The effects of sand extraction and dredging on the bottomfauna of the Belgian Continental Shelf

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1. INTRODUCTION

The study area of the laboratory for biological montoring of the Fisheries Research Station of the State is the surveillance of the biological communities in sand extraction and dredging areas.

Three important trophic levels are investigated namely the macrobenthic infauna, the epibenthic fauna and the demersal fish fauna.

The choice of the groups was made with regard to the commercial fisheries on the Belgian Continental Shelf. The demersal fish (bottom fish) were chosen because they are vitally important for the economy of the Belgian coast and because they are easy subjects for a quantitative study. The macrobenthic infauna and the epibenthic fauna were chosen because they are the main constituent for the food of those bottom fish. There are also important food links between these three trophic levels.

The monitoring studies started in 1977 for the sand extraction area II and in 1979 for area I and III (figure 1). They consist of a quantitative and a qualitative analysis of the biocoenosis and physical analyses of the sediment.

In the same time samples of the fauna-elements were examined on the presence of heavy metals, fenols, radio-activity, polychlorinated biphenyls (PCB's) and organochlorinepesticides.

2. MATERIAL AND METHODS

2.1. Sampling points and periods.

A sampling grid, covering the most charactheristic biotopes of the area extends over a large part of the Belgian Continental Shelf (figure 1).

The sampling results were grouped in series of 2 to 5 sampling sites and were compared with other similar series. The results of one and the same sampling group mostly belong to one and the same ecosystem. This grouping technique eliminates small differences between individual sampling stations, which are usually due to the sampling procedure and other abiotic factors.

The sampling periods were in March, June and September. There was no sampling in winter because of the inactivity or absence of a lot of animals. Sampling in winter is also difficult because of bad weather conditions.

2.2. Sampling methods.

A shrimp trawl was used for the sampling of fishes and sedentary bottomfauna. Two types of trawls were used, the beam trawl and the board trawl.

Sediment samples for physico-chemical analyses and the study of the macrobenthic infauna were taken by means of a Van Veen grab.

For each sampling point four samples were taken, each of minimum 5 litre.

3. ANALYSES

Figure 2 gives the successive steps in the analysis of the different samples.

3.1. Quantitative community analysis.

Considering the almost two dimensional way of living of the demersal fish and the sedentary fauna and reckon with the used trawling technique, the faunistic results of abundance and biomass were converted to a comparative surface ($10^5 m^2$).

The evaluation of the estimates of abundance and biomass are closely related to the applied sampling technique. It is generally recognized that shrimp trawls only catch a fraction of the fauna present on the sea-bed.

For monitoring purposes estimates of the absolute abundance of marine invertebrates are not necessary. These kind of studies are envolved with long term tendencies and do not care about the exact status of a biotope in a given space of time. The real interesting point is the evolution of and changes in populations.

Figure 4 gives an example of the evolution of the relative abundance of dominant species belonging to the epibenthic fauna and the demersal fishes in area III.

Figure 5 represents the catches of dab (Limanda limanda) in the monitoring area (3 extraction areas and seven sampling groups).

The evolution of all dominant species was followed in a similar way.

3.2. Qualitative community analysis.

Populations do not form separate ecological units but they are integrated in a community. These interspecific interactions within a community were examined.

The use of disturbance indices in ecological investigations makes it possible to observe tendencies in the evalution of a population and a community.

The indices used for this purpose were the general diversity index of Shannon and Weaver, the Simpson dominance index, the Sørensen similarity coëfficient and different cluster analyses.

Figure 6 gives an idea of the diversity index along the Belgian coast in different extraction areas.

3.3. Sediment analysis.

For the evaluation of biotic data some analyses of the sediment can give valuable information. Grain size analyses and estimates of Ca Co_3 and organic matter are important and were carried out since 1981 for each sample.

4. EXTRACTION AREAS.

4.1. Area I.

During 1979-1981 a high extraction rate on a small spot situated on the Goote Bank in extraction area I had an influence on the sediments in the vicinity. Geological research revealed that currents could transport the fine sediments (fine and medium sand) towards the extracted pit.

Grain size analyses during monitoring studies gave irregular indications of a coarser sediment in the last few years.

Figure 3 represents extreme results of grain size analysis. Sampling point 16 is situated in the vicinity of the extraction area. In the years 1984 and 1985 much more coarser sand and stones were found in contrast to a not influenced sampling point 15 (figure 3) containing a good classified medium sand.

No long term changes were yet seen in the benthic communities. The dominant species were each year the same. Only seasonal changes gave sometimes minor abnormalities in the distribution.

For the epibenthic fauna the sea star (Asterias rubens) and the bristle stars (Ophiura texturata and O. albida) were dominant. Also the shrimps were relative abundant (Pandalus montagui and Crangon allmanni). Other common species like Pagurus bernhardus, Macropodia rostrata, Crangon crangon and Macropipus holsatus were not dominant.

Whiting (Odontogadus merlangus) and pout (Trisopterus luscus) were dominant species among demersal fish. The most abundant flatfish is dab (Limanda limanda). Other common non dominant species are Calliommus lyra, Pomatoschistus minutus and Trachurus trachurus.

4.2. Area II.

Since 1977 untill now continious sand extraction take place on the Kwinte Bank. Two other Banks were less frequently used for extraction.

Geological investigations pointed out that the height of these Banks remains after ten years of extraction on the same level. It has been possible to prove that the water currents in the valleys between the Banks mobilize the fine sediment (fine and medium sand) to be transported to the top of the bank.

Since 1983 the gravel content in the sediment is rising in the vicinity of the active extraction on the Kwinte Bank and more specific an sampling point 6. In the last few years sample taking with a Van Veen grab becomes more difficult and trawling ends more often in damage to the fishing gear.

A change in the distribution of the benthos is not yet obvious. All species of the ichtyofauna were much less abundant since 1983 especially on sampling point 6.

The epibenthic fauna was dominated by the bristle-stars (Ophiura texturata and O. albida) and the sea star (Asterias rubens). The Crustaceans like the brown shrimp (Crangon crangon) and the common swimming crab (Macropipus holsatus) are very abundant but not dominant. Pagurus bernhardus is a common less abundant species but very good distributed among the sampling points.

Dominant species among the ichthyofauna are the Gadiformes with the whiting (Odantogadus merlangus) and pout (Trisopterus luscus) as very important representatives. A frequently catched flatfish was dab (Limanda limanda). Figure 5 indicates that the evolution of abundance of this species is not effected by sedimentological changes. However since 1983 dab is much less frequently seen in the catches. Other common species like Sprattus sprattus, Trachinus vipera, Ammodytes lancea, Pleuronectes platessa and Pomatoschistus minutus were not dominant.

The evolution of species diversity (figure 6, point 2) indicated a normal seasonal distribution of species.

The association between sampling points have not yet revealed mayor changes in the different communities (figures 7).

4.3. Area III.

This area is situated in the extraction zones of navigation channels and harbour approaches. The composition of the sediment shows a high percentage of silt especially on the sampling sites located in the coastal area (sampling group 2).

Due to the active dredging operations (about 30 million tons a year) the material in suspension is very high and the transparency of the water very law. Gyratory currents in this area allow a sedimentation of the fines along the coast. Up to 1984 this sedimentation takes place in a large area surrounding the sampling point 23 (figure 1).

With the beginning of the expansion works for the harbour of Zeebrugge the local current patterns were totaly changed and the sedimentation area became an erosion area. The re-deposition of the fines is nowadays located between the harbour of Zeebrugge and the Western Scheldt.

In the vicinity of sampling point 23 the communities common for a sand-silt sediment are nowadays replacing the mud dwelling organisms. Far example the Alra alba and Macoma balthica community has been replaced by a Spisula community since 1984. The species diversity of the epibenthic community increased since 1983 while the species diversity of the fishes decreased. This happened on sampling point 22 and 23 (figure 6).

The few dominant species in the coastal area (sampling group 2) were the brown shrimp (Crangon crangon) and the common swimming crab (Macropipus holsatus) for the epibenthic fauna. On sampling point 23 Pectinaria Koreni was very abundant up till 1980 and disappeared completely, possibly due to the high amount of silt. In sampling group 1 the bristle stars (Ophiura texturata and O. albida) and the sea star (Asterias rubens) were also dominant species.

Only two demersal fish species were dominant in the coastal area (Pomatachistus minutus and Solea solea). Solea solea disappeared completely since 1981. In sampling group 1 whiting (Odontogadus merlangus), pout (Trisopterus luscus) and dab (Limanda limanda) were dominant species. The dredging activities in this area had no effect on the evalution of dab (figure 5).

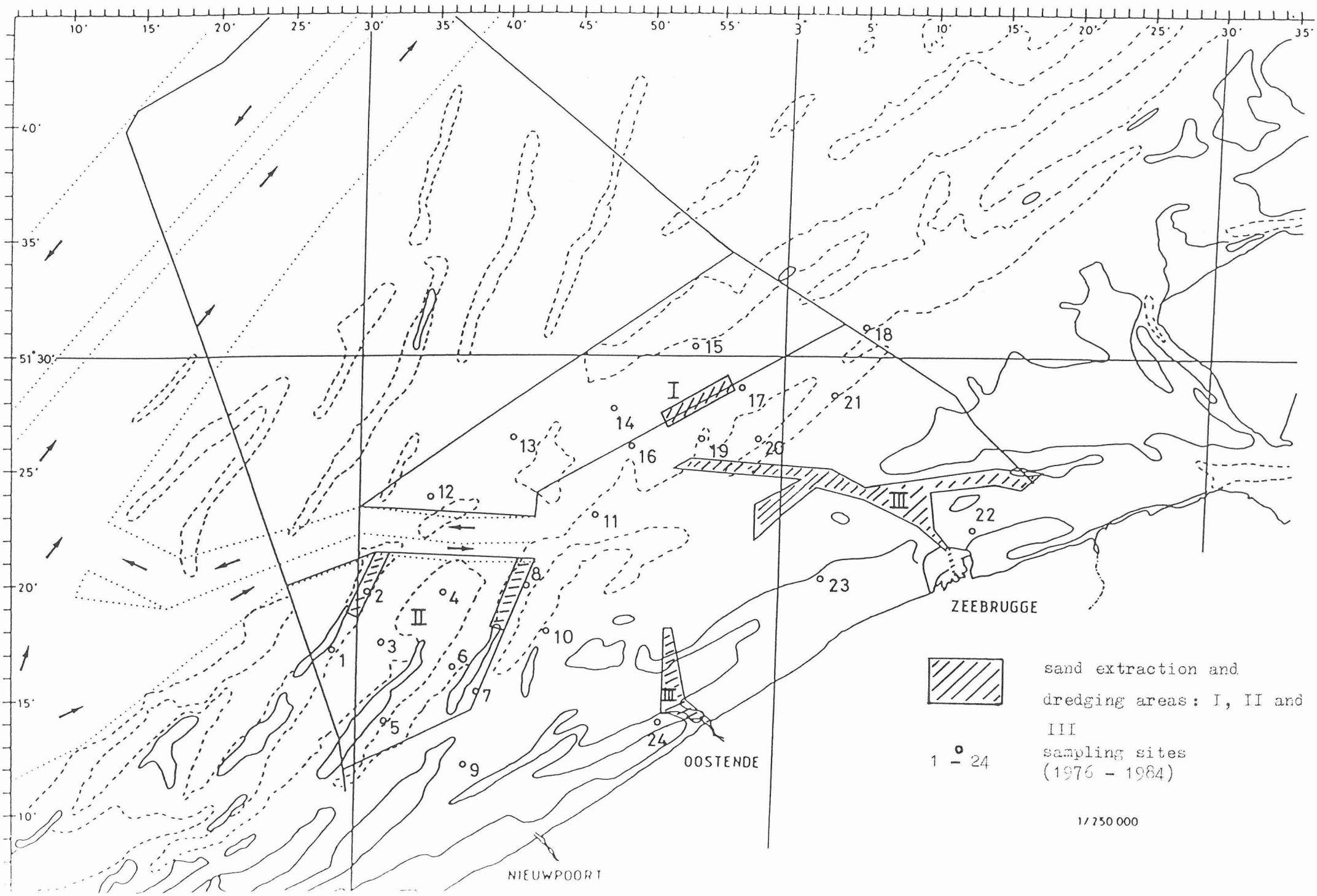


Figure 1 - Monitoring area of the Fisheries Research Station of the State, on the Belgian Continental Shelf

Figure 2 - BIOLOGICAL AND PHYSICO - CHEMICAL MONITORING

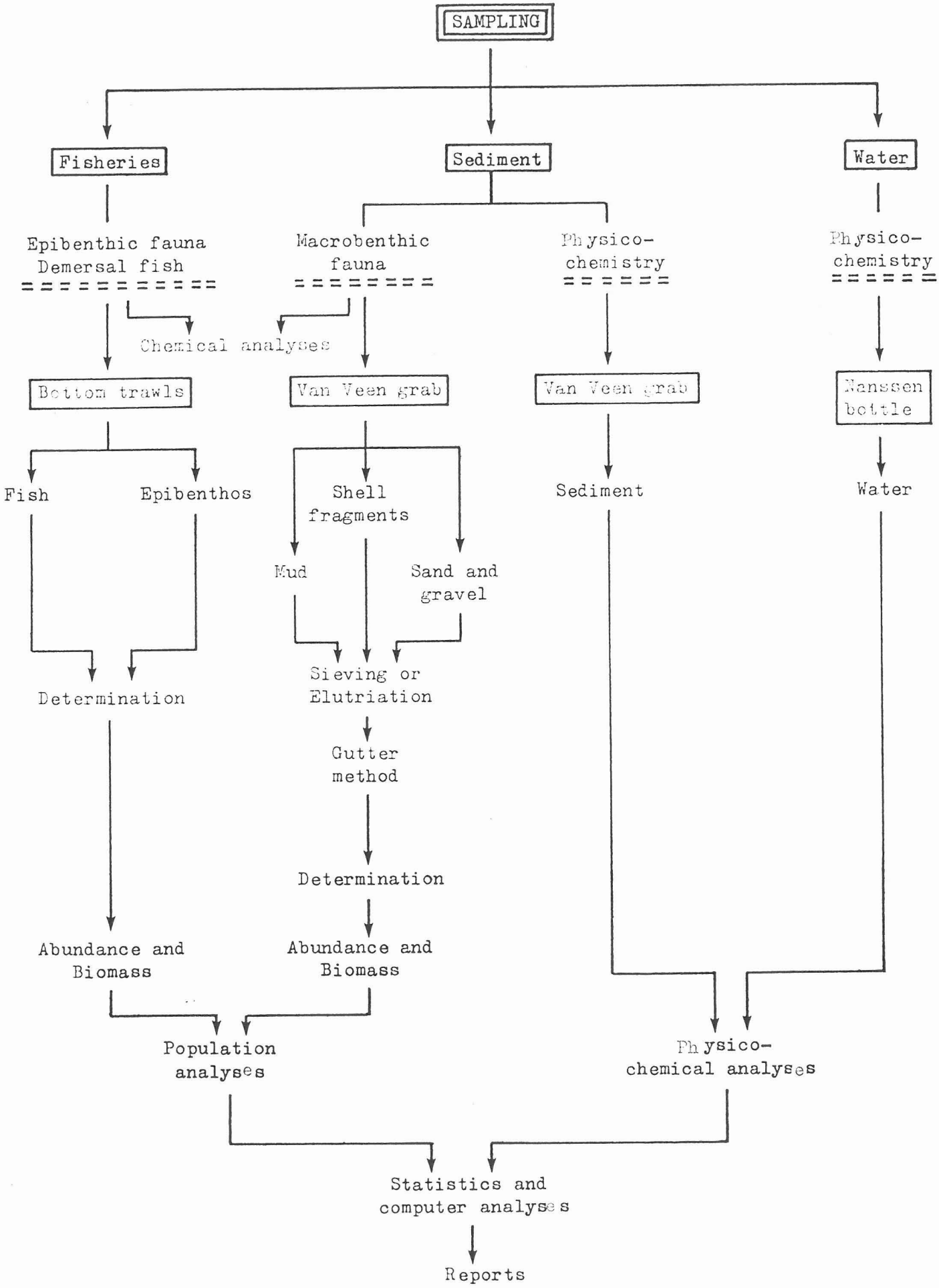
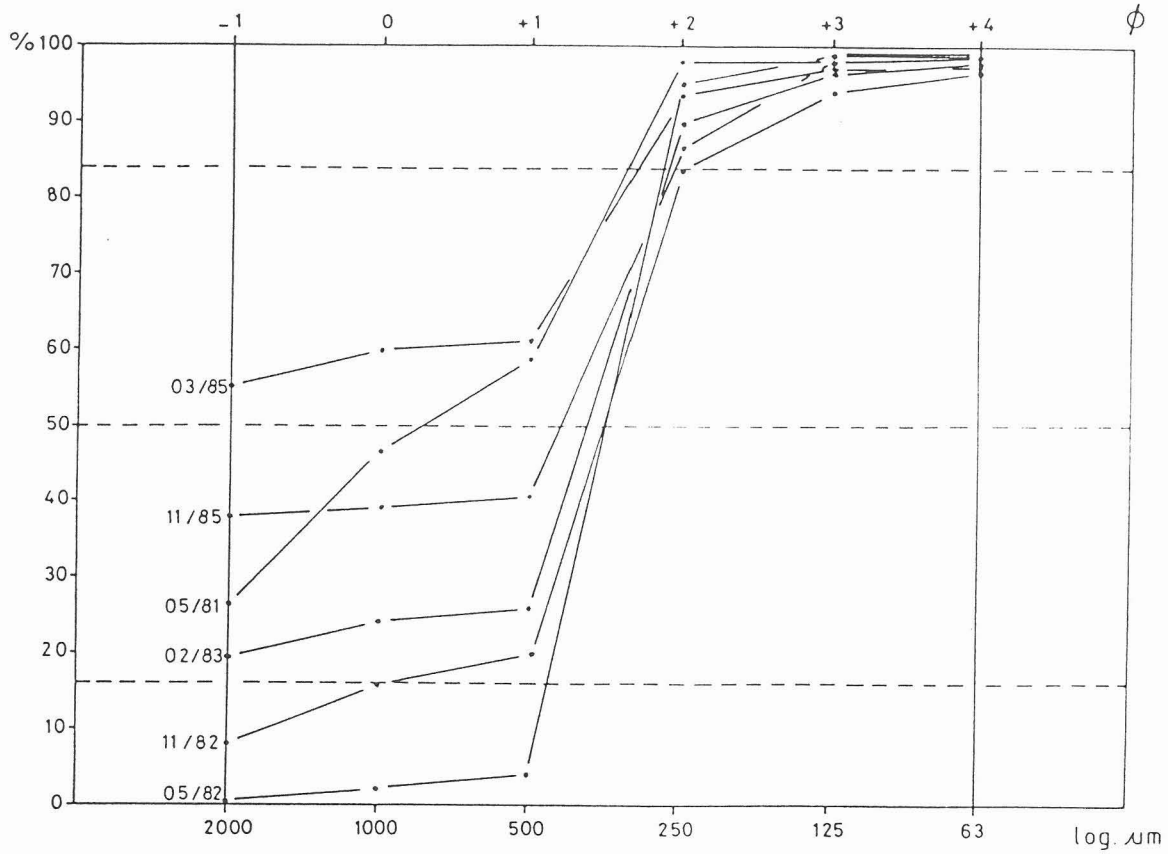


Figure 3 - Grain size analysis of sandextraction area I (sampling points 15 and 16) on the Belgian Continental Shelf.

sampling point 16



sampling point 15

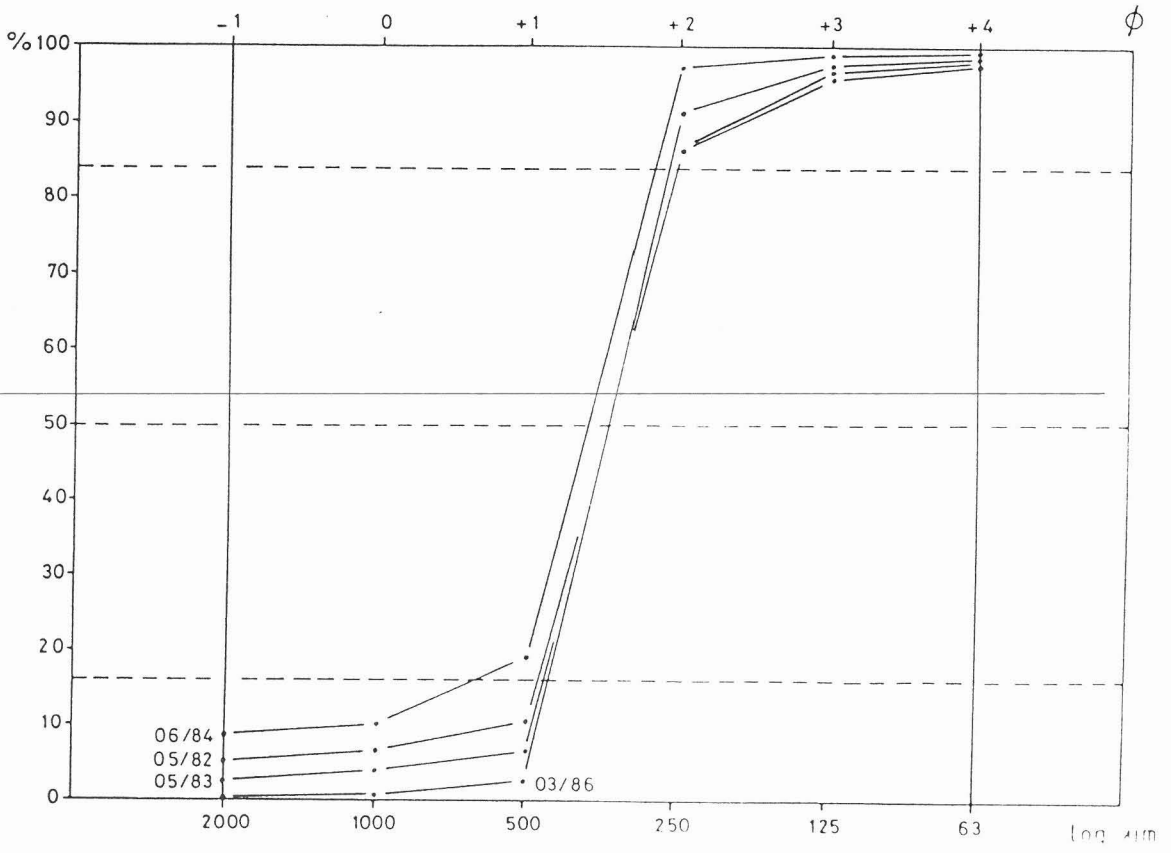
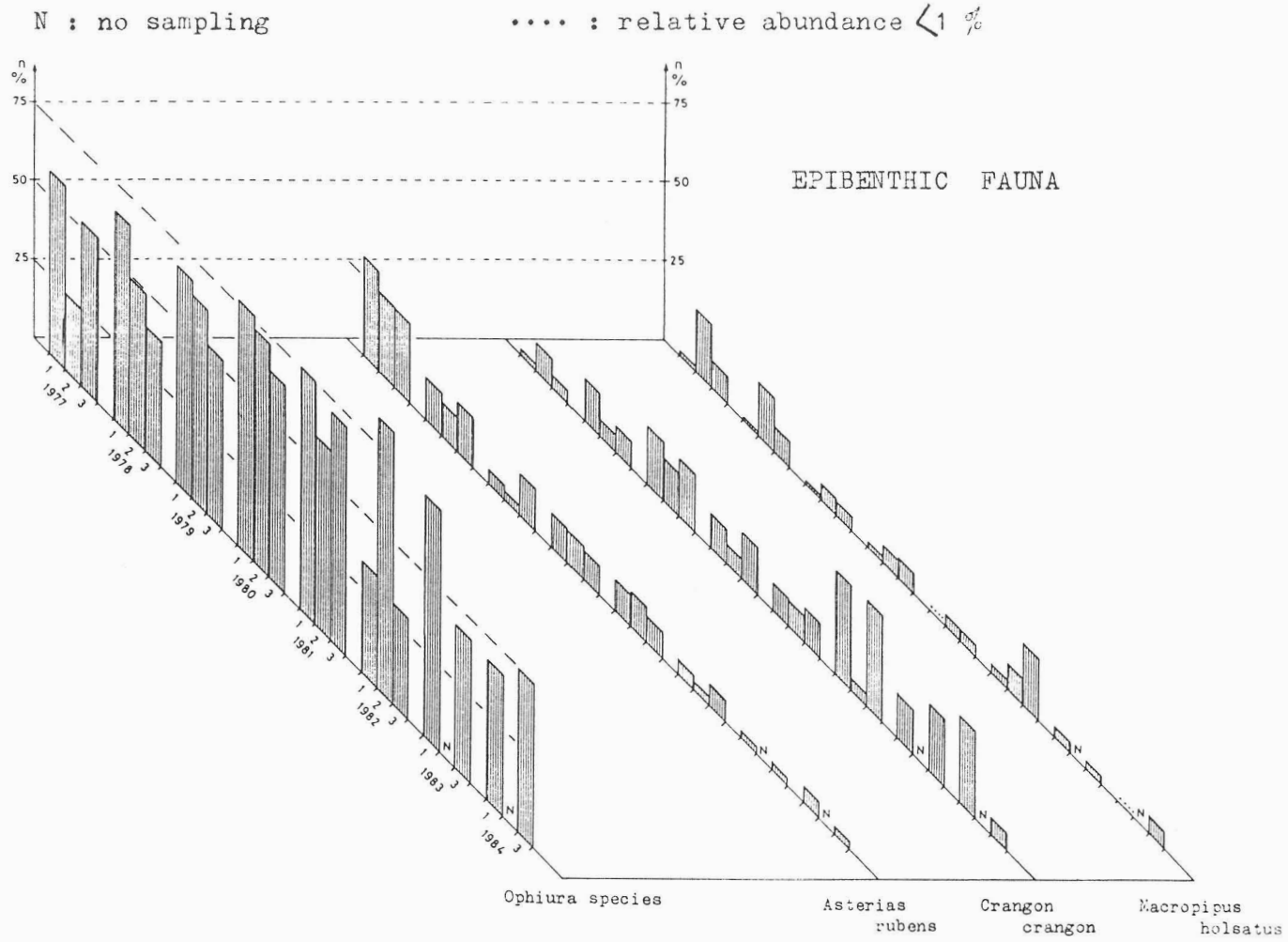


Figure 4 - Evolution of relative abundance of dominant species in dredging area III, group 1 (sampling sites 11,19,20 en 21).



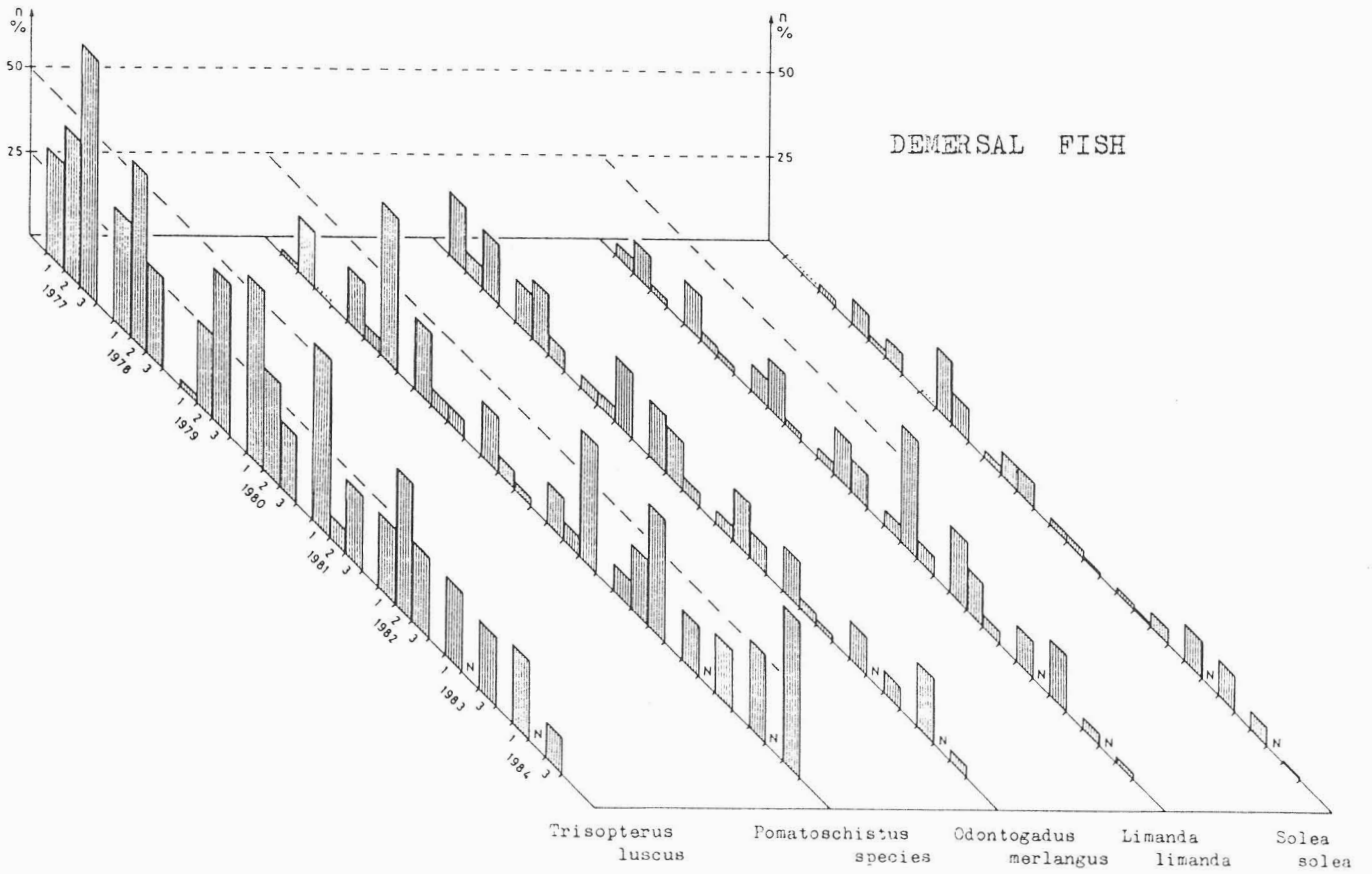


Figure 5 - Abundance of dab (Limanda limanda) in three extraction areas (I, II and III) on the Belgian Continental Shelf.

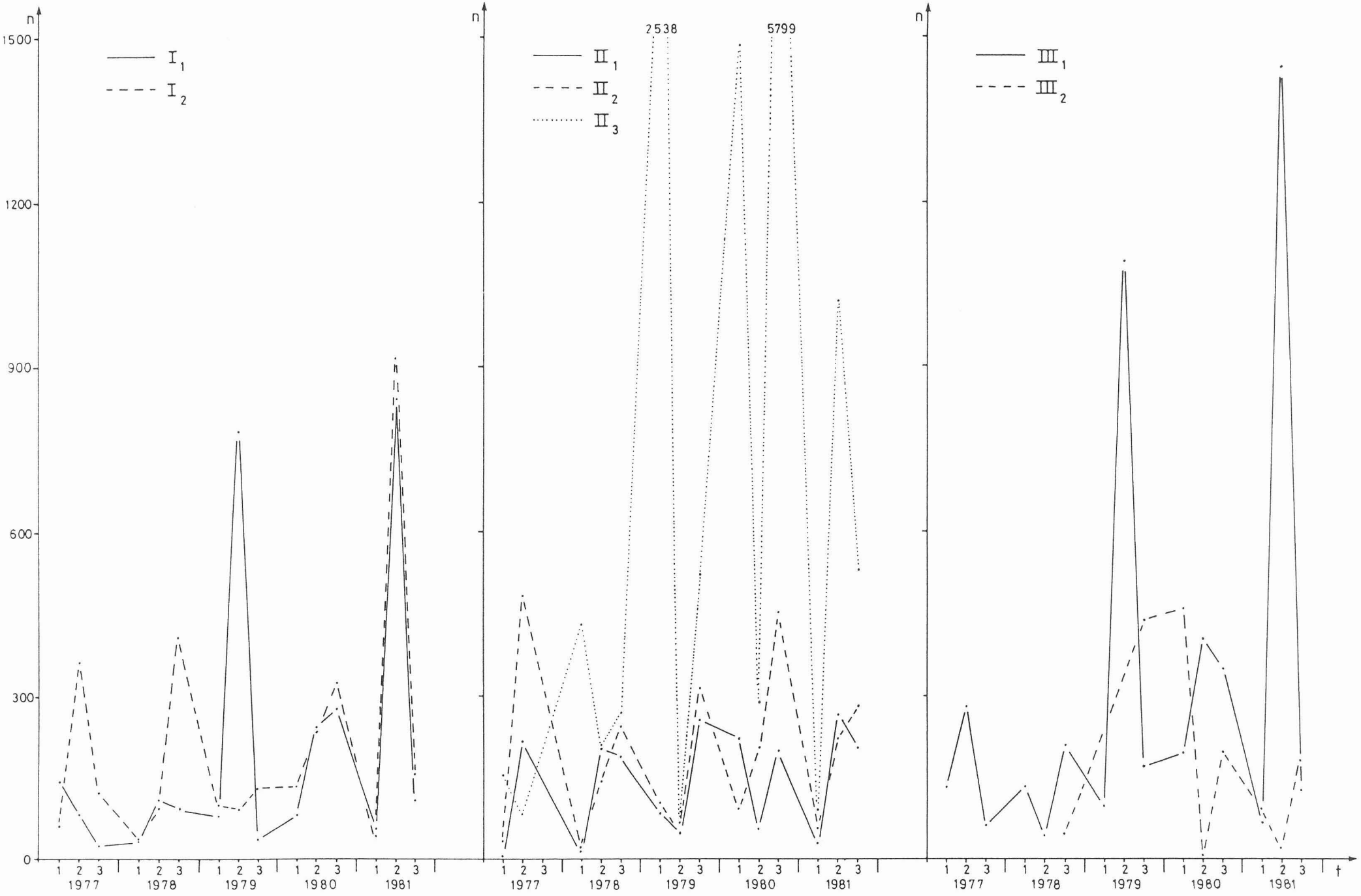
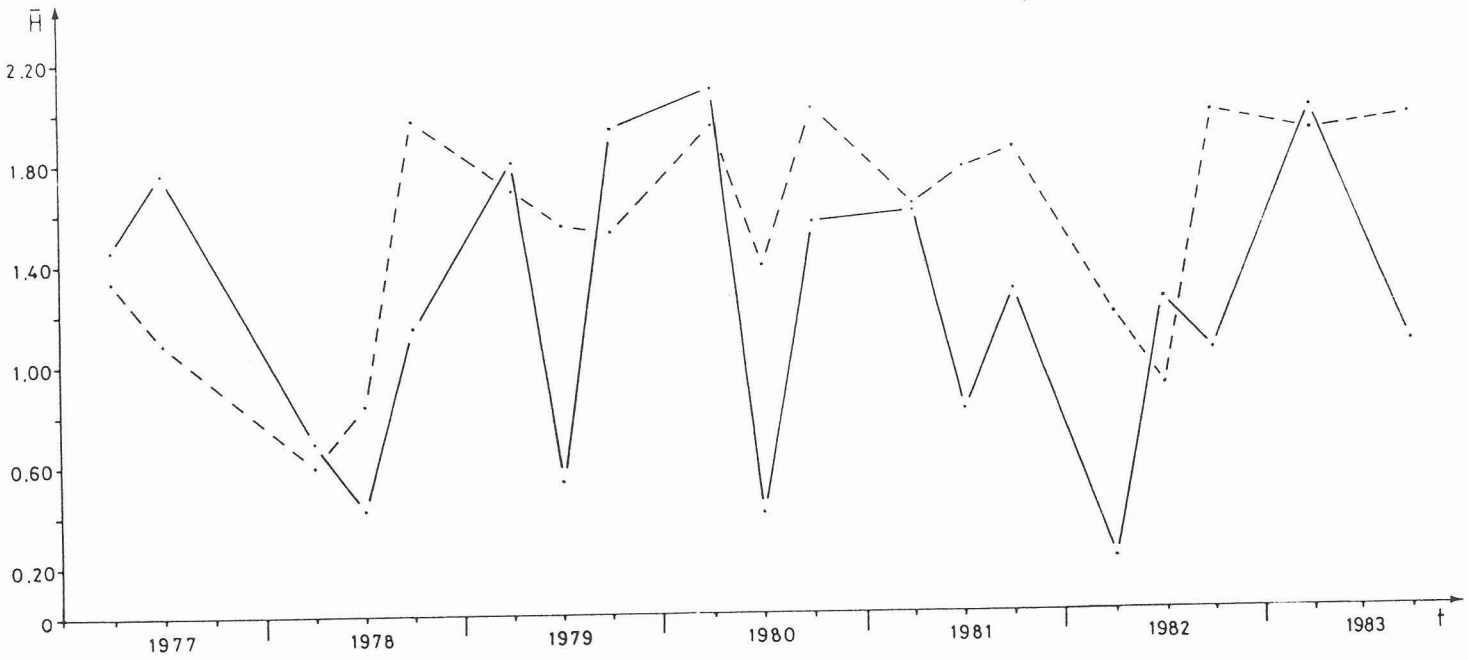


Figure 6 - Evolution of the Shannon-Weaver species diversity based on species abundance in sand extraction area II (sampling point 2) and dredging area III (sampling point 22).

——— demersal fish

- - - - epibenthic fauna

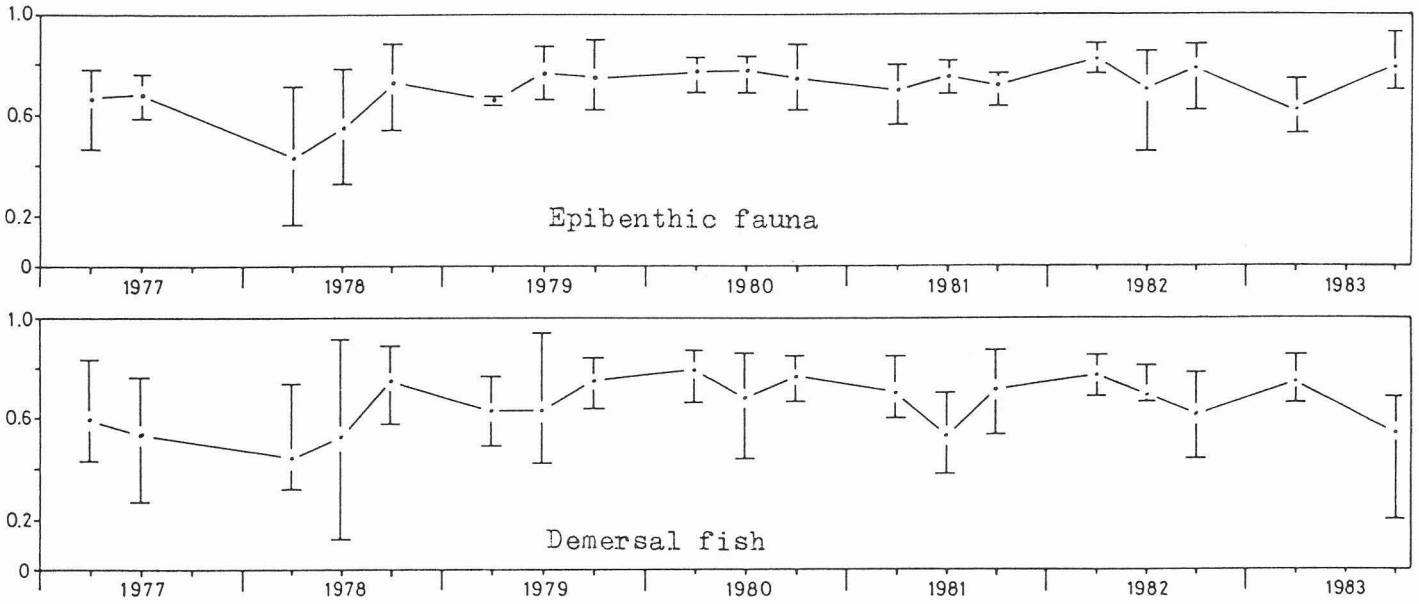
sampling point 2



sampling point 22

Figure 7 - Evolution of Sørensen similarity indices between sampling points in extraction area II (sampling group 1 and 3).
The indices are based on species abundance.

Sampling group II_1



Sampling group II_3