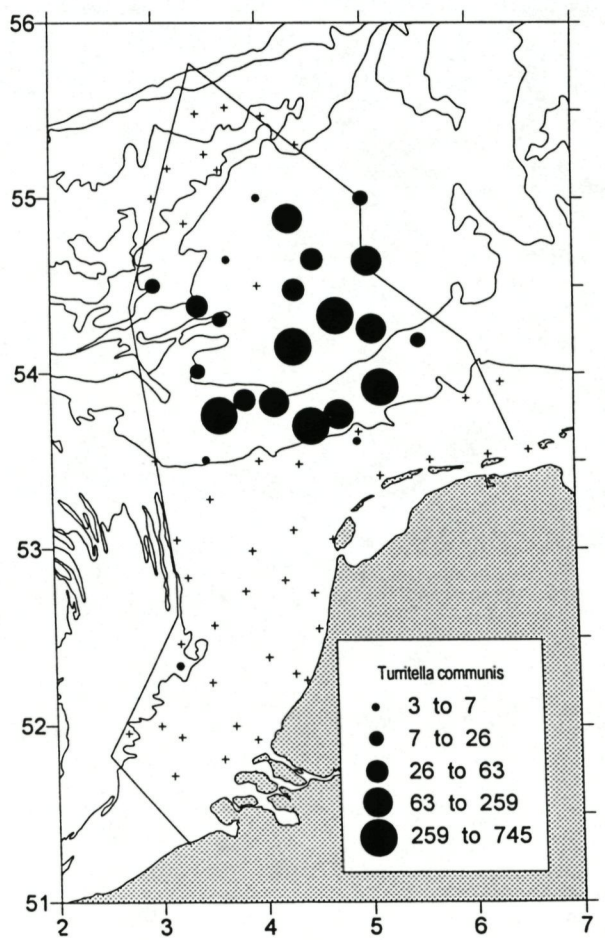

Nucula nitidosa
4 to 14
14 to 51
51 to 122
122 to 448
448 to 1289

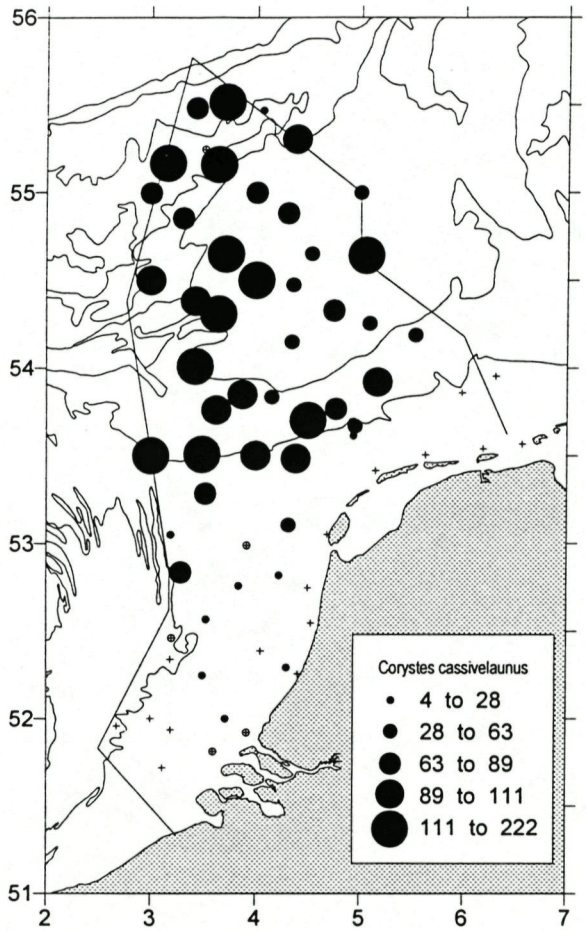

Phaxas pellucidus
3 to 4
4 to 7
7 to 11
11 to 15
15 to 230

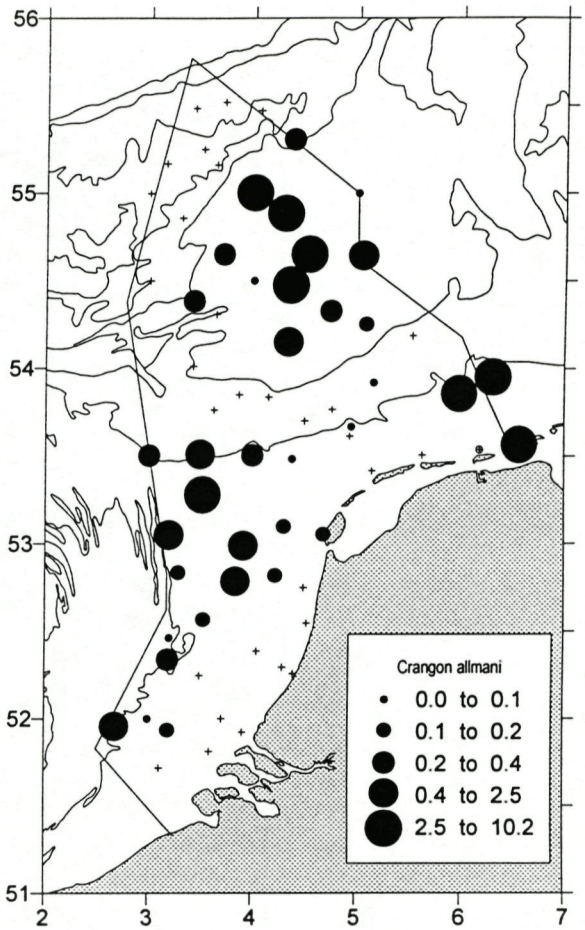

Spisula elliptica
4 to 15
15 to 30
30 to 59
59 to 122
122 to 474

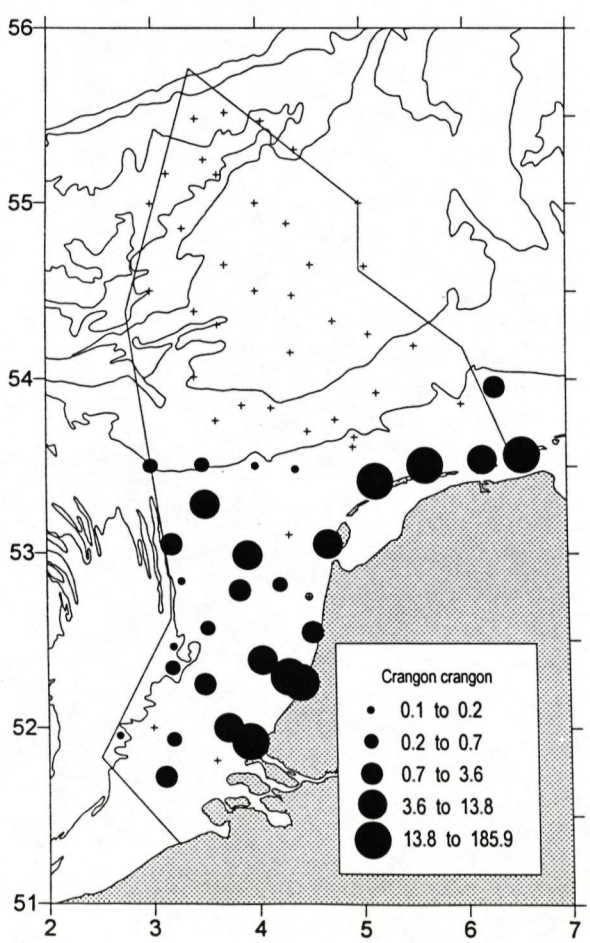

Spisula solida
4 to 7
7 to 11
11 to 15
15 to 30
30 to 119

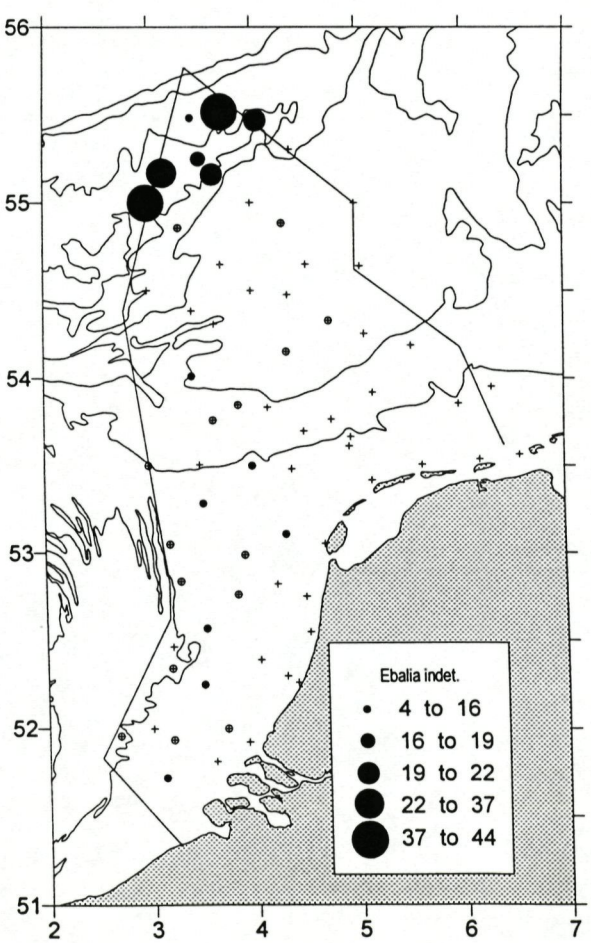

Spisula subtruncata
4 to 7
7 to 19
19 to 285
285 to 770
770 to 151600

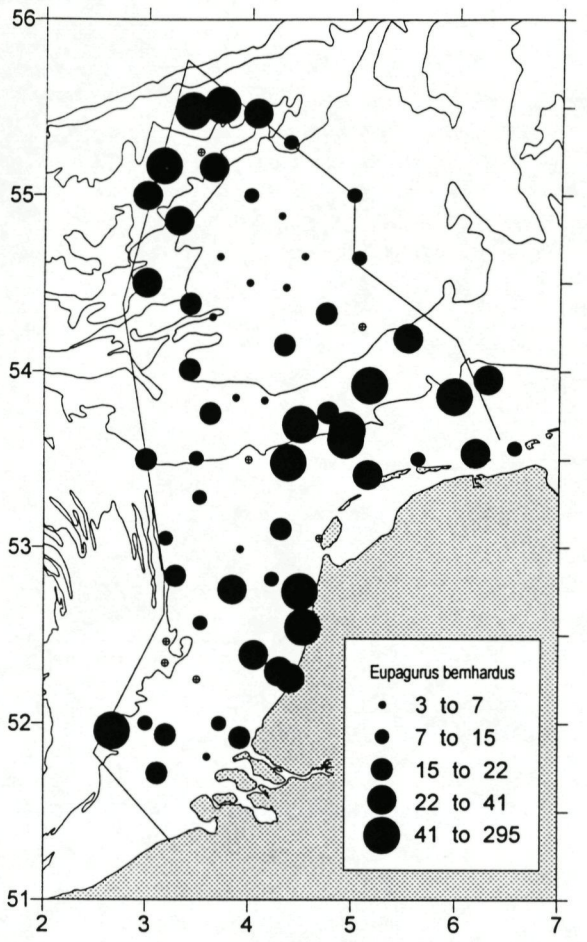

Turritella communis
3 to 7
7 to 26
26 to 63
63 to 259
259 to 745

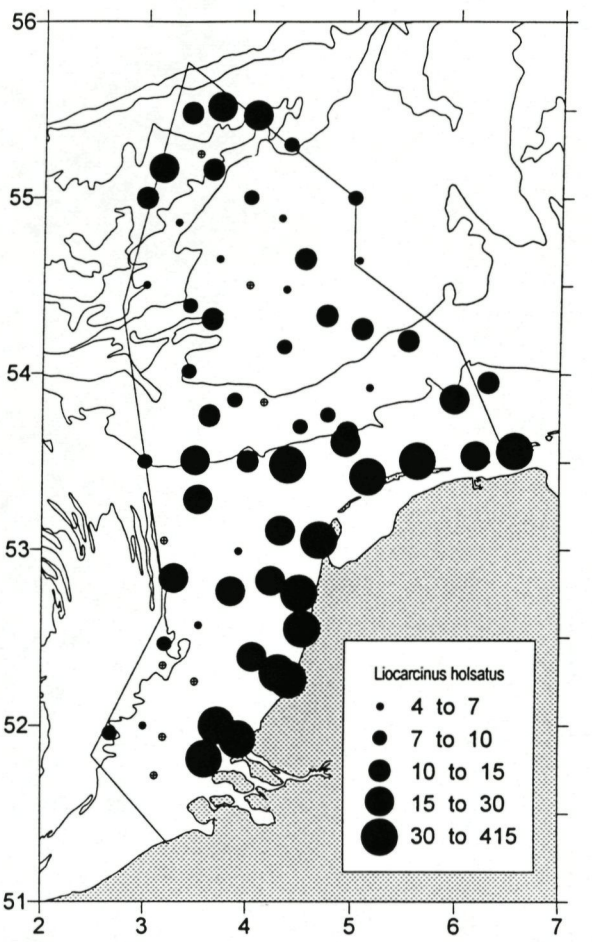

Corystes cassivelaunus
4 to 28
28 to 63
63 to 89
89 to 111
111 to 222

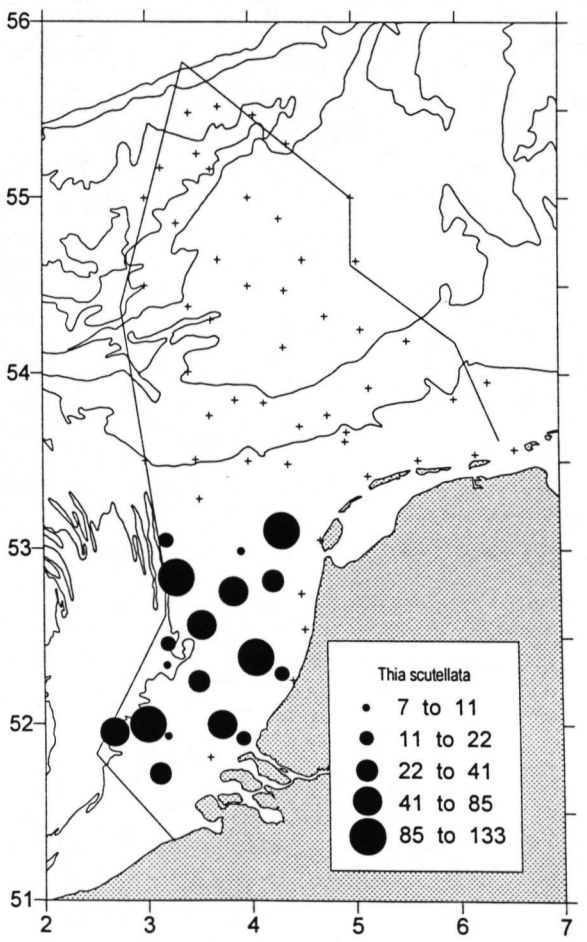

Crangon allmani
0.0 to 0.1
0.1 to 0.2
0.2 to 0.4
0.4 to 2.5
2.5 to 10.2

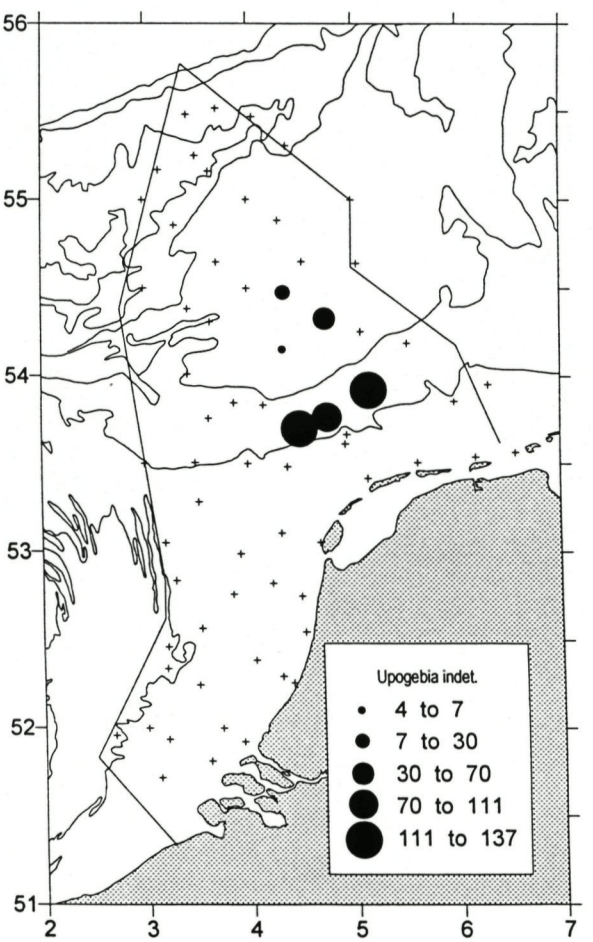

Crangon crangon
0.1 to 0.2
0.2 to 0.7
0.7 to 3.6
3.6 to 13.8
13.8 to 185.9

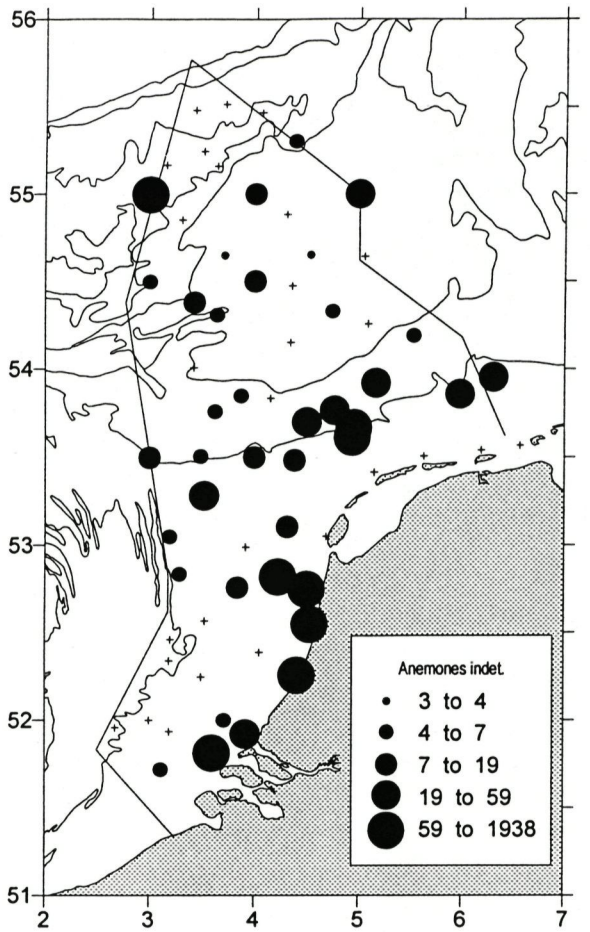

Ebalia indet.
4 to 16
16 to 19
19 to 22
22 to 37
37 to 44

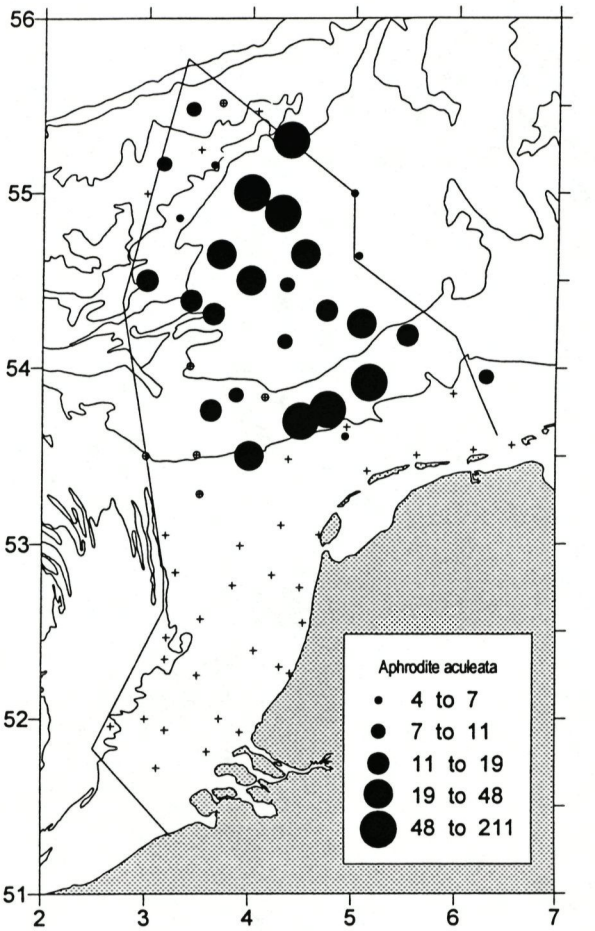

Eupagurus bernhardus
3 to 7
7 to 15
15 to 22
22 to 41
41 to 295

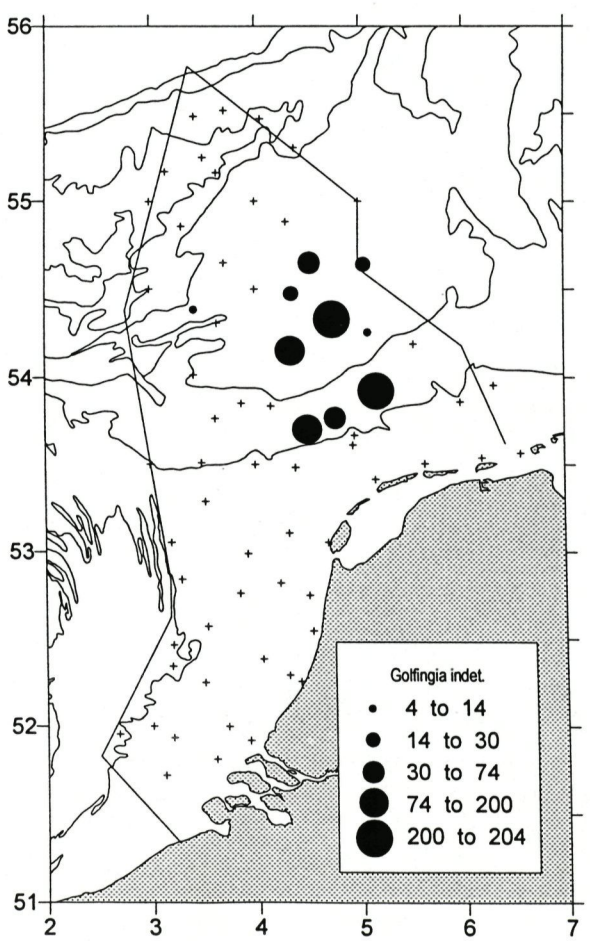

Liocarcinus holsatus
4 to 7
7 to 10
10 to 15
15 to 30
30 to 415

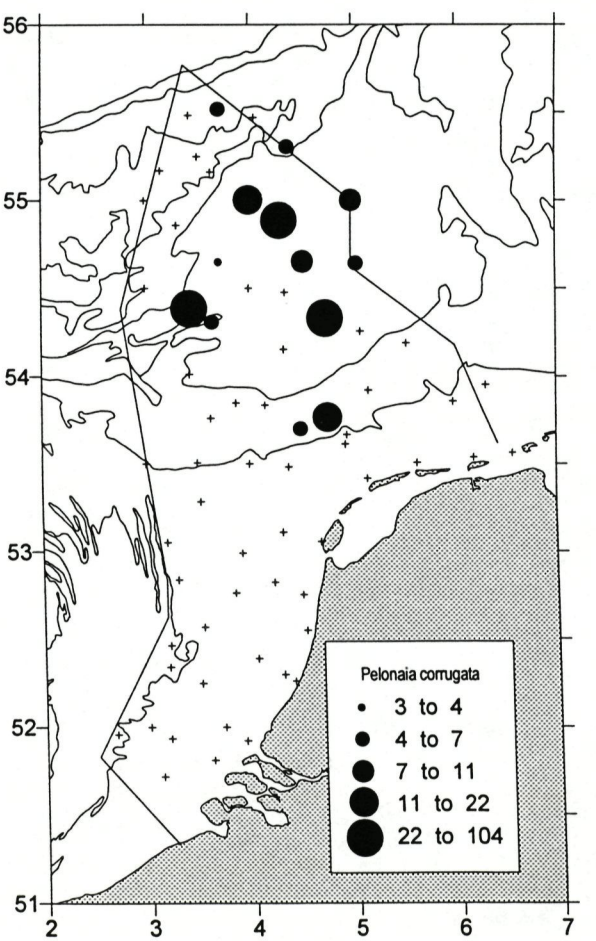

Thia scutellata
7 to 11
11 to 22
22 to 41
41 to 85
85 to 133


Upogebia indet.
4 to 7
7 to 30
30 to 70
70 to 111
111 to 137


Anemones indet.
3 to 4
4 to 7
7 to 19
19 to 59
59 to 1938


Aphrodite aculeata
4 to 7
7 to 11
11 to 19
19 to 48
48 to 211


Golfingia indet.
4 to 14
14 to 30
30 to 74
74 to 200
200 to 204


Pelonaia corrugata
3 to 4
4 to 7
7 to 11
11 to 22
22 to 104

APPENDIX 5.1.
Sampling stations, positions and abiotic variables.

station	depth	median grainsize	mud (<63um)	stations included in program 1996		1997		positions 3mBT samples latitude			longitude			positions Triple-D samples latitude			longitude		
	m	(um)	%	3mk	ddd	3mk	ddd	°	'	"	°	'	"	°	'	"	°	'	"
2	24					x	x	51	48	45	3	36	1	51	48	45	3	35	59
4	12	199	0	x	x	x	x	51	55	18	3	55	8	51	55	20	3	55	10
5	26	437	1	x	x	x	x	52	0	1	3	42	57	52	0	0	3	42	58
7	29	348	0	x	x	x	x	51	43	6	3	6	52	51	43	7	3	6	50
8	35	396	0	x	x	x	x	51	56	7	3	11	39	51	56	8	3	11	36
9	37	522	0	x	x	x	x	51	59	60	3	0	1	52	0	0	2	59	59
11	41	478	0	x	x	x	x	51	57	25	2	40	47	51	57	25	2	40	45
13	34	342	0	x	x	x	x	52	20	24	3	11	26	52	20	26	3	11	26
14	31	302	0	x	x	x	x	52	27	44	3	12	9	52	27	44	3	12	13
16	27	395	1	x	x	x	x	52	14	56	3	29	57	52	14	55	3	29	57
18	12	239	3	x	x	x	x	52	15	36	4	24	24	52	15	32	4	24	20
19	19	322	1	x	x	x	x	52	17	25	4	17	49	52	17	42	4	18	2
21	22	313	0	x	x	x	x	52	23	14	4	2	52	52	23	15	4	2	57
23	31	300	0	x	x	x	x	52	34	8	3	31	56	52	34	6	3	31	56
25	34	292	0	x	x	x	x	52	50	11	3	17	15	52	50	12	3	17	19
27	29	272	0			x	x	53	2	58	3	11	35	53	2	58	3	11	37
29	30	281	0			x	x	52	47	10	3	50	29	52	45	38	3	50	31
30	27	271	0	x	x	x	x	52	49	14	4	13	31	52	49	16	4	13	30
31	18	219	1	x	x	x	x	52	32	50	4	31	53	52	32	51	4	31	52
32	20	229	0	x	x	x	x	52	45	2	4	30	0	52	44	57	4	29	59
34	10	196	0	x	x	x	x	53	3	10	4	41	16	53	3	11	4	41	14
36	26	247	0	x	x	x	x	52	59	21	3	54	60	52	59	20	3	55	2
37	34	233	0	x	x	x	x	53	5	53	4	18	21	53	6	21	4	18	52
39	27	203	0	x	x	x	x	53	16	41	3	30	54	53	17	2	3	31	17
40	27	215	0	x	x	x	x	53	28	59	4	22	53	53	28	58	4	22	53
41	12	216	0	x	x	x	x	53	24	52	5	8	59	53	24	53	5	9	2
42	9	175	0	x	x	x	x	53	30	17	5	37	50	53	30	18	5	37	48
45	11	161	0	x	x	x	x	53	32	16	6	11	8	53	32	17	6	11	9
47	8	179	0	x	x	x	x	53	33	58	6	33	49	53	33	57	6	33	58
48	30	350	1	x	x	x	x	53	57	13	6	18	26	53	57	13	6	18	30
49	29	219	0	x	x	x	x	53	51	28	5	58	54	53	51	29	5	58	55
52	40	199	3	x	x	x	x	54	11	19	5	31	51	54	11	20	5	31	51
53	39	122	15	x		x	x	53	55	15	5	9	48	53	55	14	5	9	50
56	38	105	16	x		x	x	53	45	59	4	45	56	53	45	56	4	45	54
58	32	198	0	x	x	x	x	53	40	2	4	57	3	53	39	59	4	57	5
59	26	214	0	x	x	x	x	53	36	40	4	56	10	53	36	44	4	56	12
60	35	105	13	x	x	x	x	53	42	2	4	30	1	53	42	1	4	29	57
61	29	215	0			x	x	53	30	7	3	59	54	53	29	59	3	59	52
62	42	136	3	x	x	x	x	53	50	6	4	9	11	53	50	5	4	9	10
63	39	152	1	x	x	x	x	53	50	55	3	52	20	53	50	55	3	52	18
64	37	184	0	x	x	x	x	53	45	37	3	37	29	53	45	37	3	37	27
66	35	126	5	x	x	x	x	53	30	26	3	29	27	53	30	26	3	29	25
68	32	139	2	x	x	x	x	53	29	59	3	0	0	53	30	1	3	0	0
69	42	191	2	x	x	x	x	54	3	39	3	25	18	54	0	39	3	25	16
70	54	191	6	x				54	4	51	2	51	26						
72	37					x	x	54	29	58	3	0	1	54	29	59	3	0	0
74	46	106	9			x	x	54	23	0	3	25	29	54	22	60	3	25	31
75	44	144	5			x	x	54	18	30	3	38	29	54	18	30	3	38	30
77	49	95	11			x	x	54	9	3	4	20	28	54	9	4	4	20	27
79	47	133	7	x	x	x	x	54	19	41	4	44	39	54	19	42	4	44	39
80	44	131	14	x	x	x	x	54	15	18	5	5	13	54	15	19	5	5	13
81	44	164	4	x	x			54	29	56	4	59	24	54	29	56	4	59	24
82	46	138	9			x	x	54	38	37	5	2	58	54	38	30	5	2	60
83	41	149	1			x	x	55	0	1	5	0	0	54	59	60	4	59	58
84	49	104	15	x	x	x	x	54	38	58	4	31	49	54	38	60	4	31	51
85	50	93	11	x	x	x	x	54	28	29	4	21	12	54	28	29	4	21	14
86	45	112	4	x	x	x	x	54	29	58	4	0	3	54	29	58	4	0	6
87	50	87	14	x	x	x	x	54	52	58	4	17	55	54	52	59	4	18	11
88	46	149	1	x	x	x	x	55	18	22	4	22	49	55	18	19	4	22	47
89	49	110	5	x	x	x	x	55	0	2	4	0	7	55	0	2	4	0	7
90	30	215	0	x	x	x	x	55	28	14	4	3	25	55	28	12	4	3	23
91	28	199	0	x	x	x	x	55	14	59	3	30	27	55	14	59	3	30	25
92	36	187	0	x	x	x	x	55	9	45	3	38	12	55	9	45	3	38	10
93	30	199	0	x	x	x	x	55	10	9	3	9	7	55	10	9	3	9	4
94	23	188	0	x	x	x	x	54	59	52	2	59	37	54	59	52	2	59	48
97	39	147	1	x	x	x	x	54	51	19	3	18	16	54	51	20	3	18	12
100	45	109	6	x	x	x	x	54	38	55	3	42	35	54	38	58	3	42	38
101	45			x	x			55	37	59	3	33	34	55	37	60	3	33	34
102	35	209	1	x	x	x	x	55	31	5	3	42	41	55	31	5	3	42	39
103	38			x	x	x	x	55	29	0	3	25	27	55	29	0	3	25	25

APPENDIX 5.2a.

Densities of demersal fish and benthic invertebrates (n/100 m²) per station in 1996, sampled with a 3m beam trawl. "+" = present only in the Triple-D.

station:	4	5	7	8	9	11	13	14	16	18	19	21	23	25	30	31	32	34	36	37	39	40	41	42	45	47	48	49	52
FISH																													
Agonus cataphractus	0.26	0.25	0.18			0.08					0.09			0.51			0.16	0.20					1.30	0.28	0.35		0.05	0.05	0.09
Ammodytes spp.		0.87	0.46	0.33	0.80	0.08	0.12	0.99	0.39	0.05	0.35	0.93	0.21	0.51	0.19	0.36	+	1.40	1.04	0.14	0.08	0.41	0.54	2.85	0.07	0.21	0.70	0.10	
Arnoglossus laterna	0.09	0.12	0.09	0.99	0.36		2.81	1.90	0.28			0.07	0.63	1.11	1.03	0.06	0.49	0.70	2.28	0.69	0.89	0.24	0.22	0.14				0.05	0.13
Buglossidium luteum	0.79	2.23	0.92	0.74	0.80		7.35	13.23	2.06	0.05	0.78	2.73	13.08	18.42	7.71	0.30	1.13	4.79	11.60	8.03	10.32	2.77	3.46	0.49				0.05	7.87
Callionimus lyra	0.61	2.11	1.20	0.41	1.42	0.84		0.08	0.56	0.05		0.07	0.10	1.53	0.23	0.12	0.97	0.20	0.28	0.55	0.08		0.22						0.04
Callionymus reticulatus		2.48	5.27	6.00	3.55	0.59	1.20	0.53	5.62			0.93	2.83	1.79	1.21			0.10	0.48		0.08							0.05	
Ciliata mustela																					0.08								
Enchelyopus cimbrius					0.18	0.08	0.06	0.08							0.09		0.32	0.10						0.07			0.05		
Eutrigla gurnardus																													0.04
Gadus morhua																													
Gaidropsarus vulgaris																													
Hippoglossoides platessoides																													
Limanda limanda	4.21	2.11	1.39	2.14	2.75	0.59	1.02	1.37	4.23	3.18	6.14	2.15	1.26	8.44	1.96	7.47	7.12	7.79	1.86	4.01	1.29	4.81	0.97	5.08	4.32	2.07	9.28	2.28	2.82
Melanogrammus aeglefinus																													
Merlangius merlangus	0.18			0.58		0.17	0.06	0.23						2.56				0.70	0.14	0.14			0.43	0.83			0.16	0.10	0.31
Microstomus kitt																													
Phrynorhombus norvegicus										0.16						2.37	0.16	0.10					0.32	0.49	0.21	0.07			
Platychthys flesus		0.62			0.18			0.08			0.61	0.07	0.10	0.09	0.05	3.28	3.56	15.58		0.55		3.26	9.63	0.70	2.83	0.48	1.23	1.21	0.58
Pleuronectes platessa		5.08	8.04	3.21	1.24	1.76	3.88	6.24	3.56	17.25	39.45	3.73	5.55	4.69	2.62	45.92	11.00	2.00	5.59	22.15	3.63	19.57		4.17	3.33	1.10	7.67	4.46	18.59
Pomatoschistus spp.																								0.07					
Scophthalmus rhombus		0.62		0.16							0.09					0.30		0.80		0.42	0.16		0.97	0.14				0.05	0.04
Solea solea																										0.07			
Gasterosteus aculeatus																													
Syngnathus acus			0.09						0.06	0.05				0.09											0.07				0.36
Syngnathus rostellatus		0.12	2.40	4.93	3.64	2.60	12.07	5.71	5.34			4.88	2.31	6.91	4.02				1.17	0.14	0.08								
Trachinus vipera						0.25						0.07									0.08								
Trisopterus minutus																													
ECHINODERMS																													
Asterias rubens	3.34	19.10	0.46	0.16	0.09	0.34		0.08	1.06	0.22	2.77	0.43	0.31	0.17	1.92	2.19	144.44	3.00	0.48	13.57	0.16	11.09	0.11	0.21	0.14	0.07	40.65	67.81	0.76
Luidia sarsi																													
Ophiotrix		634.92	150.47	46.04	92.40	189.13	11.24	+	169.11		11.42	50.20	86.35	31.38	8.60	32.31	11.81		6.35	136.21	0.08	2.94				+	163.02	443.62	5.27
Ophiura albida				+	0.18				+						+												0.16		
Ophiura sp.		32.66	0.83	0.74	0.62	1.51	27.73	+	3.45	6.04	6.23	0.43	13.83	33.09	6.96	131.80	9.87		13.95	75.30	5.57	53.98						772.65	11.44
Ophiura texturata					0.09	0.42		0.08						0.09															
Psammechinus miliaris																													
MOLLUSCS																													
Aequipecten opercularis			0.37	0.08																				0.07	0.21				
Mytilus edulis																													
CRUSTACEANS			0.68		0.27	0.08	0.18	0.38	0.89	0.43			+	0.26					0.35	4.43	8.47	1.30		0.83	0.21		15.87	7.37	62.92
Crangon allmani	331.51	15.50	10.17	21.05	0.27	+	7.29	1.52	32.04	131.99	41.87	9.18	15.93	0.34	17.38	144.56	6.15	11.09	1.45	12.74	10.16	6.69	47.62	24.34	20.41	22.30	2.36	10.08	2.86
Crangon crangon	1.84	8.80	6.41	6.00	6.84	9.56	3.05	1.98	5.12	17.58	12.54	5.67	5.24	4.69	4.86	11.60	29.76	1.90	10.36	6.09	3.55	14.35	0.76	1.67	22.25	0.62	5.20	9.06	0.98
Eupagurus bernhardus					+																			0.14					
Hyas coarctatus																													
Inachus dorsettensis	0.09	0.12	0.46		+					0.05			0.10							0.97									
Macropodia indet.																													
Macropodia linearis				0.33					1.06																				
Macropodia rostrata				+																				0.21			0.11		
Palaemon elegans			2.37	+	0.18			+	0.06				0.10						0.07										
Pontophilus sp.		0.12										0.07								+	+								1.43
Processa sp.																													
OTHER GROUPS																													
Alcyonidium digitatum broodspons																													

APPENDIX 5.2a (continued).

station:	53	56	58	59	60	62	63	64	66	68	69	70	79	80	81	84	85	86	87	88	89	90	91	92	93	94	97	100	101	102	103
FISH																															
Agonus cataphractus		0.08	0.10	0.12	0.07							0.06	0.04	0.05	0.07	0.06					0.06				0.11				0.09	0.07	
Ammodytes spp.			0.10	0.12										0.42	0.03							2.54	0.19	0.18	0.11	0.10					0.18
Arnoglossus laterna	0.30	0.93		0.36	0.94	0.60	1.26	0.73	0.72	0.77	0.91	0.33	0.98	2.33	0.74	0.83	1.22	1.60	0.06	0.35	0.31		0.19	0.36	0.32	0.40	1.50	2.25	0.44	0.28	0.18
Buglossidium luteum	4.33	4.17	2.69	5.67	3.48	1.52	2.25	3.78	5.07	6.66	2.29	0.17	2.14	9.32	8.12	1.60	0.83	0.88	0.57			3.81		5.65	5.10	1.79	13.83	1.36	0.96	1.32	3.01
Callionimus lyra	0.37	0.70	0.19	1.07	0.67	0.46	0.36	0.11	0.29	0.23	0.27	0.56	0.47	0.32	0.27	0.28	1.41	0.48	0.23	0.15	0.18		0.10		0.21	0.10	0.30	0.27	0.17	0.14	
Callionymus reticulatus				0.12				0.17		0.08	0.05																			0.21	
Ciliata mustela																															
Enchelyopus cimbrius	0.15	0.08			0.80	0.07	0.14	0.06	0.14	0.08	0.05	0.22				0.33	0.19		1.19		0.06										
Eutrigla gurnardus		0.08		0.18	0.07	0.46	0.27	0.06	0.22	0.31	0.05				0.03					0.80	0.37		1.43	6.81	1.70		0.15		0.26	0.21	0.18
Gadus morhua			0.10		0.07							0.11	0.04																	0.07	
Gaidropsarus vulgaris													1.07	0.69	0.37			0.24									0.15				
Hippoglossoides platessoides												0.06	0.04			0.11	0.13		0.91		0.12						0.07		0.17		
Limanda limanda	1.79	3.32	6.53	11.51	1.81	4.96	2.48	2.26	5.14	2.83	3.62	0.50	0.94	1.38	1.39	2.54	0.71	0.80	1.81	0.50	0.80	0.56	3.91	2.06	5.21	2.78	1.94	1.91	1.04	0.90	1.86
Melanogrammus aeglefinus																								0.09							
Merlangius merlangus	0.60		23.81	1.01	0.74	0.20		0.28	0.36	0.23	0.37	0.17	0.64	0.58	0.24	0.17	0.06	0.32		0.05	0.37	0.08		0.54			0.15		0.09		
Microstomus kitt								0.06					0.04								0.06								0.09		0.09
Phrynorhombus norvegicus												0.06							0.06	0.05	0.12										
Platychthys flesus			0.10																												
Pleuronectes platessa	0.30	0.23	1.25	5.01	0.33	0.33	0.14		0.07		0.05	0.17	0.04	0.32	0.10				0.06	0.05	0.06			0.09				0.20		0.07	
Pomatoschistus spp.	2.24	1.39	6.53	3.88	0.67		2.03	1.86	0.07	0.15	1.22	0.50	0.21	0.26	2.06	0.06	1.22	1.04	0.91	0.30	0.55	1.35	2.96	3.77	3.83	1.98	1.87	0.68	2.26	1.04	3.54
Scophthalmus rhombus																															
Solea solea	0.07	0.08	0.19	0.12	0.20	0.13	0.05	0.11	0.07	0.15		0.06	0.09	0.05	0.03			0.24	0.06		0.12							0.07	0.09		
Gasterosteus aculeatus																															
Syngnathus acus																															
Syngnathus rostellatus															0.10																
Trachinus vipera																															
Trisopterus minutus																															
ECHINODERMS																															
Asterias rubens	3.80	21.10	184.72	123.34	10.03	0.07	0.72	0.90	1.67	0.54	1.81	1.33		0.05	0.14	0.11		0.16	0.06	2.45	1.10	3.57	1.53	1.08	0.64	0.40	1.20	1.09	6.96	1.18	3.45
Luidia sarsi																		0.16									0.15				
Ophiotrix							0.05				0.05	4.16						2.07	0.06		1.17			0.09				1.23			
Ophiura albida	3093.45	2354.98	184.33	4.77	201.18	0.07	+	1.19	+	+		2.05	68.32	+	5.95								0.95	0.54	0.11	1.79	0.15		4.18	34.88	8.86
Ophiura sp.																															
Ophiura texturata	459.33	84.11	349.85	2.74	1.61	0.79	0.18	0.06	+	+	0.32			0.05	3.38			0.24		12.56	16.20	0.24		0.27	0.11		2.84	0.34			
Psammechinus miliaris						1.72	2.34	3.73	0.22	0.08	8.73	1.11						+	0.06	0.35	0.68	0.48	0.86	0.36	2.02	3.67	0.90	0.41	13.84	0.55	4.69
MOLLUSCS																															
Aequipecten opercularis												0.11							0.06				0.19		0.32				0.52	0.14	0.09
Mytilus edulis																															
CRUSTACEANS																															
Crangon allmani	8.95	0.77	30.72	1.01	2.21	0.40	1.26	0.62	+		0.64	3.33		0.42	19.48	0.89	2.82	1.60		0.15	0.55	1.98		0.63	1.49		0.82	0.61	8.70	7.41	3.37
Crangon crangon			10.75	2.45	0.13		0.05	+	+	+			1.02		3.25																
Eupagurus bernhardus	6.34	10.05	33.31	30.42	5.89	2.05	1.35	2.94	1.59	1.22	2.24	10.11	1.02	2.07	0.78	1.11	1.22	2.79	2.32	3.85	3.07	7.86	13.74	11.65	5.31	10.71	10.69	3.68	23.76	31.63	29.67
Hyas coarctatus										+										0.05							0.07	0.07			
Inachus dorsettensis							0.05				0.16		+			0.06			0.06												
Macropodia indet.	0.07											0.11					0.06				0.06								0.35		
Macropodia linearis											0.05																				
Macropodia rostrata							0.05									0.06			0.17												
Palaemon elegans									0.14			0.17	0.04		0.41	0.06	+		0.06												
Pontophilus sp.																						1.67	3.91	0.09	2.34	3.77	0.22			2.21	0.27
Processa sp.								0.11	0.07				0.13			0.66	0.06	0.08	0.45		0.06	0.08				0.10	0.07		0.17		0.09
OTHER GROUPS																															
Alcyonidium digitatum							0.05	+				0.56																0.07			
broodspons																	0.06	0.08			0.06							0.07			

APPENDIX 5.2b.

Densities of benthic invertebrates (n/100 m²) per station in 1996, sampled with the Triple-D. Only those species that were sampled reliably in the (in 1996 not properly funtioning) Triple-D are listed; "+" = present only in 3m beam trawl.

station	4	5	7	8	9	11	13	14	16	18	19	21	23	25	30	31	32	34	36	37	39	40	41	42	45	47	48	49	52	53**
ECHINODERMS																														
Brissopsis lyrifera																														
Echinocardium cordatum	3.4	273.1	5.6	5.5	+	33.3	27.4		16.6	5.4	27.8		17.0	53.5	3.4	40.7	67.8		6.7	4821.0	10.0	150.0				3.4	152.4	890.7	2527.8	+
Spatangus purpureus						3.3																								
MOLLUSCS																														
Abra alba										+												4.2							402.8	+
Abra nitida																														+
Abra prismatica									2.8				2.8		3.4															
Acanthocardia echinata																														
Angulus fabulus	816.5									893.2	2.8					10.2	697.8			258.0		20.8						3.4		
Angulus tenuis										435.7	8.3																			
Arctica islandica																														
Astarte montagui																														
Chamelea gallina										+	11.1	+				6.8	6.8		3.4	41.9	36.8	25.0				13.6	+	13.5	38.2	+
Corbula gibba																													10.4	+
Donax vittatus							17.1	40.8				+	51.0	77.0	132.1				40.5											
Dosinia exoleta																				2.8							6.8			
Dosinia lupinus																			6.7		6.7	8.3							104.2	+
Ensis sp.																										17.0				
Ensis americanus	11913.0	69.4								2440.1	533.3	2.8				22052.8	470.9	776.7					197.5	1517.6	450.5					
Ensis arcuatus		50.9	16.8	5.5	9.9	3.3			8.3			13.8								2.8										
Ensis ensis		115.7	2.8				10.3	13.6	19.3			24.8	28.3	53.5	166.0		84.7		104.6	8.4	3.3	12.5					3.4			
Ensis spp. juv.		88.0							8.3			8.3	14.2							14.0										
Ensis siliqua																			13.5	8.4	100.4									
Gari fervensis																													3.5	
Laevicardium cordatum		+		2.7	3.3	+			+																					
Lucinoma borealis																														
Lutraria lutraria																														
Macoma balthica										16.3						27.1		194.2					947.9	1690.4	738.5					
Mactra corallina	3.4																			+	6.7	16.7							6.9	
Mya truncata																													3.5	
Mysia undata																														
Nucula nitidosa																					150.6	+							305.6	+
Petricola pholadiformis																	6.8													
Phaxas pellucidus																				2.8	6.7								38.2	+
Spisula elliptica		23.1	14.0	30.2	9.9	60.0	6.9		60.7		2.8	+	14.2	+	16.9				3.4								27.1			
Spisula solida		23.1	2.8	11.0	3.3						2.8	77.3			3.4				3.4											
Spisula subtruncata	13063.4	17310.2							+	610.0	41.7	11.0	+	+	10.2	498.0	618736	6148.9	6.7	138.4		33.3	695.1		3.4					+
Thracia convexa																														
Thracia papyracea																													10.4	
Thyasira flexuosa																														
Venerupis senegalensis		4.6															64.4													
CRUSTACEANS																														
Thia scutellata	+	60.2	44.7	30.2	52.7	80.0	17.1	27.2	60.7		13.9	93.8	22.7	56.9	54.2		+		6.7	64.3							+			
Upogebia sp.																													+	
ANNELIDS																														
Pectinaria koreni	+	60.2		2.7					+		2.8	+				23.7	176.2						82.9						121.5	

APPENDIX 5.2b (continued).

station	56	58	59	60	62	63	64	66	68	69	70	79	80	81	84	85	86	87	88	89	90	91	92	93	94	97	100	101	102	103
ECHINODERMS																														
Brissopsis lyrifera												23.3	+		57.4	105.6	13.6	195.7		87.0							400.5			
Echinocardium cordatum		270.8	318.0	169.9	3160.1	614.9	2097.2	5681.5	10526.3	104.2	+	46.7	626.7	10.2	54.0	86.1	132.1	13.5	103.3	174.0				4.4		13.2	332.7			9.8
Spatangus purpureus																														
MOLLUSCS																														
Abra alba	+			105.8	8.3	4.0	69.4			8.0		13.3	76.7	10.2	20.2		50.8	+	43.3	6.7			8.9			49.6	100.1			
Abra nitida	+			6.4								6.7	3.3		+			+											
Abra prismatica																													3.4	3.3
Acanthocardia echinata	+			9.6	+			3.4	13.5			3.3		3.4	3.4	2.8	13.6	40.5	6.7	13.4			+		3.4	+	12.9			
Angulus fabulus		4.2																					8.9	13.3		6.6		+		9.8
Angulus tenuis		+																												
Arctica islandica	+				4.1				+			30.0	3.3		23.6	38.9		16.9	3.3	3.3			4.4		3.4	6.6	6.5	23.1	16.9	45.9
Astarte montagui																													10.2	3.3
Chamelea gallina	+	50.0	16.1	147.4	288.8	218.4	138.9	1093.1	857.0	120.2	+	46.7	130.0	102.5	13.5	5.6	37.3	23.6	170.0	87.0	8.7	24.2	66.5	4.4	23.7	188.5	29.1	9.9	3.4	13.1
Corbula gibba	+	20.8		38.5	12.4			3.4				1146.7	660.0		84.3	5.6		40.5										+		
Donax vittatus																														
Dosinia exoleta																														
Dosinia lupinus					41.3	28.3	69.4	54.0		168.3		56.7	103.3	17.1	20.2		54.2	+	80.0	53.5	+	8.1	39.9	13.3	6.8	16.5	35.5	9.9	10.2	45.9
Ensis sp.																														
Ensis americanus																														
Ensis arcuatus																														
Ensis ensis								10.1	16.9										3.3		121.5	387.6	57.6	811.2	294.7	33.1			84.7	39.4
Ensis spp. juv.																														
Ensis siliqua									33.7												121.5	24.2	79.8	97.5	111.8			36.4	84.7	62.3
Gari fervensis					+	4.0	27.8	3.4	+	76.1	+		+	+				+	23.3		30.4	121.1	31.0	35.5	122.0	43.0	3.2	26.5	57.6	118.1
Laevicardium cordatum																								+						
Lucinoma borealis																			10.0			8.1	4.4					3.3	33.9	29.5
Lutraria lutraria					4.1	8.1	13.9	10.1	3.4				3.3	3.4							4.3				10.2				3.4	3.3
Macoma balthica																														
Mactra corallina		+		6.4				+	3.4			3.3		+								8.1	4.4	8.9	10.2					
Mya truncata	+			83.3								3.3			6.7	8.3	6.8	30.4	3.3			8.1					3.2		3.4	6.6
Mysia undata				3.2	4.1	+				4.0		33.3	6.7	+			3.4	6.7	3.3	6.7		8.1		4.4	6.8	6.6		3.3	+	
Nucula nitidosa	+	25.0		16.0	412.5	481.4	1125.0	3387.3	6815.1	308.5	+		96.7	498.6	10.1		254.1	3.4					35.5			502.6	42.0	3.3		
Petricola pholadiformis																														
Phaxas pellucidus	+				4.1	4.0	+	10.1	30.4	12.0	+	20.0	20.0	37.6	6.7	5.6	162.6	+	40.0	13.4			177.3	4.4	+	82.7	77.5	6.6	10.2	19.7
Spisula elliptica																														
Spisula solida																														
Spisula subtruncata	+	45.8	3268.9	6.4					6.7	4.0	+	3.3				+			+		+	16.1	8.9	+	+	3.3		3.3	3.4	3.3
Thracia convexa				3.2							+	6.7						3.4												
Thracia papyracea																														3.3
Thyasira flexuosa																										3.3				
Venerupis senegalensis																														
CRUSTACEANS																														
Thia scutellata																														
Upogebia sp.				201.9								106.7	10.0	+	30.4	13.9														
ANNELIDS																														
Pectinaria koreni													3.3	3.4	6.7			3.4									6.5			

APPENDIX 5.3.

Densities per station (n/100 m²) in 1997; coa = coastal zone; off = offshore; oys = oystergrounds; dog = dogger bank; 3mBT = 3m beam trawl; DDD = Triple-D; "+" = present only in the other sampling gear.

		18	19	2	31	32	34	4	41	42	45	47	11	13	14	16	21
		coa	coa	coa	coa	coa	coa	coa	coa	coa	coa	coa	off	off	off	off	off
FISH																	
agonus cataphractus	3mBT	1.091	0.446	1.941	0.226	0.152	0.213	0.478	2.445	2.813	3.399	1.091	0.538	0	0.054	0.08	0.239
ammodytes indet.	3mBT	2.863	0.127	0	1.054	0	0	0.137	0.058	0.419	0	0	0	5.023	0.269	4.944	0.159
amphioxis indet.	DDD	0	0	0	0	0	0	0	0	0	0	0	3.704	0	0	0	0
arnoglossus laterna	3mBT	0	1.02	0	0.151	1.218	0.924	0	1.106	0	0.185	0	0.06	0.304	0.376	0.319	0.637
buglossidium luteum	3mBT	0.136	1.594	0	0	1.37	1.848	0	0.466	0	0.062	0.193	0.299	2.511	7.09	3.908	3.663
callionymus lyra	3mBT	0.205	0.765	2.09	0.376	1.522	2.346	0.546	22.29	0.898	0.247	0.064	1.015	0	0	0	0.478
callionymus reticulatus	3mBT	0	0	0	0	0	0	0	0	0	0	0	0.06	0.076	0.107	1.276	0.319
ciliata mustela	3mBT	0	0	0	0	0	0	0.068	0.058	0.12	0.124	0	0	0	0	0	0
enchelyopus cimbrius	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
entelurus aequoreus	3mBT	0	0	0	0	0	0	0	0.058	0	0	0	0	0	0	0	0
eutrigla gurnardus	3mBT	0	0.064	0	0	0.152	0	0.068	0	0	0.062	0	0	0.076	0.054	0	0
gadus morhua	3mBT	0	0.064	0	0	0	0	0.478	0	0	0.062	1.091	0	0.076	0	0	0
hippoglossoides platessoides	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hyperoplus lanceolatus	3mBT	0	0	0	0	0	0	0	0	0	0.062	0	0	0	0	0	0
limanda limanda	3mBT	1.772	12.75	2.688	7.376	8.067	1.848	13.92	9.72	13.23	49.07	0	0.299	1.142	1.343	0.558	1.991
liparis liparis	3mBT	0.068	0.064	0	0	0	0	0.137	0	0.06	0	0	0	0	0	0	0
merlangius merlangus	3mBT	0.136	0	0.075	0	0	0	0	0	0.06	0	0	0.06	0	0	0.08	0
merluccius merluccius	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
microstomus kitt	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
myoxocephalus scorpius	3mBT	0.068	0.255	0.747	0.753	0.304	0.071	1.092	0	0	0.124	0	0	0	0	0	0
platichtys flesus	3mBT	0	0	0	0	0	0	0.137	0.175	0.06	0	0	0	0	0	0	0
pleuronectes platessa	3mBT	3.409	3.824	1.493	7.753	2.892	3.98	10.65	10.88	1.317	13.66	2.503	0.358	0	0.215	0.159	2.707
pomatoschistus indet.	3mBT	18	12.75	0.075	21.45	0.457	4.265	60.34	7.45	0.778	7.169	3.145	0.896	0	0	0.319	1.991
scophthalmus maximus	3mBT	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
solea solea	3mBT	4.158	0.765	5.226	1.656	0	3.483	11.33	1.746	0.479	2.534	0.385	0	0.076	0	0	0
syngnathus acus	3mBT	0	0	0	0	0	0	0.137	0	0	0	0	0	0	0	0	0
syngnathus rostellatus	3mBT	0.068	0	0	0	0	0	0	0	0	0.062	0.385	0	0	0	0	0
trachinus vipera	3mBT	0	0.255	0.672	0	0.152	0	0	0	0	0	0	5.196	5.099	2.739	4.546	5.495
trigla lucerna	3mBT	0.068	0.064	0.075	0	0	0	0.137	0	0	0	0	0	0	0	0	0
trispoterus minutus	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECHINODERMS																	
amphiura cf. chiaje	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
asterias rubens	3mBT	2.318	1.275	426.7	0.527	28.46	0.711	0.956	0	0.599	0.742	0.706	0.657	0.152	0	0.957	28.91
astropecten irregularis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
brissopsis lyrifera	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cucumaria elongata	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
echinocardium cordatum	DDD	0	3.704	14.81	0	3.704	0	0	0	0	0	0	3.704	0	+	11.11	0
echinocyamus pusillus	DDD	0	0	0	0	0	0	0	0	0	0	0	18.52	0	0	29.63	+
ophiotrix indet.	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ophiura albida	3mBT	0	597.6	58.38	+	62.1	0	0.683	0	+	0.247	0	24.07	4.186	12.89	82.3	868.9
ophiura texturata	3mBT	0.886	1.466	17.17	24.09	173.5	0	0.273	0	1.616	23.49	0	0.776	25.34	29	4.147	4.141
psammechinus miliaris	3mBT	0	0	0	0	0	0	0	0	0	0	0	0.896	0	0	0	0
MOLLUSCS																	
abra alba	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
abra nitida	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
abra prismatica	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
acanthocardia echinata	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aequipecten opercularis	3mBT	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0
angulus fabulus	DDD	592.6	0	0	35.56	157.4	0	29.63	0	0	0	0	0	0	0	0	0
angulus tenuis	DDD	237	7.407	0	11.85	0	0	0	0	0	0	0	0	0	0	0	0
aporrhais pespelicani	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
arctica islandica	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
bela nebula	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
buccinum undatum	DDD	0	0	+	0	0	0	0	0	0	0	0	+	0	0	0	0
cerastoderma edule	DDD	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
chamelea gallina	DDD	+	3.704	0	3.704	0	0	0	0	0	0	0	0	0	0	0	7.407
colus gracilis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
colus jeffreysianus	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
corbula gibba	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
donax vittatus	DDD	0	0	0	0	0	0	0	0	0	0	0	0	7.407	100	0	+
dosinia exoleta	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dosinia lupinus	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ensis americanus	DDD	118.5	244.4	1219	1304	403.7	666.7	207.4	481.5	1189	1437	3.704	0	0	0	0	0
ensis arcuatus	DDD	0	0	0	0	0	0	3.704	0	0	0	0	0	3.704	0	33.33	40.74
ensis ensis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	66.67

APPENDIX 5.3 (continued).

		18 coa	19 coa	2 coa	31 coa	32 coa	34 coa	4 coa	41 coa	42 coa	45 coa	47 coa	11 off	13 off	14 off	16 off	21 off
MOLLUSCS, continued																	
ensis siliqua	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
epitonium clathrus	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
euspira catena	DDD	0	0	0	0	0	0	0	22.22	3.704	0	0	0	0	0	0	0
euspira poliana	DDD	0	3.704	3.704	7.407	11.11	0	133.3	0	0	0	0	+	+	+	0	3.704
gari fervensis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hiatella arctica	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
laevicardium crassum	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lucinoma borealis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lutraria lutraria	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
macoma balthica	DDD	37.04	0	0	+	0	192.6	0	59.26	718.5	1319	392.6	0	0	0	0	0
mactra corallina	DDD	0	0	0	0	0	0	11.11	0	0	0	0	0	0	0	0	0
musculus niger	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mya truncata	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mysia undata	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mytilus edulis	3mBT	0	0	0	0	0	0.355	0	0.233	1.018	1.422	0	0	0	0	0	0
neptunea antiqua	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nucula nitidosa	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.11	0
nucula tenuis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
oenopota turricula	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
phaxas pellucidus	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sepiola atlantica	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
spisula elliptica	DDD	0	3.704	0	0	0	0	0	0	0	0	0	59.26	3.704	+	118.5	140.7
spisula solida	DDD	0	+	0	0	0	0	0	0	0	0	0	3.704	0	0	11.11	118.5
spisula subtruncata	DDD	285.2	485.2	337	20148	151500	770.4	4000	59.26	48.15	+	0	0	0	0	0	7.407
thracia convexa	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
thracia papyracea	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
turritella communis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	3.704	0	0	0
venerupis senegalensis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRUSTACEANS																	
callianassa spp.	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cancer pagurus	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
carcinus maenas	DDD	+	0	+	+	0	+	+	+	+	+	+	0	0	0	0	0
cirolana borealis	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
corystes cassivelaunus	DDD	0	3.704	+	0	0	0	+	0	0	0	0	0	0	+	3.704	0
crangon allmani	3mBT	0	0	0	0	0	0.071	0	0	0	+	3.723	0.776	0.228	0.054	0	0
crangon crangon	3mBT	51.26	13.77	0	2.86	+	3.625	23.21	39.11	86.43	4.45	185.9	0.119	0.228	0.107	0.718	5.733
ebalia indet.	DDD	0	0	0	0	0	0	0	0	0	0	0	+	+	0	3.704	0
eupagurus bernhardus	DDD	29.63	22.22	3.704	82.96	294.4	+	18.52	22.22	11.11	22.22	7.407	55.56	+	+	+	33.33
inachus indet.	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
liocarcinus arcuatus	DDD	0	0	+	+	+	0	0	0	0	0	0	0	0	0	0	0
liocarcinus depurator	DDD	0	0	3.704	0	0	0	0	0	0	0	0	0	0	0	+	+
liocarcinus holsatus	DDD	37.04	55.56	40.74	33.33	129.6	414.8	296.3	144.4	100	14.81	33.33	7.407	+	7.407	+	25.93
liocarcinus marmoratus	DDD	0	0	0	0	0	0	0	0	0	0	0	18.52	7.407	+	11.11	0
liocarcinus pusillus	DDD	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0
macropodia indet.	DDD	0	0	+	0	0	0	+	0	0	0	0	+	0	0	0	0
necora puber	DDD	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0
nephrops norvegicus	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
palaemon indet.	DDD	0	0	0	0	0	0	14.81	0	0	0	0	0	0	0	0	0
pinnotheres pisum	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pisidia longicornis	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pontophilus indet.	3mBT	0.545	0	0	0	0	0	0	0	0	0	0.064	+	0.381	0.161	0.797	0.159
processa indet.	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
thia scutellata	DDD	0	18.52	0	0	0	0	11.11	0	0	0	0	77.78	7.407	18.52	29.63	85.19
upogebia indet.	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER GROUPS																	
alcyonium digitatum	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
alcyonidum cf. gelatinosum	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
anemones. indet	DDD	59.26	0	363	248.9	1937	0	22.22	0	0	0	0	0	0	0	0	0
aphrodite aculeata	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halichondria panicea	3mBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
golfingia indet.	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
metridium senile	DDD	+	0	0	0	0	0	0	+	+	+	0	0	0	0	0	0
pectinaria indet.	DDD	0	0	0	0	0	0	0	0	0	3.704	0	0	0	0	0	0
pelonaia corrugata	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
urticina felina	DDD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 5.3 (continued).

	23 off	25 off	27 off	29 off	30 off	36 off	37 off	39 off	40 off	48 off	49 off	5 off	58 off	59 off	7 off	8 off	9 off
FISH																	
agonus cataphractus	0.155	0.084	0.122	0.07	0.054	0.126	0	0.145	0	0.17	0.048	0.727	0.147	0.044	0.171	0.063	0.058
ammodytes indet.	4.191	0.337	0.488	0.07	4.624	0.063	0.133	+	0	0.765	+	1.018	0	0.044	0	0.19	0
amphioxis indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
arnoglossus laterna	0.543	0.337	0.488	0.07	1.632	0.378	0.398	0.289	0.375	0.51	0.048	0.145	0.835	0.174	0.171	0.254	0.058
buglossidium luteum	10.55	18.29	5.244	8.039	6.691	6.294	3.782	6.169	3.588	2.552	1.909	2.834	6.93	2.132	0.857	1.713	0.231
callionymus lyra	0.233	0.59	0.244	0.35	0.163	0.189	0.398	0.145	0.375	0.595	0.382	1.018	0.639	0.131	0.171	0.127	0.81
callionymus reticulatus	0.388	0.084	0	0.559	0.054	0.126	0	0	0	0	0	0.872	0	0	1.542	0.825	0.521
ciliata mustela	0	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0
enchelyopus cimbrius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
entelurus aequoreus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
eutrigla gurnardus	0	0	0.183	0	0	0	0	0.048	0.054	0.255	0.143	0.073	0.197	0	0	0	0
gadus morhua	0	0	0	0	0	0	0	+	0	0	0.095	0.145	0	0	0	0.063	0.116
hippoglossoides platessoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hyperoplus lanceolatus	0	0.084	0	0	0	0	0	0	0	0	0	0	0.049	+	0	0.063	0
limanda limanda	2.251	1.601	2.439	0.489	0.762	0.504	1.46	2.506	7.604	1.446	5.394	2.544	4.571	0.957	0.857	0.381	0.463
liparis liparis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
merlangius merlangus	0	0.084	0.305	0	0	0	0	0.193	0	0	0.239	0	0.197	0	0	0	0.058
merluccius merluccius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
microstomus kitt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
myoxocephalus scorpius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
platichtys flesus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pleuronectes platessa	0.31	0.253	0.122	0.489	2.122	0.881	0.398	0.096	2.303	0.851	0.859	1.526	2.801	4.089	0.571	0.254	0.174
pomatoschistus indet.	0.233	0.421	0.915	2.097	0.598	2.455	1.46	3.808	4.713	0.851	7.447	1.817	3.145	0.261	0.343	0.063	0.116
scophthalmus maximus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
solea solea	0	0.253	0.061	+	+	0.063	0.265	0	0.696	0.085	0.143	0.218	0	0	0	0	0
syngnathus acus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
syngnathus rostellatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
trachinus vipera	2.406	0.758	0.183	2.517	2.938	1.573	0.531	0.096	0.375	0	0	2.108	0.049	0.087	2.856	3.997	7.056
trigla lucerna	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
trispoterus minutus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECHINODERMS																	
amphiura cf. chiaje	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
asterias rubens	0.388	0.421	0.122	1.188	6.963	0.378	12.01	0.482	65.17	89.14	72.66	31.83	105.3	13.53	0.628	0.317	0.578
astropecten irregularis	0	0	0	0	0	+	+	+	7.407	0	0	0	33.33	7.407	0	0	0
brissopsis lyrifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cucumaria elongata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
echinocardium cordatum	3.704	7.407	0	0	0	0	22.22	0	81.48	+	100	22.22	+	0	3.704	+	11.11
echinocyamus pusillus	+	0	0	+	+	0	0	0	0	44.44	0	0	0	0	7.407	33.33	44.44
ophiotrix indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ophiura albida	223.5	157.1	1.22	324.4	0.653	322.2	358.9	3.856	411.3	642.3	2065	865.2	675.9	86.14	497.1	97.45	262.8
ophiura texturata	14.9	7.837	0.122	3.565	9.248	46.32	45.65	13.4	134.5	1.361	536.2	5.814	139.8	20.36	1.085	0.381	0.868
psammechinus miliaris	0.078	0.084	0.183	0	0	0	0	0	0	0.085	0.095	0	0.049	0	0.628	0	0
MOLLUSCS																	
abra alba	0	11.11	3.704	0	0	0	0	+	0	0	0	0	0	0	0	0	0
abra nitida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
abra prismatica	+	3.704	14.81	0	0	0	3.704	0	0	29.63	0	0	0	0	0	0	0
acanthocardia echinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aequipecten opercularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
angulus fabulus	0	774.1	0	3.704	0	0	7.407	3.704	3.704	0	0	0	18.52	207.4	0	0	0
angulus tenuis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aporrhais pespelicani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
arctica islandica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
bela nebula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
buccinum undatum	0	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0
cerastoderma edule	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
chamelea gallina	0	0	0	0	+	0	85.19	59.26	7.407	3.704	0	3.704	85.19	14.81	0	0	0
colus gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
colus jeffreysianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
corbula gibba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
donax vittatus	248.1	77.78	37.04	77.78	218.5	22.22	7.407	0	0	0	0	0	0	0	0	0	0
dosinia exoleta	0	0	0	0	0	0	0	0	0	3.704	0	0	0	0	0	0	0
dosinia lupinus	0	0	0	0	0	0	3.704	3.704	0	0	0	0	0	0	0	0	0
ensis americanus	0	0	0	0	18.52	0	14.81	0	0	0	0	111.1	0	0	0	0	0
ensis arcuatus	0	0	0	3.704	0	11.11	0	0	0	22.22	0	177.8	0	0	11.11	7.407	+
ensis ensis	48.15	62.96	25.93	48.15	181.5	37.04	66.67	14.81	0	0	0	325.9	14.81	0	0	3.704	0

APPENDIX 5.3 (continued).

	23 off	25 off	27 off	29 off	30 off	36 off	37 off	39 off	40 off	48 off	49 off	5 off	58 off	59 off	7 off	8 off	9 off
MOLLUSCS, continued																	
ensis siliqua	0	0	11.11	0	0	7.407	0	92.59	0	0	0	0	0	0	0	0	0
epitonium clathrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
euspira catena	0	0	0	0	0	3.704	3.704	+	29.63	7.407	44.44	0	285.2	266.7	0	0	0
euspira poliana	+	3.704	+	+	+	0	11.11	+	3.704	3.704	0	62.96	333.3	81.48	+	+	+
gari fervensis	0	0	0	0	0	0	0	3.704	0	0	0	0	0	0	0	0	0
hiatella arctica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
laevicardium crassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	+
lucinoma borealis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lutraria lutraria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
macoma balthica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mactra corallina	0	0	0	0	0	0	3.704	3.704	+	0	0	0	0	0	0	0	0
musculus niger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mya truncata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mysia undata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mytilus edulis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
neptunea antiqua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nucula nitidosa	0	0	0	0	0	0	0	248.1	+	0	0	0	325.9	3.704	0	0	0
nucula tenuis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
oenopota turricula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
phaxas pellucidus	0	+	0	0	0	0	0	+	0	3.704	0	0	0	0	0	0	0
sepiola atlantica	0	0	0.061	0	0	0	0	0	0	0	0	0.073	0	0	0	0	0
spisula elliptica	40.74	29.63	+	+	14.81	3.704	0	0	0	474.1	0	14.81	0	0	122.2	85.19	37.04
spisula solida	0	0	0	+	0	0	0	0	0	0	0	29.63	0	0	7.407	7.407	14.81
spisula subtruncata	0	0	0	+	7.407	+	18.52	+	0	0	+	429.6	0	0	0	0	0
thracia convexa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
thracia papyracea	0	0	0	0	0	0	0	0	0	3.704	0	0	0	3.704	0	0	0
turritella communis	0	0	0	0	0	0	0	0	0	0	0	0	0	3.704	0	0	0
venerupis senegalensis	0	0	0	0	0	0	0	0	0	0	0	7.407	0	0	0	0	0
CRUSTACEANS																	
callianassa spp.	0	0	0	0	0	0	3.704	0	0	0	0	70.37	0	0	0	0	0
cancer pagurus	0	0	0	0	0	0	0	0	0	0	0	0.073	0	0	0	0	0
carcinus maenas	0	0	0	3.704	0	0	0	0	0	0	0	0	0	0	0	0	0
circlana borealis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
corystes cassivelaunus	3.704	74.07	11.11	3.704	11.11	+	48.15	70.37	103.7	0	0	7.407	51.85	7.407	0	0	0
crangon allmani	0.155	0.084	1.525	0.909	0.109	1.385	0.066	2.699	0.054	10.21	3.437	0	0.049	0	0	0.063	0.058
crangon crangon	0.621	0.084	0.976	1.118	0.163	9.126	0	4.241	0.054	1.021	0	4.942	0	0	0.743	0.508	0
ebalia indet.	3.704	+	+	+	0	+	3.704	3.704	0	0	0	+	0	0	3.704	+	0
eupagurus bernhardus	11.11	14.81	7.407	29.63	11.11	3.704	14.81	11.11	40.74	25.93	48.15	7.407	103.7	59.26	18.52	14.81	11.11
inachus indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
liocarcinus arcuatus	0	0	0	0	7.407	0	0	0	0	0	0	7.407	0	0	0	0	0
liocarcinus depurator	0	0	0	0	+	0	0	0	0	0	0	7.407	+	0	0	0	0
liocarcinus holsatus	3.704	22.22	+	25.93	18.52	3.704	22.22	18.52	37.04	11.11	22.22	29.63	11.11	25.93	+	+	3.704
liocarcinus marmoratus	3.704	0	0	0	0	0	0	0	0	0	0	+	0	0	+	7.407	+
liocarcinus pusillus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
macropodia indet.	0	0	0	0	0	0	0	0	0	0	0	3.704	3.704	3.704	0	0	0
necora puber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nephrops norvegicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
palaemon indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pinnotheres pisum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.19	0
pisidia longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pontophilus indet.	1.086	1.938	0.549	0.769	0.326	0.441	0	0	0	0	0	0	0	0	0.057	0.444	0.405
processa indet.	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0
thia scutellata	40.74	122.2	14.81	55.56	33.33	7.407	133.3	0	0	0	0	77.78	0	0	22.22	7.407	122.2
upogebia indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OTHER GROUPS																	
alcyonium digitatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
alcyonidum cf. gelatinosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
anemones. indet	0	3.704	3.704	7.407	70.37	0	14.81	22.22	11.11	22.22	55.56	3.704	385.2	251.9	3.704	0	0
aphrodite aculeata	0	0	0	0	0	0	0	+	0	7.407	0	0	0	3.704	0	0	0
sponges indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
golfingia indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
metridium senile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pectinaria indet.	0	3.704	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pelonaia corrugata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
urticina felina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 5.3 (continued).

	100 oys	52 oys	53 oys	56 oys	60 oys	61 oys	62 oys	63 oys	64 oys	66 oys	68 oys	69 oys	72 oys	74 oys	75 oys	77 oys	79 oys
FISH																	
agonus cataphractus	0	0	0	0.056	0.114	0.389	0	0.051	0	0.054	0.11	0	0	0	0.073	0.055	0
ammodytes indet.	0	0	0	0	0	0	0	0.102	0	0.109	0.055	0.337	0	0	0	0	0
amphioxis indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
arnoglossus laterna	0	0.35	0.239	0.056	0.171	0.777	+	0.459	1.505	0.979	0.383	0.673	0.415	0.131	0.508	0	0.191
buglossidium luteum	0	2.747	0.718	0.843	0.91	6.684	1.182	2.905	10.2	3.536	5.204	4.377	2.907	0.065	1.524	0	0.318
callionymus lyra	0	0.05	1.077	0.393	0.114	0.699	0	0	0.068	0.109	0.055	0.202	0.059	0	0.073	0.11	0
callionymus reticulatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ciliata mustela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
enchelyopus cimbrius	0	0	0.239	0.337	0	+	0	0	0	0.109	0	0	0	0	0	0.11	0.191
entelurus aequoreus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
eutrigla gurnardus	0.146	0.05	0.06	0	0	0.155	0.376	0	0	0	0.274	0.202	0	0.065	0	0	0
gadus morhua	0.292	0	0.12	0.056	0	0	0.054	0	0	0	0	0.067	0	0.065	0.145	0.055	0.064
hippoglossoides platessoides	0	+	0	0	0	0	0.054	0	0	0	0	0	0.059	0.065	0	0.164	0.127
hyperoplus lanceolatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
limanda limanda	3.507	0.05	2.634	1.911	1.649	7.461	1.182	0.816	1.847	1.741	1.589	1.481	2.255	3.798	8.202	1.315	1.461
liparis liparis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
merlangius merlangus	0.219	0	0.359	0.112	0.171	0.155	0.054	0.102	0	0.163	0.164	0.067	0.059	0.262	0.145	0.11	0.127
merluccius merluccius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
microstomus kitt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
myoxocephalus scorpius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
platichtys flesus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pleuronectes platessa	0.073	1.049	1.736	2.023	0.683	0.311	0.376	0.204	0.479	0.435	0.164	0.067	0	0.065	0	0.767	0.127
pomatoschistus indet.	0.658	0.649	1.173	0.45	0.057	2.331	1.665	2.192	2.258	0.762	1.315	1.212	1.187	2.161	1.161	1.643	0.572
scophthalmus maximus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.055	0
solea solea	0	0	0	0	0	0.311	0	0	0.068	0	0	0	0	0	0.073	0	0
syngnathus acus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
syngnathus rostellatus	0	0	0	0	0	0	0.054	0	0	+	0.164	0	0	0	0	0	0
trachinus vipera	0	0	0	0	0	0.155	0	0	0	0	0.055	0	0	0	0	0	0
trigla lucerna	0	0	0	0	0.114	0	0	0	0	0	0	0	0	0	0	0	0
trispoterus minutus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECHINODERMS																	
amphiura cf. chiaje	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
asterias rubens	2.85	4.595	29.21	2.585	9.783	17.02	0.161	0.917	1.3	0.598	0.603	1.549	0.415	0.786	0.218	0.11	42.43
astropecten irregularis	137	40.74	237	+	+	3.704	22.22	77.78	129.6	33.33	3.704	107.4	174.1	70.37	66.67	11.11	11.11
brissopsis lyrifera	102.7	0	0	0	0	0	0	0	0	0	0	0	3.704	318.5	0	107.4	7.407
cucumaria elongata	0	0	166.7	270.4	166.7	0	22.22	0	3.704	0	0	0	0	3.704	0	0	33.33
echinocardium cordatum	359.6	237	3378	10174	3589	7.407	251.9	25.93	29.63	803.7	859.3	29.63	11.11	207.4	+	196.3	207.4
echinocyamus pusillus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ophiotrix indet.	1.023	0	0	0	0	0	0	0.204	0	0	0	0.067	0.237	4.126	0.435	0	0
ophiura albida	0	21.58	17569	820.1	1412	46.01	0.107	0.051	+	0.925	0	0.135	0	0	0	0.383	16.9
ophiura texturata	2.557	0	29.33	13.49	9.101	72.88	0.752	0.408	2.6	0.707	0.548	2.895	1.365	3.209	5.807	0	0.127
psammechinus miliaris	0.438	0.1	0	0	0	0.078	0.752	1.784	9.374	0.163	0.055	7.339	2.789	0.589	0.145	0	0
MOLLUSCS																	
abra alba	13.7	3.704	214.8	44.44	66.67	14.81	7.407	0	3.704	48.15	7.407	0	0	3.704	7.407	3.704	7.407
abra nitida	0	0	170.4	3.704	0	0	0	0	0	0	0	0	0	0	0	0	0
abra prismatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
acanthocardia echinata	13.7	0	0	0	0	0	3.704	3.704	0	0	0	3.704	3.704	29.63	7.407	3.704	18.52
aequipecten opercularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.073	0	0
angulus fabulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
angulus tenuis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aporrhais pespelicani	0	+	0	0	0	0	11.11	55.56	88.89	11.11	0	0	+	0	+	+	3.704
arctica islandica	17.12	0	0	0	0	0	7.407	0	3.704	0	0	0	0	0	0	14.81	37.04
bela nebula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
buccinum undatum	0	0	+	0	0	0	0	0	0	0	0	0	3.704	+	0	+	0
cerastoderma edule	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
chamelea gallina	20.55	22.22	18.52	11.11	18.52	14.81	66.67	70.37	111.1	107.4	59.26	100	59.26	33.33	96.3	3.704	33.33
colus gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
colus jeffreysianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
corbula gibba	0	3.704	148.1	+	7.407	+	0	0	+	3.704	0	+	0	0	0	48.15	266.7
donax vittatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dosinia exoleta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
dosinia lupinus	34.25	3.704	7.407	0	0	0	11.11	0	3.704	18.52	3.704	25.93	3.704	7.407	48.15	0	59.26
ensis americanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ensis arcuatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ensis ensis	6.849	3.704	0	0	0	0	0	0	11.11	0	3.704	0	3.704	0	0	0	0

APPENDIX 5.3 (continued).

	100 oys	52 oys	53 oys	56 oys	60 oys	61 oys	62 oys	63 oys	64 oys	66 oys	68 oys	69 oys	72 oys	74 oys	75 oys	77 oys	79 oys
MOLLUSCS, continued																	
ensis siliqua	0	3.704	0	0	3.704	11.11	0	0	0	0	18.52	0	0	0	0	0	0
epitonium clathrus	0	+	+	0	0	0	+	7.407	+	0	0	+	0	3.704	+	0	0
euspira catena	0	7.407	7.407	+	0	0	0	+	0	0	0	0	0	0	0	0	0
euspira poliana	0	+	0	0	0	33.33	0	3.704	+	+	7.407	3.704	22.22	+	0	0	+
gari fervensis	0	0	0	0	0	0	0	+	3.704	0	0	18.52	0	0	+	0	0
hiatella arctica	0	0	0	0	0	0	0	0	0	0	0	0	0	0.065	0	0	0
laevicardium crassum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lucinoma borealis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lutraria lutraria	0	0	0	3.704	0	0	0	0	0	11.11	7.407	0	0	0	0	3.704	0
macoma balthica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mactra corallina	0	0	0	0	0	0	0	+	+	3.704	0	3.704	0	0	0	0	0
musculus niger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mya truncata	3.425	0	29.63	18.52	25.93	0	11.11	0	0	0	0	0	0	3.704	0	11.11	0
mysia undata	3.425	0	0	0	7.407	0	3.704	+	0	0	0	0	0	0	7.407	3.704	14.81
mytilus edulis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
neptunea antiqua	+	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0
nucula nitidosa	51.37	151.9	51.85	7.407	18.52	1289	96.3	448.1	540.7	51.85	837	122.2	585.2	11.11	155.6	18.52	7.407
nucula tenuis	13.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
oenopota turricula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
phaxas pellucidus	3.425	+	229.6	11.11	7.407	0	+	0	+	0	25.93	0	0	+	11.11	11.11	14.81
sepiola atlantica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
spisula elliptica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
spisula solida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
spisula subtruncata	0	3.704	14.81	18.52	0	0	0	0	0	0	+	3.704	0	0	0	+	+
thracia convexa	0	0	14.81	0	0	0	0	0	0	0	0	0	0	0	0	0	0
thracia papyracea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
turritella communis	3.425	18.52	496.3	125.9	259.3	0	181.5	25.93	318.5	3.704	0	18.52	11.11	33.33	7.407	340.7	744.4
venerupis senegalensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRUSTACEANS																	
callianassa spp.	0	0	88.89	0	3.704	3.704	0	0	0	0	0	0	0	0	0	0	0
cancer pagurus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
carcinus maenas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cirolana borealis	0	0	0	0	0	0	29.63	0	0	0	0	0	0	29.63	3.704	0	3.704
corystes cassivelaunus	137	48.15	88.89	85.19	222.2	107.4	59.26	96.3	88.89	111.1	118.5	122.2	88.89	88.89	155.6	37.04	77.78
crangon allmani	0.292	0	0.06	0	0	0.155	0	0	0	0.49	0.383	0	0	0.196	0	0.438	0.381
crangon crangon	0	0	0	0	0	0.078	0	0	0	0.326	0.657	0	0	0	0	0	0
ebalia indet.	0	0	0	0	0	3.704	0	+	+	0	+	3.704	0	0	0	+	+
eupagurus bernhardus	3.425	29.63	48.15	14.81	40.74	+	3.704	3.704	14.81	7.407	14.81	18.52	33.33	14.81	3.704	14.81	14.81
inachus indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	0	0
liocarcinus arcuatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
liocarcinus depurator	0	0	3.704	+	0	0	0	0	0	0	+	0	0	0	0	3.704	+
liocarcinus holsatus	6.849	11.11	3.704	7.407	7.407	11.11	+	7.407	11.11	14.81	7.407	7.407	3.704	7.407	11.11	7.407	11.11
liocarcinus marmoratus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
liocarcinus pusillus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
macropodia indet.	0	+	0	0	0	0	0	0	+	0	+	0	+	+	0	0	3.704
necora puber	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
nephrops norvegicus	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	+	+
palaemon indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pinnotheres pisum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pisidia longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0.262	0	0	0
pontophilus indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
processa indet.	0	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0
thia scutellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
upogebia indet.	0	0	137	70.37	111.1	0	0	0	0	0	0	0	0	0	0	3.704	29.63
OTHER GROUPS																	
alcyonium digitatum	0	0	0	0	0	0	0	0.102	0	0	0	0.135	0	0	0.073	0	0
alcyonidum cf. gelatinosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
anemones. indet	3.425	3.704	44.44	18.52	18.52	14.81	0	3.704	3.704	3.704	14.81	0	3.704	14.81	3.704	0	3.704
aphrodite aculeata	20.55	11.11	88.89	66.67	211.1	22.22	+	7.407	11.11	+	+	+	14.81	14.81	14.81	7.407	11.11
sponges indet.	0.073	0	0	0	0	0	0	0	0	0	0	0	0.059	0	0	0	0
golfingia indet.	0	0	200	29.63	111.1	0	0	0	0	0	0	0	0	3.704	0	74.07	203.7
metridium senile	0	0	0	+	0	0	0	0	0	0	0	0	0	0	0	0	0
pectinaria indet.	0	0	59.26	11.11	0	0	0	0	0	0	0	0	0	0	0	0	7.407
pelonaia corrugata	3.425	0	0	11.11	3.704	0	0	0	0	0	0	0	0	22.22	3.704	0	22.22
urticina felina	+	0	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0

Reeds verschenen BEON rapporten:

BEON rapport nr.	1.	BEON Meerjarenplan 1988-1993.	1987
BEON rapport nr.	2.	BEON Jaarwerkplan 1988.	1988
BEON rapport nr.	3.	BEON Modellering.	1988
BEON rapport nr.	4.	BEON meerjaren Uitvoeringsprogramma 1988-1993.	1989
BEON rapport nr.	5.	BEON Jaarwerkplan 1989.	1989
BEON rapport nr.	6.	Findings of the BEON Workshop in preparation for the Third North Sea Conference.	1989
BEON rapport nr.	7.	Beleidspresentatie BEON 23 juni 1989 Den Haag.	1989
BEON rapport nr.	8.	Effects of Beamtrawl Fishery on the Bottom Fauna in the North Sea.	1990
BEON rapport nr.	9.	BEON Jaarwerkplan 1990.	1990
BEON rapport nr.	10.	BEON Voortgangsrapport 1988-1989.	1990
BEON rapport nr.	11.	Beleidspresentatie BEON 31 mei 1990 Den Haag.	1990
BEON rapport nr.	12.	Beleidspresentatie BEON 20 juni 1991 Den Haag.	1991
BEON rapport nr.	13.	Effects of Beamtrawl Fishery on the Bottom Fauna in the North Sea. II. The 1990 - studies.	1990
BEON rapport nr.	13 A.	BEON Jaarwerkplan 1991.	1991
BEON rapport nr.	14.	BEON Jaarwerkplan 1992.	1992
BEON rapport nr.	15.	Beleidspresentatie BEON 19 juni 1992 Den Haag.	1992
BEON rapport nr.	16.	Effect of Beamtrawl Fishery on the Bottom Fauna in the North Sea. III. The 1991 - studies.	1992
BEON rapport nr.	17.	Beleidspresentatie BEON 12 december 1991.	1992
BEON rapport nr.	18.	Trace Element Geochemistry at the Sediment Water Interface in the North Sea and the Western Wadden Sea.	1993
BEON rapport nr.	19.	Effecten van met benzo(a)pyreen verontreinigd sediment op de Helmkrab (Corystes cassivelaunus). Rapportage Project BEONADD I/II.I	1993
BEON rapport nr.	20.	Scavenging seabirds behind fishing vessels in the Northeast Atlantic. (With emphasis on the Southern North Sea).	1993
BEON rapport nr.	21	Brug tussen Beleid en Onderzoek (Rapportage over het eerste BEON Meerjarenprogramma 1988-1992).	1993
BEON rapport nr.	93-1	Naar een duurzame ontwikkeling van de Noordzee. (Tweede Meerjarenprogramma BEON1993-1997).	1993
BEON rapport nr.	93-2	The appearance of scars on the shell of Arctica Islandica L. (Mollusca, Bivalvia) and their relation to bottom trawl fishery.	1993
BEON rapport nr.	93-3	BEON Jaarwerkplan 1993.	1993
BEON rapport nr.	93-4	BEON Beleidspresentatie "Zee en Wadvogels. "Voorkomen en invloeden daarop" d.d. 10 december 1993.	1993

1994

BEON rapport nr. 94-1	Effecten van verschuivingen van nutriëntenconcentraties op biota in de Nederlandse kustwateren. Philippart, C.J.M. & E.G. de Groodt, A.G. Brinkman, R.G. Jak, M.C.Th. Scholten (IBN 93 E 02).
BEON rapport nr. 94-2	Vervalt; zie 96-3
BEON rapport nr. 94-3	Jaarwerkplan 1994.
BEON rapport nr. 94-4	Jaarverslag 1993: Algenonderzoek in mesocosms en modelleringlering. Riegman, R. (NIOZ 93 E 01).
BEON rapport nr. 94-5	Impact of anthropogenic activities on the productivity of the western Wadden Sea ecosystem. Veer, H.W. van der. (NIOZ 93 E 02).
BEON rapport nr. 94-6.1	Bentic nutriënt generation in the ERSEM ecosystem model of the North Sea. Ruardij, P. and W. van Raaphorst. (NIOZ 93 E 03)
BEON rapport nr. 94-6.2	The EcoWasp model and it's environment. Smit, J.P.C., A.G. Brinkman, E.G.M. Embsen, P. Ruardij, and W. van Raaphorst. (NIOZ 93 E 03)
BEON rapport nr. 94-7	Risico-analyse Mariene Systemen (RAM*2 project) Eindrapport van de RAM-Auditgroep.
BEON rapport nr. 94-8	Comparison of models describing species composition of marine phytoplankton Michielsen, H & Berg, A. van den & Joordens, J., et al.(project MANS-FYFY, WL 93 E 01).
BEON rapport nr. 94-9	Verslag BEON Workshop Risico-analyse, d.d. 27 april 1994, Den Haag.
BEON rapport nr. 94-10	BEON Beleidspresentatie "Microverontreinigingen: effecten en trends", d.d. 21 juni 1994.
BEON rapport nr. 94-11	De epi- en endofauna van de Nederlandse, Duitse en Deense kustzone: een analyse van 20 jaar bijvangsgegevens. Buijs, J., J.A. Craeymeersch, P. van Leeuwen, A.D. Rijnsdorp. (BEONADD IV/V)
BEON rapport nr. 94-12	De inductie van cytochroom P450 1 A in platvis door blootstelling aan polyaromatische koolwaterstoffen in de Noordzee. INP-programma 1991- 1992. Boon, J.P., H.M. Sleiderink, M.L. Eggens, A.D. Vethaak (NIOZ 93 M 05)
BEON rapport nr. 94-13	Directe effecten van de visserij met de 12m en 4m boomkorren op het bodemleven in de Nederlandse sector van de Noordzee. Bergman, M.J.N. en J.W. van Santbrink. (NIOZ 93 V 07)
BEON rapport nr. 94-14	Scavenging seabirds at beamtrawlers in the southern North Sea, distribution, relative abundance, behaviour, prey selection, feeding efficiency, kleptoparastism and the possible effects of the establishment of protected areas'. Camphuysen, C.J. (BEONADD IV/V)
BEON rapport nr. 94-15	The relationship between food supply, reproductive parameters and population dynamics in Dutch Lesser Black-backed Gulls Larus fuscus: a pilot study. Spaans, A.L., M. BukaciÑska, D. BukaciÑska. (BEONADD IV/V)
BEON rapport nr. 94-16	Pilot study on the influence of feeding conditions at the North Sea on the breeding results of the Sandwich Tern Sterna sandvicensis. Brenninkmeijer, A. & E.W. M. Stienen. (BEONADD IV/V)
BEON rapport nr. 94-17	BEON-studie naar de effecten van de teruglopende nutriëntenbelasting van de Nederlandse kustzone. Boddeke, R. en P. Hagel. (RIVO 93 E 03)

1995

BEON rapport nr. 95-1	Effecten van de schelpdiervisserij op het bodemleven in de Voordelta. Van der Land, M.A. (RIVO 94 V 06).
BEON rapport nr. 95-2	Jaarwerkplan 1995.
BEON rapport nr. 95-3	Trends in het voorkomen van vissen en epibenthische evertebraten in de Noordzee: Een vergelijking van datasets. Van der Veer, H.W., J.A. Craeymeersch, J. Van der Meer, A.D. Rijnsdorp, J.IJ. Witte. (NIOZ 93 A 04)
BEON rapport nr. 95-4	De ontwikkeling van een in vitro assay voor de bepaling van de invloed van biotransformatie op de bioaccumulatie van lipofiele organohalogeen verbindingen in mariene toppredatoren. I. Validatie van de assay met PCBS en de eerste resultaten met Toxafeen. Boon, J.P., van Schanke, A., Roex, E., de Boer, J., Wester, P. (NIOZ 94 M 01)
BEON rapport nr. 95-5	BEON beleidspresentatie "Ontwikkelingen in het beleid", d.d. 9 december 1994.

BEON rapport nr. 95-6 BEON beleidspresentatie "Modellering: de stand van zaken en het belang voor beleid en beheer", d.d. 31 maart 1995.

BEON rapport nr. 95-7 Wetenschappelijke discussie. De visserij-intensiviteit van de Nederlandse boomkorvisserij op de Noordzee mede in het licht van de milieu effecten en gesloten gebieden.

BEON rapport nr. 95-8 Antropogene eutrofiëring en natuurlijke variaties. Consequenties voor de produktiviteit van de Noordzee. INP-MOORING/PELAGIC FOOD WEB/STED/ STRAECOS. Van Raaphorst, W., F.C. van Duyl, H. Ridderinkhof, R. Riegman, P. Ruardy. (NIOZ 94 E 01)

BEON rapport nr. 95-9 Effecten van antropogene aktiviteiten op de produktiviteit van het ecosysteem in de Westelijke Waddenzee. Van der Veer, H.W., J.J. Beukema, G.C. Cadée, J. Hegeman, B. Mom, W. Van Raaphorst, J. IJ.. Witte (NIOZ 93 E 02)

BEON rapport nr. 95-11 Biomarkers of Toxic effects chemoreceprion: effects of contaminated dredge spoil on chemoreception acuity in whelks.Ten Hallers-Tjabbes, C. and C.V. Fisher. (NIOZ 93 M 05)

BEON rapport nr. 95-12 Habitatkarakteristieken van de Nederlandse kustzone. Wintermans, C. et al. (IBN 94 H 02)

BEON rapport nr. 95-13 BEON Tweejaarverslag 1993-1994. Onderzoek en beleid kiezen samenhet ruime sop; PB-BEON; augustus 1995.

BEON rapport nr. 95-14 Toxische algen tussen Noordwijk- en Terschelling-raai. Peperzak, L. et al. (RIKZ 94 E 05; RKZ-040).

BEON rapport nr. 95-15 Korte en lange termijn veranderingen in macrofauna veroorzaakt door verschillende vormen bodemvisserij. Bergman, M. et al. (NIOZ 94 V 01).

BEON rapport nr. 95-16 Intercallibratie en toepassing Noordzee-modellen (MANS-FYFY) fase 2. (WL 94 E 04).

1996

BEON rapport nr. 96-1 De ontwikkeling van een in-vitro assay voor de bpaling van de invloed van biotransformatie op de bioaccumulatie en de mutageniteit van lipofiele organohalogeenverbindingen in mariene toppredatoren. II. Toxafeen. Boon, J.P., H.M. Sleiderink, J. De Boer, P. Wester, H.J. Klamer, B. Govers.(NIOZ 95 M 03).

BEON rapport nr. 96-2 Spisula subtruncata als voedselbron voor Zeeëenden in Nederland. Leopold, M.F. (IBN 95 V 29).

BEON rapport nr. 96-3 BENTOX. Toxische effecten van verontreinigde sedimenten voor marien benthos. 1e fase: Verkennend onderzoek met 'natuurlijk' verontreinigde sedimenten , 2e fase: Benzo(a)pyreen en fluoranteen, 3e fase: BaP concentratiereeks. Kaag, N.H.B.M., J.P. Boon, K. Booij, C.V. Fischer, E.M. Foekema, M.T.J. Hillebrand, H. Hummel, H. Kralt, M.C. Th. Scholten, B.M.H. Timmermans, A.P.M.A. Vonck, M. de Vries, E. van Weerlee. (TNO 93 M 04,TNO 94 M 06, TNO 95 M 16).

BEON rapport nr. 96-4 Algenbegrazing: Een nadere analyse van de invloed van toxicanten op het ontstaan van eutrofiëringsproblemen. Jak, R.G., Michielsen, B.F. (TNO 95 E 07).

BEON rapport nr. 96-5 Habitatkartering en beschrijving Nederlandse kustwateren (IBN 95 H 36)

BEON rapport nr. 96-6 Onderzoek naar de invloed van fluctuaties in de lokale voedselbeschikbaarheid op de populatiedynamiek van de grote stern Sterna sandvicensis: tussentijdse resultaten. Stienen, E.W.M. & A. Brenninkmeijer. (IBN 95 H 24).

BEON rapport nr. 96-7 Resultaten BEON Workshop NW4.

BEON rapport nr. 96-8 Thema bijeenkomst Boomkorvisserij.

BEON rapport nr. 96-9 Jaarwerkplan 1996.

BEON rapport nr. 96-10 SCREMOTOX (WL 95 M 21).

BEON rapport nr. 96-11 Effecten van de schelpdiervisserij op het bodemleven in de Voordelta: De schelpdierbestanden in de Voordelta in 1995. Van der Land, M.A. (RIVO 95 V 30).

BEON rapport nr. 96-12 Verslag van de BEON workshop ter voorbereiding van de Nederlandse inbreng van de tussenconferentie van Noordzee- en Visserijministers (IMM 97).

BEON rapport nr. 96-13 BEON thema bijeenkomst polycyclische aromatische koolwaterstoffen (PAK's). 22 februari 1996 Den Haag.

BEON rapport nr. 96-14 Evaluatierapport BEON 1996. Tussentijdse evaluatie Tweede Meerjarenprogramma BEON 1993-1997. Rapport naar aanleiding van de BEON evaluatieworkshop d.d. 2 februari 1996, Den Haag.

BEON rapport nr. 96-15 Onderzoek naar mogelijkheden tot vermindering van discard produktie door technische aanpassing van boomkornetten (NIOZ 95 V 05). Fonds, M. & W. Blom

BEON rapport nr. 96-16 INP-Mooring 94-96: Antropogene eutrofiëring en natuurlijke variaties in de open Noordzee: metingen op een verankeringsstation in de Oestergronden (NIOZ 95 E 01)

1997

BEON rapport nr. 97-1 Fluctuaties in de lokale voedselbeschikbaar in relatie tot de populatiedynamiek van de Grote Stern Sterna sandvicensis: resultaten 1995-1996 (IBN 95 H 24). Stienen, E.W.M. en A. Brenninkmeijer.

BEON rapport nr. 97-2 Vervallen.

BEON rapport nr. 97-3 Jaarwerkplan 1997.

BEON rapport nr. 97-4 De betekenis van het zout- en silicaatgehalte in Nederlandse kustwateren voor het zeegrasareaal. Kamermans, P., M.A. Hemminga, D. de Jong, K.S. Dijkema. (NIOO 96 EH 07).

BEON rapport nr. 97-5 GiftigeAlgen en de Reductie van de Nutriëntenbelasting (BEON-GARdeN) Competitie tussen algen. Jaarverslag 1996. Riegman, R., K. Peeters, H. Los.(NIOZ 95 E 02).

BEON rapport nr. 97-6 In vitro biotransformatie van organohalogeenverbidingen in zeezoogdieren en vogels. Mogelijke gevolgen voor bioaccumulatie en genotoxiciteit. III: Gebromeerde vlamvertragers (Polybroom difenylethers & polybroom bifenylen). Boon, J.P., M.J. Greve, J.B. Bouma, M.K. de Boer, W.E. Lewis, H.J.C. Klamer, D. Pastor, P. Wester, J. de Boer (NIOZ 95 M 03).

BEON rapport nr. 97-7 The impact of marine eutrophication on phytoplankton, zooplankton and benthic suspension feeders. Stratification in mesocosms, a pilot experiment (Escaravage, V, Wetsteyn, L.P.M.J., T.C. Prins, A.J. Pouwer, A. de Kruyff, M. Vink-Lievaart, C.M. van der Voorn, J.C.H. Peeters &A.C. Smaal (RIKZ 96 E 01).

1998

BEON rapport nr. 98-1 In vitro biotransformatie van organohalogeenverbindingen in zeezoogdieren en vogels. Mogelijke gevolgen voor bioaccumulatie en genotoxiciteit. IV. Polychloor terfenylen (PCT's). Boon, J.P. D.E.C. Smith, W.E. Lewis, H.J.C. Klamer, D. Pastor, P. G. Wester, J. de Boer (NIOZ 95 M 03)

Informatie BEON:

PROGRAMMA BUREAU BEON
p/a Directoraat-Generaal Rijkswaterstaat
Rijks Instituut voor Kust en Zee
Kortenaerkade 1
2518 AX Den Haag
Postbus 20907
2500 EX Den Haag
070- 3114258/3114259/3114260
Telefax: 070- 3114321

