COOPERATIVE RESEARCH REPORT

No. 126

THE ICES COORDINATED MONITORING PROGRAMME FOR CONTAMINANTS IN FISH AND SHELLFISH, 1978 and 1979

and

SIX-YEAR REVIEW OF ICES COORDINATED MONITORING PROGRAMME

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THE ICES COORDINATED MONITORING PROGRAMME, 1978

INTRODUCTION

This report presents the results of the fifth year of the Coordinated Monitoring Programme. Under this programme, member countries of ICES submit the results of their analyses for certain selected contaminants in samples of fish and shellfish which are collected annually from a number of specified areas.

The programme began in 1974 as a follow-up to the 1972 baseline survey of the concentrations of contaminants in fish and shellfish of the North Sea (results in Coop. Res. Rep., No. 39 (1974)), which showed that certain areas, particularly the coastal areas around the North Sea and the Southern and German Bights, were significantly more contaminated than elsewhere in the North Sea. It was agreed that the results of national monitoring studies conducted in the identified areas should be submitted to ICES for inclusion in an annual report. In 1974 and 1975, only the above-mentioned areas were covered by the programme. However, in 1976 the geographical range was extended following the 1975 baseline survey of contaminant levels in fish and shellfish of the North Atlantic. The areas studied included the North Sea, the Irish Sea, certain coastal areas in the Northeast Atlantic, and several areas in the Northwest Atlantic off the coasts of Iceland, Greenland and Canada. Later, areas were included off the coast of Portugal and the northeast coast of the USA. The results are published in Coop. Res. Rep. Nos. 69 (1977) and 95 (1980).

On the basis of the results of the baseline survey, the following areas were identified as being contaminated to such an extent as to require monitoring: the Irish Sea, the German Bight and Southern Bight of the North Sea; the estuaries of the Thames, Forth, Rhine, Schelde, and Clyde; and certain parts of the Gulf of St. Lawrence and the New York Bight. Additionally, it was agreed that because there was very little information about the Skagerrak, Kattegat and Oslofjord, and the area off Portugal, further results should be obtained for these areas.

Initially, only data on species of fish and shellfish sampled in the baseline study were to be included in the monitoring programme. This requirement may, however, be waived to permit inclusion of information on other species maintained in national or other international programmes. Regardless of species, particular procedures for the preparation of samples prior to analysis and for the reporting of results should be used. These procedures are developed and expanded from time to time. Those which applied to the 1978 programme are reported in Annex II of Coop. Res. Rep., No. 84 (1979).

The quality of data submitted under this programme is controlled by periodic intercalibration exercises on the analyses of heavy metals and organochlorine residues in biological materials. Only results, the validity of which can be verified by the performance of that laboratory in a recent intercalibration exercise, are included in a coordinated monitoring report. The results of the intercalibrations applicable to the data in this report can be found in Coop. Res. Rep., No. 80 (1978).

Reports of the results for the previous years of this programme have been published as follows: 1974 - Coop. Res. Rep., No. 58 (1977); 1975 and 1976 - Coop. Res. Rep., No. 72 (1977); 1977 - Coop. Res. Rep., No. 98 (1980).

RESULTS

For 1978, data were received from Belgium, Canada, England/Wales, France, the Federal Republic of Germany, Ireland, the Netherlands, Norway, Portugal and the United States. Many of the data were for cod (Gadus morhua), but results were also received for plaice (Pleuronectes platessa), flounder (Platichthys flesus), winter flounder (Pseudopleuronectes americanus), whiting (Merlangius merlangus), blue whiting (Micromesistius poutassou), hake (Merluccius merluccius), haddock (Melanogrammus aeglefinus), silver hake (Merluccius bilinearis), herring (Clupea harengus), pilchard (Sardina pilchardus), mackerel (Scomber scombrus), ocean pout (Macrozoarces americanus), cunner (Tautogolabrus adspersus), redfish (Sebastes marinus), and yellowtail flounder (Limanda ferruginea). Some data were also submitted on mussels (Mytilus edulis) and shrimp (Crangon crangon). The locations of sampling areas are shown in Figures 1-4. It should be noted that the data for the Norwegian Sea areas are included for comparison only, as these areas are not part of the regular coordinated monitoring programme.

The four species reported on by the United States, ocean pout, cunner, winter flounder and silver hake, are groundfish characteristic of the New York Bight and adjacent areas. All these species feed on organisms which live either in sediments or on solid surfaces such as rocks. Mussels are one of the principal food items of the cunner.

METALS IN FISH

The data submitted from the analyses of heavy metal concentrations in fish muscle are shown in Table 1a (pp. 7-12), and the results from similar analyses of fish livers are given in Table 1b (pp. 13-16). The following discussion relates to mean levels unless otherwise indicated.

Concentrations of mercury in cod muscle fell in the range 0.03 - 0.26 mg/kg wet weight. This is similar to the ranges reported in previous years, e.g., 0.02 - 0.33 mg/kg in 1977. The highest average concentration was found in a sample of cod taken from the Southern Bight of the North Sea. The highest individual concentration for a fish in this sample was 0.71 mg/kg. Overall, the highest mercury concentration reported for an individual cod was 0.96 mg/kg in a fish from the north coast of Norway.

Plaice muscle contained concentrations of mercury similar to those found in cod (range 0.05 - 0.30 mg/kg). There was, however, a considerable difference in the concentrations reported in plaice from different areas. Mercury levels in plaice from the Irish Sea were higher (0.25 - 0.30 mg/kg, maximum individual 0.65 mg/kg) than those in plaice from the Southern Bight of the North Sea (0.05 - 0.11 mg/kg).

As was apparent in the results obtained in 1977, the concentrations of mercury in flounder muscle were somewhat higher than those found in cod or plaice muscle. Levels reported ranged from 0.26 - 0.34 mg/kg in the three samples studied.

With one exception, the mercury concentrations in the other species of fish studied (haddock, herring, mackerel, redfish, whiting and yellowtail) were less than 0.1 mg/kg. The exception was a sample of redfish from the Gulf of St. Lawrence, which contained 0.18 mg/kg of mercury.

For all species of fish, the concentrations of mercury in liver were generally lower than those in muscle tissue. However, in contrast to the previous three years when mercury concentrations between 0.02 and 0.12 mg/kg had been reported for cod and plaice liver, a wider range was found in 1978. For cod, the overall range was 0.02 - 0.3 mg/kg. Marked regional differences were found, with cod from the Gulf of St. Lawrence containing between 0.02 and 0.04 mg/kg of mercury, whereas cod from the Irish Sea and North Sea contained between 0.1 and 0.3 mg/kg of mercury in their livers. Mercury concentrations in plaice liver ranged from 0.07 to 0.26 mg/kg. The amounts in flounder liver were similar to those in plaice liver.

The cadmium and lead data for fish muscle and liver tissues must be evaluated carefully because only a few laboratories are using analytical methods which are sufficiently accurate and sensitive to allow them to obtain true values for these metals (see intercalibration results in Coop. Res. Rep., No. 80 (1978)). For cadmium, only the data from laboratories using methods with a detection limit at the 0.00X mg/kg level are included. These results showed that the concentrations in the muscle of cod from the Gulf of St. Lawrence ranged from 0.004 - 0.008 mg/kg; in the livers of these samples, cadmium concentrations of 0.05 - 0.26 mg/kg were reported. Similar concentrations were found in the muscle of several other species of fish, e.g., haddock (0.003 mg/kg), whiting (0.009 mg/kg) and herring (0.003 - 0.013 mg/kg) from the Gulf of St. Lawrence and/or the Irish Sea.

For lead analyses, a detection limit at the 0.0X mg/kg level is needed as well as special handling to avoid contamination of the samples. Only data from laboratories which can meet this requirement are included in this report. These indicate that the concentrations of lead in plaice and herring from the Irish Sea are around 0.04 mg/kg in muscle tissue. Samples of whiting from the Irish Sea and the Southern Bight of the North Sea contained concentrations of lead in muscle of 0.05 - 0.09 mg/kg.

The data on copper concentrations in fish muscle and liver tissues are generally similar to those reported in previous years. For most species of fish studied, copper concentrations in muscle were below 1 mg/kg with only very slight apparent differences between regions. However, some of the results appeared to show higher concentrations of copper in certain fish from the Gulf of St. Lawrence than in samples of the same species taken from several areas in the Northeast Atlantic. For cod muscle, copper levels in samples from the Southern Bight of the North Sea and the Irish Sea ranged from 0.14 - 0.6 mg/kg, whereas concentrations of between 0.39 and 1.55 mg/kg were reported for cod from the Gulf of St. Lawrence. Copper concentrations in herring muscle were somewhat higher than those found in the other species of fish studied and again appeared to show a difference between regions. Herring from the Irish Sea contained 0.36 - 1.55 mg Cu/kg muscle, while herring from several areas near the Canadian coast was reported to contain 1.8 - 3.0 mg/kg of copper.

As has been pointed out in previous years, concentrations of copper in liver were generally about one order of magnitude higher than those in muscle. The concentrations in all species studied were below 10 mg/kg, with the exception of one sample of flounder from the Irish Sea which contained 14 mg/kg of copper in liver tissue. The results from 1977 also indicated slightly higher concentrations of copper in livers of flounder from the Irish Sea. The apparent regional differences in copper concentrations in muscle tissue were less obvious in liver tissue.

As has been reported in previous years, concentrations of zinc in the muscle tissue of most fish species studied are generally below 10 mg/kg with flounder and herring containing somewhat higher concentrations than other species. The data presented here show concentrations of zinc in cod and plaice muscle between 2.8 and 9.0 mg/kg and in whiting muscle from 1.6 - 3.9 mg/kg. Of the three samples of flounder studied, two contained less than 10 mg/kg zinc, whereas one sample from the Southern Bight of the North Sea was reported to contain a mean zinc concentration of 21.3 mg/kg.

The concentration of zinc in fish liver tissue is generally higher than that in muscle tissue, usually in the tens of mg/kg. In the data presented here, the lowest concentrations were reported in the fish obtained from the New York Bight. Livers of flounder, ocean pout and cunner all contained less than 10 mg/kg zinc and those of silver hake were only slightly higher at 14 mg/kg. One sample of whiting from the Irish Sea also contained less than 10 mg/kg. Concentrations of zinc in cod liver (15 - 31 mg/kg) were similar to those reported in previous years, while the highest concentrations of zinc in plaice liver (range: 26 - 43 mg/kg) were slightly lower than those in 1977 (range: 23-70 mg/kg).

The concentration of arsenic was measured in several samples of cod and herring and in one sample each of several different species from the Gulf of St. Lawrence. Concentrations of arsenic in the muscle of cod from the Barents Sea ranged from 13 - 34 mg/kg, whereas cod from the Gulf of St. Lawrence were within the range 1.7 - 2.0 mg/kg. The corresponding concentrations in the livers of the cod from the Gulf of St. Lawrence were similar to those in muscle. Of the other species studied, all taken from Canadian coastal waters, arsenic concentrations were below 1 mg/kg in herring, mackerel, and redfish, and somewhat higher in plaice (1.9 mg/kg), haddock (3.8 mg/kg) and yellowtail flounder (4.0 mg/kg).

METALS IN SHELLFISH

The results reported for metals in shellfish are shown in Table 1c (pp. 17-18). These include results for seventeen samples of mussels from around the coast of England and Wales, as well as one sample from Raritan Bay, New Jersey (USA). The samples from England and Wales were taken in connection with a mussel watch study and were not collected from areas of commercial exploitation. In the whole soft bodies of mussels, mercury concentrations were mainly in the range 0.04 to 0.07 mg/kg wet weight, which is similar to that found in previous years (e.g., 0.02 - 0.09 mg/kg in 1977). The concentrations of mercury in two samples were higher than this: mussels from the Mersey Estuary near Liverpool contained 0.12 mg/kg and those from the Crouch Estuary contained 0.30 mg/kg. Concentrations of cadmium in mussels ranged from 0.2 - 2.0 mg/kg wet weight. This is a somewhat higher range than reported in previous years, for example, ranges of 0.2 - 1.4 mg/kg in 1977 and 0.09 - 0.44 mg/kg in 1975. Lead concentrations were reported between 0.7 and 4.3 mg/kg wet weight, with the highest concentration found in the sample from the Mersey Estuary. This range is also somewhat higher than reported in previous years (e.g., 0.2 - 1.2 mg/kg in 1977).

Results were reported for 16 samples of Crangon crangon from the Southern Bight of the North Sea. The concentrations of heavy metals in these samples were within the ranges of the respective metals reported in previous years. Mercury concentrations ranged from 0.06 - 0.19 mg/kg wet weight and cadmium was reported in a concentration range of 0.02 to 0.06 mg/kg. The concentrations of lead were from 0.28 to 0.88 mg/kg. Copper levels in the Crangon samples were reported from 11.7 - 19.3 mg/kg, while zinc concentrations were 25.6 to 82.8 mg/kg.

ORGANOCHLORINE PESTICIDE AND PCB RESIDUES IN FISH

The results reported on analyses of organochlorine residues in fish muscle are given in Table 2a[1] (pp. 19-21) on a wet weight basis and Table 2a[2] (p. 22-23) on a fat weight basis. Results for fish liver are presented in Table 2b[1] (pp. 24-26) on a wet weight basis and in Table 2b[2] (pp. 27-28) on a fat weight basis. It should be noted that in order to save space, only one column is included for HCH. The majority of data relate to α-HCH; where this is not the case, an * indicates that the figures quoted relate to γ-HCH.

The results of analyses of fish muscle for pesticide residues showed that the concentrations of dieldrin found in cod, plaice, and blue whiting were low (maximum reported value, 0.002 mg/kg wet weight). Concentrations of the DDT group residues were also low in cod, plaice, whiting, blue whiting, and hake, with all reported values at or below 0.01 mg/kg wet weight. PCB concentrations in the muscle tissue of these five species were also low, with the maximum value 0.07 mg/kg wet weight. These results are very similar to those reported for cod, plaice, and whiting muscle in 1977.

The low concentrations of organochlorine residues found in the above-mentioned species is almost certainly due to the fact that the muscle tissue of these fish contains less than 1% lipids, and thus exhibits low levels of organochlorines on a wet weight basis. Mackerel, herring and, to a lesser extent, pilchard contain higher percentages of lipids in their muscle tissue, and correspondingly higher levels of organochlorine residues are generally reported in the muscle tissue of these species. The concentration of dieldrin in one sample of herring from the Southern Bight of the North Sea was 0.01 mg/kg wet weight and two samples of mackerel contained 0.01 and 0.03 mg/kg, with the higher concentration found in fish taken from the western English Channel. The concentrations of DDT group residues in the muscle of herring, pilchard and mackerel ranged from 0.008 - 0.026 mg/kg wet weight, with DDE the predominant residue. PCB concentrations differed slightly in the different species. In the one sample of pilchard, the mean concentration was 0.11 mg/kg wet weight. The three samples of mackerel contained an average PCB concentration of 0.22 mg/kg. PCB concentrations in herring muscle were higher, ranging from 0.13 - 0.66 mg/kg, with the highest concentration found in a sample taken off Cap Breton Island, Canada. HCB and γ-HCH residues were measured in herring and mackerel. The levels of HCB were all reported to be at or below 0.01 mg/kg wet weight, while the highest reported concentration of γ-HCH was 0.009 mg/kg.

Due to the higher fat content in liver, organochlorine residues tend to accumulate in fish liver and concentrations are generally one order of magnitude higher than in fish muscle. As shown in Table 2b[1], the maximum level of dieldrin in cod liver reported in 1978 was 0.27 mg/kg wet weight. This is slightly lower than the maximum mean levels reported in previous years (compare with 0.32 mg/kg in 1977 and 0.68 mg/kg in 1976). The concentrations of DDT group residues in cod liver were similar to those reported in 1977. The maximum average concentration for an individual DDT residue was 0.53 mg/kg wet weight, while the maximum average Σ DDT concentration was 1.3 mg/kg. The sample with the highest DDT group concentrations was taken from the central North Sea.

PCB concentrations in cod liver were reported from 0.8 to 15 mg/kg wet weight, with the highest concentrations found in samples from the Southern Bight of the North Sea. As was reported in 1977, Dutch data on samples of cod from the northern, central and southern North Sea show a clear trend of increasing PCB levels from north to south. Although the concentrations reported in 1978 do not appear to be quite so high as those reported in 1977, there is no real evidence that the differences reflect a true decline in concentration with time.

Concentrations of HCB in the livers of cod from the Gulf of St. Lawrence ranged from 0.01 - 0.05 mg/kg wet weight, whereas in those from the North Sea the range was 0.04 - 0.17 mg/kg. Here again, Dutch data showed an increased concentration in samples from the southern North Sea compared with samples taken in the more northern areas. Concentrations of α-HCH in cod liver were reported to lie between 0.02 - 0.10 mg/kg, with no apparent regional differences.

The data in the tables include results for a few samples of herring and hake and one sample of mackerel. In all cases, the concentrations of pesticide residues and PCBs were low in comparison with respective concentrations in cod liver.

One overall observation can be made concerning the relative concentrations of individual residues in the DDT group. Generally, of the three compounds measured, the concentrations of DDE were usually higher than those of p,p'-DDT, which in turn were either slightly higher than or nearly equivalent to those of TDE (=DDD). A similar distribution was also noted in the 1977 results.

ORGANOCHLORINE PESTICIDE AND PCB RESIDUES IN SHELLFISH

Data were supplied by the Federal Republic of Germany on the results of analyses for two samples of mussels (Mytilus edulis) and five samples of Crangon crangon. The data are shown in Table 2c (p. 29), which gives concentrations according to both wet weight and fat weight. The discussion here, however, pertains only to wet weight values.

For both mussels and Crangon , the concentrations of pesticide residues were all below 0.01 mg/kg. The maximum ΣDDT concentration was 0.009 mg/kg, which is considerably lower than the maximum ΣDDT concentration reported in 1977 (0.074 mg/kg in mussels from northern Brittany). The concentrations of PCBs were reported to range from 0.009 - 0.10 mg/kg, a range similar to that generally found in previous years.

SUMMARY

In 1978, data were reported for a wider geographical area than had been covered in previous years. Additionally, the results covered a larger number of species of fish than in previous reports. Although some comparisons have been made with results obtained in previous years of this programme, it must be strongly emphasized that these differences in many cases may be only apparent, since the sampling procedures followed have in the main probably not been rigorous enough to show anything other than gross changes.

Having these difficulties in mind, on the basis of the information reported, no changes are apparent in the concentrations of heavy metals and organochlorine residues in the fish and shellfish from the areas studied compared with levels reported in 1977 and the two previous years. In confirmation of earlier results, DDE levels were again found to exceed those of p,p'-DDT and DDD in fish tissues. PCB concentrations were also considerably higher than concentrations of DDT.

Table 1a. Metals in Fish Muscle

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Cod	I	KO 71	Norway	1978	20	19-40 (30)		3	0.004 0.96 0.112 0.211			0.09 0.79 0.37 0.19	3.3 7.7 4.6 1.1		7.2 47.6 22.8 10.7	0.10 0.30 0.20 0.05
"		"	"		7	39-62 (45)		4	0.018 0.084 0.037 0.022			0.16 0.40 0.25 0.10	3.3 4.6 3.6 0.5		6.3 53.5 26.0 18.8	0.12 0.22 0.17 0.04
"		"	"		16	47-71 (54)		5	0.008 0.218 0.053 0.058			0.02 0.50 0.27 0.12	2.6 5.5 4.3 0.8		7.6 73.1 30.6 19.9	0.16 0.37 0.22 0.05
"	IIa	H4 71	"		7	39-50 (45)		3+4	0.014 0.092 0.060 0.031			0.09 0.48 0.23 0.14	2.8 4.9 3.7 0.6		3.6 27.0 18.0 8.5	0.17 0.26 0.21 0.03
"		"	"		6	50-56 (53)		5	0.022 0.092 0.057 0.025			0.09 0.45 0.20 0.13	2.9 3.4 3.1 0.2		5.0 98.7 33.8 33.6	0.14 0.19 0.17 0.02
"	I	J5 71	"		1	72		6-7	0.044			0.37	3.1		13.2	0.20
"	IIa	G8 71	"		8	63-80 (73)		6-8	0.058 0.16 0.098 0.042			0.09 0.60 0.24 0.20	2.6 3.0 2.8 0.2		0.8 37.4 15.4 12.7	0.11 0.34 0.17 0.07

Table 1a. Metals in Fish Muscle (cont'd)

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Cod	IVc	F1 33	England/ Wales	1978 Aug.	20	42-77 (54)	19M 1F	2	0.03 0.1 0.06 0.02	<0.2 <0.2		<0.2 0.2 0.14 0.11	2.9 5.0 4.0 0.5			
"	VIIa	E6 36	"	Sept.	20	27-46 (37)	9I 7F 4M	1	0.08 0.37 0.19 0.09	<0.2 <0.2	<0.2 <0.2	<0.2 0.6 0.4 0.1	3.5 5.4 4.3 0.5			
"	"	E4 36	Ireland		12	38-54.5 (43.5)	8M 4F	2		0.006 0.126 0.031 0.041		0.17 0.55 0.31 0.13	3.2 5.2 4.4 0.6			
"	IVc	F2 31	Belgium	Dec.	20	26-75 (52)	8M 12F	1-4	0.07 0.71 0.26 0.15	0.01 0.02 0.01 -	0.22 0.45 0.30 0.05	0.21 1.24 0.39 0.23	3.4 47.0 9.0 9.9	<0.10 0.35 0.18 0.08		
"	VIIa	E2 33	France	Nov.	2	35-40 (37)			0.13	0.02	0.8	0.6	4.4			
"		4T	Canada	Sept.	5			1	0.02 0.05 0.04 0.01	0.005 0.008 0.007 0.001	0.15 0.54 0.34 0.14	0.49 0.77 0.63 0.12	4.6 6.4 5.0 0.8		0.91 3.12 1.66 0.88	0.28 0.36 0.32 0.003
"		"	"	"	4			2	0.02 0.04 0.03 0.01	0.004 0.008 0.006 0.002	0.22 0.38 0.27 0.08	0.54 3.53 1.55 1.36	4.4 6.0 4.9 0.8		1.61 1.78 1.70 0.07	0.30 0.32 0.31 0.01

Table 1a. Metals in Fish Muscle (cont'd)

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Cod		4T	Canada	1978 Sept.	8			3	0.02 0.04 0.03 0.01	0.003 0.010 0.006 0.002	0.26 0.51 0.37 0.09	0.27 0.62 0.42 0.13	3.9 4.7 4.3 0.3		1.27 2.60 1.87 0.54	0.25 0.30 0.28 0.02
"		"	"	"	9			3	0.03 0.08 0.04 0.02	0.002 0.013 0.007 0.004	0.09 0.31 0.21 0.08	0.41 1.63 0.65 0.39	3.8 4.6 4.1 0.3		1.36 3.50 1.99 0.68	0.25 0.41 0.35 0.05
"		"	"	"	11			4	0.04 0.08 0.06 0.01	0.002 0.019 0.007 0.005	0.13 0.64 0.37 0.14	0.28 0.89 0.50 0.17	3.7 5.5 4.3 0.5		0.35 3.01 1.82 0.87	0.27 0.38 0.32 0.03
"		"	"	"	14			5	0.06 0.09 0.07 0.01	0.002 0.039 0.008 0.011	0.07 0.68 0.33 0.16	0.25 0.57 0.39 0.10	3.5 6.4 3.9 1.2		0.89 3.27 1.78 0.68	0.25 0.37 0.31 0.03
"		"	"	"	10			6	0.07 0.12 0.09 0.02	0.003 0.008 0.004 0.002	0.07 0.41 0.24 0.14	0.24 0.71 0.42 0.14	3.6 4.6 4.1 0.4		0.56 3.50 1.83 0.99	0.25 0.33 0.30 0.02
Plaice	IVc	F1 33	England/ Wales	Feb.	37	26-49 (33)	22F 11M 4I		0.02 0.37 0.08 0.06	<0.2 <0.2	<0.2 0.3	<0.2 0.6 0.3 0.1	2.6 12. 4.3 1.6			
"	"	F2 34	"	Aug.	20	28-33 (33)	17F 3M	2+3	<0.02 0.10 0.05 0.03	<0.2 <0.2		<0.2 0.3 0.2 -	4.2 7.1 5.5 0.9			

Table 1a. Metals in Fish Muscle (cont'd)

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Plaice	VIIa	E6 36	England/ Wales	1978 Sept.	20	29-52 (35)	19I 1M	2-15 (5)	0.16 0.65 0.30 0.16	<0.2 <0.2	<0.2 0.3 0.2 0.02	<0.2 1.3 0.4 0.3	4.6 7.9 6.2 1.1			
"	"	E4 36	Ireland		12	29-35 (30.5)	7M 5F	3-5		0.004 0.123 0.028 0.034	0.003 0.104 0.037 0.032	0.18 1.66 0.69 0.43	0.9 8.0 4.9 1.9			
"	IVc	F2 31	Belgium	Oct.-Nov.	20	24-37 (28)	13M 7F	1+2 (one 7 yrs)	0.04 0.48 0.11 0.10	<0.01 0.02 0.01	0.15 0.43 0.30 0.08	0.20 0.98 0.38 0.15	5.3 15.7 8.4 2.7	0.14 0.68 0.41 0.12		
"	VIIa	E6 36	"	Feb.	10	26-32 (29.4)	5M 5F	1+2	0.08 0.46 0.25 0.12	<0.01 0.01 0.01	0.19 0.44 0.27 0.08	0.25 0.55 0.35 0.11	5.0 9.8 6.8 1.9	0.10 0.33 0.20 0.09		
"		4T	Canada		10(H)				0.048	0.004	0.28	0.66	3.7		1.86	0.32
Flounder	IVc	FO 32	England/ Wales	Sept.	20	22-28 (25)	2M 11F 1I	3	0.16 0.41 0.26 0.08	<0.2 <0.2		<0.2 0.5 0.26 0.14	2.0 9.5 4.3 1.8			
"	VIIa	E6 36	"	"	14	26.5-35 (30)	6M 8I	3-6	0.14 0.46 0.34 0.95	<0.2 <0.2		<0.2 0.5 0.24 0.09	5.0 10. 7.8 1.6			

Table 1a. Metals in Fish Muscle (cont'd)

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Flounder	IVc	F2 31	Belgium	1978 Nov.	20	25-48 (34.5)	7M 13F	2-7	0.07 0.55 0.30 0.15	0.01 0.01 0.01	0.21 0.57 0.36 0.10	0.24 1.31 0.49 0.29	4.4 88. 21.3 23.2	0.10 0.68 0.27 0.16		
Winter flounder	I	1-6	U.S.A.	Feb.	11	18.8- 30.5 (24.4)				<0.12	<0.7	<0.40	2.4 4.9 3.6 0.6			
Whiting	VIIa	E4 36	Ireland		11	31-34.4 (32.4)	6F 5M	1		0.004 0.019 0.009 0.006		0.15 0.41 0.26 0.09	3.0 4.9 3.9 0.7			
"	IVc	F2 31	France	Oct.	5	18-20 (19)			0.06	0.03	0.05	0.5	1.6			
"	VIIa	E5 33	"	Nov.	4	25-36 (31)			0.05	<0.01	0.09	0.2	2.6			
Herring	"	E4 37	Ireland		19	22.5-26 (24.4)	12M 7F	2		0.002 0.039 0.012 0.010	0.025 0.054 0.040 0.009	0.41 1.30 0.71 0.27	3.4 9.2 5.5 1.8			
"	"	"	"		4	24.5-26	2M 2F	3		0.004 0.007 0.005 0.001	0.041 0.065 0.048 0.012	0.39 1.1 0.83 0.30	3.6 7.7 6.4 2.0			
"	"	"	"		1	27.5	F	4		0.004	0.052	0.36	4.1			
"	"	"	"		1	29	M	7		0.006	0.052	1.55	6.5			

Table 1a. Metals in Fish Muscle (cont'd)

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
				1978												
Herring		4Vn	Canada		10(H)				0.071	0.013	0.54	1.79	6.6		0.61	0.34
"		5Y	"		10(H)				0.035	0.012	0.26	2.03	7.0		0.90	0.32
"		4T	"		10(H)				0.030	0.003	0.55	3.01			0.87	0.37
Mackerel		"	"		10(H)				0.048	0.008	0.32	3.17	7.0		0.88	0.40
Haddock		"	"		10(H)				0.028	0.003	0.13	0.23	6.1		3.80	0.28
Redfish		"	"		10(H)				0.180	0.007	0.13	0.71	3.2		0.94	0.34
Yellowtail		"	"		10(H)				0.051	0.012	0.15	1.0	5.9		4.0	0.32
Ocean Pout	I	1-6	U.S.A.	Feb.	10	23.3-32 (27.8)				<0.06 –	<0.6 0.9	<0.5 1.8	2.6 12.2 6.3 2.6			
Cunner	I	1-6	"	"	10	16.4-20 (18.4)				<0.1 –	<0.7 –	<0.5 –	2.2 3.3 2.8 0.4			
Silver Hake	I	1-6	"	"	10	27.5-35 (32.5)				<0.1 0.5	<0.7 –	<0.5 0.5	2.2 3.2 2.5 0.3			

H = analysed as an homogenate

Table 1b. Metals in Fish Liver

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Cod	IVc	F1 33	England/ Wales	1978 Aug.	20	42-77 (54)	19M 1F	2	<0.2 0.7 0.3 1.1	<0.2 <0.2	<0.2 1.2 0.7 0.3	1.6 11. 6.6 2.1	9. 52. 24.9 8.6			
"	VIIa	E6 36	"	Sept.	17	27-46 (37)	9I 7F 4M	1	<0.01 0.20 0.10 0.05	<0.2 <0.2	<0.2 0.6 0.25 0.1	3.0 17. 6.5 3.8	1.8 28. 18.1 7.2			
"	"	E4 36	Ireland		12	38-54.5 (43.5)	8M 4F	2		0.024 0.164 0.065 0.047	0.11 0.63 0.37 0.18	1.46 7.33 4.13 2.06	2.4 34.0 17.2 8.2			
"	IVc	F2 31	Belgium	Dec.	20	26-75 (52)	8M 12F	1-4	0.02 0.33 0.12 0.07							
"		4T	Canada	Sept.	5			1	0.03 0.05 0.04 0.01	0.01 0.18 0.05 0.07	0.40 0.87 0.66 0.18	3.4 12.8 8.0 3.4	24.8 39.9 30.8 5.9		2.72 4.65 3.88 0.75	1.68 2.22 1.92 0.21
"		"	"	"	4			2	<0.01 0.04 0.02 0.01	0.03 0.27 0.15 0.13	0.05 0.62 0.28 0.28	3.9 8.0 5.6 1.8	15.6 29.8 22.7 6.0		2.09 3.09 2.55 0.41	1.05 1.86 1.45 0.33
"		"	"	"	8			3	<0.01 0.04 0.02 0.01	0.03 0.29 0.17 0.11	0.03 0.34 0.09 0.10	3.9 6.1 5.1 0.8	14.8 25.0 19.1 3.8		1.24 2.43 1.83 0.41	0.99 1.52 1.23 0.18

Table 1b. Metals in Fish Liver (cont'd)

									Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Cod		4T	Canada	1978 Sept.	9			3	0.01 0.02 0.02 0.003	0.082 0.557 0.264 0.158	0.01 0.21 0.07 0.07	2.4 8.6 5.7 1.8	10.2 19.5 16.0 3.1		0.99 2.54 1.58 0.54	0.60 1.53 1.07 0.26
"		"	"	"	11			4	0.02 0.06 0.03 0.01	0.06 0.27 0.15 0.07	0.02 0.35 0.13 0.10	1.4 18.9 6.0 4.7	11.2 24.4 15.4 3.9		1.39 3.17 1.82 0.59	0.77 1.80 1.08 0.29
"		"	"	"	14			5	0.01 0.06 0.03 0.01	0.07 0.29 0.15 0.08	<0.001 0.91 0.20 0.24	1.7 8.2 4.7 1.3	11.3 27.0 16.0 4.5		1.03 3.35 1.85 0.69	0.80 1.40 1.05 0.18
"		"	"	"	10			6	0.01 0.10 0.04 0.03	0.06 0.31 0.18 0.09	0.09 0.71 0.24 0.20	1.6 13.8 5.8 3.8	7.9 24.0 15.6 5.3		1.18 4.47 2.08 0.96	0.50 2.02 1.16 0.47
Plaice	IVc	F1 33	England/ Wales	Feb.	37(H)	26-49 (33)	11M 22F 4I		0.15	0.3	0.3	6.5	30.			
"	"	F2 34	"	Aug.	20	28-38 (33)	17F 3M	2+3	0.03 0.12 0.07 0.02	<0.2 <0.2	1.7 3.5 2.5 0.5	1.4 4.2 2.6 0.8	21 34 25.8 3.0			
"	VIIa	E6 36	"	Sept.	20	29-52 (35)	19I 1M	2-15 (5)	0.15 0.55 0.26 0.15	<0.2 <0.2	0.3 0.8 0.6 0.2	1.6 10. 5.1 2.9	32 69 43 16			

Table 1b. Metals in Fish Liver (cont'd)

Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Concentration (mg/kg wet weight)							
									Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
				1978												
Plaice	VIIa	E4 36	Ireland		12	29-35 (30.5)	7M 5F	3-5		0.051 0.316 0.118 0.072	0.02 1.52 0.65 0.58	1.18 2.68 2.10 0.47	2.0 58.2 28.3 15.6			
"	IVc	F2 31	Belgium	Oct.-Nov.	20	24-37 (28)	13M 7F	1+2 (one 7)	0.02 0.38 0.08 0.08							
Flounder	VIIa	E6 36	England/ Wales	Sept.	3 samples	26.5-35 (30)	6M 8I	3-6	0.19 0.25 0.22 0.03	<0.2 <0.2	0.4 0.8 0.56 0.21	12 16 14 2.0	32 36.6 41 4.5			
"	IVb	F8 36	Fed.Rep. of Germany	Oct.	55	9.8-35.7 (21.8)		2-3.5		0.027 0.57 0.23 0.14			8.7 67.3 37.5 12.3			
"	IVc	F2 31	Belgium	Nov.	20	25-48 (34.5)	7M 13F	2-7	0.02 0.30 0.13 0.08							
Winter flounder	I	1-6	U.S.A.		4	20.3-28.9 (24.6)				<0.1	<0.6	0.88 4.13 2.59 1.34	3.2 10.1 7.3 2.9	<0.4		
Whiting	VIIa	E4 36	Ireland		11	31-34.4 (32.4)	5M 6F	1		0.007 0.068 0.029 0.019	0.08 0.39 0.19 0.09	0.007 0.068 0.029 0.019	1.3 11.7 8.3 2.9			

Table 1b. Metals in Fish Liver (cont'd)

Species	Area	Source	Country	Date of Collection	Number analysed	Size (cm) (mean)	Sex	Age (yrs)	Concentration (mg/kg wet weight) Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Se min max MEAN s.d.
Ocean Pout	I	1-6	U.S.A.	1978 Feb.	4	23.3-29.3 (26.5)				<0.1	<0.8	0.60 1.53 1.09 0.40	2.0 7.5 4.9 2.4	<0.5		
Cunner	I	1-6	U.S.A.	Feb.	4	16.9-20 (19)				<0.1	<0.6	0.94 1.37 1.20 0.16	3.8 7.8 5.1 1.8	<0.4		
Silver Hake	I	1-6	U.S.A.	Feb.	6	27.5-34.8 (32.2)				<0.14 0.27 0.19 0.05	<0.5	3.82 6.39 4.69 0.95	11.2 17.1 14.8 2.2	<0.3		

Table 1c. Metals in Shellfish

								Concentration (mg/kg)									
								Mercury		Cadmium		Lead		Copper		Zinc	
Species	Area	Source	Country	Location	Date of Collect.	Number analysed	Size Range (mm)	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
					1978												
Mussels*	IVc	F1 33	England/ Wales	Blythburgh	Aug.	52(H)	33-67	0.06	0.2	0.3	1.4	1.1	5.1	1.5	6.9	17	79
	"	"		Walton on the Naze	"	56(H)	39-54	0.07	0.33	0.3	1.4	1.1	5.2	1.0	4.8	17	81
	"	F0 32		West Mersea	"	51(H)	34-45	0.06	0.33	0.5	2.7	1.3	7.1	1.5	8.2	18	99
	"	"		River Crouch	"	50(H)	18-35	0.30	1.6	0.5	2.7	0.7	3.8	2.0	11.	29	160
	"	"		Southend	"	50(H)	35-50	0.07	0.40	0.7	4.0	1.5	8.2	2.5	14.	36	200
	"	F1 31		Whitstable	"	82(H)	29-47	0.06	0.32	1.0	5.5	0.9	4.9	1.6	8.8	25	140
	"	"		Deal	"	41(H)	18 30	0.05	0.22	0.4	1.7	0.9	4.4	1.8	8.0	25	110
	VIIa	E7 35		Liverpool	"	72(H)	29-52	0.12	0.87	0.5	3.6	4.3	31.	2.2	16.	62	450
	"	E7 36		River Ribble	"	50(H)	49-72	0.04	0.19	<0.2	-	1.7	8.0	2.3	11.	36	170
	"	E6 36		Blackpool	"	70(H)	43-66	0.05	0.22	<0.2	-	1.6	7.1	1.9	8.5	29	130
	"	"		Fleetwood	"	50(H)	32-65	0.07	0.49	0.3	2.1	2.0	14.	1.5	10.	27	190
	"	E7 37		Heysham	"	50(H)	35-50	0.07	0.47	0.4	2.7	1.6	10.	1.8	12.	28	190
	"	"		Morecambe	"	50(H)	35-50	0.06	0.35	0.3	1.7	1.9	11.	1.8	10.	25	140
	"	E6 38		Ravenglass	"	50(H)	35-60	0.06	0.42	0.5	3.5	1.0	14.	1.4	9.7	24	170
	"	"		Whitehaven	"	54(H)	30-50	0.05	0.38	2.0	15.	2.0	15.	1.5	12.	20	150
	"	"		Maryport	"	48(H)	28-55	0.06	0.41	0.6	4.2	1.5	11.	1.0	7.1	17	120
	"	"		Silloth	"	50(H)	30-45	0.04	0.18	0.5	2.2	1.2	5.3	1.7	7.5	15	66

*Whole soft bodies analysed

H = homogenate

Table 1c. Metals in Shellfish (cont'd)

							Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of Collection	Number analysed	Size Range (mm)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
Mussels	I Raritan Bay	1	U.S.A.	1978 Feb.	29	33-40		0.46 1.51 0.84 0.27	<1.2	1.11 2.34 1.49 0.30	9.2 25. 15. 4.4		
Shrimp	IVc	F2 31	Belgium	Nov.	100		0.19	0.06	0.88	17.7	31.0	0.25	
"	"	"	"	"	100		0.15	0.05	0.63	18.9	25.6	0.26	
"	"	"	"	"	100		0.16	0.05	0.47	19.3	26.3	0.44	
"	"	"	"	"	100		0.16	0.04	0.54	18.3	31.0	0.47	
"	"	"	"	"	100		0.16	0.04	0.33	18.8	27.8	0.24	
"	"	"	"	"	100		0.12	0.05	0.38	17.6	26.7	0.10	
"	"	"	"	"	100		0.16	0.04	0.54	17.7	28.0	0.18	
"	"	"	"	"	100		0.08	0.03	0.68	16.6	34.9	0.12	
"	"	"	"	"	100		0.06	0.03	0.42	13.1	30.2	0.10	
"	"	"	"	"	100		0.07	0.03	0.61	14.6	37.4	0.13	
"	"	"	"	"	100		0.08	0.03	0.31	13.4	31.6	0.77	
"	"	"	"	"	100		0.10	0.03	0.55	16.3	82.8	0.18	
"	"	"	"	"	100		0.13	0.02	0.28	11.8	31.4	<0.1	
"	"	"	"	"	100		0.12	0.02	0.30	13.4	54.8	<0.1	
"	"	"	"	"	100		0.13	0.02	0.29	11.7	35.1	<0.1	
"	"	"	"	"	100		0.12	0.02	0.30	12.4	46.4	<0.1	
			overall mean				0.12	0.04	0.48	15.7	36.3	0.22	
			standard deviation				0.04	0.01	0.17	2.8	14.6	0.20	

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis)

Country Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	Concentration (mg/kg)									
								% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Cod																	
Germany, Fed. Rep.	IVb	F8 36	Jan. 1979	45-60 (52.5)	1975 1974	6M 4F	10	0.03 0.20 0.11 0.06	<0.001 0.001	<0.001* 0.005	<0.001 0.001 0.001	0.001 0.002 0.001 0.001	<0.001 0.002 0.001	<0.001 <0.001	0.001 0.004 0.002 0.001	<0.030 0.031	
France	VIIa	E2 33	Nov.	35-40 (37)			2	0.38				0.009	0.001	<0.004	<0.15	0.024	>1.6
Canada		4T	Sept.		1		4	0.88 2.50 1.68 0.70	<0.001 <0.001							0.008 0.021 0.014 0.006	
"		"	"		2		6	0.84 1.09 0.96 0.09	<0.001 <0.001							0.004 0.016 0.009 0.005	
"		"	"		3		18	0.64 1.30 0.87 0.18	<0.001 <0.001							0.001 0.013 0.007 0.003	
"		"	"		4		11	0.61 1.19 0.74 0.17	<0.001 <0.001							0.004 0.026 0.009 0.006	
"		"	"		5		14	0.36 1.28 0.65 0.25	<0.001 <0.001							0.005 0.027 0.012 0.007	

*values are for γ-HCH

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis) (cont'd)

Country / Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	Concentration (mg/kg)									
								% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Cod (cont'd)																	
Canada		4T	Sept.		6		10	0.46 0.79 0.59 0.10	<0.001 <0.001							0.005 0.039 0.013 0.010	
Plaice																	
Germany, Fed. Rep.	IVb	F8 36	Dec.	26-29.4 (27.3)	1975	5F 5M	10	0.14 0.30 0.24 0.05	<0.001 0.001	<0.001* 0.002	0.001 0.005 0.002 0.001	0.001 0.004 0.002 0.001	0.002 0.004 0.002 0.001	<0.001 0.005 - -	0.003 0.009 0.006 0.002	0.027 0.051 0.042 0.009	7
Canada		4Vn					10(H)	0.94	0.004							0.01	
Whiting																	
France	IVc	F2 31	Oct.	18-20 (19)			5	0.31				0.001	0.003	<0.004	<0.008	0.065	>8.3
"	VIIa	E5 33	Nov.	25-36 (31)			4	0.35				0.010	<0.001	<0.004	<0.015	0.011	>0.7
Blue Whiting																	
Netherlands	Vb1	E4 49	Mar.	(30)			3	0.63	0.001	0.0004	0.0005	0.002	0.001	0.001	0.004	0.01	2.5
Herring																	
Netherlands	IVc	F4 33-34	Feb.	(18)	1		10	3.2	0.01	0.005	0.01	0.01	0.01	0.009	0.03	0.30	10
Canada		4T					10(H)	15.67	<0.001							0.13	
"		5Y					10(H)	15.1	0.006							0.35	
"		4Vn					10(H)	11.1	0.009							0.66	

H = homogenate *values are for γ-HCH

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis) (cont'd)

Country								Concentration (mg/kg)									
Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Pilchard																	
Portugal	IX	E0 10	Feb. 1979	20-22 (21.1)			10	0.26 7.92 3.71 2.97			- -	0.010 0.048 0.026 0.013	0.002 0.012 0.008 0.003	0.003 0.015 0.008 0.004	0.019 0.069 0.041 0.019	0.054 0.170 0.114 0.037	2.00 4.86 3.04 1.04
Mackerel																	
Netherlands	VIIe	E6 29	Dec. 1977	(29)	1.5		25	15.0	0.01	0.009	0.03	0.02	0.01	0.02	0.05	0.24	4.8
"	VIIg	E3 30	"	(35)	5.3		25	18.1	0.007	0.009	0.01	0.02	0.02	0.02	0.06	0.20	3.3
Canada		4T					10(H)	12.6	0.004							0.22	
Hake																	
Portugal	IX	E0 10	Feb. 1979	40-48 (43.9)			10	0.22 0.90 0.49 0.26			- -	0.001 0.005 0.003 0.001	- 0.004	0.002 0.020 0.004 0.006	0.003 0.023 0.008 0.006	0.005 0.023 0.015 0.005	0.89 5.00 2.35 1.06
Haddock																	
Canada		4T					10(H)	0.50	<0.001							0.02	
Redfish																	
Canada		4T					10(H)	2.97	<0.001							0.05	
Yellowtail flounder																	
Canada		4T					10(H)	1.08	<0.001							0.01	

Table 2a^2. Organochlorines in Fish Muscle (on a fat weight basis)

Species \ Country	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	Concentration (mg/kg)									
								% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Cod																	
Germany, Fed. Rep.	IVb	F8 36	Jan. 1979	45-60 (52.5)	1975 1974	6M 4F	10	0.03 0.20 0.11 0.06	- 0.67	- 6.25*	- 3.33 1.32 0.90	0.71 3.33 1.60 0.80	- 2.00 1.16 0.52	- -	1.05 4.00 2.53 1.04	- 20.67	
Canada		4T	Sept.		3		18	0.64 1.30 0.87 0.18	0.011 0.074 0.043 0.017							0.17 1.49 0.80 0.37	
"		"	"		4		11	0.61 1.19 0.74 0.17	0.007 0.116 0.064 0.029							0.56 3.59 1.28 0.88	
"		"	"		5		14	0.36 1.25 0.65 0.25	0.008 0.146 0.066 0.034							0.36 6.41 2.09 1.56	
"		"	"		6		10	0.46 0.79 0.59 0.10	<0.001 0.085 0.056 0.030							0.72 5.88 2.17 1.53	
Plaice																	
Germany, Fed. Rep.	IVb	F8 36	Dec.	26-29.4 (27.3)	1975	5F 5M	10	0.14 0.30 0.24 0.05	- 0.50	- 0.74*	0.37 2.27 0.86 0.53	0.43 1.43 0.84 0.37	0.67 1.74 1.04 0.38	- 2.14	1.48 5.00 2.51 1.07	10.00 25.50 17.73 5.87	7.1

*values are for γ-HCH

Table 2a^2. Organochlorines in Fish Muscle (on a fat weight basis) (cont'd)

Species / Country	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Plaice (cont'd)																	
Canada		4Vn					10(H)	0.94	0.46							1.04	
Blue Whiting																	
Netherlands	Vb2	E4 49	Mar.	(30)			3	0.63	0.17	0.07	0.08	0.36	0.17	0.23	0.76	2.2	2.9
Herring																	
Netherlands	IVc	F4 33-34	Feb.	(18)	1.2		10	3.2	0.35	0.16	0.40	0.42	0.32	0.09	0.88	9.5	10.8
Canada		4T					10(H)	15.67	0.005							4.40	
"		5Y					10(H)	15.1	0.04							2.36	
"		4Vn					10(H)	11.1	0.08							6.02	
Mackerel																	
Netherlands	VIIe	E6 29	Dec. 1977	(29)	1.5		25	15.0	0.07	0.06	0.17	0.10	0.09	0.10	0.29	1.6	5.5
"	VIIg	E3 30	"	(35)	5.3		25	18.1	0.04	0.05	0.06	0.09	0.09	0.10	0.28	1.1	3.9
Canada		4T					10(H)	12.6	0.03							2.19	
Haddock																	
Canada		"					10(H)	0.50	0.04							3.29	
Redfish																	
Canada		"					10(H)	2.97	0.02							1.65	
Yellowtail flounder																	
Canada		"					10(H)	1.08	0.04							0.94	

Table 2b[1]. Organochlorines in Fish Liver (on a wet weight basis)

Country / Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
								Concentration (mg/kg)									
			1978														
Cod																	
England/ Wales	IVc	F1 33	Aug.	42-77 (54)	2	19M 1F	20				0.045 0.26 0.14 0.061	0.12 1.2 0.39 0.28	0.05 0.65 0.23 0.13	<0.002 0.46 0.15 0.11	0.34 1.5 0.78 0.49	1.6 16 6.0 7.8	7.7
"	VIIa	E6 36	Sept.	27-46 (37)	1	9I 7F 4M	16				0.12 0.32 0.22 0.07	0.11 1.2 0.36 0.34	0.12 0.33 0.20 0.63	<0.002 0.12 0.024 0.035	0.28 1.5 0.58 0.36	1.0 16. 3.6 4.1	6.2
Germany, Fed. Rep.	IVb	F8 36	Jan. 1979	45-60 (52.5)	1975 1974	6M 4F	10	26.9 59.5 49.3 10.2	0.002 0.052 0.037 0.016	0.012* 0.156 0.079 0.046	0.116 0.534 0.266 0.115	0.120 0.512 0.271 0.134	0.200 1.10 0.517 0.268	0.196 0.700 0.376 0.188	0.516 2.10 1.12 0.511	2.76 9.76 5.00 2.57	4.5
Netherlands	IVa	F3 49	Nov.	(81)	5		10	56.9	0.05	0.06	0.09	0.39	0.17	0.39	1.1	5.7	5.2
"	IVb	F4 40	Feb. 1979	(93)	5.9		10	50.2	0.08	0.10	0.15	0.53	0.25	0.38	1.3	8.0	6.2
"	IVc	F4 34	Nov.	(62)	3		10	51.8	0.17	0.07	0.19	0.41	0.18	0.18	0.82	15.0	18.3
Canada		4T	Sept.		1		4	7.1 27.8 14.9 8.2	0.007 0.015 0.010 0.004	0.010 0.038 0.022 0.011				0.072 0.142 0.107 0.028		0.63 1.02 0.82 0.19	
"		"	"		2		6	13.9 35.9 25.5 7.2	0.013 0.027 0.022 0.005	0.024 0.052 0.038 0.009				0.192 0.348 0.240 0.060		1.12 1.88 1.40 0.44	

*values are for γ-HCH

Table 2b[1]. Organochlorines in Fish Liver (on a wet weight basis) (cont'd)

Country Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	Concentration (mg/kg) % fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Cod (cont'd)																	
Canada	4T		Sept.		3		18	14.1 65.3 45.2 14.6	0.012 0.107 0.047 0.024	0.018 0.085 0.063 0.017				0.137 0.291 0.189 0.039		1.33 3.03 1.98 0.45	
"	"		"		4		11	27.1 69.2 53.6 12.9	0.038 0.080 0.049 0.012	0.035 0.088 0.070 0.015				0.124 0.582 0.256 0.120		1.95 5.17 2.98 1.00	
"	"		"		5		14	15.1 63.1 50.4 15.3	0.014 0.078 0.052 0.018	0.026 0.087 0.065 0.018				0.140 0.672 0.356 0.172		1.59 6.42 3.78 1.60	
"	"		"		6		10	13.5 76.6 51.5 16.8	0.007 0.071 0.046 0.018	0.022 0.097 0.069 0.021				0.260 0.975 0.479 0.221		1.49 8.56 3.68 1.93	
Herring																	
Canada	"						10(H)	10.6	0.005	0.02				0.01		0.09	
"	5Y						10(H)	8.2	0.002	0.01				0.006		0.05	
"	4Vn						10(H)	2.6	0.002	0.003				0.004		0.03	
Mackerel																	
Canada	4T						10(H)	15.4	0.005	0.02				0.03		0.16	

Table 2b[1]. Organochlorines in Fish Liver (on a wet weight basis) (cont'd)

Country / Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	% fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Hake																	
Netherlands	VIIf	E4 29	Apr. 1979	(47)	3.6		10	53.0	0.05	0.04	0.08	0.12	0.06	0.15	0.36	3.7	10.3
Portugal	IX	EO 10	Feb. 1979	40-48 (43.9)			10	41.1 67.8 49.3 7.2			- -	0.102 0.293 0.207 0.071	0.070 0.187 0.126 0.038	0.067 0.400 0.189 0.089	0.239 0.692 0.522 0.142	0.93 2.10 1.61 0.39	1.6 4.6 3.2 0.8

Concentration (mg/kg)

Table 2b^2. Organochlorines in Fish Liver (on a fat weight basis)

Country Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	Concentration (mg/kg) % fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
			1978														
Cod																	
England/ Wales	IVc	F1 33	Aug.	42-77 (54)	2	19M 1F	20				0.097 0.85 0.39 0.19	0.26 2.8 1.04 0.73	0.11 1.5 0.65 0.32	- 1.1 0.43 0.29	0.37 5.4 2.1 1.2	3.7 42 12.3 11.2	5.8
"	VIIa	E6 36	Sept.	27-46 (37)	1	9I 7F 4M	16				0.22 1.2 0.54 0.31	0.20 5.0 1.0 1.28	0.24 1.3 0.50 0.30	0.002 0.32 0.069 0.11	0.53 6.1 1.6 1.5	1.8 66. 10.7 16.3	6.7
Germany, Fed. Rep.	IVb	F8 36	Jan. 1979	45-60 (52.5)	1975 1974	6M 4F	10	26.9 59.5 49.3 10.2	0.04 0.10 0.08 0.02	0.02* 0.29 0.17 0.09	0.21 1.0 0.55 0.22	0.23 1.2 0.59 0.34	0.38 2.06 1.10 0.57	0.33 1.83 0.86 0.60	0.98 4.58 2.56 1.40	5.4 18.1 10.1 4.2	3.9
Canada		4T	Sept.		3		18	14.1 65.3 45.2 14.6	0.072 0.138 0.095 0.019	0.123 0.171 0.141 0.016				0.245 1.21 0.494 0.246		2.29 10.1 4.92 2.05	
"		"	"		4		11	27.1 69.2 53.6 12.9	0.067 0.151 0.097 0.028	0.118 0.187 0.137 0.021				0.223 0.886 0.511 0.258		3.16 14.6 6.11 3.41	
"		"	"		5		14	15.1 63.1 50.4 15.3	0.062 0.164 0.104 0.025	0.110 0.174 0.132 0.015				0.245 1.43 0.778 0.387		2.74 24.3 9.94 7.49	

*values are for γ-HCH

Table 2b^2. Organochlorines in Fish Liver (on a fat weight basis) (cont'd)

Country / Species	Area	Source	Date of collect.	Size (cm) (mean)	Age or year class (yrs)	Sex	Number in sample	Concentration (mg/kg) % fat min max MEAN s.d.	HCB min max MEAN s.d.	α-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB/ΣDDT min max MEAN s.d.
Cod (cont'd)																	
Canada		4T	1978 Sept.		6		10	13.5 76.6 51.5 16.8	0.055 0.116 0.086 0.021	0.118 0.167 0.137 0.013				0.641 2.05 1.01 0.52		3.34 30.8 9.18 8.72	
Netherlands	IVa	F3 49	Nov.	(81)	5		10	56.9	0.08	0.11	0.15	0.68	0.29	0.68	1.9	10	5.3
"	IVb	F4 40	Feb. 1979	(93)	5.9		10	50.2	0.15	0.20	0.31	1.05	0.49	0.75	2.5	16	6.4
"	IVc	F4 34	Nov.	(62)	3		10	51.8	0.32	0.13	0.36	0.79	0.35	0.35	1.6	29	18.1
Herring																	
Canada		4T					10(H)	10.6	0.04	0.18				0.17		0.81	
"		5Y					10(H)	8.2	0.08	0.11				0.07		0.62	
"		4Vn					10(H)	2.6	0.05	0.12				0.16		1.30	
Mackerel																	
Canada		4T					10(H)	15.4	0.03	0.14				0.24		1.07	
Hake																	
Netherlands	VIIf	E4 29	Apr. 1979	(47)	3.6		10	53.0	0.10	0.07	0.16	0.22	0.12	0.74	1.1	7.3	6.6

Table 2c. Organochlorines in Shellfish

						Concentration (mg/kg) wet weight (fat weight)									
Country	Area	Source	Date of collect.	Size (cm)	Number in sample	% fat	HCB	γ-HCH	Dieldrin	DDE	TDE	p,p'DDT	ΣDDT	PCBs	PCB/ΣDDT
			1978												
Mytilus edilus															
Germany, Fed. Rep.	IVb Westeriede		Dec.	4.7-6.5	50	1.12	0.001 (0.09)	0.002 (0.18)	0.001 (0.09)	0.003 (0.27)	0.004 (0.36)	0.002 (0.18)	0.009 (0.81)	0.045 (4.02)	5.0
"	IVb Osteriede		"	4.9-6.2	50	0.95	0.001 (0.11)	0.001 (0.11)	0.006 (0.63)	0.002 (0.21)	0.004 (0.42)	0.001 (0.11)	0.007 (0.74)	0.071 (7.47)	10.1
*Crangon crangon**															
Germany, Fed. Rep.	IVb Amrüm	F8 38	"	5.1-7.4	100	0.24	0.001 (0.42)	0.003 (1.25)	0.001 (0.42)	0.002 (0.84)	0.001 (0.42)	<0.001 -	0.003 (1.26)	0.101 (4.21)	33.7
"	"	"	"	5.0-8.5	100	0.10	0.002 (2.00)	0.002 (2.00)	0.001 (1.00)	0.002 (2.00)	0.001 (1.00)	0.004 (4.00)	0.007 (7.00)	0.011 (11.0)	1.6
"	"	"	"	5.1-7.3	100	0.17	<0.001 -	0.001 (0.59)	0.001 (0.59)	0.001 (0.59)	0.001 (0.59)	<0.001 -	0.002 (1.18)	0.009 (5.25)	4.5
"	"	"	"	5.4-7.6	100	0.15	0.001 (0.66)	0.002 (1.33)	0.003 (2.00)	0.002 (1.33)	0.002 (1.33)	<0.001 -	0.004 (2.66)	0.024 (13.3)	6.0
"	"	"	"	5.0-7.3	100	0.32	0.001 (0.31)	0.001 (0.31)	0.001 (0.31)	0.002 (0.63)	0.003 (0.94)	0.002 (0.63)	0.007 (2.10)	0.041 (12.8)	5.9

*Portion analyzed was last one-third of tail, cooked.

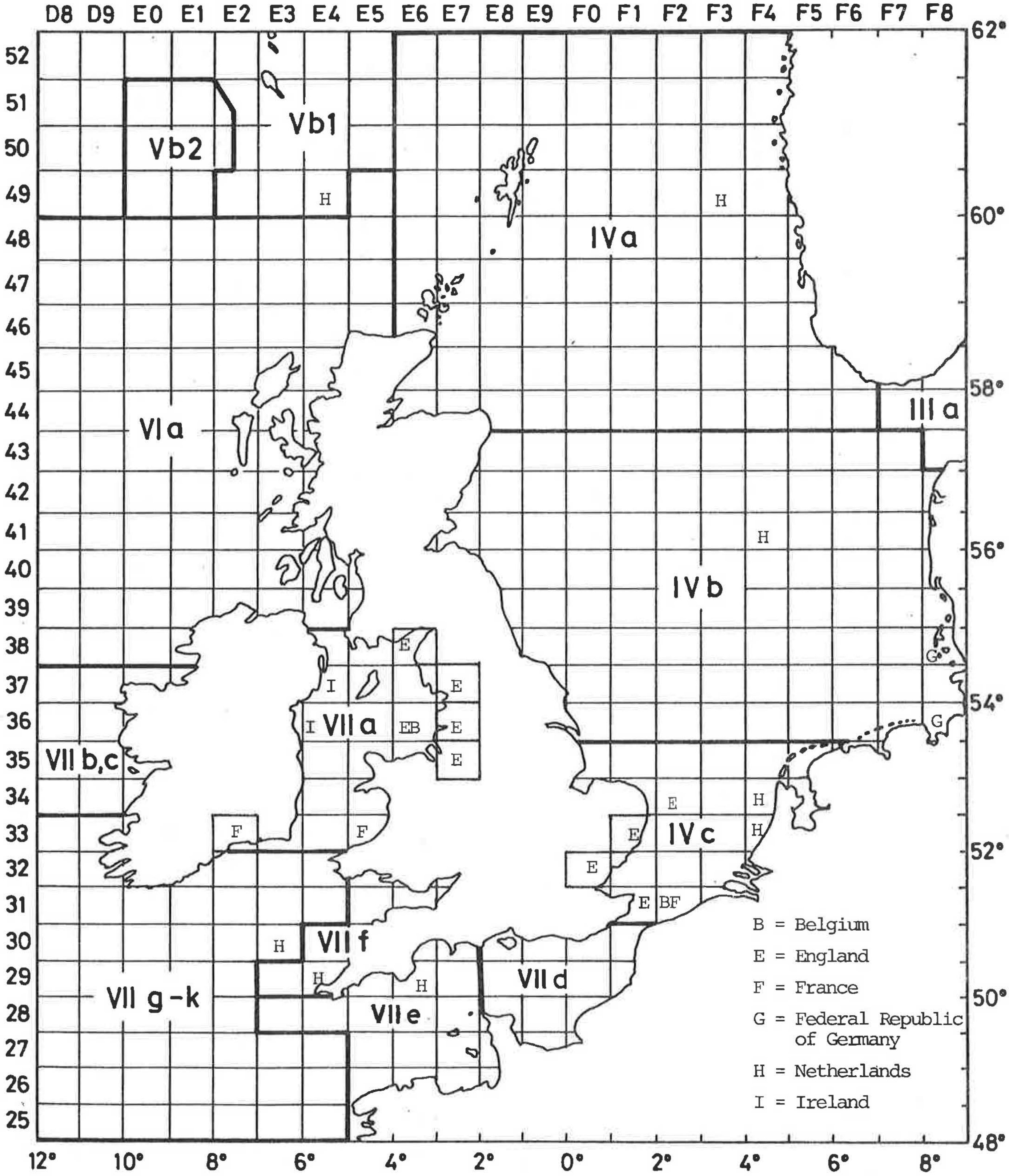


Figure 1. Areas in the North Sea, Irish Sea and English Channel sampled by named countries, 1978.

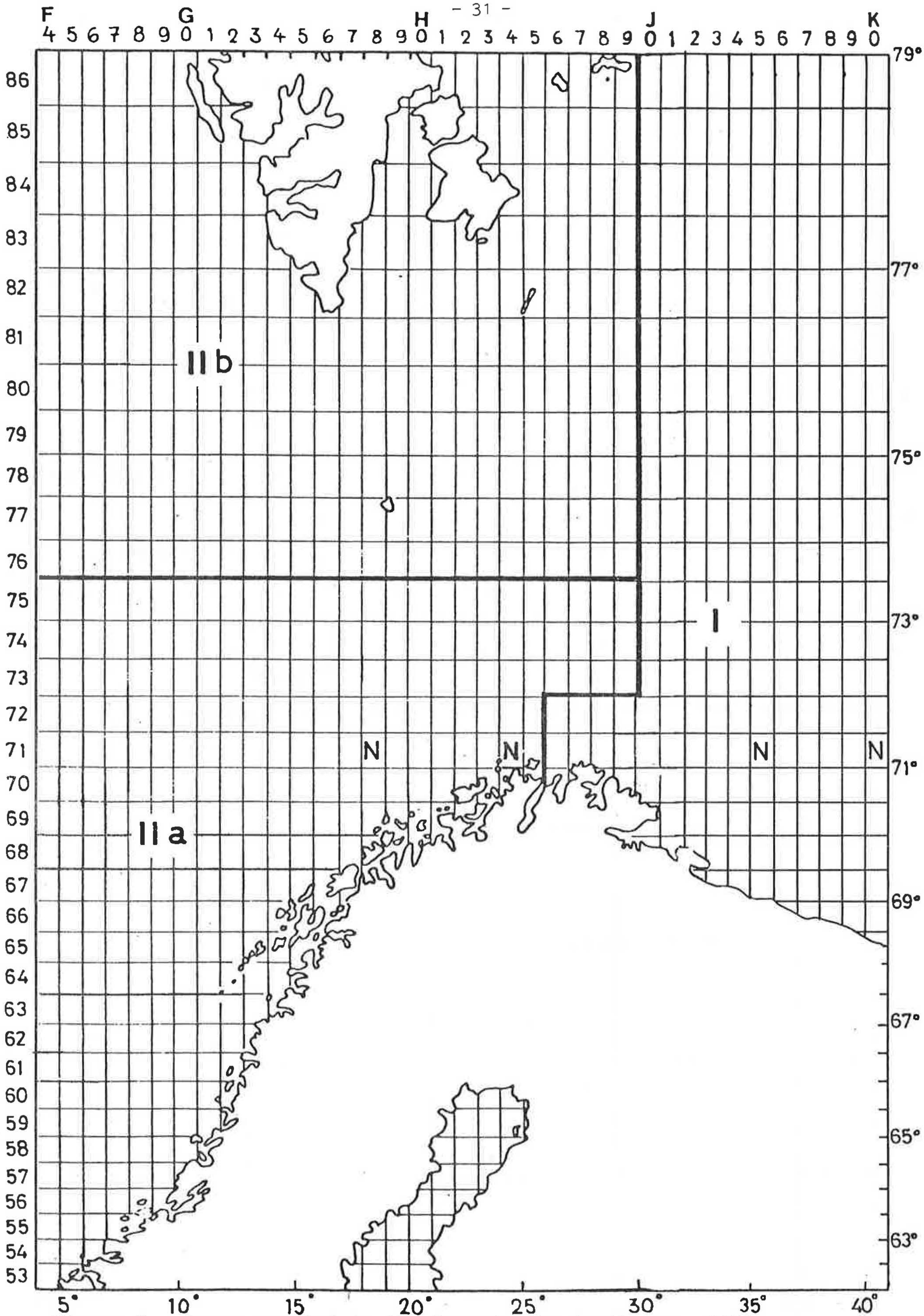


Figure 2. Areas sampled in the Barents Sea by Norway, 1978.

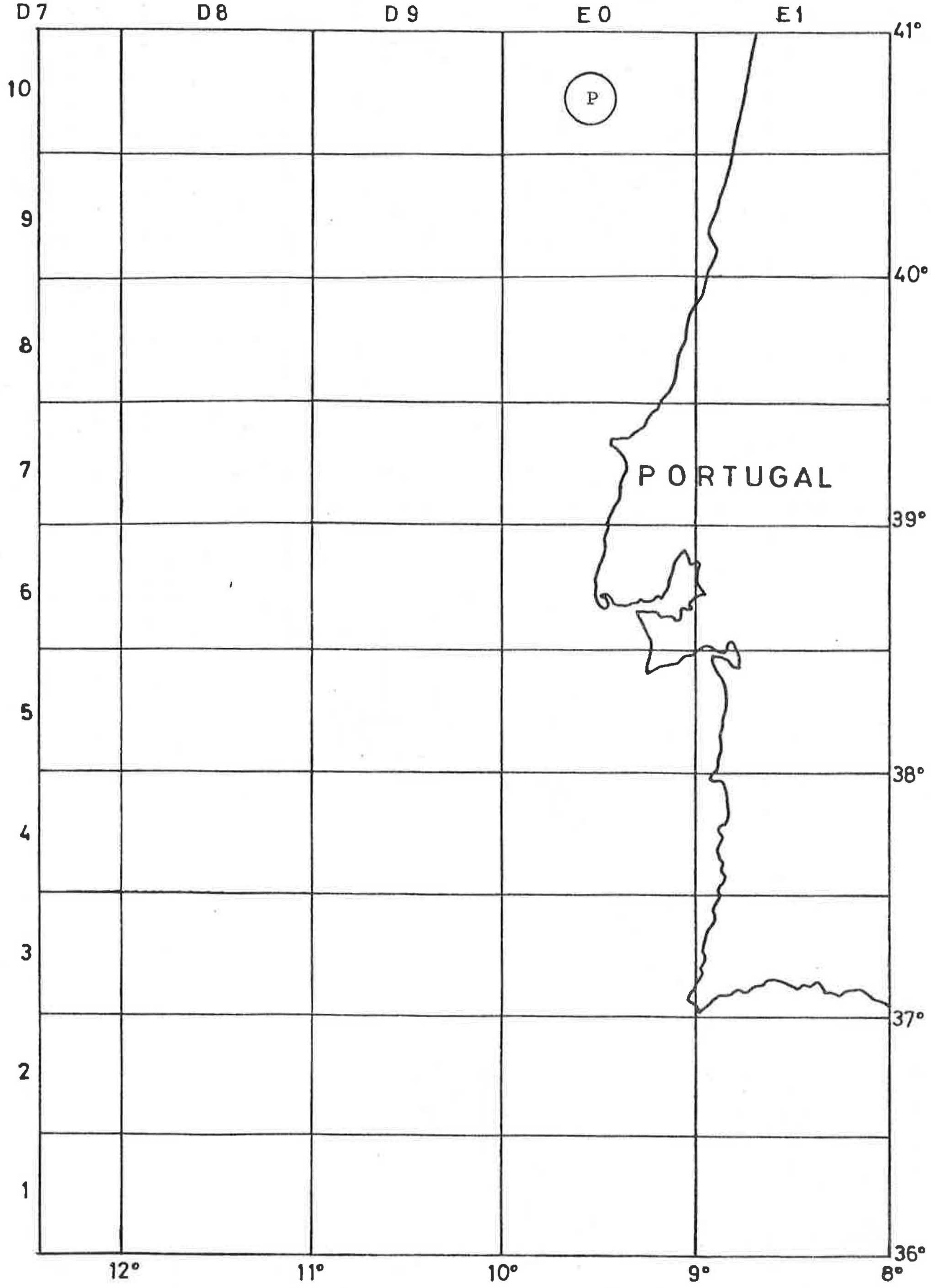


Figure 3. Area sampled by Portugal, 1978.

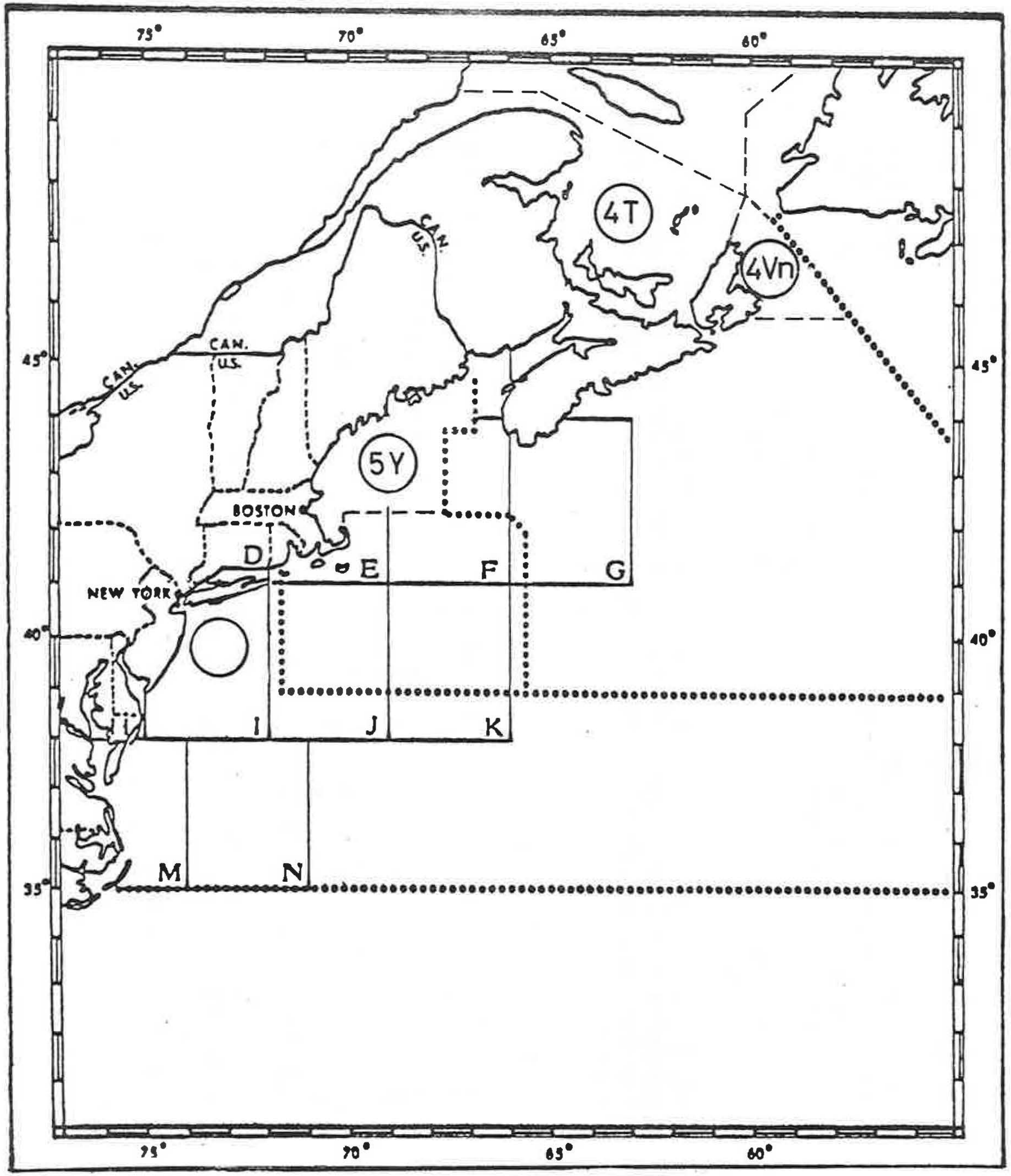


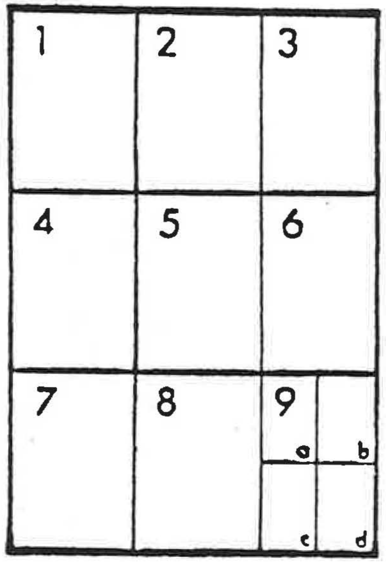
Figure 4. Areas sampled by Canada and the United States, 1978.

Blocks with capital letters indicate 3° x 3° sampling areas.

Blocks with numerals indicate 1° x 1° areas.

Blocks with lower case letters indicate 1/2° x 1/2° areas.

Dotted lines indicate ICNAF area boundaries.



THE ICES COORDINATED MONITORING PROGRAMME, 1979

INTRODUCTION

In this report, the results are presented of the sixth year of the Coordinated Monitoring Programme. Under this programme, member countries of ICES submit the results of their analyses for certain selected contaminants in samples of fish and shellfish which are collected annually from a number of specified areas.

A description of the history of this programme is contained in the introduction to the report on the 1978 results of the Coordinated Monitoring Programme earlier in this volume. The procedures for the preparation of samples prior to analysis and for the reporting of results which applied to the 1979 programme are reported in Annex II of Coop.Res.Rep. No. 84(1979).

The quality of the data submitted under this programme is controlled by periodic intercalibration exercises on the analyses of heavy metals and organochlorine residues in biological materials. Only results, the validity of which can be verified by the performance of that laboratory in a recent intercalibration exercise, are included in a coordinated monitoring report. The results of the intercalibrations applicable to the data in this report can be found in Coop. Res.Rep. No. 108(1981).

Reports of the results for the previous years of this programme have been published as follows: 1974 - Coop.Res.Rep. No. 58(1977); 1975 and 1976 - Coop.Res.Rep. No. 72(1977); 1977 - Coop.Res.Rep. No. 98(1980); 1978 - this volume.

RESULTS

For 1979, data were received from Belgium, Canada, Denmark, England/Wales, France, the Federal Republic of Germany, Ireland, the Netherlands, and Sweden. Most of the data were for cod (Gadus morhua) and plaice (Pleuronectes platessa), but results were also received for European flounder (Platichthys flesus), common sole (Solea solea), dab (Limanda limanda), European hake (Merluccius merluccius), and European eel (Anguilla anguilla). Data on shellfish were submitted for oysters (Crassostrea gigas), blue mussels (Mytilus edulis), and common shrimp (Crangon crangon). The location of sampling areas are shown in Figures 5-8.

The discussion of the results below relates to mean concentrations, unless otherwise indicated. Although some comparisons are made with the results obtained in previous years of the programme, it must be strongly emphasized that these differences in many cases may only be apparent, since (1) the stipulated sampling procedures have not in the main been rigorously followed, and (2) the level of agreement between data produced by different laboratories places certain constraints on the degree of valid comparisons possible. The overall result is that without detailed statistical analysis, the data will only reveal gross changes.

METALS IN FISH

The data submitted from the analyses of heavy metal concentrations in fish muscle are shown in Table 1a (pp. 40-45), and the results from similar analyses of fish livers are given in Table 1b (pp. 46-49).

Data were submitted for nine samples of cod, three from the Southern Bight of the North Sea, five from the Irish Sea and one from the Gulf of St Lawrence. The mean concentrations of mercury in cod muscle ranged from 0.06 - 0.34 mg/kg on a wet weight basis. This is similar to the ranges reported in previous years, for example, 0.03 - 0.26 mg/kg in 1978. The highest average concentration (0.34 mg/kg) of mercury was found in a sample of cod from the Irish Sea; a different sample from this same area contained the fish with the highest individual mercury concentration (0.64 mg/kg).

For the 18 samples of plaice on which data were reported, average mercury concentrations in muscle were found from 0.02 - 0.43 mg/kg (wet weight). As was the case with cod, the sample with the highest average mercury concentration was taken from the Irish Sea; this sample also contained the fish with the highest individual concentration (0.78 mg/kg). Although nothing can be concluded on the basis of such a small number of samples, this situation is similar to that observed in the 1978 monitoring data, in which higher mercury levels were found in plaice from the Irish Sea (particularly on the eastern side) than in those from the Southern Bight of the North Sea.

Data were reported on seven samples of flounder. The average mercury concentrations in the muscle of these samples ranged from 0.063 - 0.60 mg/kg. The sample with the highest average concentration was taken from the southern part of the Skagerrak, off the northwest coast of Denmark. The range of values reported here is wider than those reported in earlier years, e.g., 0.26 - 0.34 mg/kg in 1978.

Two samples of sole were analyzed. The mean mercury concentration in the muscle of the sample from the Southern Bight of the North Sea was 0.12 mg/kg, while the level in the sample from the Irish Sea was higher, at 0.31 mg/kg.

For the two samples of dab taken from the eastern part of the North Sea off the west coast of Denmark, the average mercury concentrations reported in muscle were the same, 0.16 mg/kg.

In general, the concentrations of mercury in liver tissue were somewhat lower than those in muscle tissue for all four species studied. With one exception, the overall mean concentration range was 0.02 - 0.3 mg/kg, which is identical to the range reported in 1978. The exception was a sample of plaice from the eastern Irish Sea, which contained 0.83 mg/kg mercury in the liver tissue. This high concentration may be partially due to the fact that the fish in this sample were much older (ages of 4 - 16 years, average 7 years) than the fish in the other samples. Nonetheless, other data are indicative of somewhat higher concentrations of mercury in this part of the Irish Sea which is influenced by the River Mersey. For example, the cod sampled in this area show mercury concentrations at the upper end of the range. Additionally, data from previous years often show elevated concentrations of mercury in both muscle and liver of fish from this area.

As mentioned in previous reports on coordinated monitoring results, cadmium and lead data for fish muscle and liver tissues must be evaluated carefully because only a few laboratories use sufficiently accurate and sensitive analytical methods to be able to obtain true values for these metals (see intercalibration results in Coop.Res.Rep. No. 108). For cadmium, a detection limit at the 0.00X mg/kg level is necessary. Of the results for fish muscle reported meeting this criterion, a cadmium concentration of 0.010 mg/kg was found in a sample of cod from the Irish Sea and concentrations in plaice from off the French coast ranged from 0.003 - 0.013 mg/kg (wet weight). Three values of cadmium in fish liver were reported which met this criterion: a concentration of 0.024 mg/kg in a sample of cod from the Irish Sea, 0.071 mg/kg in cod from the Gulf of St Lawrence and 0.143 in flounder from the German Bight. Several results were reported for cadmium in fish liver on a dry weight basis; these concentrations of cadmium in plaice, flounder, and dab liver ranged from 0.07 - 1.1 mg/kg dry weight.

For the determination of lead in fish tissues, a detection limit of 0.0X mg/kg is needed as well as special handling to avoid contamination of samples. Several results were available for fish muscle meeting these criteria. These showed lead levels in cod, plaice, flounder and sole of 0.02 - 0.08 mg/kg, except for one sample of sole from the Irish Sea which contained 0.14 mg/kg. Only one result was available on lead in fish liver. This was a concentration of 0.10 mg/kg in a sample of cod from the Irish Sea.

The average concentrations of copper in fish muscle tissue were all below 0.5 mg/kg, with no apparent differences between species or sampling areas. In liver, copper concentrations were about one order of magnitude higher than in muscle, with values ranging from 3.0 to 8.4 mg/kg.

The results reported for zinc analyses showed that, with one exception, all concentrations of zinc in fish muscle tissue were below 10 mg/kg (range 0.8 - 7.4 mg/kg). The exception was a sample of flounder from the Irish Sea which contained 12 mg/kg zinc in muscle. These results are similar to those reported in previous years of this programme.

The average concentrations reported for zinc in liver tissue ranged from 5.7 - 21 mg/kg for cod and 26 - 41 mg/kg for plaice on a wet weight basis. In comparison with 1978 data, the values for cod are somewhat lower, whereas for plaice the range is nearly identical.

METALS IN SHELLFISH

The data submitted on heavy metals in shellfish are given in Table 1c (pp. 50-59). The results of the analyses of the tail muscle of shrimp (Crangon crangon) have been given on a wet weight basis in Table 1c[1], while results for the analyses of whole soft bodies of mussels (Mytilus edulis) and oysters (Crassostrea gigas) have been reported on a dry weight basis in Table 1c[2]. All samples of oysters were taken from the coast of France, as is the case for many of the samples of mussels. In addition, 21 samples of mussels were taken from the Belgian coast and two samples from Danish coastal areas.

Mean concentrations reported for mercury in the tail muscle of 20 samples of shrimp from off the coast of Belgium (Table 1c[1]) were uniformly low, ranging from 0.03 to 0.12 mg/kg wet weight. The concentrations of cadmium in these shrimp samples were in the range 0.008 - 0.026 mg/kg, while lead was reported at 0.05 - 0.10 mg/kg. Copper concentrations in the shrimp samples ranged from 3.8 to 11 mg/kg and zinc from 18 to 23 mg/kg wet weight.

In Table 1c[2], the mercury concentrations reported on a dry weight basis for mussels were uniformly low, ranging from 0.09 to 0.3 mg/kg. The concentrations of mercury in oysters were slightly higher, at 0.14 - 0.67 mg/kg dry weight.

Cadmium concentrations, particularly those in oysters, varied according to the sampling location. Concentrations in mussels ranged from 0.40 to 8.1 mg/kg dry weight, with the highest concentrations found in mussels from the Baie de Seine. Concentrations of cadmium in oysters, with the exception of samples from the Gironde Estuary, were similar to those in mussels, showing a range of 1.2 - 6.9 mg/kg. Oysters sampled from the Baies de Marennes-Oleron contained cadmium levels at the higher end of this range. Values reported for oysters from the Gironde Estuary, however, were much higher than those from the other areas sampled; there, cadmium concentrations were found in the range 29 - 52 mg/kg.

The lead concentrations reported for mussels were 1.4 - 9.3 mg/kg dry weight, and slightly lower for oysters, 0.6 - 3.9 mg/kg.

While the concentrations of copper reported in mussels were relatively low (4.6 - 24 mg/kg dry weight), copper concentrations in oysters were higher and showed pronounced elevation at certain sampling locations. For most locations, the copper concentrations reported in oysters were from 26 - 105 mg/kg dry weight; however, oysters sampled at sites in the Baies de Marennes-Oleron contained concentrations of 141 - 336 mg/kg and oysters from the Gironde Estuary contained still higher concentrations, at 705 - 922 mg/kg. Similarly, zinc concentrations in mussels were low relative to those in oysters. Zinc in mussels ranged from 70 - 241 mg/kg dry weight. For oysters from all locations except the Gironde Estuary, the zinc concentrations were reported in the range 750 - 3 960 mg/kg, while samples from the Gironde Estuary contained 3 720 - 7 160 mg Zn/kg.

ORGANOCHLORINE PESTICIDE AND PCB RESIDUES IN FISH

The data submitted on the concentrations of organochlorines in fish muscle are presented in Table 2a^1 (pp. 60-63) on a wet weight basis. For the eels and one sample of cod, the data were also submitted on a fat weight basis and these results are given in Table 2a^2 (page 64). This is the first year that data have been reported for eels and it should be noted that, although the eels were caught in marine areas, their contaminant concentrations are probably greatly influenced by the freshwater areas from which they are migrating.

The only species for which dieldrin concentrations were reported was eel, in which levels ranged from 0.03 - 0.19 mg/kg on a wet weight basis. There are no data on eel from previous years of the coordinated monitoring programme with which to compare these values. However, given that eel muscle contains a fairly high percentage of lipids (12-15%), it can be expected that higher levels of organochlorine residues will be reported for this species than for species with a low percentage of lipids (e.g., cod). Nonetheless, the highest level of dieldrin reported for eel (0.19 mg/kg) seems to be fairly high, if a comparison may be allowed with a different species of fish, namely mackerel, which contains a similar percentage of lipids. Limited data on mackerel for 1978 show dieldrin concentrations in the range 0.01 - 0.03 mg/kg wet weight.

The concentrations of DDT group residues in the three samples of eel also appear to be somewhat elevated. DDE showed the highest range of concentrations, 0.03 - 0.14 mg/kg (wet weight), while p,p'-DDT occurred at slightly lower levels, i.e., 0.01 - 0.09 mg/kg. ΣDDT concentrations were 0.06 - 0.35 mg/kg. In comparison, the 1978 data on mackerel show ΣDDT concentrations from 0.05 - 0.06 mg/kg. For the other species of fish analyzed - cod, plaice, flounder and dab - the concentrations of the DDT group residues were low. ΣDDT values were in the range 0.004 - 0.030 mg/kg wet weight, which is similar to levels reported in previous years.

The PCB concentrations reported for eel muscle were rather high, ranging from 2.5 - 5.0 mg/kg wet weight. This is an order of magnitude above the levels reported for mackerel in 1978 and is considerably higher than the concentrations reported in 1979 for PCBs in cod, plaice, flounder and dab, in which values ranged from 0.018 to 0.20 mg/kg, with most values less than 0.09 mg/kg.

The concentrations of HCB reported for the three eel samples were in the range 0.05 - 0.19 mg/kg, while in two samples of cod HCB levels were 0.00017 - 0.001 mg/kg. The concentrations of γ-HCH were only determined in eel, in which levels of 0.04 - 0.07 mg/kg were reported. The concentrations of HCB and γ-HCH in eels are higher than those for other species reported on in previous years of the programme.

The data on the concentrations of organochlorine residues in fish liver are presented on a wet weight basis in Table $2b^1$ (pp. 65-66) and on a fat weight basis in Table $2b^2$ (pp. 67-68). For cod liver, dieldrin concentrations were reported between 0.11 and 0.35 mg/kg wet weight. This is similar to the values reported in previous years. The concentrations of individual DDT group residues in cod liver ranged from <0.005 - 1.2 mg/kg wet weight, with DDE values the highest of the three residues determined. The maximum average ΣDDT concentration reported was 2.8 mg/kg. These values are slightly elevated over those reported in previous years, but the difference cannot be said to be significant bearing in mind the restrictions imposed by the quality and number of data available.

The concentrations of PCBs in cod liver fell in the range 0.51 - 39 mg/kg, with the highest concentrations in fish from the Southern Bight of the North Sea.

HCB was determined in four samples of cod liver. Concentrations reported were from 0.014 to 0.19 mg/kg wet weight, with the higher values observed in samples from the Southern Bight of the North Sea. Concentrations of γ-HCH in cod liver from the Southern Bight of the North Sea were 0.03 - 0.06 mg/kg, and α-HCH was determined in the cod sample from the Gulf of St Lawrence at a level of 0.069 mg/kg. These values, including the regional differences, are similar to those reported for cod liver in 1978.

Data on only two samples of plaice, both taken from the Irish Sea, were reported. Dieldrin concentrations were 0.055 and 0.067 mg/kg (wet weight) in the plaice liver. Of the residues in the DDT group, DDE exhibited the highest concentrations with a maximum average concentration of 0.20 mg/kg. The ΣDDT levels in plaice liver were 0.31 and 0.35 mg/kg, while the maximum average PCB concentration was 1.1 mg/kg. The data reported on the concentrations of organochlorine residues in one sample of hake liver showed levels very similar to those reported for plaice liver, except for the PCB concentration, which was 5.7 mg/kg.

The results of the analysis of one sample of flounder liver showed organochlorine concentrations in the same range as those reported for cod liver.

ORGANOCHLORINE PESTICIDE AND PCB RESIDUES IN SHELLFISH

The concentrations reported for DDT group pesticide and PCB residues in shellfish are presented in Table 2c (pp. 69-73). All concentrations are given in a dry weight basis.

With the exception of two samples of mussels which were taken from Danish coastal areas, all mussels and oysters were sampled at various sites along the coast of France. The concentrations of individual DDT group residues reported in mussels were 1.8 - 104 mg/kg dry weight for p,p'-DDE (of these values, however, all but three were less than 50 mg/kg), 4 - 116 mg/kg for p,p'-DDD and 4 - 78 mg/kg for p,p'-DDT. There were fairly large variations in the concentrations of the DDT group residues according to sampling site and time of the year. The highest concentrations of p,p'-DDD and p,p'-DDT were found in samples from the coast of Dunkerque, where low values of p,p'-DDE were found. For p,p'-DDE, both the highest and the lowest concentrations were found in mussel samples taken from the Baie de Seine, with these samples being collected at different times of the year. Total DDT concentrations in mussels were reported in the range 22 - 214 mg/kg dry weight, with the exception of the two samples taken off the Danish coasts which contained concentrations below the detection limit of the method used (0.03 mg/kg).

In oysters, p,p'-DDE concentrations were reported in the range 7.3 - 46 mg/kg dry weight, except for one sample from the Bassin d'Arcachon which contained 77 mg/kg. Concentrations of p,p'-DDD were nearly identical (7.5 - 47 mg/kg), with the exception of the four samples of oysters from the Bassin d'Arcachon, which contained levels from 65 to 115 mg/kg. Concentrations of p,p'-DDT varied widely in samples of oysters from different coastal areas. Oysters from most areas sampled contained p,p'-DDT in the range 13 - 66 mg/kg dry weight, however, one sample from the Baie de Daoulas was reported to contain 192 mg/kg, two samples from the Gironde Estuary contained 115 and 131 mg/kg, and all four samples from the Bassin d'Arcachon contained elevated levels of p,p'-DDT, ranging from 150 to 352 mg/kg. The ΣDDT concentrations reported were generally in the range 32 - 172 mg/kg, however, the sample from the Baie de Daoulas with an elevated p,p'-DDT concentration had a ΣDDT level of 235 mg/kg, and the four samples from the Bassin d'Archachon contained the highest ΣDDT levels, at 264 - 545 mg/kg.

PCB concentrations reported for mussels generally ranged from 165 - 2 273 mg/kg dry weight, except for mussels taken from the Baie de Seine, which contained higher values (4 660 - 9 400 mg/kg) and the mussels from the Danish coasts, which were reported to contain very low concentrations of PCBs (<0.35 mg/kg).

Concentrations of PCBs reported for oysters were lower than those for mussels. The overall average concentrations of PCBs in oysters were 74 - 660 mg/kg dry weight.

SUMMARY

Results are reported here for the determination of concentrations of certain heavy metals and organochlorine residues in six species of fish and three species of shellfish sampled in 1979. Sampling areas included the North Sea, the Irish Sea, the Skagerrak, the Kattegat, the English Channel, various sites along the coast of France, and the Gulf of St Lawrence.

Bearing in mind the constraints on making valid comparisons on data from different laboratories and from different years, it nonetheless appears that no major changes are evident in the concentrations of trace metals and organochlorine residues in the organisms studied compared with concentrations reported in 1978 and the previous three years.

Table 1a. Metals in Fish Muscle

										Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
COD (*Gadus morhua*)	IVc	F1 33	England/ Wales	1979 Jan.	48	22-85 (44)	97-6818 (1286)	F41 M7	1-3	0.05 0.49 0.13 0.08			<0.2 0.8 <0.3 0.1	2.8 8.4 4.6 1.5		
	"	F1 32	"	Mar.	48	35-65 (48)	530-2636 (1444)	F46 M2	2+3	0.05 0.46 0.16 0.08			<0.2 0.5 <0.2 0.1	1.4 6.4 3.4 1.0		
	VIIa	E5 35	"	May	20	20-37 (30)	159-410 (286)	F	1-6 (2)	0.09 0.64 0.33 0.14			<0.2 0.3 <0.2 -	2.6 7.8 4.1 1.3		
	"	E4 37	"	"	10	44-61 (53)	1041-2439 (1698)	M6 F4	2+3	0.06 0.42 0.17 0.12				2.1 13 6.1 3.7		
	"	E6 36	"	June	10	22-32 (28)	151-337 (236)	F	1	0.17 0.33 0.22 0.04			<0.2 0.2 <0.2 -	1.9 3.2 2.4 0.4		
	"	E6 35	"	Sept.	20	28-40 (33)	242-779 (476)	F	1	0.22 0.54 0.34 0.08			<0.2 0.7 <0.4 0.4	3.4 5.9 4.3 0.6		

Table 1a. Metals in Fish Muscle (cont'd)

										Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Ni min max MEAN s.d.
COD (cont'd)	VIIa	E4 37	Ireland	1979 Nov.	48	40-49 (44)	677-1518 (1017)	M26 F22	1	0.041 0.511 0.099 0.069	0.0004 0.075 0.010 0.016	0.01 0.15 0.04 0.02	0.10 0.35 0.18 0.06	1.87 4.49 3.00 0.60			
	IVc	F2 31	Belgium		20	22-45 (25)	110-925 (211)	F17 M3	1	0.03 0.19 0.08 0.04	<0.005	0.02 0.08 0.04 0.02	0.22 0.43 0.33 0.05	3.11 5.39 4.34 0.58	0.07 0.17 0.13 0.02		0.20 0.51 0.37 0.08
		4T	Canada	Sept.	12	46.5-60.2 (52.5)	908-1858 (1307)		6	0.048 0.089 0.062 0.014			0.17 1.08 0.38 0.24	3.59 5.75 4.36 0.55		1.13 4.62 2.20 0.97	
PLAICE (*Pleuronectes platessa*)	"	F1 33	England/ Wales	"	10	31-51 (36)	333-1553 (555)	F	3	0.03 0.10 0.05 0.02				3.3 5.6 4.7 0.8			
	VIIa	E5 35	"	May	10	20-33 (28)	139-358 (226)	F	2-4	0.09 0.35 0.26 0.10			0.3 0.5 0.4 0.1	4.8 20. 7.0 4.6			
	"	E4 37	"	"	10	26.5-32 (29.6)	187-415 (286)	F	3	0.06 0.26 0.16 0.07				3.8 17. 7.4 2.3			

Table 1a. Metals in Fish Muscle (cont'd)

										Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
				1979												
PLAICE (cont'd)	VIIa	E6 36	England/ Wales	June	10	34-43 (38)	479-767 (602)	F	4-16 (7)	0.27 0.78 0.43 0.15			<0.2 0.4 <0.2 -	3.2 8.6 4.9 1.5		
	"	E6 35	"	Sept.	20	24-33 (28)	160-397 (259)	M11 F8 I1	2-5 (3)	0.09 0.52 0.21 0.11						
	IVb	F7 37	Germany Fed.Rep.	Aug.	16	27-34 (30)	206-476 (284)			0.024 0.048 0.038 0.007						
	IIIa	F8 43	Denmark	"	20	29-53 (38)	225-1470 (639)	M5 F15	3-6 (4.7)	0.025 0.197 0.065 0.039						
	"	F9 44	"	"	10	26-28 (27)	165-225 (202)	M7 F3	2-3 (2.1)	0.014 0.040 0.027 0.009						
	IVc	F2 31	France	May	5	31-38 (34.4)	390-560 (440)			0.09 0.12 0.11 -	0.002 0.020 0.009 -	0.01 0.03 0.02 -	0.15 0.30 0.24 -	3.8 4.6 4.1 -		
	"	"	"	Sept.	5	24-27 (25.5)	187-272 (217)			0.02 0.05 0.03 -	0.002 0.007 0.003 -	0.02 0.10 0.04 -	0.10 0.51 0.27 -	3.7 6.2 4.6 -		

Table 1a. Metals in Fish Muscle (cont'd)

Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Concentration (mg/kg wet weight) Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
PLAICE (cont'd)	VIId	E9/FO 27	France	1979 June	5	25-34.5 (30.3)	215-465 (365)			0.02 0.23 0.09 -	0.002 0.007 0.003 -	0.04 0.08 0.05 -	0.06 0.11 0.09 -	3.2 5.0 4.0 -		
	"	FO 28	"	April	6	24.5-27 (25.8)	160-235 (192)			0.03 0.20 0.07 -	0.004 0.034 0.013 -	0.02 0.12 0.05 -	0.16 0.32 0.23 -	4.2 5.1 4.6 -		
	"	E9/FO 28	"	Sept.	5	27-28.5 (27.6)				0.04 0.06 0.05 -	0.002 0.011 0.006 -	0.06 0.11 0.08 -	0.19 0.32 0.24 -	3.8 5.6 4.9 -		
	VIIe	E8 26	"	May	6	28-36 (32.4)	260-490 (358)			0.06 0.22 0.16 -	0.002 0.004 0.003 -	0.04 0.15 0.07 -	0.20 0.30 0.26 -	4.5 10.6 6.1 -		
	VIId	E8 28	"	"	6	21-35 (28.2)	105-480 (265)			0.02 0.17 0.09 -	0.002 0.004 0.003 -	0.02 0.08 0.05 -	0.22 0.51 0.28 -	4.5 8.7 6.8 -		
	VIII	E7 24	"	"	5	20-34 (26.4)				0.01 0.04 0.02 -	0.002 0.010 0.004 -	0.04 0.10 0.07 -	0.12 0.46 0.27 -	4.0 4.4 4.2 -		
	"	E7 23	"	"	6	21-30 (23.5)	120-450 (193)			0.006 0.12 0.03 -	0.004 0.028 0.012 -	0.04 0.11 0.07 -	0.13 0.32 0.18 -	3.4 4.8 4.0 -		

Table 1a. Metals in Fish Muscle (cont'd)

Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Concentration (mg/kg wet weight) Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Ni min max MEAN s.d.
PLAICE (cont'd)	VIII	E7 23	France	1979 Dec.	2	24-34.5 (27.2)	163-340 (252)			0.04 0.06 0.05 -	0.004 0.007 0.006 -	0.02 0.15 0.08 -	0.11 0.21 0.16 -	4.6 5.0 4.8 -			
EUROPEAN FLOUNDER (*Platichthys flesus*)	VIIa	E6 35	England/ Wales	Oct.	24	25-32 (28)	193-463 (290)	F		0.15 0.58 0.32 0.11			0.3 0.6 0.4 0.08	3.6 15. 12. 5.2			
	IVc	F2 31	Belgium		20	26-38 (32)	221-610 (371)	F15 M5		0.09 0.99 0.32 0.23	<0.005 0.025 - -	<0.01 0.12 0.03 0.03	0.14 1.02 0.41 0.20	3.04 9.06 6.27 1.58	0.07 0.29 0.17 0.09		0.20 0.58 0.41 0.10
	IVb	F8 39	Denmark	Oct.	8	22-30 (25)	118-348 (186)	M5 F3	2-3 (2.5)	0.063 0.087 0.079 0.008							
	"	F7 40	"	"	20	28-39 (34)	255-740 (491)	M6 F14	3-6 (3.8)	0.062 0.428 0.204 0.099							
	"	F7 41	"	Sept.	22	25-37 (30)	185-560 (320)	M5 F17	3-8 (4.7)	0.043 0.650 0.212 0.152							
	IIIa	F9 44	"	Aug.	6	30-34 (31)	295-400 (345)	M4 F2	2-4 (3.2)	0.031 3.18 0.602 1.264							

Table 1a. Metals in Fish Muscle (cont'd)

										Concentration (mg/kg wet weight)							
Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.	Ni min max MEAN s.d.
FLOUNDER (cont'd)	IIIa	G1 43	Denmark	1979 Aug.	26	26-38 (30)	190-540 (313)	M5 F21	3-7 (4.5)	0.025 0.161 0.063 0.033							
COMMON SOLE (*Solea solea*)	IVc	F2 31	Belgium		20	24-34 (28)	110-387 (204)	M14 F6		0.06 0.18 0.12 0.03	<0.005 0.005 <0.005 -	<0.01 0.20 0.03 0.04	0.27 0.68 0.41 0.11	4.14 6.17 4.86 0.50	0.13 0.30 0.19 0.04		0.21 0.50 0.31 0.08
	VIIa		"		20	23-39 (31)	98-658 (310)	M6 F14		0.18 0.46 0.31 0.08	<0.005 <0.005 <0.005 -	0.03 0.33 0.14 0.10	0.18 0.32 0.23 0.04	3.72 5.65 4.47 0.49	0.05 0.08 0.07 0.01		0.20 0.53 0.29 0.08
DAB (*Limanda limanda*)	IVb	F7 40	Denmark	Aug.	14	22-29 (25)	120-260 (163)	M4 F10	2-6 (2.5)	0.090 0.226 0.157 0.044							
	"	F7 41	"	"	18	20-28 (26)	90-220 (163)	M5 F6 *7	2-3 (2.7)	0.070 0.298 0.159 0.063							

*Sex unknown

Table 1b. Metals in Fish Liver

										Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of collect. 1979	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
COD (*Gadus morhua*)	IVc	F1 33	England/ Wales	Jan.	41	24-85	121-6818	F41 M7	1-3	0.03 0.19 0.07 0.04			1.3 45 7.6 8.6	12. 42. 20. 8.3		
	"	F1 32	"	March	23	35-61	608-2636	F46 M2	2+3	0.04 0.27 0.09 0.05			<0.2 36. 7.4 7.2	15. 48. 21. 7.1		
	VIIa	E4 37	"	May	10*	44-61 (53)	1041-2439 (1698)	M6 F4	2+3	0.04			6.8	15.		
	VIIa	E6 36	"	June	10**	22-32 (28)	151-337 (236)	F	1	0.27 0.33 0.30 0.04			- - 8.4 -	24. 27. 26. 2.1		
	"	E6 35	"	Sept.	20**	28-40 (33)	242-779 (476)	F	1	0.08 0.23 0.13 0.07			4.4 6.4 5.2 0.9	21. 70. 36. 23.		
	VIIa	E4 37	Ireland	Nov.	48	40-49 (44)	677-1518 (1017)	M26 F22	1		0.003 0.062 0.024 0.016	0.02 0.23 0.10 0.05	1.66 12.1 5.55 2.27	7.3 25.8 15.8 4.2		
	IVc	F2 31	Belgium		20	22-45 (25)	110-925 (211)	F17 M3	1	0.01 0.14 0.06 0.03						

*Bulked sample analysed

**Partially bulked sample analysed

Table 1b. Metals in Fish Liver (cont'd)

										Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
				1979												
COD (*Gadus morhua*) (cont'd)		4T	Canada	Sept.	12	46.5-60.2 (52.5)	908-1858 (1307)		6	0.010 0.059 0.023 0.014	0.044 0.143 0.071 0.027		3.70 13.8 6.97 3.44	12.7 32.4 18.3 5.7		1.25 2.88 1.96 0.56
PLAICE (*Pleuronectes platessa*)	IVc	F1 33	England/ Wales	"	10**	31-51 (36)	333-1553 (555)	F	3	0.06 0.06 0.06 0.00			4.0 7.1 5.5 2.2	40. 42. 41. 7.1		
	VIIa	E6 36	"	June	10	34-43 (38)	479-767 (602)	F	4-16 (7)	0.45 1.2 0.83 0.53			2.2 3.7 3.0 1.1	24. 28. 26. 2.8		
	"	E6 35	"	Sept.	20	24-33 (28)	160-397 (259)	M11 F8 I1	2-5	0.04 0.14 0.09 0.04			2.6 4.8 3.5 0.9	19. 38. 30. 7.9		
										(in mg/kg dry weight)						
	IIIa	F8 43	Denmark	Aug.	20	29-53 (38)	225-1470 (639)	M5 F15	3-6 (4.7)		0.15 1.2 0.45 0.31		1.6 20. 8.1 3.6	69. 168. 105. 30.		
	"	F9 44	"	"	10	26-28 (27)	165-225 (202)	M7 F3	2-3 (2.1)		0.15 2.8 1.06 0.92		0.1 22. 7.42 5.6	59. 183. 109 39.		

**Partially bulked sample analysed

Table 1b. Metals in Fish Liver (cont'd)

Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Concentration (mg/kg wet weight) Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
				1979												
EUROPEAN FLOUNDER (Platichthys flesus)	IVb	F8 36	Germany, Fed.Rep. of	Oct.	60	15-37 (26)	35-703 (232)				0.017 0.555 0.143 0.100					
	IVc	F2 31	Belgium		20	26-38 (32)	221-610 (371)	F15 M5		0.02 0.73 0.18 0.19						
											(Danish values are in mg/kg dry weight)					
	IVb	F8 39	Denmark	Oct.	8	22-30 (25)	118-348 (186)	M5 F3	2-3 (2.5)		0.03 0.16 0.073 0.062		12 27 20 6.0	99 177 132 25		
	"	F7 40	"	"	20	28-39 (34)	255-740 (491)	M6 F14	3-6 (3.8)		0.22 1.6 0.62 0.34		8.4 69 25 15	79 202 133 38		
	"	F7 41	"	Sept.	22	25-37 (30)	185-560 (320)	M5 F17	3-8 (4.7)		0.03 2.4 0.33 0.49		1.3 112 20 24	0.9 1059 157 224		
	IIIa	F9 44	"	Aug.	6	30-34 (31)	295-400 (345)	M4 F2	2-4 (3.2)		0.24 0.65 0.44 0.17		9.9 25 17 7.0	52 151 105 46		

Table 1b. Metals in Fish Liver (cont'd)

										Concentration (mg/kg)						
Species	Area	Source	Country	Date of collect.	Number analysed	Length (cm) (mean)	Weight (g) (mean)	Sex	Age (yrs)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	As min max MEAN s.d.
				1979							(in mg/kg dry weight)					
EUROPEAN FLOUNDER (cont'd)	IIIa	G1 43	Denmark	Aug.	26	26-38 (30)	190-540 (313)	M5 F21	3-7 (4.5)		0.11 1.6 0.65 0.44		3.3 76 27 17	77 196 121 29		
DAB (*Limanda limanda*)	IVb	F7 40	"	"	14	22-29 (25)	120-260 (163)	M4 F10	2-6 (2.5)		0.01 1.65 0.64 0.56		0.2 9.7 5.3 2.8	3.7 96 55 27		
	"	F7 41	"	"	18	20-28 (26)	90-220 (163)	M5 F6 *7	2-3 (2.7)		0.13 3.6 0.84 1.27		0.7 9.1 5.9 2.3	45 193 80 46		

*Sex unknown.

Table 1c[1]. Metals in Shellfish (on a wet weight basis)

						Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of collect.	Number in sample	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
*COMMON SHRIMP (*Crangon crangon*)	IVc	F2 31	Belgium	1979	100	0.08	0.015	0.10	8.00	18.5	0.19	0.22
	"	"	"		100	0.08	0.022	0.10	9.69	22.4	0.21	0.27
	"	"	"		100	0.09	0.019	0.06	7.72	19.8	0.23	0.23
	"	"	"		100	0.06	0.019	0.08	9.40	20.0	0.27	0.29
	"	"	"		100	0.03	0.026	0.08	4.08	19.4	0.27	0.29
	"	"	"		100	0.09	0.018	0.07	8.52	19.4	0.29	0.26
	"	"	"		100	0.08	0.022	0.08	6.53	20.5	0.29	0.37
	"	"	"		100	0.09	0.016	0.08	6.89	19.5	0.27	0.29
	"	"	"		100	0.05	0.016	0.07	4.06	21.1	0.29	0.30
	"	"	"		100	0.08	0.018	0.08	3.83	20.3	0.27	0.36
	"	"	"		100	0.07	0.026	0.09	6.87	20.4	0.34	0.50
	"	"	"		100	0.08	0.013	0.09	5.35	20.2	0.32	0.41
	"	"	"		100	0.08	0.018	0.10	5.56	19.8	0.35	0.48
	"	"	"		100	0.10	0.012	0.09	9.79	21.0	0.36	0.58
	"	"	"		100	0.11	0.018	0.10	8.01	22.8	0.40	0.67
	"	"	"		100	0.11	0.011	0.07	11.1	20.3	0.40	0.61
	"	"	"		100	0.11	0.009	0.07	9.23	19.7	0.43	0.68

*Tail muscle tissue

Table 1c[1]. Metals in Shellfish (on a wet weight basis) (cont'd)

							Concentration (mg/kg wet weight)						
Species	Area	Source	Country	Date of collect.	Number in sample		Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
				1979									
*COMMON SHRIMP (*Crangon crangon*) (cont'd)	IVc	F2 31	Belgium		100		0.12	0.008	0.05	9.64	19.1	0.46	0.53
	"	"	"		100		0.09	0.015	0.08	9.05	20.5	0.40	0.55
	"	"	"		100		0.09	0.012	0.07	8.54	20.9	0.37	0.58
						overall mean	0.08	0.017	0.08	7.60	20.3	0.32	0.42
						standard deviation	0.02	0.005	0.01	2.13	1.04	0.07	0.15

*Tail muscle tissue

Table 1c^2. Metals in Shellfish (on a dry weight basis)

						Concentration (mg/kg dry weight)					
Species	Area	Source	Country	Date of collect.	Number in sample	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.
				1979							
*BLUE MUSSEL (*Mytilus edulis*)	IVc	F2 31	Belgium		50		3.76	9.29	13.4	221	7
	"	"	"		50		2.46	9.08	15.9	167	6
	"	"	"		50		1.94	7.10	18.6	172	5
	"	"	"		50		1.56	6.20	17.3	133	5
	"	"	"		50		1.55	6.54	17.8	151	5
	"	"	"		50		1.24	7.31	24.2	150	5
	"	"	"		50		1.91	7.65	7.65	140	-
	"	"	"		50		1.35	5.24	7.94	175	-
	"	"	"		50		1.85	7.00	9.48	119	-
	"	"	"		50		1.00	3.20	6.86	117	-
	"	"	"		50		2.71	5.24	19.9	159	9
	"	"	"		50		2.35	6.60	12.0	195	6
	"	"	"		50		2.23	3.51	15.1	188	7
	"	"	"		50		0.92	4.59	8.52	119	3
	"	"	"		50		0.51	2.94	14.2	81.6	3
	"	"	"		50		0.89	2.98	14.0	103	6
	"	"	"		50	0.13	1.15	5.25	10.8	137	10
	"	"	"		50	0.17	1.70	5.25	13.3	241	10
	"	"	"		50	0.092	1.33	5.25	12.7	167	5
	"	"	"		50	0.12	1.15	4.25	12.3	160	10

*Whole soft bodies analyzed

Table 1c^2. Metals in Shellfish (on a dry weight basis) (cont'd)

							Concentration (mg/kg dry weight)					
Species	Area	Source	Country	Date of collect. 1979	Number in sample	Size (mm) (mean)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.
*BLUE MUSSEL (*Mytilus edulis*) (cont'd)	IVc	F2 31	Belgium		50		0.12	0.40	3.90	8.55	130	<5
						overall mean	0.13	1.62	5.64	13.4	154	6
						standard deviation	0.030	0.79	1.87	4.52	38.2	2
	IIIa	G1 43	Denmark	Aug.	50	42.0±7.4	0.25	0.80		12.4	99	0.6
	"	F9 44	"	"	50	38.6±4.5	0.16	0.94		5.2	114	1.1
	VIId	F1 30	France	June	2 x 100	45	0.10 0.24 0.17 –	0.50 0.66 0.58 –	4.0 4.9 4.5 –	5.6 16.5 11.0 –	53 88 70 –	
	"	"	"	Sept.	2 x 100	38-33 (33)	0.13 0.26 0.20 –	0.40 6.37 3.38 –	3.5 7.8 5.6 –	3.8 6.6 5.2 –	63 138 100 –	
	" Baie de Seine	F028	"	Feb.	3 x 100	37-55 (48)	0.17 0.37 0.30 –	2.48 4.99 3.81 –	1.2 1.6 1.4 –	7.0 12.1 9.6 –	81 153 119 –	

*Whole soft bodies analysed

Table 1c^2. Metals in Shellfish (on a dry weight basis) (cont'd)

Species	Area	Source	Country	Date of collect. 1979	Number in sample	Size (mm) (mean)	Concentration (mg/kg dry weight)						
							Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
*BLUE MUSSEL (*Mytilus edulis*) (cont'd)	VIId Baie de Seine	FO 28	France	June	5 x 100	20-50 (38)	0.08 0.32 0.17 -	3.36 7.75 5.83 -	0.7 4.7 2.3 -	7.3 15.5 10.3 -	87 182 134 -		
	"	"	"	Dec.	2 x 100	46-50 (48)	0.15 0.16 0.16 -	7.35 8.79 8.07 -	2.7 4.3 3.5 -	6.0 7.4 6.7 -	129 142 136 -		
	VIId	FO 28	"	April	2 x 100	40-50 (45)	0.16 0.41 0.28 -	2.70 4.90 3.80 -	2.1 3.0 2.6 -	10.4 12.9 11.7 -	97 159 128 -		
	"	"	"	Sept.	2 x 100	37-47 (42)	0.21 0.36 0.28 -	1.10 2.29 1.70 -	3.6 4.0 3.8 -	7.7 8.4 8.0 -	57 106 82 -		
	"	"	"	Dec.	2 x 100	32-45 (38.5)	0.11 0.47 0.29 -	1.65 3.29 2.47 -	3.3 5.4 4.4 -	5.7 6.1 5.9 -	73 115 94 -		
	VIIe	E7 26	"	Mar.	3 x 100	32-57 (44)	0.11 0.22 0.15 -	0.89 2.42 1.57 -	1.8 3.9 2.8 -	6.4 7.2 6.8 -	95 257 185 -		
	"	"	"	Sept.	3 x 100	35-47 (40)	0.12 0.18 0.14 -	0.59 1.36 1.05 -	5.1 7.4 6.6 -	6.6 8.7 7.9 -	107 318 210 -		

*Whole soft bodies analysed

Table 1c^2. Metals in Shellfish (on a dry weight basis) (cont'd)

							Concentration (mg/kg dry weight)						
Species	Area	Source	Country	Date of collect.	Number in sample	Size (mm) (mean)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
				1979									
*BLUE MUSSEL (_Mytilus edulis_) (cont'd)	VIIe	E7 26	France	Dec.	3 x 100	34-48 (43.3)	0.07 0.18 0.13 -	0.92 1.65 1.22 -	0.8 2.5 1.5 -	4.4 5.0 4.6 -	96 283 174 -		
	VIII	E7 23	"	Mar.	4 x 100	35-40 (38)	0.19 0.39 0.27 -	0.77 2.23 1.42 -	3.7 9.3 6.4 -	8.3 17.9 13.2 -	86 131 107 -		
	"	"	"	June	4 x 100	38-48 (40)	0.14 0.19 0.16 -	1.70 3.70 2.95 -	5.1 7.6 6.0 -	9.5 17.8 12.6 -	114 148 132 -		
	"	"	"	Sept.	4 x 100	38-53 (43)	0.08 0.16 0.10 -	0.87 1.30 1.04 -	2.7 3.5 3.0 -	5.4 6.4 5.8 -	62 121 89 -		
	"	"	"	Dec.	4 x 100	41-46 (43)	0.06 0.12 0.09 -	1.35 2.19 1.66 -	2.6 7.2 4.6 -	4.6 15.9 8.7 -	66 91 78 -		
*OYSTERS (_Crassostrea gigas_)	VIIe	E6 26	France	Dec.	5 x 10	80-103 (91)	0.09 0.35 0.18 -	1.11 2.24 1.47 -	0.9 2.1 1.3 -	7.7 39.6 25.7 -	489 931 751 -		

*Whole soft bodies analysed

Table 1c^2. Metals in Shellfish (on a dry weight basis) (cont'd)

							Concentration (mg/kg dry weight)						
Species	Area	Source	Country	Date of collect. 1979	Number in sample	Size (mm) (mean)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
*OYSTERS (cont'd) (*Crassostrea gigas*)	VIIe	E5 25	France	May	4 x 10	79-85 (82)	0.14 0.19 0.17 -	2.12 2.68 2.37 -	1.2 4.4 2.6 -	11.8 93.6 57.1 -	524 1444 1039 -		
	"	"	"	Sept.	3 x 10	79-83 (82)	0.08 0.22 0.14 -	1.68 5.42 3.32 -	2.2 4.0 3.1 -	2.3 167 75 -	2125 3511 2753 -		
	"	"	"	Dec.	3 x 10	100-108 (103)	0.14 0.30 0.21 -	1.78 2.39 1.99 -	0.3 3.7 1.7 -	48.6 82.5 64.0 -	1365 2407 1935 -		
	VIII	E7 24	"	March	4 x 10	80-120 (100)	0.23 0.38 0.29 -	1.88 2.33 2.06 -	1.3 4.6 2.6 -	51.0 98.5 63.0 -	1607 2983 2090 -		
	"	"	"	June	4 x 10	80-90 (84)	0.14 0.46 0.28 -	0.43 2.46 1.26 -	0.9 1.5 1.1 -	31.7 124 66.4 -	810 2751 1633 -		
	"	"	"	Sept.	4 x 10	76-80 (77)	0.07 0.27 0.18 -	0.96 1.32 1.16 -	1.7 2.0 1.9 -	36.1 74.8 53.9 -	1235 2093 1648 -		
	"	"	"	Dec.	4 x 10	85-90 (87.5)	0.18 0.38 0.26 -	1.31 2.32 1.79 -	1.2 1.6 1.4 -	43.3 98.5 62.5 -	1562 2983 2146 -		

*Whole soft bodies analysed

Table 1c^2. Metals in Shellfish (on a dry weight basis) (cont'd)

Species	Area	Source	Country	Date of collect. 1979	Number in sample	Size (mm) (mean)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
*OYSTERS (cont'd) (*Crassostrea gigas*)	VIII	E8 20 Baies de Marennes-Oleron	France	Apr.	5 x 10	65-110 (86)	0.56 0.81 0.67 -	4.93 7.22 6.42 -	1.3 4.4 3.0 -	164 364 285 -	2365 5859 3961 -		
	"	"	"	June	5 x 10	82-99 (93)	0.36 0.48 0.43 -	3.06 4.63 3.49 -	0.9 2.1 1.4 -	113 181 141 -	1772 2243 1966 -		
	"	"	"	Sept.	4 x 10	85-130 (104)	0.27 0.37 0.32 -	3.78 5.02 4.32 -	3.1 4.1 3.5 -	216 417 336 -	2176 3001 2431 -		
	"	"	"	Nov.	8 x 10	80-145 (112.5)	0.32 0.67 0.49 -	5.33 9.86 6.87 -	1.2 5.2 2.5 -	172 490 320 -	2285 3581 2742 -		
	"	"	"	Dec.	6 x 10	93-118 (105)	0.32 0.56 0.46 -	3.88 7.0 5.84 -	0.6 4.5 2.2 -	108 345 240 -	1817 2927 2416 -		
	VIII	E8 20 Estuaire de la Gironde	"	Apr.	2 x 10	70-95 (82)	0.47 0.47 0.47 -	22.2 36.0 29.1 -	2.6 2.8 2.7 -	607 1081 844 -	5727 8601 7164 -		

*Whole soft bodies analysed

Table 1c^2. Metals in Shellfish (on a dry weight basis) (cont'd)

							Concentration (mg/kg dry weight)						
Species	Area	Source	Country	Date of collect. 1979	Number in sample	Size (mm) (mean)	Hg min max MEAN s.d.	Cd min max MEAN s.d.	Pb min max MEAN s.d.	Cu min max MEAN s.d.	Zn min max MEAN s.d.	Cr min max MEAN s.d.	Ni min max MEAN s.d.
*OYSTERS (cont'd) (*Crassostrea gigas*)	VIII	E8 20 Estuaire de la Gironde	France	June	3 x 10	70-81 (74)	0.23 0.56 0.42 –	22.6 96.3 52.3 –	1.9 3.3 2.5 –	342 1450 972 –	2440 9994 6160 –		
	"	"	"	Sept.	3 x 10	55-90 (72)	0.16 0.19 0.18 –	33.7 62.0 44.7 –	3.8 4.1 3.9 –	507 1048 810 –	2539 5448 3940 –		
	"	"	"	Dec.	3 x 10	63-101 (82)	0.19 0.40 0.26 –	10.7 96.1 43.3 –	1.6 3.0 2.1 –	361 1013 705 –	2153 4140 3715 –		
	"	E8 18	"	March	4 x 10	70-90 (80)	0.24 0.44 0.33 –	1.12 2.51 1.64 –	2.0 5.3 3.2 –	42.6 102. 65.8 –	1559 2635 2058 –		
	"	"	"	June	5 x 10	79-100 (85)	0.17 0.29 0.23 –	1.12 1.46 1.28 –	0.6 2.3 1.1 –	49.1 220. 105. –	1165 2155 1573 –		
	"	"	"	Sept./ Oct.	7 x 10	58-100 (77)	0.10 0.25 0.18 –	0.73 2.03 1.45 –	0.8 3.5 2.8 –	57.2 81.2 70.4 –	1062 2277 1726 –		
	"	"	"	Dec.	4 x 10	63-88 (76)	0.01 0.26 0.18 –	0.73 2.76 1.82 –	0.1 1.0 0.6 –	39.9 70.4 51.8 –	1179 1872 1586 –		

*Whole soft bodies analysed

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis)

								Concentration (mg/kg)									
Area	Source	Country	Date of collect. 1979	No. analysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
								COD (Gadus morhua)									
IIIa	G1 43	Sweden		20	24-35.5 (30)	160-400 (260)		0.58	0.00017	0.00023					0.0026	0.015	5.8
IVb	F8 36	Germany, Fed.Rep. of	Sept.	20	37-46 (40.3)	610-950 (732)	M10 F10 2-4 yrs (3)	0.04	0.001							0.042	
								PLAICE (Pleuronectes platessa)									
IIIa	F8 43	Denmark	Aug.	20	29-53 (38)	225-1470 (639)	M5 F15 3-6 yrs (4.7)	0.70							<0.005	<0.05	
"	F9 44	"	Aug.	10	26-28 (27)	165-225 (202)	M7 F3 2-3 yrs (2.1)	0.49							<0.005	<0.05	
IVc	F2 31	France	May	5	31-38 (34.4)	390-560 (440)						0.0004 0.001 0.0007 –	0.001 0.002 0.001 –	0.002 0.003 0.002 –	0.0034 0.0057 0.004 –	0.021 0.062 0.034 –	8.5
"	F2 31	"	Sept.	5	24-27 (25.5)	187-272 (217)						0.003 0.004 0.003 –	0.001 0.002 0.001 –	0.003 0.007 0.005 –	0.007 0.013 0.009 –	0.035 0.070 0.053 –	5.9

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis) (cont'd)

Area	Source	Country	Date of collect. 1979	No. ana-lysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
							PLAICE (Pleuronectes platessa) (cont'd)										
VIId	E9/ FO 27	France	June	5	25-34.5 (30.3)	215-465 (365)						0.0006 0.007 0.005 –	0.0005 0.019 0.005 –	0.001 0.005 0.004 –	0.002 0.031 0.014 –	0.074 0.350 0.199 –	14.2
"	FO 28	"	April	6	24.5-27 (25.8)	160-235 (192)						0.0004 0.002 0.001 –	0.002 0.003 0.002 –	0.003 0.004 0.004 –	0.0054 0.009 0.007 –	0.023 0.131 0.060 –	8.6
"	E9/ FO 28	"	Sept.	5	27-28.5 (27.6)							0.001 0.003 0.002 –	0.0006 0.001 0.001 –	0.002 0.004 0.003 –	0.0036 0.008 0.006 –	0.055 0.136 0.101 –	16.8
VIIe	E8 26	"	May	6	28-36 (32.4)	260-490 (358)						0.0004 0.001 0.0008 –	0.002 0.003 0.003 –	0.002 0.014 0.010 –	0.0044 0.018 0.014 –	0.013 0.056 0.033 –	2.4
VIId	E8 28	"	"	6	21-35 (28.2)	105-480 (265)						0.0004 0.003 0.001 –	0.001 0.005 0.002 –	0.003 0.005 0.004 –	0.0044 0.013 0.007 –	0.018 0.12 0.052 –	7.4
VIII	E7 24	"	"	5	20-34 (26.4)							0.0003 0.0003 0.0003 –	0.001 0.003 0.002 –	0.002 0.004 0.003 –	0.0033 0.0073 0.0053 –	0.007 0.056 0.018 –	3.4

Concentration (mg/kg) applies to columns % fat through PCB/Σ DDT.

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis) (cont'd)

Area	Source	Country	Date of collect.	No. analysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	Concentration (mg/kg) % fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
			1979														
							PLAICE (Pleuronectes platessa) (cont'd)										
VIII	E7 23	France	May	6	21-30 (23.5)	120-450 (193)						0.0002 0.001 0.001 -	0.001 0.008 0.003 -	0.002 0.110 0.026 -	0.0032 0.119 0.030 -	0.010 0.081 0.040 -	1.3
"	"	"	Dec.	2	24-34.5 (27.2)	163-340 (252)						0.002 0.005 0.004 -	0.002 0.004 0.003 -	0.004 0.004 0.004 -	0.008 0.013 0.011 -	0.036 0.142 0.089 -	8.1
							FLOUNDER (Platichthys flesus)										
IVb	F8 39	Denmark	Oct.	8	22-30 (25)	118-348 (186)	M5 F3 2-3 yrs (2.5)	0.62							<0.005	<0.05	
"	F7 40	"	"	20	28-39 (34)	255-740 (491)	M6 F14 3-6 yrs (3.8)	0.49							<0.005	<0.05	
"	F7 41	"	Sept.	22	25-37 (30)	185-560 (320)	M5 F17 3-8 yrs (4.7)	0.53							<0.005	<0.05	
IIIa	F9 44	"	Aug.	6	30-34 (31)	295-400 (345)	M4 F2 2-4 yrs (3.2)	0.63							<0.005	<0.05	

Table 2a[1]. Organochlorines in Fish Muscle (on a wet weight basis) (cont'd)

								Concentration (mg/kg)									
Area	Source	Country	Date of collect.	No. analysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
			1979														
							FLOUNDER (Platichthys flesus) (cont'd)										
IIIa	G1 43	Denmark	Aug.	26	26-38 (30)	190-540 (313)	M5 F21 3-7 yrs (4.5)	0.68							<0.005	<0.05	
							DAB (Limanda limanda)										
IVb	F7 40	"	"	14	22-29 (25)	120-260 (163)	M4 F10 2-6 yrs (2.5)	0.75							<0.005	0.05	
"	F7 41	"	"	18	20-28 (26)	90-220 (163)	M5 F6 *7 2-3 yrs (2.7)	0.78							<0.005	0.07	
							EUROPEAN EEL (Anguilla anguilla)										
IVc	F5 35	Netherlands	June	9	32-47 (39)	52-174 (100)		11.9	0.05	0.04	0.03	0.03	0.03	-	0.06	2.5	41.7
"	F4 34	"	"	10	29-48 (41)	44-184 (116)		15.2	0.16	0.07	0.19	0.14	0.12	0.09	0.35	3.9	11.1
"	F3 32	"	"	10	35-48 (42)	69-201 (121)		15.4	0.19	0.06	0.04	0.06	0.07	0.01	0.14	5.0	35.7

*Sex unknown

Table 2a^2. Organochlorines in Fish Muscle (on a fat weight basis)

Area	Source	Country	Date of collect.	No. analysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	Concentration (mg/kg)									
								% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	$\frac{PCB}{\Sigma DDT}$
			1979														
COD (Gadus morhua)																	
IIIa	G1 43	Sweden		20	24-35.5 (30)	160-400 (260)		0.58	0.03	0.04					0.44	2.5	
EUROPEAN EEL (Anguilla anguilla)																	
IVc	F5 35	Netherlands	June	9	32-47 (39)	52-174 (100)		11.9	0.39	0.34	0.22	0.28	0.25	-	0.53	21.	
"	F4 34	"	"	10	29-48 (41)	44-184 (116)		15.2	1.1	0.47	1.3	0.97	0.81	0.57	2.4	26.	
"	F3 32	"	"	10	35-48 (42)	69-201 (121)		15.4	1.2	0.40	0.27	0.36	0.45	0.09	0.90	32.	

Table 2b[1]. Organochlorines in Fish Liver (on a wet weight basis)

								Concentration (mg/kg)									
Area	Source	Country	Date of collect.	No. ana-lysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
			1979														
COD (*Gadus morhua*)																	
IVc	F1 33	England/ Wales	Jan.	13	37-70 (54)	553-4244 (1945)	F9 M4 2+3 yrs				0.010 0.19 0.11 0.06	0.010 0.60 0.29 0.21	<0.005 0.27 0.059 0.076	0.010 1.2 0.18 0.31	0.15 1.3 0.53 0.31	0.62 6.9 2.4 1.7	4.5
"	F1 32	"	March	19	35-65 (47.6)	669-2636 (1486)	F 2+3 yrs				0.18 0.42 0.32 0.06	0.21 1.1 0.45 0.24	0.070 0.45 0.22 0.10	0.070 0.77 0.24 0.16	0.42 2.2 0.93 0.45	0.29 7.7 2.8 1.7	3.0
VIIa	E5 35	"	May	5*	27-37 (30.6)	159-410 (301)	F 1,3,6 yrs				0.35	1.2	1.2	0.36	2.8	0.51	0.18
VIIa	E6 36	"	June	5*	22-29 (26)	151-309 (233)	F 1 yr				0.20	0.58	0.51	0.11	1.2	3.4	2.8
VIIa	E6 35	"	Sept.	20**	28-40 (33)	242-779 (476)	F 1 yr				0.090 0.21 0.14 0.05	0.27 1.1 0.50 0.40	0.010 0.11 0.06 0.04	0.010 0.10 0.06 0.04	0.40 1.2 0.62 0.39	0.27 1.5 1.1 0.71	1.8
IVc	F4 34	Nether-lands	Nov.	25	68-80 (74)	3200-6350 (4686)	3.5 yrs	56.2	0.19	0.06	0.23	0.47	0.30	0.15	0.92	39.	42.4
IVb	F4 40	"	Feb. 1980	27	78-112 (96)		6 yrs	53.6	0.09	0.03	0.19	0.51	0.28	0.34	1.1	11.	10.
"	F8 36	Germany, Fed. Rep.	Sept.	20	37-46 (40.3)	610-950 (732)	M10 F10 2-4 yrs (3)	41.97	0.014							2.79	

*Bulked sample analysed

**Partially bulked sample analysed

Table 2b[1]. Organochlorines in Fish Liver (on a wet weight basis) (cont'd)

Area	Source	Country	Date of collect.	No. ana- lysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	Concentration (mg/kg)									
								% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
			1979														
								COD (Gadus morhua) (cont'd)									
	4T	Canada	Sept.	12	46.5-60.2 (52.5)	908-1858 (1307)	6 yrs	30.5 67.3 50.6 11.4	0.031 0.055 0.041 0.031	0.041[+] 0.089 0.069 0.041						1.47 3.93 2.51 0.683	
								PLAICE (Pleuronectes platessa)									
VIIa	E6 36	England/ Wales	June	10**	34-43 (38)	479-767 (602)	F 4-16 yrs				0.050 0.060 0.055 0.000	0.14 0.16 0.15 0.014	0.090 0.12 0.11 0.02	0.020 0.17 0.10 0.11	0.25 0.45 0.35 0.14	0.58 0.75 0.67 0.12	1.9
VIIa	E6 35	"	Sept.	20**	24-33 (28)	160-397 (259)	M11 F8 I1 2-5 yrs				0.060 0.080 0.067 0.01	0.10 0.37 0.20 0.12	0.040 0.080 0.055 0.020	0.030 0.12 0.055 0.044	0.18 0.46 0.31 0.12	0.79 1.3 1.1 0.23	1.3
								FLOUNDER (Platichthys flesus)									
VIIa	E6 35	England/ Wales	Oct.	5*	26-29 (27.4)	218-307 (266)	F				0.21	0.40	0.63	0.30	1.33	0.18	0.14
								EUROPEAN HAKE (Merluccius merluccius)									
VIIe	E4 28	Nether- lands	March 1980	32*	34-62 (46)	280-1850 (790)	3.5 yrs	57.2	0.05	0.01	0.10	0.12	0.06	0.10	0.28	5.7	20.4

[+] α-HCH

*Bulked sample analysed
**Partially bulked sample analysed

Table 2b[2]. Organochlorines in Fish Liver (on a fat weight basis)

								Concentration (mg/kg)									
Area	Source	Country	Date of collect.	No. analysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
			1979														
							COD (Gadus morhua)										
IVc	F1 33	England/ Wales	Jan.	13	37-70 (54)	553-4244 (1945)	F9 M4 2+3 yrs				0.040 0.92 0.41 0.25	0.020 1.9 1.1 0.56	0.050 0.87 0.21 0.25	0.020 13. 1.3 3.5	0.42 14. 2.5 3.5	3.0 54. 11. 14.	
"	F1 32	"	March	19	35-65 (47.6)	669-2636 (1486)	F 2+3 yrs				0.60 1.8 0.99 0.29	0.47 4.3 1.4 0.94	0.30 1.8 0.76 0.42	0.16 3.2 0.78 0.65	0.95 9.3 2.9 1.9	0.73 23. 8.7 5.4	
VIIa	E5 35	"	May	5*	27-37 (30.6)	159-410 (301)	F 1,3,6 yrs				1.1	3.8	3.8	1.1	8.7	1.6	
VIIa	E6 36	"	June	5*	22-29 (26)	151-309 (233)	F 1 yr				1.3	3.7	3.3	0.71	7.7	22.	
VIIa	E6 35	"	Sept.	20**	28-40 (33)	242-779 (476)	F 1 yr				0.27 0.66 0.46 0.22	0.72 3.1 1.5 1.1	0.020 0.33 0.20 0.16	0.030 0.38 0.21 0.16	0.90 3.5 1.9 1.1	0.81 4.3 3.4 1.7	
IVc	F4 34	Netherlands	Nov.	25*	68-80 (74)	3200-6350 (4686)	3.5 yrs	56.2	0.33	0.11	0.41	0.83	0.53	0.26	1.6	63.	
IVb	F4 40	"	Feb. 1980	27*	78-112 (96)		6 yrs	53.6	0.16	0.05	0.36	0.94	0.52	0.63	2.1	21.	

*Bulked sample analysed
**Partially bulked sample analysed

Table 2b^2. Organochlorines in Fish Liver (on a fat weight basis) (cont'd)

								Concentration (mg/kg)									
Area	Source	Country	Date of collect.	No. ana-lysed	Length (cm) (mean)	Weight (g) (mean)	Sex and age or year class	% fat min max MEAN s.d.	HCB min max MEAN s.d.	γ-HCH min max MEAN s.d.	Dieldrin min max MEAN s.d.	DDE min max MEAN s.d.	TDE min max MEAN s.d.	p,p'DDT min max MEAN s.d.	Σ DDT min max MEAN s.d.	PCBs min max MEAN s.d.	PCB / Σ DDT
			1979														
							PLAICE (Pleuronectes platessa)										
VIIa	E6 36	England/	June	10**	34-43	479-767	F				0.94	2.2	1.4	0.31	3.9	12	
		Wales			(38)	(602)	4-16				1.0	3.3	2.5	3.5	9.4	12	
							yrs				0.97	2.8	2.0	1.9	6.7	12	
											0.04	0.78	0.78	2.3	3.9	0.0	
VIIa	E6 35	"	Sept.	20**	24-33	160-397	M11				0.25	0.41	0.16	0.12	0.74	3.2	
					(28)	(259)	F8				0.47	2.5	0.41	0.6	3.1	7.8	
							I1				0.34	1.1	0.28	0.27	1.6	5.4	
							2-5				0.09	0.96	0.12	0.22	1.0	1.9	
							yrs										
							FLOUNDER (Platichthys flesus)										
VIIa	"	"	Oct.	5*	26-29	218-307	F				0.82	0.63	0.30	1.2	5.2	0.70	
					(27.4)	(266)											
							EUROPEAN HAKE (Merluccius merluccius)										
VIIe	E4 28	Nether-	March	32*	34-62	280-1850	3.5	57.2	0.09	0.02	0.17	0.21	0.11	0.17	0.49	10.	
		lands	1980		(46)	(790)	yrs										

*Bulked sample analysed
**Partially bulked sample analysed

Table 2c. Organochlorines in Shellfish

							Concentration (mg/kg dry weight)					
Species	Area	Source	Country	Date of collect.	Size (mm) (mean)	Number in sample	DDE min max MEAN	DDD min max MEAN	p,p'DDT min max MEAN	Σ DDT min max MEAN	PCBs min max MEAN	PCB / Σ DDT
*BLUE MUSSEL (*Mytilus edulis*)	IIIa	G1 43	Denmark	1979 Aug.	42.0±7.4	50				<0.03	<0.35	
	"	F9 44	"	Aug.	38.6±4.5	50				<0.03	<0.35	
	VIId	F1 30	France	June	45	2 x 100	3.20 3.20 3.20	43.0 64.3 53.6	72.0 84.0 78.0	118.2 151.5 134.8	237 237 237	1.76
	"	"	"	Sept.	28-38 (33)	2 x 100	18.5 23.6 21.0	101.1 130.2 115.6	69.8 84.9 77.4	189.4 238.7 214.0	1085 1095 1090	5.09
	"	FO 28 Baie de Seine	"	Feb.	37-55 (48)	3 x 100	1.72 1.82 1.78	55.0 72.0 61.6	2.05 22.9 9.0	58.8 96.7 72.4	8225 10427 9400	130.
	"	"	"	June	20-50 (38)	5 x 100	2.5 74.5 42.9	3.6 48.6 24.4	15.1 65.7 40.8	21.2 188.8 108.1	1555 9474 4660	43.
	"	"	"	Dec.	46-50 (48)	2 x 100	59.0 150. 104.5	39.8 41.9 40.8	9.3 41.1 25.2	133.3 233. 170.5	5081 7546 6314	37.
	VIId	FO 28	"	April	40-50 (45)	2 x 100	17.3 18.1 17.7	16.9 36.7 26.8	28.9 61.0 45.0	63.1 115.8 89.5	716 1055 885	9.9
	"	"	"	Sept.	37-47 (42)	2 x 100	13.1 13.2 13.2	3.0 25.2 14.1	5.1 22.0 13.6	21.2 60.4 40.9	1110 1494 1302	31.8

*Whole soft body tissues analysed

Table 2c. Organochlorines in Shellfish (cont'd)

							Concentration (mg/kg dry weight)					
Species	Area	Source	Country	Date of collect.	Size (mm) (mean)	Number in sample	DDE min max MEAN	DDD min max MEAN	p,p'DDT min max MEAN	Σ DDT min max MEAN	PCBs min max MEAN	PCB / Σ DDT
				1979								
*BLUE MUSSEL (Mytilus edulis) (cont'd)	VIId	FO 28	France	Dec.	32-45 (38.5)	2 x 100	68.2 87.7 78.0	26.3 28.9 27.6	31.8 35.8 33.8	126.3 152.4 139.4	1681 2865 2273	16.3
	VIIe	E7 26	"	March	32-57 (44)	3 x 100	6.3 7.1 6.6	2.5 5.0 3.9	36.9 56.2 45.9	45.7 68.3 56.4	258 306 274	4.8
	"	"	"	Sept.	35-47 (40)	3 x 100	7.3 26.4 13.7	35.7 114.2 64.8	31.6 84.1 50.0	74.6 224.7 128.5	26 272 165	1.3
	"	"	"	Dec.	34-48 (43.3)	3 x 100	0.7 14.3 7.5	6.0 10.8 8.4	6.6 17.6 12.1	13.3 42.7 28.0	227 313 270	9.6
	VIII	E7 23	"	March	35-40 (38)	4 x 100	18.9 37.3 29.4	14.7 28.7 22.7	1.9 9.8 3.9	35.5 75.8 51.5	595 1762 1159	22.5
	"	"	"	June	38-48 (40)	4 x 100	1.3 15.1 6.6	5.4 12.5 7.8	5.3 13.9 7.7	12.0 41.5 22.1	71 2112 638	28.9
	"	"	"	Sept.	38-53 (43)	4 x 100	9.2 21.7 14.2	8.7 31.2 22.5	11.6 39.7 24.7	29.5 92.6 61.4	928 1444 1138	18.5
	"	"	"	Dec.	41-46 (43)	4 x 100	71.4 87.6 78.7	39.0 49.4 43.0	25.3 46.7 32.4	135.7 183.7 154.1	1208 1861 1525	9.9

*Whole soft body tissues analysed

Table 2c. Organochlorines in Shellfish (cont'd)

Species	Area	Source	Country	Date of collect.	Size (mm) (mean)	Number in sample	Concentration (mg/kg dry weight)					
							DDE min max MEAN	DDD min max MEAN	p,p'DDT min max MEAN	Σ DDT min max MEAN	PCBs min max MEAN	$\frac{\text{PCB}}{\Sigma\ \text{DDT}}$
*OYSTERS (*Crassostrea gigas*)	VIIe	E6 26	France	1979 Dec.	80-103 (91)	5 x 10	1.9 18.3 8.5	6.6 16.4 11.1	9.4 60.1 23.0	17.9 94.8 42.6	254 382 323	7.6
	"	E5 25	"	May	79-85 (82)	4 x 10	7.3 7.3 7.3	18.8 63.0 36.1	139. 293. 192.	165. 363. 235.	41.5 112. 73.6	0.3
	"	"	"	Sept.	79-83 (82)	3 x 10	9.2 12.2 10.4	6.8 10.5 8.1	9.8 19.8 13.2	25.8 42.5 31.7	278 352 316	10.
	"	"	"	Dec.	100-108 (103)	3 x 10	5.5 27.5 15.3	5.2 14.5 8.7	19.2 43.8 31.8	29.9 85.8 55.8	483 563 529	9.5
	VIII	E7 24	"	March	80-120 (100)	4 x 10	6.9 40.0 21.7	7.3 13.0 9.8	33.8 36.5 35.7	48.0 89.5 67.2	350 628 508	7.6
	"	"	"	June	80-90 (84)	4 x 10	2.7 18.7 10.4	9.4 47.1 25.7	14.4 27.6 18.5	26.5 93.4 54.6	305 813 454	8.3
	"	"	"	Sept.	76-80 (77)	4 x 10	8.9 21.8 14.7	6.3 10.0 7.5	14.5 25.3 20.8	29.7 57.1 43.0	244 331 279	6.5
	"	E7 27	"	Dec.	85-90 (87.5)	4 x 10	3.7 22.9 15.8	0.6 74.2 22.2	17.9 100.7 39.8	22.2 197.8 77.8	378 702 497	6.4

*Whole soft body tissues analysed

Table 2c. Organochlorines in Shellfish (cont'd)

							Concentration (mg/kg dry weight)					
Species	Area	Source	Country	Date of collect.	Size (mm) (mean)	Number in sample	DDE min max MEAN	DDD min max MEAN	p,p'DDT min max MEAN	Σ DDT min max MEAN	PCBs min max MEAN	$\frac{\text{PCB}}{\Sigma\text{ DDT}}$
*OYSTERS (*Crassostrea gigas*) (cont'd)	VIII	E8 20 Baies de Marennes-Oleron	France	1979 April	65-110 (86)	5 x 10	29.6 61.4 45.6	16.4 55.0 26.9	28.7 134.3 65.8	74.7 250.7 138.3	350 804 647	4.7
	"	"	"	June	82-99 (93)	5 x 10	5.3 12.3 8.0	9.8 60.0 35.7	28.3 73.1 56.6	43.4 145.4 100.3	34.8 412. 258.	2.6
	"	"	"	Sept.	85-130 (104)	4 x 10	13.1 27.9 21.3	18.7 85.1 46.0	14.6 118.2 58.5	46.4 231.2 125.8	258 347 315	2.5
	"	"	"	Nov.	80-145 (112.5)	8 x 10	11.1 35.5 21.5	14.4 68.5 30.3	16.8 86.4 36.7	42.3 190.4 88.5	289 781 484	5.5
	"	"	"	Dec.	93-118 (105)	6 x 10	18.7 46.2 29.8	16.7 81.0 46.9	21.8 123. 43.4	57.2 250. 120.	206 563 365	3.0
	"	E8 20 Estuaire de la Gironde	"	April	70-95 (82)	2 x 10	25.6 28.0 26.8	25.5 26.9 26.2	9.8 221. 115.4	60.9 276. 168.	595 731 663	3.9
	"	"	"	June	70-81 (74)	3 x 10	1.3 9.7 4.2	6.5 92.5 36.0	5.3 381.5 131.3	13.1 483.7 171.5	52 121 87	0.5

*Whole soft body tissues analysed

Table 2c. Organochlorines in Shellfish (cont'd)

							Concentration (mg/kg dry weight)					
Species	Area	Source	Country	Date of collect.	Size (mm) (mean)	Number in sample	DDE min max MEAN	DDD min max MEAN	p,p'DDT min max MEAN	Σ DDT min max MEAN	PCBs min max MEAN	PCB / Σ DDT
*OYSTERS (*Crassostrea gigas*) (cont'd)	VIII	E8 20 Estuaire de la Gironde	France	1979 Sept.	55-90 (72)	3 x 10	13.1 23.2 18.1	30.0 35.6 33.2	24.7 48.8 36.1	67.8 107.6 87.4	303 429 378	4.3
	"	"	"	Dec.	63-101 (82)	3 x 10	14.6 16.5 15.8	25.7 65.6 41.8	21.4 27.4 23.5	61.7 109.5 81.1	319 799 505	6.2
	"	E8 18	"	March	70-90 (80)	4 x 10	21.6 52.6 37.1	15.7 134.8 62.1	58.9 444. 206.5	96.2 631. 305.7	281 618 437	1.4
	"	"	"	June	79-100 (85)	5 x 10	4.6 32.3 12.7	62.1 206.9 100.3	96.5 275. 150.5	163.2 514.2 263.5	198 393 265	1.0
	"	"	"	Sept./ Oct.	58-100 (77)	7 x 10	22.1 40.8 29.9	47.9 103.9 69.2	32.1 540. 179.4	102.1 684.7 278.5	171 225 200	0.7
	"	"	"	Dec.	63-88 (76)	4 x 10	38.0 174.5 77.4	65.1 204.1 115.	122.7 584.3 352.2	225.8 963. 544.6	158 290 206	0.4

*Whole soft body tissues analysed

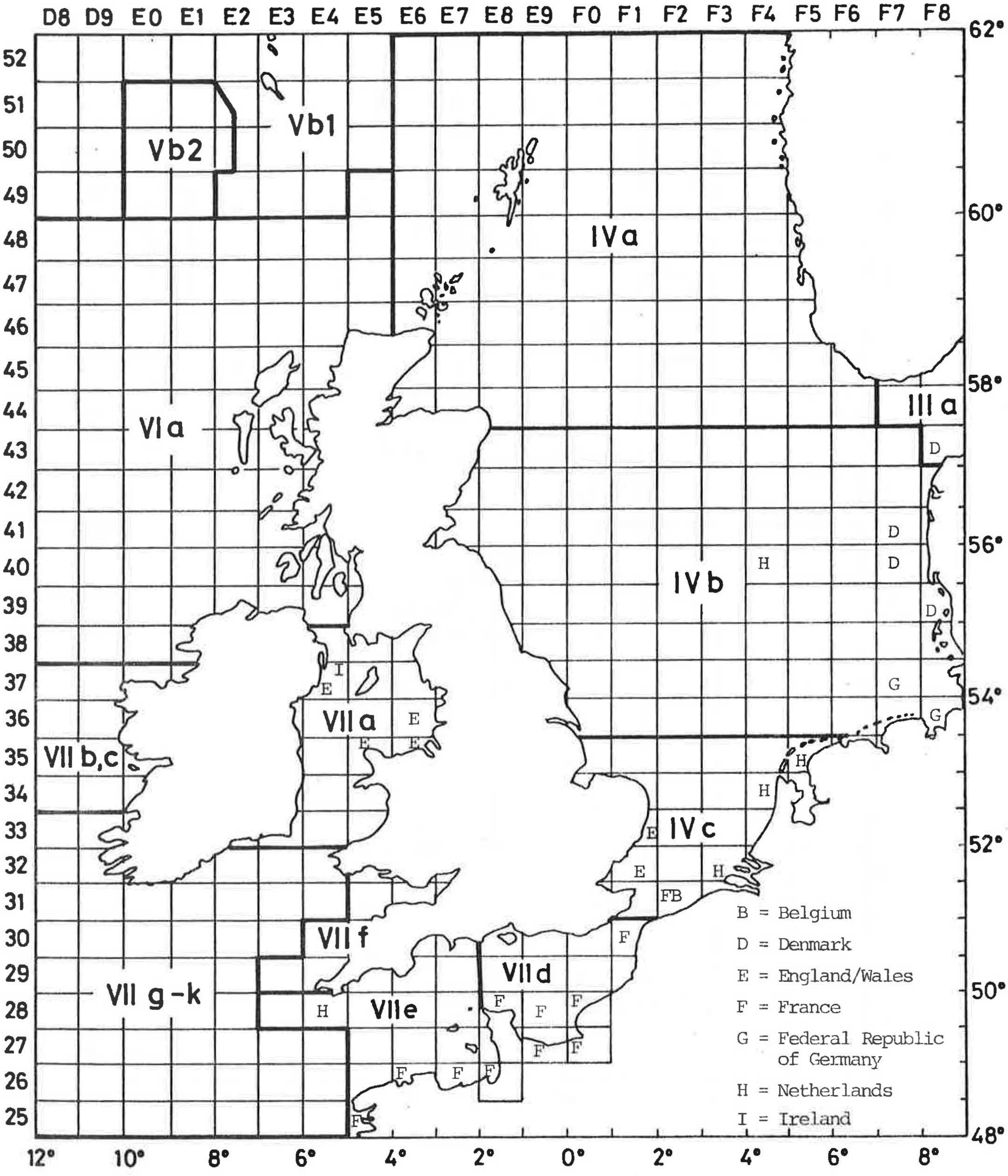


Figure 5. Areas in the North Sea, Irish Sea, and English Channel sampled by named countries, 1979.

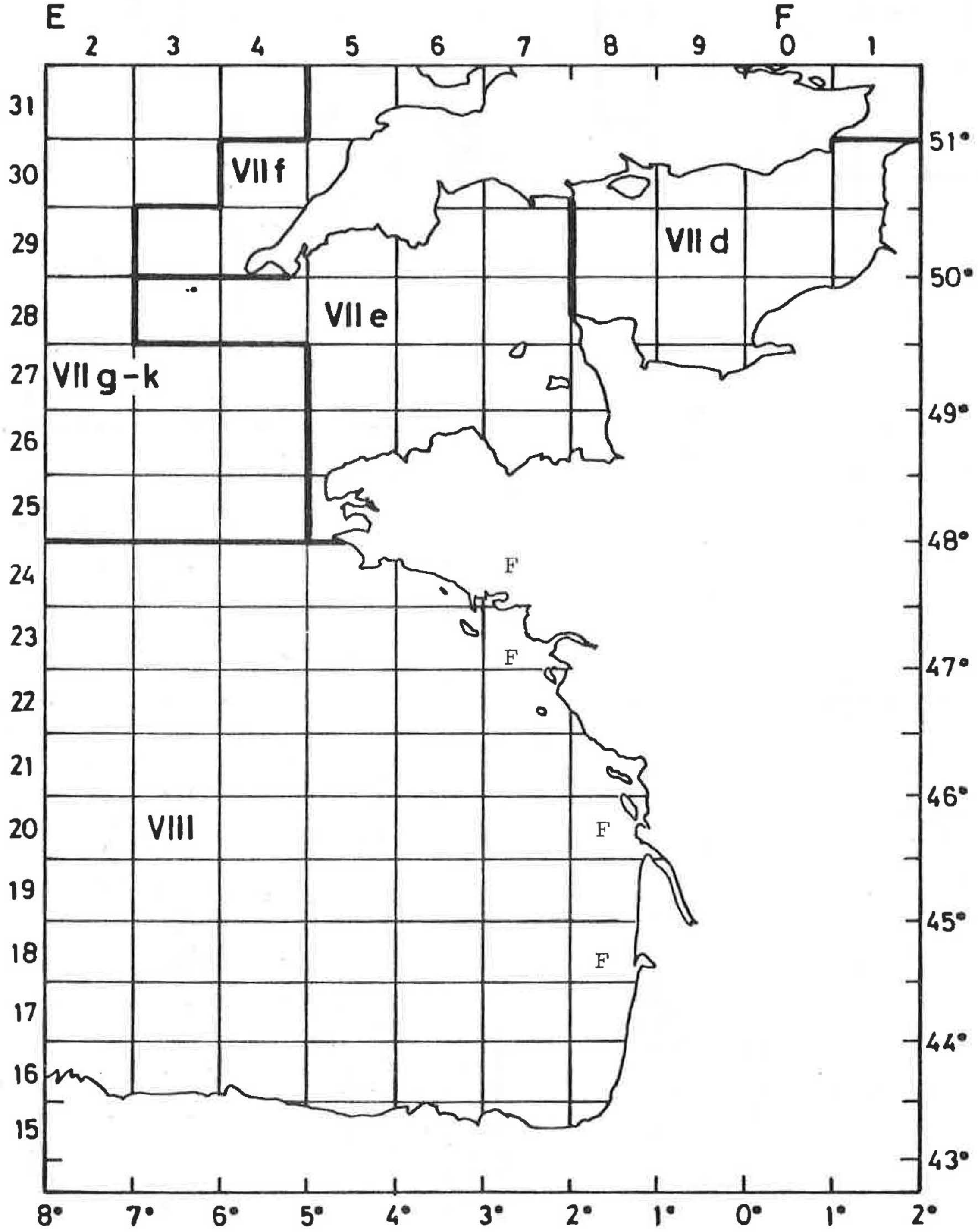


Figure 6. Areas sampled on the west coast of France, 1979.

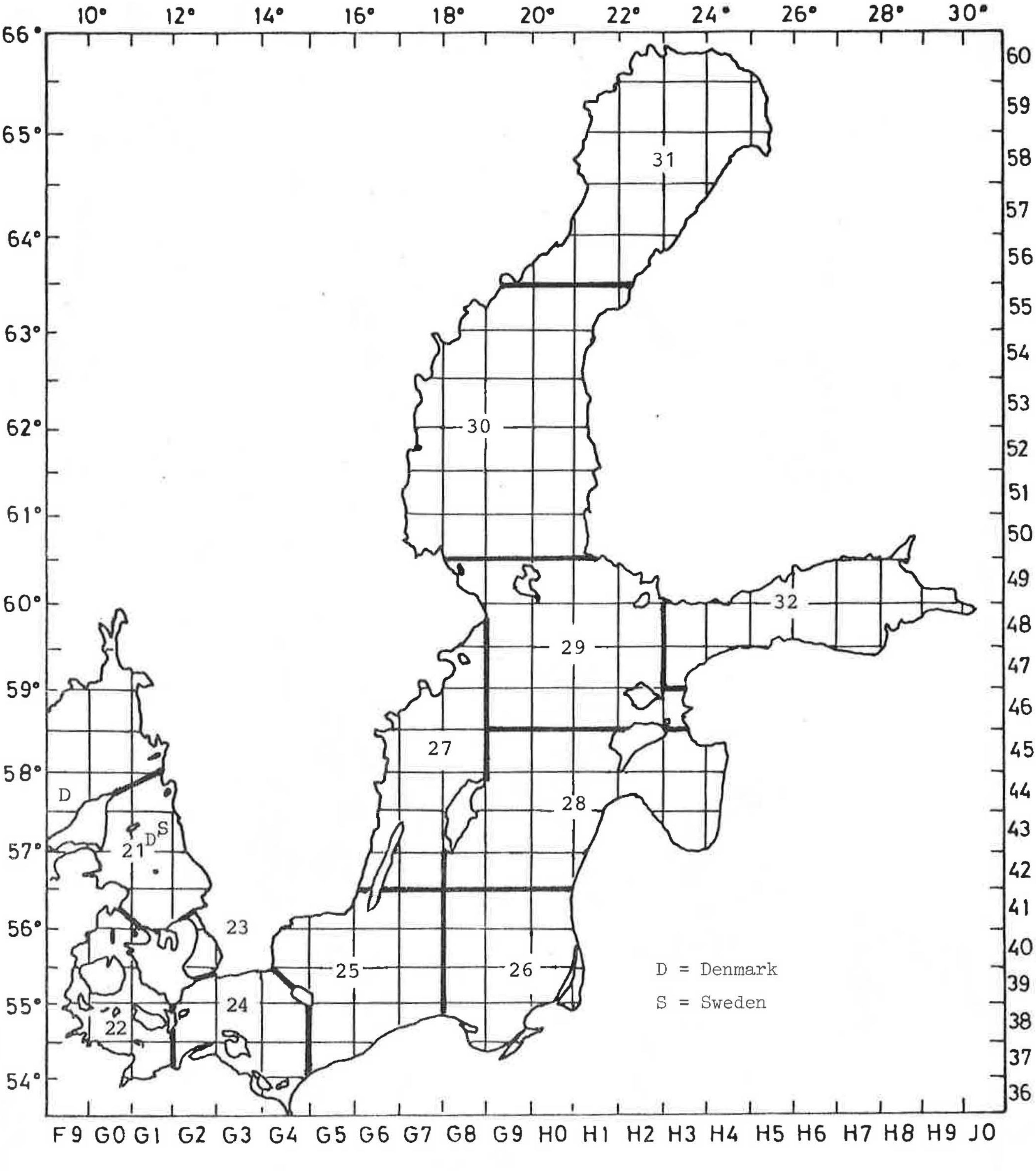


Figure 7. Areas sampled in the Kattegat and Skagerrak, 1979

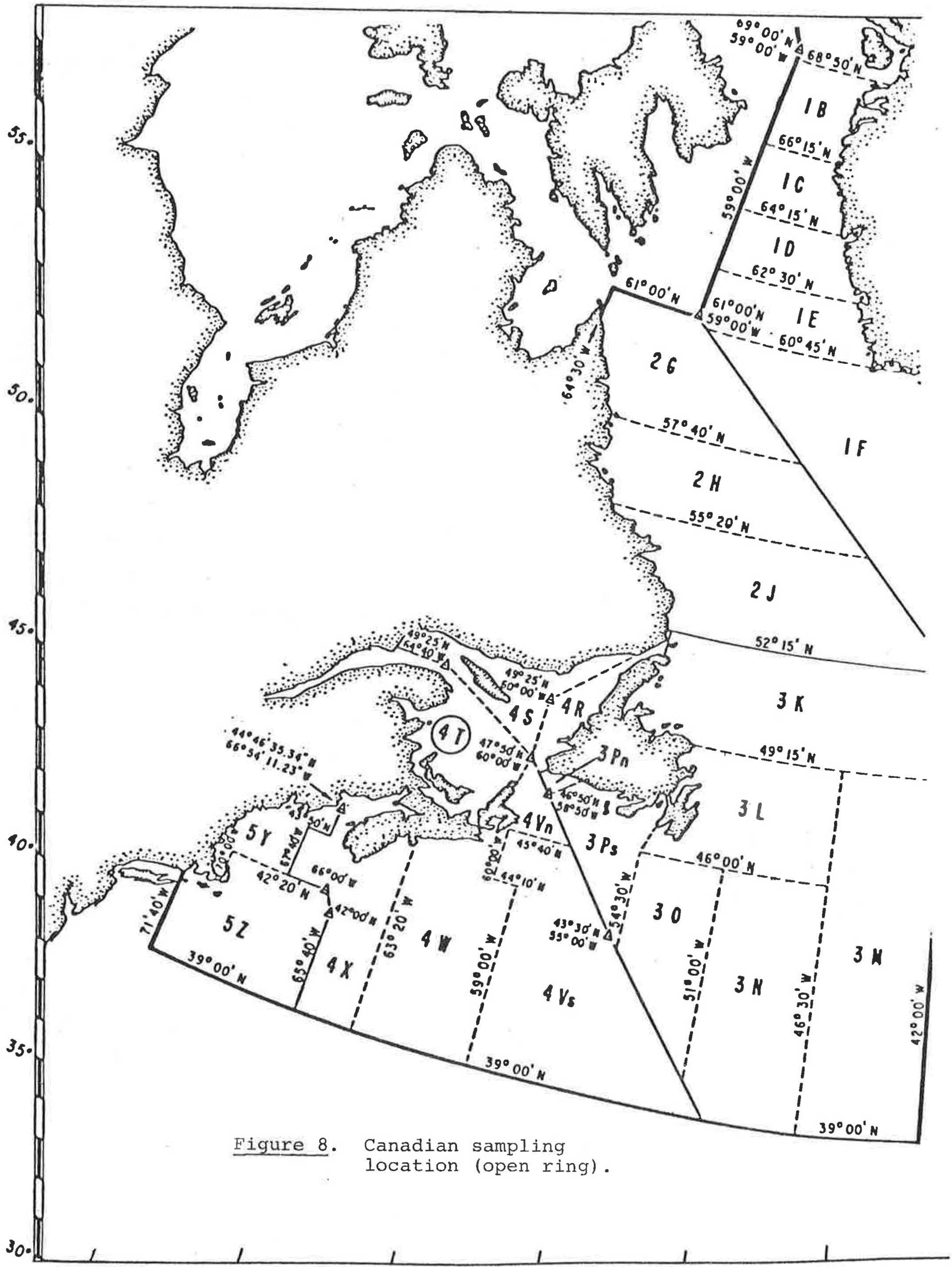


Figure 8. Canadian sampling location (open ring).

SIX-YEAR REVIEW OF ICES COORDINATED MONITORING PROGRAMMES IN THE NORTH ATLANTIC*

1. Introduction

In 1972 ICES conducted a baseline study of pollutants in fish and shellfish in the North Sea (ICES, 1974) and in 1974, 1975 and 1976 further investigations were undertaken, on a monitoring basis, in those areas which the baseline study indicated were contaminated to the greatest extent (ICES, 1977a and 1977b). In 1975 the baseline study was effectively repeated, but on this occasion over the entire North Atlantic area, extending west to include the eastern sea-board of North America, and the coast of Portugal to the south, including in the process areas off Iceland and Greenland and off the western coasts of the United Kingdom and Ireland (ICES, 1977c and 1980a).

Since it was known that marine organisms accumulate most of the contaminants of current concern, there was considerable interest in whether edible species were seriously contaminated; consequently, the emphasis in both baseline studies was placed on the determination of residue levels in fish and shellfish. At the same time, however, it was recognised that other activities should be pursued, e.g., analysis of sea water samples and sediments to confirm or support distribution patterns revealed by the fish and shellfish survey, and that biological effects studies should be pursued as soon as practicable. To this end, since 1974, various activities have been pursued, within the ICES framework, to establish the practicality of such investigations on a coordinated basis. Where gaps were obvious, strenuous attempts have been made to fill them. An intercalibration programme for sea water analysis for metals is now at the fifth round ship-borne exercise stage, a review of the quality of much of the existing data on metals in sea water has been completed (Topping _et al._, 1980), workshops on sediments and biological effects monitoring techniques have been held and a Working Group on marine sediments in relation to pollution has been established.

For the baseline study of contaminant levels in fish and shellfish in the North Atlantic, it was recognised that no single species would be available throughout the entire area and that where possible more than one species ought to be collected for each area. Accordingly, the following species were selected: cod (_Gadus morhua_), sole (_Solea solea_), hake (_Merluccius merluccius_), plaice (_Pleuronectes platessa_), herring (_Clupea harengus_), capelin (_Mallotus villosus_), pilchard (_Sardina pilchardus_), Greenland halibut (_Reinhardius hippoglossoides_) and deep-sea prawn (_Pandalus borealis_). In an early attempt to reduce variations which it was considered would be caused by physiological factors induced by season, age, etc., it was decreed that all samples should be of a specified year class and that all samples should be collected during a three-month period. Each sample was to consist of 10 individuals and guidelines were established as to where samples should be obtained and by which country or countries. Finally, brief guidelines were set out as to how the samples should be analysed and for what determinands.

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The determinands selected for both the 1972 and the 1975 baseline surveys were: organochlorine pesticide residues, polychlorinated biphenyls (PCBs), mercury, cadmium, lead, copper and zinc. In the 1975 North Atlantic Baseline Study, where possible, organic mercury and polychlorinated terphenyls (PCTs) were to be included. If individual countries wished to do so, it was agreed that other contaminants could be included at their discretion. In practice, few countries did include any other determinands; nobody reported data for PCTs and very few for organic mercury.

To run in parallel with both baseline studies, it was agreed that all participating laboratories should take part in an analytical intercalibration exercise for metals and for organochlorine pesticide residues and PCBs. The inclusion of results from the analysis of fish or shellfish samples was to be conditional on reasonable agreement being achieved with the consensus values obtained in the course of the intercalibration exercise. No clear limits were laid down as to what was meant by reasonable agreement but in practice, especially in the conduct of the North Atlantic Baseline Study, it was agreed that most analysts were able to achieve a satisfactory level of competence for most determinands. The major exceptions to this were hexachlorocyclohexane (HCH), lead and cadmium. In the event, all reported results were included in the baseline study reports. However, comments were made, particularly in the report on the North Atlantic Baseline Study, about the probable doubtful validity, especially of the higher reported values, for lead and cadmium.

2. Findings of the North Atlantic Baseline Study

One of the main objectives of the extended Baseline Study was to establish how the trace metal levels in fish from the more open ocean fishing grounds compared with those from the more enclosed areas, such as the Irish Sea and southern North Sea. Assumptions were made as to the probable important physiological variables in an attempt to limit the possibility of variations in residue concentrations being caused by differences in sample material. However, subsequent work has shown that these assumptions may not have taken account of all the important variables, and that, as a result, the measures taken may not have been entirely successful. Additionally, in spite of the intercalibration programme, the level of agreement obtained among analysts was not perfect and the possibility of differences being caused by analytical discrepancies cannot be entirely ruled out. Nevertheless, in spite of these reservations, clear differences are discernable between some areas and some general statements can be made.

As expected, the results tended to confirm that the trace metal levels were lower in fish from areas which were the least likely to be affected by industrial inputs. The only metal which gave any real cause for concern, even close to land, was mercury, which in several areas was detected in concentrations clearly above the background level (maximum in individual fish was as high as 1.5 mg/kg wet weight, although all means were below 0.5 mg/kg). The main areas which appeared to be affected were the German Bight, the Bristol and English Channels, the Irish Sea - especially the northeastern sector - and possibly the Gulf of St. Lawrence. Standards or guidelines have been adopted by a number of countries for the acceptable concentration of mercury in fish tissues for human consumption; for the ICES countries these range from 0.5 mg/kg to 1.0 mg/kg wet weight for individual fish. An average of 0.3 mg/kg wet weight for all fish species typically consumed locally has been agreed as a standard for countries applying discharge controls by Environmental Quality Objective (EQO) methods under the Paris Convention and the EEC Dangerous Substances Directive in relation to discharges of mercury to coastal waters from chlor-alkali plants.

Although a substantial number of positive values were reported for lead and cadmium, the intercalibration studies clearly indicated that the positive values at the higher end of the range were of doubtful validity, and that typically the true concentration of cadmium in fish muscle tissue was about 0.00X mg/kg and for lead 0.0X mg/kg wet weight. Copper and zinc concentrations in fish were generally below 1 and 10 mg/kg, respectively, in muscle tissue and there was little variation in the concentrations found regardless of the source of the fish, although there did appear to be some differences between species. Such concentrations are well below the levels generally accepted as being harmful to man; indeed both elements are regarded as essential with a wide safety margin between normal intake and dangerous levels (FAO/WHO 1967, 1976). The same overall pattern of lower concentrations in fish from the more open ocean fishing grounds, as compared to those nearer to land, was shown by the results of the survey of organochlorine pesticide and PCB residues. The areas which appeared to be most affected by contamination with residues of these compounds were the Irish Sea, the Southern Bight of the North Sea and the Gulf of St. Lawrence. In no case were any of the residue concentrations considered likely to give particular cause for concern, either from the standpoint of the well-being of the fish or the safety of their consumption by man.

The only pesticide residue which was found in concentrations close to the limits set for foodstuffs was dieldrin, for which the usually accepted limit is 0.1 mg/kg. A few samples of fish were examined in which the concentration in liver tissues exceeded this concentration. However, although fish livers are consumed in many countries, the livers of the fish from the area concerned are not normally consumed and the highest concentration in fish muscle tissue was much lower (0.017 mg/kg). All the highest values were found in fish from the North Sea. However, it should be pointed out that several of the laboratories which contributed to the baseline studies (and also the subsequent monitoring programme) used methods of analysis which preclude the determination of dieldrin.

Concentrations of PCBs in fish muscle tissue were generally found to be low. For example, in the North Atlantic Baseline Survey concentrations in excess of 0.1 mg/kg were only very rarely recorded, even in herrings which contain fairly high quantities of lipid and might be expected to contain the greatest concentrations of such residues in muscle tissue. However, much higher concentrations were reported in the fatty liver tissues of cod from certain areas. Particularly high concentrations (mean 19.6 mg/kg) in one sample of cod from the southern North Sea and concentrations of between 1/3 and 1/2 of this value were reported in other cod liver samples from the North Sea and in hake livers from the English Channel. Although livers from these fish are unlikely to be used for human consumption, fish livers are consumed in some ICES countries and such concentrations would exceed guideline standards set in a number of countries, e.g., for the USA, 5 mg PCB/kg wet weight of fish.

3. Decision to proceed with Coordinated Monitoring

In the light of the findings of the North Atlantic Baseline Study (including the rather later results for the east coast of the USA (ICES, 1980a)), it was decided that for much of the area no regular repeat surveys were necessary. However, it was concluded that it was desirable that the situation should be kept under annual review in the following areas, where higher than average concentrations had been found for one or more pollutants: Irish Sea, German Bight, Southern Bight of the North Sea, the estuaries of the Forth, Thames, Rhine, Scheldt and Clyde, the Skagerrak, Kattegat and Oslo Fjord, plus certain parts of the Gulf of St. Lawrence and the New York Bight. Additionally, it was agreed that in view of the limited amount of information available for the area off Portugal more data should be collected. It was therefore agreed that those countries with interests in these areas should supply to ICES, on an annual basis, the results of analyses of samples of fish and shellfish which they collect as part of their national monitoring programmes from the areas in question.

Restrictions were placed on the type of data which would be accepted. Additional strength was given to the requirement that the contributing laboratory should have taken part in an ICES intercalibration exercise and achieved results which match the consensus values for the determinands concerned. In the light of this requirement, since that date, some data for lead, cadmium and PCBs have been rejected and thus not been included in the published monitoring reports. The main reasons for rejection have been the reporting of high positive results for lead and cadmium by laboratories with obviously high detection limits, since it is known that the true concentrations of lead and cadmium in fish muscle are very low (Topping, 1982). Some PCB data submitted by laboratories which reported either very low or very high results (i.e., greater than three standard deviations from the consensus mean value) in the intercalibration exercises have also been rejected. The guidelines for sampling and preparation of samples for analysis have continually been updated and elaborated in the light of experience gained and all countries have been expected to adhere as closely as practicable to these guidelines. In practice, few participants have observed all the guidelines, although most participants have observed most of them.

However, in the light of experience from the North Atlantic Baseline Study and earlier from the North Sea Baseline Study and the subsequent monitoring programme, it was agreed that to attempt to specify a single sampling period which would apply throughout the area was quite impracticable. Instead, it was recommended that for any one area samples should be collected by the sampling country at the same time of the year and from the same place. This allowed for considerable variation in the sampling period from area to area, but was intended to ensure that for any one area the samples obtained were comparable from year to year. Although this was meant to improve the prospects of making realistic comparisons of data collected within any one area, it was recognised that it would mean that the comparison of data on an area to area basis would be impossible, except where substantial differences in concentrations were apparent.

Also, in the light of sampling difficulties for certain species in certain areas, it was agreed that the list of species which could be used should be extended to include mussels (Mytilus edulis) and brown shrimps (Crangon crangon). More recently, in the light of investigations being pursued in fora such as the Joint Monitoring Group of the Oslo and Paris Commissions, flounder (Platichthys flesus) and scallops (Pecten maximus) have been added.

As mentioned earlier, the guidelines for sampling have been amended from time to time and in 1978 it was agreed that sample sizes should be increased to at least 50 specimens for mussels, at least 100 specimens for shrimps and at least 10, preferably 20, individuals for fish. Recommendations were also made as to how the samples should be processed, i.e., bulked or individually analysed.

4. Results of the Coordinated Monitoring Programme thus far

In the following brief resume of the results thus far, all results, except where specifically stated otherwise, are expressed on a wet weight basis. Full details of the results of each year of monitoring, together with a more complete discussion, will be found in the Cooperative Research Reports by ICES (ICES, 1977a, 1977b, 1980b and this volume). Only a very brief review of the data obtained is undertaken here, but Figures 1 to 8 and 10 to 14 show the areas in which samples were collected each year by each country. Figure 9 shows the general area covered by the Coordinated Monitoring Programme, while Figures 15 and 16 show the number of years in which samples were taken from each major area.

4.1 Metals

The concentrations of copper and zinc in fish muscle tissue were found to be generally below 1 and 10 mg/kg, respectively, in the baseline survey regardless of species or area. There have been no major departures from this initial finding, although there is now fairly clear evidence that a few species, notably flounder, herring and sardine/pilchard, do appear to accumulate rather higher concentrations of these metals than other species of fish. Additionally, occasional samples of fish from one area or another are reported to contain more copper or zinc than is usual for that species. Since most species of bony fish can in fact regulate the content of copper or zinc in their muscle (Pentreath, 1973 and 1976), these apparently higher than usual values are probably caused by sample or analysis contamination.

The data for lead and cadmium have slowly improved in quality and few results now have to be rejected. On the other hand, the majority of analysts are using methods which only allow them to report that the concentration in fish muscle is below a particular level of detection. Only a very few analysts are routinely using methods which allow them to report actual concentrations, although their work does confirm that the concentrations are always low, usually 0.00X mg/kg for cadmium and 0.0X mg/kg for lead.

With the possible exception of the northeastern Irish Sea, there has been little evidence of any major change in the concentrations of mercury reported from any of the areas studied, at least for the species on which comparable data are available. Mean concentrations in the range 0.2 to 0.5 mg/kg were still reported, for example, in samples of flounder collected in 1977 from the Irish Sea and the Southern Bight of the North Sea. However, the concentrations of mercury found in flounders collected in 1978 and 1979 from these two areas were somewhat lower (maximum 0.34 and 0.32 mg/kg, respectively), a pattern which has been confirmed by more detailed UK studies of both inputs and concentrations in fish (Preston and Portmann, 1981) and the 1979 results (maximum 0.32 mg/kg). As in the Baseline Survey, the concentrations of mercury in species such as cod and plaice have been below 0.2 mg/kg in most samples.

The baseline studies clearly showed that for all metals except mercury the concentrations found in shellfish are generally higher than those found in fish muscle. The quantity of data which has been supplied on the concentrations of metals in shellfish is really too small and too variable for any meaningful comparisons to be made from year to year. Nevertheless, although the number of results available for shellfish in the course of the monitoring programme are limited, they tend to confirm the findings of the baseline study.

4.2 Organochlorine pesticide and PCB residues

The results of the coordinated monitoring of organochlorine pesticide residues in fish have almost all shown low concentrations of these residues. There does appear to be some variation in the levels reported from year to year, but this may well be due to physiological differences induced by sampling at different seasons, etc., especially during the years 1976 and 1977. For example, in 1976 most of the concentrations in muscle tissue of the DDT group of residues were reported to be below the usually reported detectable concentration of 0.001 mg/kg. However in 1977, a substantial proportion of the results exceeded the detectable concentration of 0.001 mg/kg, although most were still below 0.01 mg/kg.

No particularly high concentrations of dieldrin have been reported in either fish liver or muscle tissue in samples from the Southern Bight of the North Sea, since the Baseline Study in 1975. The highest concentrations of this pesticide in fish muscle tissue were reported in fish from the Clyde estuary, e.g., 0.013 mg/kg in plaice and 0.068 mg/kg in herring in 1977. It is, however, known that this area was subjected to unusually high dieldrin inputs in the past and there is evidence from UK data that inputs have declined, and that the concentration of dieldrin in herring from the area is decreasing. The area of contamination is not extensive and samples from elsewhere along the West Coast of Scotland contain low concentrations of dieldrin.

Concentrations of PCBs in the muscle tissue of plaice, cod and whiting have generally not exceeded 0.1 mg/kg, although in herring occasional higher concentrations are reported. The general geographical distribution observed in the 1975 Baseline Study of the highest concentrations of PCBs usually being found in samples from either the North Sea or Irish Sea has continued. The concentration of PCBs is usually much higher in the livers of cod and whiting: 10 to 20 mg/kg is not uncommon in samples from these areas, and 39 mg/kg was reported in one sample of cod liver collected in 1979 from the Southern Bight of the North Sea. The geographical distribution of PCB residues, as shown by the concentrations found in fish muscle tissues, is much the same as that shown by the residues found in their liver tissues. Certainly up to 1979 there was no clear evidence of any overall decline in concentrations of residues of PCBs, although a decline might perhaps have been expected in the light of restrictions on the manufacture and use of PCBs applied in the early 1970s.

Apart from the fact that, as with PCBs, the general level of concentration of organochlorine pesticide residues is higher in fish livers than in muscle, little more can be said. The overall pattern of distribution and concentration levels has not obviously changed since 1975.

The quantity of data available on either PCBs or organochlorine pesticide residues in shellfish is very limited and no general statements can be made.

5. The need for changes to the existing programme

During the course of the meetings of the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic in 1979, 1980 and 1981, the question of the aims of the coordinated monitoring programme were discussed. Following a meeting of chemists, biologists and statisticians prior to the 1981 meeting, three separate objectives were confirmed:

(1) the provision of a continuing assurance of the quality of marine foodstuffs with respect to human health;

(2) the provision over a wide geographic area of an indication of the health of the marine environment in the entire ICES North Atlantic area;

(3) to provide an analysis of trends over time in pollutant concentrations in selected areas, e.g., estuaries and coastal waters, especially in relation to the assessment of the efficiency of control measures.

All three of these objectives, whilst obviously also of interest to other organisations, are of clear interest to ICES. All three fall within the ICES area of interest in the general investigation of the quality of the marine environment. The monitoring of, and where practical recommendation for, actions to alleviate or control pollution of the marine environment is of particular importance to the activities of the ICES Advisory Committee on Marine Pollution (ACMP). Here again, studies to meet all three objectives are likely to be of relevance in this more applied context.

It is, therefore, recommended that monitoring under the auspices of ICES should continue. However, the programme as currently conducted does not provide all the answers to the three questions, and it is doubtful whether the answers it does provide are obtained in as cost effective a way as possible, i.e., with the minimum of sampling and analysis. Bearing in mind that the control ICES can exert is limited to advice and voluntary contributions, it is also recommended that future activities be known not as coordinated but as Cooperative Monitoring Studies.

The discussion of objectives and the recommendations which follow for this Cooperative Monitoring programme take account of developments made progressively through the 1979 and 1980 meetings of the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic and finalised at the 1981 meeting of that Working Group on the basis of advice derived from a joint meeting of chemists, biologists and statisticians. These recommendations were approved by ACMP in the course of its 1981 meeting, and all countries are urged to adopt the new guidelines as soon as practicable.

In relation to objective (1) (monitoring the quality of marine foodstuffs with respect to human health), the information obtained so far goes some way towards answering the questions raised but, in so far as the range of species is limited, it is likely that certain countries do not obtain, either from their own or others' efforts, data on species which are of particular interest to them. There is therefore a case for extending the range of species which are used.

Under the existing programme, samples are only supposed to be collected from those areas which were identified as being the most contaminated or from areas where the information base is very limited. Consequently, provided the residue concentrations found are considered acceptable on human health grounds, i.e., levels of contaminants are well below defined tolerance limits, there is unlikely to be a need, in relation to objective (1), to analyse samples of fish or shellfish from other areas. However, since under the existing programme it is recommended that the samples should be of a restricted size range (which may or may not coincide with that normally consumed), the results obtained up to now may not be totally satisfactory from a human health risk assessment standpoint. Additionally, the current instructions require analysis of all samples, if at all possible, once per year on an individual fish basis. Since a mean value representing what is normally consumed is all that is necessary in order to meet objective (1) requirements, it is not necessary to analyse fish on an individual basis. This conclusion takes account of the fact that residue concentrations are usually log-normally distributed, but unless the levels are close to the limit of those considered acceptable, replicate analysis of a bulked sample is considered adequate. It is, however, important that the sample collected reflect as accurately as possible the pattern of human consumption and the new sampling recommendations (Appendix 1) provide for this.

In relation to objective (2) (a geographical baseline study of contaminant distribution), the current programme specifies only a limited number of areas for monitoring and specifically excludes unnamed areas. It therefore follows that good geographical coverage cannot be provided, although those areas which were judged most likely to be sensitive are included in the programme. There is clearly scope for the cooperative monitoring programme to cater for a wider geographical area, although this would place an onus on all ICES countries bordering the North Atlantic to make a contribution to the programme. Such broad geographical scale studies would provide an opportunity to review the health of the marine environment throughout the ICES North Atlantic area. This would provide an on-going mechanism for the review of which areas are most contaminated. However, since concentrations are unlikely to change rapidly over the entire area of interest, and those areas of particular concern will be assessed more frequently under objective (3), this type of survey need not be repeated very frequently.

It is obvious from even a cursory look at the replication of sample collection from year to year that it is unlikely that the data obtained are really suitable to answer the question implicit in objective (3), namely monitoring trends in concentrations of contaminants. Reference to the work done, specifically to establish what biological parameters are important and what size of samples need to be analysed in order to be able to show trends, clearly demonstrates that changes will be required to meet objective (3). Unfortunately, a substantial analytical work load is likely to be involved in each case. In practice, this is likely to restrict the study of trends to a limited number of pollutants in a limited number of areas and, specifically, those areas which have been, or in future will be, identified as most heavily contaminated, although the techniques recommended may be applicable even in uncontaminated areas. Since in some areas, the topics of interest in this context will be of concern to several countries there is an opportunity for sharing of the work-load, which, as a consequence, for any one country need not be excessive.

Since, in most cases, national authorities will, at least for national purposes, but possibly also in order to meet international obligations, wish to conduct trend studies in any areas around their own coasts which happen to be contaminated, the ease with which agreement on work sharing can be achieved is probably greatest in the trend type of study. Nevertheless, in view of the wide area to be covered, serious attempts should be made to divide up the work on a reasonably equitable basis so that all three objectives are met in as full a sense as possible. Failure to reach and adhere to agreement on this point will inevitably mean that large areas will not be catered for, whilst in others there will be pointless duplication and waste of effort.

6. Reporting format and method for future Cooperative ICES Monitoring Studies

In this six-year review, three aims of monitoring have been identified, each requiring different approaches. A set of methodological guidelines for each has been developed (Appendix 1).

It is recognised that the cooperative studies will be carried out according to national priorities concerning areas, contaminants and species. As a result, some divergence from the guidelines may be unavoidable. However, it is believed that the guidelines represent the best procedures that can at the present time be recommended for the objectives identified; the guidelines have been developed drawing on more than six years of experience of ICES coordinated monitoring and experimental studies. Accordingly, it is strongly recommended that they should, as far as possible, be followed by all laboratories which contribute to the cooperative programme.

Data from studies carried out under these guidelines should be presented, at the recommended intervals, by each country, together with brief commentaries on the significance of the results obtained in the reporting year as compared to previous years. These commentaries are regarded as essential for the data obtained to meet Food Quality/Public Health (objective (1)) and Hot Spot trend monitoring (objective (3)) aims and are optional for the 5-year repeat baseline survey (objective (2)) aims.

The ICES Environment Officer will compile these national data sets into separate reports concerning Food Quality/Public Health Studies, Geographic Baseline Studies and Trend Monitoring Studies and shall make use of the national commentaries to prepare commentaries to each report, adding any overall conclusions which may seem appropriate. These reports will be reviewed by the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic. The draft as amended by this Working Group will be reviewed and approved for publication by the ACMP as a continuation of the series previously described as Coordinated Monitoring Reports.

Data collected nationally using methods other than those recommended in the guidelines for cooperative studies may be reported separately to the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic in a brief written summary of national pollution baseline and monitoring programmes. Such reports should place particular emphasis on the criteria and strategy of the study (i.e., why was it done, what is the problem, how is it being tackled, what are its implications).

Areas, species and pollutants of interest

Although it is recognised that the selection of areas, species and pollutants for which analysis is performed will vary depending upon national priorities, it is possible to specify certain areas and pollutants which are of particular interest in an international context. Thus, in the light of the baseline studies and coordinated monitoring to date, it is desirable that countries ensure that at least the following areas are adequately covered for both human health assurance and temporal trend analysis purposes: the estuaries of the Forth, Thames, Rhine, Scheldt and Clyde, the Skagerrak, Kattegat and Oslo Fjord, the Irish Sea, German Bight and Southern Bight of the North Sea, certain parts of the Gulf of St. Lawrence and the US middle-Atlantic Bight, and the area off Portugal. This advice does not exclude data from other areas.

The species of particular interest in an ICES context are cod or hake, plaice, flounder, mackerel (*Scomber scombrus*), mussels and shrimps, but data for other species are also required. Due to the present restrictions on catching herring throughout much of the ICES area, this species is not included in the programme recommendations.

The pollutants of particular interest in both fish muscle and liver tissue or other fatty tissue that can be dissected out and weighed are PCBs, HCB, DDT and its metabolites; mercury is of particular interest in fish muscle, and in shellfish and fish liver, cadmium and lead are of special interest.

Frequency and commencement of surveys; reporting of results

Surveys for the purpose of meeting objective (3) should be conducted annually commencing no later than 1982. Surveys for the purpose of meeting objective (1) should be reported every 2 years, commencing in 1982. Surveys for the purpose of meeting objective (2) should be conducted every 5 years with the first repeat survey being undertaken in 1985.

In order to ensure comparability of data from all contributing laboratories, intercalibration exercises should be conducted from time to time for all determinands. The frequency of such exercises should not be less than once every five years. If, between intercalibration exercises, new laboratories or analysts become involved they should analyse samples from earlier exercises and/or take part in a bilateral exercise with one of the established laboratories. The first of these continued exercises should take place not later than 1983 so as to coincide with the preparations for the 1985 repeat Baseline Survey.

All data should be reported to the Environment Officer of ICES not later than 30 June of the calendar year after that in which samples are taken, together with details of the laboratory(s) which conducted the analyses and which ICES intercalibration exercise they have completed most recently. The ICES Interim Reporting Format for Contaminants in Fish and Shellfish should be used for submitting these data.

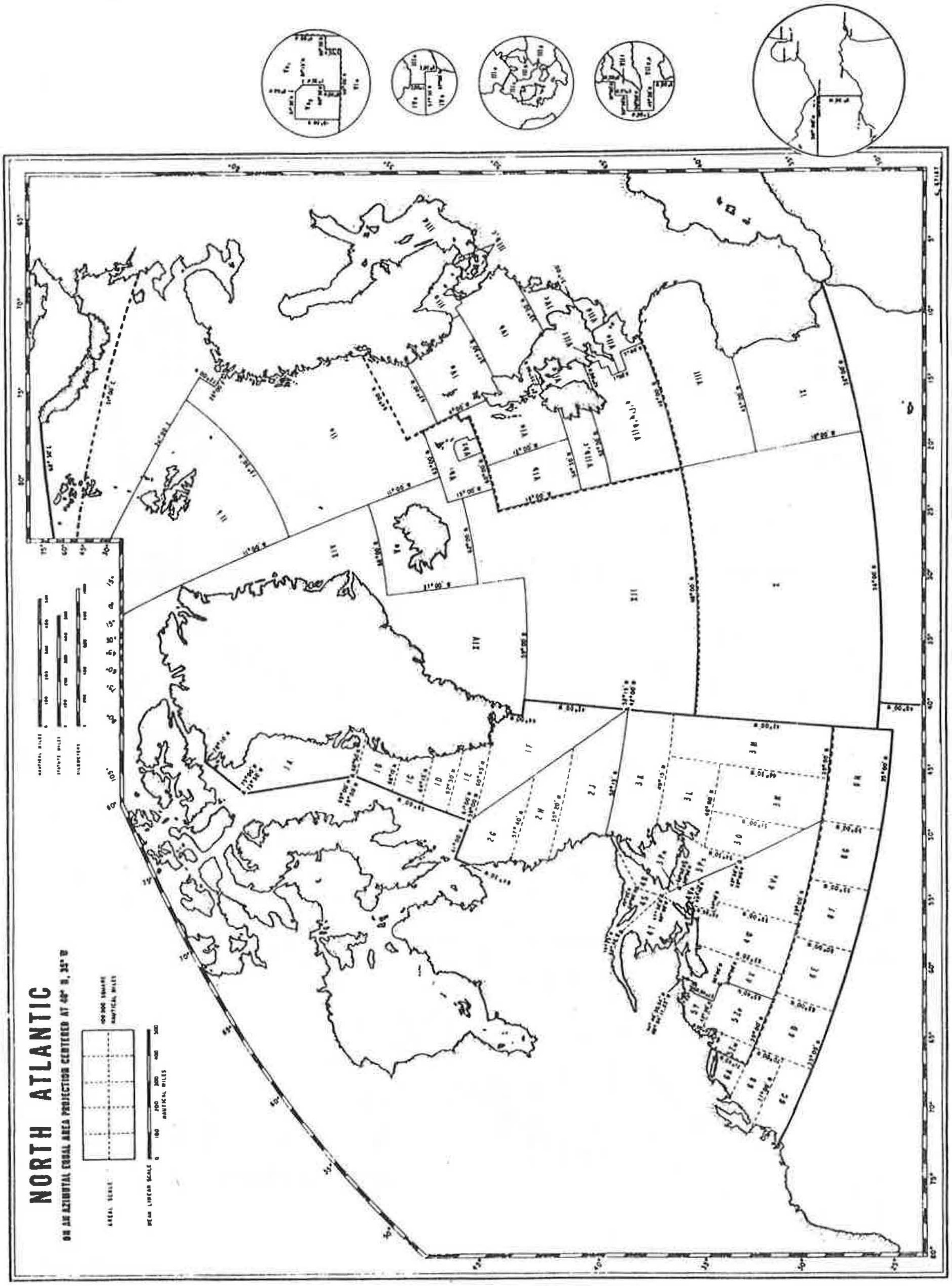

Figure 9. General area covered by the Coordinated Monitoring Programme.

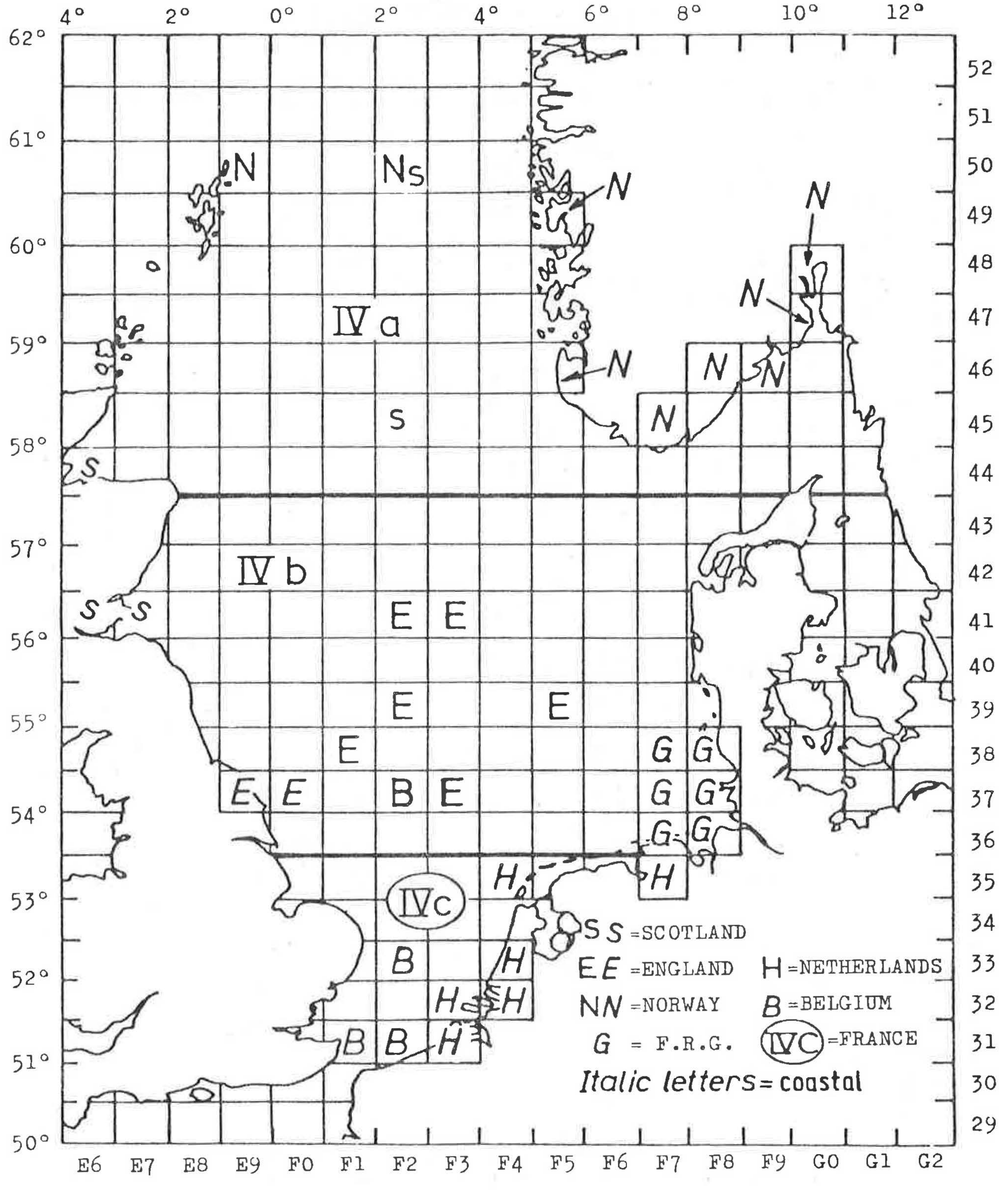

Figure 10. Localities sampled by named countries in 1974.

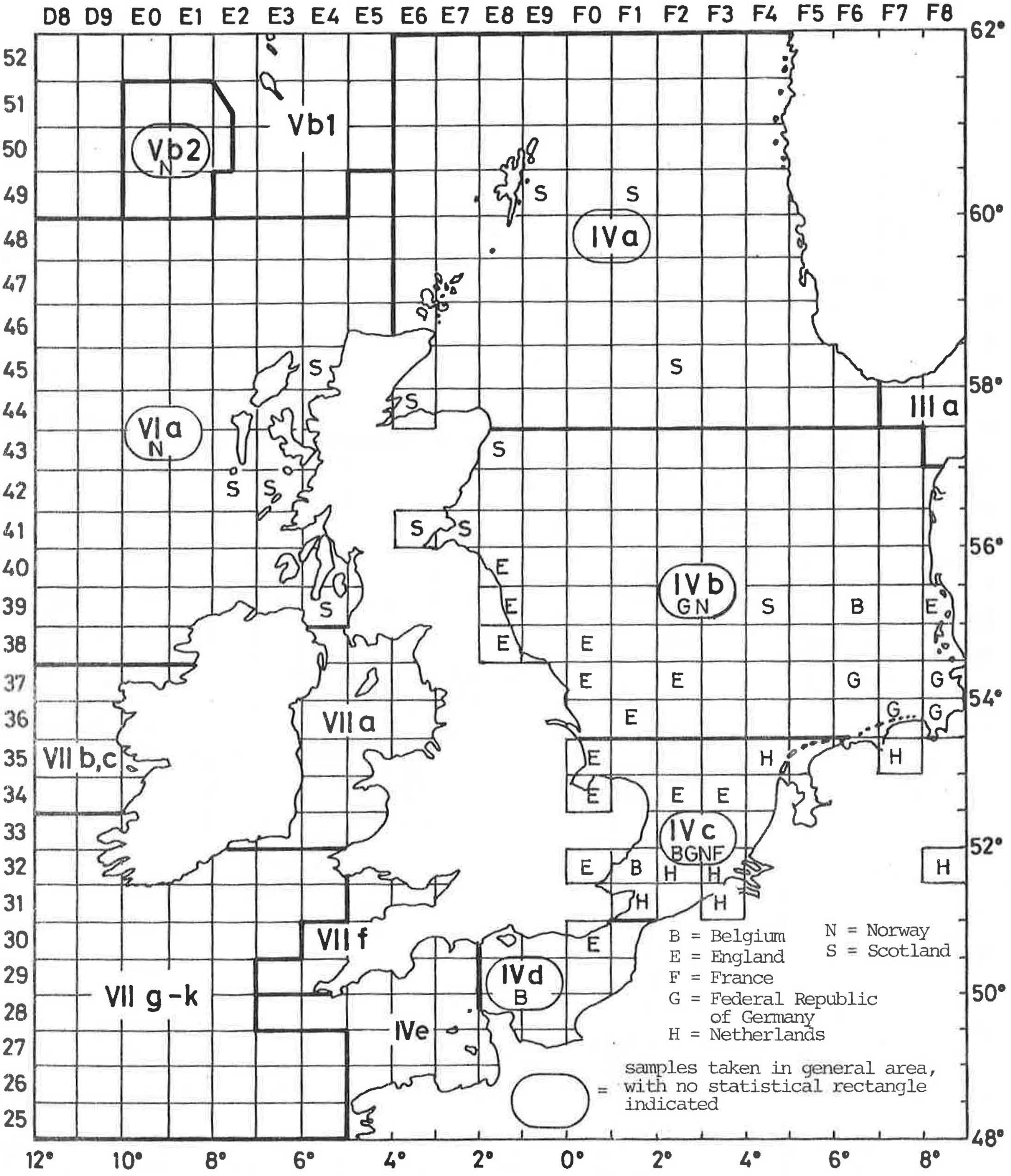

Figure 11. Localities sampled by named countries in 1975

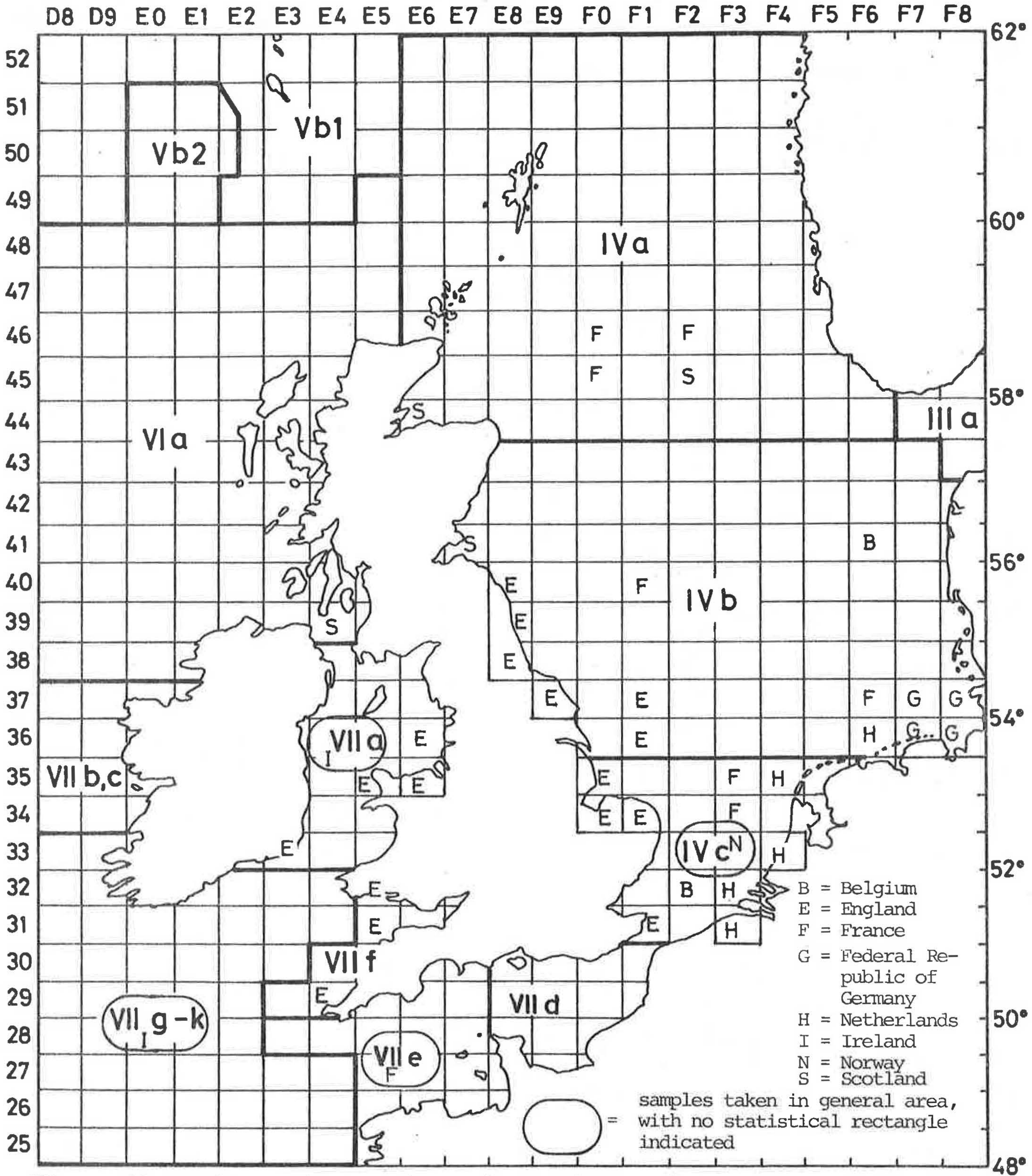

Figure 12. Localities sampled by named countries in 1976.

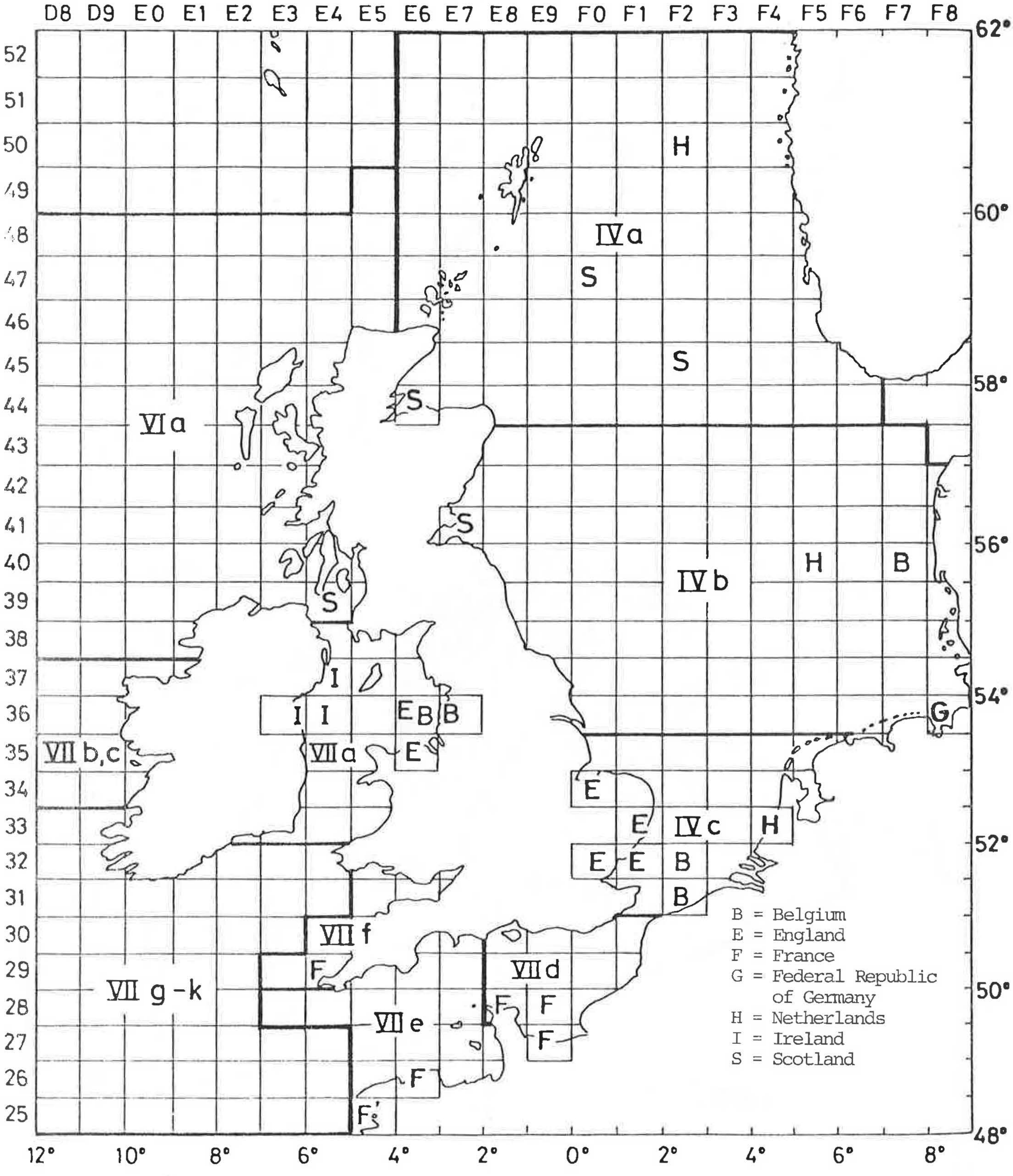

Figure 13. Localities in Northeast Atlantic sampled by named countries in 1977.

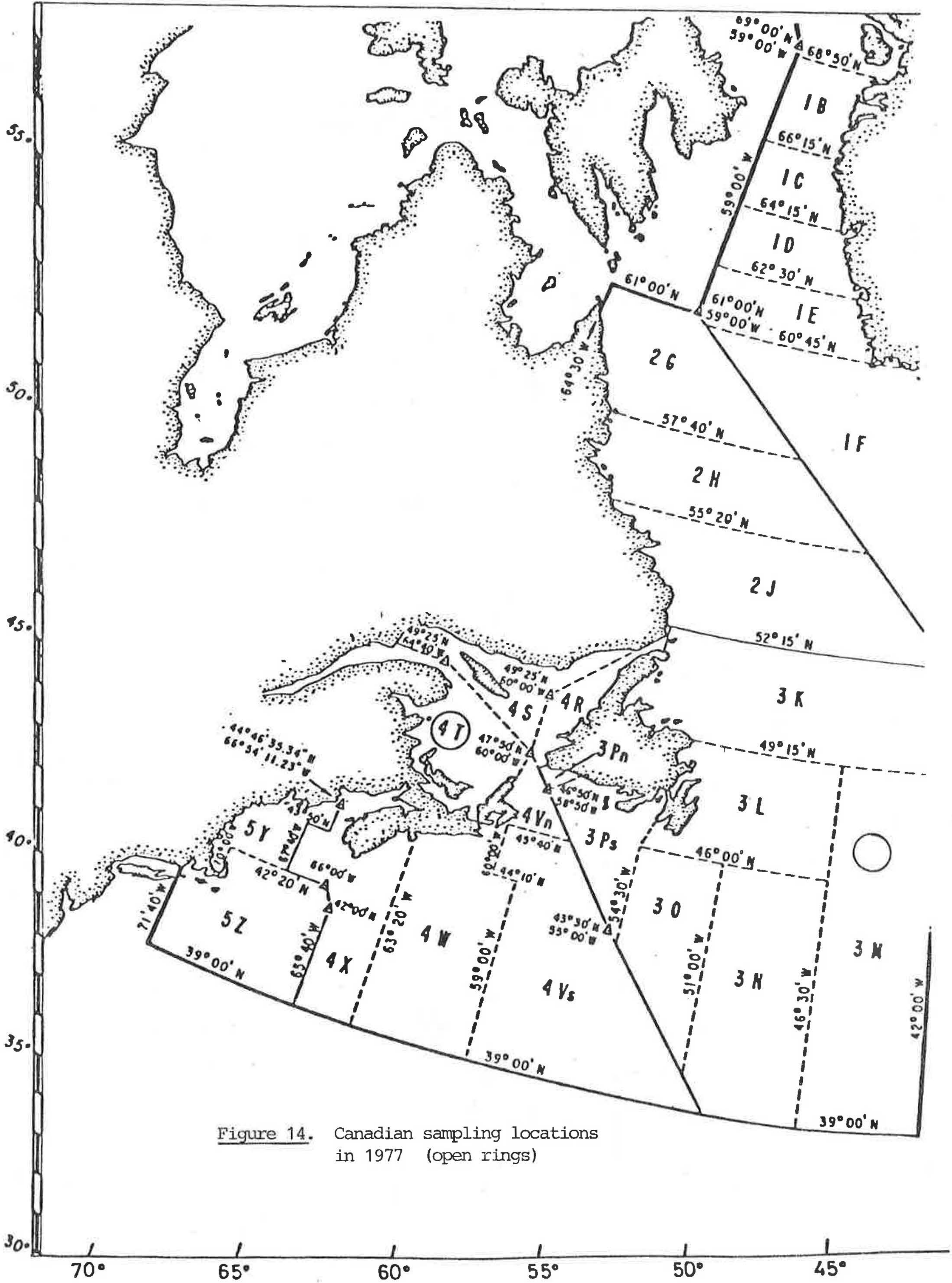

Figure 14. Canadian sampling locations in 1977 (open rings)

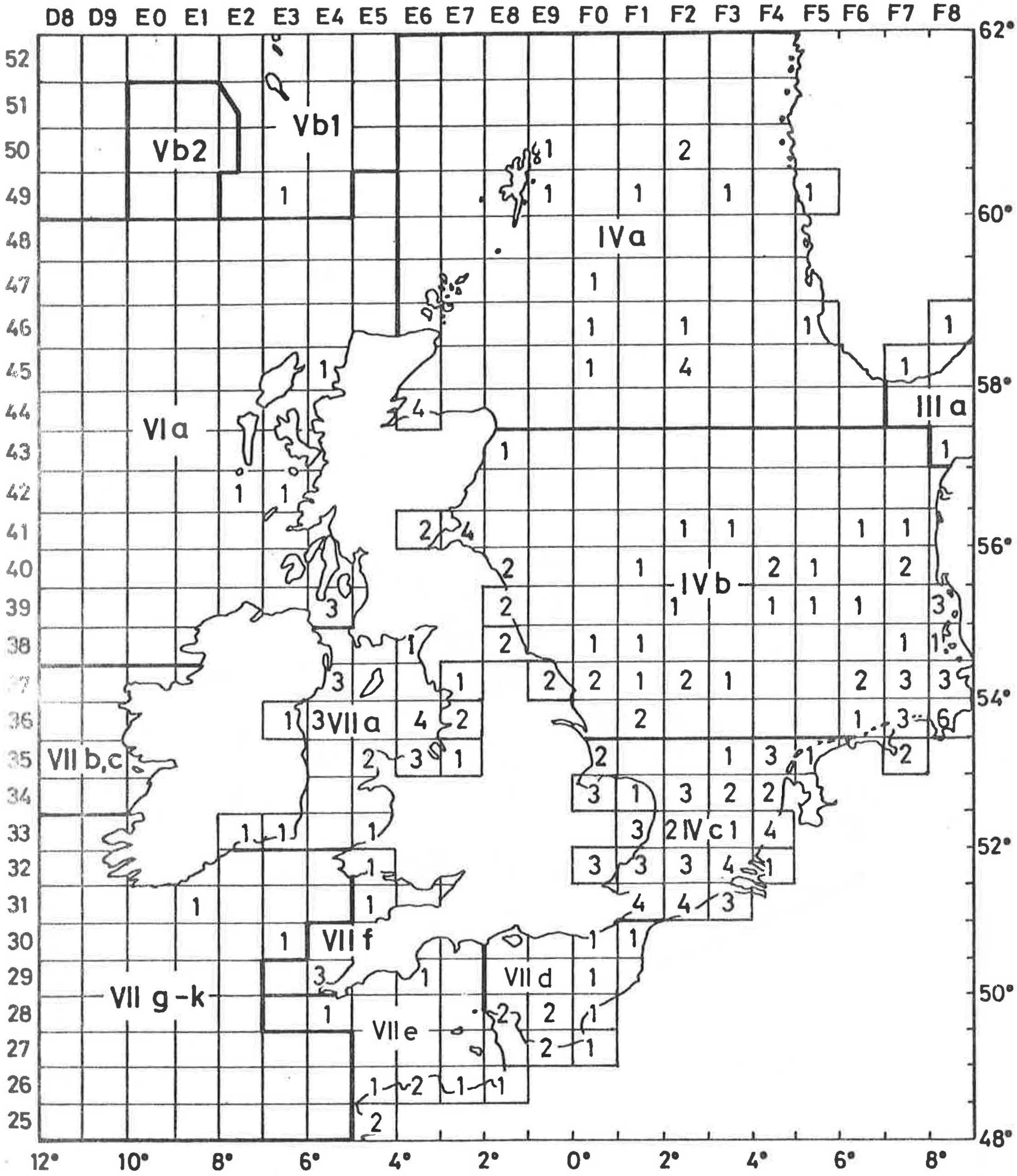

Figure 15. Total number of years each area was sampled from 1974 through 1979.

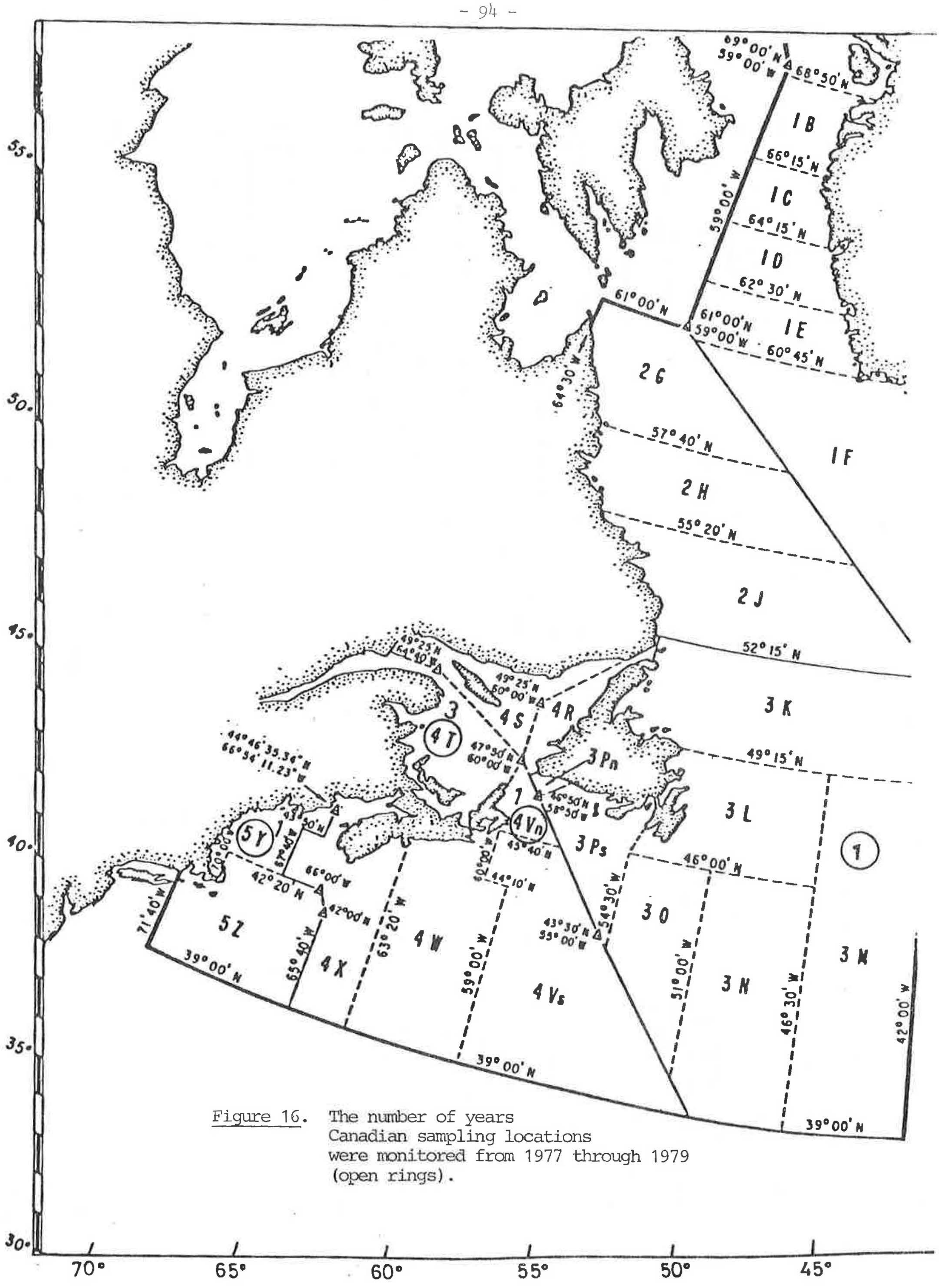

Figure 16. The number of years Canadian sampling locations were monitored from 1977 through 1979 (open rings).

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APPENDIX 1

DETAILS TO BE FOLLOWED FOR SAMPLE COLLECTION, PREPARATION AND ANALYSIS IN THE CONDUCT OF COOPERATIVE MONITORING

Monitoring, using fish or shellfish as indicator species, may be conducted for one of the following three purposes:

(1) The provision of a continuing assurance of the quality of marine foodstuffs with respect to human health.

(2) The provision over a wide geographical area of an indication of the health of the marine environment in the entire ICES North Atlantic area.

(3) To provide an analysis of trends over time in pollutant concentrations in selected areas, especially in relation to the assessment of the efficacy of control measures.

SAMPLING

Samples to meet Objective 1 (Samples to be collected every second year starting in 1982)

(a) A sample should consist of 25 fish or large crustaceans such as crabs or lobsters, 50 mussels or other molluscs, and 100 small crustaceans such as shrimps.

(b) The sample should be selected in such a way as to reflect the size distribution of the commercially exploitable portion of the catch of that species within that particular geographical area. This distribution may be determined from previous data or on board the sampling vessel but, having been established, should only be amended if a significant change in the distribution can be demonstrated.

(c) Sampling should be conducted prior to spawning of the species concerned.

(d) Samples should be collected from at least the following areas: the estuaries of the Forth, Thames, Rhine, Scheldt and Clyde, the Skagerrak, Kattegat and Oslo Fjord, the Irish Sea, German Bight and Southern Bight of the North Sea, certain parts of the Gulf of St Lawrence and the US middle Atlantic Bight, and the area off Portugal.

Samples to meet Objective 2 (Samples to be collected every 5 years starting in 1985)

(a) A sample should consist of 25 fish or 50 mussels.

(b) Fish should be selected so as to be representative of the area in question, i.e., should not be very recent immigrants to the area or on passage through it. Each sample should consist of the same or similar sized fish.

(c) Mussels should be between 20 and 50 mm in size and preferably as close to the lower end of this range as possible.

(d) Sampling should take place prior to spawning of the species concerned.

(e) Samples should be collected from as many locations as practicable throughout the ICES area.

Samples to meet Objective 3 (Samples to be collected every year starting in 1982)

(a) A sample of fish should consist of at least 25 individuals, and preferably more individuals. The sample should be collected in a length-stratified manner, i.e.,the sizes of the fish should span as wide a length range as possible and there should be an equal number of individuals in each length grouping.

The stratification should be based upon an equidistant logged length interval, i.e., the log (upper bound) minus log (lower bound) should be equal for each length interval. The length range of the entire sample should be selected so that the individuals in the lower bound yield sufficient tissue for the chemical analyses, while the upper bound should be selected such that at least 5 fish can readily be found in the sampled catch. The length range should be divided into 5 (or more) length intervals of equal size (after log transformation). (See notes on length stratification at end for an example.) Once the length stratification for a particular species and area has been agreed, this stratification should be strictly adhered to for a number of years. No length interval should be less than 2-3 cm. If the length range is smaller than 2-3 cm, the species is not ideally suited for the proposed analysis.

(b) A sample of mussels should span as wide a size range as possible and should consist of sufficient individuals to provide material for analysis in groups of the different sizes. The number of individuals in each length range should be recorded for each site and this distribution should thereafter be used for that site each year.

(c) Sampling should be conducted annually from the same areas and from the same stock and at the same time each year; mussel samples should be collected at the same position in relation to tidal height each year.

(d) Samples should be collected in such a way that at least the following areas are adequately covered: the estuaries of the Forth, Thames, Rhine, Scheldt and Clyde, the Skagerrak, Kattegat and Oslo Fjord, the Irish Sea, German Bight and Southern Bight of the North Sea, certain parts of the Gulf of St Lawrence and the US middle Atlantic Bight and the area off Portugal.

(e) The species of interest can only be selected in the light of information on fish stock composition and history and the known or perceived problems which define national priorities. It is preferable to use a fish species which continues to grow throughout its life. Species which are of particular interest in an ICES context are:

Cod or Hake
Plaice
Flounder
Mackerel (*Scomber scombrus*)
Mussels
Shrimps

but data relating to other species are also required.

STORAGE AND PRETREATMENT OF SAMPLES PRIOR TO ANALYSIS

General - i.e., for all three objectives:

(a) Fish samples should be collected ungutted and preserved (deep frozen) as soon as practicable after collection; length and weight should be determined before freezing.

(b) Mussels should be held live in clean (settled) sea water from the area of collection for 12-24 hours to allow discharge of pseudo-faeces. The length of each individual, even if used as part of a composite, should be measured as a maximum value regardless of direction of orientation.

(c) After cleaning and measuring the mussels, the individual animals should be carefully freed from their shells by cutting the adductor muscle. The shell cavity liquor can then be drained and discarded by placing the opened shells vertically in a filter funnel for 5 minutes. The remaining shell contents may then be preserved either individually or as pooled samples.

(d) Since a wide variety of factors can affect the total body burden of a pollutant in shrimps, the only useful objective in analysing shrimps is Objective 1. For this purpose, the shrimps should be boiled whole in sea water from the area of collection for 10 minutes. The tails should then be removed, peeled and thoroughly homogenised in preparation for storage or analysis.

To meet Objectives 1 or 2

(a) In order to reduce the number of analyses which have to be performed, pooled samples may be used. These should be prepared as described below and analysed in duplicate.

(b) An equivalent quantity of muscle tissue must be taken from each fish, e.g., a whole fillet of every fish. If the total quantity of tissue so yielded would be too large to be handled conveniently, the tissue may be sub-sampled, but a fixed proportion of each tissue must then be taken, e.g., 10% of each whole fillet or 10% of each whole liver, the sub-sample being taken after homogenisation of the whole fillet/liver or in the form of complete longitudinal sections.

To meet Objective 3

(a) Each fish should be analysed individually and the following biological variables should always be recorded when sampling for time trend analysis purposes:

Age
Total weight
Total length
Liver weight when contaminants in liver are determined.
(If another fatty organ is used, the weight should be recorded.)
Sex)
Degree of sexual maturation) where applicable.

(b) Mussels may be pooled in small groups to provide enough tissue for analysis but different size groups should be analysed separately.

REPORTING OF RESULTS

For Objective 1

Results should be reported on a wet weight basis along with details of the size range of the sample and details of site, date and method of collection, preservation details (if appropriate) and brief details of the methods of analysis used; if PCBs were analysed for, these details should include the formulation or isomer(s) and the method of quantitation used.

For Objective 2

(a) Results should be reported as for Objective 1. In addition, results of analyses of mussels for metals should also be reported on a dry weight basis. All results of analyses for organochlorine compounds must be reported also on an extracted fat weight basis <u>or</u> as a minimum be accompanied by a fat weight determination result.

(b) Dry weight determinations should be carried out in duplicate by air-drying to constant weight at 105°C of sub-samples of the material analysed for the contaminants.

(c) Fat weight should be determined on a sub-sample of the extract used for the organochlorine compound analyses. The results should be accompanied by a brief description of the method used for extraction.

For Objective 3

Results should be reported as for Objective 2, but the individual analysis figures should be given together with full details of the size, age, weight, sex, etc., of the individual fish analysed.

In reporting these data to ICES, the ICES Interim Reporting Format for Contaminants in Fish and Shellfish must be used for such data so as to allow machine handling and statistical analysis of the data.

General

Results should be submitted to the ICES Environment Officer not later than 30 June of the calendar year following collection of the sample. These results should be accompanied by the name of the contributing laboratory(s) and the name of an individual contact in the event of queries. The contributors should specify the most recent ICES intercalibration exercise in which they took part. A brief commentary on the data is also required, at least in relation to that supplied for the purposes of Objectives 1 and 3.

Notes on Length stratification

The main finding from the statistical analyses of data on contaminants in fish tissue is the gain in precision which can be obtained from stratification using biological variables. Although several biological parameters have been shown to be significant as stratification variables in different materials, length appears to be the only parameter which is simple to apply at sea and which shows up as being significant in most analyses.

Much discussion has been devoted to whether simple linear or log-linear (multiplicative) models give the better fit. General experience with other fish and other types of data indicate preference for the log-normal model at least for the present. As the length dependence of the contaminant level is not well understood, sampling should keep the length-contaminant relationship under constant surveillance, i.e., the entire length range should be covered evenly. The length range should be defined from practical considerations, the lower bound ensuring that enough tissue is available for chemical analysis and the upper bound such that at least 5 fish in the largest length interval can readily be found. The length stratification should be determined in such a way that it can be maintained over many years. The length interval should be at least 2-3 cm in size.

It is suggested that the length range be split into 5 length intervals which are of equal size after log transformation. For example, if the length range is 20-70 cm, then the interval boundaries could be (rounded to 0.5 cm) as follows:

cm	No. of fish	Log upper - log lower
20 - 25.5	5	0.243
25.5 - 33.0	5	0.258
33.0 - 42.5	5	0.253
42.5 - 54.5	5	0.249
54.5 - 70.0	5	0.250
Total	25	

Care should be taken that samples are not unduly clustered within each stratum (length interval). More length intervals could be used and the test of the hypothesized contaminant-length relationship becomes stronger if the lengths are evenly distributed. But the item of major importance is to keep the length stratification identical from one year to the next.

Indication of spine colours

Reports of the Advisory Committee on Fishery Management	Red
Reports of the Advisory Committee on Marine Pollution	Yellow
Fish Assessment Reports	Grey
Pollution Studies	Green
Others	Black

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