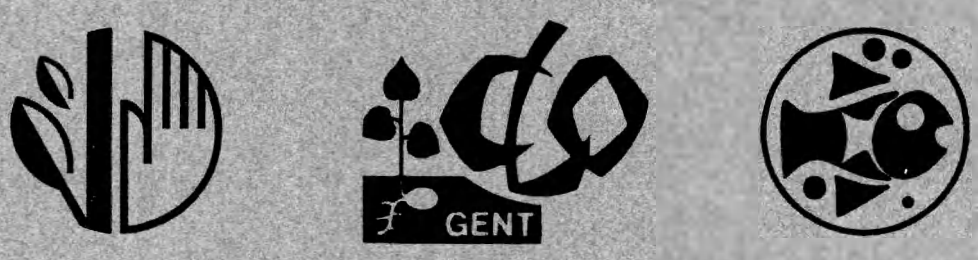
MINISTRY OF MIDDLE CLASSES AND AGRICULTURE

Centre for Agricultural Research Gent

FISHERIES RESEARCH STATION OOSTENDE

Environmental Impact Study in the framework of the construction of the INTERCONNECTOR gas pipeline on the Belgian Continental Shelf

Second report : period immediately after the pipe laying



Report - January 1998

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CONTENTS

SUMMARY

In 1997, samples were taken along the trajectory of the Interconnector gas pipeline and at some reference stations across the Belgian coastal waters of the North Sea, in order to assess the environmental impact of such an installation on the benthic and fish communities in the area. This second report reflects the situation of the biota in the period following the installation of the pipe.

Density and species composition of the macro- and epibenthos as well as the fish populations were studied. Furthermore sediment characteristics were determined for each sampled station along the pipeline trajectory.

The sediment samples, taken along the pipeline, showed higher median grain sizes than those recorded in spring '97. A significant gradient in median grain size was recorded from the coastal area to the open sea. The inshore stations were characterised by a low median grain size, while the highest values were noted at the offshore stations.

In total 89 macrobenthos species were observed, with a total average density of 752 ind./m^2. The different communities were dominated either by polychaetes or crustaceans or exceptionally by molluscs. A comparison was made with the situation before the installation of the pipeline (spring '97) showing an enriched macrobenthos population.

The epibenthos communities ranged from 655 ind./10^5m^2 to 48,820 ind./10^5m^2 and were dominated by brittle stars (*Ophiura* species), with very high densities near and in the vicinity of the Thornton and Goote Sand Banks. The flying crabs (*Liocarcinus holsatus*) represented the highest biomass in the epibenthic communities, except in the offshore areas. A general increase in density and biomass was recorded at all sampled sites in comparison with spring '97. The biomass values indicated a downward trend along the pipeline track from the coastal stations towards the offshore sampling stations, similar to the observations as reported in the first survey.

The fish densities ranged from 814 ind./10^5m^2 to 8,505 ind./10^5m^2. The most common species were sand gobies (*Pomatoschistus minutus* and *P. lozanoi*), dab (*Limanda limanda*) and lesser weever (*Trachurus vipera*).

This second report must, similar to the first one, be considered as a further basis for final comparison with results from the third survey, which will be carried out about one year following the completion of the pipeline.

1. INTRODUCTION

In compliance with the Oslo and Paris Conventions, the Fisheries Research Station evaluates the quality of the marine environment and the possible harmful effects of the laying of pipelines, dumping of dredge spoils and sand extraction.

This research includes biological, granulometric and chemical studies. Three periods of sampling will be carried out: before, during and after the execution of the INTERCONNECTOR project. In addition underwater TV video recordings will take place to monitor the position and the condition of the pipe. The end of the research is scheduled for 1998.

This second of three reports presents the results of :

- the second survey, done in 1997, of the biotic environment along the trajectory of the planned pipeline, just after the installation.
- previous campaigns, done in the framework of the ongoing biomonitoring projects.

2. MATERIAL AND METHODS

See first report (pages 3-6).

Sampling positions and periods are shown in Figs. 1-3 and Tables 1 and 2.

3. RESULTS

In addition to the data, retrieved from the sampling sites along the pipeline trajectory, other sampling stations (120, 215, 315, 330, 340 and ZG02) were also taken into account as a reference. This enabled to compare both areas and to observe possible changes in the environment in a more detailed way.

3.1. Sediment

Table 3a. : Sediment characteristics of sampling stations along the pipeline.

Station	reference	Med. gr.	Med. gr. (µm)	grain fraction						
		(phi)	(µm)	>2000µm	<2000µm	<1000µm	<500µm	<250µm	<125µm	<63µm
H4	Pipeline	1.6	323.0	3.91	1.89	6.37	60.13	24.79	1.08	1.83
H5	Pipeline	1.4	385.0	5.74	6.13	13.06	66.76	7.31	0.27	0.73
H6	Pipeline	0.7	608.0	1.48	7.68	56.96	27.59	5.32	0.26	0.72
H7	Pipeline	1.2	443.0	3.17	2.29	35.34	52.38	6.10	0.08	0.64
H8	Pipeline	1.2	436.0	10.35	3.85	24.29	58.52	2.33	0.06	0.60
700	Zeebrugge	2.9	134.5	2.25	0.95	4.75	7.42	38.75	17.11	28.78
710	Loswal S2	2.4	185.9	1.18	0.29	0.78	13.50	80.08	2.21	1.95
780	Loswal S1	2.4	195.7	0.77	1.30	2.80	19.38	72.85	1.38	1.53
435	Bligh Bank	1.4	386.7	2.57	3.75	21.14	60.79	10.74	0.22	0.78

(phi = - $\log_2$ of the particle diameters)

All sampled stations along the pipeline (H4-H8 and 435) were characterised by a sediment with a median grain size varying between 323 and 608 µm. The fractions 250-500 µm, which are defined, according to the Wenthworth scale (Fig. 4), as medium coarse sand, dominated the sediment except for station H6. In the latter a considerable amount of particles (66%) of the sampled sediment exceeded 1000 µm, therefore cataloguing it under a coarser sediment type.

The coastal stations (710 and 780) tended to have a finer substrate, dominated by fine sand fractions. The sediment of station 700, nearest to the coast, showed besides a large fraction of fine sands also a large fraction of silt (29%). (Fig. 4).

Furthermore a significant gradient in median grain size was noticed from the coastal area towards the open sea.

The sampled sites in the coastal area were characterised by a low median grain size, while the highest values were recorded at the offshore stations. Station H6, however did not follow this trend.

Generally, an increase in medium grain size was reported in all sampled stations compared to last spring, except for H8. Although these changes were not always as radical as in station H6, they show a clear tendency that the sediment samples were characterised by the larger fractions of particles. Whether this was a direct result of the works that coincided with the pipe laying, could not yet be determined. But the laying of the pipe and the preparation of the seabed (presweeping) might have caused at some stage some disturbances to the sediment.

When comparing the sediment types of the reference stations for the last two years, clear changes were also observed. These changes were not the result of mechanic disturbances, but were probably caused by natural oceanographic processes. This made it difficult to assess, at this stage, how big the actual impact of the pipeline was on the bottom and in a next stage, on its biota (Figs. 5 & 6).

Table 3b. : The chemical characteristics (Organic material, TOC and $CaCO_3$content) of the sediment samples of the pipeline.

This data set includes also the results from the first survey (spring '97). As the TOC analyses were not yet completed, these results will be stated and discussed in the final report.

Chemical characteristics (in %)						
	Spring '97			Autumn '97		
Station	Organic material	TOC	CaCO3	Organic material	TOC	CaCO3
H4	1.83	-	5.01	1.70	-	5.91
H5	0.49	-	2.77	0.66	-	5.20
H6	0.47	-	2.58	1.33	-	0.67
H7	0.40	-	1.59	0.37	-	2.41
H8	0.74	-	3.34	0.48	-	3.07
700	6.77	-	10.13	5.16	-	8.69
710	0.59	-	12.64	0.75	-	7.9
780	2.14	-	7.45	0.80	-	5.62
435	0.47	-	3.24	0.45	-	3.69

3.2. Macrobenthos

Benthos comprises all organisms living on or in the sediment. The term macrobenthos as used in this study, refers to the animal fraction of the benthos larger than 1 mm and living on or in the sediment. They represent a major component in the trofic organisation of the marine environment, as food for the epibenthic- and demersal fishcommunities. The major faunistic groups represented in these samples were bristle worms (Polychaeta), crustaceans (mostly sea hoppers, Amphipoda; opossum shrimps, Mysidacea; and cumaceans, Cumacea), molluscs (particularly bivalves, Bivalvia; and sea snails, Gastropoda) and echinoderms (particularly brittle stars, Ophiuroidea; and sea urchins, Echinoidea).

3.2.1. Density : (Tables 4 & 5 ; Figs. 7-9)

Densities of the macrofauna, taken in autumn 1997 along the pipeline track, ranged from 300 ind./m² (in station H8) to 2,287 ind./m² (in station 700) with a mean value of 705 ind./m². In most sampling stations polychaetes and crustaceans dominated the benthic communities, except in station 710, where one bivalve (*Ensis* species) represented 82% of the total macrobenthic community. The most common species in the data set were : the polychaetes, *Spiophanes bombyx* (79%), *Nephtys* species and *Scoloplos armiger* (71%) ; the crustacean, *Bathyporeia guilliamsoniana* (64%) and the echinoderm *Ophiura* species (64%).

In the reference stations, densities varied between 86 ind./m² (ZG02) and 2,946 ind./m² (120). Similar to the pipeline stations there was a clear dominance of polychaetes (> 50% of the population), except in station 330, where the crustaceans from the genera *Urothoe* and *Bathyporeia* reached almost 50% of the entire population.

A comparison of fauna densities from the previous year (autumn '96) showed in all the stations (140, 435, 700, 710 and 780) an upward tendency in macrobenthos abundancy. In some stations (140 and 700) however this phenomenon was accompanied with a decrease in diversity.

3.2.2. Diversity : (Table 4 ; Fig. 7)

During the autumn survey (1997), a total of 89 macrobenthic species was recorded. In terms of species richness the sampled sites were dominated by polychaetes : they formed nearly half of the total number of species (43). Other important groups were crustaceans (24) and molluscs (13). The values of the Shannon-Wiener diversity index, from the stations along the pipeline track, varied from 0.15 (in station 140) to 3.79 (in station H8).

General considerations:

The overall macrobenthos densities, recorded in the autumn of 1997, from the two sampling areas (pipeline and reference) were considerably higher than the ones found in spring '97, with the exception of one reference station ZG02 and one pipeline station H4. This is not unusual if we take into account the recruitment that has taken place within the macrobenthic communities during the early summer until the beginning of autumn. However, to determine any influences of the pipe (positive or negative) on the present macrobenthic populations it might be advisable to compare similar situations with a following spring-spring and autumn-autumn period.

The fact that there is no reference material available for the pipeline stations of the autumn of 1996, created difficulties in interpreting the current data. Two stations (435 and 710), which are situated close to the pipeline and which are biomonitoring sites, have been sampled during that period. They indicated a upward tendency in macrobenthos density. Whether this is also the case in the other pipeline stations (H4-H8) is not yet clear. Maybe the next and final sampling campaign, (*) a year after the first, in spring 1998 could clear things up a little bit. It would enable us to compare two similar situations (spring-spring)(**) and conclude whether the laying of the pipeline caused changes of any kind within the local macrobenthic communities.

Considerable differences in diversity between the two periods of sampling were reported. While most of the pipeline stations and one reference station ZG02 have similar Shannon-Wiener indices, other sites show either a steep decrease (140, 700) or a similar increase (120, 315) in diversity. Possible explanations for these phenomena will be discussed in the third and final report.

As a final consideration it is clear that in the case of such a single disturbance (e.g. the laying of a pipeline), it might be very difficult to assess the exact effect on the surrounding biota, especially in those areas where the variation in density and diversity is liable to natural processes. This is certainly the case in the areas around the sandbanks.

(*) a year after the completion of the pipeline, in autumn 1998.

(**) autumn-autumn

3.3. Epibenthos

The term epibenthos as used in this study, refers to the animal fraction of the large benthos living on the sediment (> 1 cm). The major faunistic groups represented in these samples were sea anemones (Anthozoa), crustaceans (particularly crabs, Brachyura; hermit crabs, Paguridae; shrimps and prawns, Caridea), molluscs (mostly sea snails, Gastropoda; squid and cuttlefish, Cephalopoda), and echinoderms (mostly brittle stars, Ophiuroidea; and starfish, Asteroidea).

This study aimed at gathering qualitative data on the epibenthic fauna which can be correlated with quantitative data obtained by the macrobenthos and sediment sampling programmes. Time trends on presence/absence and relative abundance were also investigated.

3.3.1. Density : (Tables 7 & 8 ; Fig. 10)

The total abundancy of the epibenthos population along the Interconnector pipeline ranged from 655 ind./10^5m^2 in H8 to 47,915 ind./10^5m^2 in H5. Generally there were two opposite tendencies noticed along the pipeline trajectory. The first one showed an increase in density from the coastal sampling sites (710 & 780) up to the Thornton Bank (H5), the other one indicated a steep decline from the latter, evolving in a gradual decrease in density towards the offshore stations (H6, H7 & H8).

The most common species were *Ophiura* species (brittle stars); *Liocarcinus holsatus* (flying crab) ; *Asterias rubens* (starfish) and *Pagurus bernhardus* (hermit crab). Their relative densities (in %) are shown in Fig. 11.

Most of the epibenthic communities were dominated (>50% of the total population) by the echinoderm *Ophiura* species and/or the crustacean *Liocarcinus holsatus*. The *Ophiura* species reached its highest abundancy (39,236 ind./10^5m^2) in station H5, *Liocarcinus holsatus* in station 710 (18,201 ind./10^5m^2).

The other important species (*Asterias rubens* and *Pagurus bernhardus*) occurred in all the sampled locations. *Pagurus bernhardus* dominated the epibenthic community in H7 (50.5%) and formed the largest fraction in H8 (42%). The echinoderm *Asterias rubens* never exceeded more than 13% of the total population.

3.3.2. Biomass : (Tables 9 & 10 ; Figs. 12 & 13)

Although the flying crab population (*Liocarcinus holsatus*) nearly always was outnumbered by the brittle star (*Ophiura* species) by ratio 2/1, its mean biomass was considerably higher (resp. 60% and 11% of the entire epibenthos population along the pipeline). Also the starfish species (*Asterias rubens*) represented about 22% of the total mean biomass of the epibenthos community.

In both areas (pipeline and reference) a similar biomass distribution was observed among the epibenthic community. There was a tendency in biomass decrease in the pipeline area from the coastal stations towards the offshore sampling sites. The highest biomass values were recorded in station 780 (127,126 g/10^5m^2), the lowest in station H8 (2,999 g/10^5m^2).

3.3.3. Diversity : (Fig. 10)

A total of 20 epibenthos species was recorded during autumn 1997 at the different sampling stations along the pipeline trajectory. The Shannon-Wiener diversity index varied from 0.38 (710) to 2.27 (H8).

These values seem very low in comparison with the macrobenthos diversity (mean diversity = 2.71). A high density however does not necessarily correspond with a high diversity. The community is often dominated by one species and a fall of the diversity is the result.

General considerations :

The epibenthic populations caught in autumn differed considerably from those in spring, not only in their abundancy but also in their biomass and diversity. Nearly all sampling sites were characterised by larger and more diverse populations, with higher biomass values. Whether this phenomenon was the direct result of the construction of the Interconnector pipeline is doubtful, because the same density and biomass ratio's between both periods of sampling were reported in the reference stations.

In the following paragraphs a few feasible hypotheses are proposed :

(a). As most of the epibenthic species have the ability to move quickly and over greater distances than e.g. the macrobenthic species, the possibility exists that they temporarily left their territories due to the disturbances caused by the laying of the pipeline on the bottom of the seafloor bed. After the completion of the works (thereby damaging the local flora and fauna), they recolonised the site and benefited from the greater food availability, that mainly consisted of dead macrobenthos and epibenthos species and resuspended organic material (detritus). In a following stage they reproduced, resulting in a large epibenthic community.

(b). Another possibility is that the local epibenthos community could not escape in time and was killed or damaged as the construction of the pipeline continued. In a second phase epibenthic species and demersal fish species from outside the construction area colonised the damaged area, feeding on the dead organic organisms. As the pipeline was completed in August and the samples were taken in September, it is possible that during that period a new population was reinstalled. That would also explain the higher diversity in the latter campaign.

3.4. Fish

3.4.1. Density : (Tables 11 & 12 ; Fig. 14)

In autumn 1997 the total density of the sampling sites along the pipeline varied between 1,612 ind./10^5m^2 (station H7) and 8,505 ind./10^5m^2 (station H4). The amount of fish, in the total area under study, which was caught equalled to 38,872 individuals. The most common species were sand gobies (*Pomatoschistus minutus* and *P. lozanoi*)(9,778 ind./10^5m^2), dab (*Limanda limanda*) (7,435 ind./10^5m^2), lesser weever (*Trachurus vipera*) (7,038 ind./10^5m^2), dragonet (*Callionymus lyra*) (2,279 ind./10^5m^2), and bib (*Trisopterus luscus* and *T. minutus*) (2,766 ind./10^5m^2). Practically all stations were dominated by either one or several of these species.

The average density in the reference area was lower than in the pipeline area. Similar species, as in the pipeline zone, reached their highest densities (sand gobies, dragonet and bib).

General information (e.g. habitat, size, food and reproduction) of the fish species is given in appendix II. The latter serves as an addition to the appendix in the first report, as different fish species were caught during the autumn campaign.

Length-frequency figures of the commercial fish species are shown in Figs. 15 and 16.

The dab population, in autumn 1997, was clearly separated into a juvenile (around 6 cm, with a max. of 2,374 ind./10^5m^2) and a semi-adult fraction (around 15 cm, with a max. of 217 ind./10^5m^2). A similar distribution was also reported in the plaice and common sole communities, although their densities were considerably lower. The whiting population lacked juveniles; instead the population was characterised by a large semi-adult and a small adult fraction. In the bib population both juvenile and adult fraction were well represented with respectively maximums of 502 and 413 ind./10^5m^2. Finally, the cod catches did not show a distinct length-distribution pattern. The few species that were caught, were all juveniles with lengths varying between 25 and 40 cm.

In comparison with the reference zone, there were a lot of similarities recorded. Some of the commercial fish populations showed in general the same structure (whiting, dab, cod and bib). The common sole and plaice catches differed from the pipeline zone by lacking a clear juvenile fraction. Although the reference zone consisted only out of three stations the mean abundancy of some commercial fish was comparable with those of the pipeline zone with 9 sampling stations (the highest density recorded in the reference area was 7,266 ind./10^5m^2) (station 120).

3.4.2. Diversity : (Tables 11 & 12 ; Fig. 14)

A total of 29 species was found at the different sampling sites along the pipeline. The diversity index of the pipeline stations ranged from 1.54 (in station H8) to 2.95 (in station H5). Stations 710 and 780 were dominated by sand gobies (*Pomatoschistus minutus and P. lozanoi*)(respectively 58 and 53% of the entire fish catch). Lesser weever (*Trachurus vipera*) dominated (64%) the fish population in station H6. The other sites had a more stable community in which the different species were more or less equally divided.

The fish communities in the reference zone had comparable diversities except in station 140, where the sand gobies (*P. minutus* and *P. lozanoi*) represented nearly 80% of the total fish catches.

General considerations :

In general the catches in autumn '97 showed a greater abundancy than those in spring '97. In nearly all sampling stations (pipeline and reference) an increase in fish density was recorded. Only station 315 did not show this trend. Maybe the fact that near this station another pipeline was constructed in the same period of sampling could explain those low densities. However, the amount of commercial fish (cod, dab, whiting and plaice) caught in spring '97 dropped from 14,501 to 9,777 ind./10^5m^2 (in the pipeline area) and from 10,706 to 3,478 ind./10^5m^2 (in the reference area). Only the bib catches showed a spectacular increase in comparison with the spring campaign. Common sole densities stayed at a status quo level.

In terms of diversity no radical changes have taken place. Some species disappeared, others were newly caught.

3.4.3. Results of other fish campaigns in 1997 : (Table 13 ; Fig. 17)

(1) Vessel 0.29 Broodwinner (period September '97):

Twelve stations were sampled situated along the Belgian coast in the neighbourhood of the Interconnector pipeline. A 18 mm meshed beam trawl was used.

In relation to the previous year ('96), the total amount of commercial fish (common sole, plaice, dab, whiting and cod), caught in '97, was considerably lower (respectively 13,601 ind./10^5m^2 and 7,378 ind./10^5m^2). (Fig. 17)

No general trend was noticed. In the total area an average decline in the common sole and the plaice populations was noted. This decline was limited to the juvenile stages. However, in the sampling stations near the coast (7, 27, 49 & 92) there was a considerable increase in juvenile common sole noticed, in comparison with '96. The other age categories maintained or even exceeded their last year densities. In the dab population the opposite was reported. An increase of juveniles went together with a decrease in the occurrence of the bigger categories. The whiting population was characterised by a general decrease whereas the cod communities showed a slight increase through all age categories, compared to last years catches.

(2) Research vessel A.962 Belgica (period August 1997) :

Ten sites were sampled scattered all over the Belgian Continental Shelf. A 40 mm meshed bottom trawl was used. The sampling positions were mentioned in the first report..

With the exception of stations 37 and P3, a general increase in fish catches was reported, in comparison with '96. (Fig. 19).

The total densities per sampled station varied from 275 ind./10^5m^2 (in station 37) to 4,040 ind./10^5m^2 (in station 86). All samples were dominated by the commercial important species: dab (*Limanda limanda*), plaice (*Pleuronectes platessa*) and common sole (*Solea solea*).

Twenty different species were determined of which five that didn't occur in '96 (turbot, whiting, Norwegian topknot, grey gurnard and smoothhound).

Some species seemed to be associated with specific areas e.g. flounder and brill were only caught at respectively stations 40a and 1 in '96 and '97.

The diversity index ranged from 1.61 (P2) to 3.10 (37). In station 40a only 4 species (common sole, bib, flounder and dab) were caught, whereas in station 1 11 different species were recorded. (Table 14 ; Fig. 18).

4. BIBLIOGRAPHY

ADEMA, J.P.H.M. (1991). *Krabben van Nederland en België*. Nationaal Natuurhistorisch Museum, Leiden. Universal Book Services.

ARNTZ, W.E. (1981). Zonation and dynamics of macrobenthic biomass in an area stressed by oxygen deficiency. In: *Stress effects on natural ecosystems*, edited by G. Barrett and R. Rosenberg. John Wiley & Sons, New York, pp. 215-225.

ARNTZ, W.E. and RUMOHR, H. (1986). Fluctuations of benthic macrofauna during succession and in an established community. *Meeresforschung*. 31: 97-114.

BARNES, R.D. (1980). *Invertebrate Zoology, fourth edition*. Saunders college, Philadelphia.

BERGMAN, M.J.N. and HUP, M. (1992). Direct effects of beamtrawling on macrofauna in a sandy sediment in the southern North Sea. *ICES J. mar. Sci.*, 49: 5-11.

DE GROOT, S.J. and LINDEBOOM, H.J. (Editors)(1994). Environmental impact of bottom gears on benthic fauna in relation to natural resources management and protection of the North Sea. *NIOZ-Rapport* 1994-11 ; *RIVO-DLO Report CO26/94.*

DEKKER, R. (1989). The macrozoobenthos of the subtidal western Dutch Wadden Sea. Biomass and species richness. *Netherlands Journal of Sea Research* 23(1): 57-68.

FRAUENHEIM, K. et All. (1989). The distribution of the larger Epifauna during summer and winter in the North Sea and its suitability for environmental monitoring. *Senckenbergiana marit.*, 20: 101-118.

HARTMANN-SCHRÖDER, G. (1996). *Annelida, Borstenwürmer, Polychaetea*. Gustav Fischer, Verlag Jena.

HAYWARD, P.J. and RYLAND, J.S. (1990). *The Marine Fauna of the British Isles and North-West Europe*. Clarendon Press. Oxford.

HILL, M.O. (1979). TWINSPAN- A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. In: *Ecology and Systematics*, Cornell University, Ithaca, New York : 1-48.

HOLMANN et All. (1995). The macrobenthic fauna in the Dutch sector of the North Sea in 1995 and a comparison with previous data. *NIOZ-Rapport* 1996-8.

McINTYRE, A.D. and ELEFTHERIOU, A. (1968). The bottom fauna of a flatfish nursery ground. *Journal of marine biol. Ass.* U.K. 48: 113-142.

SAETEVIK, S. (1988). Environmental cooperation between the North Sea states. Success or failure? (1988), Belhaven Press. London and New York.

VANOSMAEL, C. & HEIP, C. (1985). A comparative study of the macrobenthos of three sandbanks in the Belgian coastal waters in 1980-1984.

VANOSMAEL, C., et All (1982). Macrobenthos of a sublittoral sandbank in the Southern Bight of the North Sea. *Journal of the Marine Biological Association of the United Kingdom*, 62: 521-534.

WARWICK, R.M., PEARSON, T.H. and RUSWAHYUNI. (1987). Detection of pollution effects on marine macrobenthos: further evaluation of the species abundance/biomass method. *Marine Biology* 95: 193-200.

WILLEMS, K.A. et All (1982). Benthos of a sublittoral sandbank in the southern bight of the North Sea : general considerations. *Journal of marine biol. Ass.* U.K. (1982) 62: 549-557.

Figures & Tables

Fig. 1. - INTERCONNECTOR - Positions of sampling stations for macrobenthos research

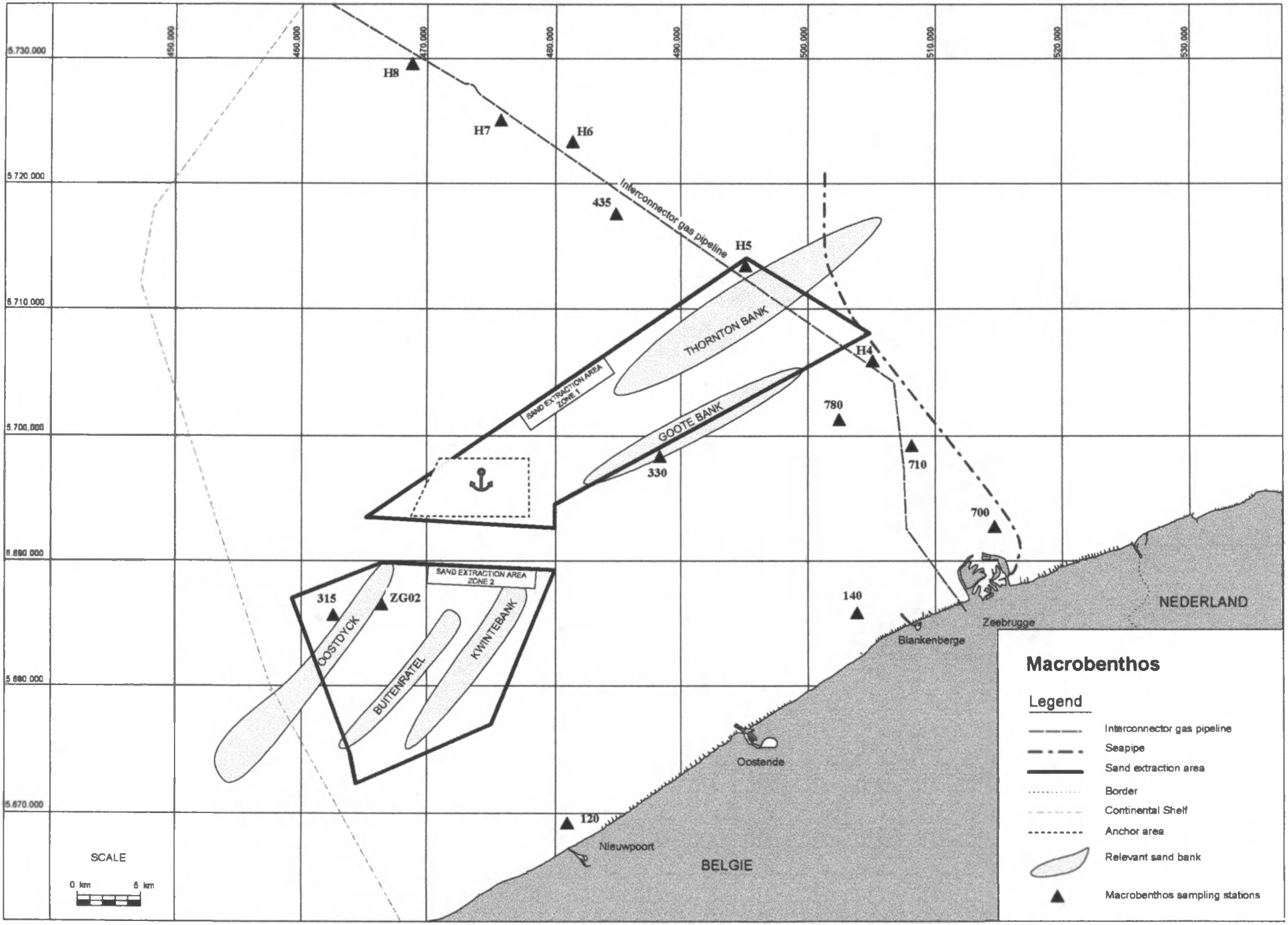


Fig. 2. - INTERCONNECTOR - Positions of sampling stations for epibenthos research

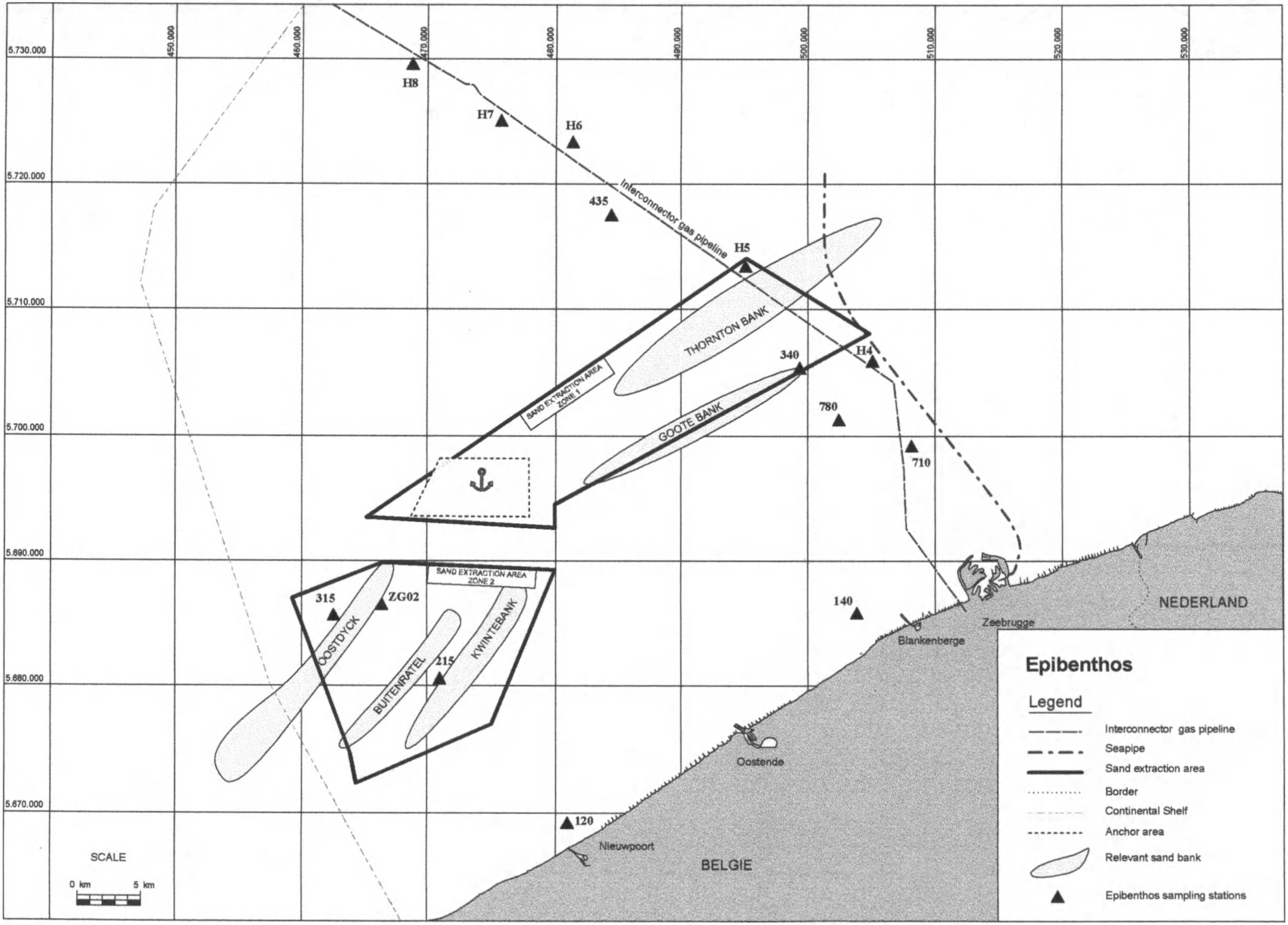


Fig. 3. - INTERCONNECTOR - Positions of sampling stations for fish research

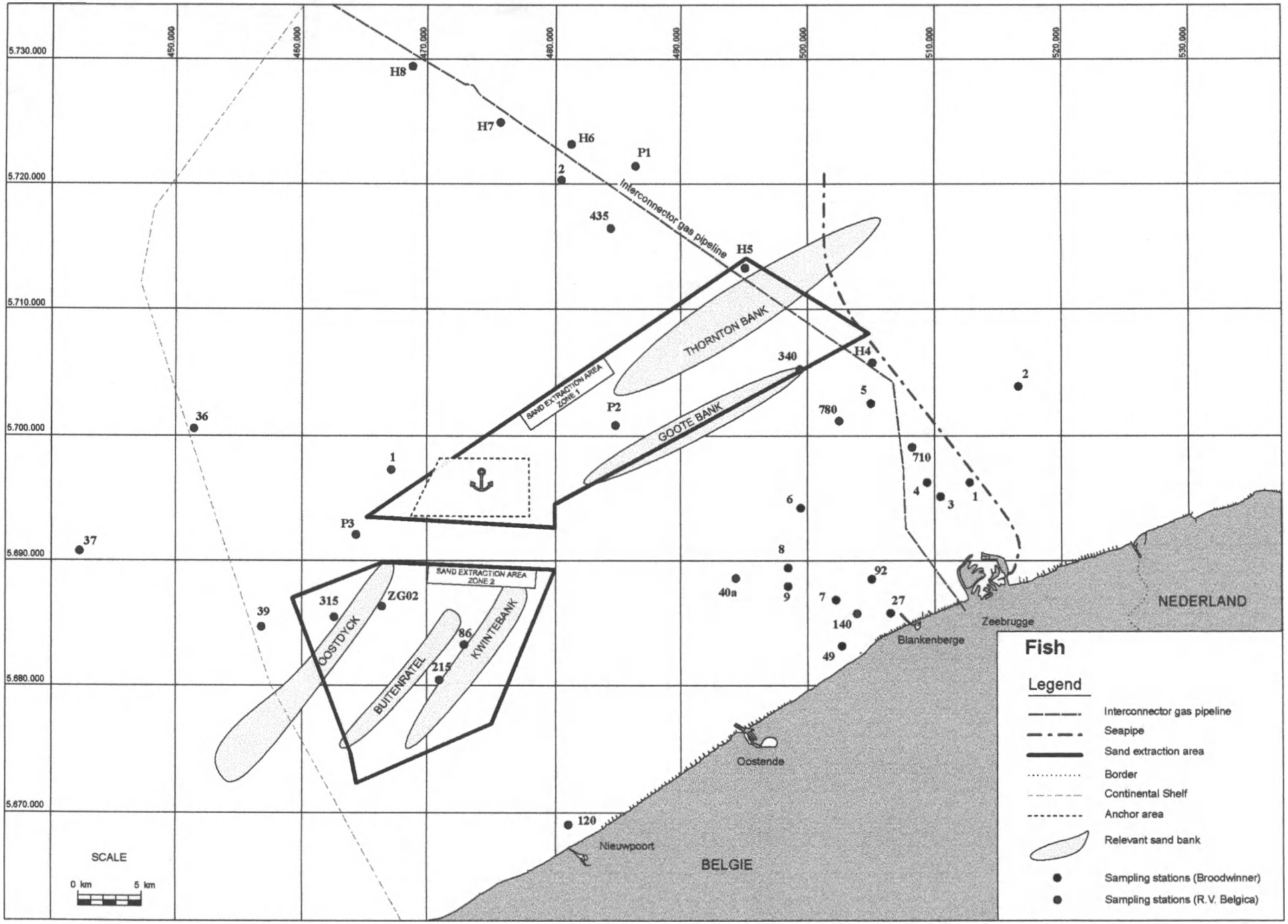


Table 1. : Sampling positions epi-and macrobenthos and fish (Interconnector)

Ship : A.962 "R.V. Belgica"

STATION	POSITION SHOT		TYPE
H4	51°30.00'	3°03.00'	Pipeline
H5	51°34.00'	2°55.00'	Pipeline
H6	51°40.00'	2°43.50'	Pipeline
H7	51°42.50'	2°38.50'	Pipeline
H8	51°45.00'	2°32.50'	Pipeline
120	51°11.05'	2°42.15'	reference
140	51°19.65'	3°03.05'	dredging
315	51°19.35'	2°27.80'	reference
215	51°16.75'	2°36.95'	reference
330*	51°26.00'	2°48.50'	sand
340	51°30.00'	3°00.10'	sand
435	51°34.80'	2°47.40'	reference
700*	51°22.60'	3°13.20'	dredging
710	51°26.00'	3°08.00'	dredging
780	51°28.30'	3°03.55'	dredging
ZG02*	51°20.00'	2°30.00'	reference

(*) no epibenthos and fish catches

Ship : 0.29 "Broodwinner"

STATION	POSITION SHOT	
1	51°25'47"	3°12'21"
2	51°29'17"	3°15'36"
3	51°25'02"	3°09'17"
4	51°25'83"	3°08'58"
5	51°28'45"	3°03'43"
6	51°23'86"	2°59'56"
7	51°19'69"	3°01'51"
8	51°21'45"	2°58'50"
9	51°20'29"	2°57'64"
27	51°18'88"	3°04'54"
49	51°17'23"	3°07'32"
92	51°20'62"	3°04'50"

Table 2. : Sampling periods (Interconnector)

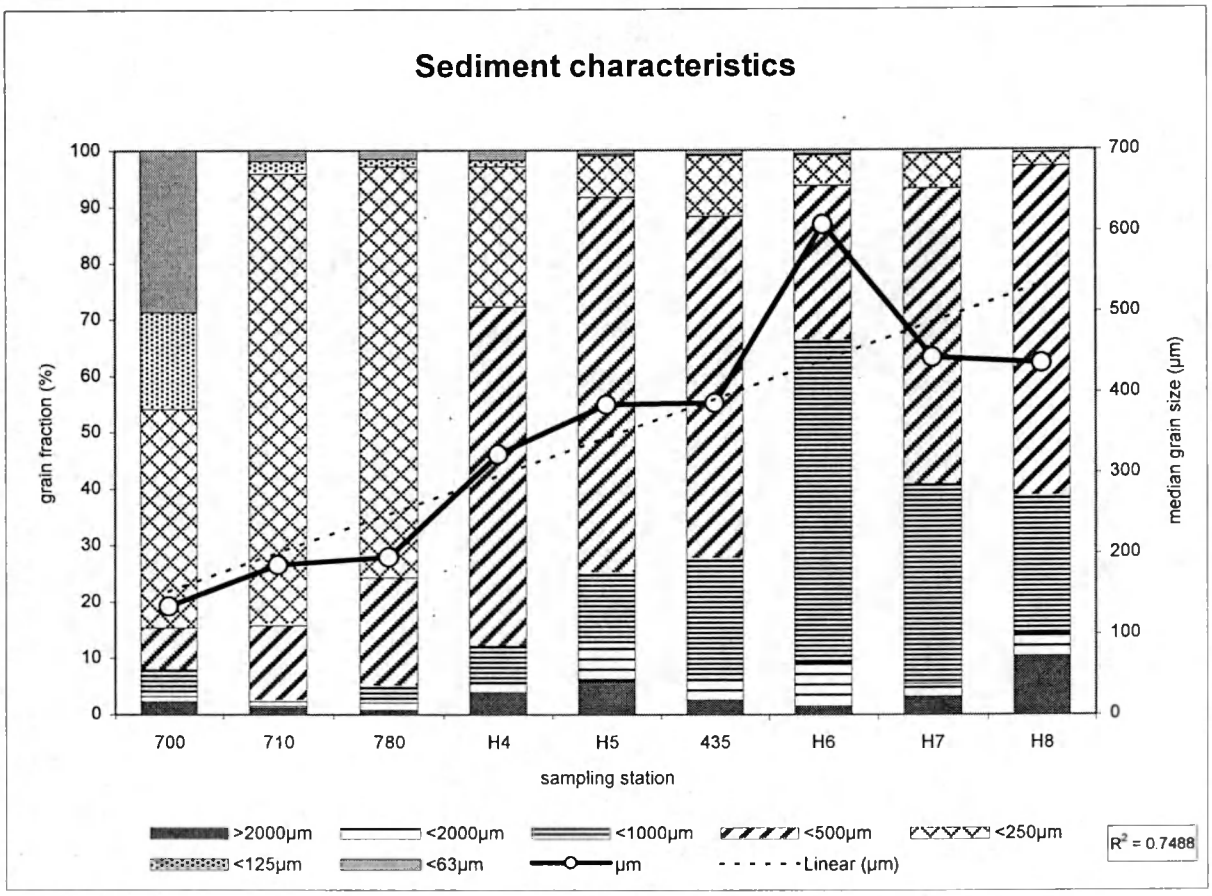
Ship : A.962 "R.V. Belgica"

Station	macrobenthos	epibenthos	Fish
H4	Autumn 1997	Autumn 1997	Autumn 1997
H5	Autumn 1997	Autumn 1997	Autumn 1997
H6	Autumn 1997	Autumn 1997	Autumn 1997
H7	Autumn 1997	Autumn 1997	Autumn 1997
H8	Autumn 1997	Autumn 1997	Autumn 1997
315	Autumn 1997	Autumn 1997	Autumn 1997
215	-	Autumn 1997	Autumn 1997
340	-	Autumn 1997	Autumn 1997
120	Autumn 1997	Autumn 1997	Autumn 1997
710	Autumn 1997	Autumn 1997	Autumn 1997
780	Autumn 1997	Autumn 1997	Autumn 1997
140	Autumn 1997	Autumn 1997	Autumn 1997
435	Autumn 1997	Autumn 1997	Autumn 1997
700	Autumn 1997	-	-
330	Autumn 1997	-	-
ZG02	Autumn 1997	-	-

Ship : 0.29 "Broodwinner"

Station	Fish
1	1996-1997
2	1996-1997
3	1996-1997
4	1996-1997
5	1996-1997
6	1996-1997
7	1996-1997
8	1996-1997
9	1996-1997
27	1996-1997
49	1996-1997
92	1996-1997

Fig. 4. : Sediment characteristics Interconnector pipeline (autumn 1997)



Wentworth scale

Phi	Median grain size (µm)	description
-1 - 0	1000-2000	very coarse sand
0 - 1	500-1000	coarse sand
1 - 2	250-500	medium coarse sand
2 - 3	125-250	fine sand
3 - 4	62.5-125	very fine sand
< 4	<62.5	silt

Fig. 5. : Average median grain size and standard deviation of 9 sampling sites scattered over the Belgian Continental Shelf (period '95-'97)

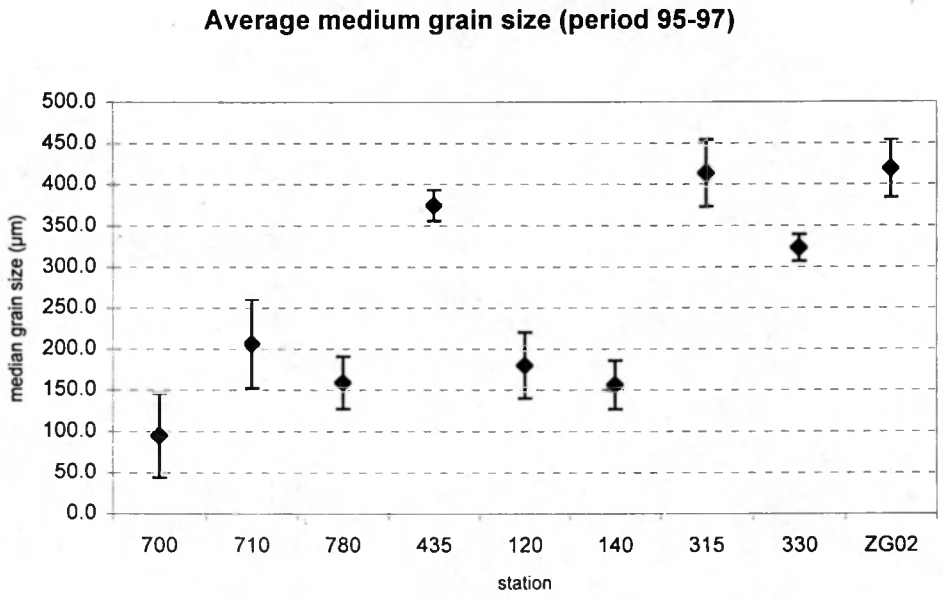
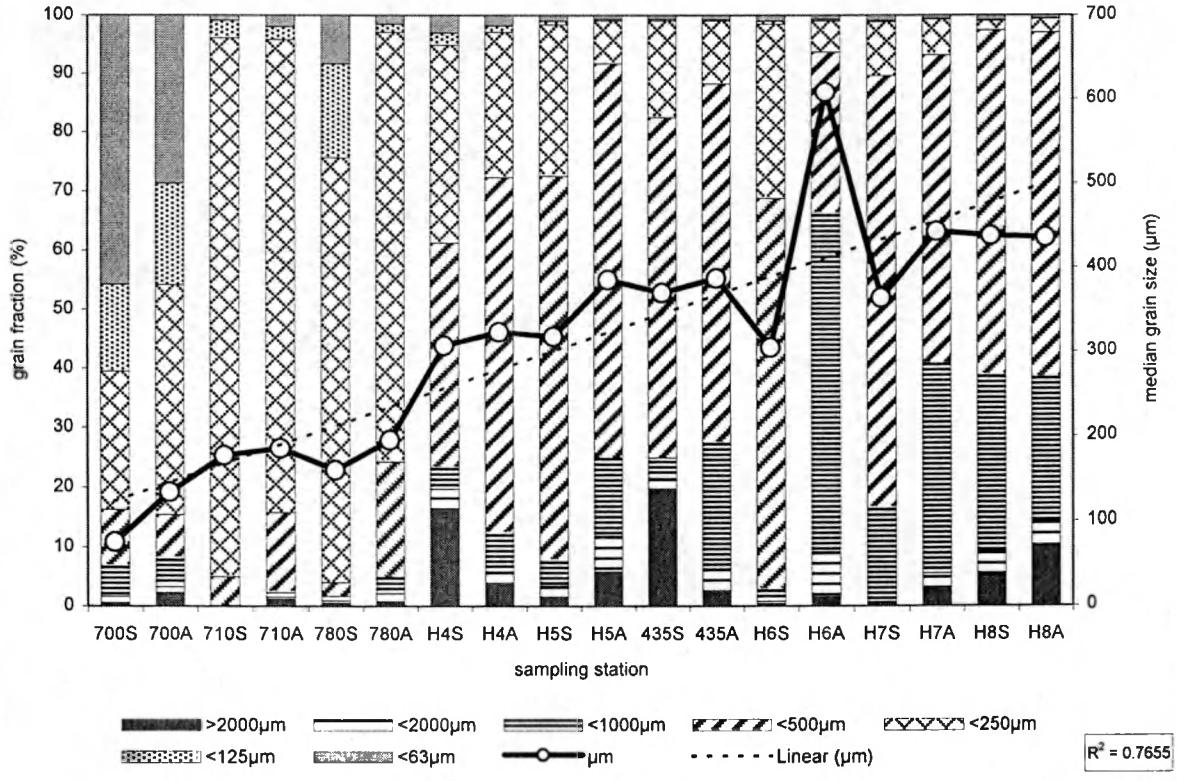
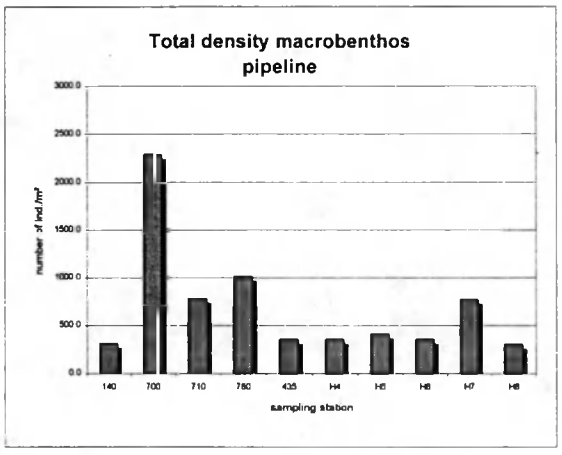


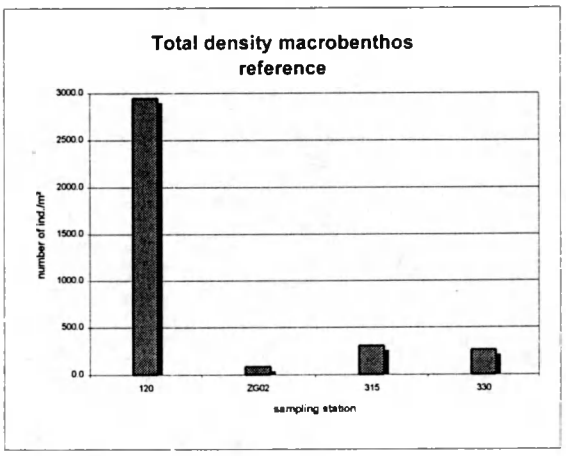
Fig. 6. : Sediment characteristics Interconnector Spring (S) and Autumn (A) 1997.

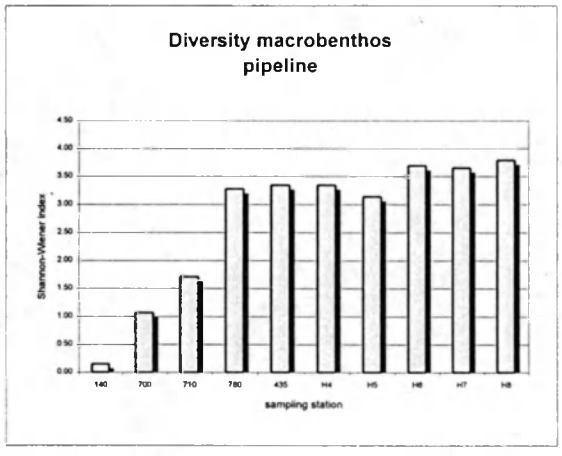


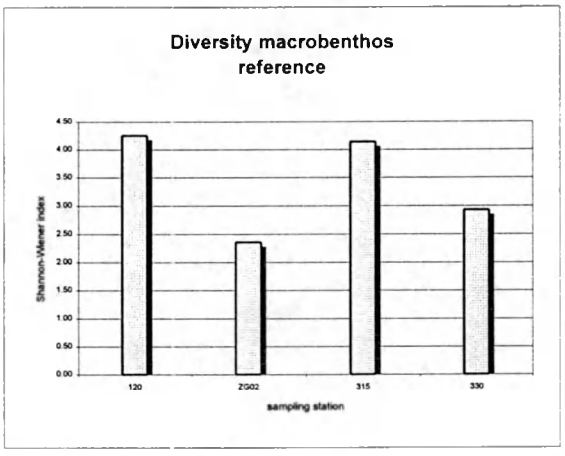
Macrobenthos

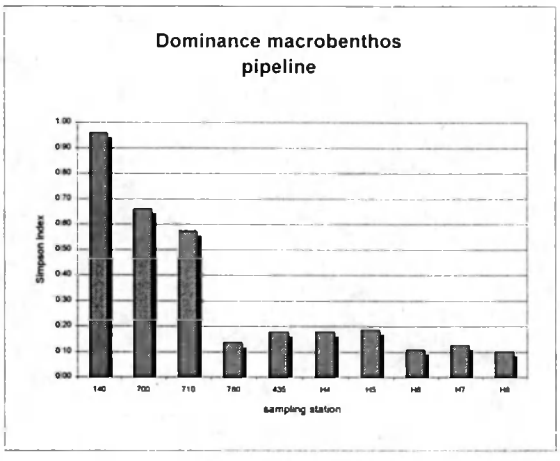
Fig. 7. : Total macrobenthos density, diversity and dominance of sampled stations along the pipeline and reference, after the installation (autumn 1997).











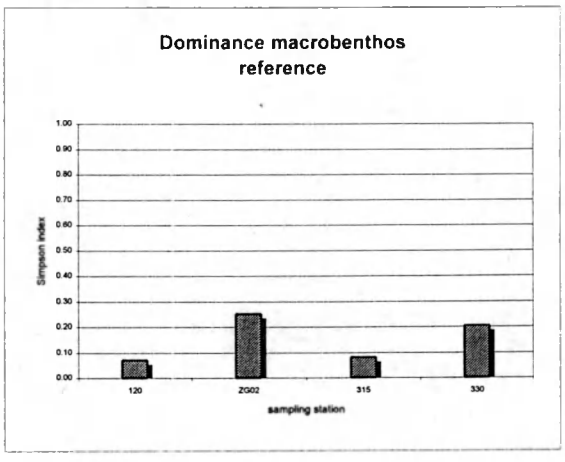


Fig. 8. : Mean macrobenthos composition of the sampling sites along the Interconnector pipeline (autumn 1997)

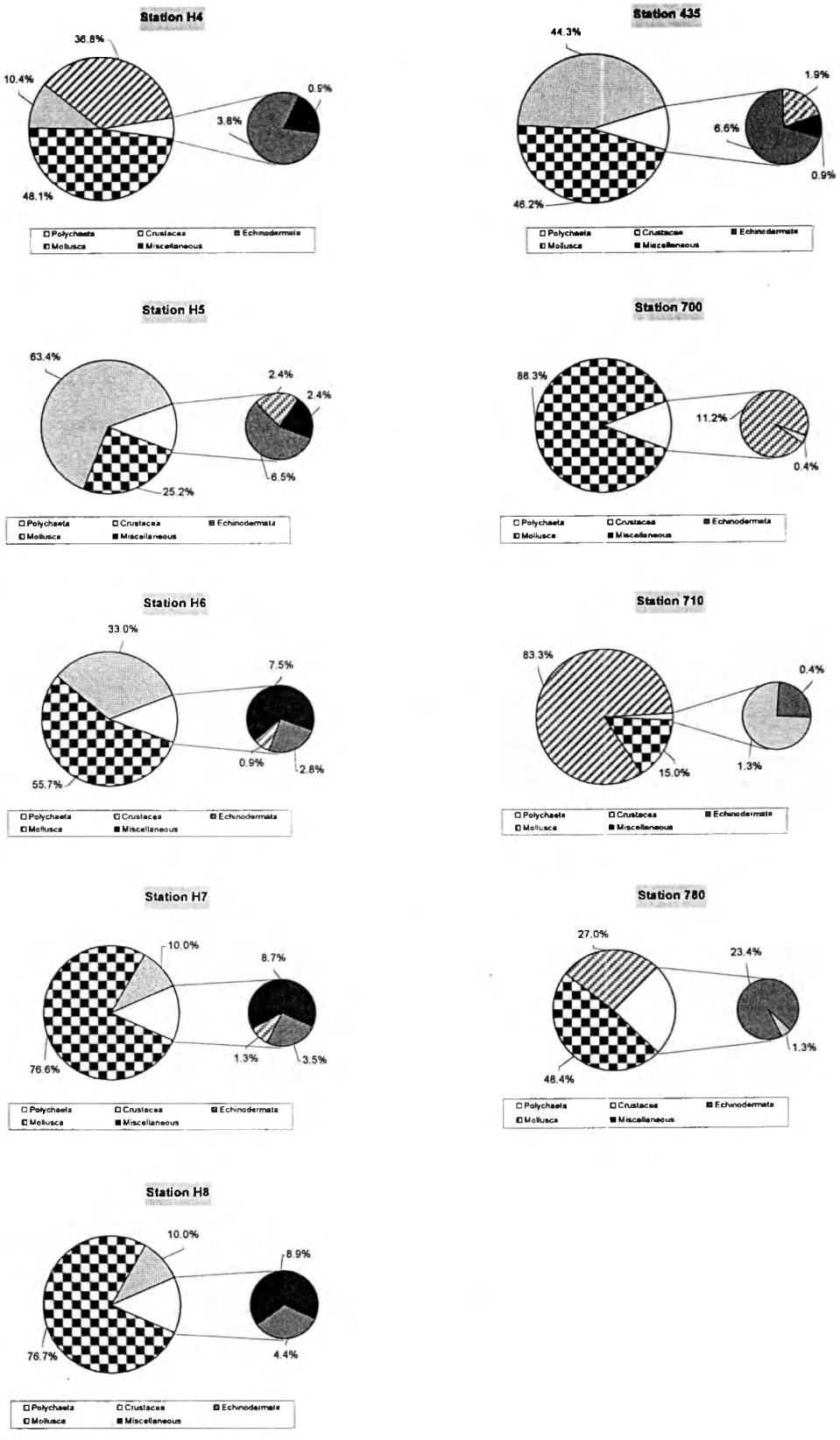


Fig. 9. : Mean macrobenthos composition (in % values) of the reference sampling sites (autumn 1997)

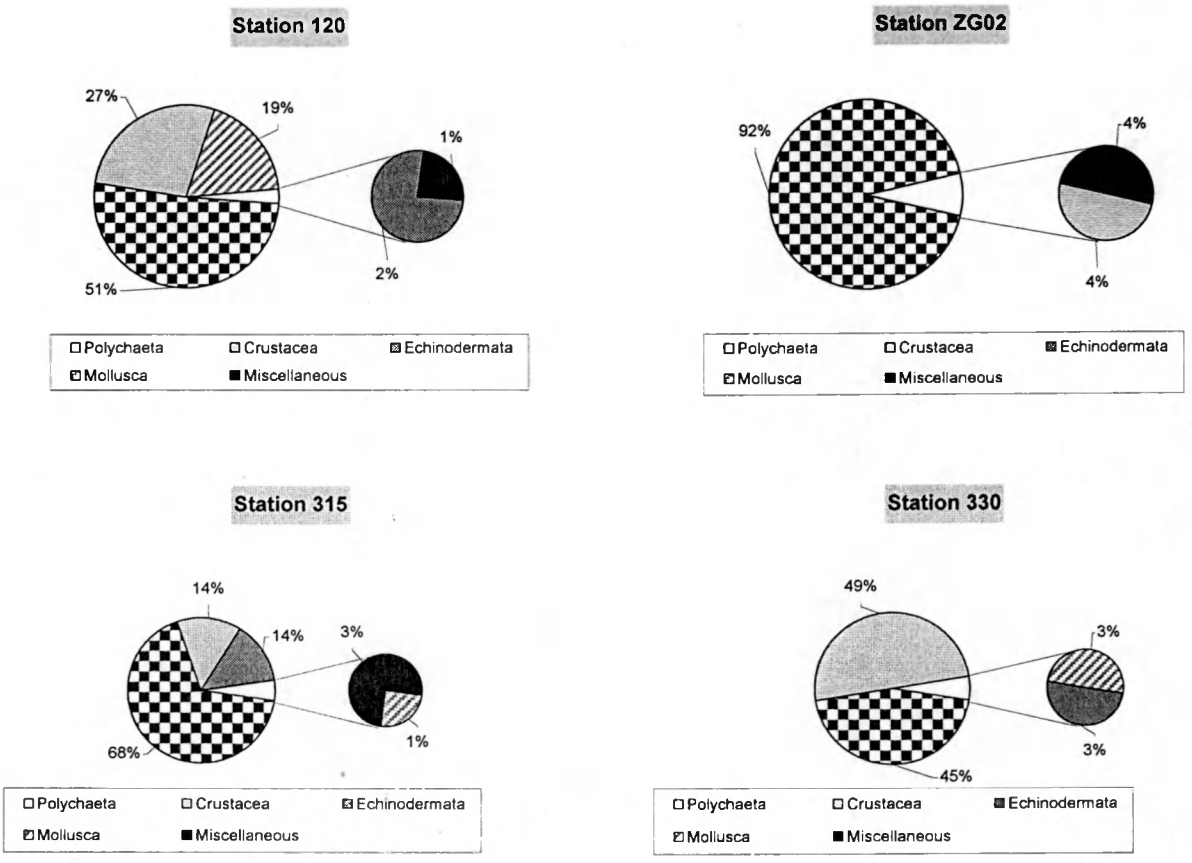


Table 4a. : Macrobenthos density (# ind./m²) and diversity along the trajectory of the Interconnector pipeline after installation (autumn 1997)

STATION	H4	H5	H6	H7	H8	140	435	700	710	780	Total
Polychaeta											
Aonides paucibranchiata	3.3	0.0	0.0	170.0	23.3	0.0	0.0	0.0	0.0	0.0	196.7
Chaetozone setosa	0.0	0.0	0.0	0.0	0.0	303.3	0.0	3.3	6.7	0.0	313.3
Eteone species	6.7	10.0	6.7	0.0	0.0	0.0	0.0	20.0	3.3	3.3	49.9
Eumida sanguinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	6.7
Eusyllis blomstrandi	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Exogone hebes	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	10.0
Glycera species	0.0	20.0	13.3	163.3	70.0	0.0	6.7	0.0	0.0	0.0	273.4
Hesionura elongata	0.0	0.0	6.7	23.3	13.3	0.0	6.7	0.0	0.0	0.0	50.0
Lanice conchilega	3.3	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	3.3	9.9
Lumbrineris species	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	6.7
Magelona mirabilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	3.3	16.6
Nephtys caeca	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	16.7	26.7
Nephtys cirrosa	3.3	30.0	23.3	6.7	23.3	0.0	33.3	0.0	0.0	0.0	119.9
Nephtys hombergii	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	123.3	146.7
Nephtys species	23.3	0.0	6.7	0.0	3.3	6.7	13.3	0.0	30.0	190.0	273.3
Nereis longissima	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	3.3	6.6
Nereis succinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	150.0	0.0	0.0	150.0
Notomastus latericeus	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Ophelia limacina	0.0	6.7	0.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	20.0
Pectinaria koreni	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7
Phyllodoce groenlandica	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7
Phyllodoce maculata	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	10.0	0.0	13.3
Poecilochaetus serpens	0.0	3.3	0.0	3.3	3.3	0.0	3.3	0.0	0.0	0.0	13.3
polychaeta species	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Polydora species	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1836.7	0.0	0.0	1836.7
Polygordius species	0.0	6.7	6.7	103.3	26.7	0.0	0.0	0.0	0.0	0.0	143.3
Protodorvillea kefersteini	0.0	0.0	0.0	6.7	3.3	0.0	0.0	0.0	0.0	0.0	10.0
Scolelepis species	0.0	0.0	3.3	0.0	0.0	0.0	33.3	0.0	0.0	0.0	36.6
Scoloplos armiger	33.3	6.7	16.7	3.3	0.0	0.0	6.7	0.0	6.7	63.3	136.7
Spio filicornis	0.0	0.0	13.3	10.0	30.0	0.0	0.0	0.0	0.0	0.0	53.3
Spio martinensis	16.7	10.0	23.3	10.0	0.0	0.0	0.0	0.0	20.0	63.3	143.3
Spio species	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	33.3
Spiophanes bombyx	53.3	10.0	76.7	0.0	6.7	0.0	16.7	0.0	6.7	20.0	190.1
Syllidae species	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	6.7
Thelepus cincinnatus	0.0	0.0	0.0	23.3	3.3	0.0	0.0	0.0	0.0	0.0	26.7
Travisia forbesii	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	3.3
Typosyllis armillaris	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
Crustacea											
Abludomelita obtusata	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
amphipoda species	6.7	0.0	13.3	10.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
Ampelisca brevicornis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.3
Atylus falcatus	3.3	0.0	0.0	3.3	3.3	0.0	0.0	0.0	0.0	0.0	10.0
Atylus species	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	3.3
Atylus swammerdami	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Bathyporeia guilliamsoniana	3.3	136.7	66.7	36.7	10.0	0.0	133.3	0.0	6.7	0.0	393.3
Bathyporeia species	0.0	0.0	16.7	0.0	0.0	0.0	0.0	6.7	0.0	3.3	26.7
Bodotria species	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Corophium species	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	3.3
Diastylis bradyi	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	3.3
Diastylis rathkei	0.0	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	16.6
Pariambus typicus	3.3	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	10.0
Perioculodes longimanus	6.7	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	10.0
Pontocrates altamarinus	0.0	0.0	0.0	6.7	6.7	0.0	0.0	0.0	0.0	0.0	13.3
Pseudocuma longicornis	0.0	0.0	3.3	3.3	10.0	0.0	0.0	0.0	0.0	0.0	16.7
Stenothoe marina	0.0	0.0	0.0	3.3	0.0	0.0	3.3	0.0	0.0	0.0	6.6
Thia scutellata	0.0	6.7	3.3	10.0	0.0	0.0	3.3	0.0	0.0	0.0	23.3
Urothoe brevicornis	6.7	100.0	13.3	0.0	0.0	0.0	10.0	0.0	0.0	0.0	130.0
Echinodermata											
Echinocardium cordatum	0.0	0.0	0.0	3.3	0.0	0.0	16.7	0.0	0.0	0.0	20.0
Echinocyamus pusillus	0.0	6.7	0.0	10.0	10.0	0.0	6.7	0.0	0.0	0.0	33.4
Psammechinus miliaris	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	3.3
juvenile ophiura species	13.3	20.0	10.0	13.3	0.0	0.0	0.0	0.0	3.3	233.3	293.3
Ophiura texturata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.3

Table 4b. : Macrobenthos density (# ind./m²) and diversity along the trajectory of the Interconnector pipeline after installation (autumn 1997)

STATION	H4	H5	H6	H7	H8	140	435	700	710	780	Total
Mollusca											
Abra alba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	123.3	130.0
Barnea candida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.3	0.0	0.0	23.3
Ensis species	130.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	586.7	13.3	730.0
Fabulina fabula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	3.3	16.6
Lunatia alderi	0.0	0.0	3.3	3.3	0.0	0.0	6.7	0.0	0.0	3.3	16.7
Macoma balitica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.3
Moerella pygmaea	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	6.7
Mysella bidentata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	33.3	36.6
Petricola pholadiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	233.3	0.0	0.0	233.3
Spisula subtruncata	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	93.3	143.3
Miscellaneous											
anthozoa species	3.3	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	6.6
Branchiostoma lanceolatum	0.0	10.0	26.7	66.7	26.7	0.0	0.0	0.0	0.0	0.0	130.0
Total # ind./m²	353.3	410.0	353.3	770.0	300.0	310.0	353.1	2286.6	780.0	1012.7	6929.0
Diversity											
Number of species	23	18	20	30	21	2	22	10	18	23	
Shannon-Wiener index	3.34	3.14	3.69	3.65	3.79	0.15	3.34	1.07	1.71	3.27	
Simpson's index	0.18	0.19	0.11	0.13	0.10	0.96	0.18	0.66	0.57	0.14	

Table 5a. : Macrobenthos density (# ind./m²) and diversity of 4 reference stations after installation of pipeline (autumn 1997)

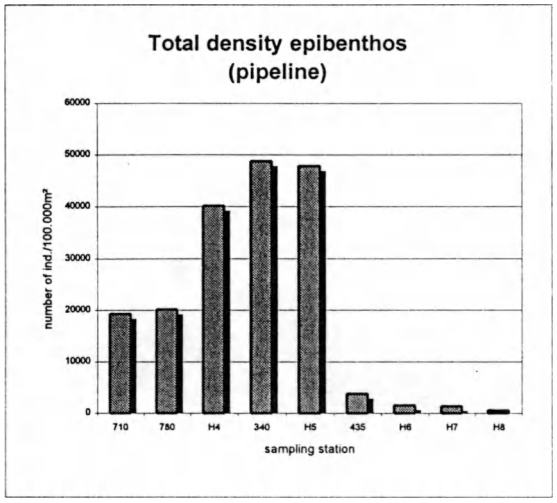
STATION	120	ZG02	315	330	Total
Polychaeta					
Ampharete species	3.3	0.0	0.0	0.0	3.3
Aonides paucibranchiata	0.0	0.0	13.3	0.0	13.3
Autolytus prolifer	156.7	0.0	0.0	0.0	156.7
Capitella species	113.3	0.0	0.0	0.0	113.3
Chaetozone setosa	293.3	0.0	0.0	0.0	293.3
Eteone species	33.3	0.0	3.3	0.0	36.6
Eumida sanguinea	110.0	0.0	0.0	0.0	110.0
Glycera species	0.0	0.0	23.3	0.0	23.3
Harmothoe glabra	0.0	0.0	3.3	0.0	3.3
Harmothoe species	16.7	0.0	0.0	0.0	16.7
Hesionura elongata	0.0	23.3	3.3	0.0	26.6
Lanice conchilega	193.3	0.0	3.3	0.0	196.6
Magelona mirabilis	3.3	0.0	0.0	0.0	3.3
Nephtys caeca	26.7	0.0	0.0	0.0	26.7
Nephtys cirrosa	0.0	33.3	36.7	60.0	130.0
Nephtys hombergii	6.7	0.0	0.0	0.0	6.7
Nephtys species	253.3	0.0	3.3	26.7	283.3
Nereis longissima	0.0	0.0	0.0	3.3	3.3
Nereis species	3.3	0.0	0.0	0.0	3.3
Ophelia limacina	0.0	3.3	3.3	0.0	6.6
Pectinaria koreni	16.7	0.0	33.3	0.0	50.0
Pholoe minuta	10.0	0.0	0.0	0.0	10.0
Phyllodoce maculata	13.3	0.0	0.0	3.3	16.6
Poecilochaetus serpens	3.3	0.0	50.0	0.0	53.3
Polydora species	3.3	0.0	0.0	0.0	3.3
Polygordius species	0.0	0.0	3.3	0.0	3.3
Scolelepis species	0.0	3.3	0.0	0.0	3.3
Scoloplos armiger	56.7	0.0	3.3	6.7	66.7
Spio filicornis	0.0	3.3	0.0	0.0	3.3
Spio martinensis	3.3	0.0	0.0	0.0	3.3
Spio species	0.0	13.3	20.0	13.3	46.6
Spiophanes bombyx	193.3	3.3	3.3	3.3	203.2
Crustacea					
Abludomelita obtusata	100.0	0.0	0.0	0.0	100.0
Amphilochus manudens	30.0	0.0	0.0	0.0	30.0
amphipoda species	3.3	0.0	6.7	0.0	10.0
Atylus species	0.0	0.0	3.3	0.0	3.3
Atylus swammerdami	0.0	0.0	0.0	3.3	3.3
Bathyporeia guilliamsoniana	0.0	0.0	6.7	16.7	23.4
Bathyporeia species	0.0	0.0	0.0	10.0	10.0
Bodotria arenosa	26.7	0.0	0.0	0.0	26.7
Bodotria scorpioides	43.3	0.0	0.0	0.0	43.3
Bodotria species	16.7	0.0	3.3	0.0	20.0
Corophium bonelli	3.3	0.0	0.0	0.0	3.3
Corophium volutator	3.3	0.0	0.0	0.0	3.3
Diastylis bradyi	0.0	0.0	0.0	3.3	3.3
Diastylis species	10.0	0.0	3.3	0.0	13.3
Eurydice spinigera	0.0	3.3	0.0	0.0	3.3
Leucothoe incisa	0.0	0.0	6.7	0.0	6.7
Microprotopus maculatus	303.3	0.0	0.0	0.0	303.3
Pariambus typicus	240.0	0.0	0.0	0.0	240.0
Perioculodes longimanus	0.0	0.0	3.3	0.0	3.3
Phtisica marina	30.0	0.0	0.0	0.0	30.0
Thia scutellata	0.0	0.0	3.3	3.3	6.6
Urothoe brevicornis	0.0	0.0	6.7	93.3	100.0
Echinodermata					
Echinocardium cordatum	0.0	0.0	3.3	0.0	3.3
Echinocyamus pusillus	0.0	0.0	3.3	0.0	3.3
Psammechinus miliaris	0.0	0.0	0.0	0.0	0.0
juvenile ophiura species	53.3	0.0	33.3	6.7	93.3
Ophiura albida	0.0	0.0	3.3	0.0	3.3

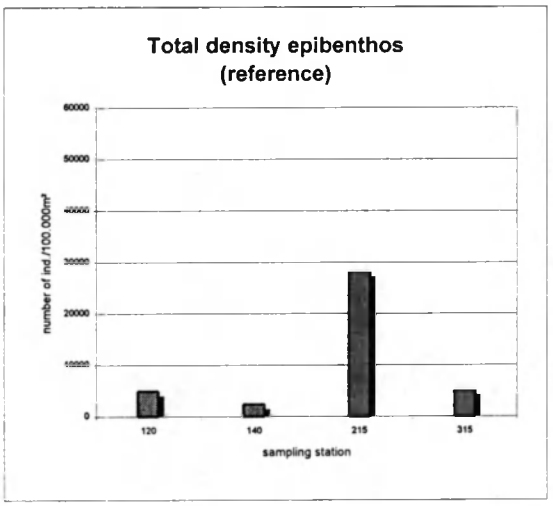
Table 5b. : Macrobenthos density (# ind./m²) and diversity of 4 reference stations after installation of pipeline (autumn 1997)

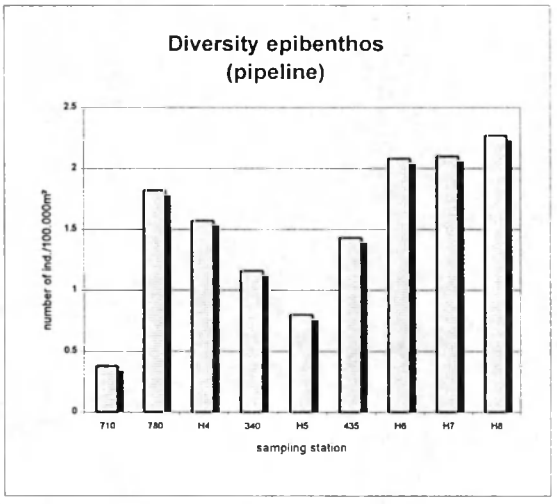
STATION	120	ZG02	315	330	Total
Mollusca					
Abra alba	56.7	0.0	0.0	0.0	56.7
Arca tetragona	0.0	0.0	3.3	3.3	6.6
Crepidula fornicata	13.3	0.0	0.0	0.0	13.3
Ensis species	53.3	0.0	0.0	0.0	53.3
Mysella bidentata	23.3	0.0	0.0	0.0	23.3
Spisula subtruncata	403.3	0.0	0.0	3.3	406.6
Venerupis pullastra	3.3	0.0	0.0	0.0	3.3
Miscellaneous					
anthozoa species	16.7	0.0	0.0	0.0	16.7
Branchiostoma lanceolatum	0.0	0.0	10.0	0.0	10.0
Total # ind./m²	2946.2	86.4	306.1	259.8	3598.5
Diversity					
Number of species	41	8	30	16	
Shannon-Wiener index	4.25	2.36	4.14	2.92	
Simpson's index	0.07	0.25	0.08	0.20	

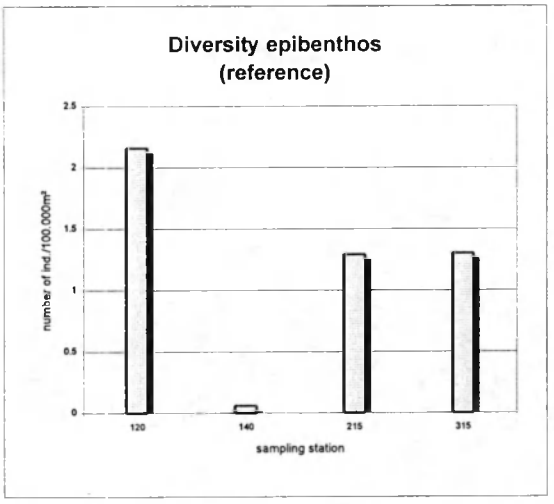
Epibenthos

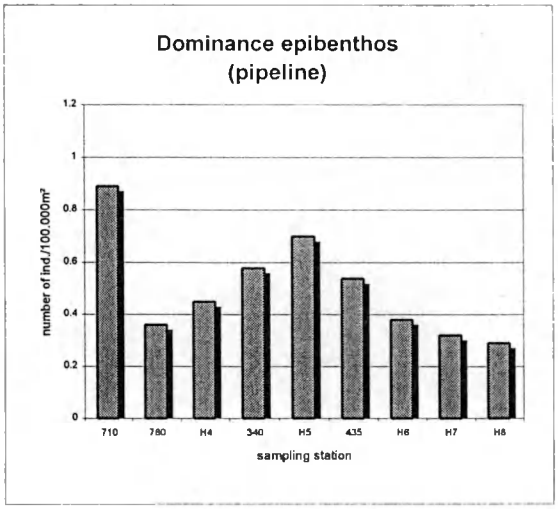
Fig. 10. : Total density, diversity and dominance of sampled epibenthos stations (autumn 1997)











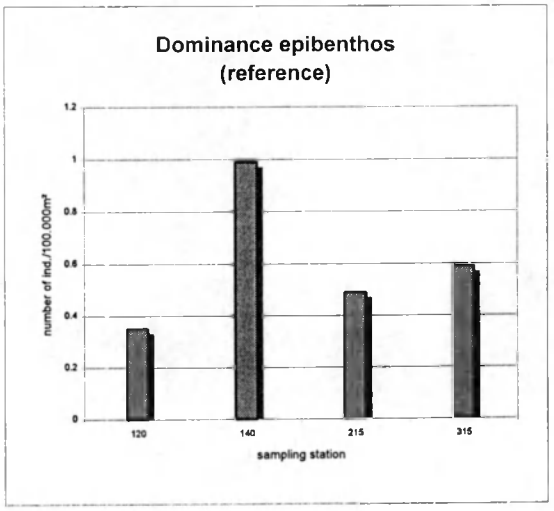
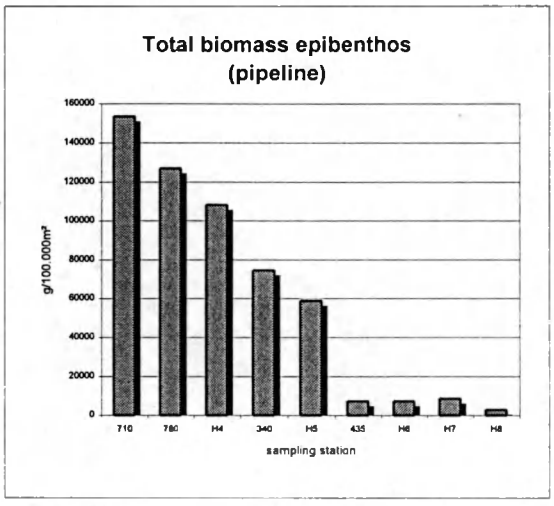


Fig. 11. : Total biomass of sampled epibenthos stations (autumn 1997)



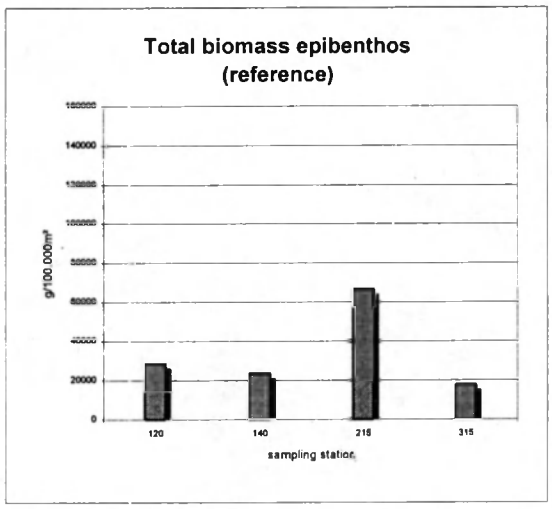
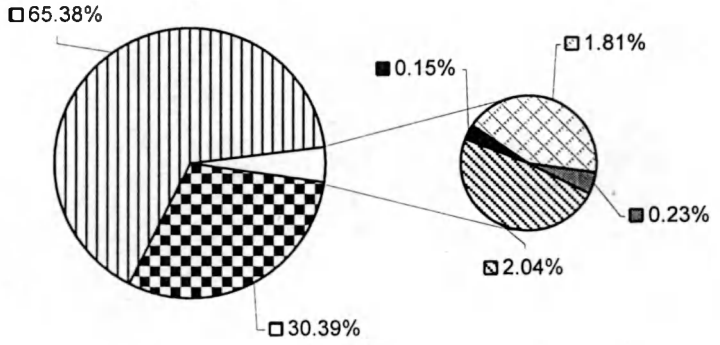


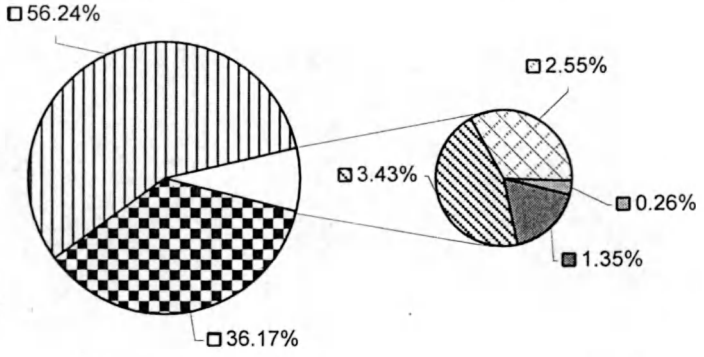
Fig. 12. : Mean densities (in % values) of the most important epibenthic species along the Interconnector pipeline (a) and of some reference stations (b) (autumn 1997).

(a) Mean density (in %) pipeline
(H4, H5, H6, H7, H8, 435, 340, 710 & 780)



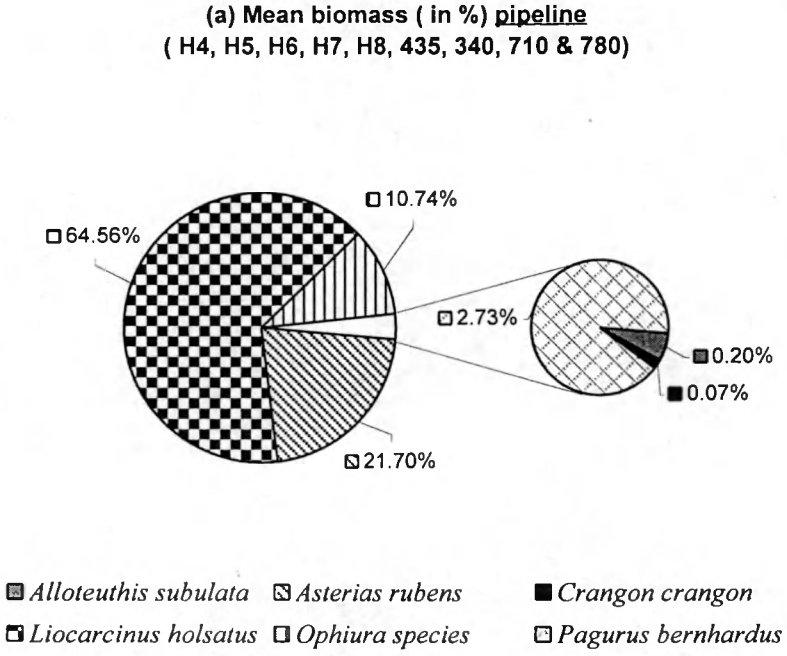
Alloteuthis subulata *Asterias rubens* *Crangon crangon*
Liocarcinus holsatus *Ophiura species* *Pagurus bernhardus*

(b) Mean density (in %) reference stations
(120,140, 215 & 315)



Actinia equina *Asterias rubens* *Liocarcinus holsatus*
Ophiura species *Pagurus bernhardus* *Sepia officinalis*

Fig. 13. : Mean biomass (in % values) of the most important epibenthic species along the Interconnector pipeline (a) and of some reference stations (b) (autumn 1997).



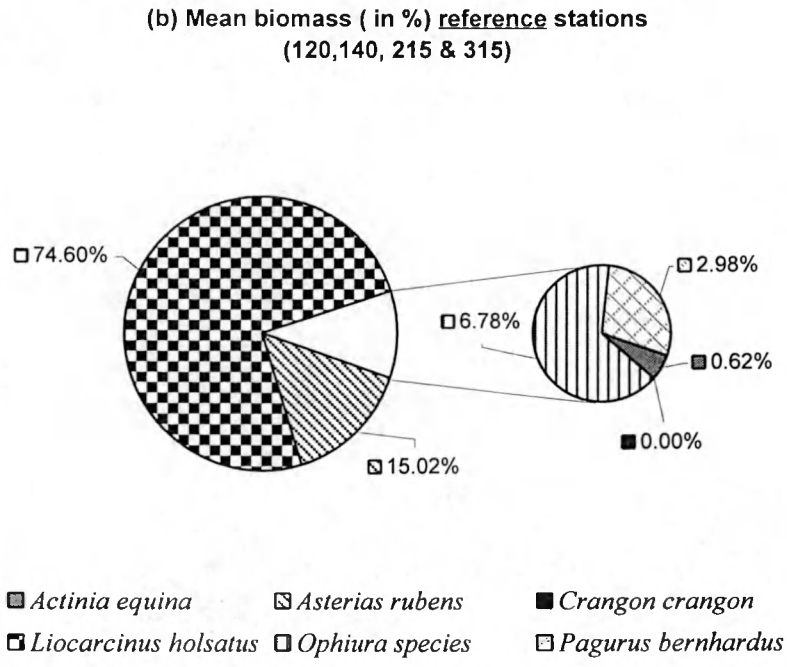


Table 7. : Total density of epibenthos for sampling stations along the trajectory of the Interconnector pipeline (density in # ind./100.000 m²)(autumn 1997)

STATION	H4	H5	H6	H7	H8	340	435	710	780	Total
anthozoa species	0	0	10	0	0	0	0	0	274	284
Alloteuthis subulata	0	68	34	65	44	110	92	0	0	413
Asterias rubens	1362	90	68	195	44	964	41	151	801	3716
Crangon crangon	241	0	34	0	5	0	0	0	0	280
Echinocardium cordatum	0	0	15	0	0	0	0	0	0	15
Hyas coarctatus	0	0	0	4	0	0	13	0	0	17
Loligo vulgaris	0	0	0	9	5	0	35	0	0	49
Liocarcinus arcuatus	0	0	0	0	0	0	0	0	223	223
Liocarcinus holsatus	7952	7978	926	113	10	9693	730	18201	9780	55383
Liocarcinus depurator	121	0	0	0	0	28	0	0	0	149
Liocarcinus marmoreus	0	0	39	9	0	0	0	0	0	48
Macropodia rostrata	0	23	15	26	44	55	19	0	0	182
Necora puber	131	0	0	0	0	0	0	0	0	131
Ophiura albida	25410	39146	270	0	203	35937	2738	678	1341	105723
Ophiura texturata	4579	90	5	9	0	1735	32	0	6978	13428
Pagurus bernhardus	412	407	154	741	275	193	117	243	760	3302
Psammechinus miliaris	0	0	0	295	10	0	3	0	0	308
Sepia officinalis	0	0	0	0	0	22	0	0	0	22
Sepiola atlantica	0	90	19	0	0	83	6	0	0	198
Spatangus purpureus	0	0	0	0	5	0	0	0	0	5
Thia polita	0	23	5	0	10	0	35	0	0	73
Total	40208	47915	1594	1466	655	48820	3861	19273	20157	183949
Diversity										
Number of species	8	9	13	10	0	10	12	4	7	
Shannon-Wiener index	1.57	0.80	2.08	2.10	2.27	1.16	1.43	0.38	1.82	
Simpson index	0.45	0.70	0.38	0.32	0.29	0.58	0.54	0.89	0.36	

Table 8. : Total density of epibenthos for reference sampling stations (density in # ind./100.000 m²)(autumn 1997)

STATION	120	140	215	315	Total
anthozoa species	381	16	148	0	545
Alloteuthis subulata	0	0	49	78	127
Asterias rubens	180	0	641	558	1379
Liocarcinus holsatus	2761	2402	9126	262	14551
Liocarcinus arcuatus	43	0	0	0	43
Macropodia rostrata	27	0	0	0	27
Mytilus edulis	274	0	0	0	274
Ophiura albida	147	0	17513	3871	21531
Ophiura texturata	841	0	222	34	1097
Pagurus bernhardus	284	0	444	296	1024
Psammechinus miliaris	0	0	0	23	23
Sepia officinalis	70	0	25	10	105
Total	5008	2418	28168	5132	40726
Diversity					
Number of species	10	2	8	8	
Shannon-Wiener index	2.16	0.06	1.29	1.30	
Simpson index	0.35	0.99	0.49	0.59	

Table 9. : Total biomass of epibenthos for sampling stations along the trajectory of the Interconnector pipeline (biomass in g/100.000 m²)(autumn 1997)

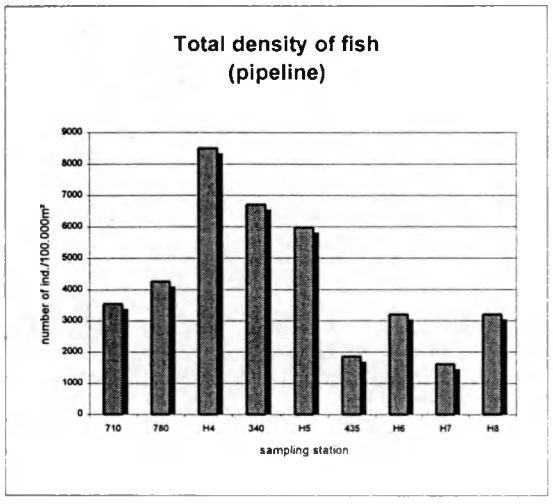
STATION	H4	H5	H6	H7	H8	340	435	710	780	Total
anthozoa species	0	0	10	0	0	0	0	0	420	430
Alloteuthis subulata	0	77	34	98	46	606	207	0	0	1068
Asterias rubens	53449	457	68	1765	775	8170	780	3514	48572	117550
Crangon crangon	357	0	33	0	4	0	0	0	0	394
Echinocardium cordatum	0	0	402	0	0	0	0	0	0	402
Hyas coarctatus	0	0	0	8	0	0	12	0	0	20
Loligo vulgaris	0	0	0	116	35	0	872	0	0	1023
Liocarcinus arcuatus	0	0	0	0	0	0	0	0	156	156
Liocarcinus holsatus	40341	38190	4932	285	8	47134	3187	149489	66117	349683
Liocarcinus depurator	605	0	0	0	0	308	0	0	0	913
Liocarcinus marmoreus	0	0	439	39	0	0	0	0	0	478
Macropodia rostrata	0	2	15	38	46	52	10	0	0	163
Necora puber	209	0	0	0	0	0	0	0	0	209
Ophiura albida	6611	16235	84	0	84	11739	1495	166	481	36895
Ophiura texturata	5977	249	7	32	0	4458	155	0	10378	21256
Pagurus bernhardus	719	3469	1376	4745	1733	746	556	443	1002	14789
Psammechinus miliaris	0	0	0	1595	135	0	50	0	0	1780
Sepia officinalis	0	0	0	0	0	1200	0	0	0	1200
Sepiola atlantica	0	213	41	0	0	168	18	0	0	440
Spatangus purpureus	0	0	0	0	112	0	0	0	0	112
Thia polita	0	45	6	0	21	0	34	0	0	106
Total	108268	58937	7447	8721	2999	74581	7376	153612	127126	549067

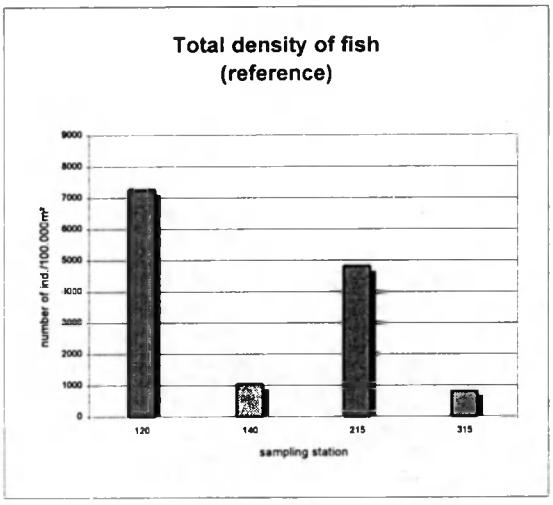
Table 10. : Total biomass of epibenthos for reference sampling stations (biomass in g/100.000 m²)

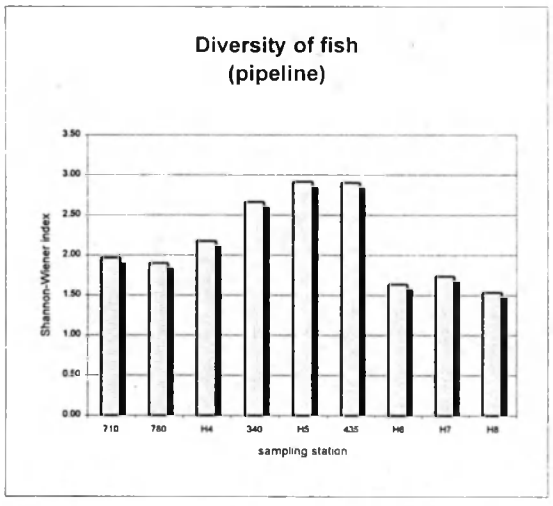
STATION	120	140	215	315	Total
anthozoa species	559	46	224	0	829
Alloteuthis subulata	0	0	382	1497	1879
Asterias rubens	2949	0	5054	11956	19959
Liocarcinus holsatus	21412	23619	52752	1348	99131
Liocarcinus arcuatus	48	0	0	0	48
Macropodia rostrata	18	0	0	0	18
Mytilus edulis	1033	0	0	0	1033
Ophiura albida	59	0	5671	1291	7021
Ophiura texturata	1279	0	602	105	1986
Pagurus bernhardus	725	0	1754	1478	3957
Psammechinus miliaris	0	0	0	154	154
Sepia officinalis	677	0	289	98	1064
Total	28759	23665	66728	17927	137079

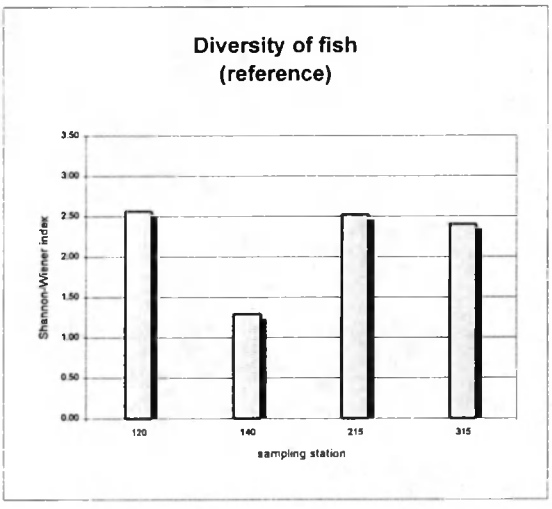
Fish

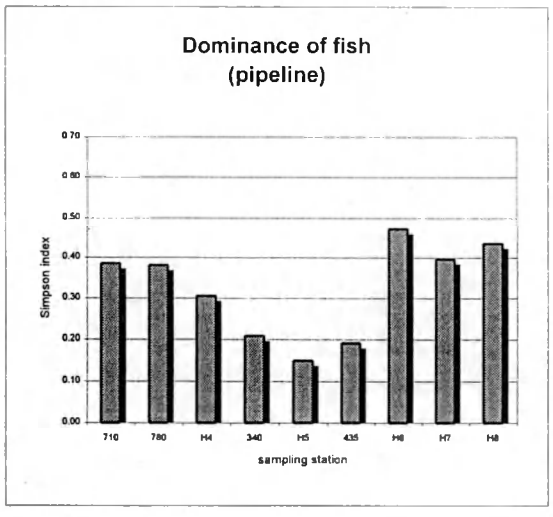
Fig. 14. : Total density, diversity and dominance of sampled fishstock (autumn 1997)











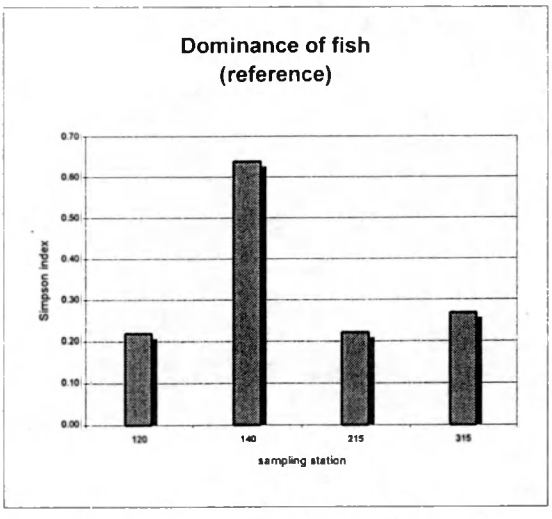
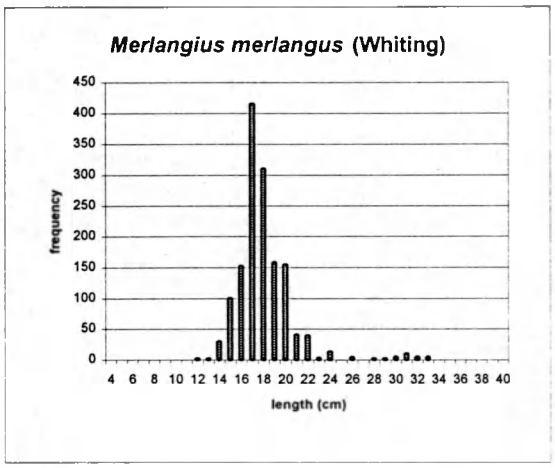
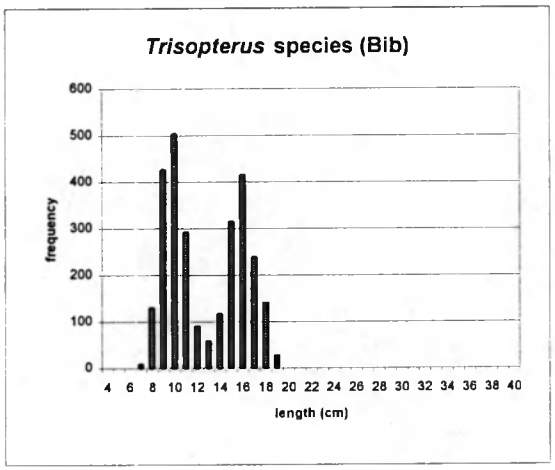
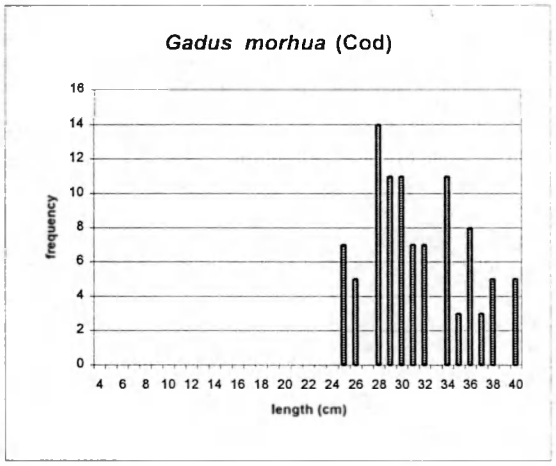
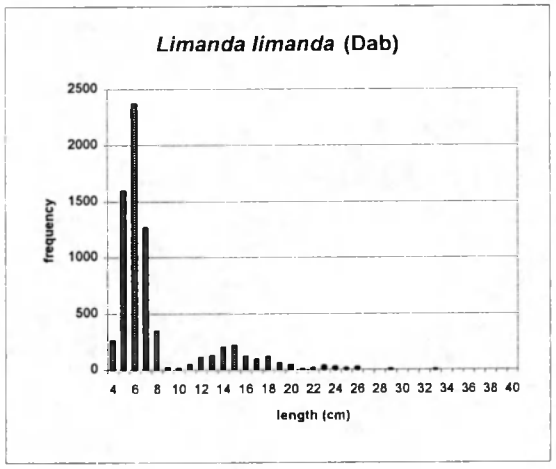


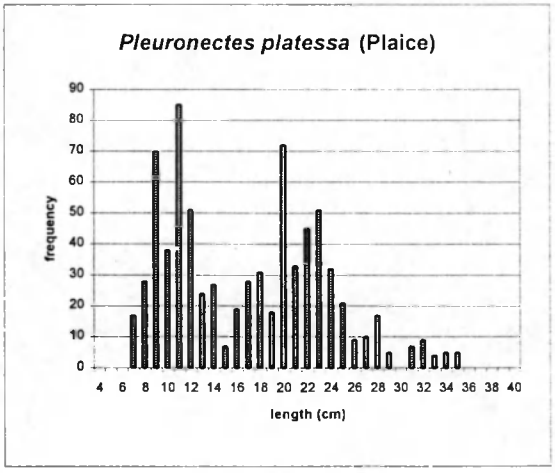
Fig. 15. : Length-frequency distribution of the commercial fish species along the **Interconnector pipeline** (sampling stations 710-780-H4-340-H5-435-H6-H7-H8)(autumn 1997)











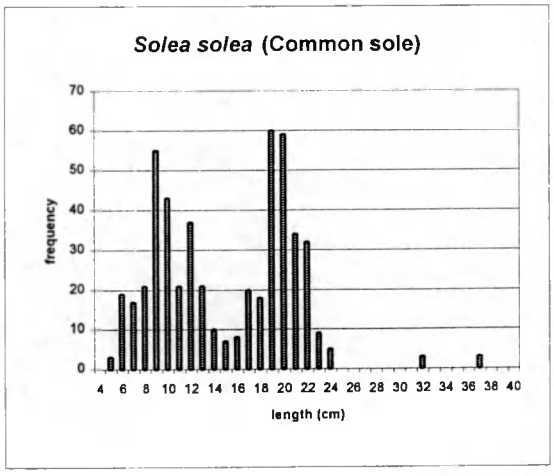
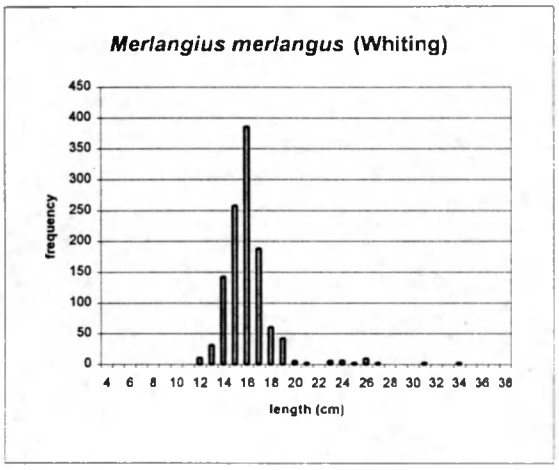
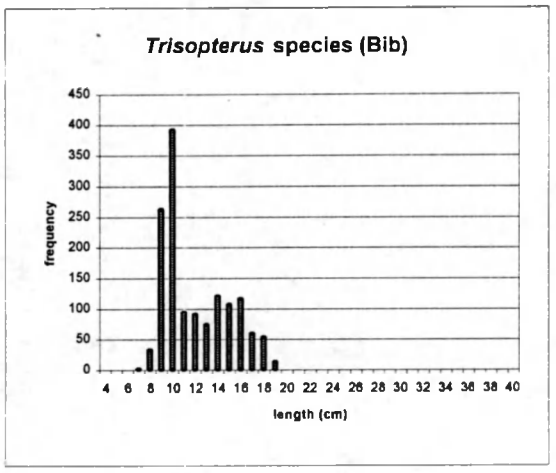
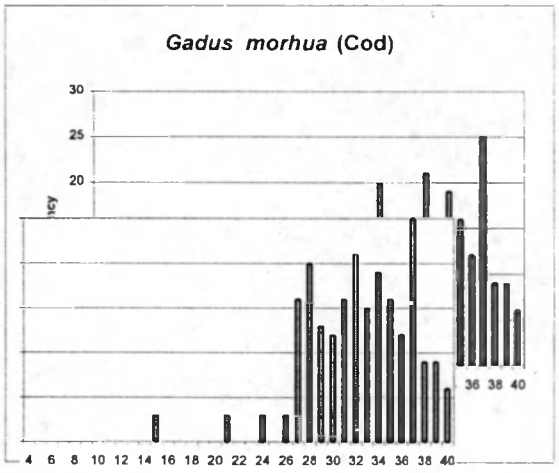
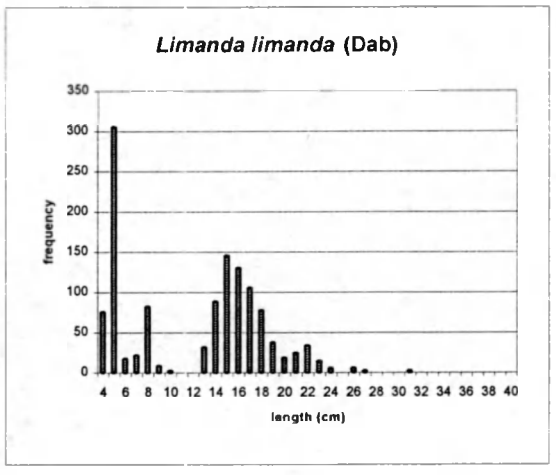


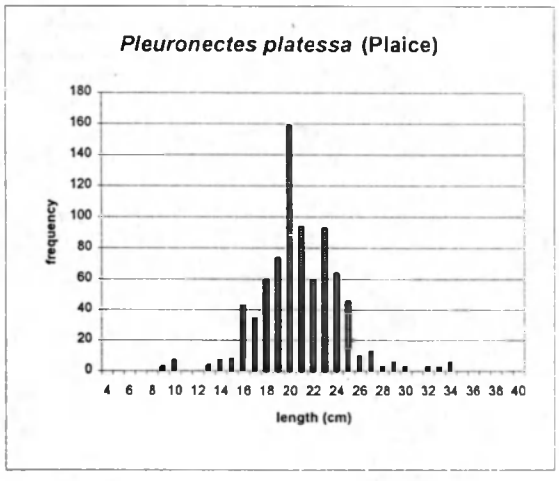
Fig. 16. : Length-frequency distribution of the commercial fish species caught at the **reference** stations (sampling stations 120-215-315)(autumn 1997)











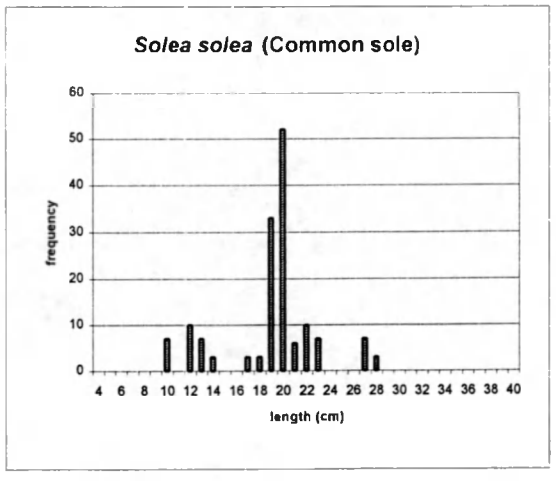


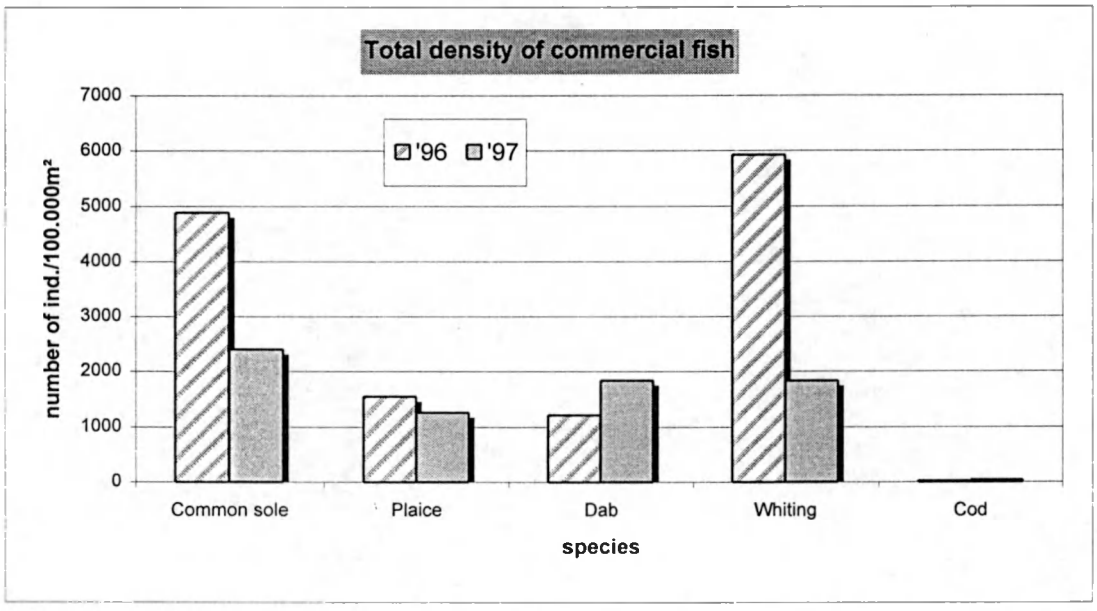
Table 11. : Density, diversity of fish species along the **Interconnector pipeline** (autumn 1997)

STATION	710	780	H4	340	H5	435	H6	H7	H8	Total
Agonus cataphractus	202	1274	704	65	0	3	0	0	0	2248
Ammodytes tobianus	10	10	0	4	20	44	34	26	24	172
Arnoglossus laterna	0	0	0	0	10	3	0	0	0	13
Buglossidium luteum	3	0	5	32	55	19	19	0	0	133
Callionymus lyra	3	27	412	528	829	314	125	22	19	2279
Callionymus recticulatus	0	0	0	14	377	16	0	0	0	407
Ciliata mustela	21	10	0	0	0	0	0	0	0	31
Clupea harengus	51	7	0	0	0	0	0	0	0	58
Cyclopterus lumpus	0	0	0	0	0	0	0	0	5	5
Gadus morhua	0	26	10	15	5	9	0	12	25	102
Gobius niger	0	0	0	0	0	0	0	4	0	4
Hyperoplus lanceolatus	0	0	0	0	0	0	48	17	14	79
Hyppoglossoides platessoides	0	0	45	0	0	0	0	0	0	45
Limanda limanda	615	219	4176	1247	958	95	58	33	34	7435
Liparis liparis	0	3	0	0	0	0	0	0	0	3
Merlangius merlangus	29	49	250	209	835	100	0	0	0	1472
Microstomus kitt	0	0	15	0	0	0	0	0	0	15
Mullus surmuletus	0	0	0	4	35	0	19	30	53	141
Mustelus mustelus	0	0	0	7	0	57	0	0	0	64
Myoxocephalus scorpius	3	7	0	0	0	0	0	0	0	10
Platichthys flesus	3	7	0	11	0	0	0	0	0	21
Pleuronectes platessa	317	84	10	211	30	63	15	8	30	768
Pomatoschistus minutus	2064	2285	1598	2342	1291	136	39	4	19	9778
Scomber scombrus	0	0	0	4	0	0	5	0	0	9
Solea solea	200	124	40	106	30	0	5	0	0	505
Trachurus trachurus	0	0	30	22	5	54	752	676	1667	3206
Trachurus vipera	0	0	10	1256	1010	660	2058	754	1290	7038
Trigla gurnardus	3	0	0	0	0	3	14	26	19	65
Trisopterus luscus	16	134	1200	634	492	280	10	0	0	2766
total	3540	4266	8505	6711	5982	1856	3201	1612	3199	38872
Diversity										
Number of species	15	15	14	18	15	16	14	12	12	
Shannon-Wiener index	1.97	1.90	2.18	2.66	2.92	2.90	1.64	1.74	1.54	
Simpson index	0.38	0.38	0.31	0.21	0.15	0.19	0.47	0.40	0.43	

Table 12. : Density, diversity of fish species of **reference** sampling stations (autumn 1997)

STATION	120	140	215	315	Total
Agonus cataphractus	53	20	136	3	212
Ammodytes tobianus	0	0	3	0	3
Anguilla anguilla	0	20	0	0	20
Buglossidium luteum	0	0	9	3	12
Callionymus lyra	1676	0	1036	364	3076
Callionymus recticulatus	0	0	0	7	7
Ciliata mustela	0	7	0	0	7
Clupea harengus	0	72	0	0	72
Gadus morhua	72	0	136	19	227
Gobius niger	0	0	6	0	6
Hyperoplus lanceolatus	0	0	0	7	7
Limanda limanda	460	7	660	128	1255
Merlangius merlangus	1107	19	30	30	1186
Microstomus kitt	7	0	40	3	50
Mullus surmuletus	0	0	0	3	3
Mustelus mustelus	7	0	0	0	7
Myoxocephalus scorpius	13	0	0	0	13
Platichthys flesus	7	3	0	0	10
Pleuronectes platessa	552	3	240	15	810
Pomatoschistus minutus	2581	829	1708	0	5118
Solea solea	127	56	24	0	207
Spratus spratus	13	3	6	0	22
Trachurus trachurus	27	0	0	3	30
Trachurus vipera	0	0	0	137	137
Trisopterus luscus	564	6	783	92	1445
total	7266	1045	4817	814	13942
Diversity					
Number of species	15	12	14	14	
Shannon-Wiener index	2.56	1.29	2.52	2.40	
Simpson index	0.22	0.64	0.22	0.27	

Fig. 17. : Total density of commercial fishstock along the eastside of the Belgian Coast, near the pipeline, during periods August '96 and September '97 (0.29 Broodwinner) (density in ind./100.000m²)



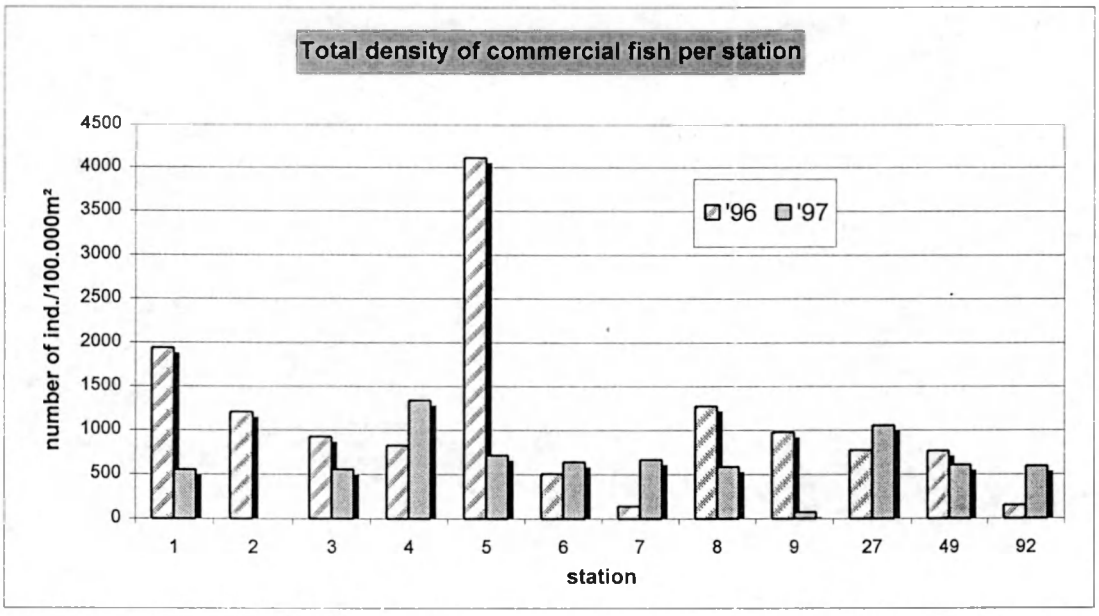
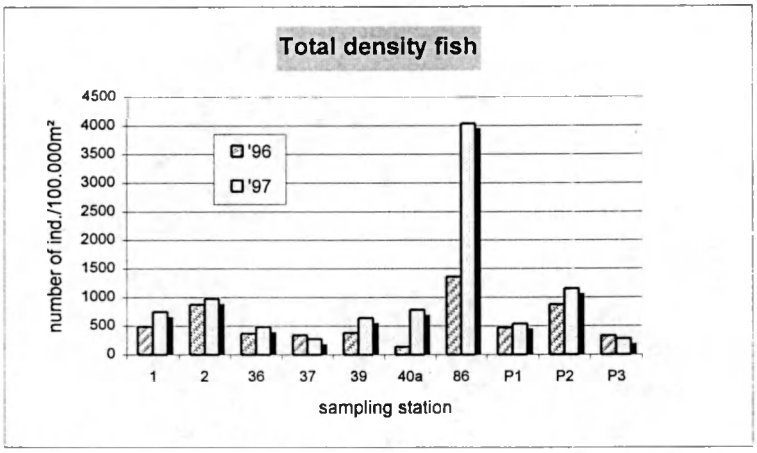


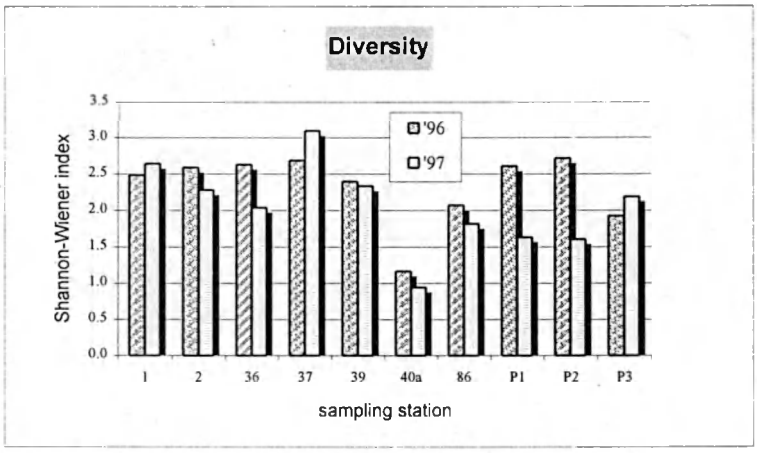
Table 13. : Length-frequency distribution of the commercial fish caught during period August '96 and September '97 (0.29 Broodwinner)(density in # ind./100.000m²)

1996	Station	1	2	3	4	5	6	7	8	9	27	49	92	Total
Common sole	<13	962	125	305	192	2420	2	6	36	-	240	130	5	4423
	13 - 19	20	30	-	-	96	-	5	-	-	-	-	-	151
	20 -23	20	18	-	-	191	-	10	10	-	8	10	-	267
	>23	-	-	-	10	20	10	-	-	6	-	1	-	47
Plaice	<13	533	100	110	98	122	31	14	130	75	70	27	-	1310
	13 - 19	-	62	12	-	27	-	-	-	-	3	-	-	104
	20 - 24	10	29	10	-	58	-	-	-	-	-	-	-	107
	>24	-	-	-	-	27	-	-	-	-	-	-	-	27
Dab	<11	174	168	130	50	159	-	-	-	17	74	27	-	799
	11 - 14	20	86	11	5	164	-	-	-	-	-	-	-	286
	15 - 19	-	15	10	-	85	-	-	-	-	-	-	-	110
	>19	-	-	-	-	21	-	-	-	-	-	-	-	21
Whiting	<22	191	520	330	450	679	464	107	1078	878	350	570	100	5717
	22 - 30	10	34	8	20	27	-	-	-	-	19	1	48	167
	>30	-	14	-	-	16	-	-	10	-	-	-	-	40
Cod	<22	-	6	-	-	-	-	-	8	-	-	-	-	14
	22 - 35	-	-	-	-	-	-	-	-	-	-	-	-	0
	>35	-	-	-	-	-	-	-	-	-	11	-	-	11
	Total	1940	1207	926	825	4112	507	142	1272	976	775	766	153	13601

1997	Stations	1	2	3	4	5	6	7	8	9	27	49	92	Total
Common sole	<13	49	-	15	164	101	56	123	37	9	565	176	199	1494
	13 - 19	16	-	15	11	44	13	50	46	17	255	20	94	581
	20 -23	16	-	-	5	52	17	23	17	13	49	10	65	267
	>23	-	-	-	-	8	-	5	4	4	5	10	30	66
Plaice	<13	205	-	103	328	8	22	14	21	-	5	-	10	716
	13 - 19	43	-	34	290	8	4	5	12	-	-	-	-	396
	20 - 24	-	-	5	131	-	4	-	-	-	-	-	-	140
	>24	-	-	10	-	-	-	-	-	-	-	-	-	10
Dab	<11	173	-	260	295	302	225	109	79	-	11	186	40	1680
	11 - 14	-	-	-	22	44	9	-	29	-	-	-	-	104
	15 - 19	5	-	10	11	12	13	-	-	-	-	-	-	51
	>19	-	-	-	-	4	-	-	-	-	-	-	-	4
Whiting	<22	43	-	98	82	105	273	337	332	31	163	201	154	1819
	22 - 30	-	-	-	-	8	-	-	-	-	-	-	-	8
	>30	-	-	-	-	4	-	-	-	-	-	-	-	4
Cod	<22	-	-	-	-	-	-	-	8	-	-	-	-	8
	22 - 35	-	-	5	-	4	4	-	-	-	-	5	-	18
	>35	-	-	-	-	12	-	-	-	-	-	-	-	12
	Total	550	0	555	1339	716	640	666	585	74	1053	608	592	7378

Fig. 18. : Total density, diversity and dominance of the fishstock around the Belgian Continental Shelf during periods August 96-97 (A. 962 R.V. Belgica campaign)





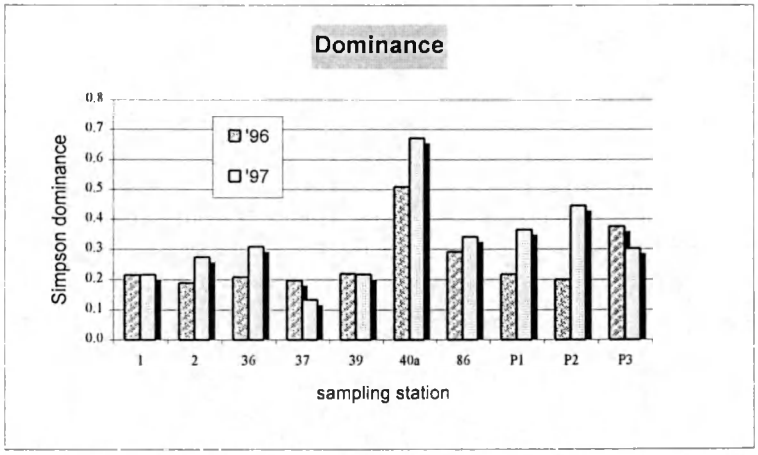
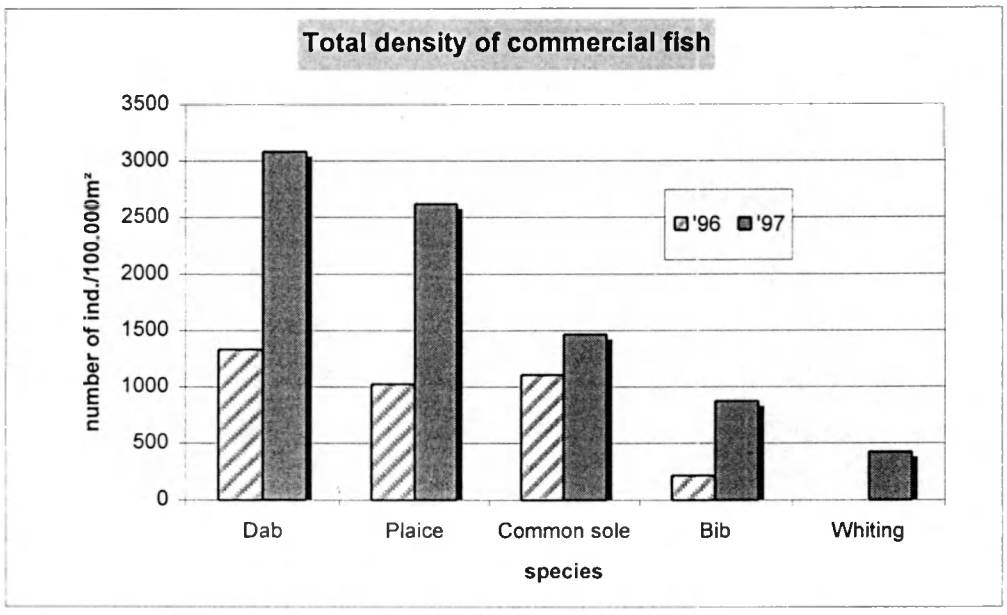


Fig. 19. : Total density of commercial fishstock around the Belgian Continental Shelf during the period August '96 and '97 (Belgica campaign)



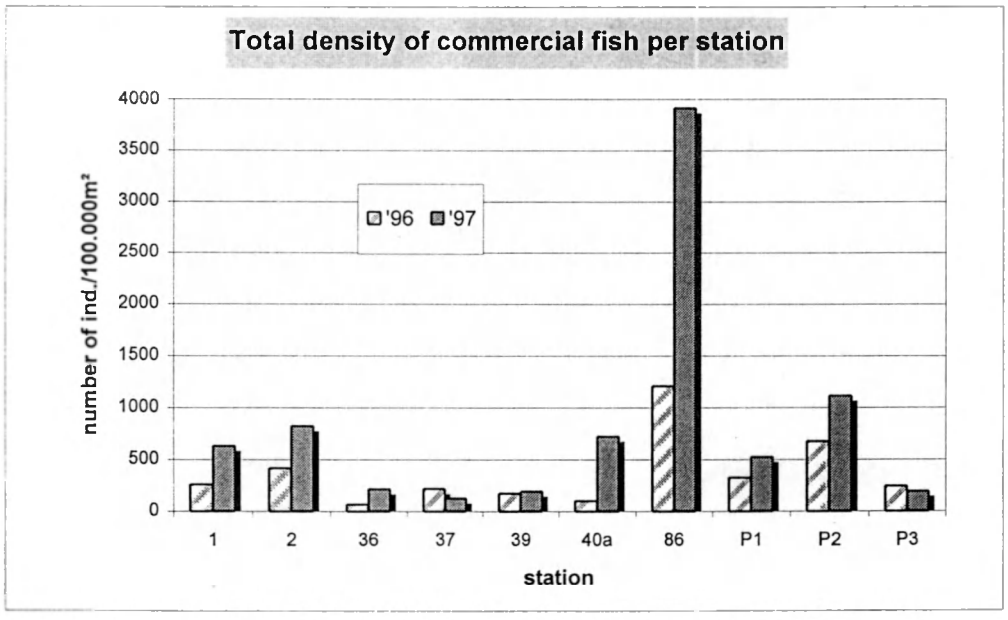


Table 14. : Density and diversity of fishstock around the Belgian Continental Shelf and in the vicinity of the Interconnector pipeline (August 1997 ; A. 962 R.V. Belgica)(density in # ind./100.000m²)

Station		1	2	36	37	39	40a	86	P1	P2	P3	Total
Bib	*Trisopterus* species	83	0	0	0	0	83	0	0	708	0	875
Brill	*Scophthalmus rhombus*	8	0	0	0	0	0	0	0	0	8	17
Cod	*Gadus morhua*	0	8	0	17	0	0	0	0	17	42	83
Common sole	*Solea solea*	108	100	0	25	0	633	375	75	8	142	1466
Dab	*Limanda limanda*	133	383	83	25	117	8	1808	217	283	25	3082
Flounder	*Platichthys flesus*	0	0	0	0	0	58	0	0	0	0	58
Greater sand eel	*Hyperoplus lanceolatus*	50	8	8	25	183	0	0	0	0	0	275
Grey gurnard	*Eutrigla gurnardus*	0	0	0	8	0	0	0	0	0	0	8
Lemon sole	*Microstomus kitt*	8	0	0	33	0	0	0	0	8	33	83
Lesser sand eel	*Ammodytes tobianus*	0	0	8	33	175	0	0	0	0	0	217
Norwegian topknot	*Phrynorhombus norvegicus*	0	0	0	0	0	0	0	0	8	0	8
Plaice	*Pleuronectes platessa*	283	308	133	67	75	0	1441	233	50	25	2616
Red gurnard	*Aspitrigla cuculus*	0	17	8	33	0	0	0	8	0	0	67
Scaldfish	*Arnoglossus laterna*	33	75	217	0	75	0	0	0	0	0	400
Smoothhound	*Mustelus mustelus*	0	8	0	0	0	0	0	0	0	0	8
Solenette	*Buglossidium luteum*	0	25	8	0	0	0	108	0	0	8	150
Stripped red mullet	*Mullus surmuletus*	0	0	0	0	0	0	8	0	0	0	8
Tub gurnard	*Trigla lucerna*	8	0	17	8	17	0	8	0	0	0	58
Turbot	*Scophthalmus maximus*	8	0	0	0	0	0	0	8	0	0	17
Whiting	*Merlangius merlangus*	25	42	0	0	0	0	292	0	67	0	425
	total	750	975	483	275	641	783	4040	541	1150	283	9921
	diversity											
	number of species	11	10	8	10	6	4	7	5	8	7	
	Shannon-Wiener diversity	2.64	2.28	2.04	3.10	2.34	0.94	1.82	1.63	1.61	2.19	
	Simpson dominance	0.22	0.27	0.31	0.13	0.22	0.67	0.34	0.37	0.45	0.30	

Appendix

Description of the fish species

Hooknose - *Agonus cataphractus*:

Colour: upper parts greyish-brown, with 4-5 darker saddles (indistinct); lower parts lighter, sometimes with greyish spots; fins yellowish, with dark dots and stripes. Mouth and gill cavities densely pigmented; peritoneum pale. Size: to 21 cm TL, usually 13 -15 cm.

Habitat: benthic in inshore waters, min. depth 35 m, deeper in winter, down to 270 m in Skaggerak, preferring sandy bottoms, rarely with stones, at temperatures always above 0°C (most often 4-12°C). Food: small bottom crustaceans and polychaetes. Reproduction: February-May in North Sea; mature at 3-4 years; eggs about 2,700 of up to 2.2 mm, yellowish or orange, laid in clumps among the branches of Laminaria or other brown seaweed holdfasts; fry planktonic in February-April.

Distribution: Atlantic coasts from English Channel to Finmarken and Murman coasts and White Sea, also the Shetlands, the Faroes and southern and south-western coasts of Iceland; southern part of Baltic.

Common names:
harnasmannetje [Ne]
souris de mer [Fr]

Five-beard rockling - *Ciliata mustela* :

Colour: reddish-brown to dark brown, sometimes almost black. Size: to 45 cm SL, usually 25 cm.

Habitat: littoral, between tide marks, on rocky shores, in intertidal pools on sand, larger fishes beneath low-tide mark on muddy, sandy and shell gravel grounds. Food: mainly crustaceans, gammarids, amphipods, small crabs and shrimps, occasionally small fish. Reproduction: winter and spring, offshore.

Distribution: north-eastern Atlantic from Portugal to Finnmark and Iceland, Kattegat to Øre Sund.

Common names:
vijfdradige meun [Ne]
motelle à cinq barbillons [Fr]

Hen-fish - *Cyclopterus lumpus* :

Colour: variable; usually bluish-grey, yellow-green or yellow-brown. Spawning males are reddish on sides, fins and ventral surface. Size: to 61 cm; weight to 9.5 kg, but usually much smaller.

Habitat: benthic on rocky bottoms usually between 50 and 150 m, but occasionally to 400 m; may occur in floating seaweed. Food: feeding more intensive in the winter; favoured are ctenophores, medusae, small crustaceans, polychaetes and small fishes. Reproduction: move inshore to spawn, in

summer in waters of about 8°C; may have up to about 300,000 eggs, 2.2-2.7 mm in diameter, in masses of 15,000-100,000; male guards egg-mass aggressively.

Distribution: throughout the Clofnam area north of 45° N latitude in appropriate habitats; rarely off coast of Portugal and southern Bay of Biscay.

Common names:
snotolf [Ne]
lompe [Fr]

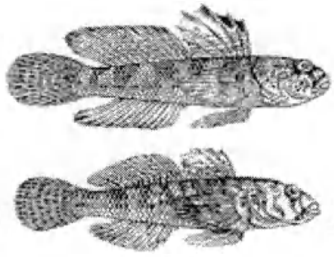
Black goby - *Gobius niger* :

Colour: pale brown, with lateral dark blotches and spots; males dusky; dark blotch in upper anterior corner of each dorsal fin; branchiostegal membrane dark. Size: to 15 cm.

Habitat: estuaries, lagoons and inshore waters, to 50-75 m, on sand or mud, in sea-grass or algae, rarely intertidal at ELWS. Food: crustaceans (larger amphipods, isopods, shrimps, mysids, small crabs), bivalves, gastropods, polychaetes, chironomid larvae, sometimes small fish. Reproduction: March-May (Naples), April early June (Veerse Meer, the Netherlands), May-August (Baltic) ; repeat spawning. Eggs spindle-shaped, blunt apex, 1.5 x 0.45 mm, under stones and shells; hatch at 2.5 mm. Sexually mature at 2 years. Lifespan: at least 4 years.

Distribution: eastern Atlantic, from Norway and Baltic Sea to Mauritania, Mediterranean and Black Sea.

Common names:
zwarte grondel [Ne]
gobie noir [Fr]



Sea snail - *Liparis liparis* :

Habitat: benthic in depths from subtidal to less than 300 m. Food: primarily crustaceans, especially shrimp, crabs and amphipods, occasionally fishes and polychaetes. Reproduction: eggs benthic, 1.4-1.7 mm diameter; spawning occurs from December to March in the southern portion of the range and in spring in the north; larvae are pelagic.

Distribution: Baltic Sea, southern Norway north to Barents Sea, east coast of Greenland, around the British Isles, in the North Sea.

Common names:
slakdolf [Ne]
limace de mer [Fr]

Smoothhound - *Mustelus mustelus* :

Colour: uniform grey to brown above, white below. Size: to 150 cm TL, mature at approximately 75 cm TL.

Habitat: coastal demersal species, usually above 150 m. Food: crabs, fishes, molluscs. Reproduction: viviparous, 4-10 pups, born at 35 cm TL.

Distribution: Madeira and Morocco northward to British Isles, also whole of Mediterranean. Elsewhere, the Canaries, also the Cape Cerde Is.

Common names:
gladde haai [Ne]
Emissole lisse [Fr]

Seascorpion - *Myoxocephalus scorpius* :

Colour: greeny-brown above, often with dark blotches and bright milky-white spots above pectoral fins; underside cherry red (males) or light orange (females) with white spots; fins with dark bands. Size: to 60 cm SL, usually 18-30 cm.

Habitat: benthic on rocky bottoms with sand or mud, or among seaweeds, at (0) 20-50 (250) m, with temperatures below OCC, usually 2-7 °C or up to 10-15 °C in the south. and salinities usually 32-33‰, but also in brackish water (to 24‰ or less in Finland Bay). Food: fishes (cod, flounders, smelts, herrings, sticklebacks, etc.), large crustaceans (Hyas, Crangon, Sclerocrangon, Leander, Mesidothea, etc.), occasionally polychaetes and amphipods. Reproduction: spawns December-March; eggs demersal, diameter 2.0-2.5 mm, laid in clumps between rocks and guarded by males; fry pelagic.

Distribution: south-eastern coasts of Greenland, Jan Mayen I., Iceland to British Isles and southward to Bay of Biscay, also North Sea, Baltic Sea, northward to Spitzbergen and southern part of Barents Sea (including White Sea).

Common names:
zeedonderpad [Ne]
chaboisseau de mer commun [Fr]

Sand goby - *Pomatoschistus minutus* :

Colour: sandy or grey with fine darker reticulation and ferruginous specks; males with 4 vertical dark bars and breast usually unpigmented; first dorsal fin rear dark spot present in both sexes, distal. Size: to 9.5 cm.

Habitat: inshore sand and muddy sand, typically to about 20 m, but may occur to 60-70 m; juveniles in lower estuaries.

Food: small polychaetes, amphipods (corophiids, caprellids), cumaceans, mysids. Reproduction: February-May (Plymouth), February-June (Ythan, Aberdeenshire).

Distribution: eastern Atlantic (Tromsø, Norway, to Spain); Mediterranean and Black Sea, but probably not throughout.

Common names:
dikkopje [Ne]
bourgette [Fr]

Atlantic mackerel - *Scomber scombrus* :

Colour: belly unmarked. Size: commonly to 35-46 cm fork length; exceptional individuals may reach 1.8 kg in weight.

Habitat: epipelagic or mesodemersal in depths to 200-250 m. Schooling, sometimes in enormous schools. Food: adults eat vast quantities of pelagic crustaceans, chiefly copepods and euphausiids, but also crab larvae, amphipods, arrow worms, and young clupeoid fishes. Reproduction: spawn in shallow water over the continental shelf in spring and early summer. Eggs and larvae planktonic.

Distribution: a north Atlantic species found throughout the area from Norway to the Azores and Morocco, the Mediterranean and Black Seas. Present in the western Baltic Sea.

Common names:
makreel [Ne]
maquereau commun [Fr]

Horse mackerel - *Trachurus trachurus* :

Colour: small, black opercular spot on edge near upper angle; upper part of body and head nearly black to grey or bluishgreen; lower two-thirds of body and head usually paler, whitish to silvery. Size: to about 60 cm fork length, common to 30 cm.

Habitat: usually over sandy bottom in 100-200 m, but reported to 500 m, also pelagic and near surface at times; often shoals with juvenile herrings. Food: crustaceans, squids and small fishes.

Distribution: north-eastern Atlantic from Iceland to Cape Verde Is., Mediterranean and Marmara Seas, rare in Black Sea.

Common names:
horsmakreel [Ne]
chinchard [Fr]