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2nd REPORT OF THE WORKING GROUP ON POLLUTION BASELINE AND MONITORING STUDIES IN THE OSLO COMMISSION AND ICNAF AREAS

Charlottenlund, 10-13 May 1976

ANNEXES 5a, 5b, 6 and 7 to Doc. C.M.1976/E:4

These Annexes give full details of an intercalibration study, a fish baseline study and sea water analysis programme carried out under the auspices of this ICES Working Group. They are bound separately from the Report of the Meeting as they are likely to be widely referred to and are complete in themselves.

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ANNEX 5a

REPORT ON 1975 ICES TRACE METAL INTERCALIBRATION EXERCISE

by

G. Topping, DAFS, Marine Laboratory, Aberdeen, Scotland

Introduction

At the first meeting of the ICES Working Group on Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas it was agreed that a 3rd ICES intercalibration exercise for trace metals, on the lines of those conducted in 1972 and 1973/74 by the ICES Working Group on Pollution of the North Sea, could provide valuable comparative data for the laboratories participating in the 1975 ICES fish and shellfish baseline study.

This report discusses the results of this exercise.

Reference Samples

In accordance with the proposals made by the Working Group the Marine Laboratory, Aberdeen, prepared, (see Appendix I to this report) and circulated to all laboratories participating in the fish and shellfish baseline exercise 100g of a new reference fish flour and 10 ml of each stock (1000 ppm) metal standard solution (Cu, Zn, Hg, Pb and Cd) in July 1975.

Participants were asked to analyse the fish flour using the method of analysis to be employed by their institute for the forthcoming ICES baseline survey for Cu, Zn, Hg, Pb and Cd, and where possible As, Cr and organic mercury. They were asked to calibrate their methods using their own standard metal solutions (prepared in accordance with instructions issued in an accompanying circular, Appendix II) and using the reference metal solutions issued by the Marine Laboratory, Aberdeen. All analyses were to be done six times and the results, together with details of methods, instrumentation and calibration, were to be submitted to the coordinator not later than 30 September 1975.

Results

A list of laboratories and reporting analysts, a summary table of methods of analysis employed by these laboratories and a list of limits of detection are presented in Tables 1, 2 and 3 respectively. The results of the fish flour analyses are presented in Table 4.

The results of the fish flour analyses were examined by the Statistics section of the Marine Laboratory, Aberdeen.

Copper

Mean values of copper in fish flour, reported by 18 analysts, ranged from 2.69 ppm - 5.68 ppm (Table 4). The largest standard deviation and coefficient of variation were produced by Lab 4. Two of the six values quoted by this laboratory (5.6 + 8.7) were considerably higher than the other four values which gave a mean, standard deviation and coefficient of variation of 3.38, 0.17 and 5.1 respectively. Because of the distortion that one very large variance would put on the overall statistical analysis it was decided that there was sufficient justification for excluding the two very high values from further analyses.

An analysis of variance showed that there were significant differences between mean levels of copper as measured by the different analysts. The significance of the differences between analysts was determined by means of a multiple range test (Kramer, 1956). The results of this test are shown on page 3 in tabular form.

It can be seen from the multiple range test that laboratory 5 has produced a mean copper value significantly higher than any other laboratory. There is a group of 11 laboratories in the middle of the range which has no significant difference between mean copper values. Two of these laboratories, 7 and 18, have much higher variability than the others but this has been ignored in computing the multiple range test which assumes the same within group variance.

The problems raised by the presence of outlying observations require careful consideration. In the present exercise all participants were instructed to report every determination made. In practice however, it is quite likely that outlying observations will be discarded immediately on the basis of some criterion. In the analysis of the copper data for example; if all six observations reported by analyst 4 are accepted the mean value 4.63 will be very different from those reported by other analysts. If, however, we reject the two highest values his results are similar to those presented by the other analysts.

The detection of real errors as distinct from extreme, but correct, values is a difficult problem and one which statistics can only solve in a probabilistic sense. Since there is always a possibility of errors arising it is suggested that a careful analysis of rejection procedures adopted by any of the different laboratories should be made.

Zinc

Mean values of zinc in fish flour, reported by 19 laboratories, ranged from 27.8 ppm - 52.7 ppm (Table 4). One laboratory (Lab 19) submitted two sets of results produced by different methods of analysis. It can also be seen from the table that five laboratories (5, 6, 8, 18 and 19b) produced more variable results than the others. A multiple range test was carried out using the remaining data from the 14 laboratories with an overall coefficient of variation of 3% and the results are tabulated on page 3.

The mean values of laboratories 14 and 13 are significantly higher than any of the other mean values and they themselves also differ significantly, while the mean zinc value of 31.4 is significantly lower than every other mean. Although the remaining mean values are more closely linked together there still exists a number of significant differences among them. The five laboratories excluded from the multiple range test tended to produce fairly extreme (both high and low) mean values of zinc content in the fish flour.

Total mercury

Mean values of total mercury in fish flour, reported by 16 laboratories ranged from 0.74 - 1.26 ppm (Table 4). The coefficients of variation for all but three of the laboratories (2, 12 and 19) were fairly consistent (<10%) giving an overall coefficient of variation of 7%. An analysis of variance for the 13 laboratories was computed. This showed statistically significant differences between mean levels of total mercury. A multiple range test gave the following results:

Lab no.	13	17	1	9	14	15	3	4	8	16	18	10	6
Mean value	0.74	0.80	0.80	0.81	0.82	0.83	0.88	0.89	0.90	0.90	0.90	0.93	0.94

Results of Multiple Ranges Tests - Copper and Zinc Data

Copper

Lab no.	6	2	1	10	4	17	3	7	18	16	15	9	19	11	14	13	5
Mean value	2.69	3.05	3.09	3.35	3.38	3.38	3.42	3.53	3.58	3.67	3.72	3.82	3.84	3.86	4.22	4.37	5.68

Zinc

Lab no.	17	7	15	19a	2	3	4	11	10	1	9	16	14	13
Mean value	31.4	33.7	34.8	35.6	35.9	36.6	36.9	37.6	38.4	38.5	39.2	40.3	42.8	52.7

[Key: Any two or more mean values underscored by the same line are not significantly different]

Although there are a number of significant differences between 13 laboratories the differences are small compared with the corresponding results of the 2nd ICES intercalibration exercise.

Lead

Mean values of lead in fish flour reported by 19 laboratories ranged from 0.16 ppm to 4.0 ppm (Table 4). An examination of the results submitted by laboratories 2, 4, 5, 6, 9, 10, 11 and 14 was made as the analysts in these laboratories had used methods with detection limits of < 0.02 ppm. Within this group mean values ranged from 0.16 ppm to 2.99 ppm and coefficients of variation ranged from 4% to 41% and so a multiple range test was not considered appropriate. There clearly exist differences in means within this group of analyses, the most striking features being the exceptionally large differences between laboratories and the very high variability within some laboratories.

Cadmium

Mean values of cadmium in fish flour reported by 19 laboratories ranged from 0.020 ppm to 0.552 (Table 4) except for laboratory 7 which quoted a value < 1.8 ppm. With such tremendous variability within laboratories it seems inappropriate to compare differences between laboratories at this stage.

Arsenic

Only two laboratories (3 and 11) reported arsenic analysis. The former produced 4 replicate analyses with a mean value of 9.6 ppm (C.V. = 8%) the latter reported on two replicate analyses with a mean value of 9.0 ppm (C.V. = 5%).

Chromium

Only five laboratories (5, 11, 15, 18 and 19) reported chromium analysis. Laboratories 5, 15, 18 and 19 produced mean values based on 6 replicates of 2.15 ppm, 1.07 ppm, 1.53 ppm and 1.82 ppm respectively while Lab 11 produced only a mean value (0.72 ppm) and a range of values (0.68 ppm - 0.79 ppm).

Organic mercury

Only two laboratories (1 and 11) reported on organic mercury analysis; their respective mean values were 0.18 ppm and 0.24 ppm.

Discussion

Although the statistical examination of the fish flour analytical data has revealed that there are significant differences between data submitted by the individual laboratories, the results for copper, zinc and mercury confirm the trend in improvement in successive ICES exercises. The overall spread of data for these three metals for the majority of participating laboratories is small enough to allow meaningful comparisons of the fish and shellfish metal data collected in the baseline study.

Unfortunately the results do not agree when it comes to the analyses of lead and cadmium at levels of 0.X ppm and 0.0X ppm respectively which represent middle values for these metals in the muscle of fish and shellfish collected from North Sea areas. There is little doubt that the inherent differences are related to the analytical methods and the limits of detection. In selecting a method for the analysis of an element within a known concentration range a method should be used whose detection level (based on two or three times the S.D of the background noise) is at least an order of magnitude lower than the lower limit of the expected concentration range. Table 3 clearly shows that ca 50% of the laboratories who submitted data on detection levels employed analytical methods which satisfy the above criteria. The majority of these laboratories produced data which not only agree reasonably well with each other but are significantly lower than the majority of the remaining laboratories.

All but one analyst reported that they could find no difference between their own standards and the ones issued by the Marine Laboratory, Aberdeen. Lab 17 reported that both copper and mercury standards were significantly higher than the one used by their laboratory. An examination of the information supplied by Lab 17 indicated that their copper and mercury standards contained no added acid. This lack of acidity could well mean that mercury losses could have taken place from their stock solution which would then make the ICES mercury stock standard appear higher.

The use of common stock standard solutions and the adoption of a common procedure for the preparation of working standards (Appendix II), has noticeably improved the overall performance in this intercalibration exercise compared to previous exercises. Overall C.Vs for Hg, Cu and Zn have now been reduced to single figures ompared to the double figures produced on 1st and 2nd ICES intercalibration exercise. It is essential that analysts continue to check their standards from time to time both within and between laboratories.

Summary and suggestions for future work

The results of this exercise indicate that in general there has been an overall improvement in the performance and comparability of participating laboratories. On the basis of this work it should now be possible, to compare mercury, copper and zinc data produced by the majority of laboratories participating in the ICES fish and shellfish baseline study. However, the comparison of lead and cadmium data, in the concentration range encountered in fish tissue, may be difficult if not impossible for the group as a whole using present methods and equipment; but it should be possible for a number of the laboratories in our group. The group must obviously give some thought to whether or not the current methodology of some laboratories is sufficiently good to deal with the low levels of lead and cadmium currently encountered in the uncontaminated environment.

he adoption of common stock standard solutions and a common procedure for the preparation of working standard solutions has obviously eliminated one major source of variation between analysts. It would be in the interest of the group as a whole that this procedure should be formally adopted by the analytical group and new participants would be required to adopt them.

The analytical group should give some thought to future intercalibration requirements. The last three exercises have shown the value of this work. We must continue to maintain the present high standards by conducting exercises at frequent intervals, perhaps once every 2-3 years - some of the group may consider that this is too infrequent but the time involved in the preparation and circulation of samples and the collection and analyses of data precludes this. Future exercises should include two or more reference materials so that we can adequately cover the range of concentration of metals encountered in our work; the last two reference fish flours have contained quite high concentrations of mercury in comparison to the levels encountered in the fish monitoring programmes.

The analytical group must also give some thought to the form in which we present our data to the coordinator for analysis. It would certainly assist future coordinators of these exercises if the analysts could present their data on a standard sheet and we ought to adopt a common procedure for the calculation and presentation of limits of detection.

Acknowledgements

Thanks are due to Dr Topping who coordinated this study and report, and to Miss A. Shanks of the Statistics and Computing Team, D.A.F.S. Marine Laboratory, Aberdeen, for the statistical analysis presented in this paper. Thanks are also due to Dr Burgess, MAFF, Torry Research, Aberdeen and Mr Wignall, MAFF, Humber Laboratory, Hull, for arranging the preparation of the fish flour used in this exercise, and to Dr R. Scott and his colleagues, Macaulay Institute for Soil Research, Aberdeen, for their help with the final grinding of the fish flour and for the advice received during the preparation of this reference sample.

Reference

KRAMER, C.Y., 1956. Extension of multiple range tests to group means with unequal numbers of replicates. Biometrics, 12:307-310.

Table 1. Countries/Institutes participating in 1975 ICES Intercalibration Exercise.

No.	Country	Institute	Reporting Analyst(s)
1.	Belgium	Ministère de l'Agriculture Institut de Recherches Chimiques	Herman
2.	Belgium	Vrije Universiteit Brussel	Janssen
3.	Canada	Environment Canada. Fisheries & Marine	Lutz
4.	Canada	Research and Development Directorate, Halifax Lab - Nova Scotia	Sirota
5.	Canada	Ministry of Agriculture and Food, Provincial Pesticide Residue Testing Lab - Guelph, Ontario	Braun
6.	Denmark	Grønlands Geologiske Undersøgelser Copenhagen	Kystol and Asmund
7.	Denmark	Institut of Petrologi, University of Copenhagen	Bollingberg
8.	France	Institut Scientifique et Technique des Pêches Maritimes	Thibaud
9.	Germany, F.R.	Bundesforschungsanstalt für Fischerei Hamburg	Harms
10.	Iceland	Marine Research Institute, Reykjavik	Olafsson
11.	Netherlands	Rijksinstitut voor Visserijproducten, TNO, IJmuiden	Ruiter
12.	Norway	Fiskeridirektoratets Havforskningsinstitut, Bergen	Julshamn
13.	Portugal	Instituto de Biologia Maritima, Lisbon	Mergulhao
14.	Sweden	Statens Naturvårdsverk, Drottningholm	Lindgren
15.	England	MAFF, Fisheries Laboratory, Burnham on Crouch	Portmann
16.	Scotland	DAFS, Marine Laboratory, Aberdeen	Topping
17.	USA	Marine Research Lab, University of Connecticut	Feng
18.	USA	Middle Atlantic Coastal Fisheries Centre, Milford Lab, Connecticut	Greig
19.	USA	US Dept of Commerce, NOAA, National Marine Fisheries Service, Maryland	Meaburn

Table 2. Summary of the individual analytical techniques employed by each laboratory.

No.	Mercury	Other Metals
1.	Wet digestion with H_2SO_4 and H_2O_2 FAA using MAS 50.	Dry ashing at 450° C followed by HNO_3 and H_2O_2. Cu, Pb and Cd - FAA - Perkin Elmer - 303, Zn - AA-Perkin Elmer 107.
2.	Wet digestion with HNO_3 and H_2O_2 FAA using MAS 50.	Low temp ashing (Tracer Lab LTA 505) followed by dil. HCl. Cu, Pb and Cd - FAA - Perkin Elmer 300, HGA - 70. Zn - AA - Perkin Elmer 300.
3.	Wet digestion with HNO_3, H_2SO_4 and $KMnO_4$ FAA using Perkin Elmer 403.	Wet digestion using HNO_3, H_2SO_4 and H_2O_2 for Cu, Cd, Pb and Zn. Cu, Pb and Cd - extracted with Na DDC followed by TECHTRON AA5. Zn - AA - Techtron AA5 As - wet digestion - followed by FAA - Perkin Elmer 403.
4.	No details.	No details.
5.	Not applicable.	Wet digestion using HNO_3, followed by FAA using TECHTRON AA5 with carbon rod Model 63.
6.	Wet digestion with H_2SO_4 and $KMnO_4$ FAA using MAS 50.	Wet digestion followed by Anodic Stripping Voltametry - CMGE.
7.	Not applicable.	Dry ashing at 430 °C followed by spectrographic analysis using Hilger Quartz spectrometer (photographic plate and Jarrel Ash micro photometer)
8.	Wet digestion with HNO_3/H_2SO_4 and $KMnO_4$ FAA - Perkin Elmer 305.	Wet digestion using HNO_3 and H_2O_2. AA using Perkin Elmer 305.
9.	Wet digestion using HNO_3 and $HClO_4$ FAA using Jarrell Ash Hg kit and Perkin Elmer 300S.	Wet digestion using HNO_3 and $HClO_4$ Cu and Zn - AA - Perkin Elmer 305 Cd and Pb - FAA " " HGA72.
10.	Wet digestion with HNO_3 H_2SO_4 and $KMnO_4$. Hg amalgamated onto gold prior to FAA - Techtron AA5.	Wet digestion using HNO_3 and H_2O_2. Zn - AA - Techtron AA5. Cu, Pb and Cd - FAA - Techtron AA5 with carbon rod Model 63.
11.	Wet digestion/FAA	Wet digestion with HNO_3 followed by FAA using Techtron CRA with carbon rod Model 63.
12.	Wet digestion with HNO_3/H_2SO_4 + V_2O_5 - FAA using Perkin Elmer 403.	Dry ashing followed by extraction AA Cd and Pb by extraction with Na DDC using Perkin Elmer 403.

/Cont'd. ......

Table 2 (Continued)

No.	Mercury	Other Metals
13.	Wet ashing with $HNO_3/HClO_4$ followed by FAA using Perkin Elmer.	Wet ashing with $HNO_3/HClO_4$ Cu and Zn - AA using Perkin Elmer 403. Cd and Pb - FAA using Perkin Elmer 300 SG.
14.	Wet digestion with HNO_3 followed by FAA using IRD double beam mercury meter.	Zn and Cu wet digestion with HNO_3 Cd and Pb - Wet digestion with $HNO_3/HClO_4$. Zn and Cu - AA - using Perkin Elmer 303. Cd and Pb - FAA - using Perkin Elmer 305 and HGA 70.
15.	Wet digestion with HNO_3/H_2SO_4 followed by FAA - A-3000 single beam.	Wet digestion with HNO_3 followed by AA - Perkin Elmer - 306.
16.	Dry ash at 900 - 1000°C followed by absorption in $KMnO_4/H_2SO_4$ FAA - using Techtron 120.	Wet digestion with $HNO_3/HClO_4$ followed by AA - IL 251 .
17.	Wet digestion using H_2SO_4 followed by FAA - MAS 50.	Wet digestion using HNO_3 followed by AA - IL 151.
18.	Wet digestion with HNO_3, H_2SO_4 and $KMnO_4$ at 50-60°C, followed by FAA using Perkin Elmer 305.	Wet digestion with HNO_3 followed by AA - Perkin Elmer 403.
19.	Wet digestion with H_2SO_4, $KMnO_4$ and H_2O_2 followed by FAA using Techtron AA5.	Dry ashing at 480°C, dissolution in dil.HCl/HNO_3 followed by AA using Jarrell Ash Model.

Key to Table 2.

AA = Atomic Absorption Spectrophotometry
FAA = Flameless Atomic Absorption Spectrophotometry

Table 3. Detection Limits (expressed as μg/gm fish meal) of analytical techniques employed by each laboratory.

Lab No.	Cu	Zn	Hg	Cd	Pb
1	0.5	5	0.2	0.02	1
2	0.1	2.5	0.2	0.005	0.01
3	0.02	0.05	0.02	0.005	0.02
4	0.01	0.002	0.0004	0.0005	0.005
5	0.08	0.6	-	0.006	0.007
6	0.02	1	-	0.002	0.002
7	0.01	1.8	-	1.8	0.1
8	-	2	0.02	0.05	1.5
9	0.008	0.004	0.02	0.001	0.004
10	0.03	0.3	0.005	0.001	0.01
11	0.048	0.078	0.001	0.0014	0.02
12	1.6	0.8	0.001	0.005	0.05
13	0.002	0.1	0.05	-	-
14	0.3	1	0.02	0.001	0.01
15	0.2	1	0.005	0.2	0.4
16	0.1	0.1	0.03	0.03	0.2
17	0.05	0.25	0.02	0.06	0.35
18	1.0	0.25	0.14	0.20	1.5
19	0.04	0.015	-	0.015	0.2

Table 4. Results of fish flour analysis (µg/gm).

Lab No.	Copper			Zinc			Mercury			Cadmium			Lead		
	Mean value	s.d.*	C.V.**	Mean value	s.d.	C.V.	Mean value	s.d.	C.V.	Mean value	s.d.	C.V.	Mean value	s.d.	C.V.
1	3.09	0.17	5.6	38.5	0.5	1.2	0.80	0.03	3.4	0.053	0.022	40.8	2.08	0.08	3.7
2	3.05	0.19	6.1	35.9	1.5	4.2	1.26	0.15	12.1	0.123	0.006	4.6	2.99	0.13	4.4
3	3.42	0.20	5.8	36.6	0.9	2.5	0.88	0.04	4.1	0.023	0.003	12.2	0.52	0.01	2.7
4	4.63	2.2	47.2	36.9	0.5	1.3	0.89	0.08	8.5	0.060	0.0005	5.0	1.45	0.21	14.6
5	5.68	0.77	13.5	49.5	5.5	11.2				0.177	0.059	33.3	0.25	0.07	26.5
6	2.69	0.63	23.6	27.8	6.8	24.6	0.94	0.05	5.3	0.036	0.009	24.4	0.59	0.10	16.2
7	3.53	0.66	18.6	33.7	2.1	6.2				<1.8			1.08	0.45	41.5
8				33.8	5.4	16.0	0.90	0.05	5.6	0.41	0.05	12.2	4.00	0.4	10.0
9	3.82	0.13	3.3	39.2	1.1	2.9	0.81	0.02	2.9	0.028	0.002	6.4	0.53	0.06	10.5
10	3.35	0.09	2.7	38.3	0.9	2.3	0.93	0.02	2.8	0.022	0.013	59.5	0.16	0.06	40.8
11	3.86	0.28	7.2	37.6	1.6	4.4				0.055	0.012	21.1	0.51	0.08	16.6
12+	4.2	0.02	0.5	36.0	0.14	-	0.79	0.12	15.2	0.042	0.056	133.3	0.81	0.02	2.5
13	4.37	0.62	14.2	52.7	0.8	1.6	0.74	0.03	4.5	0.552	0.041	7.5	1.04	0.26	24.9
14	4.22	0.50	11.9	42.8	1.6	3.7	0.82	0.02	2.6	0.020	0.008	42.0	0.21	0.03	14.4
15	3.72	0.17	4.6	34.8	1.7	4.9	0.83	0.01	1.2	<0.2			0.53	0.27	49.9
16	3.67	0.20	5.5	40.3	1.1	2.8	0.90	0.03	3.7	<0.030			0.34	0.07	20.5
17	3.38	0.17	5.1	31.4	1.3	4.1	0.80	0.02	2.8	0.39	0.05	12.0	2.30	0.06	2.8
18	3.58	0.62	17.3	28.3	8.6	30.4	0.90	0.04	4.0	<0.24			3.00	1.35	45.1
19a, b	3.84	0.08	2.1	35.6	0.8	2.3	0.90	0.16	18.1	0.17	0.12	69.9	1.18	0.21	18.0
				41.7	3.4	8.2									

+Mean values were based on a standard addition technique and not on the analysis of six replicates. Because of this the results from Lab 12 have been excluded from the multiple range test analysis.

* Standard deviation.

** Coefficient of variation.

APPENDIX 1

Preparation of reference fish flour

400 kg of distant water cod were bought from Hull fish market and processed by MAFF Humber Laboratory as follows.

1. The fish were filleted and then skinned.

2. The fillets were then cooked continuously by indirect steam at 80 psig at a temperature 80-100°C and broken up into small pieces.

3. The cooked fish plus liquor was then dried by indirect heating (ca 80°) to a moisture content of 20%. The drying stage was completed by air drying at ambient temperature.

4. The meal was then sieved to remove large pieces, caused by overheating and ground repeatedly in a hammer mill to a fine flour.

5. The final product (ca 20 kg) was subdivided using the classical coning and quartering technique* into 100 gm portions, which were transferred to individual 300 ml clear polystyrene containers.

Preparation of reference metal standard solutions

The stock solutions (2 litre) of metal standards (Cu, Zn, Cd, Pb and Hg) were prepared from BDH AA stock standards (1000 ppm) by bulking 4 x 500 ml of each metal standard. 10 ml aliquots of each standard was pipetted into individual phials with leak proof stoppers (plastic phials were used for Cu, Zn, Pb and Cd - glass phials were used for Hg standards).

Each analyst received 100 gm of fish flour and 10 ml of each of the stock metal standard solution.

* Standard Method of Chemical Analysis by
Scott and Furman
5th Edition. Vol. II. 1937
p. 1620-1624.

APPENDIX II

Department of Agriculture and Fisheries for Scotland,
Marine Laboratory,
P.O. Box No. 101,
Victoria Road, Torry, Aberdeen AB9 8DB, SCOTLAND.

1 July 1975

Dear Colleague,

ICES Working Group on Pollution Baseline and Monitoring Studies in the Oslo Commission and ICNAF Areas

1975 Trace Metal Intercalibration Exercise

You will recall from the meeting of the above Working Group held in January that it was agreed that a further intercalibration exercise for trace metals, on the lines of the ones conducted in 1972 and 1973/74, would be most valuable in providing comparative data for the laboratories participating in the baseline study of the Oslo Commission and ICNAF areas. I was instructed to do two things.

a. Prepare a report on the results of 1973 exercise and circulate it to members for comment as soon as possible and

b. Prepare and circulate a new reference fish meal sample together with suitable metal standard solutions.

The report referred to in (a) has been completed and circulated (2.6.75) to all participants in the 1973 exercise and to the new analysts who will be participating in the 1975 exercise. In addition to reporting on the results of the 1973 exercise I also made specific proposals regarding the use of metal standard solutions i.e. all participating analysts should prepare stock standard solutions and working solutions in the same way and that this laboratory should circulate individual metal solutions (Hg, Cu, Zn, Pb and Cd) which would be used as reference standard. I gather from the response to my report that these proposals are acceptable to all participants.

Procedure for the analysis of the fish flour

1. Before subsampling the fish flour, the container holding the flour should be inverted 3 times to thoroughly mix the sample. Once any fine dust has settled, the sample for analysis should be taken using a plastic spoon or spatula. This complete procedure should be repeated for each replicate sample.

2. The samples of fish flour should be analysed by the analytical procedure currently in use in your laboratory which should be the one you will adopt for the forthcoming fish and shellfish baseline study.

3. All analyses should be carried out 6 times. In accordance with Dr Portmann's letter of 11 March, which dealt with pollutants to be measured, it is essential that you include the measurements of copper, zinc, lead, cadmium and total mercury in your determinations. Wherever possible analyses should be made for arsenic, chromium and organic mercury.

4. Calibration of your analytical procedure should be made using

   (a) the standards provided with the fish flour; working standards being prepared and used according to the procedure outlined below.

   (b) the standards normally adopted by your laboratory for this work.

5. On completion of this intercalibration exercise (see note below) the following information should be returned to me (copy to Dr Portmann);

   I. Full results of all metal analyses made on the fish meal.

   II. Details of the analytical procedure used for these analyses, including the detection limits, sensitivity of the procedure and blanks.

   III. Make and model of the instrumentation used in these procedures.

   IV. Xerox copies of all calibration curves and where possible xerox copies of recorder data.

Preparation and storage of working standards

Mercury

Stock solutions (1000 ppm) should be prepared using 1N H_2SO_4 or 1N HCl and stored in glass bottles. Fresh stock solutions should be prepared every 6 months or when the level of solution in the container falls below the halfway mark.

Working solutions should be prepared daily by dilution of the above stock solution using 1N H_2SO_4 together with sufficient 6% $KMnO_4$ solution to produce a distinct pink colour in the final solution. (Please check the mercury content of your Potassium permanganate solution as this can contain very high levels of mercury.) In practice the working solution should be prepared immediately before use and should only have a bench life of *ca* 2 hrs.

Other metals

Stock solution (1000 ppm) should be made up in 1N acid and can be stored in either glass or plastic bottles. Fresh solutions should be prepared every 6 months or when the level of the solution in the container falls below the half way mark.

Working solutions should be prepared daily by dilution of the above stock solution using 1N acid.

Submission of results

It is extremely important that all participants in the fish and shellfish baseline study should complete the analyses of the fish flour reference sample as soon as possible and return the results to me and Dr Portmann not later than 30 September 1975.

Prompt analyses and an early return of intercalibration data is essential to the success of the whole baseline study. Indeed the comparison of baseline data from individual laboratories can only begin when the necessary correction factors have been applied to these data and these factors are obtained from the results of the intercalibration exercise.

I look forward, with interest, to hearing from you all in the near future.

Yours sincerely,

(Signed) G. Topping

REPORT ON ANALYSES OF ICES INTERCALIBRATION SAMPLE NO.3 FOR ORGANOCHLORINE RESIDUES BY ICES BASELINE STUDY GROUP, 1975-6

by

A.V. Holden, DAFS Freshwater Fisheries Laboratory, Pitlochry, Scotland.

Previous intercalibration samples for organochlorine analysis, using spiked oils, have been circulated among both ICES and OECD member countries in the past to check on the ability of analysts in those countries to achieve agreement in the analysis when using their own choice of analytical method. The concentrations of the residues used to spike the oil matrix have usually been much higher than those normally encountered in fish, and consequently a new intercalibration sample, containing more realistic levels of contaminants, was prepared.

It was found impossible to obtain a fish oil with residue sufficiently low to provide a suitable control (matrix) and consequently a vegetable (maize) oil was selected. A large volume of the oil was spiked with a mixture of know concentrations of several organochlorine compounds, and aliquots of this oil (3B) were circulated to participating laboratories together with an equal volume of the unspiked oil (3A). The samples were mostly distributed in November 1974, but not all laboratories had reported by March 1976. This report records the results so far received from ten laboratories, the tables giving the concentrations (in micrograms per kilogram) in the unspiked sample (3A) and in the spiked sample (3B) after correction for 3A.

A total of nine separate additions of organochlorines (including a PCB mixture) were made to the oil, but several laboratories did not report values for all residues. Most did not indicate whether the value of pp-DDE had been corrected for interference by PCB where necessary. A few values for individual residues were clearly very inaccurate, and were omitted from the calculations of mean values. At this stage no attempt has been made to calculate standard deviations, in view of the small number of laboratories involved.

In general the analytical results are reasonably good, although several laboratories had difficulty with beta-BHC. The level of detection of residues reported for the control sample (3A) varied widely, but in most cases it has been assumed that no correction of the results from sample 3B for the control residues was necessary. Most laboratories correctly selected a 50% (or 54%) chlorinated PCB mixture as reference standard.

The samples were also circulated to the Baltic group of countries (through both Professor Grasshoff and Dr Vaz), but so far no results have been received from these countries. As the true values are given in this report, results from other laboratories cannot be given the same respect if reported at a later date.

There appears to have been some improvement in the standard of analysis achieved by several of the participating laboratories, bearing in mind that sample No.3 is more difficult to analyse. Individual laboratories do, however, seem to encounter problems with certain residues.

Analysis of control sample 3A (maize oil unspiked)

(concentrations in μg/kg)

Lab No.	HCB	α-BHC	B-BHC	γ-BHC	Dieldrin	pp-DDE	pp-TDE	pp-DDT	PCB	PCB Ref
1				1	5	4	9	11	27	1254
2	6	n.d		2	n.d	n.d	n.d	n.d	n.d	1260
3	<1	6		7	3	3	<1	<1	2	
4	<10	<10	<10	<10	<10	<30	<10	<20	<300	
5							22	59	470	
6					7	15	6	6	14	1254
7		(87)		(59)	(80)	(40)	(Nil)	(170)		
8	<5	<5	<5	<5	<5	<5	<10	<5	<50	A.50
9	<2	<2	<5	<2	<5	<5	<10	<20	<50	1254
10	<2	<5	<10	<5	5	5	<5	<5	<20	1254

Lab No.	Address
1	Dr R.F. Addison, Bedford Institute, Halifax, Canada
2	Dr K. Voldum-Clausen, National Food Institute, Søborg, Denmark
3	Dr E. Huschenbeth, Bundesforschungsanstalt, Hamburg, FRG
4	Netherlands Institute for Fishery Investigations, IJmuiden, Netherlands
5	Dr K. Palmork, Institute of Marine Research, Bergen, Norway
6	Mrs M.C. de Barros, Laboratory of Phytopharmacy, Oeiras, Portugal
7	Dr C. Cendrero, Oceanographic Laboratory, Santander, Spain
8	Dr R. Vaz, Special Analytical Laboratory, Stockholm, Sweden
9	Dr J.E. Portmann, MAFF, Burnham-on-Crouch, England
10	Mr A.V. Holden, DAFS, Pitlochry, Scotland

Analysis of sample 3B (spiked) - 3A (control)

(concentrations in µg/kg)

Lab No.	HCB	α-BHC	β-BHC	γ-BHC	Dieldrin	pp-DDE	pp-TDE	pp-DDT	PCB	PCB Ref
Spike value	53	47	57	50	100	100	210	210	1100	1254
1				47	72	98	236	193	1020	1254
2	14	42		42	92	109	193	190	480	1260
3	30	29		41	80	100	200	175	948	
4	70	50	<10	60	120	30	130	140	1100	
5							257	192	1970	
6	53	40	49	45	90	103	205	209	944	1254
7		(80)		(75)	(150)	(42)	(180)	(170)		
8	56	40	45	46	53*	99	200	200	1100	A.50
9	55	42	<5	52	100	83	130	190	1000	1254
10	44	45	44	85	113	128	212	197	1190	1254
Mean value	51	41	46	52	90	102	196	187	1050	-
Lab (Nos) omitted from Mean	2	7	4,9	7	7	4,7	7	7	2,5	-

NB: Control values given as "less than" have been ignored in calculating the spike concentrations.

*repeat 97

ANNEX 6

Extension of the North Sea Fish and Shellfish Baseline Survey to the Remainder of the Oslo Commission and Parts of the ICNAF Areas

Preface

The difficulties involved in carrying out a large-scale baseline sampling programme of the type conducted by the Group are very considerable. The plan, therefore, paid careful attention to a number of variables which might significantly bias any interpretation of the results, in an attempt to ensure that the data obtained would at least permit broad geographical comparisons, against the background of public health criteria. It might also have been reasonable to assume that strict adherence to the adopted procedures by all participants would have resulted in the data providing a basis for judging future temporal and spatial trends.

In the event the stricture on sampling time, sample size and individual fish size were not, for valid logistic reasons at the time, always observed. Neither were all analytical methods of sufficient sensitivity to ensure that the level of detection afforded by a particular method was at least capable of detection at 1/10th the lowest level encountered in the survey, to a precision of ± 10%.

These reservations have meant a more restrictive approach to the interpretation of the data than might ultimately have been adopted if all had worked exactly according to plan. Nevertheless it should be recognised that this is the largest scale coordinated survey of its kind ever carried out and in its broad objectives can, even within the constraints outlined above, be regarded as highly successful.

Introduction

After the 1971/72 Baseline Survey of the North Sea had been completed, a Group of analysts and biologists met in Charlottenlund in December 1973 to discuss how the Baseline Study in the North Sea could be extended to cover the remainder of the NEAFC area. This plan was eventually approved in principle by both the Working Group on the Study of the Pollution of the North Sea and the Advisory Committee on Marine Pollution (ACMP). Originally it had been proposed to carry out this extension to the North Sea Baseline in 1974 but, as Council approval was not obtained until the 62nd Statutory Meeting, the survey had to be postponed until 1975. Responsibility for the conduct of the survey was given to the newly constituted Working Group on Pollution Baseline and Monitoring Studies, which, at its first meeting in January 1975, examined the proposal for compatibility with the requirements of the Oslo Commission and the IOC for baseline measurements. The plans were duly approved, with a few minor changes, and the last details were finalised by correspondence in April 1975. The survey was extended to parts of the ICNAF area when Canada and Greenland expressed an interest in participation. At a late stage (October 1975) USA also joined the study, thereby providing the potential to give coverage to the entire NEAFC and ICNAF areas.

The major effort was to be concentrated on Cod and Hake but additional samples of Sole, Plaice, Herring, Capelin, Pilchard, Greenland Halibut and Deep Sea Prawn were included as optional extras bearing in mind the restrictions imposed by differences in analytical capacity. It was also agreed that samples should be taken from the North Sea to ensure compatibility and continuity of baseline data throughout the ICES area.

The proposed list of priority contaminants to be studied was examined and agreed as PCBs, organochlorine pesticide residues and the metals lead, cadmium, mercury, copper and zinc. It was further suggested that it might be desirable to analyse for the additional contaminants: chromium, arsenic, thallium and other chlorinated organic substances - possibly as total organically bound chlorine, and petroleum hydrocarbons. Full details of the agreed procedure and sampling arrangements are given in Appendix 1.

All the results were to be submitted not later than 31 December 1975. In the event, approximately 60% of the expected data had been submitted by the 31 March, 1976 and a draft based on these results was considered by the Working Group on Baseline Studies and Monitoring at its meeting in Charlottenlund 11-13 May 1976.

The text which follows is based on the report considered by the Working Group but has been amended to take account of the discussions and suggestions made in the course of the Working Group meeting. Further data received subsequent to 31 March but before 24 May have also been incorporated in the revised text. A few further results are expected notably from Iceland (organochlorine pesticides and PCBs). It is hoped that these will be available before the 64th Statutory Meeting so that they can be included in the version to be given final approval for publication.

The study was accompanied by intercalibration exercises for metals and for organochlorine pesticides and PCBs. In general, results showed an improvement on the previous exercises and most workers are now producing reasonably comparable results for organochlorine pesticides (except HCH), PCBs, mercury, copper and zinc but not for lead and cadmium. It is doubtful if the data for the latter two metals can be compared safely. The problem with lead and cadmium is largely one of detection levels and those laboratories using the more sensitive flameless technique of atomic absorption analysis are producing very low but positive values for both metals (0.00X for cadmium and 0.0X for lead), whereas the other laboratories merely report levels to be below a relatively high detection level. All data have been included in the tables but it should be noted that where a less than value is given the true value is likely to be considerably less than that figure.

Results of the Baseline Survey

The results of the Baseline Survey are given in Tables 1 to 4. They are discussed in some detail below. In order to minimise the dangers of variations with season and age etc., the programme of sampling was designed to eliminate as many of these potential variables as practicable. A collection period from July to September was stipulated, 10 fish per sample and various year classes (size for Hake) according to sample area were specified. The survey area covered the NEAFC area north of 36°00'N and south of 80°00'N, and parts of the ICNAF area around the west and south coasts of Greenland and an area west of 51°00'W lying between 39°00'N and 52°00'N.

Unfortunately, as mentioned in the preface, theoretical biological practicalities proved not to be the same as actual biological practicalities and, for a variety of reasons, it proved impossible, in many cases, to adhere to the instructions for sampling and analysis laid down in the plan of the Baseline. As a result, it has not been possible to eliminate such potential sources of variation as size and season and the data have therefore had to be interpreted in a rather more restrictive fashion than had been hoped. A few results pertaining to samples collected in 1974 have also been included as these were collected according to the original instructions when the Baseline was intended to be conducted in 1974.

Metal Analyses

The results for each species of fish are considered separately below. From the results returned so far a number of general observations can be made. Cod (28 samples), Plaice and Sole (9 samples) were the most intensively studied. Seven samples of Hake and Capelin and 5 of Herring were collected. Results are also available for Greenland Halibut, the Deep Sea Prawn, Pilchard and Scabbard. In general more samples were analysed for metals than for organochlorine pesticides and PCBs and there is a higher proportion of returns for muscle tissue analysis than for livers. In some cases this appears to have been caused by a misunderstanding with the collectors, leading to the fish being gutted before being sent to the laboratory; in others it appears to be related to analytical difficulties.

With a few minor exceptions, all the participating laboratories were able to carry out analyses for a full range of metals. Some data were presented for chromium, cobalt and arsenic but these are so limited that they are merely included in the tables and no comment is made. In the large majority of cases in addition to the mean concentration, the minimum and maximum concentrations and standard deviation figures are also available.

Comments are for simplicity confined to the mean concentrations, since on an overall fish population basis, and from a human consumption standpoint, this figure is of the most significance.

Cod

The mean concentrations of mercury in cod reported in the course of the survey ranged from 0.01 to 0.09 mg/kg for the liver and 0.02-0.32 mg/kg for muscle and were similar to the figures reported in the previous North Sea Baseline Study. The cod from Greenland all contained low muscle levels (mean 0.04 mg/kg), similar to those found in the Barents (mean 0.03 mg/kg) and Norwegian Seas (mean 0.02 mg/kg). The levels in muscle found in the Irish Sea (mean 0.26 mg/kg) were higher and compare well with the figures reported by Portmann (1975). At present only two results are available for cod from the Icelandic coast and one of these indicates levels similar to those found in the mid North Sea. However, this was reported by a laboratory which also recorded a high value for the intercalibration sample, the lower figure (0.052) was reported by a laboratory which performed well in the intercalibration exercise and should therefore be accorded greater credence. The levels of mercury in muscle of cod from the Canadian coast appear to be slightly elevated compared with the open ocean figures, although with the exception of a single sample (mean 0.14 mg/kg) they are all below the 0.1 mg/kg level regarded as typical of cod from waters subject to minimal mercury pollution from man made sources.

The mean concentrations for zinc and copper were variously reported as 10 to 36 mg/kg and 2.4 to 12.5 mg/kg for the liver respectively and between 1.9 and 7.3 mg/kg and 0.1 and 2.1 mg/kg for the muscle. The zinc in muscle levels agree well with the North Sea Baseline Study. The copper levels in muscle tissue are somewhat lower than previously reported although they compare reasonably well with the North Sea levels for cod reported by Portmann (1973). Both zinc and copper levels in muscle show little variation; within any one sample a spread of two-fold is about the maximum. A slightly greater variability is seen in the levels of both metals in liver, both within any one sample and from sample to sample, probably this is related to recent food intake, which may or may not be affected by local levels of copper or zinc in the water.

The muscle cadmium levels covered a wide range from 0.004 to less than 0.2 mg/kg with the highest positive value being reported as 0.05 mg/kg. As mentioned in the introduction this variation is very probably due to differences in detection limits rather than actual tissue level variations, since there is an obvious pattern related to the laboratories doing the analysis and the methods they used. The liver tissue appears to contain higher levels of cadmium than the muscle but the highest concentration was only 0.43 mg/kg . The lead results were all fairly low ranging from 0.06 to 0.31 mg/kg for liver and 0.05 to 0.9 mg/kg for muscle. As for cadmium, most of the higher values were reported by laboratories using less suitable flame atomic absorption methods and these apparently higher values for some areas should be regarded with considerable caution.

Plaice

The mean concentrations of mercury in Plaice ranged from 0.02 to 0.26 mg/kg in the muscle tissue and 0.05 to 0.09 mg/kg in the liver. The higher levels being recorded in the northern part of the Irish Sea and the Southern Bight of the North Sea, the lowest level occurring in the Norwegian Sea, and intermediate concentrations in the southern Irish Sea and English Channel. These distributions are in agreement with the cod mercury results and reflect the likely areas of industrial input.

The mean concentrations of zinc and copper were very similar to those of Cod with a range of 26 to 40 mg/kg and 3.6 to 6.1 mg/kg for zinc in the liver and muscle respectively and of 2.4 to 6.1 mg/kg and 0.14 to 0.8 mg/kg for copper in the liver and muscle. The muscle zinc levels appear to be slightly higher around the United Kingdom coasts averaging around 5.4 mg/kg; the concentrations dropping to around 4.4 mg/kg in the Faroes and Norwegian Sea areas. The converse appears to apply to muscle copper levels, the Norwegian Sea results being about twice the mean of those around the United Kingdom coast. However, as the laboratory reporting the higher values also reported higher values in the intercalibration exercise the higher values should be treated with caution. Cadmium levels in muscle tissue were very low with an apparent maximum concentration of less than 0.05 mg/kg reported in the Norwegian Sea; however, on the basis of other positive values e.g. for the North Sea this is likely to be less than 0.005 mg/kg at most. The highest liver level recorded was 1.8 mg/kg in the Faroes region. The highest lead levels in both liver and muscle were reported for plaice from the Southern Bight and compared closely with those previously reported (Portmann, 1973) to be typical for plaice in the North Sea. As these results were mainly reported by a laboratory from the Federal Republic of Germany which used a flameless atomic absorption technique they can probably be regarded as reliable.

Hake

Although the number of Hake samples reported was fairly small, only four countries providing results for metals, the spread is interesting allowing a contrast between open Atlantic waters off Portugal and France and the more enclosed waters of the Irish Sea and coastal waters of Western Scotland. The mercury levels in muscle tissue ranged from 0.03 to 0.13 mg/kg and in liver tissue from 0.03 to 0.04 mg/kg, the higher muscle level reported from the Irish Sea (0.13 mg/kg) being very similar to the reported (Portmann and Preston, 1975) levels for the mid North Sea. The levels off the Portuguese and French Atlantic coasts were lower, with a mean for muscle tissue of 0.09 mg/kg.

The zinc and copper levels in both muscle and liver were similar to those in cod and plaice, the zinc concentrations varying from 17 to 35.1 mg/kg in liver and from 1.8 to 6.4 mg/kg in muscle tissue, copper levels from 0.5 to 5.9 mg/kg in liver and less than 0.3 to 1.1 mg/kg in muscle. No pattern in the areal distribution is apparent.

The high copper value of 3.7 mg/kg in muscle is clearly anomalous and should be discounted; such action appears to be justified from an examination of the intercalibration exercise results.

All the reported levels of cadmium in liver fall within a range of less than 0.2 to 0.38 mg/kg but most of the lead levels were below the level of detection. Both the laboratories which reported the results used flame atomic absorption spectrophotometric methods which are too insensitive, and no significance should be accorded to the positive values. It would be more realistic to regard the less than levels as being considerably less than 0.2 mg/kg.

Sole

The distribution of Sole samples is similar to that of hake samples being collected from around the English coast and off Portugal. The mercury levels in muscle tissue ranged from 0.05 to 0.32 mg/kg, the high levels all occurring in the Irish Sea and in the English Channel and the lower levels off Portugal and in the northern North Sea. Levels in liver (0.039 to 0.18 mg/kg) were lower than in muscle. The zinc and copper results were similar to those of cod and plaice with a slightly smaller range 3.6 to 6.5 mg/kg for muscle zinc and 0.22 to 0.75 mg/kg for muscle copper,; there is a suggestion that the copper levels off the Portuguese coast were slightly lower than from around the English coast while the zinc levels were fairly uniform throughout. Cadmium levels all appear to be low. The lead results ranged from less than detectable to 0.14 mg/kg and, as with other species, the few positive values should be regarded with caution.

Herring

Mercury levels were much lower than for cod and plaice, ranging from 0.01 to 0.035 mg/kg in muscle tissue. These were lower than the levels reported in the North Sea Baseline Study and were generally lower than for most other species. The ranges of copper and zinc were small, varying by only a factor of two, zinc 3.3 to 7.5 mg/kg and copper 0.76 to 1.8 mg/kg. The general levels, unlike mercury were similar to the cod and plaice figures. The cadmium and lead levels in muscle were all below the level of detection of the flame atomic absorption method used by the reporting laboratories and are consistent with the levels reported for the other species.

Capelin

Two countries reported data for Capelin, all the samples were collected from open ocean areas, the Barents Sea and round the coasts of Greenland. One of the most striking points about the results is their very narrow range. In no case was the highest level more than treble the lowest and in the large majority of cases much less variation was exhibited. The mercury results were low (all 0.03 mg/kg or less). The zinc levels were reported as 16-18 mg/kg for the whole fish and the 4.8 to 7.2 mg/kg reported for the muscle were about average. Copper was reported as 0.7 to 0.9 mg/kg and 0.7 to 1.8 mg/kg for the whole fish and muscle only respectively. Both cadmium and lead levels were generally reported as being less than the detection levels.

Greenland Halibut

Only one country reported on this fish, all the samples were taken from the west coast of Greenland. In almost all cases the levels of mercury, zinc, copper and lead were lower both in the muscle and liver tissues when compared with the two other flat fish sampled in the course of the survey. The results ranged from: mercury, liver 0.02 to 0.04 mg/kg, muscle 0.03 to 0.05 mg/kg; zinc, liver 18 to 25 mg/kg, muscle 1.2 to 4.0 mg/kg; copper, liver 12 to 46.6 mg/kg, muscle 0.16 to 0.3 mg/kg; and lead, liver all less than 0.5 mg/kg, muscle all less than 0.2 mg/kg. Similarly the cadmium in muscle results were all reported as less than 0.3 mg/kg.

Pilchard

The metal levels for Pilchard showed little variance from those quoted for the other species sampled. None of the three areas reported on, Portugal, Biscay, or the southwest coast of England showed any remarkable concentrations.

Scabbard

Scabbard was sampled from the Azores region, the metal levels reported were in general near the low end of the muscle ranges quoted for the other species sampled.

Deep Sea Prawn

Only one country reported Deep Sea Prawn from the west coast of Greenland. This was the only shellfish sample and the whole body was analysed. The general level of mercury was low (all were below 0.03 mg/kg), this was similar to the levels found in the halibut and capelin from the same area. The zinc and copper levels were higher than in fish muscle: ranging from 13 to 17 mg/kg for zinc and 13 to 18 mg/kg for copper. These bear much more resemblance to the liver levels quoted for the whitefish and are probably the result of analysing the whole fish rather than muscle and liver/digestive gland separately. Similar patterns of low mercury and raised zinc and copper levels have been reported for shrimps in the previous North Sea Baseline Study. Bearing in mind the detection levels of the methods used the cadmium levels (ranging from < 0.2 to 0.9 mg/kg) and the lead levels (with a range of < 0.2 to 1.5 mg/kg), probably give a slightly misleading impression and the apparently positive values should be regarded with some suspicion.

Summary

Throughout the text tentative comparisons between areas and species have been made wherever possible. However, as stated in the Introduction, difficulties encountered in sampling according to the agreed pattern, and differing detection levels for lead and cadmium make general comparisons difficult and leave room for speculation as to the interpretation and strength of the trends noted. Nevertheless on the basis of the results so far available, a number of general conclusions can be drawn. One of the main objectives of this extended Baseline Survey was to determine the metal levels in the fish from the more open ocean fishing grounds and compare them with the levels reported for fish from areas more likely to be affected by industrial pollution.

None of the samples contained mean levels of any of the metals, other than mercury, approaching those generally acknowledged to be undesirably high from the human consumption point of view. None of the mean mercury results were reported higher than 0.5 mg/kg although individual fish from the Irish Sea were found containing up to 1.5 mg/kg (mean for the sample 0.5 mg/kg). The copper and zinc levels are much lower than the toxic dose to man which for copper is 100 mg (McKee and Wolf, 1963) and for zinc is likely to be even higher (Browning, 1969).

Livers appear to contain higher levels of copper, zinc, cadmium and lead than the muscle tissue. In contrast mercury levels in liver tended to be lower than in muscle. Most of the reliable cadmium and lead levels reported were either below the level of detection or very low (0.00X for cadmiun and 0.0X for lead).

The results of analyses of fish from the open North Atlantic as opposed to those from the marginal seas of the European continental shelf do not highlight any particular area. Fish from Greenland contain low levels of metals as do the fish from the Norwegian and Barents Seas. There is some indication that the fish from the east coast of Canada have slightly elevated levels for mercury. However, although some of the data for fish taken off the coast of Portugal indicate elevated levels of some metals compared with the Greenland, Norwegian and Barents Seas data, the species analysed were different, and other data for the same area and species are comparatively low. It seems likely, from an examination of the intercalibration data, that the higher results are somewhat misleading.

The mid and north North Sea results are similar or only slightly higher than the Atlantic fish data. In the German Bight area, the Bristol and English Channels and the Irish Sea, the levels of mercury were elevated usually by at least four to five times over the open ocean background level although the spread of any particular species sampled was limited, making comparisons difficult.

Organochlorine Pesticide Residues and PCB Analyses

In general the fish analysed for organochlorine pesticide residues and PCBs were the same as those analysed for metals although not all countries managed as good a coverage for pesticides as they did for the metals. The results for each species are considered separately below but a few generalisations can be made.

Five core organochlorine residues were reported, Dieldrin, pp DDE, pp TDE, pp DDT and PCBs; in addition three other compounds were reported on, to a varying but lesser extent. α HCH reported by England, γ HCH by England, Scotland and Germany, op DDT by Norway only. The intercalibration exercise indicated that all the results supplied by the laboratories reporting results for fish were likely to be directly comparable with the exception of HCH residues. Thus, although these are included in Tables 3 and 4 as reported, no discussion is attempted.

As arranged, in almost all cases, the livers were analysed on an individual basis for organochlorine pesticides and PCBs. Muscle tissue was analysed at least in duplicate on an homogenate of muscle tissue from all the fish in a sample and by some laboratories on an individual fish basis. Results for livers are given in Table 4 with data for minimum, maximum, mean and standard deviation, equivalent data are given where available for muscle in Table 3; where both figures are available for the replicate analysis both are given but in some cases only the mean value was available. All data are given on a fresh weight basis but in all cases the lipid content is also given, thereby allowing recalculation on a fat weight basis if required.

Cod

The reported muscle levels for all the pesticides were very low, never reaching 0.01 mg/kg. No area stood out as being high or low, the range in muscle for all the pesticide levels being < 0.001 to 0.01 mg/kg excluding (for the reasons stated above) the highest level of γ HCH reported by a laboratory from the Federal Republic of Germany for fish caught off the east coast of Greenland, the highest concentration of organichlorine pesticide in cod muscle was 0.009 mg/kg total DDT in fish from the North Sea.

The liver results,as would be expected, are much higher, often by a factor of 100, and it is possible to pick out areas with consistently different results. Dieldrin figures ranged from 0.001 to 0.41 mg/kg, the highest levels being reported for fish from the Southern Bight of the North Sea. Higher concentrations of dieldrin were also found off the eastern coast of Canada. This pattern of high levels in this region of the Northwest Atlantic was particularly noticeable for DDT where the maximum of 0.59 mg/kg exceeded the highest level in the North Sea by a factor of 2 (0.28 mg/kg). There is some indication from the results for pp DDT and pp TDE that the Barents Sea levels were elevated in comparison with those from Greenland and the Faroes region. The levels for pp DDT ranged from 0.09 mg/kg around Greenland to 0.59 mg/kg in the Gulf of St Lawrence region with 0.31 mg/kg for the Barents Sea, and for pp TDE from < 0.03 mg/kg for Greenland to 0.4 mg/kg in the Gulf of St Lawrence region with 0.17 mg/kg in the Barents Sea. Total DDT levels were highest in the Gulf of St Lawrence (maximum ca. 1.8 mg/kg) and lowest off the west coast of Greenland (< 0.18 mg/kg). DDT residue levels in cod from the east coast of Greenland appear to be slightly higher (mean ca. 0.3 mg/kg). There also appears to be a preponderance of DDE in both muscle and liver in fish from the more open sea areas. This does not apply closer inshore e.g. in the Gulf of St Lawrence and the southern North Sea.

The PCB results follow the same general pattern as the pesticides ranging from 4.1 to 0.44 mg/kg in the Gulf of St Lawrence and off the east coast of Greenland respectively with intermediate levels in the Barents Sea of 1.7 mg/kg. Unlike DDT however PCB residue levels appear to be very similar in fish caught off the west and east coasts of Greenland 0.44 and 0.46 mg/kg respectively. Without exception the concentration of PCB was reported to be greater than the total DDT, usually by a factor of at least 2, a very similar conclusion to that drawn from the previous Baseline Survey of the North Sea.

Plaice

Only three areas were reported on: Southern Bight of the North Sea, the Faroes and the Barents Sea giving a good spread of geographical and likely contamination. Only two pesticides pp TDE and pp DDT were common to all three sets of results, the Faroes levels both being reported as < 0.001 mg/kg while the Barents Sea levels were reported as 0.003 mg/kg for pp TDE and 0.006 mg/kg for pp DDT, the muscle PCB results were also slightly higher for the Barents Sea being 0.04 mg/kg compared with 0.02 mg/kg for the Faroes. DDT group and

Dieldrin residue levels were all highest in both muscle and liver in fish from the Southern Bight of the North Sea. Liver results were only reported from the Faroes and Southern Bight of the North Sea. PCB was greater than total DDT in the liver by a factor 4 to 5, and in the muscle by a factor of 2 to 10.

Hake

The hake muscle data are rather inconclusive. The two sets of data for the Bay of Biscay are conflicting in terms of the DDT group and PCBs. The laboratory reporting the lower values performed rather better in the intercalibration exercise, which was on a low residue level sample, and the lower values are probably more realistic. It is interesting that in the two sets of data for residue levels in fish livers from the Bay of Biscay, which are higher, agreement is good. If the higher set of data for the levels in muscle are set aside the highest residues of both pesticides and PCBs appear to be found in fish from the Irish Sea.

Liver results were only available from the area off Portugal and the Bay of Biscay. In both areas the two sets of data were reported by different laboratories but the agreement is good. Levels in the Bay of Biscay for both pesticides and PCBs are clearly higher than those found off the Portuguese coast (for PCBs the difference is ca. 6.2 mg/kg compared to 1.4 mg/kg).

Sole

Reports were received for two areas, the Southern Bight of the North Sea and off Portugal for muscle tissue, but only one sample off Portugal for liver residues. All the muscle pesticide levels were low, mostly below 0.001 mg/kg. The liver levels were somewhat higher reaching 0.048 mg/kg for pp DDE. The PCB levels ranged from 00.008 mg/kg off Portugal to 0.05 mg/kg in the Southern Bight for muscle and 0.68 mg/kg of PCB was found in livers of sole caught off Portugal.

Herring

As was found in the North Sea Baseline Survey the reported results suggested that the herring have a somewhat higher muscle pesticide burden than other fish such as cod, sampled from the same area. This is almost certainly a reflection of the much higher lipid content of herring muscle compared with that found in cod or plaice. Nevertheless the highest pesticide level recorded was still low 0.076 mg/kg for pp DDT in a sample from the North Sea. This same sample also contained the highest PCB residue level (0.33 mg/kg).

The remaining PCB levels were low, with a range of 0.01 to 0.07 mg/kg and for the sample from the Norwegian Sea at least, the combined DDT metabolites possibly exceeded PCB levels.

Pilchard

England, France and Portugal reported on pilchard, only Portugal analysing liver. The muscle pesticide levels were all low, most being less than 0.003 mg/kg, the only exception being pp DDE which ranged from 0.007 to 0.034 mg/kg the highest levels occurring off the coast of France. The only pesticide results reported for the liver were of 0.018 mg/kg pp DDE.

The PCB levels ranged from 0.007 to 0.3 mg/kg in muscle and 0.032 in the liver. It is perhaps worth noting that as with the other pelagic species, e.g. herring, these PCB levels are similar to the combined DDT group concentrations.

Greenland Halibut

The muscle pesticide levels ranged from 0.002 mg/kg for dieldrin to 0.013 mg/kg for pp DDE and pp DDT. There is some indication that the samples collected from the mid-region (1C & 1D) of the west coast of Greenland have slightly elevated levels, this applies to both liver and muscle tissue levels but at least in the muscle sample from Area 1D this might be explained by the higher lipid content of the muscle. The liver levels are approximately 2 or 3 times higher than the corresponding muscle concentrations ranging from less than 0.004 mg/kg for pp TDE to 0.025 mg/kg for pp DDT.

The PCB levels ranged from 0.017 to 0.06 mg/kg in muscle and 0.046 to 0.091 mg/kg in the liver and exceeded the combined DDT metabolites by approximately a factor of two.

Capelin

Two countries Greenland and Norway reported pesticide levels for capelin. The samples from the west coast of Greenland were analysed whole, but the Norwegian samples from the north of the Norwegian Sea and the Barents Sea were analysed on a muscle tissue only basis.

The whole fish pesticide levels fall in general between the levels reported for muscle tissue and liver tissue for the other fish species sampled from the west coast of Greenland. Of the firmly identifiable pesticides pp DDE was present in the highest concentrations (i.e. at levels of ca. 0.004 mg/kg), all the other pesticides being less than 0.003 mg/kg.

The muscle only levels reported by the Norwegians are slightly higher (maximum 0.014 mg/kg pp DDT). Only the op DDT results were less than the detection level, the others ranged from 0.002 mg/kg for pp TDE to 0.014 mg/kg for pp DDT. Levels in the north of the Norwegian Sea being higher than those from the Barents Sea which were, in turn, higher than those from the west coast of Greenland.

In contrast the PCB levels were highest in the muscle tissue analysed from the samples collected in the Barents Sea 0.93 mg/kg and lowest in the whole fish samples from the Norwegian Sea (less than 0.01 mg/kg).

Scabbard

The muscle pesticide levels in fish from both the Azores and Madeira (included for comparison purposes although actually south of the NEAFC area), were low ranging from 0.002 mg/kg for pp TDE to 0.006 mg/kg for pp DDT. The levels in liver of pp DDE, pp DDT and pp TDE were all higher off Madeira (Σ DDT 0.30 mg/kg) than those found off the Azores where the levels were very low for liver (Σ DDT 0.026 mg/kg). The PCB levels ranged from 0.03 mg/kg for muscle tissue and 0.08 mg/kg for the liver in fish from the Azores, to 0.01 and 0.26 mg/kg in muscle and liver respectively of fish from Madeira. The PCB concentrations were higher than the combined DDT metabolites by a factor of three approximately for fish off the Azores but in those from Madeira the levels were approximately the same.

Deep Sea Prawn

The Deep Sea Prawn was only sampled from the west coast of Greenland and was analysed whole. The pesticide levels were extremely low being less than 0.001 mg/kg for most of the pesticides. The only apparently positive values being recorded for dieldrin at just above the level of detection of 0.001 mg/kg. The PCB levels were about a factor of ten higher and the range of from 0.008 to 0.015 mg/kg is of doubtful significance in analytical terms.

Summary

Of the pesticides analysed, only dieldrin has a high mammalian toxicity and it is generally recommended that food should not contain more than 0.1 mg/kg on a wet weight basis (Egan, 1967). The maximum concentration of dieldrin recorded in any of the fish samples was 0.41 mg/kg (in cod liver from the Southern Bight of the North Sea). The highest levels in the edible muscle tissue was much lower (0.017 mg/kg) but again was found in fish (plaice) from the North Sea. As concluded in the North Sea Baseline Report, as far as the species so far investigated are concerned, it seems unlikely that levels of PCBs and organochlorine pesticide residues found in fish and shellfish tissues from the NEAFC area pose any hazard to the consumer.

As with the metal survey, one of the main objectives of this extended Baseline Survey was to determine the pesticide and PCB levels in the fish from the more open ocean fishing grounds and compare them with the levels reported for fish from areas more likely to be affected by industrial pollution. From the coverage point of view cod is the best species to use for comparison. The fish from the Gulf of St Lawrence and the east coast of Canada generally contained elevated pesticide levels, although the highest residue levels were recorded in a sample from the North Sea. Elevated levels from certain areas off the USA have previously been reported (Butler, 1973; Ernest and Benville, 1973) and suggest that these elevated Canadian results form part of a pattern for that area.

From the information available, no other single species can be used to compare all the various areas of interest, but the Hake results indicate that the Irish Sea fish have elevated muscle levels for dieldrin, pp DDE, pp TDE, pp DDT and PCBs compared with the levels off the coast of Portugal and the Bay of Biscay. Sole returns indicate slightly elevated levels for pesticides in the southern North Sea compared with the Portuguese coast, but this is inconclusive and the reverse appears to apply for the liver levels.

In general the Greenland levels are low by comparison with the other areas although with the exception of the slightly elevated Barents Sea cod results all the open ocean areas appear to have low levels of contamination with higher residues being found in fish from the Irish Sea, Southern Bight of the North Sea, and the eastern seabord of Canada. In this same context it is perhaps significant that species such as Herring, Greenland Halibut and Scabbard taken from open or extreme northern ocean areas contained either lower or roughly equivalent PCB concentrations compared to the pesticides. In areas closer to land the fish usually contained levels of organochlorine pesticides well below the PCB residues, factors of up to ten being common.

The fish livers tend to contain higher concentrations of organochlorine pesticide residues and PCB than the muscles. This is not surprising since the pesticides are fat soluble and the liver contains a higher proportion of fat than muscle tissue.

Conclusion

In general, the levels of both metals and organochlorine pesticide residues in the North Atlantic are similar to or lower than those of the mid and north North Seas and correspondingly lower than those for the hot spot and coastal areas reported in the previous North Sea Baseline Study and no repeat study for the North Atlantic is thought necessary for 5 years. However, the Irish Sea and the area of and immediately off the Gulf of St Lawrence would appear to be relatively highly contaminated, especially with the organochlorine compounds and, as with the Southern Bight of the North Sea, more frequent studies would be advisable, with an intensification of sampling effort and an expansion in the number of species sampled. Very few data were available for the Bay of Biscay area but some of the results indicated the possibility of pollution and again a more intensive programme in the Bay of Biscay and off the Portuguese coast and Azores region would help to clarify the situation. No information was available for the west or south coasts of Ireland and studies in these areas would be valuable.

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APPENDIX 1

1. ARRANGEMENTS FOR SAMPLING OF COD*

Area	Country
E Greenland	Germany, Federal Republic of
Iceland	Iceland/Denmark, Belgium
Spitzbergen	Norway
N Norway (x2)	Norway
W Barents Sea	Norway+/Sweden, Netherlands+
E Barents Sea	Norway+/Sweden, Netherlands+
Faroes	Scotland, Denmark
Faroes Bank	Scotland
W Scotland	Scotland
Irish Sea	England
W Ireland	Ireland
SW Ireland	Ireland
Kattegat	Sweden, Denmark
Biscay	France, Spain
Portugal	Portugal
English Channel	England
Bristol Channel	England
Azores	Portugal
S North Sea	Belgium
E North Sea	Netherlands
Grand Banks	Canada
Emerald Banks	Canada
Scotia Shelf	Canada
and 3 other areas	Canada
ICNAF Area 1; all sub-areas will be sampled if possible	Greenland

All samples to consist of 10 fish.

For metals each fish to be analysed individually for muscle tissue and in duplicate on an homogenate of the livers.

For organochlorines and PCBs each fish to be analysed individually for liver tissue and in duplicate on an homogenate of the muscle tissues.

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* where cod are not available, use hake.

+ to be assisted by Sweden with analysis if necessary.

Appendix I (ctd)

2. SPECIES OF FISH IN ADDITION TO COD TO BE ANALYSED DURING THE BASELINE SURVEY

Country	Area	Species
Norway	Barents Sea	Capelin, Plaice or Flounder
	Norwegian Coast	Herring and Flounder or Plaice
Sweden	Skagerrak	Flounder or Plaice, Herring
	Iceland*	" " "
	E Barents Sea	" " "
Denmark	Faroe	Herring
	E Greenland	Capelin
	Kattegat	Herring, Plaice, Sole
Germany, Federal Republic of	S North Sea	Plaice
Netherlands	S Ireland	Hake
	Irish Sea	Sole
	North Sea	Sole
Belgium	Irish Sea	Sole, Plaice
	English Channel	Sole, Plaice
	Bristol Channel	Sole, Plaice
	S North Sea	Sole, Plaice
	S North Sea	Herring
Portugal	Portugal	Hake, Pilchard, Sole
	Azores	as above, if possible
England	W Scotland	Hake
	N Irish Sea	Hake
	S North Sea	Sole
	English Channel	Pilchard
Scotland	Faroe	Plaice
	Faroe Bank	Plaice
	W Scotland	Plaice, Herring
Canada	Grand Banks	Herring, Mackerel; Capelin?
	Emerald Banks	" " "
	Scotia Shelf	" " "
	3 other major areas	" " "
Greenland	ICNAF area 1 all ICNAF sub-areas will be sampled if possible	Capelin, Greenland Halibut and Deep Sea Prawn

* if required by Iceland

Appendix I (ctd)

Each sample to consist of 10 fish, liver and muscle tissue to be analysed either separately or in duplicate on homogenates of muscle samples from the 10 fish, and of the livers from the 10 fish.

3. DETAILS OF YEAR CLASS AND TIME OF SAMPLING and Substances to be analysed

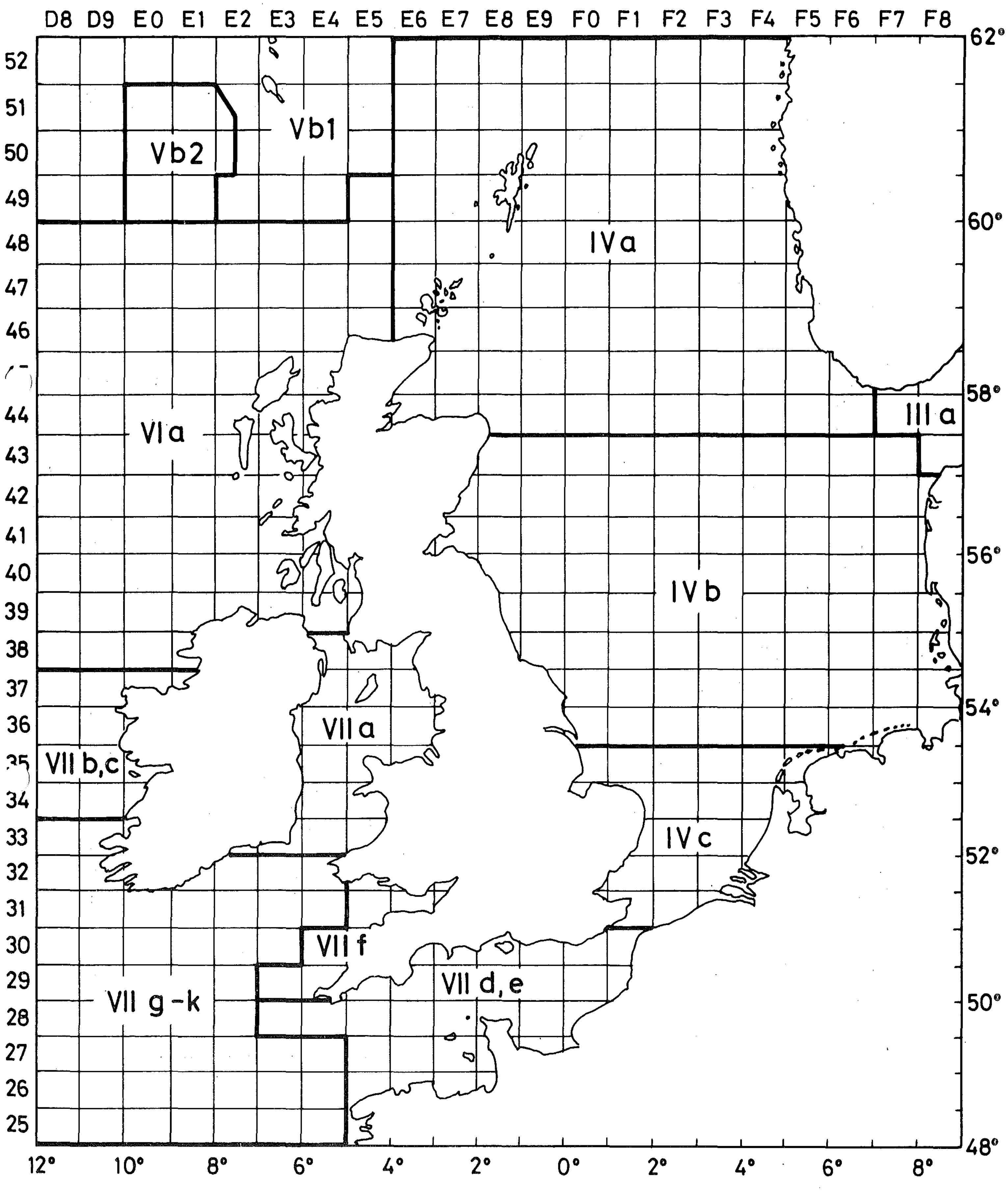
Species	Year Class	Remarks
Cod	1972 1969	1969 year class in northern waters
Sole	1963 (N Sea)	1967 - Irish Sea 1969 - Bristol Channel 1969 or 1963 - English Channel 1969 - S North Sea/English coast 1966 Portugal & Azores ca.32 cms
Hake	Age difficulty - length to be selected 40-50 cm.	
Plaice	1968	1969 (Irish Sea, Bristol Channel, English Channel)
Herring	1972	Norway will do the best they can to get 1972 year class
Capelin	1971	
Pilchard	1972 or three years old	
Greenland Halibut	ca 7 years old or 55-60 cm	
Deep Sea Prawn	25-30 mm carapace	

Special instructions:

(1) the above samples should be collected within the period July-September and each sample should consist of 10 fish.

(2) All samples (muscle and liver) to be analysed for the following organic substances: organochlorine pesticide residues, PCBs, and wherever possible polychlorinated terphenyls; all samples will also be analysed for mercury, cadmium, lead, copper and zinc, and wherever possible for organic mercury. Other metals and organics may be included at the discretion of the analyst concerned, but certainly wherever possible, for all liver samples, results for pesticides and PCBs to be expressed on both fat and fresh weight basis.

(3) Full details of the sample and its area of collection should accompany the analytical results, which should include brief details of methods used. In addition, for each substance analysed the limit of detection and blank values should be given. If duplicate analyses are conducted, provide both results.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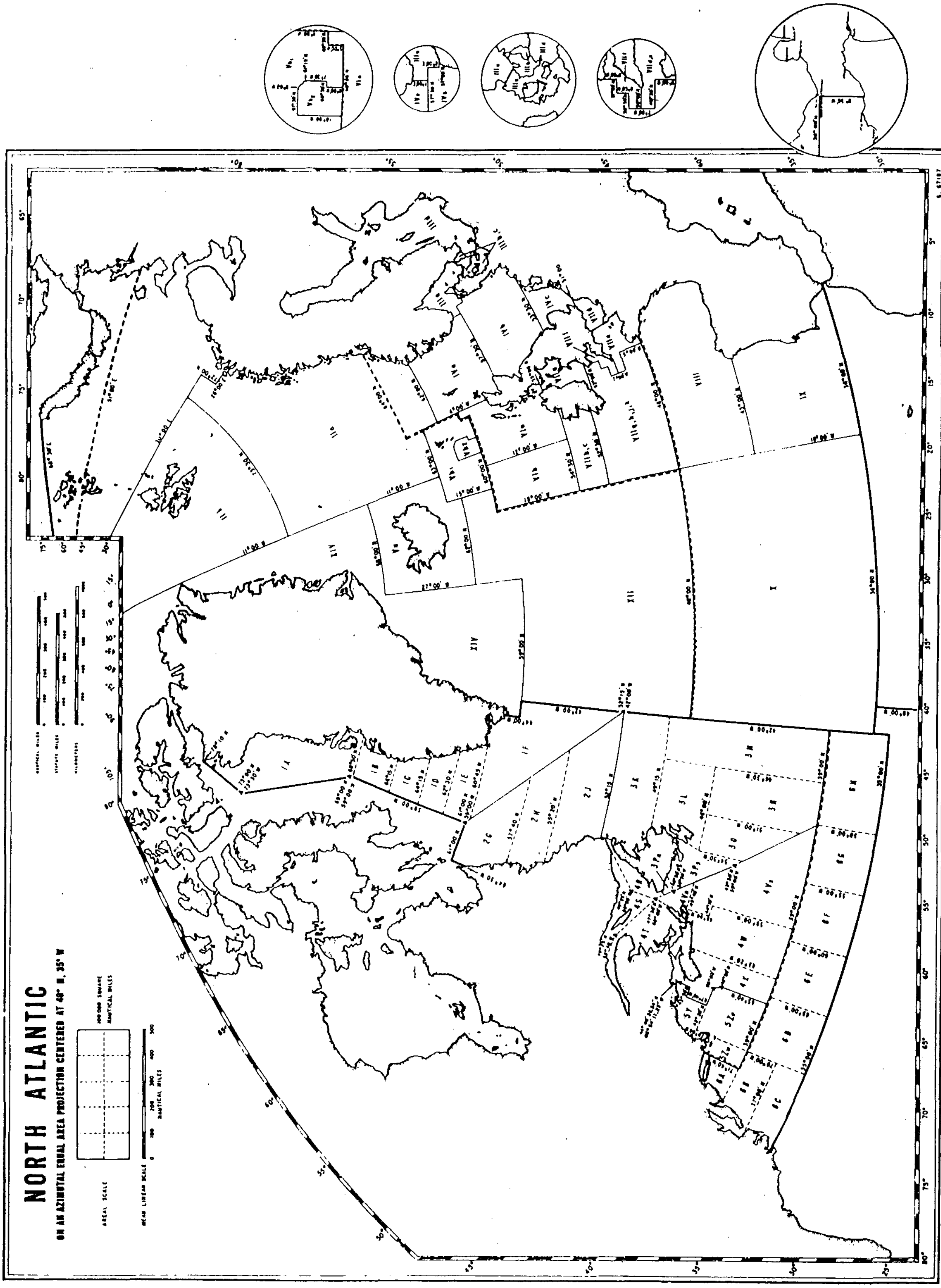
NORTH ATLANTIC
ON AN AZIMUTHAL EQUAL AREA PROJECTION CENTERED AT 40° N, 35° W
AREAL SCALE
100 000 SQUARE NAUTICAL MILES
MEAN LINEAR SCALE
0 100 200 300 400 500
NAUTICAL MILES

Table 1. Results of Base-Line Survey: Metals in fish and shellfish

Table 1A Cod (*Gadus morhua*) Muscle

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
I	November 1975	1967-1970	15	0.02 0.09 0.03 0.01	2.7 5.6 3.8 0.8	0.2 1.3 0.6 0.3	<0.05 0.05 <0.05 -	<0.5 <0.5 <0.5 -			
IIa	November 1975	1969-1972	18	0.01 0.05 0.02 0.01	2.7 5.6 4.0 0.7	0.1 1.4 0.8 0.3	<0.05 <0.05 <0.05 -	<0.5 <0.5 <0.5 -			
IIb	August 1975	1969-1970	10	0.01 0.04 0.02 0.01	2.6 5.4 4.3 0.8	0.2 1.0 0.6 0.3	<0.05 <0.05 <0.05 -	<0.5 <0.5 <0.5 -			
IIb	August 1975	1970-1971	11	0.02 0.10 0.04 0.02	3.1 4.1 3.5 0.4	0.2 2.0 0.9 0.6	<0.05 <0.05 <0.05 -	<0.5 <0.5 <0.5 -			

Table 1A continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IVb	July 1975	1972	15	0.09 0.23 0.13 0.04	4.3 10.0 6.0 1.6	0.12 0.56 0.34 0.13	<0.01 0.05 <0.01 -				
IVb	July 1975	1971- 1972	10	0.04 0.12 0.08 0.03	3.1 4.1 3.7 0.3	0.19 0.23 0.21 0.01	0.003 0.006 0.004 <0.001	0.04 0.07 0.05 0.01			
IVb	1974	-	7	0.03 0.13 0.09 0.06	3.8 4.4 4.2 0.2	0.34 0.68 0.55 0.11	0.01 0.02 0.01 0.00	0.05 0.14 0.08 0.03	0.24 0.41 0.34 0.06		
IVb	1975	-	10	0.03 0.10 0.06 0.03	3.7 4.8 4.2 0.3	0.24 1.30 0.71 0.37	0.01 0.02 0.02 0.00	0.03 0.08 0.06 0.02	0.13 0.36 0.24 0.08		
IVc	August 1975	1972	15	0.19 0.60 0.32 0.11	4.1 9.1 5.6 1.3	0.19 0.74 0.36 0.15	<0.01 0.14 0.03 -				

Table 1A continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d	 Zn min max MEAN s.d.	 Cu min max MEAN s.d.	 Cd min max MEAN s.d.	 Pb min max MEAN s.d.	 Cr min max MEAN s.d.	 Co min max MEAN s.d.	 As min max MEAN s.d.
IVc	1974	-	10	0.12 0.29 0.19 0.05	3.9 4.9 4.3 0.3	0.16 1.70 0.49 0.48	0.01 0.01 0.01 0.01	0.04 0.11 0.09 0.02	0.16 0.32 0.22 0.06		
IVc	1975	-	5	0.09 0.12 0.10 0.01	3.2 4.4 4.1 0.5	0.25 1.30 0.81 0.37	0.01 0.02 0.02 0.00	0.05 0.12 0.08 0.03	0.20 0.40 0.26 0.08		
Va	July-September	1969	15	0.08 0.22 0.15 0.04	3.8 14.3 6.3 3.0	0.25 0.75 0.40 0.13	<0.01 0.10 - -				
Va		1969	10	0.026 0.077 0.052 0.018	2.6 3.7 2.9 0.4	0.25 0.53 0.36 0.09	0.01 0.03 0.02 <0.01	0.13 0.18 0.17 0.02			
Vb	May 1975	1972	10	0.01 0.06 0.03 0.01	3.2 4.8 3.8 0.5	0.06 0.15 0.11 0.03	<0.02 0.02 <0.02 -	<0.1 <0.1 <0.1 -			
Vb	May 1975	1972	10	0.02 0.05 0.03 0.01	2.7 5.0 3.5 0.7	0.08 0.15 0.10 0.02	<0.02 0.02 <0.02 -	<0.1 <0.1 <0.1 -			

Table 1A continued

Source	Date of collection	Year-Class	Number in sample	Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
VIa	December 1975	1972	7	0.02	3.0	N.D.	<0.001	0.09			
				0.22	6.7	2.7	0.03	0.60			
				0.10	4.3	<0.52	<0.005	0.33			
				0.09	1.4	0.99	0.010	0.20			
VIIa	September 1975	62-64cm	10	0.17	2.5	0.3	<0.2	<0.2	<0.2		
				0.37	3.0	0.6	<0.2	0.5	<0.2		
				0.26	2.7	0.4	<0.2	0.3	<0.2		
				0.08	0.3	0.1	-	0.1	-		
XIV	July 1975	1968	4	0.03	3.2	0.16	0.003	0.04			
				0.06	3.5	0.28	0.005	0.06			
				0.04	3.4	0.21	0.004	0.05			
				0.01	0.1	0.05	0.000	0.01			
XIV	July 1975	1969	10	0.03	2.7	0.15	0.002	0.02			
				0.06	3.6	0.26	0.008	0.07			
				0.05	3.1	0.20	0.004	0.04			
				0.01	0.3	0.03	0.000	0.01			
XIV	July 1975	1970	3	0.04	3.3	0.18	0.003	0.05			
				0.07	4.0	0.25	0.004	0.06			
				0.05	3.7	0.21	0.004	0.05			
				-	-	-	-	-			

Table 1A continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
1B	December 1975	1968–1971	4	0.03 0.05 0.04	3.6 4.9 4.4	0.3 0.6 0.4	<0.2 <0.2 -	0.7 1.0 0.9	<0.2 <0.2 -		
1C	March 1975	1968–1971	20		0.6 4.4 1.9 0.28	0.20 0.86 0.38 0.04	<0.2 <0.2 <0.2 -	0.02 0.07 0.03 0.003			
1E	August 1975	1967–1970	10	0.03 0.08 0.05 0.01	3.6 8.1 5.1 1.5	0.3 0.7 0.5 0.1	<0.2 <0.2 <0.2 -	<0.2 0.4 <0.2 <0.1	<0.2 <0.2 <0.2 -		
4X	1975	-	10	0.06 0.20 0.14 0.05	4.4 15.0 6.2 4.1	0.4 1.6 0.2 0.4	0.016 0.052 0.031 0.013	0.16 1.20 0.43 0.42			1.2 7.1 5.2 2.5
4W	1975	-	10	0.06 0.10 0.08 0.01	2.0 5.0 3.2 1.0	0.4 2.0 1.4 0.6	0.018 0.062 0.041 0.013	0.12 0.60 0.28 0.16			1.9 6.8 4.1 1.9
4T	1975	-	10	<0.04 0.08 0.05 0.02	3.2 7.0 4.8 1.1	0.2 1.2 0.8 0.5	0.012 0.042 0.027 0.009	0.14 0.50 0.27 0.13			0.9 5.8 2.8 2.0

Table 1A continued

Source	Date of collection	Year-Class	Number in sample	Statistic	Hg	Zn	Cu	Cd	Pb	Cr	Co	As
					Concentration (in mg/kg, wet weight)							
4T	1975	-	10	min	<0.04	5.0	0.4	0.014	0.48		0.4	0.6
				max	0.08	14.0	4.6	0.070	1.22		4.6	7.1
				MEAN	0.06	7.3	2.1	0.050	0.71		2.1	2.8
				s.d.	0.01	3.9	1.5	0.018	0.24		1.5	2.4
4Vn	1975	-	10	min	0.06	2.8	0.6	0.010	0.04		0.6	1.2
				max	0.12	4.4	2.0	0.16	0.30		2.0	15.0
				MEAN	0.09	3.2	1.6	0.053	0.17		1.6	4.8
				s.d.	0.02	0.5	2.3	0.037	0.10		2.3	4.4

Table 1B Plaice (Pleuronectes platessa) Muscle

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
II	October 1975	1967-1971	13	0.01 0.05 0.02 0.01	3.2 5.9 4.3 0.9	0.5 1.2 0.8 0.3	<0.05 <0.05 <0.05 -	<0.5 <0.5 <0.5 -			
IVb	July 1975	1971-1972	10	0.03 0.06 0.04 0.01	4.0 5.2 5.0 0.8	0.16 0.30 0.23 0.05	0.002 0.006 0.003 0.001	0.03 0.05 0.04 0.01			
IVc	September 1975	1968	4	0.07 0.15 0.12 0.03	3.2 4.4 3.6 0.5	0.17 0.22 0.20 0.03	0.003 0.005 0.004 <0.001	0.04 0.06 0.05 <0.01			
IVc	September 1975	1969	6	0.04 0.11 0.07 0.03	2.8 4.7 3.6 0.7	0.16 0.20 0.19 0.02	0.003 0.007 0.004 <0.001	0.04 0.07 0.05 0.01			
IVc	June-July 1975	1969	15	0.12 0.37 0.26 0.07	4.4 6.9 5.6 0.8	0.20 0.86 0.42 0.16	<0.01 0.06 0.02 -				

Table 1B continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
Vb	May-June 1975	1968	9	0.01 0.08 0.04 0.02	3.9 5.3 4.4 0.6	0.11 0.16 0.14 0.02	<0.02 <0.02 <0.02 -	<0.1 <0.1 <0.1 -			
VIIa	May 1975	1969	15	0.08 1.5 0.50 0.46	3.9 8.8 6.0 1.5	0.13 0.45 0.25 0.09	<0.01 0.03 <0.01 -				
VIId	June 1975	1969	8	0.15 0.32 0.22 0.07	4.2 7.2 5.4 0.9	0.28 0.61 0.42 0.12	<0.01 0.07 <0.01 -				
VIIg, VIIf	June 1975	1969	15	0.10 0.27 0.18 0.05	4.3 11.0 6.1 1.5	0.19 0.89 0.32 0.19	<0.01 0.02 <0.01 -				

Table 1C Hake (Merluccius merluccius) Muscle

Source	Date of collection	Year-Class	Number in sample	Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
VIa	September 1975	43-48 cm	10	0.02 0.04 0.03 0.005	1.4 4.0 2.2 0.8	0.2 0.8 0.5 0.2	<0.2 <0.2 <0.2 -	<0.2 0.5 <0.3 0.1	<0.2 <0.2 <0.2 -		
VIIa	September 1975	45-47 cm	7	0.07 0.21 0.13 0.05	2.0 3.5 2.7 0.6	0.2 0.4 0.4 0.05	<0.2 <0.2 <0.2 -	0.4 0.6 0.5 0.08	<0.2 <0.2 <0.2 -		
VIIh	November 1975	30-72 cm	5	0.05 0.19 0.10 -	3.9 7.5 6.1 -	2.1 5.8 3.7 -	0.01 0.10 0.06 -				
VIII	1974	-	10	0.06 0.12 0.08 0.03	3.4 4.0 3.8 0.48	0.2 2.6 1.1 0.57	0.01 0.02 0.02 -	0.07 0.45 0.14 0.11	0.12 0.23 0.17 0.04		
VIII	October 1975	44-49 cm	10	0.04 0.15 0.09 0.04	0.8 4.0 1.8 1.1	0.2 0.5 0.3 0.1	<0.2 <0.2 <0.2 -	<0.2 0.8 0.3 0.2	<0.2 <0.2 <0.2 -		
IX	October 1975	40-79 cm	11	0.05 0.22 0.09 0.05	1.1 4.0 2.3 0.7	<0.2 0.6 <0.3 0.1	<0.2 <0.2 <0.2 -	<0.2 0.6 <0.2 0.1	<0.2 <0.2 <0.2 -		

Table 1C continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight)							
				Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IX	July 1975	40-43 cm	12	0.04 0.12 0.09 0.03	3.7 11.0 6.4 2.0	0.25 2.10 0.83 0.63					

Table 1D Sole (Solea solea) Muscle

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IVb	1974	-	7	0.02 0.11 0.05 0.03	5.3 6.3 5.8 0.4	0.16 0.51 0.33 0.13	0.02 0.02 0.02 0.00	0.03 0.11 0.06 0.03	0.12 0.33 0.24 0.69		
IVc	1974	-	10	0.05 0.29 0.15 0.08	5.3 7.8 6.5 0.7	0.18 1.41 0.75 0.48	0.02 0.03 0.02 <0.01	0.07 0.17 0.14 0.03	0.09 0.31 0.22 0.08		
IVc	September 1975	1969	8	0.10 0.38 0.20 0.11	3.0 4.0 3.6 0.3	<0.2 0.9 0.4 0.2	<0.2 <0.2 <0.2 -	<0.2 0.8 <0.3 0.2	<0.2 <0.2 <0.2 -		
IVc	September 1975	1971	8	0.04 0.21 0.10 0.06	3.3 5.6 4.1 0.7	<0.2 0.5 0.3 0.09	<0.2 <0.2 <0.2 -	<0.2 0.6 <0.3 0.1	<0.2 <0.2 <0.2 -		
IVc	June-July 1975	1969	15	0.12 0.47 0.28 0.11	4.0 7.6 5.2 0.9	0.18 0.75 0.42 0.15	<0.01 0.04 - -				

Table 1D continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
VIIa	May 1975	1967	15	0.10 0.57 0.29 0.14	3.8 6.9 5.1 0.9	0.24 0.49 0.34 0.09	<0.01 0.07 - -				
VIId	June 1975	1969	15	0.24 0.45 0.32 0.06	3.8 7.3 4.9 0.8	0.18 0.52 0.34 0.09	<0.01 0.01 <0.01 -				
VIIg, VIIf	June 1975	1969	15	0.07 0.26 0.15 0.06	3.9 5.9 4.6 0.6	0.15 0.40 0.24 0.08	<0.01 0.02 <0.01 -				
IX	August 1975	31-34 cm	10	0.007 0.33 0.087 -	0.35 12.0 5.2 -	0.06 0.51 0.22 -	<0.01 0.47 0.05 -				

Table 1E Herring (<u>Clupea harengus</u>) Muscle

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
II	November 1975	1973	10	0.01	3.8	0.6	<0.07	<0.7			
				0.03	10.6	4.1	<0.07	<0.7			
				0.02	6.6	1.3	<0.07	<0.7			
				0.01	2.3	1.1	-	-			
IIa	August 1975	1972-1974	10	<0.005	3.2	1.0	<0.07	<0.7			
				0.01	16.3	4.9	<0.07	<0.7			
				0.01	7.5	1.8	<0.07	<0.7			
				0.001	3.0	1.5	-	-			
Va	-	1972	10	0.022	2.8	0.28	0.01	0.06			
				0.047	3.8	1.25	0.05	0.36			
				0.035	3.3	0.76	0.02	0.21			
				0.007	0.3	0.35	0.01	0.08			
VIa	September 1975	1972	10	0.01	4.4	0.40	<0.02	<0.1			
				0.06	6.1	1.73	<0.02	<0.1			
				0.02	4.9	0.76	<0.02	<0.1			
				0.01	0.6	0.45	<0.02	<0.1			

Table 1F Capelin (Mallotus villosus) Muscle and Whole

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
I	September 1975	1971-1973	20	≤0.005 0.03 0.01 0.007	0.3 9.6 5.6 3.1	0.2 2.6 0.7 0.6	≤0.07 ≤0.07 ≤0.07 -	≤0.7 ≤0.7 ≤0.7 -			
I	September 1975	1972-1973	10	0.02 0.08 0.03 0.02	4.1 11.0 6.8 2.3	0.6 1.5 0.9 0.3	≤0.07 ≤0.07 ≤0.07 -	≤0.7 ≤0.7 ≤0.7 -			
I	September 1975	1971-1973	10	0.01 0.04 0.01 0.01	3.2 6.2 4.8 1.0	0.9 3.8 1.2 0.3	≤0.07 ≤0.07 ≤0.07 -	≤0.7 ≤0.7 ≤0.7 -			
I	September 1975	1972	4	0.03 0.04 0.03 0.01	4.7 9.3 7.2 2.1	1.6 2.1 1.8 0.2	≤0.07 ≤0.07 ≤0.07 -	≤0.7 ≤0.7 ≤0.7 -			
IIb	August 1975	1971-1972	10	<0.005 0.02 0.01 0.01	2.3 9.8 5.5 2.4	0.8 1.7 1.1 0.3	≤0.07 ≤0.07 ≤0.07 -	≤0.7 ≤0.7 ≤0.7 -			

Table 1F continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
1A	October 1975		5 (whole)	(0.02 (0.02	16.0 15.0	1.0 0.8	<0.2 <0.2	<0.2 0.4	<0.2 <0.2		
1B	August 1975		21 (whole)	(0.01 (0.01	16.0 19.0	0.6 0.8	<0.2 <0.2	0.4 0.4	<0.2 <0.2		

Table 1G Greenland Halibut (<u>Reinhardtius hippoglossoides</u>) Muscle

Source	Date of collection	Year-Class	Number in sample	Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
				Concentration (in mg/kg, wet weight)							
1A	September 1975	-	10		- 2.7 1.2 0.3	- 0.25 0.16 0.03	<0.3 <0.3 <0.3 -	- 0.05 0.03 0.005			
1B	August 1975	50-57 cm	4	0.02 0.04 0.03 0.01	3.1 4.6 3.7 0.7	<0.2 0.3 <0.2 0.1	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -		
1C	August 1975	49-74 cm	7	0.02 0.10 0.05 0.03	1.0 4.0 1.7 1.1	0.2 0.4 0.3 0.1	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -		
1D	August 1975	47-69 cm	4	0.02 0.06 0.03 0.02	3.7 4.5 4.0 0.4	0.2 0.5 0.3 0.1	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -		
1E	August 1975	51-65 cm	10	0.02 0.07 0.04 0.02	0.6 4.0 1.7 1.0	<0.2 0.4 0.3 0.06	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -	<0.2 <0.2 <0.2 -		

Table 1H Pilchard (<u>Sardina pilchardus</u>) Muscle

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight)							
				Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
VIIe	December 1975	22-26 cm	10	0.05 0.11 0.08 0.02	5.4 13.0 8.9 2.5	0.6 1.4 1.1 0.3	<0.2 <0.2 <0.2 -	<0.2 0.4 <0.2 0.06	<0.2 0.2 <0.2 -		
VIII	October 1975	19-23 cm	25	0.04 0.08 0.06		0.8 2.2 1.5	0.02 0.17 0.11				
IX	July 1975	20-21 cm	10	<0.001 0.031 0.006 -	5.4 18.0 10.0 -	0.66 21.0 6.8 -	<0.001 0.042 0.009 -				

Table 1I Scabbard (*Aphanopus carbo*) Muscle

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight)							
				Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
X	October 1975	80–115 cm	10	0.11 0.42 0.21 - -	2.4 3.3 2.7 - -	<0.2 0.5 <0.3 - -	<0.2 <0.2 <0.2 - -	<0.2 0.6 <0.3 - -	<0.2 <0.2 <0.2 - -		

Table 1J Deep Sea Prawn (<u>Pandalus borealis</u>), Whole

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
1B	August 1975	2.5-5.0 cm	124	(0.02 (0.02	13.0 12.0	16.0 16.0	1.0 0.9	0.3 0.5	<0.2 <0.2		
1D	August 1975	2.5-5.0 cm	52	(0.02 (0.02	12.0 14.0	18.0 18.0	0.2 0.3	<0.2 <0.2	0.4 0.4		
1E	August 1975	2.5-5.0 cm	54	(0.02 (0.02	13.0 16.0	11.0 14.0	<0.2 <0.2	<0.2 0.3	<0.2 0.3		
1F	October 1975	2.5-5.0 cm	51	(0.03 (0.03	17.0 17.0	17.0 17.0	0.3 0.4	2.8 0.2	0.3 0.3		

Table 2. Results of Base-Line Survey: Metals in fish liver

Table 2A Cod (<u>Gadus morhua</u>) Liver

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
I	November 1975	1969-1970	14	<0.02 0.04 <0.003 <0.001	10.0 29.0 20.0 5.8	0.8 5.8 2.6 1.5	<0.01 0.02 <0.01 <0.001	<0.1 <0.1 <0.1 -			
IIa	November 1975	1969-1972	18	<0.02 0.03 <0.02 <0.01	6.0 37.0 20.0 10.0	0.5 6.1 2.4 1.3	<0.01 0.02 <0.01 <0.01	<0.1 <0.1 <0.1 -			
IIb	August 1975	1969-1970	9	<0.02 0.02 <0.02 -	9.0 30.0 17.0 6.2	2.0 4.6 3.2 0.9	<0.01 0.02 <0.01 <0.01	<0.1 0.1 <0.1 -			
IIb	August 1975	1970-1971	9	<0.02 0.02 <0.02 -	10.0 32.0 21.0 8.2	0.9 3.3 2.5 0.9	<0.01 0.02 <0.01 -	<0.1 <0.1 <0.1 -			
IVb	July 1975	1971-1972	10	0.03 0.07 0.05 0.01	12.9 22.5 18.4 3.4	4.3 9.3 7.1 1.9	0.022 0.048 0.0[illegible]4 0.008	0.09 0.20 0.13 0.04			

Table 2A continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IV b	1974	-	1	0.05	30.3	12.5	0.07	0.12	0.19		
IV b	1975	-	1	0.02	27.3	8.0	0.04	0.04	0.22		
IV c	1974	-	1	0.04	22.6	11.1	0.02	0.14	0.03		
IV c	1975	-	1	0.08	24.1	11.6	0.02	0.06	0.07		
Va		1969	10	0.019 0.048 0.031 0.009	8.6 18.0 12.7 3.0	1.8 10.0 5.2 2.4	0.08 0.19 0.11 0.03	0.05 0.23 0.13 0.07			
V b	May 1975	1972	10	<0.02 0.04 <0.03 0.01	14.0 25.0 20.0 3.0	1.5 9.3 3.7 2.2	0.06 0.16 0.09 0.03	<0.5 <0.5 <0.5 -			
V b	May 1975	1972	10	0.01 0.08 0.03 0.02	21.0 72.0 36.0 14.0	3.1 12.3 7.3 3.0	0.21 0.79 0.43 0.19	<0.5 <0.5 <0.5 -			

Table 2A continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
VIa	December 1975	1972	7	(0.05 (0.09	29.0 28.0	4.6 4.2	0.027 0.034	0.29 0.20			
XIV	July 1975	1969	5	(0.04 (0.05	15.0 16.0	4.1 4.5	0.19 0.21	0.05 0.06			
XIV	July 1975	1969	5	(0.02 (0.03	13.0 14.0	2.5 2.7	0.18 0.20	0.08 0.10			
1B	December 1975	1968-1971	4	(0.01 (0.01	14.5 14.5	6.7 7.0	<0.2 <0.2	<0.5 <0.5	<0.2 <0.2		
1E	August 1975	1967-1970	10	(0.01 (0.02	21.0 11.0	5.0 6.0	<0.2 <0.2	<0.5 1.2	<0.2 <0.2		
4X	1975	-	10	0.02 0.22 0.09 0.07	13.0 63.0 36.0 20.0	4.3 20.6 9.8 5.9	0.16 0.93 0.41 0.28	0.13 0.52 0.31 0.13			2.1 34.0 12.0 12.0
4W	1975	-	10	<0.03 0.10 0.04 0.02	9.0 20.0 11.0 4.4	2.7 6.3 4.1 1.1	0.19 0.58 0.28 0.11	0.08 0.55 0.24 0.15			1.6 13.4 4.5 3.4
4T	1975	-	10	<0.03 0.09 0.05 0.02	12.0 22.0 15.0 3.1	2.0 7.3 4.3 2.1	0.08 0.25 0.17 0.06	0.10 0.44 0.25 0.12			1.5 4.9 2.8 1.1

Table 2A continued

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight)							
				Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
4T	1975	-	10	<0.03 <0.03 <0.03 -	6.7 19.0 10.0 3.8	1.3 5.2 3.1 1.1	0.08 0.25 0.13 0.06	0.14 0.28 0.21 0.21			0.6 5.6 1.7 1.6
4Vn	1975	-	10	<0.03 0.06 0.04 0.01	9.3 18.0 13.0 2.9	3.4 9.7 5.1 1.8	0.15 0.46 0.28 0.10	0.13 0.77 0.28 0.21			1.0 6.3 2.7 1.5

Table 2B Plaice (<u>Pleuronectes platessa</u>) Liver

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IVb	July 1975	1971-1972	10	0.04 0.09 0.06 0.01	11.6 61.1 27.9 13.9	3.4 8.3 5.5 1.6	0.08 0.29 0.16 0.07	0.15 0.41 0.25 0.09			
IVc	September 1975	1968	4	0.06 0.12 0.09 0.03	11.0 39.0 26.0 12.0	1.2 10.0 4.6 4.1	0.24 0.43 0.35 0.09	0.16 0.36 0.25 0.08			
IVc	September 1975	1968	6	0.06 0.12 0.09 0.04	29.0 46.0 38.0 12.0	5.1 7.1 6.1 1.4	0.24 0.34 0.29 0.06	0.35 0.73 0.54 0.27			
Vb	May-June 1975	1969	8	0.04 0.07 0.05 0.01	27.0 48.0 40.0 7.0	1.5 4.4 2.4 0.9	0.6 4.2 1.8 1.4	<0.5 <0.5 <0.5 -			

Table 2C Hake (<u>Merluccius merluccius</u>) Liver

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
VIII	1974	-	1	0.04	35.1	5.9	0.04	0.09	0.13		
VIII	October 1975	44-49 cm	10	(0.01 (0.07	34.0 34.0	3.0 3.0	<0.2 <0.2				
IX	October 1975	40-79 cm	11	(0.03 (0.03	21.0 17.0	0.5 0.7	<0.2 <0.2				
IX	July 1975	40-43 cm	12	0.037 0.039 0.038 -	22.0 39.0 30.0 -	3.5 9.4 5.2 -	0.04 1.9 0.38 -				

Table 2D Sole (<u>Solea</u> <u>solea</u>) Liver

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight)							
				Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IVb	1974	-	1	0.05	27.3	26.1	0.06	0.17	0.14		
IVc	1974	-	1	0.18	35.1	38.8	0.08	0.31	0.20		
IX	August 1975	31-34 cm	10	<0.01 0.06 0.04 -	18.0 43.0 26.0 -	51.0 69.0 65.0 -	<0.01 0.16 0.05 -				

Table 2E Herring (*Clupea harengus*) Liver

Source	Date of collection	Year-Class	Number in sample		Concentration (in mg/kg, wet weight) Hg	Zn	Cu	Cd	Pb	Cr	Co	As
				min								
				max								
				MEAN								
				s.d.								
Va	1975	1972	10	min	0.012	19.4	2.8	0.19	0.07			
				max	0.051	33.6	4.0	0.27	0.47			
				MEAN	0.034	25.7	3.5	0.24	0.20			
				s.d.	0.012	4.1	0.4	0.02	0.13			
VIa	September 1975	1972	10	min	0.01	15.0	0.5	<0.1	<0.1			
				max	0.08	29.0	7.1	0.3	<0.5			
				MEAN	0.05	23.0	3.9	<0.1	<0.5			
				s.d.	0.03	5.2	2.1	<0.1	<0.1			

Table 2G Greenland Halibut (Reinhardtius hippoglossoides) Liver

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
1A	September 1975	-	5		13.0 23.4 17.8 1.8	34.0 59.7 46.6 4.2	0.44 2.07 1.09 0.30	0.12 0.33 0.18 0.04			
1B	August 1975	50-57 cm	4	(0.02 (0.02	28.0 23.0	22.0 21.0	<0.5 <0.5	<0.5 <0.5	0.5 0.5		
1C	August 1975	49-74 cm	7	(0.03 (0.04	18.0 20.0	12.0 11.0	<0.5 <0.5	<0.5 <0.5	<0.2 <0.2		
1D	August 1975	47-69 cm	4	(0.02 (0.02	24.0 26.0	16.0 20.0	0.9 1.0	<0.5 <0.5	<0.5 0.5		
1E	August 1975	51-65 cm	10	(0.03 (0.03	20.0 20.0	13.0 12.0	<0.5 <0.5	<0.5 <0.5	<0.2 <0.2		

Table 2H Pilchard (Sardinia pilchardus) Liver

Source	Date of collection	Year-Class	Number in sample	Concentration (in mg/kg, wet weight) Hg min max MEAN s.d.	Zn min max MEAN s.d.	Cu min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cr min max MEAN s.d.	Co min max MEAN s.d.	As min max MEAN s.d.
IX	July	20-21 cm	10	<0.001 0.099 0.004 -	29.0 45.0 37.0 -	4.0 18.0 6.7 -	<0.001 0.077 0.038 -				

Table 21 Scabbard (Aphanopus carbo) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
X	October 1975	80–115 cm	10	0.2	<0.001	<0.001	0.002	0.003	0.003	0.005			0.03
Madeira	April 1974	100–115cm	15	0.10 5.63 0.72 1.37				0.002 0.023 0.006 0.005	<0.001 0.008 0.002 0.002	<0.001 0.024 0.005 0.005		0.002 0.055 0.012 0.012	0.001 0.140 0.016 0.034
Madeira	September 1974	82–100 cm	10	0.15 1.27 0.54 0.36				0.004 0.011 0.008 0.003	<0.001 0.004 0.002 0.001	0.003 0.011 0.006 0.003		0.010 0.025 0.015 0.005	0.006 0.021 0.013 0.006

Table 2J Deep Sea Prawn (<u>Pandalus borealis</u>) Whole

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
1B	August 1975	2.5-5.0 cm	124	4.0 3.2	0.002 <0.001	0.001 <0.001	0.002 0.002	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001			0.010 0.010
1D	August 1975	2.5-5.0 cm	52	1.6 2.2	<0.001 0.001	<0.001 <0.001	0.001 0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001			0.010 0.010
1E	August 1975	2.5-5.0 cm	54	1.8 1.8	0.001 0.001	<0.001 <0.001	0.001 0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001			0.008 0.008
1F	October 1975	2.5-5.0 cm		2.2 2.2	0.002 0.002	<0.001 <0.001	0.001 0.001	<0.001 <0.001	<0.001 <0.001	<0.001 <0.001			0.010 0.020

Table 3 Results of Base-Line Survey:Organochlorine pesticide residues and PCB's in Fish and Shellfish
Table 3A Cod (*Gadus morhua*) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
I	November 1975	1970	10	(0.12 (0.10						0.001 0.001	≤0.001 ≤0.001	≤0.002 ≤0.002	N.D. -
IIa	November 1975	1970	10	(0.21 (0.16					0.001 0.001	0.001 0.002	≤0.001 ≤0.001	≤0.003 ≤0.004	0.02 N.D.
IIb	August 1975	1970	9	(1.0 (1.1					0.003 0.001	0.003 0.001	≤0.001 ≤0.001	≤0.007 ≤0.003	0.57 0.30
IIb	August 1975	1970	10	(0.24 (0.21					0.001 -	0.001 0.001	≤0.001 ≤0.001	≤0.003 ≤0.002	N.D. 0.32
IVa	1974-1975		10	0.10	0.0004	0.0001	0.0002	0.0006	0.0003	0.0005		0.0013	0.0061
IVb	September 1975	1971	8	0.02 0.07 0.05 0.02		0.002 0.005 0.003 0.001	0.001 0.002 0.001 ≤0.001	0.001 0.003 0.002 ≤0.001	0.004 0.004 0.004 ≤0.001	0.003 0.004 0.003 ≤0.001		0.008 0.010 0.009 <0.001	0.036 0.080 0.049 0.018
IVb	1974-1975	-	-	0.06	0.0002	0.0001	0.0002	0.0010	0.0003	0.0010		0.0024	0.030
IVc	1974-1975	-	-	0.05	0.0001	0.0001	0.0005	0.0005	0.0001	0.0010		0.0016	0.019
Vb	May 1975	1972	10	(0.3 (0.1		≤0.001 ≤0.001	0.001 ≤0.001	0.001 ≤0.001	≤0.001 ≤0.001	≤0.001 ≤0.001		≤0.003 ≤0.003	0.03 0.03
Vb	May 1975	1972	10	(0.1 (0.2		≤0.001 ≤0.001	≤0.001 ≤0.001	0.001 0.001	≤0.001 ≤0.001	≤0.001 ≤0.001		≤0.003 ≤0.003	0.03 0.02

Table 3A continued

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight) αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
VIIa	September 1975	62–65	10	0.2 0.6 0.3 0.1	<0.001 <0.001 <0.001 –	<0.001 <0.001 <0.001 –	<0.001 <0.002 0.002 <0.001	<0.001 0.009 0.002 0.002	<0.001 0.002 <0.001 <0.001	<0.001 0.003 <0.001 <0.001		<0.003 0.014 <0.005 <0.001	<0.01 0.05 0.02 0.01
XIV	April 1975	1967	1	– – 0.12 –	– –	– – 0.004 –	– – <0.001 –	– – 0.002 –	– – 0.002 –	– – 0.004 –		– – 0.008 –	– – 0.021 –
XIV	April 1975	1968	4	0.01 0.27 0.16 0.08		0.004 0.009 0.005 <0.001	<0.001 0.004 <0.002 <0.001	0.001 0.002 0.002 <0.001	0.001 0.003 0.002 <0.001	0.003 0.007 0.004 <0.001		0.006 0.009 0.007 <0.001	0.023 0.068 0.042 0.020
XIV	April 1975	1969	2	0.06 0.16 0.11 –		0.003 0.004 0.004 –	<0.001 0.003 <0.002 –	0.002 0.002 0.002 –	0.001 0.002 0.002 –	0.003 0.003 0.003 –		0.006 0.006 0.006 –	0.019 0.021 0.020 –
XIV	April 1975	1970	1	– – 0.36 –		– – 0.010 –	– – <0.001 –	– – 0.002 –	– – 0.001 –	– – 0.004 –		– – 0.007 –	– – 0.071 –
XIV	July 1975	1968	2	0.21 0.29 0.25 –		0.001 0.002 0.002 –	<0.001 <0.001 <0.001 –	0.002 0.002 0.002 –	0.001 0.002 0.002 –	0.002 0.003 0.003 –		0.005 0.007 0.006 –	0.036 0.036 0.036 –

Table 3A continued

Source	Date of collection	Year class or size	Number in sample	% fat	α HCH min max MEAN s.d.	γ HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
XIV	July 1975	1969	4	0.25		0.001	<0.001	0.001	0.001	0.003		0.005	0.032
				0.29		0.002	<0.001	0.002	0.002	0.003		0.007	0.036
				0.27		0.001	<0.001	0.002	0.001	0.003		0.006	0.037
				0.02		<0.001	-	<0.001	<0.001	-		<0.001	<0.001
XIV	July 1975	1970	4	0.26		0.001	<0.001	0.001	0.001	0.002		0.005	0.035
				0.42		0.002	<0.001	0.003	0.004	0.006		0.013	0.038
				0.34		0.002	<0.001	0.002	0.002	0.004		0.008	0.037
				0.07		<0.001	-	<0.001	<0.001	<0.001		<0.001	<0.001
1B	December 1975	1968-1971	4	(0.6	<0.001	<0.001	0.001	0.001	<0.001	<0.001		<0.003	0.006
				(0.6	<0.001	<0.001	0.001	<0.001	<0.001	<0.001		<0.003	0.005
1E	August	1967-1970	10	(0.4	<0.001	<0.001	0.001	<0.001	<0.001	<0.001		<0.003	0.004
				(0.4	<0.001	<0.001	0.001	<0.001	<0.001	<0.001		<0.003	0.004
4T	June 1975	1969	7	0.61				0.004	0.001	0.002		-	0.017
				1.5				0.013	0.006	0.010		-	0.060
				0.98			0.001	0.007	0.003	0.005		0.015	0.033
				0.33			-	0.003	0.002	0.003		-	0.016
4T	1975	-	5	0.10			<0.001	0.002	<0.001	0.002			0.011
				0.48			0.003	0.003	0.001	0.006			0.020
				0.21			0.001	0.002	<0.001	0.003		<0.006	0.015
				0.16			0.001	<0.001	<0.001	0.002			0.004
4X	1975	-	4	0.28			<0.001	0.001	<0.001	0.002			0.009
				0.76			0.003	0.012	0.013	0.019			0.054
				0.45			0.001	0.004	0.004	0.007		0.015	0.022
				0.21			0.001	0.004	0.006	0.003			0.022

Table 3A continued

Source	Date of collection	Year class or size	Number in sample	% fat	αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
					Concentration (in mg/kg, wet weight)								
4W	1975	-	6	0.22 0.78 0.52 0.21			<0.001 0.004 0.002 0.001	<0.001 0.002 0.001 <0.001	<0.001 0.016 0.004 0.005	0.002 0.007 0.004 0.002		0.009	0.005 0.011 0.008 0.002
4Va	1975	-	5	0.12 0.82 0.41 0.26			<0.001 0.005 0.002 0.002	<0.001 0.002 0.001 <0.001	<0.001 0.001 <0.001 <0.001	0.001 0.005 0.004 0.002		<0.006	0.007 0.011 0.009 0.002

Table 3B Plaice (Pleuronectes platessa) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
I	October 1975	1967	5	{1.7 {1.5					– 0.003	0.008 0.003	0.001 <0.001	0.009 <0.007	0.01 0.06
IVc	September 1975	1968–1971	10	0.10 0.19 0.14 0.03		0.001 0.005 0.002 0.001	0.005 0.014 0.008 0.002	0.005 0.016 0.009 0.003	0.002 0.007 0.003 0.001	0.003 0.004 0.003 0.000		0.008 0.027 0.015 0.004	0.132 0.200 0.162 0.025
Vb	May–June 1975	1968	9	{0.3 {0.5		N.D. N.D.	0.001 <0.001	0.001 0.001	<0.001 <0.001	<0.001 <0.001		<0.003 <0.003	0.02 0.02

Table 3C Hake (Merluccius merluccius) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
VIa	September 1975	43-48 cm	10	0.6	<0.001	<0.001	0.001	<0.001	<0.001	<0.001		<0.003	0.01
				4.8	0.002	<0.001	0.004	0.008	0.003	0.007		0.017	0.25
				2.0	<0.001	<0.001	0.003	0.003	0.002	0.003		0.008	0.08
				1.2	<0.001	-	0.003	0.002	0.001	0.002		<0.001	0.08
VIIa	September 1975	45-47 cm	7	0.8	<0.001	<0.001	0.001	0.004	0.008	0.006		0.021	0.06
				3.0	0.002	0.001	0.007	0.007	0.030	0.014		0.066	0.17
				1.8	<0.001	<0.001	0.004	0.006	0.015	0.012		0.033	0.10
				0.7	<0.001	-	0.002	0.002	0.008	0.008		0.007	0.05
VIIh	November 1975		3					0.028	0.045	0.120		0.193	0.089
VIII	October 1975	44-49 cm	10	0.2	<0.001	<0.001	<0.001	0.001	<0.001	0.001		<0.003	0.01
				1.6	<0.001	<0.001	0.002	0.005	0.008	0.019		0.030	0.15
				0.6	<0.001	<0.001	0.001	0.003	0.002	0.005		0.009	0.05
				0.5	-	-	<0.001	0.001	0.002	<0.001		<0.001	0.05
VIII	1974-1975		-	0.70	0.0006	0.0004	0.0036	0.028	0.0088	0.022		0.055	0.39
IX	October 1975	40-79 cm	11	0.6	<0.001	<0.001	0.001	0.001	<0.001	0.001		<0.003	<0.01
				3.2	<0.001	<0.001	0.002	0.009	0.002	0.014		0.016	0.05
				1.4	<0.001	<0.001	0.002	0.004	0.001	0.006		0.013	0.02
				0.7	-	-	<0.001	0.002	<0.001	0.004		<0.001	0.01
IX	July 1975	40-43 cm	10	(0.46				0.003	0.001	0.005		0.009	0.014
				(0.67				0.006	0.001	0.005		0.012	0.011

Table 3D Sole (*Solea solea*) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
IVc	September 1975	1969	8	{1.6 {0.6	<0.001 <0.001	<0.001 <0.001	<0.001 0.003	<0.001 0.003	0.006 0.006	0.002 <0.001		<0.009 <0.010	0.03 0.07
IVc	September 1975	1971	8	{0.4 {0.6	<0.001 <0.001	<0.001 <0.001	0.002 0.002	0.002 0.001	0.006 0.002	0.001 0.001		0.009 0.004	0.08 0.02
IX	August 1975	31-34 cm	10	{0.13 {0.11				0.002 0.003					0.006 0.010

Table 3E Herring (<u>Clupea harengus</u>) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
I	November 1975	1973	10	(7.4 (7.3					0.001 –	0.002 0.001	<0.001 <0.001	<0.004 <0.002	N.D. 0.06
IIa	August 1975	1973	7	(10.0 (9.0					0.001 0.003	0.003 0.004	<0.001 <0.001	<0.005 <0.008	0.01 N.D.
VIa	September 1975	1972	10	(9.3 (9.5		0.004 0.004	0.014 0.015	0.012 0.009	0.007 0.009	0.008 0.011		0.027 0.029	0.08 0.06

Table 3F Capelin (<u>Mallotus villosus</u>) Muscle and Whole

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
I	1975	1972	10	(7.9						0.006	<0.001	<0.007	N.D.
				(10.0					0.002	0.005	<0.001	<0.008	0.93
IIb	1975	1974	10	(1.7						0.014	0.003	0.017	0.16
				(2.4						-	-	-	0.12
IA	October	-	5 (whole)	(13.0	0.010	0.002	0.001	0.003	<0.001	<0.003		<0.007	<0.010
	1975			(13.0	0.010	0.002	0.001	0.004	<0.001	<0.003		<0.005	<0.010
												0.008	
1B	August	-	21 (whole)	(3.2	0.002	<0.001	<0.001	0.004	0.001	0.003		0.009	0.010
	1975			(2.4	0.002	<0.001	<0.001	0.005	0.001	0.003			0.020

Table 3G Pilchard (Sardina pilchardus) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
VIIe	December 1975	22-26 cm	10	2.4 5.8 3.5 1.1	<0.001 0.003 <0.002 0.001	<0.001 0.001 0.001 -	0.001 0.005 0.003 0.001	0.008 0.036 0.020 0.009	<0.001 0.003 <0.001 0.001	<0.002 0.007 0.003 0.002		0.013 0.044 0.024 0.003	0.10 0.61 0.30 0.21
VIII	October 1975	19-23 cm	25					0.034	0.032	0.046		0.082	0.216
IX	July 1975	20-21 cm	10	(8.7 (8.4				0.006 0.007					0.005 0.008

Table 3H Greenland Halibut (Reinhardtius hippoglossoides) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
1B	August 1975	50-57 cm	4	(8.8 (8.8	0.003 0.003	0.002 0.002	0.004 0.005	0.005 0.005	0.006 0.001	0.003 0.002		0.014 0.008	0.020 0.020
1C	August 1975	49-74 cm	7	(5.2 (6.2	0.002 0.002	<0.001 <0.001	0.004 0.003	0.004 0.006	0.003 0.006	0.007 0.008		0.014 0.020	0.017 0.019
1D	August 1975	47-69 cm	4	(10.0 (9.4	0.006 0.006	0.002 0.002	0.008 0.007	0.014 0.011	0.011 0.004	0.012 0.013		0.037 0.028	0.070 0.050
1E	August 1975	51-65 cm	10	(7.4 (5.2	0.003 0.002	<0.001 <0.001	0.001 0.003	0.002 0.003	0.002 0.002			0.011 0.012	0.017 0.017

Table 3I Scabbard (*Aphanopus carbo*) Muscle

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
X	October 1975	80–115 cm	10	0.2	<0.001	<0.001	0.002	0.003	0.003	0.005		0.011	0.03
Madeira	April 1974	100–115cm	15	0.10 5.63 0.72 1.37				0.002 0.023 0.006 0.005	<0.001 0.008 0.002 0.002	<0.001 0.024 0.005 0.005		0.002 0.055 0.012 0.012	0.001 0.140 0.016 0.034
Madeira	September 1974	82–100 cm	10	0.15 1.27 0.54 0.36				0.004 0.011 0.008 0.003	<0.001 0.004 0.002 0.001	0.003 0.011 0.006 0.003		0.010 0.025 0.015 0.005	0.006 0.021 0.013 0.006

Table 3J Deep Sea Prawn (Pandalus borealis) Whole

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
1B	August 1975	2.5–5.0 cm	124	4.0 3.2	0.002 ≤0.001	0.001 ≤0.001	0.002 0.002	≤0.001 ≤0.001	≤0.001 ≤0.001	≤0.001 ≤0.001		<0.003 <0.003	0.010 0.010
1D	August 1975	2.5–5.0 cm	52	1.6 2.2	≤0.001 0.001	≤0.001 ≤0.001	0.001 0.001	≤0.001 ≤0.001	≤0.001 ≤0.001	≤0.001 ≤0.001		<0.003 <0.003	0.010 0.010
1E	August 1975	2.5–5.0 cm	54	1.8 1.8	0.001 0.001	≤0.001 ≤0.001	0.001 0.001	≤0.001 ≤0.001	≤0.001 ≤0.001	≤0.001 ≤0.001		<0.003 <0.003	0.008 0.008
1F	October 1975	2.5–5.0 cm	-	2.2 2.2	0.002 0.002	≤0.001 ≤0.001	0.001 0.001	≤0.001 ≤0.001	≤0.001 ≤0.001	≤0.001 ≤0.001		<0.003 <0.003	0.010 0.020

Table 4 Results of Base-Line Survey: Organochlorine pesticide residues and PCBs in Fish

Table 4A Cod (<u>Gadus morhua</u>) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight) αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
I	November 1975	1970	10	28.0 92.0 58.0 27.0					0.10 0.27 0.17 0.06	0.11 0.32 0.31 0.07	0.01 0.02 0.02 < .01	0.30 0.60 0.44 0.10	0.96 3.24 1.74 0.66
IIa	November 1975	1970	9	61.0 90.0 81.0 11.0					0.04 0.20 0.10 0.05	0.10 0.33 0.18 0.06	<0.01 0.02 <0.01 <0.01	0.10 0.54 0.27 0.12	0.24 1.52 0.96 0.40
IIb	August 1975	1970	19	26.0 94.0 62.0 23.0					0.03 0.15 0.06 0.03	0.04 0.53 0.13 0.12	<0.01 0.02 <0.01 <0.01	0.08 0.72 0.20 0.16	0.20 2.46 0.60 0.52
IVa	1974-1975	-	10	30.8 50.0 40.4 1.8	0.02 0.11 0.03 <0.01	<0.001 0.002 0.0004 <0.001	0.02 0.11 0.05 <0.01	0.08 0.38 0.18 0.03	0.07 0.24 0.13 0.02	0.03 0.18 0.13 0.02		0.29 0.78 0.44 0.03	0.65 4.20 1.80 0.38

Table 4A continued

Source	Date of collection	Year class or size	Number in sample	% fat	αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
IVb	1974-75	-	6	32.0 46.3 40.5 2.4	0.05 0.11 0.08 0.02	0.003 0.05 0.02 <0.01	0.13 0.34 0.19 0.03	0.13 0.87 0.51 0.11	0.08 0.34 0.23 0.04	0.04 0.08 0.07 <0.01		0.33 1.30 0.98 0.15	1.5 18.0 8.5 2.9
IVb	Sept 1975	1971	8	49.48 79.34 55.21 9.96		0.030 0.046 0.038 0.005	0.080 0.120 0.096 0.012	0.170 0.296 0.222 0.049	0.144 0.600 0.33 0.181	0.072 0.360 0.189 0.085		0.386 0.988 0.740 0.223	3.22 8.74 5.58 2.01
IVc	1974-75	-	10	40.6 62.5 52.7 2.3	0.04 0.09 0.06 <0.01	0.01 0.05 0.03 <0.01	0.18 0.66 0.41 0.04	0.19 1.0 0.42 0.08	0.12 0.43 0.26 0.04	0.12 0.62 0.28 0.05		0.51 1.70 0.95 0.14	10.5 43.6 19.6 3.0
Vb	May 1975	1972	10	37.0 58.0 47.0 6.8		0.014 0.075 0.032 0.017	0.008 0.062 0.024 0.014	0.03 0.19 0.10 0.047	0.014 0.13 0.061 0.032	0.018 0.113 0.063 0.022		0.08 0.37 0.22 0.03	0.17 1.0 0.58 0.24
Vb	May 1975	1972	10	5.1 53.0 30.0 14.2		0.005 0.047 0.023 0.014	0.005 0.051 0.023 0.014	0.06 0.54 0.17 0.14	0.03 0.51 0.12 0.14	0.044 0.414 0.127 0.110		0.16 1.46 0.60 0.21	0.46 3.00 1.20 0.77
XIV	July 1975	1968	2	50.0 56.0 53.0 3.7		0.008 0.010 0.009 -	0.016 0.062 0.039 -	0.10 0.22 0.16 -	0.05 0.09 0.07 -	0.08 0.17 0.12 -		0.23 0.49 0.40 -	0.43 0.44 0.44 -

Table 4A continued

Source	Date of collection	Year class or size	Number in sample	% fat	αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
XIV	July 1975	1969	4	50.0 64.0 57.0 6.2		0.008 0.016 0.012 <0.001	0.010 0.048 0.033 0.017	0.098 0.19 0.13 0.041	0.038 0.086 0.072 0.022	0.060 0.17 0.092 0.050		0.15 0.44 0.27 0.11	0.40 0.59 0.48 0.08
XIV	July 1975	1970	4	48.0 58.0 54.0 4.1		0.010 0.014 0.012 <0.001	0.018 0.028 0.023 <0.001	0.11 0.16 0.12 0.03	0.044 0.064 0.055 0.010	0.064 0.14 0.091 0.036		0.23 0.36 0.27 0.07	0.37 0.52 0.45 0.07
1B	December 1975	1968–1971	4	13.0 56.0 42.0 20.0	0.016 0.043 0.029 0.012	0.003 0.010 0.007 0.003	0.022 0.039 0.032 0.007	0.070 0.14 0.097 0.032	<0.007 0.057 <0.030 0.024	0.040 0.062 0.050 0.010		0.12 0.26 0.18 0.03	0.29 0.58 0.43 0.14
1E	August 1975	1967–1970	10	34.0 64.0 49.0 8.6	0.006 0.033 0.022 0.008	0.005 0.010 0.007 0.002	0.012 0.094 0.049 0.024	0.055 0.14 0.092 0.031	<0.005 0.065 <0.026 0.020	<0.021 0.12 <0.059 0.033		0.09 0.31 0.18 0.02	0.26 0.77 0.45 0.14
4X	1975	-	-	31.0 64.0 42.0 14.0			0.022 0.084 0.049 0.024	0.13 0.90 0.46 0.34	- - 0.16 -	0.01 0.35 0.22 0.13	- 0.087 0.039 0.032	 0.88 	0.42 2.3 1.45 0.91
4W	1975	-	-	52.0 75.0 64.0 8.0			0.022 0.11 0.064 0.023	0.40 0.99 0.62 0.17	0.13 0.53 0.30 0.11	0.32 0.76 0.54 0.13		 1.46 	1.35 2.70 2.05 0.47

Table 4A continued

Source	Date of collection	Year class or size	Number in sample	% fat	α HCH min max MEAN s.d.	γ HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCB min max MEAN s.d.
4T	June 1975	1969	7	23.0			0.015	0.50	0.23	0.33			2.4
				43.0			0.077	1.4	0.63	0.83			5.9
				36.0			0.046	0.94	0.40	0.59		1.93	4.1
				7.7			0.079	0.38	0.15	0.21			1.4
4T	1975	-	-	49.0			0.038	0.16	0.27	0.27			1.2
				68.0			0.150	1.07	0.44	1.02			5.2
				63.0			0.073	0.70	0.36	0.59		1.65	2.9
				6.0			0.034	0.35	0.07	0.27			1.2
4Vn	1975	-	-	44.0			0.034	0.33	0.12	0.25			1.2
				78.0				0.78	0.53	0.65			2.5
				66.0			0.064	0.57	0.06	0.44		1.07	1.9
				11.0			0.021	0.20	0.14	0.15			0.4

Table 4B Plaice (<u>Pleuronectes platessa</u>) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					α HCH min max MEAN s.d.	γ HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCB min max MEAN s.d.
IVc	September 1975	1971	1	2.88		0.009	0.014	0.043	0.018	0.096		0.157	0.405
Vb	May-June 1975	1966	8	4.0 17.0 9.1 4.4		N.D. 0.005 - -	0.002 0.015 0.007 0.000	0.004 0.061 0.019 0.017	0.002 0.021 0.008 0.000	<0.001 0.016 <0.006 0.000		0.007 0.098 0.033 0.011	0.06 0.43 0.16 0.12

Table 4C Hake (<u>Merluccius merluccius</u>) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	HCH α min max MEAN s.d.	HCH γ min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCB min max MEAN s.d.
					Concentration (in mg/kg, wet weight)								
VIII	October 1975	44-49 cm	10	40.0 69.0 52.0 8.5	0.04 0.28 0.10 0.01	0.002 0.012 0.006 0.003	0.013 0.082 0.033 0.020	0.15 0.69 0.32 0.18	0.04 0.82 0.23 0.08	0.21 1.2 0.59 0.33		0.45 1.88 1.16 0.16	1.9 13.0 5.5 3.8
VIII	1974-1975	-	9	41.5 54.0 47.9 2.7	0.02 0.10 0.05 <0.01	0.01 0.03 0.02 <0.01	0.04 0.11 0.08 <0.01	0.10 1.1 0.36 0.11	0.07 0.36 0.14 0.05	0.10 0.92 0.28 0.38		0.29 2.4 0.78 0.22	3.9 13.6 7.0 1.4
IX	July 1975	40-43 cm	10	14.0 78.3 53.8 24.5			0.017 0.056 0.032 0.012	0.20 0.46 0.30 0.09	0.06 0.26 0.16 0.07	0.11 0.60 0.29 0.18		0.51 1.17 0.76 0.08	0.99 2.3 1.5 0.52
IX	October 1975	40-79 cm	11	44.0 71.0 61.0 7.9	0.005 0.011 0.009 0.002	0.005 0.010 0.007 0.002	0.029 0.065 0.043 0.011	0.17 0.29 0.23 0.04	0.042 0.120 0.074 0.024	0.21 0.65 0.37 0.015		0.44 0.95 0.68 0.05	0.9 1.9 1.3 0.33

Table 4D Sole (<u>Solea solea</u>) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					α HCH min max MEAN s.d.	γ HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCB min max MEAN s.d.
IX	August 1975	31-34 cm	10	(6.7 (6.9			0.002 0.004	0.038 0.058	0.023 0.032	0.017 0.033		0.078 0.123	0.61 0.75

Table 4E Pilchard (<u>Sardinia pilchardus</u>) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					α HCH min max MEAN s.d.	γ HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCB min max MEAN s.d.
IX	July 1975	20-21 cm	10	(16.0 (14.0				0.020 0.017				0.020 0.017	0.033 0.032

Table 4F Greenland Halibut (<u>Reinhardtius hippoglassoides</u>) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					α HCH min max MEAN s.d.	γ HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCB min max MEAN s.d.
1B	August 1975	50-57 cm	4	20.0 26.0 22.0 3.0	0.006 0.014 0.010 0.003	0.003 0.008 0.006 0.003	0.010 0.014 0.012 0.002	0.008 0.014 0.010 0.003	<0.002 <0.008 <0.004 0.003	<0.004 0.009 <0.007 0.002		0.018 0.026 0.021 <0.001	0.040 0.060 0.050 0.008
1C	August 1975	49-74 cm	7	16.0 32.0 24.0 6.1	0.007 0.012 0.010 0.002	0.003 0.005 0.004 0.001	0.004 0.021 0.014 0.006	0.012 0.066 0.022 0.020	0.003 0.034 0.012 0.011	0.010 0.027 0.016 0.006		0.029 0.127 0.051 0.013	0.040 0.31 0.091 0.098
1D	August 1975	47-69 cm	4	16.0 31.0 22.0 6.8	0.002 0.022 0.009 0.009	0.004 0.008 0.005 0.002	0.009 0.026 0.015 0.008	0.013 0.027 0.020 0.007	0.002 0.007 0.004 0.002	0.013 0.042 0.025 0.013		0.031 0.069 0.051 0.009	0.060 0.11 0.083 0.026
1E	August 1975	51-65 cm	10	11.0 25.0 18.0 4.2	0.003 0.012 0.007 0.003	0.001 0.004 0.002 0.001	0.006 0.017 0.010 0.003	0.003 0.015 0.007 0.004	0.002 0.011 0.006 0.003	0.010 0.034 0.019 0.009		0.016 0.041 0.031 0.005	0.030 0.10 0.046 0.022

Table 4G Scabbard (*Aphanopus carbo*) Liver

Source	Date of collection	Year class or size	Number in sample	% fat	Concentration (in mg/kg, wet weight)								
					αHCH min max MEAN s.d.	γHCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	ppDDE min max MEAN s.d.	ppTDE min max MEAN s.d.	ppDDT min max MEAN s.d.	opDDT min max MEAN s.d.	ΣDDT min max MEAN s.d.	PCB min max MEAN s.d.
X	October 1975	80–115 cm	10	0.8	0.001	<0.001	0.002	0.015	0.004	0.007		0.026	0.08
Madeira	April 1975	100–115 cm	15	3.92 39.40 12.68 10.13				0.036 0.220 0.104 0.060	0.021 0.187 0.052 0.046	0.040 0.300 0.125 0.086		0.100 0.612 0.281 0.172	0.067 0.670 0.220 0.174
Madeira	September 1975	82–100 cm	10	3.62 18.22 7.62 3.92				0.070 0.147 0.111 0.029	0.031 0.106 0.061 0.020	0.045 0.172 0.138 0.042		0.120 0.380 0.314 0.069	0.167 0.416 0.311 0.084

ANNEX 7

Report on MAFF-UK Trace Metal Baseline Studies in the North Atlantic

by

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This report lists data from trace metal surveys at present being conducted by the MAFF Lowestoft Fisheries Laboratory for consideration by the ACMP as a submission to the Oslo Commission.

The recent review of the distribution of trace metals in the North Atlantic (ICES Coop.Res.Rep. No.50) showed large sea areas not yet surveyed, particularly in respect of metals other than mercury. Therefore, during 1975 the Lowestoft Fisheries Laboratory surveyed the distribution of selected metals in the NEAFC/Oslo Comm. area from as many localities as possible. Unfiltered water samples were taken between Spitzbergen and the Azores and between the Canadian coast and the European continental shelf. The opportunity was taken to sample during several fishing research cruises. In addition, a specific oceanographic survey was made in the southern part of the region, during which metals were sampled in detailed vertical profiles. A joint investigation of the shelf water off the Portuguese coast was made with Portuguese fishing scientists. In addition, a survey will be conducted during October 1976 in which detailed vertical profiles of metals will be made at stations in the northern part of the NEAFC/Oslo Commission area, thus complementing the detailed survey in the southern region made during the previous year. Figure 1 shows the area surveyed and the provisional track of the 1976 investigation.

The metals being analysed are copper, nickel, zinc and cadmium on all samples and mercury at selected locations. Water samples were collected by means of Niskin bottles. Mercury was analysed by a cold vapour technique employing a Coleman MAS 50 instrument. Some inorganic mercury was determined at sea on fresh samples using a liquid nitrogen trap. In addition, both total and inorganic values were measured ashore on acidified deep frozen samples employing a gold wire trap. The remaining samples were stored deep frozen prior to analysis by atomic absorption spectroscopy after an MIBK/APDC extraction. Zinc was measured in an air/acetylene flame (Perkin Elmer 305 instrument) and copper, nickel and cadmium were measured in an HGA 74 graphite furnace.

Chemical analysis of the samples is still proceeding but the set of detailed vertical profiles made in the southern North Atlantic is now complete. Figure 2 shows the position of stations on this part of the survey and Table 1 lists the range and mean values at each station for copper, nickel, zinc and cadmium. Values for cadmium have been omitted from stations 2 and 4 since contamination is suspected. Also included for comparison is the range of values measured in the North Sea based on material presented in the ICES Cooperative Research Report No.39, 1974. Table 2 shows the results of mercury analyses, which were made on selected samples only.

The mean values depicted in Table 1 are presented only to give an approximate guide to the average levels encountered, since clearly the range of depths measured on different stations and hence the water masses sampled will vary between the locations. The range of values measured for each metal often spans an order of magnitude. However, the general level of metal encountered was near the detection for sampling and analysis and this is considered to be the most likely cause for the relatively wide scatter. The low offshore level of the North Sea range of values generally approximated to the upper end of the North Atlantic range. However, the values reported in the enriched near bottom water on some North Atlantic stations exceeded the offshore North Sea levels and, in the case of zinc, approached the higher near shore upper end of the scale.

Some duplicate samples were collected on station 84 and filtered through 0.22µ millipore membranes. Their Cu, Ni, Zn and Cd did not show a significant difference to the unfiltered samples.

The mercury values depicted in Table 2 showed a similar, fairly wide range of levels. The "total" values, however, were usually higher than the inorganic contents of the samples. It was considered that the techniques using the liquid nitrogen trap was somewhat less precise than the gold wire method.

In spite of the relatively wide range of metal values recorded during this survey, the mean levels reported were lower than many published data for the area (ICES Coop.Res.Rep. No.50) but were comparable to values from the most recently conducted investigations. It is hoped that by the end of the year the analysis will be complete, including the proposed survey of October 1976. A more detailed statistical analysis of the data will then be possible including a comparative study of the different water masses present.

<u>Table 1</u>. The range of copper, nickel, zinc and cadmium in unfiltered water samples collected during Cirolana cruise 9/75 (September-October 1975).

Station	Metres		No samples	Cu µg/l		Ni µg/l		Zn µg/l		Cd µg/l	
	Bottom	Sample depth range		Range	Mean	Range	Mean	Range	Mean	Range	Mean
2	2350	0-2212	15	0.05-0.14	0.10	0.11-0.33	0.23	0.5-2.6	1.2		
4	3260	0-2742	19	0.05-0.20	0.09	0.06-0.30	0.21	0.6-3.0	1.3		
5	3210	0-3165	26	0.08-0.25	0.14	0.12-0.35	0.23	0.4-3.2	1.6	0.02-0.18	0.07
6	880	0-841	15	0.04-0.58	0.17	0.10-0.25	0.15	0.4-3.9	1.8	0.01-0.07	0.03
7	2040	0-1974	20	0.03-0.35*	0.11	0.07-0.40*	0.19	0.5-5.0*	1.7	0.01-0.08	0.04
8	2560	0-2487	21	0.05-0.49*	0.14	0.08-0.34*	0.20	0.4-3.5*	1.5	0.01-0.10*	0.04
10	420	0-391	9	0.06-0.21	0.11	0.08-0.18	0.16	0.5-3.1	2.0	0.01-0.04	0.02
11	4630	0-4503	25	0.04-0.56*	0.12	0.15-0.97*	0.27	0.7-9.9*	1.9	0.01-0.16*	0.05
12	1720	0-1584	16	0.03-0.46*	0.09	0.10-0.82*	0.22	0.2-6.8*	1.3	0.00-0.13*	0.04
13	4810	0-4645	27	0.05-0.51*	0.16	0.10-0.42*	0.26	0.4-9.3*	2.0	0.01-0.09	0.03
14	1992	0-1899	20	0.07-0.12	0.08	0.16-0.36	0.28	0.6-1.9	0.9	0.00-0.06	0.03
15	850	0-819	12	0.03-0.10	0.07	0.20-0.74	0.34	0.5-2.1	0.8	0.00-0.04	0.01
16	542	0-501	8	0.01-0.12	0.07	0.05-0.25	0.15	0.4-2.6	0.9	0.00-0.01	0.01
84	4650	0-4397	28	0.01-0.15	0.06	0.08-0.36	0.21	0.5-5.3	1.8	0.00-0.06	0.03
North Sea		Surface		0.04-2.0		<0.4-4.0		2.0-10		0.05-0.4	

*Bottom sample showed "high" value.

Table 2. The inorganic and total mercury content of unfiltered water samples collected during Cirolana cruise 9/75 (September-October 1975).

Station	Depth	ng Hg/l	
		Inorganic	Total
4	0	8*	
	3131	4*	
5	0	8*	
	3165	2*	
6	0	6*	
	841	1*	
7	0	3*	
	1974	7*	
8	0	5	8.3
	1122	2.5	6.5
	2341	3.0	6.0
	2349	3.5	6.3
	2487	3.3	8.0
10	0	2*	
	391	2*	
11	0	3*	
	4503	7*	
12	0	6*	
	1584	7*	
13	0	6.5	8.0
	4645	11*	
16	0	8.5	11.5
	100	11	12.5
	253	6	6

*Analysis using liquid nitrogen trap.

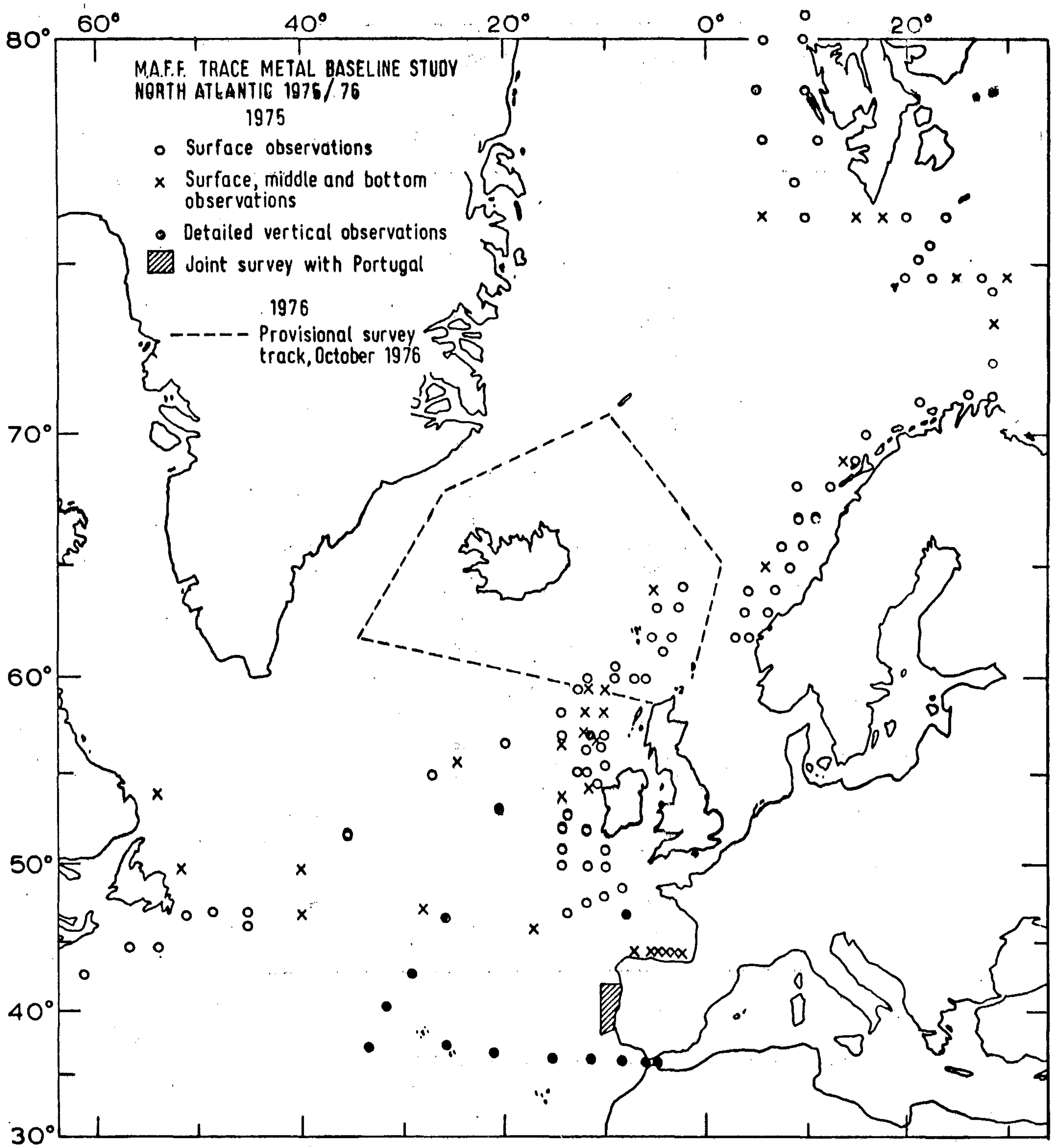
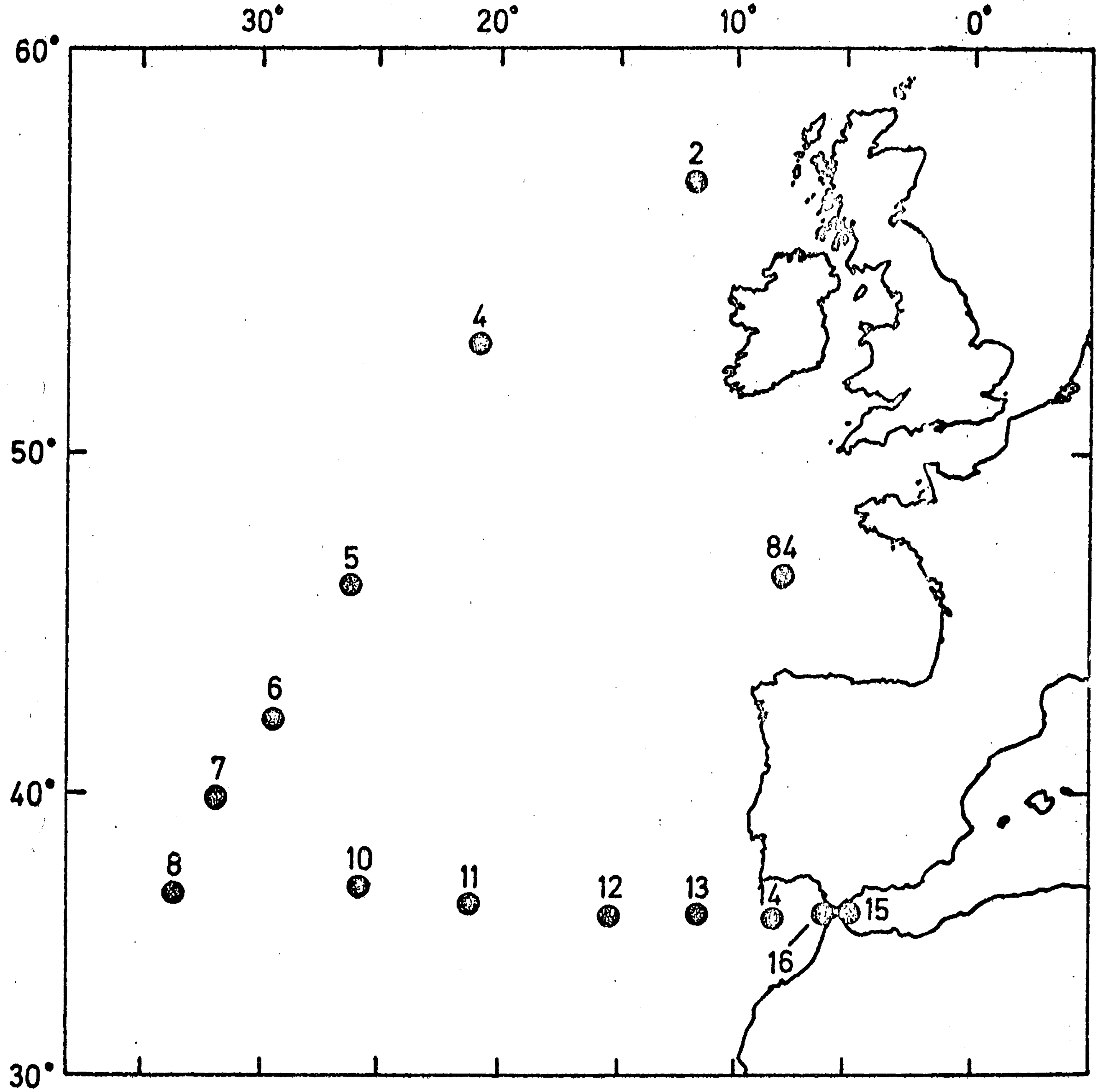

M.A.F.F. TRACE METAL BASELINE STUDY
NORTH ATLANTIC 1975/76
1975
Surface observations
Surface, middle and bottom observations
Detailed vertical observations
Joint survey with Portugal
1976
Provisional survey track, October 1976
60°
40°
20°
0°
20°
80°
70°
60°
50°
40°
30°

FIGURE 1



Trace metal station positions Cirolana cruise 9/75 (September - October 1975)

FIGURE 2