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BASELINE STUDY OF CONTAMINANTS IN THE BARENTS SEA

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Rapporten beskriver prøvetakingsprogrammet og status for analysene pr. mars 1995 for AMAP-prosjektet "Basisundersøkelser av forurensing i Barentshavet" som gjennomføres av Havforskningsinstituttet.

Summary:

This report describes the sampling programme and status of the analytical programme up until March 1995 for the AMAP project "Baseline study of contaminants in the Barents Sea" carried out by Institute of Marine Research.

Emneord - norsk:
1. Forurensninger
2. Arktis
3. Miljøovervåkning

Emneord - engelsk:
1. Contaminants
2. Arctic
3. Monitoring

Jarle Klungsøyr
Prosjektleder

Seksjonsleder

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SUMMARY

This report gives an overview of Institute of Marine Research's (IMR) project "Baseline study of contaminants in the Barents Sea". This is a progress report describing the status of the project as of March 1995. It is intended to be a supplement to the technical reports which presents data generated in this project. The baseline study is a part of the international Arctic Monitoring and Assessment Programme (AMAP). The aim of the project is to carry out a baseline study to establish the present levels of contaminants in the Barents Sea. Parameters analysed are in correspondence with those given priority in the AMAP implementation plan for the marine environment. Fish, zooplankton and sediments from the Barents Sea were collected during 1991 - 1993. Samples have been analysed for PAH, PCBs, organochlorine pesticides and Cs^{137} at IMR's chemistry laboratory. Metal analyses have been performed at Institute of Nutrition, Directorate of Fisheries. Sediment samples have been analysed for PCDD, PCDF and planar PCBs, and fish samples have been analysed for PCC at Norwegian Institute of Air Research. Completing major parts of the analytical programme in time for the data to be available for the drafting of the AMAP Assessment Report is given high priority. Analytical results will be published in technical reports as soon as the data processing is completed. The data will also be made available to the ICES database .

SAMMENDRAG

Denne rapporten gir en oversikt over Havforskningsinstituttets prosjekt "Basisundersøkelser av forurensning i Barentshavet (AMAP)". Dette er en framdriftsrapport som beskriver prosjektets status pr. mars 1995. Den er ment som et supplement til de tekniske rapportene som inneholder data generert i dette prosjektet. Prosjektet inngår i det internasjonale Arctic Monitoring and Assessment Programme (AMAP). Hovedmålsettingen er å gjennomføre en basisundersøkelse for å kartlegge dagens nivå av forurensninger i Barentshavet. Analyseparametrene er i overensstemmelse med de prioriterte parametrene spesifisert i AMAPs handlingsplan for det marine miljø. Fisk, zooplankton og sedimenter fra Barentshavet ble samlet inn i 1991 - 1993. Prøvene er analysert for PAH, PCB, klororganiske pesticider og Cs^{137} ved Havforskningsinstituttets kjemilaboratorium. Metallanalyser er utført ved Fiskeridirektoratets Ernæringsinstitutt. Sedimentprøver er analysert for PCDD, PCDF og plane PCB, og fisk for PCC, ved Norsk Institutt for Luftforskning. Å ferdigstille data fra deler av analyseprogrammet slik at disse blir tilgjengelige for forfatterne av AMAP Assessment Report er gitt høy prioritet. Analyseresultatene vil bli publisert i tekniske rapporter så snart databearbeidingen er gjennomført. Data vil også bli gjort tilgjengelig for ICES-databasen.

1. INTRODUCTION

This report gives an updated overview of Institute of Marine Research's (IMR) project "Baseline study of contaminants in the Barents Sea". In a previous report the status for sampling and analysis up until May 1993 was described (STANGE and KLUNGSØYR 1993). Since that time, fish and sediment samples from the Svalbard area have been added, and much of the material collected in 1991-1993 has been analysed.

From more than 200 sediment stations sampled during the 3-year sampling programme, a number of stations have been chosen for analysis of selected parameters of the category "essential" described in the Arctic Monitoring and Assessment Programme (AMAP) monitoring plan for the marine environment (ANON. 1993). Of the 14 species of fish sampled from more than 100 trawl hauls, the "essential" AMAP species polar cod (*Boreogadus saida),* and "recommended" AMAP species cod (*Gadus morhua*) and long rough dab (*Hippoglossoides platessoides*) have been given priority in the analytical programme.

In order to complete parts of the analytical programme in time for the drafting of the chapters of the AMAP Assessment Report, the following analyses have been given priority: polycyclic aromatic hydrocarbons (PAH), metals and Cs^{137} in sediments, and polychlorinated biphenyls (PCBs), organochlorine pesticides (OCP) and metals in fish. Data reports on these parameters will be available to AMAP by July 1995.

Field sampling was done according to current IMR procedures. A brief description is given in this report together with summaries of analytical procedures.

2. BACKGROUND

A growing concern during the last decade about the environmental quality of the Barents Sea and its biological resources highlighted the need for documentation on levels of contaminants in the Barents Sea ecosystem. As part of a baseline study IMR started in 1991 an extensive sampling programme in the Barents Sea including surface sediments, fish and zooplankton. The programme was designed to include sub-samples for persistent organic pollutants (POPs), metals, radionuclides and sediment characteristics.

In 1991, the Arctic Monitoring and Assessment Programme (AMAP) was initiated. IMR's Barents Sea sampling and analysis programme was included in AMAP as the project titled "Baseline study of contaminants in the Barents and Norwegian Seas" (ANON. 1994). In addition to IMR's funding from the Norwegian Ministry of Fisheries, AMAP funding was made available from the Norwegian Ministry of Environment through the State Pollution Control Authority of Norway (SFT).

The sampling programme continued through 1992 and 1993, until samples from all areas of the Barents Sea had been collected.

Samples from the Norwegian Sea have been collected during several cruises in 1994. This sampling programme forms part of the project "Monitoring of pollutants in fish and sediments in the North Atlantic Ocean", initiated by the Nordic Council of Ministers. The status for this project is described in a separate report (STANGE and KLUNGSØYR in. prep.).

3. SAMPLING

Sediments, fish and zooplankton were collected during five cruises in 1991-1993:
1991: R/V J. Hjort, 11 Sept. - 11 Oct.
1992: R/V J. Hjort, 4 Sept. - 12 Oct.; R/V G. O. Sars, 17 Aug. - 7 Oct.
1993: R/V J. Hjort, 29 Mar.-12 Apr.; R/V J. Hjort ,16 Aug.-9 Sept.
Track charts are shown in Figures 1a-1e.

3. 1. Sediments

Surface sediments were collected from a total of 206 grab stations using box corers (JONASSON and OLAUSSON 1966) (Figure 2). The samplers collected 0.1 m^2 of the sediment surface. Sample volume varied with the consistency of the bottom sediments, i.e. how deep into the sediments the samplers would sink on gravity alone. The water on top of the sediment in the box corer was siphoned off, leaving the sediment surface undisturbed.

A sub-sample (10 cm x 10 cm x 1 cm) for analysis of POPs was collected with a stainless steel scoop and packed in aluminium foil. Two other sub-samples of a similar size were collected for analysis of sediment characteristics (particle size distribution and organic carbon) and for analysis of Cs^{137}. A sub-sample for analysis of metals was collected with a plastic scoop and transferred through a plastic funnel to a plastic bottle with screw cap.

Three separate box corer samples were collected at all individual sediment stations, giving three parallel samples for analyses of POPs, metals and sediment characteristics. Sediments from the three separate grabs taken at one location were combined to give one pooled sample for analysis of Cs^{137}.

All sediment samples were stored at -20°C until analysed.

3. 2. Fish

Samples of 14 species of fish were collected from a total of 111 pelagic and bottom trawl hauls (Figure 3). The majority of the fish collected were cod (*Gadus morhua*), capelin (*Mallotus villosus*), long rough dab (*Hippoglossoides platessoides*), polar cod (*Boreogadus saida*) and redfish (*Sebastes marinus* and *Sebastes mentella*). Following the recommendations from ICES, 25 individuals of each species were sampled at each location to fulfil the requirement of a complete sample. At a few locations this requirement was not met due to insufficient catch.

Total fresh weight and length were recorded for all fish. Sex was registered for most fish. Otoliths were collected from fish from a majority of the stations for age determination.

The livers were weighed and packed in glass jars with screw caps. Cod livers were stored separately while livers from other species were combined in pooled samples of five. Pieces of skin free filet were cut out from each fish and stored in glass jars or wrapped in aluminium foil. Filets from small fish were combined in pooled samples of five, others were stored individually.

All fish samples were stored at -20°C until analysed.

3. 3. Zooplankton

Samples of shrimp and krill were collected with pelagic trawl (Figure 4). Copepods and amphipods were collected with MOCNESS multinet sampler in 180-1000 µm, 1000-2000 µm and >2000 µm size fractions (WIEBE *et al.* 1985). Samples were stored in glass jars at -20°C.

4. STATUS FOR SAMPLES AND ANALYSES

4. 1. Sediments

4. 1. 1. Particle size distribution

A sub-sample from all sediment stations was wet sieved through a 63 µm stainless steel sieve using a gentle stream of tap water and a brush to remove the clay/silt fraction. The percentage of clay/silt was calculated by subtracting the dry weight of the sand remaining on the sieve from the dry weight of the total sediment. The sand was fractionated by dry sieving through 2 mm, 1 mm, 0.5 mm, 0.25 mm and 0.125 mm stainless steel sieves (Retsch GmbH & CO, Germany) and the particle size distribution determined from the weight of the fractions. This work is completed and particle size distribution data is available for interpretation of sediment data on other analytical parameters.

4. 1. 2. Organic carbon

A sub-sample of sediment from stations selected for POPs and metal analyses was analysed for total organic carbon. Samples collected in 1991 and 1992 were analysed in duplicates at Institute of Geology, University of Bergen. Inorganic carbonates were removed with HCl and total organic carbon determined using a LECO elemental analyser (LECO Corp., USA). Samples collected in 1993 were analysed for organic carbon at the Geological Survey of Norway (NGU) in Trondheim. This work is recently completed.

4. 1. 3. PAH in sediments

A total of 140 sediment stations from the Barents Sea have been analysed for PAH (Table 1, Figure 5). Approximately 50 g wet sediment were boiled under reflux with 0.5N alcoholic KOH for 1.5 hours followed by liquid/liquid extraction with pentane. Extracts were volume reduced and cleaned on silica columns prior to injection on a Hewlett Packard 5987A GC/MS in SIM mode (KLUNGSØYR *et al.* 1988).

The following components were included in the analytical protocol:

naphtalene and C_1-, C_2- and C_3-alkyl derivatives
antracene
phenanthrene and C_1- og C_2-alkyl derivatives
dibenzothiophene and C_1-, C_2- and C_3-alkyl derivatives
fluoranthene
pyrene
benz[a]anthracene
chrysene
benzofluoranthenes
benzo[e]pyrene
benzo[a]pyrene
perylene
benzo[g,h,i]perylene
indeno[1,2,3-cd]pyrene
dibenzo[a,h]anthracene.

Two separate grab samples from all stations have been analysed. The analyses are recently completed and the data is currently being processed.

4. 1. 4. PCBs and OCP in sediment

Twelve sediment stations from the Barents Sea were analysed for PCBs and OCP in 1993. The levels were very low, often below the detection limit of the method in use. Improved methods for sediment extraction and sample clean-up are now being developed at IMR. A selection of stations from the Barents Sea will be analysed for PCBs and OCP as soon as this work is completed.

4. 1. 5. Metals in sediment

A total of 43 sediment stations from the Barents Sea have been analysed for the metals of the category "essential" in the AMAP monitoring plan for the marine environment; Cd, Cu, Hg, Pb, Zn, Li and Se (Table 1, Figure 6). Freeze dried sediments (0.1g) were digested in nitric acid/hydrogen peroxide/hydrofluoric acid in a microwave oven. Litium was analysed using flame atomic absoption spectroscopy (Perkin Elmer 3030). Other elements were analysed using ICP-MS (Perkin Elmer ELAN 5000). The analyses were performed at Institute of Nutrition, Directorate of Fisheries in Bergen in co-operation with Dr. Amund Måge. This work is recently completed and the data is currently being processed.

4. 1. 6. Caesium-137 in sediments

A total of 102 sediment stations from the Barents Sea have been analysed for Cs^{137} (Table 1, Figure 7). Freeze dried sediment samples were analysed by gamma spectrometry using a high-resolution HPGe-detector (resolution 1,9 keV; efficiency 30%; counting time ca. 20 hours). This data set is complete except for a few stations from one of the 1992 cruises that are still to be analysed. The work has been carried out at IMR by Ingrid Sværen and Lars Føyn as a part of an ongoing IMR project "Radioactivity in the marine environment".

4. 1. 7. PCDD, PCDF and planar PCBs in sediments

Sediment samples from 11 stations in the Barents Sea were analysed for polychlorinated dibenzo-*p*-dioxins (PCDD), dibenzofurans (PCDF) and planar PCBs (IUPAC Nos. 77, 126 and 169) at the Norwegian Institute of Air Research (NILU) in co-operation with Dr. Michael Oehme (OEHME *et al.* 1993). (Table 1, Figure 8).

4. 2. Fish

4. 2. 1. PCBs and OCP in fish

Fish livers have been the tissue of choice for IMR's extensive analytical program of PCBs and OCP in biota from the Barents Sea. The lipophilic PCBs and OCP accumulate to higher levels in the lipid rich livers than in any other tissues. A less extensive analytical programme is planned on fish muscle tissue at a later stage.

Samples were extracted using a "cold blend" method modified from JENSEN *et al.* (1983). The livers were homogenised in a Waring blender. A sub-sample was used for dry weight determination. Approximately 2 g wet liver tissue were extracted twice in an Ultra Turrax homogeniser with acetone and acetone:hexane. The combined extracts were liquid/liquid extracted with a NaCl solution in phosphoric acid. Extractable lipids were determined gravimetrically in duplicate by evaporating sub-samples of the extract to constant weight before removing the fat from the extracts with concentrated sulphuric acid. The extracts were separated into two fractions on Florisil columns, one fraction containing the PCBs and some of the OCP, and the other fraction containing the rest of the OCP. The samples were analysed both as whole extracts and separated extracts on a Hewlett Packard 5880 GC - ECD.

The following components were included in the analytical protocol:

PCBs: IUPAC Nos. 28, 31, 52, 101, 105, 118, 128, 138, 149, 153, 156, 170, 180
DDTs: o'p-DDT, p'p-DDT, o'p-DDE, p'p- DDE, o'p-DDD, p'p-DDD
HCHs: alpha-, beta- and gamma-
HCB
Chlordanes: trans-nonachlor, oxychlordane, alpha-chlordane and gamma-chlordane

Cod (105) from five different locations in the Barents Sea have been analysed for PCBs and OCP as individual samples (Table 2, Figure 9). Four of the stations were complete with 25 fish, while one station had five fish. Polar cod (125) from five different locations have been analysed. Fish from four of the stations were analysed as pooled samples of five. Fish from one of the locations had large enough livers to allow for individual analysis. Long rough dab (175) from seven locations have been analysed. All long rough dab samples were analysed as pooled samples of five.

All the fish liver samples have been extracted and the whole extracts analysed. Most of the samples have been fractionated and the PCB and OCP data are currently being processed.

4. 2. 3. Metals in fish

Two stations of cod (50 individuals), two of polar cod (50 individuals, pooled samples of five) and three of long rough dab (75 individuals, pooled samples of five) were selected for analyses of the category "essential" metals in the AMAP monitoring plan for the marine environment; Cd, Cu, Hg and Se (Table 2, Figure 10). Mercury was analysed in muscle tissue while Cd, Cu and Se were analysed in liver. Freeze dried filet of fish and fresh liver samples (0.2 g) were digested in nitric acid/hydrogen peroxide in a microwave oven. Mercury was analysed using cold vapour atomic absorption spectroscopy. Selenium was analysed by graphite furnace atomic absorption spectroscopy (Perkin Elmer 5000/HGA 500). Other elements were analysed using ICP-MS (Perkin Elmer ELAN 5000). This work is currently being performed at Institute of Nutrition, Directorate of Fisheries in Bergen.

4. 2. 4. Caesium-137 in fish

A number of cod, polar cod and redfish samples have been selected for analysis of Cs^{137}. The analytical work will be carried out in 1995 as a part of the IMR's project "Radioactivity in the marine environment".

4. 2. 5. PCC in fish

A selection of cod and polar cod samples from the Barents Sea is currently being analysed for polychlorinated camphenes, PCC (Toxaphene) at the Norwegian Institute of Air Research (NILU) in co-operation with Dr. Michael Oehme (Table 2).

4.3. Method validation

IMR's chemistry laboratory has participated in a number of intercomparison exercises for validation of the methods used in this project:

1989-1993: ICES/IOC/JMG intercalibration exercises on PCB in marine media. Samples included standards, seal blubber extracts and sediment extracts.

1992-1993: International Sediment Exchange for Tests on Organic Contaminants, SETOC. PCB and PAH in sediment.

1993-present: Quality Assurance of Information for Marine Environmental Monitoring in Europe, QUASIMEME. PCB and organochlorine pesticides in standard solutions, fish oil and sediment. PAH in standard solutions.

Since 1984 IMR has regularly contributed to the European Commission's Measurement and Testing Programme for Certification of Reference Materials (BCR). These contributions include certification of PCB in fish oil (GRIEPINK *et al.* 1988), sewage sludge (GRIEPINK *et al.* 1990), mineral oil (MAIER *et al.* 1993), milk powder (MAIER *et al.* 1994), soil (completed 1994, report in prep.) and certification of organochlorine pesticides in fish oil (completed 1995, report in prep.).

5. PLAN FOR FUTURE WORK

Completing parts of the analytical programme in time for the data to be available for the AMAP assessment is given high priority. The data will be published in technical reports and will be made available for the ICES database as soon as this work is completed.

5. 1. Analyses

- Sediments will be analysed for PCBs and OCP as soon as the analytical protocol for improved sample extraction and clean-up is established (see section 4. 1. 4.)
- Muscle tissue of cod will be analysed for PCBs and OCP in order to meet the need for documentation of levels of these compounds in the edible part of the fish.
- A selection of cod livers will be analysed for PAH and oil hydrocarbons such as decalins and pristane/phytane.
- Other species than cod, polar cod and long rough dab will be included in the analytical program.
- Zooplankton will be analysed for PCBs and OCP.

5. 2. Reporting

Technical reports on the following topics will be prepared in time for the AMAP assessment:

- PAH in sediments
- Cs^{137} in sediments
- Metals in sediments
- Metals in fish
- PCBs and organochlorine pesticides in fish
- PCBs and organochlorine pesticides in sediments

These data will be available for the ICES database in 1995. A comprehensive report will be made in 1996 when all the analytical work has been completed.
Preparation of manuscripts with data generated in this project for publication in peer reviewed journals will be given high priority in 1995 and 1996.

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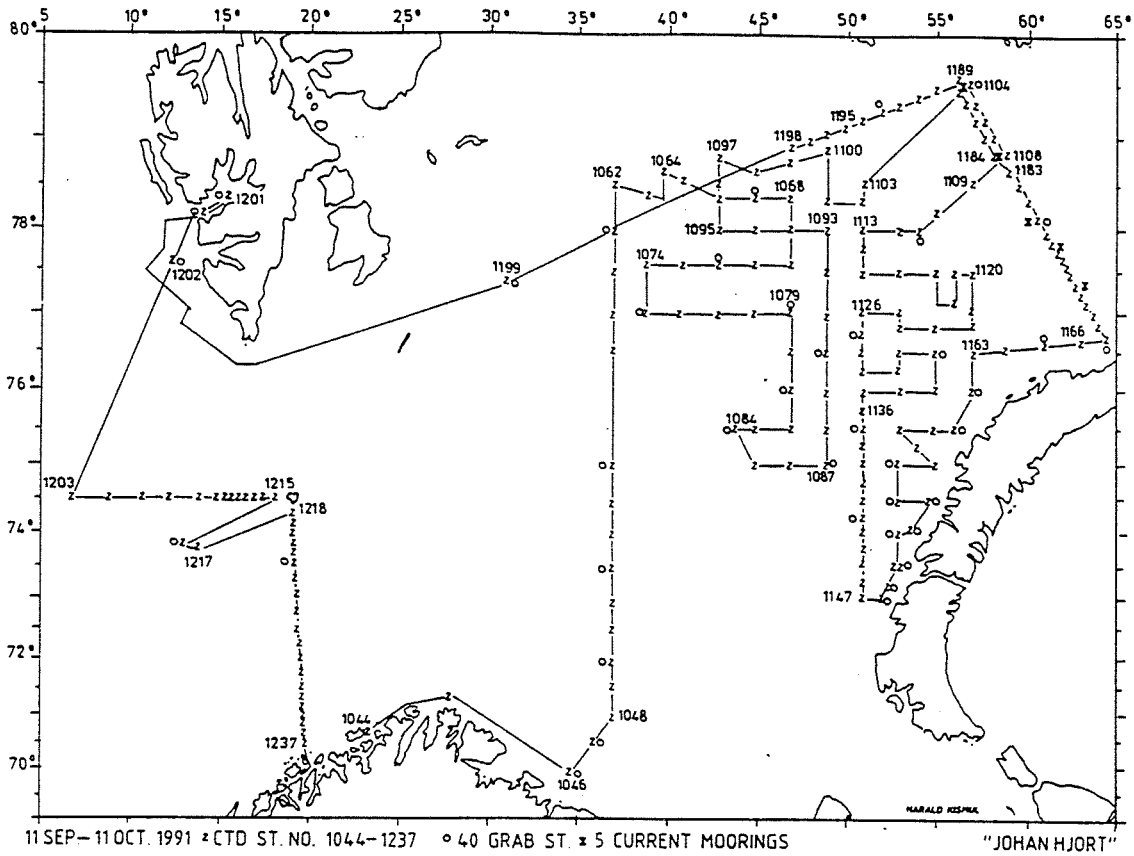
Figure 1a: Track chart for R/V J. Hjort Sept. - Oct. 1991 (*Kurskart for F/F J. Hjort sept. - okt. 1991*)



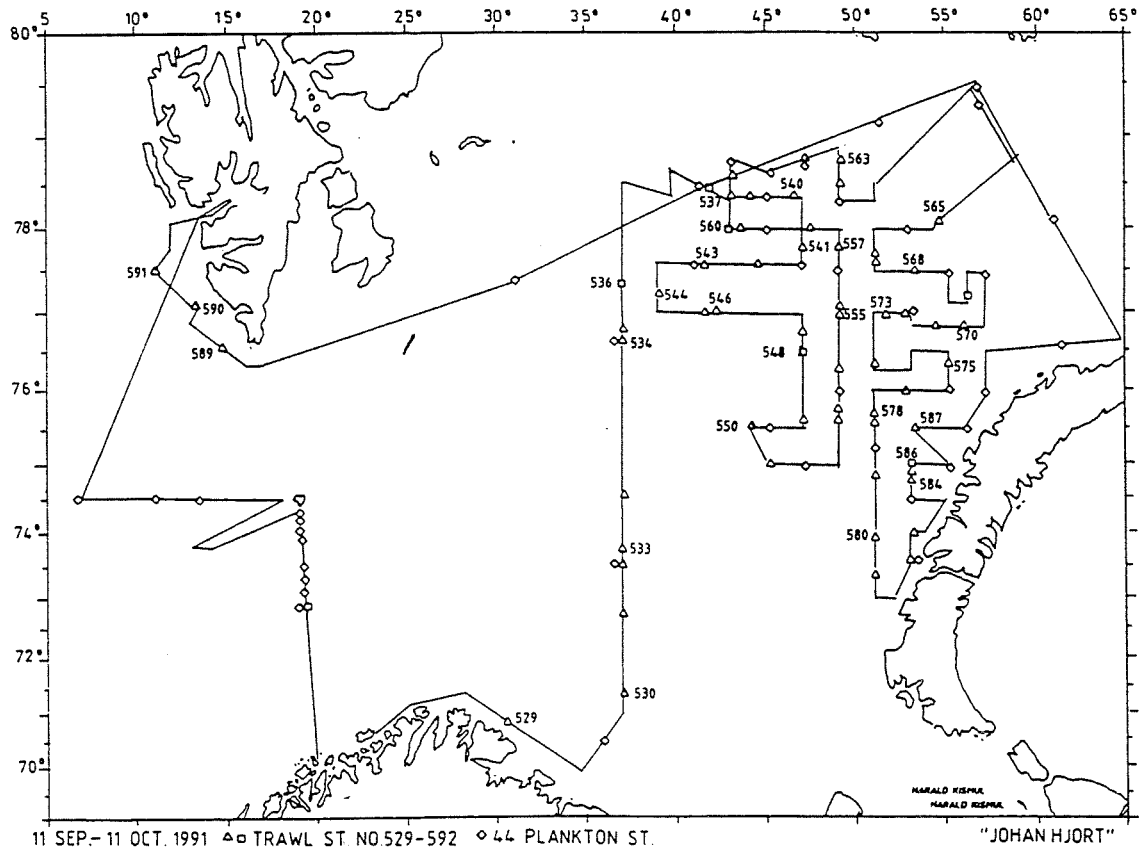
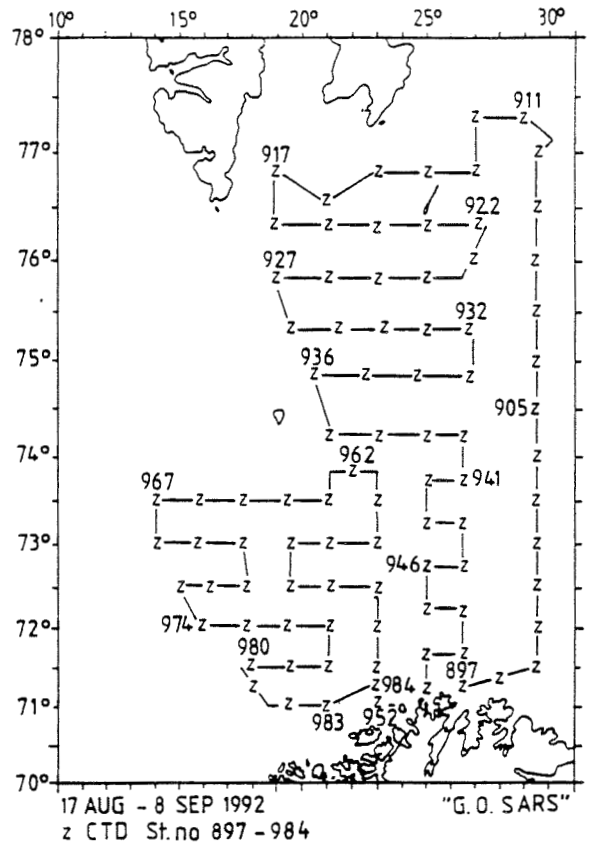


Figure 1b: Track chart for R/V G. O. Sars Aug. - Oct. 1992 (*Kurskart for F/F G. O. Sars aug.- okt. 1992*)



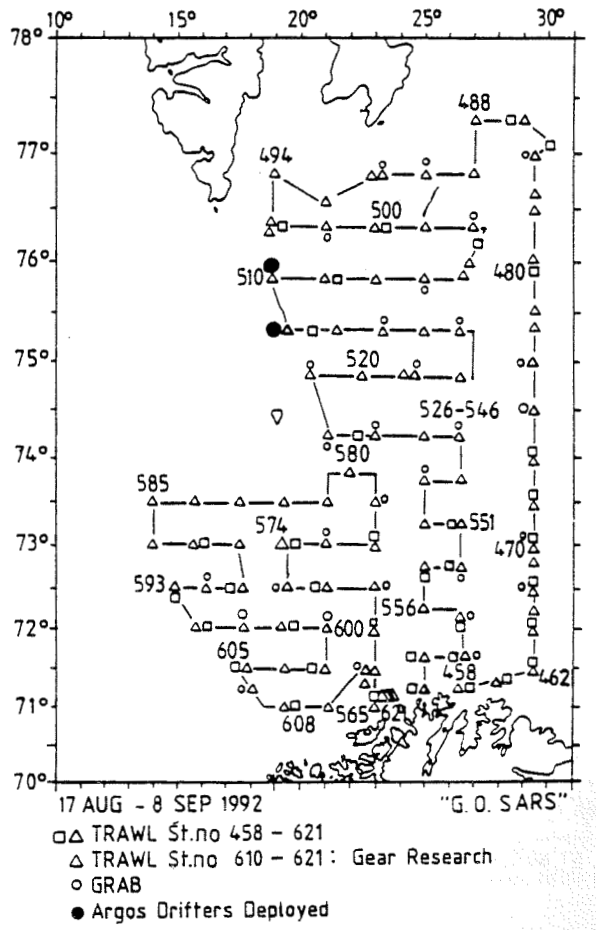


Figure 1b (cont.): Track chart for R/V G. O. Sars Aug. - Oct. 1992 (*Kurskart for F/F G. O. Sars aug. - okt. 1992*)

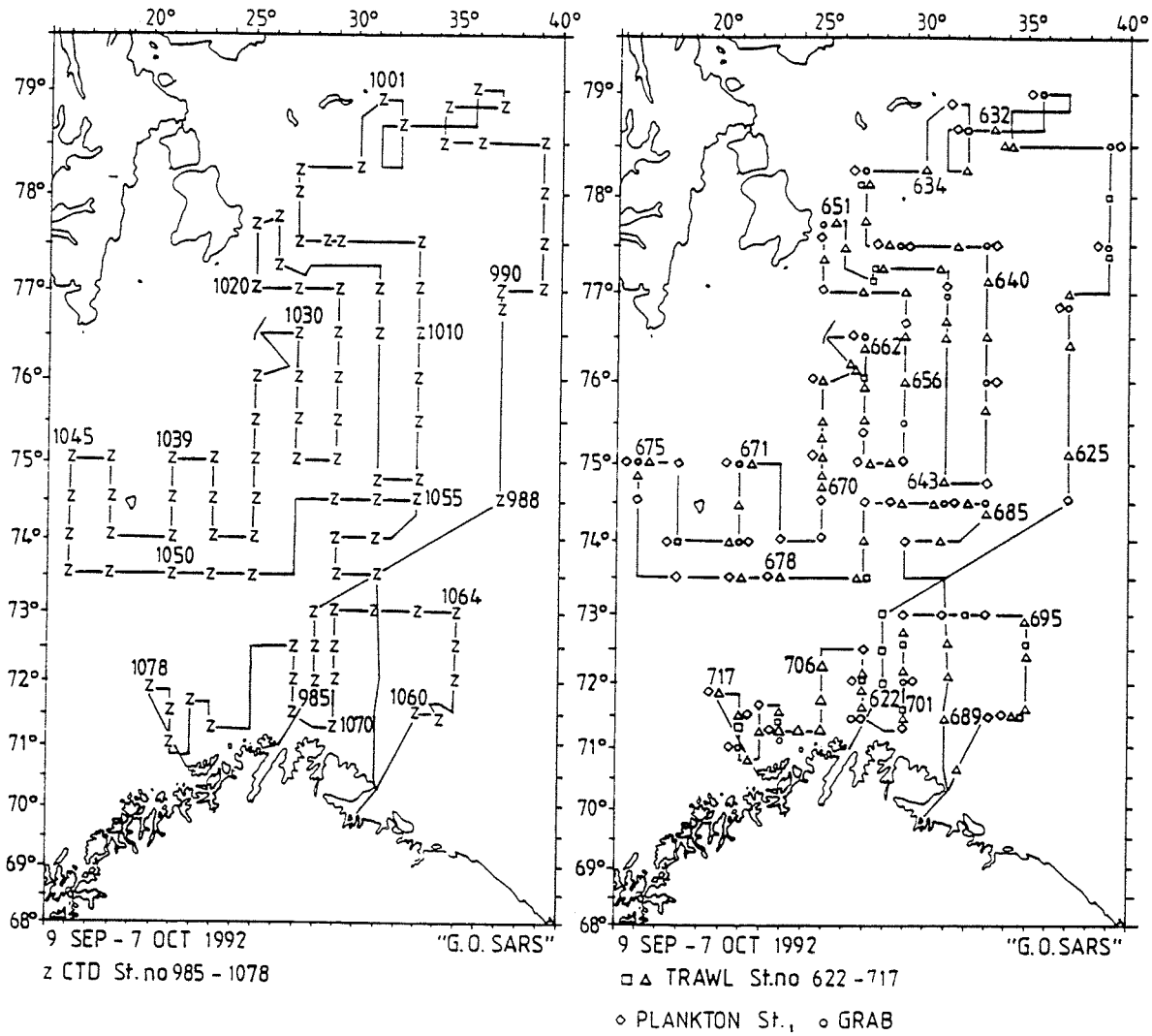
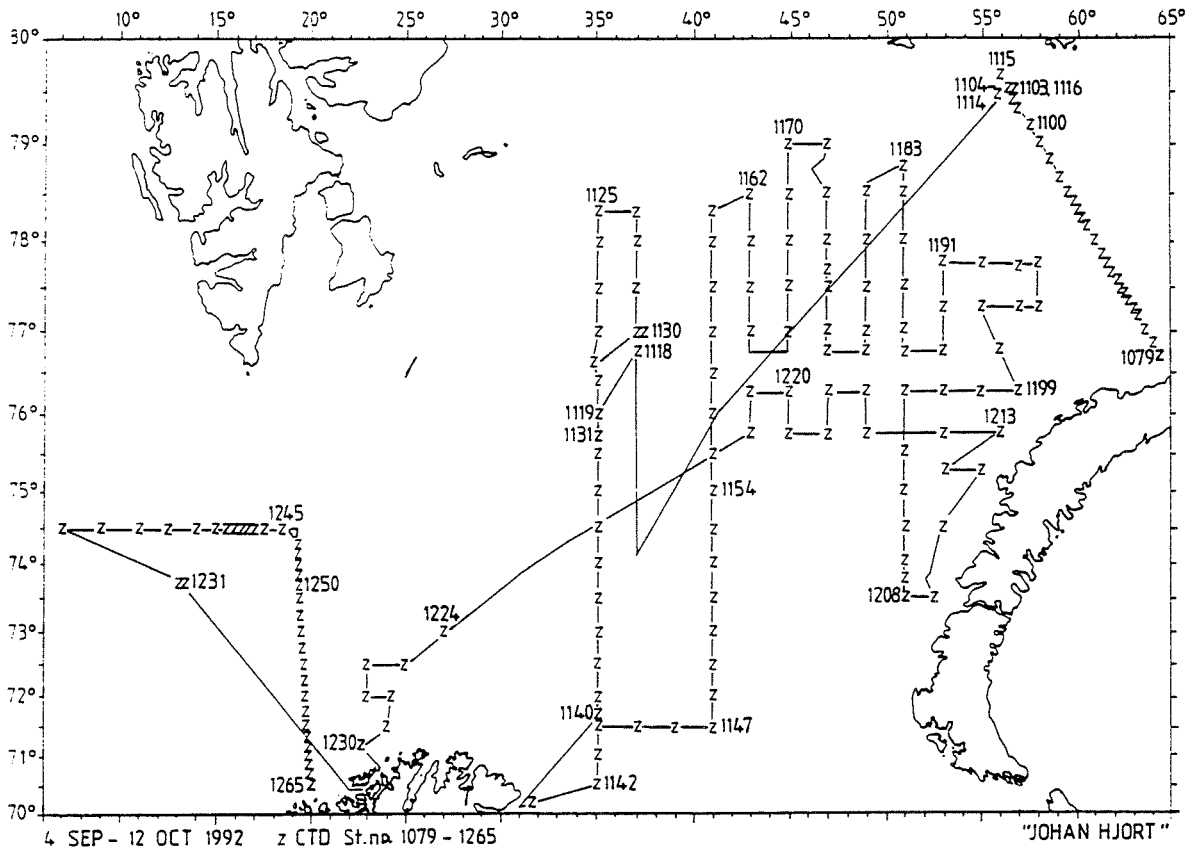


Figure 1c: Track chart for R/V J. Hjort Sept. - Oct. 1992 (*Kurskart for F/F J. Hjort sept. - okt. 1992*)



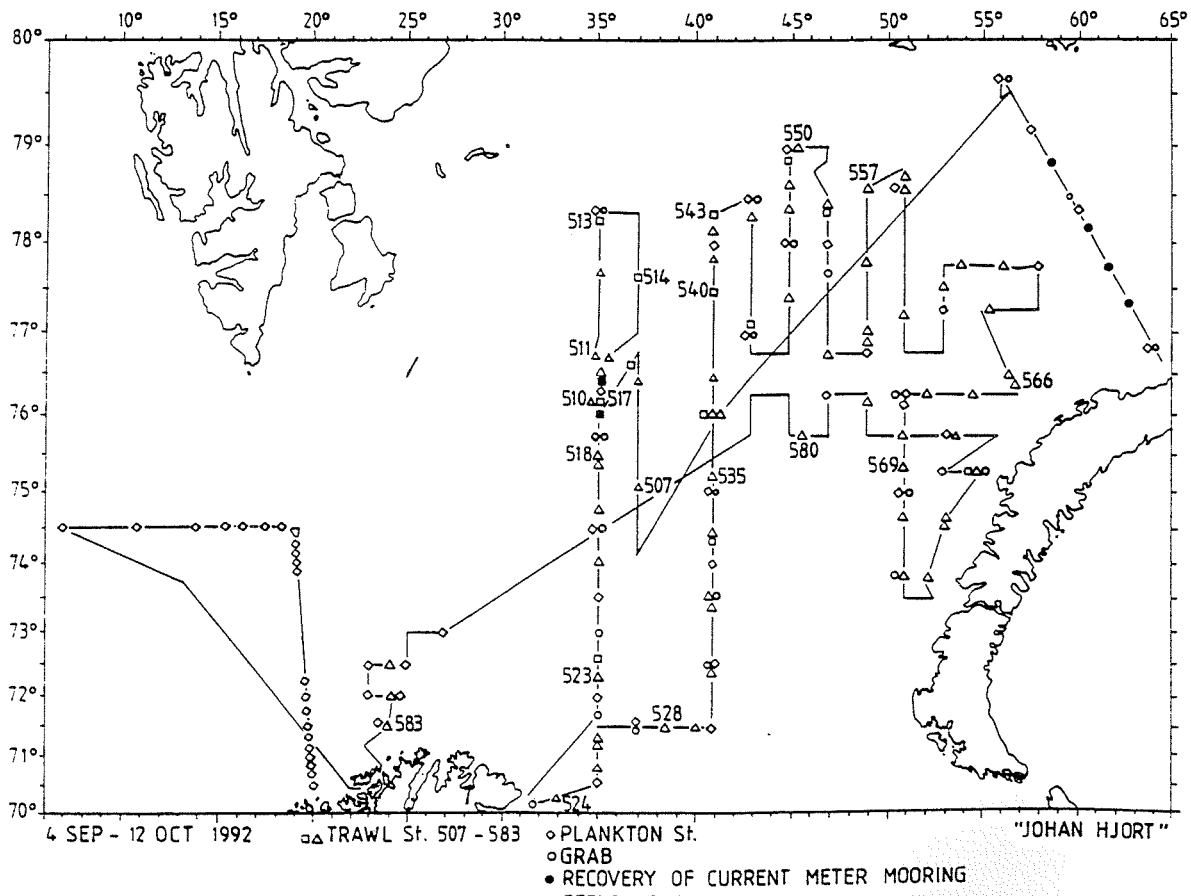


Figure 1d: Track chart for R/V J. Hjort Mar. - Apr. 1993 (*Kurskart for F/F J. Hjort mar.- apr. 1993*)

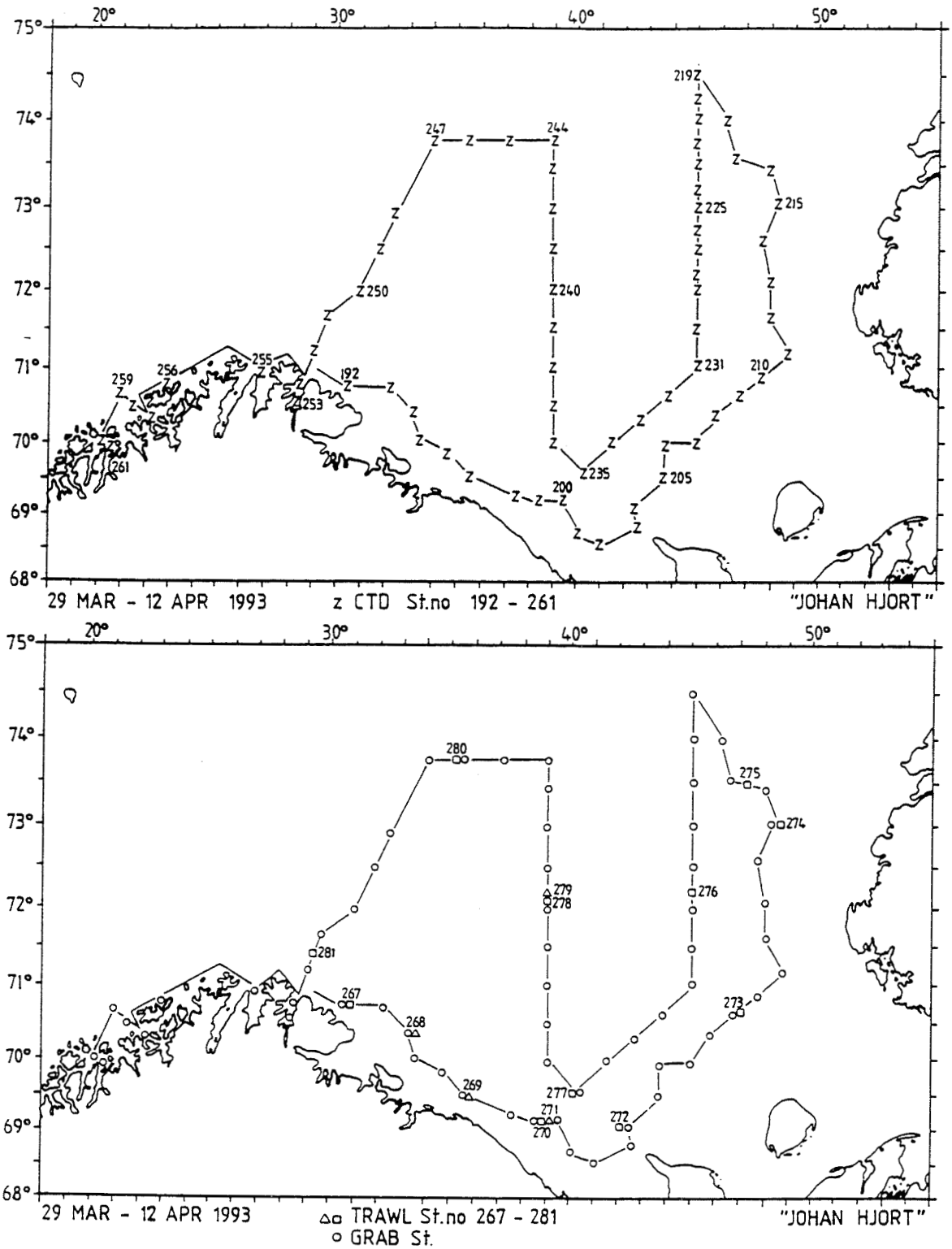


Figure 1e: Track chart for R/V J. Hjort Aug. - Sept. 1993 (*Kurskart for F/F J. Hjort mar. - apr. 1993*)

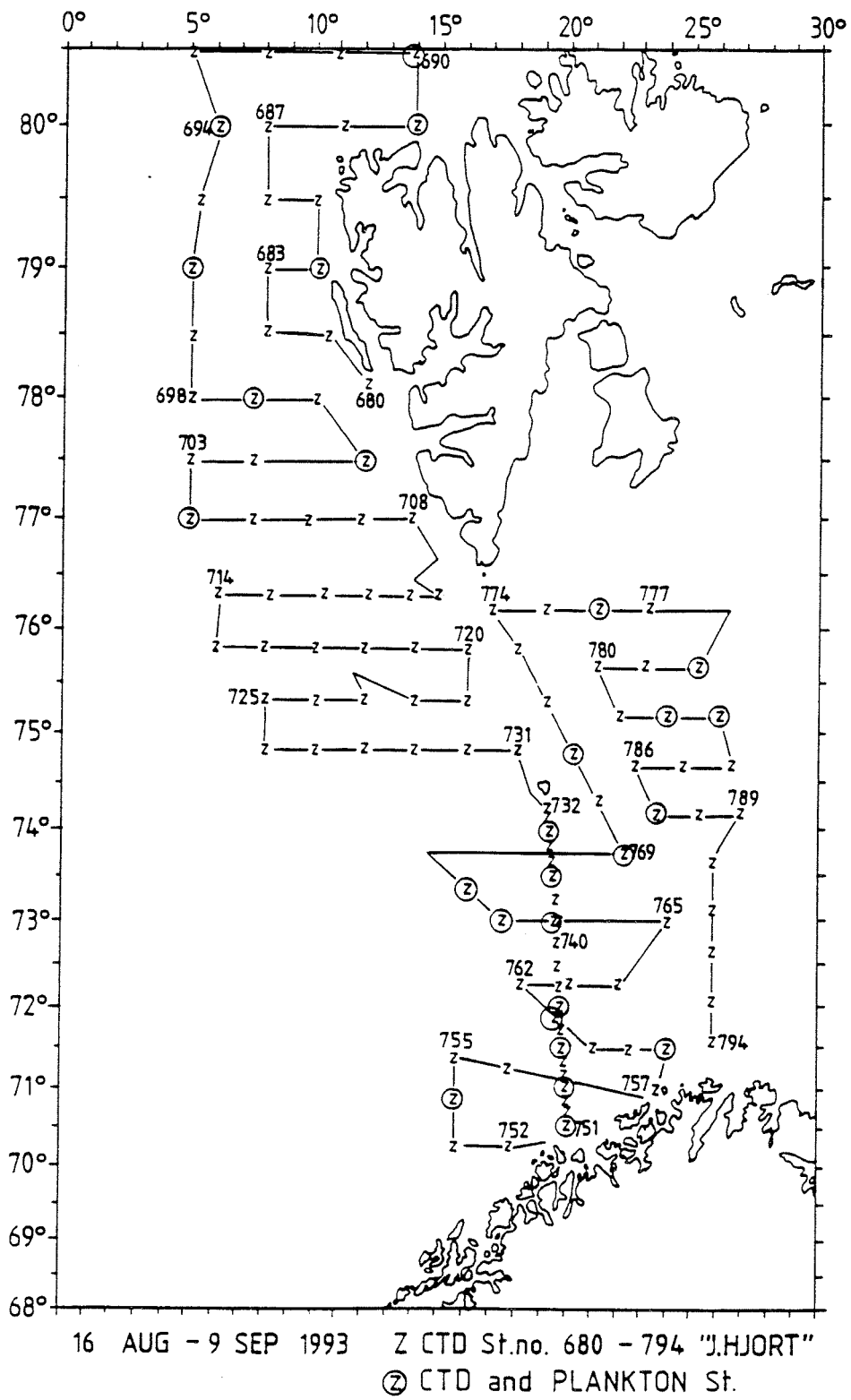


Figure 1e (cont).: Track chart for R/V J. Hjort Aug. - Sept. 1993
(Kurskart for F/F J. Hjort mar. - apr. 1993)

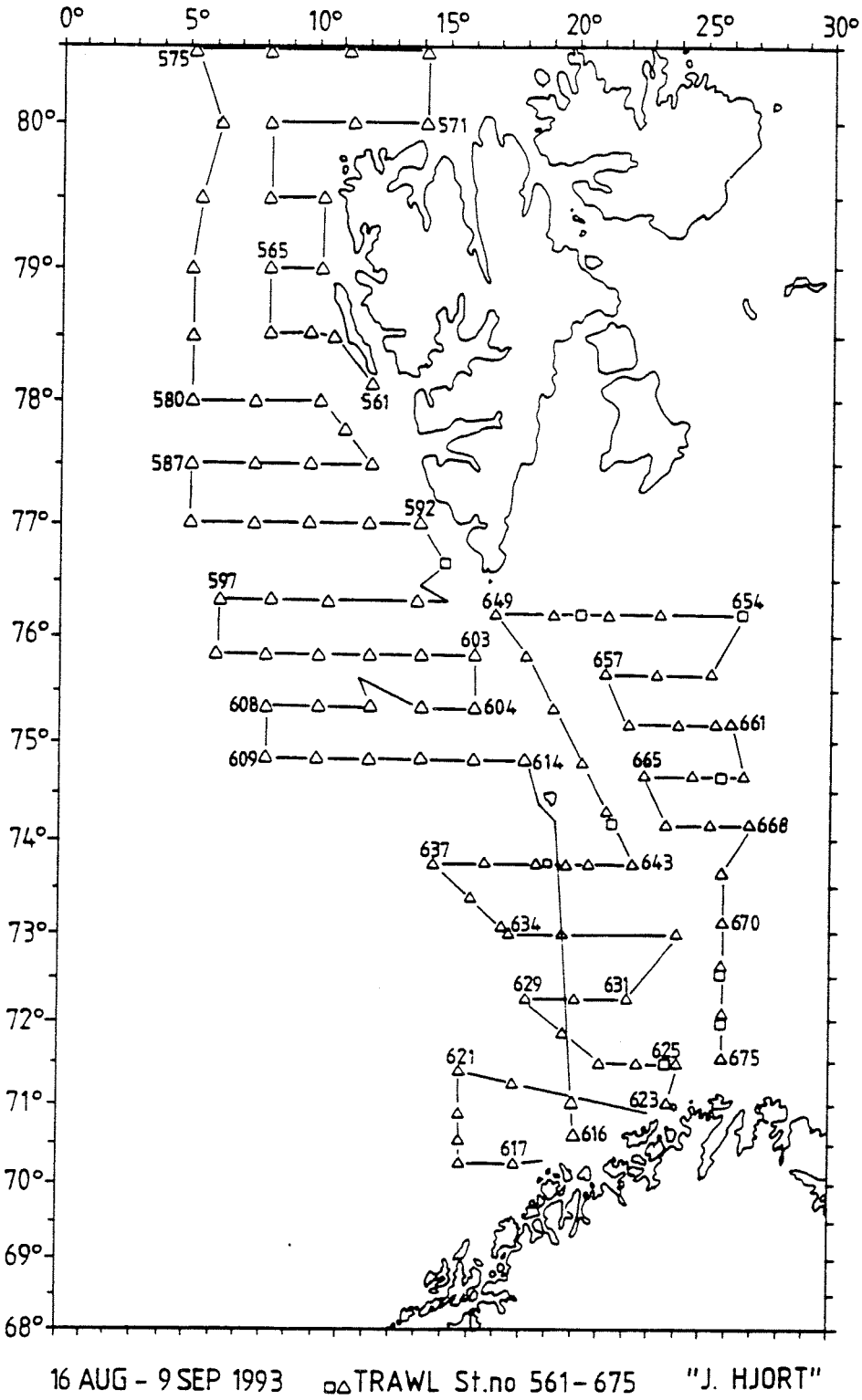


Figure 2: Sediment grab stations 1991 - 1993 (*Sediment grab stasjoner 1991 - 1993*)

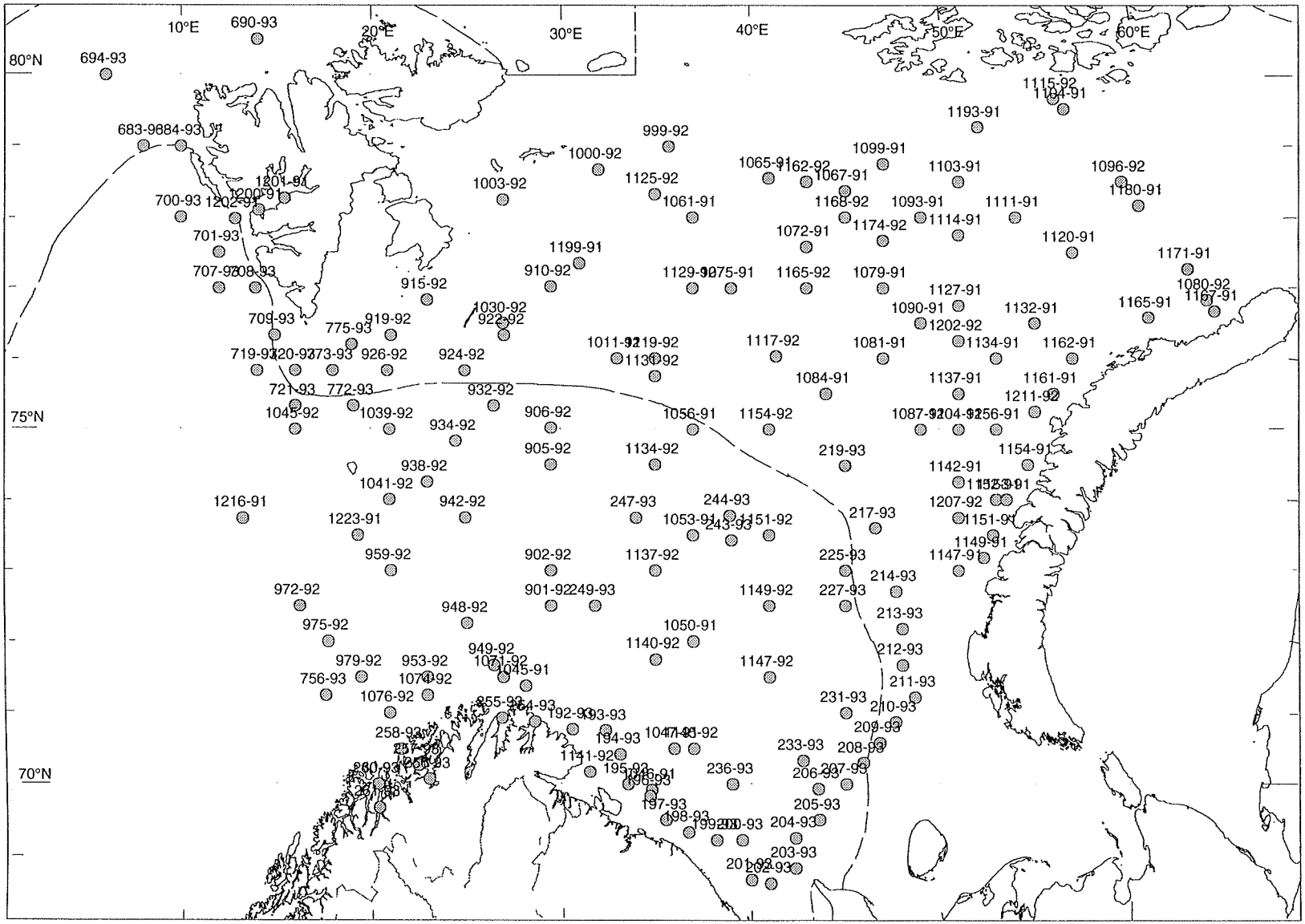


Figure 3: Fish trawl stations 1991 - 1993 (*Trålstasjoner 1991 - 1993*)

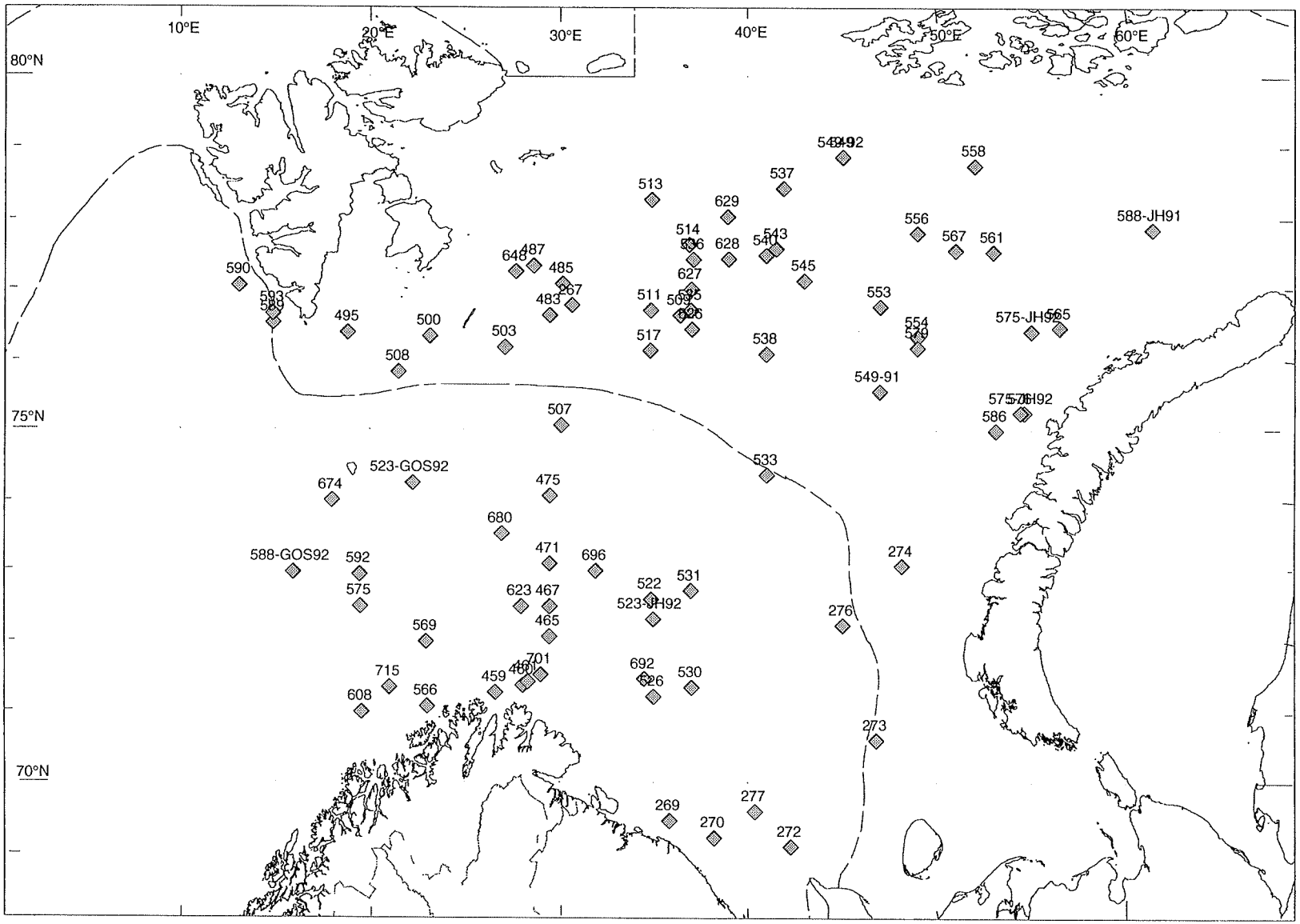


Figure 4: Zooplankton samples 1992 - 1993 (*Zooplanktonprøver 1992 - 1993*)

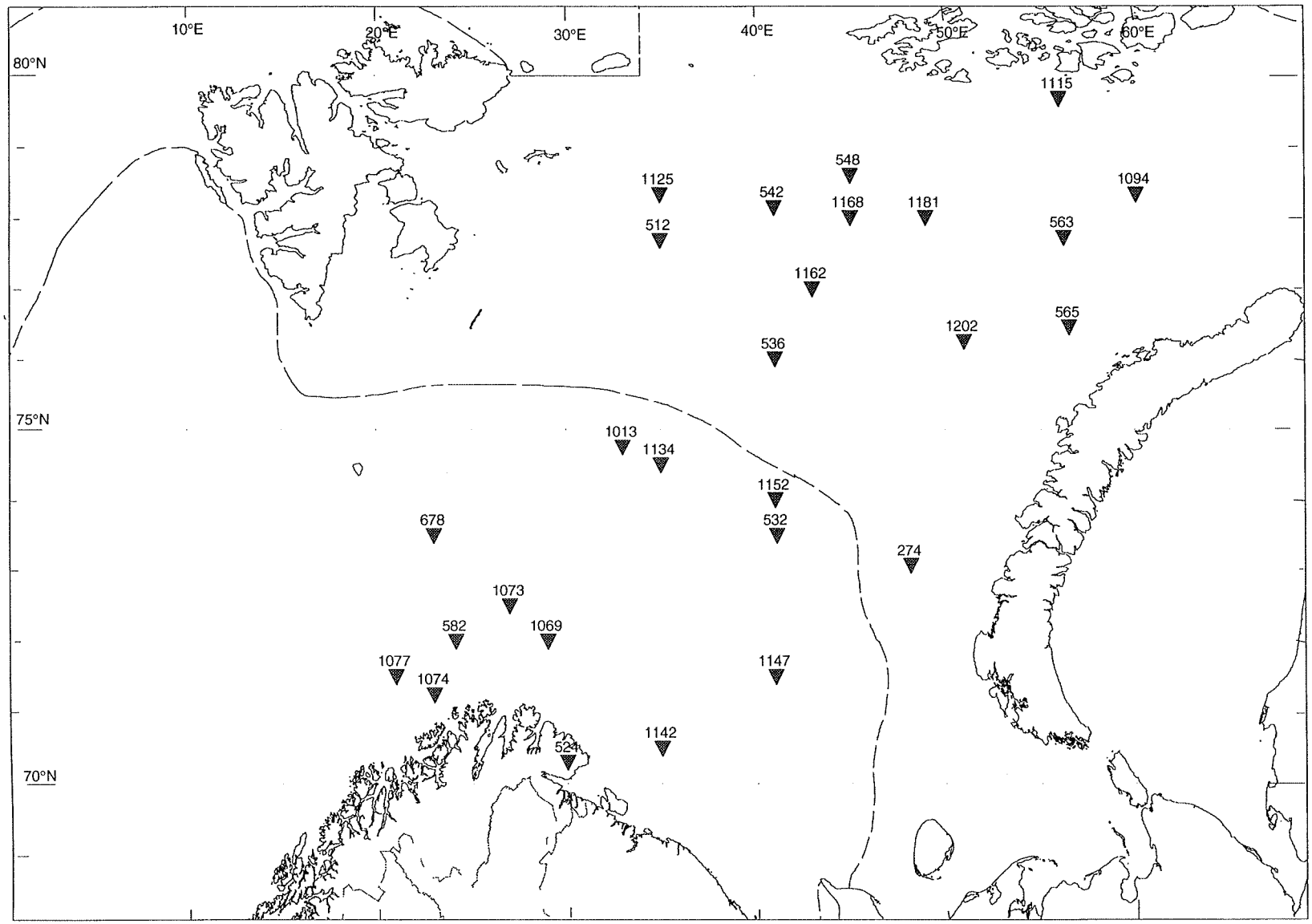


Figure 5: Sediment stations analysed for PAH (*Sedimentstasjoner analysert for PAH*)

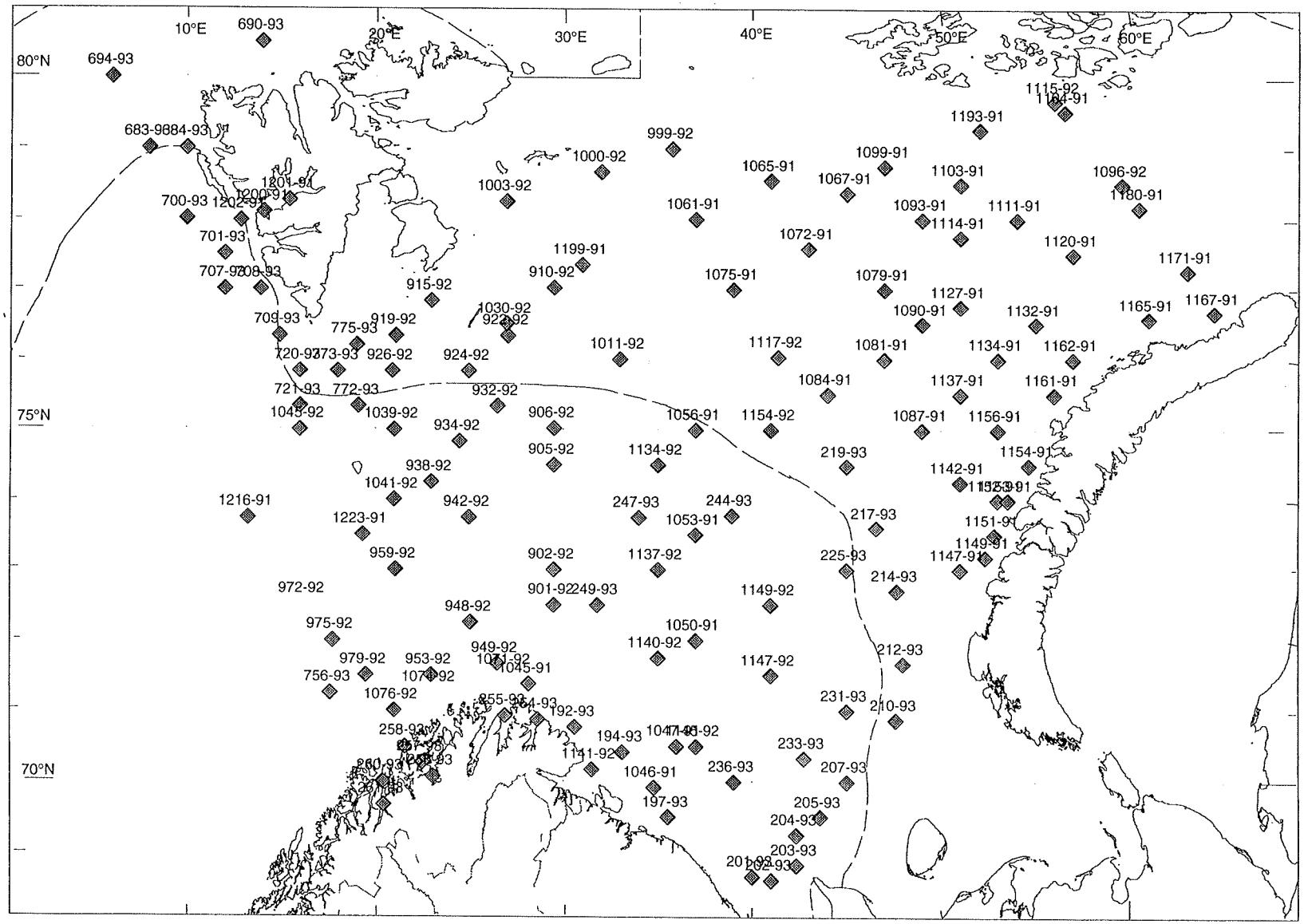


Figure 6: Sediment stations analysed for metals (*Sedimentstasjoner analysert for metaller*)

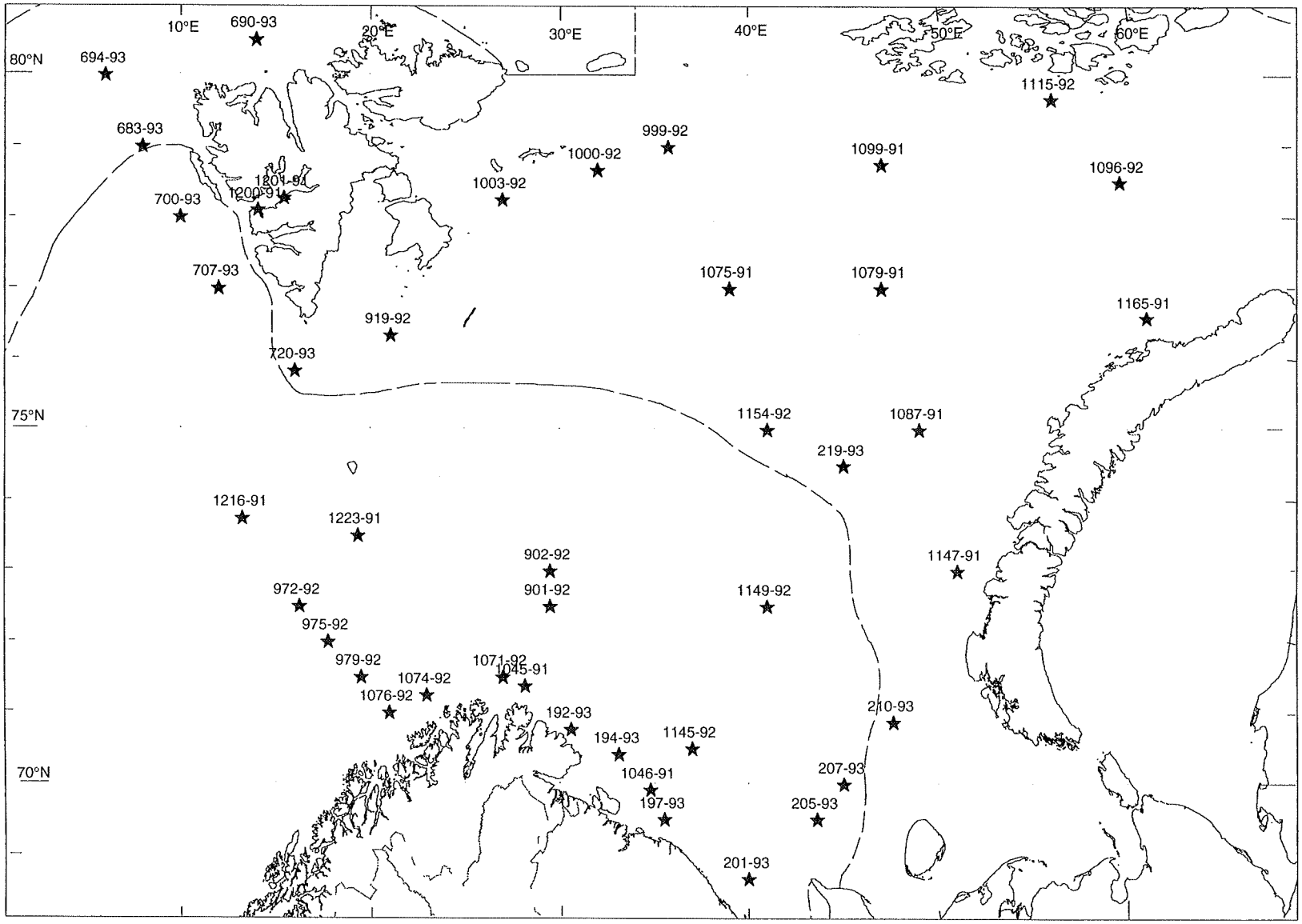


Figure 7: Sediment stations analysed for Cs^{137} (*Sedimentstasjoner analysert for* Cs^{137})

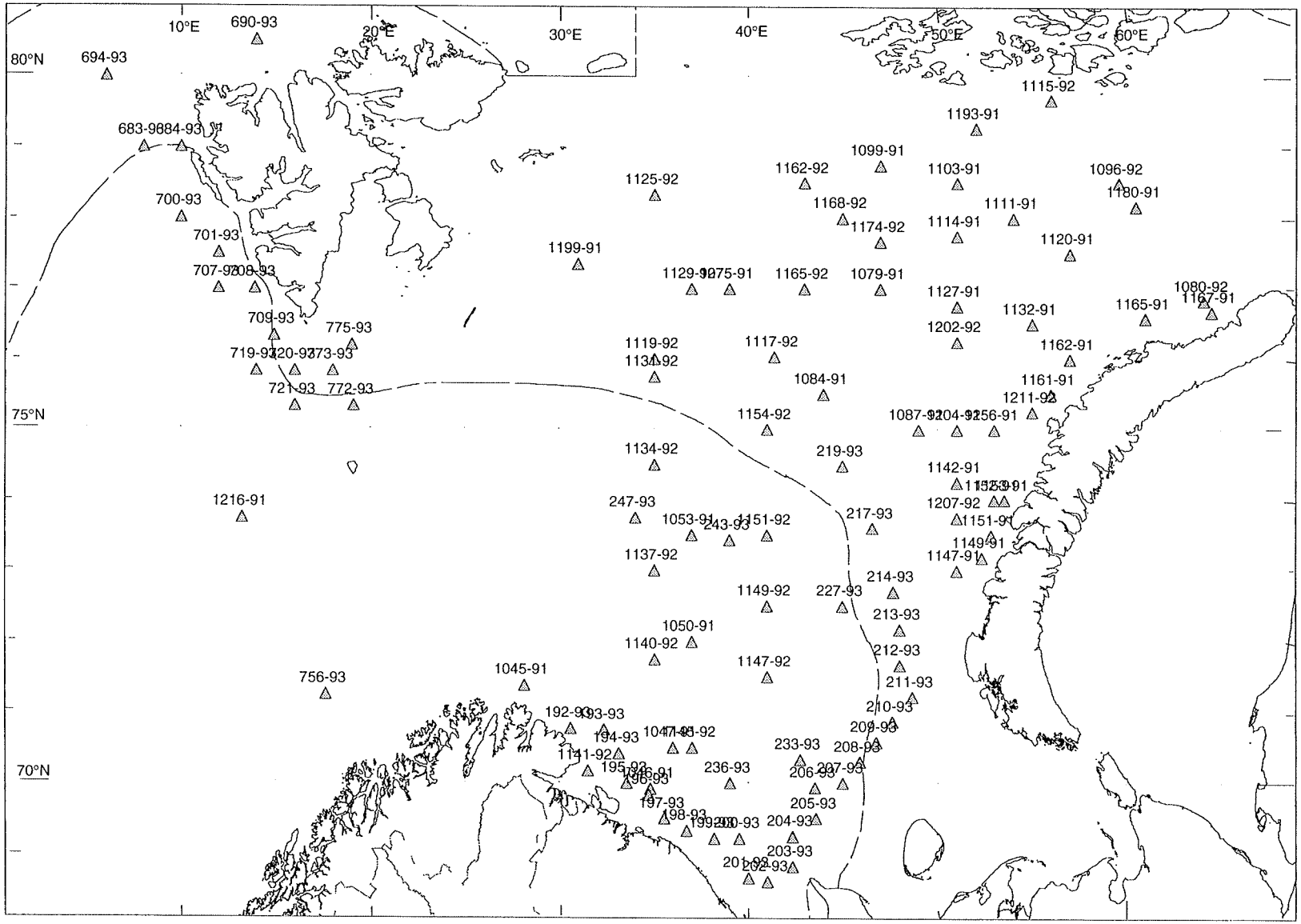


Figure 8: Sediment stations analysed for PCDD, PCDF and planar PCBs (*Sedimentstasjoner analysert for dioxiner, furaner og plane PCB*)

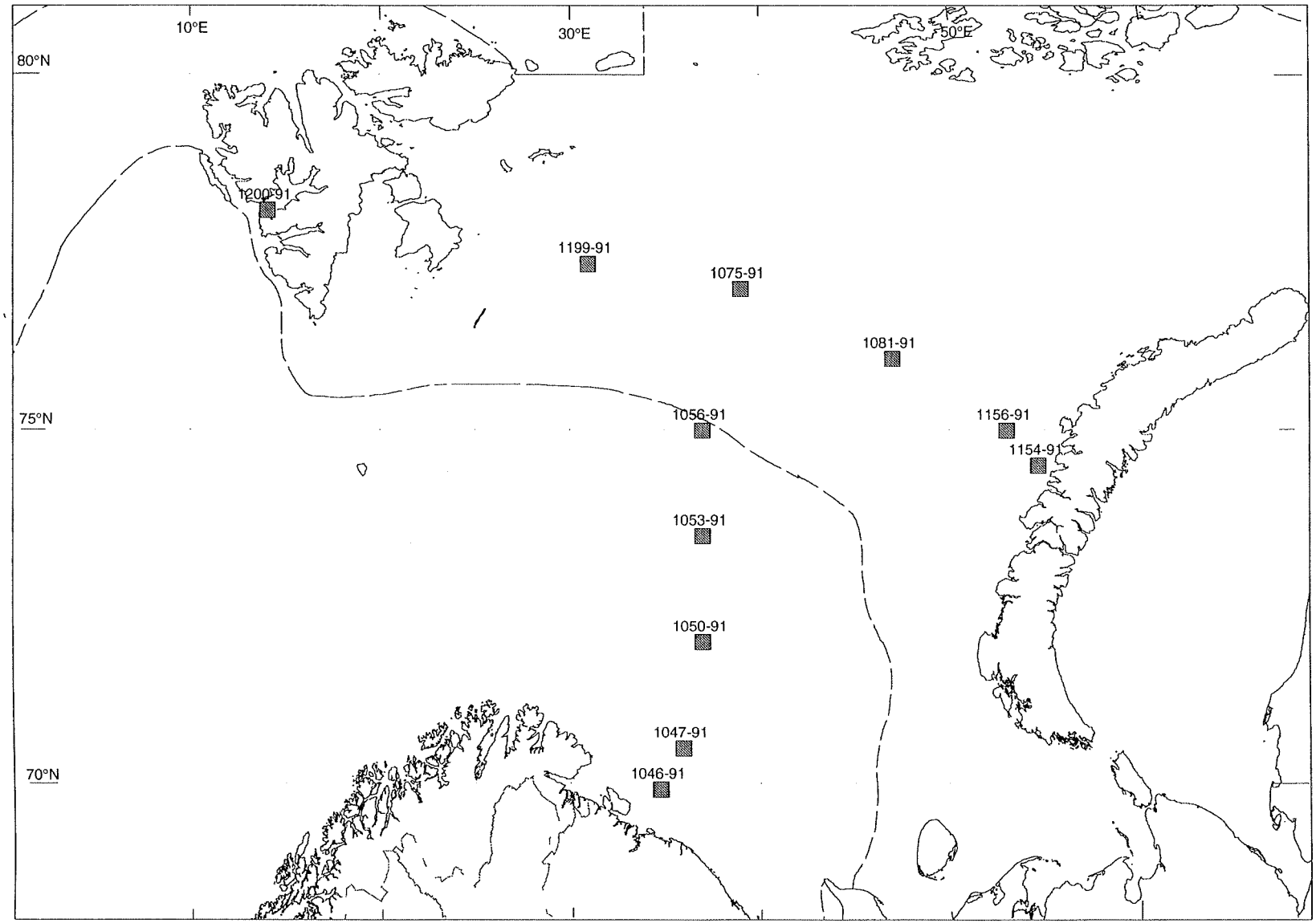


Figure 9: Fish analysed for PCBs and OCP (*Fisk analysert for polyklorerte bifenyler og klororganiske pesticider*)

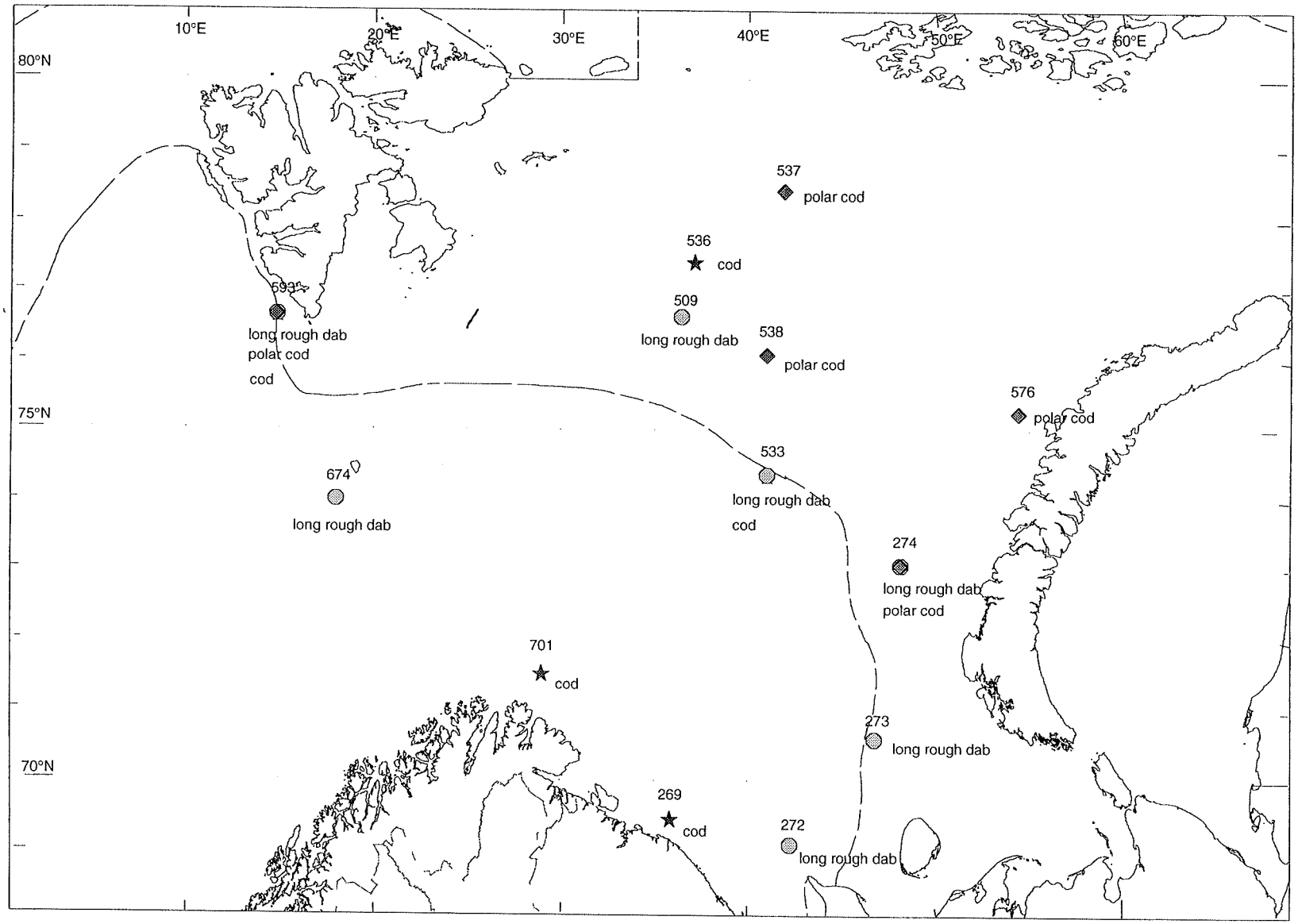


Figure 10: Fish analysed for metals (*Fisk analysert for metaller*)

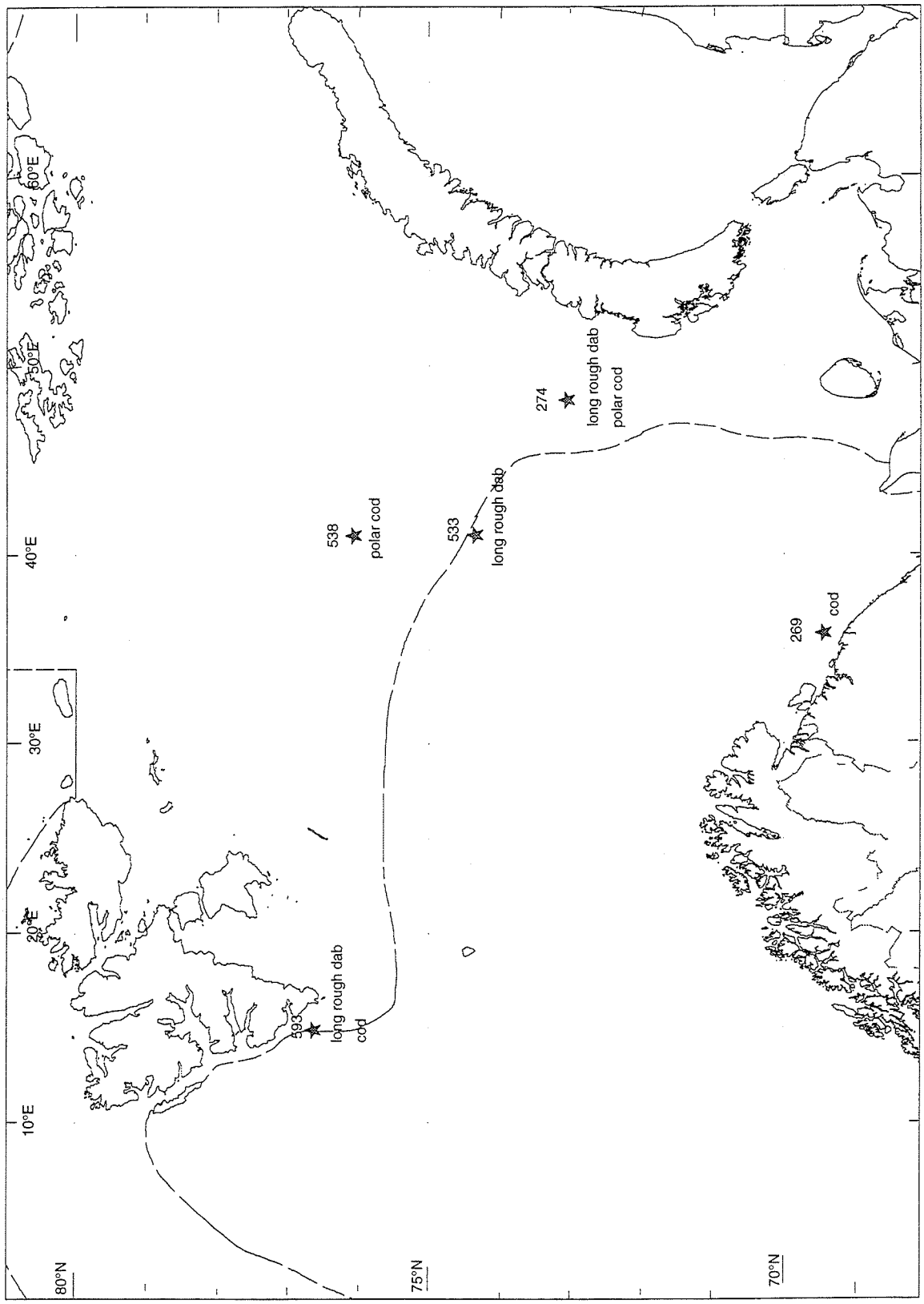


Table 1: Sediment stations for selected analytical parameters (*Sedimentstasjoner for utvalgte analyseparametere*)

Station id.	Boat	Date	Depth	Position				Parameters analysed						
CTD		(day/mo/yr)	(meters)	latitude		longitude		PAH	PCB	Metals	Cs137	PCDD/PCDF	Grain size	TOC
1045	J. Hjort	13.09.91.	399	71°23'	N	28°10'	E	1		1	1		1	1
1046	J. Hjort	13.09.91.	243	69°55'	N	34°45'	E	1	1	1	1	1	1	1
1047	J. Hjort	14.09.91.	175	70°30'	N	35°58'	E	1	1		1	1	1	1
1050	J. Hjort	14.09.91.	265	72°00'	N	37°00'	E	1	1		1	1	1	1
1053	J. Hjort	14.09.91.	268	73°30'	N	37°00'	E	1	1		1	1	1	1
1056	J. Hjort	15.09.91.	180	75°00'	N	37°00'	E	1	1			1	1	1
1061	J. Hjort	16.09.91.	168	78°00'	N	37°00'	E	1					1	1
1065'	J. Hjort	17.09.91.	306	78°33'	N	41°00'	E	1					1	1
1067	J. Hjort	17.09.91.	281	78°22.5'	N	45°00'	E	1					1	1
1072	J. Hjort	18.09.91.	234	77°35'	N	43°00'	E	1					1	1
1075	J. Hjort	18.09.91.	180	77°00'	N	39°00'	E	1	1	1	1	1	1	1
1079	J. Hjort	19.09.91.	226	77°00'	N	47°00'	E	1		1	1		1	1
1081	J. Hjort	19.09.91.	250	76°00'	N	47°00'	E	1	1			1	1	1
1084	J. Hjort	20.09.91.	306	75°30'	N	44°00'	E	1			1		1	1
1087	J. Hjort	20.09.91.	240	75°00'	N	49°00'	E	1		1	1		1	1
1090	J. Hjort	21.09.91.	223	76°30'	N	49°00'	E	1					1	1
1093	J. Hjort	21.09.91.	325	78°00'	N	49°00'	E	1					1	1
1099	J. Hjort	22.09.91.	240	78°45'	N	47°00'	E	1		1	1		1	1
1103	J. Hjort	23.09.91.	240	78°30'	N	51°00'	E	1			1		1	1
1104	J. Hjort	23.09.91.	270	79°32'	N	56°32'	E	1					1	1
1111	J. Hjort	24.09.91.	223	78°00'	N	54°00'	E	1			1		1	1
1114	J. Hjort	24.09.91.	238	77°45'	N	51°00'	E	1			1		1	1
1120	J. Hjort	25.09.91.	207	77°30'	N	57°00'	E	1			1		1	1
1127	J. Hjort	26.09.91.	309	76°45'	N	51°00'	E	1			1		1	1
1132	J. Hjort	26.09.91.	113	76°30'	N	55°00'	E	1			1		1	1
1134	J. Hjort	27.09.91.	132	76°00'	N	53°00'	E	1					1	1
1137	J. Hjort	27.09.91.	212	75°30'	N	51°00'	E	1	1				1	1
1142	J. Hjort	27.09.91.	127	74°15'	N	51°00'	E	1			1		1	1

Table 1 (cont.)

Station id.	Boat	Date	Depth	Position					Parameters analysed					
CTD		(day/mo/yr)	(meters)	latitude		longitude		PAH	PCB	Metals	Cs137	PCDD/PCDF	Grain size	TOC
1147	J. Hjort	28.09.91.	180	73°00'	N	51°00'	E	1		1	1		1	1
1149	J. Hjort	28.09.91.	63	73°10.5'	N	52°20'	E	1			1		1	1
1151	J. Hjort	28.09.91.	65	73°30'	N	52°50'	E	1			1		1	1
1152	J. Hjort	28.09.91.	152	74°00'	N	53°00'	E	1			1		1	1
1153	J. Hjort	28.09.91.	132	74°00'	N	53°32'	E	1			1		1	1
1154	J. Hjort	28.09.91.	144	74°30'	N	54°40'	E	1	1			1	1	1
1156	J. Hjort	29.09.91.	113	75°00'	N	53°00'	E	1	1		1	1	1	1
1161	J. Hjort	29.09.91.	175	75°30'	N	56°00'	E	1			1		1	1
1162	J. Hjort	30.09.91.	101	76°00'	N	57°00'	E	1			1		1	1
1165	J. Hjort	30.09.91.	82	76°35'	N	61°00'	E	1		1	1		1	1
1167	J. Hjort	30.09.91.	138	76°40'	N	64°30'	E	1			1		1	1
1171	J. Hjort	30.09.91.	105	77°16'	N	63°05'	E	1					1	1
1180	J. Hjort	01.10.91.	350	78°10'	N	60°30'	E	1			1		1	1
1193	J. Hjort	02.10.91.	324	79°16'	N	52°00'	E	1			1		1	1
1199	J. Hjort	03.10.91.	190	77°21'	N	31°00'	E	1	1		1	1	1	1
1200	J. Hjort	05.10.91.	165	78°06.3'	N	14°05'	E	1	1	1		1	1	1
1201	J. Hjort	05.10.91.	115	78°16.4'	N	15°27'	E	1		1			1	1
1202	J. Hjort	05.10.91.	124	77°58.8'	N	12°50.5'	E	1					1	1
1216	J. Hjort	08.10.91.	1680	73°43.5'	N	13°15.8'	E	1		1	1		1	1
1223	J. Hjort	10.10.91.	425	73°30'	N	19°20'	E	1		1			1	1
901	G. O. Sars	19.08.92.	280	72°30'	N	29°30'	E	1		1			1	1
902	G. O. Sars	19.08.92.	275	73°00'	N	29°30'	E	1		1			1	
905	G. O. Sars	20.08.92.	365	74°30'	N	29°30'	E	1					1	1
906	G. O. Sars	20.08.92.	370	75°01'	N	29°30'	E	1					1	1
910	G. O. Sars	21.08.92.	220	77°01'	N	29°30'	E	1					1	1
915	G. O. Sars	22.08.92.	100	76°50'	N	23°00'	E	1					1	1
919	G. O. Sars	23.08.92.	220	76°20'	N	21°05'	E	1		1			1	1
922	G. O. Sars	23.08.92.	122	76°20'	N	27°03'	E	1					1	1

Table 1 (cont.)

Station id.	Boat	Date	Depth	Position				Parameters analysed						
CTD		(day/mo/yr)	(meters)	latitude		longitude		PAH	PCB	Metals	Cs137	PCDD/PCDF	Grain size	TOC
924	G. O. Sars	24.08.92.	104	75°50'	N	24°58'	E	1					1	1
926	G. O. Sars	24.08.92.	40	75°50'	N	20°54'	E	1					1	1
932	G. O. Sars	25.08.92.	190	75°20'	N	26°30'	E	1					1	1
934	G. O. Sars	25.08.92.	160	74°50'	N	24°29'	E	1					1	1
938	G. O. Sars	26.08.92.	260	74°15'	N	23°00'	E	1					1	1
942	G. O. Sars	28.08.92.	435	73°45'	N	25°00'	E	1					1	1
948	G. O. Sars	29.08.92.	265	72°15'	N	25°06'	E	1					1	1
949	G. O. Sars	30.08.92.	346	71°40'	N	26°30'	E	1					1	1
953	G. O. Sars	31.08.92.	420	71°30'	N	23°00'	E	1					1	1
959	G. O. Sars	02.09.92.	450	73°00'	N	21°05'	E	1					1	1
972	G. O. Sars	04.09.92.	385	72°30'	N	16°15'	E			1			1	1
975	G. O. Sars	05.09.92.	302	72°00'	N	17°45'	E	1		1			1	1
979	G. O. Sars	06.09.92.	225	71°30'	N	19°30'	E	1		1			1	1
999	G. O. Sars	14.09.92.	310	79°00'	N	35°45'	E	1		1			1	1
1000	G. O. Sars	14.09.92.	275	78°40'	N	32°00'	E	1		1			1	1
1003	G. O. Sars	15.09.92.	309	78°15'	N	27°00'	E	1		1			1	1
1011	G. O. Sars	17.09.92.	319	76°00'	N	33°00'	E	1					1	1
1030	G. O. Sars	21.09.92.	96	76°30'	N	27°00'	E	1					1	1
1039	G. O. Sars	23.09.92.	53	75°00'	N	21°00'	E	1					1	1
1041	G. O. Sars	23.09.92.	288	74°00'	N	21°00'	E	1					1	1
1045	G. O. Sars	24.09.92.	240	75°00'	N	16°00'	E	1					1	1
1071	G. O. Sars	03.10.92.	342	71°30'	N	27°00'	E			1			1	1
1074	G. O. Sars	05.10.92.	390	71°15'	N	23°00'	E			1			1	1
1076	G. O. Sars	06.10.92.	166	71°00'	N	21°00'	E	1		1			1	1
1080	J. Hjort	08.09.92.	225	76°50'	N	64°05'	E				1		1	1
1096	J. Hjort	09.09.92.	261	78°30'	N	59°35'	E	1		1	1		1	1
1115	J. Hjort	10.09.92.	201	79°40'	N	56°00'	E	1		1	1		1	1
1117	J. Hjort	11.09.92.	304	76°02'	N	41°23'	E	1			1		1	1

Table 1 (cont.)

Station id.	Boat	Date	Depth	Position				Parameters analysed						
CTD		(day/mo/yr)	(meters)	latitude		longitude		PAH	PCB	Metals	Cs137	PCDD/PCDF	Grain size	TOC
1119	J. Hjort	13.09.92.	245	76°00'	N	35°00'	E				1		1	1
1125	J. Hjort	14.09.92.	266	78°20'	N	35°00'	E				1		1	
1129	J. Hjort	14.09.92.	170	77°00'	N	37°00'	E				1		1	1
1131	J. Hjort	15.09.92.	175	75°45'	N	35°00'	E				1		1	1
1134	J. Hjort	15.09.92.	272	74°30'	N	35°00'	E	1			1		1	1
1137	J. Hjort	16.09.92.	220	73°00'	N	35°00'	E	1			1		1	1
1140	J. Hjort	16.09.92.	240	71°45'	N	35°00'	E	1			1		1	1
1141	J. Hjort	18.09.92.	224	70°10'	N	31°30'	E	1			1		1	1
1145	J. Hjort	19.09.92.	242	70°30'	N	37°00'	E	1		1	1		1	1
1147	J. Hjort	20.09.92.	329	71°30'	N	41°00'	E	1			1		1	1
1149	J. Hjort	20.09.92.	346	72°30'	N	41°00'	E	1		1	1		1	1
1151	J. Hjort	20.09.92.	200	73°30'	N	41°00'	E				1		1	
1154	J. Hjort	21.09.92.	189	75°00'	N	41°00'	E	1		1	1		1	1
1162	J. Hjort	22.09.92.	206	78°30'	N	43°00'	E				1		1	
1165	J. Hjort	23.09.92.	243	77°00'	N	43°00'	E				1		1	1
1168	J. Hjort	24.09.92.	358	78°00'	N	45°00'	E				1		1	1
1174	J. Hjort	25.09.92.	230	77°40'	N	47°00'	E				1		1	1
1202	J. Hjort	29.09.92.	314	76°15'	N	51°00'	E				1		1	1
1204	J. Hjort	29.09.92.	141	75°00'	N	51°00'	E				1		1	1
1207	J. Hjort	29.09.92.	210	73°45'	N	51°00'	E				1		1	1
1211	J. Hjort	30.09.92.	209	75°15'	N	55°00'	E				1		1	1
192	J. Hjort	30.03.93	376	70°46'	N	30°35'	E	1		1	1		1	1
193	J. Hjort	30.03.93	257	70°45'	N	32°20'	E				1		1	
194	J. Hjort	30.03.93	257	70°25'	N	33°06'	E	1		1	1		1	1
195	J. Hjort	31.03.93	145	70°00'	N	33°30'	E				1		1	
196	J. Hjort	31.03.93	214	69°50'	N	34°40'	E				1		1	
197	J. Hjort	31.03.93	187	69°30'	N	35°30'	E	1		1	1		1	1
198	J. Hjort	31.03.93	186	69°20'	N	36°42'	E				1		1	

Table 1 (cont.)

Station id.	Boat	Date	Depth	Position				Parameters analysed						
CTD		(day/mo/yr)	(meters)	latitude		longitude		PAH	PCB	Metals	Cs137	PCDD/PCDF	Grain size	TOC
199	J. Hjort	31.03.93	196	69°13'	N	38°10'	E				1		1	
200	J. Hjort	01.04.93	148	69°13'	N	39°30'	E				1		1	
201	J. Hjort	01.04.93	100	68°40'	N	40°00'	E	1		1	1		1	1
202	J. Hjort	01.04.93	74	68°37'	N	41°00'	E	1			1		1	1
203	J. Hjort	01.04.93	75	68°50'	N	42°20'	E	1			1		1	1
204	J. Hjort	01.04.93	84	69°15'	N	42°20'	E	1			1		1	1
205	J. Hjort	01.04.93	51	69°30'	N	43°36'	E	1		1	1		1	1
206	J. Hjort	01.04.93	103	69°56'	N	43°32'	E				1		1	
207	J. Hjort	02.04.93	103	70°00'	N	45°00'	E	1		1	1		1	1
208	J. Hjort	02.04.93	79	70°18'	N	45°54'	E				1		1	
209	J. Hjort	02.04.93	120	70°35'	N	46°46'	E				1		1	
210	J. Hjort	02.04.93	165	70°52'	N	47°38'	E	1		1	1		1	1
211	J. Hjort	02.04.93	140	71°13'	N	48°40'	E				1			
212	J. Hjort	02.04.93	73	71°40'	N	48°00'	E	1			1		1	1
213	J. Hjort	03.04.93	222	72°10'	N	48°00'	E				1		1	
214	J. Hjort	03.04.93	264	72°42'	N	47°40'	E	1			1		1	1
217	J. Hjort	03.04.93	320	73°36'	N	46°35'	E	1			1		1	1
219	J. Hjort	04.04.93	302	74°29'	N	45°00'	E	1		1	1		1	1
225	J. Hjort	05.04.93	352	73°00'	N	45°00'	E	1					1	1
227	J. Hjort	05.04.93	280	72°30'	N	45°00'	E				1		1	
231	J. Hjort	05.04.93	155	71°00'	N	45°00'	E	1					1	1
233	J. Hjort	06.04.93	72	70°20'	N	42°45'	E	1			1		1	1
236	J. Hjort	06.04.93	166	70°00'	N	39°00'	E	1			1		1	1
243	J. Hjort	08.04.93	263	73°26'	N	39°00'	E				1			
244	J. Hjort	08.04.93	233	73°47'	N	38°56'	E	1					1	1
247	J. Hjort	08.04.93	320	73°45'	N	34°00'	E	1			1		1	1
249	J. Hjort	09.04.93	264	72°30'	N	31°50'	E	1					1	1
254	J. Hjort	10.04.93	294	70°53'	N	28°37'	E	1					1	1
255	J. Hjort	10.04.93	305	70°56'	N	26°55'	E	1					1	1

Table 1 (cont.)

Station id.	Boat	Date	Depth	Position					Parameters analysed					
CTD		(day/mo/yr)	(meters)	latitude		longitude		PAH	PCB	Metals	Cs137	PCDD/PCDF	Grain size	TOC
256	J. Hjort	11.04.93	298	70°04'	N	23°05'	E	1					1	1
257	J. Hjort	11.04.93	464	70°16'	N	22°30'	E	1					1	1
258	J. Hjort	11.04.93	435	70°29.4'	N	21°35'	E	1					1	1
260	J. Hjort	12.04.93	300	70°00'	N	20°23'	E	1					1	1
261	J. Hjort	12.04.93		69°40'	N	20°25.4'	E	1					1	1
683	J. Hjort	17.08.93	1094	79°00'	N	08°00'	E	1		1	1		1	1
684	J. Hjort	17.08.93	259	79°00'	N	10°00'	E	1			1		1	1
690	J. Hjort	18.08.93	120	80°30'	N	14°00'	E	1		1	1		1	1
694	J. Hjort	19.08.93	890	80°00'	N	06°00'	E	1		1	1		1	1
700	J. Hjort	20.08.93	172	78°00'	N	10°00'	E	1		1	1		1	1
701	J. Hjort	20.08.93	168	77°30'	N	12°00'	E	1			1		1	1
707	J. Hjort	22.08.93	750	77°00'	N	12°00'	E	1		1	1		1	1
708	J. Hjort	22.08.93	106	77°00'	N	13°54'	E	1			1		1	1
709	J. Hjort	22.08.93	327	76°20'	N	14°55'	E	1			1		1	1
719	J. Hjort	23.08.93	637	75°50'	N	14°00'	E				1			
720	J. Hjort	24.08.93	380	75°50'	N	16°00'	E	1		1	1		1	1
721	J. Hjort	24.08.93	203	75°20'	N	16°00'	E	1			1		1	1
756	J. Hjort	29.08.93	253	71°15'	N	17°38'	E	1			1		1	1
772	J. Hjort	03.09.93	61	75°20'	N	19°05'	E	1			1		1	1
773	J. Hjort	03.09.93	175	75°50'	N	18°00'	E	1			1		1	1
775	J. Hjort	04.09.93	247	76°12'	N	19°00'	E	1			1		1	1
Tot.# sediment stations:		161		# Stations analysed:				131	12	43	102	11	159	144

Table 2: Fish samples for selected analytical parameters (*Fiskeprøver for utvalgte analyseparametere*)

Station id	Boat	Date	Species		# fish	Position				Parameters analysed/to be analysed					
(trawl)		(day/mo/yr)				latitude		longitude		PAH	PCB	Pesticides	Metals	PCC	Age
269	J. Hjort	31.03.93	Cod	*Gadus morhua*	25	69°28'	N	35°49'	E	1	1	1	1	1	1
533	J. Hjort	21.09.92	Cod	*Gadus morhua*	5	74°22'	N	41°02'	E		1	1			1
536	J. Hjort	16.09.92	Cod	*Gadus morhua*	25	77°25'	N	37°07'	E		1	1		1	1
593	J. Hjort	22.08.93	Cod	*Gadus morhua*	25	76°39'	N	14°52'	E		1	1	1	1	1
701	G.O. Sars	03.10.92	Cod	*Gadus morhua*	25	71°32'	N	29°00'	E		1	1			1
274	J. Hjort	03.04.93	Polar cod	*Boreogadus saida*	25	73°04'	N	48°10'	E		1	1	1		1
537	J. Hjort	17.09.92	Polar cod	*Boreogadus saida*	25	78°26'	N	41°54'	E		1	1			1
538	J. Hjort	21.09.92	Polar cod	*Boreogadus saida*	25	76°05'	N	41°00'	E		1	1	1		
576	J. Hjort	30.09.92	Polar cod	*Boreogadus saida*	27	75°15'	N	54°27'	E		1	1			
593	J. Hjort	22.08.93	Polar cod	*Boreogadus saida*	25	76°39'	N	14°52'	E		1	1		1	1
272	J. Hjort	01.04.93	Long rough dab	*Hippoglossoides platessoides*	20	69°06'	N	42°15'	E		1	1			
273	J. Hjort	02.04.93	Long rough dab	*Hippoglossoides platessoides*	25	70°36'	N	46°47'	E		1	1			
274	J. Hjort	03.04.93	Long rough dab	*Hippoglossoides platessoides*	25	73°04'	N	48°10'	E		1	1	1		
509	J. Hjort	13.09.92	Long rough dab	*Hippoglossoides platessoides*	25	76°38'	N	36°26'	E		1	1			
533	J. Hjort	21.09.92	Long rough dab	*Hippoglossoides platessoides*	25	74°22'	N	41°02'	E		1	1	1		
593	J. Hjort	22.08.93	Long rough dab	*Hippoglossoides platessoides*	25	76°39'	N	14°52'	E		1	1	1		1
674	G.O. Sars	23.09.92	Long rough dab	*Hippoglossoides platessoides*	25	74°00'	N	18°00'	E		1	1			1