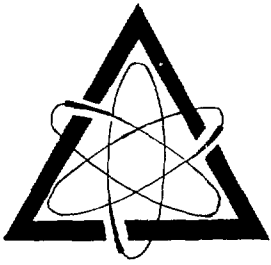


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DIGEST OF DATA FROM THE MEASUREMENT
OF RADIOACTIVITY IN THE IRISH
MARINE ENVIRONMENT 1982 - 1984

PART 1: FISH AND SHELLFISH

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LABORATORY REPORT NO. 1

DIGEST OF DATA FROM THE MEASUREMENT

OF RADIOACTIVITY IN THE IRISH

MARINE ENVIRONMENT 1982 - 1984

PART 1: FISH AND SHELLFISH

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November 1985.

ABSTRACT

This laboratory report systematically summarises the data generated in the measurement of radioactivity levels in fish and shellfish taken from the Irish Sea in the three-year period 1982-1984. The aspects of sampling (Tables 1-5), radioactivity concentrations (Tables 6-13) and radiation doses (Tables 14-19) are covered quite comprehensively. The report indicates trends but further interpretations are deferred.

INTRODUCTION

Levels of radioactivity in fish and shellfish have been measured at the National Radiation Monitoring Service since 1982. These measurements are part of the Nuclear Energy Board's radioactivity monitoring of the marine environment. The main effort was directed at the measurement of radioactivity, in particular radiocaesium, in fish and shellfish from the Irish Sea where the polluting effect of radioactive wastes from the nuclear fuel reprocessing plant at Sellafield is greatest. The measured levels of Cs-137 and Cs-134 in the popular species of fish and shellfish allow the estimation of the population dose to the Irish public as a result of eating seafood contaminated with radiocaesium. This report attempts to set out, in summarised form, a comprehensive review of sampling, analytical and dose assessment details for the three-year period 1982 to 1984. Levels of K-40, the naturally occurring radionuclide, in the fish and shellfish samples are also reported.

SAMPLING

The main popular species monitored over the three years were whiting (*Merlangius merlangus*), cod (*Gadus morhua*), plaice (*Pleuronectes platessa*), herring (*Clupea harengus*) and prawns (*Nephrops norvegicus*). In addition small numbers of haddock (*Melanogrammus aeglefinus*), mackerel (*Scomber scombrus*), sole (*solea solea*), ray (*Raja batis*) and mussels (*Mytilus edulis*) were collected. These species constitute the major proportion of the catches from the fishing grounds of the Irish Sea and are representative of the types of seafood consumed by the Irish public. Samples of fish and shellfish were obtained primarily at the Dublin and Howth fish markets and were taken from catches landed at the east coast ports of Howth, Clogherhead, Skerries and Arklow; Killybegs and Galway in the west and Dunmore East in the south (see Fig. 1). A small proportion of the samples were taken directly at the ports of landing. In cases where the east coast ports of landing were not known the samples were listed as Irish Sea samples. The samples collected on the RV Lough Beltra cruise (2-11-1984), which was conducted in the north-west sector of the Irish Sea, are included in the list of samples for 1984. The frequency of sampling from east coast catches was selected to enable a reasonable estimate to be made of the radiological dose to the public as a result of eating seafood from the Irish Sea. Details of the sampling distribution for the three-year period are set out in Tables 1-5 according to species and ports of landing. (See also Fig. 2)

In general, samples consisted of 1-3 kg of wet fish and comprised 2-8 specimens, depending on the fish size. The edible portions of the samples were dried at 100°C for 24 h, at the Department of Pure and Applied Physics of Trinity College Dublin and at the Department of Fisheries Research Laboratory, Castleknock, Co. Dublin. The dried samples were ground to a fine powder and packed into 200g polythene tubs of 75 mm diameter. Sample weights varied from about 130 to 180g, depending on the species being analysed.

ANALYSIS

The fish and shellfish samples were analysed by conventional gamma-ray spectrometry using either a standard or a well-type 75 mm x 75 mm NaI (Tl) detector coupled to a 1024-channel multichannel analyser. The detector was housed in a lead shield, of 100 mm thickness, to reduce the background radiation. Calibration of the two detectors was carried out with suitable

reference Cs-137, Cs-134 and K-40 sources prepared in a solid matrix similar to the dried seafood samples. The energy resolution values were approximately 10% and 12%, respectively, for the standard and well-type detectors and the detection efficiencies were approximately 3% and 2.7%, respectively, for the Cs-137 gamma rays at 0.66 MeV. Samples and reference sources were packed in the 200g containers to a standard height of 40 mm to maintain uniform geometry.

Spectra were recorded using either 512 or 1024 channels of the multichannel analyser. In each case the gamma-ray energy range covered was about 0 - 1.8 MeV. The spectral data were analysed to derive radioactivity concentrations using a computer programme written for the purpose. The data inserted into the programme included the sample weight and percentage dry weight, counting time, sample and background counts in the energy regions of interest and the detection efficiencies of the Cs-137, Cs-134 and K-40 reference sources. The programme carries out background subtraction, corrections for Compton scattered radiation and for radioactive decay of Cs-137 and Cs-134 leading to the estimation of Cs-137, Cs-134 and K-40 concentrations from the nett counts in the appropriate energy regions. (Ref. 1)

The standard errors in the calculated activities, arising from random errors, background variation and sampling handling errors, were determined by the computer programme using the error propagation formula and were, typically, about 5% for Cs-137, 50% for Cs-134 and 7% for K-40. The large uncertainties in the Cs-134 concentrations reflect the difficulty encountered in attempting to measure, by low resolution gamma-ray spectrometry, the very low levels of this radionuclide found in these seafood samples. At these levels the Cs-134 peaks are completely masked by the Cs-137 peak and the analysis is further complicated by the presence of small concentrations of other radionuclides such as Ru-106 and Bi-214 in some of the samples. This has lead, in many measurements, to over-estimation of the Cs-134 concentration and a ratio of Cs-137 to Cs-134 level significantly lower than the expected ratio of about 30 confirmed in high resolution gamma-ray measurements. The limit of detection for both Cs-137 and Cs-134 was found to be about 1 Bq kg⁻¹ of wet fish.

Intercalibration checks were carried out with the Department of Pure and Applied Physics, Trinity College Dublin and the Department of Experimental Physics, University College Dublin. Samples of fish and reference sources analysed in the three laboratories show good agreement which provides an independent basis for confidence in the reliability of the measurements presented in this report.

RADIOACTIVITY CONCENTRATIONS

Average radioactivity concentrations of Cs-137, Cs-134 and K-40 for all species analysed in the three-year period 1982-84, are listed in Tables 6-11. In particular Tables 6-10 give the activity levels in the five popular species sampled from catches landed at east coast locations. During this period 170 samples of these five species were analysed and the results for each species are presented on an annual basis. Ranges of activities and three-year weighted average activities are also given.

It can be seen from the activity values given in Tables 6-10 that the average radiocaesium concentrations in all five species have steadily declined over the three-year period. This decrease reflects the gradual reduction, since the late 1970's, in the quantities of radionuclides discharged to the Irish Sea from the Sellafield reprocessing plant. While some caution must be exercised in evaluating the significance of the 1982 average activities, because of the much smaller number of samples analysed in that year, it is noteworthy that these and all other Cs-137 values are in close agreement with values published for the same period by the Physics Departments of both Trinity College and University College Dublin (Refs 2-3).

Section a of Table 11 presents the average activity levels in the 13 samples of three other species of seafood collected from east coast locations in 1983 and 1984. Sections b and c of the same table present the average activities in the 41 west coast and 10 south coast samples which were also collected in 1983 and 1984. Radiocaesium levels in west and south coast samples can be seen to be generally much lower than the corresponding east coast levels. This is verified in sections d of Tables 6-10 which list the average radionuclide concentrations by the major ports or locations of landing and show that, while some few samples from Killybegs and Dunmore East contain Cs-137 concentrations as high as about 30 Bq kg^{-1} , the majority of west and south coast samples have very low levels of Cs-137. These lists also show the large variations in the Cs-137 levels in whiting and cod samples, particularly from the catches landed at Howth, which were those most extensively sampled. Plaice and prawn samples contain considerably less radiocaesium than whiting and cod samples and also exhibit much less variation in their levels. Herring samples occupy an intermediate position in this respect.

Table 12 sets out the average radiocaesium concentrations in whiting, cod, plaice, herring and prawns landed at east coast locations for the three years 1982 to 1984. Three-year average radiocaesium concentrations, weighted on an annual basis, are also given. These radiocaesium values were used in the calculation of annual individual and collective radiation doses which are presented in the later tables. Finally Table 13 outlines the overall frequency distribution of Cs-137 activities in the 170 east coast fish and shellfish samples and gives a break-down of this distribution by year and species. The distribution is also depicted in histogram form in Fig. 2 accompanied by some summary statistics. Ratios of Cs-137 to Cs-134 activities are not presented in these tables because of the large uncertainties in the latter values.

RADIATION DOSES

The estimated annual and three-year weighted individual radiation doses arising from the consumption of fish and shellfish from the Irish Sea are summarised in Tables 14-17. Four consumption rates are assessed which vary from a critical group comprising consumers of 200 g.d.⁻¹ of fish, through two intermediate groups, to a group comprising consumers of 15 g.d.⁻¹ fish. This latter consumption rate is the overall average per capita consumption of fish by members of the Irish public during 1982, the latest year for which such dietary information is available (Ref. 4). The dose equivalent conversion factors for radiocaesium used in calculating the doses were 1.4×10^{-8} Sv Bq⁻¹ for Cs-137 and 2.1×10^{-8} Sv Bq⁻¹ for Cs-134. The steady decrease in the effective dose equivalent levels between 1982 and 1984 reflect the decrease in radiocaesium concentrations in the fish and shellfish samples over the same period. These doses are generally less than 1% of the ICRP dose limit for members of the public and less than 2% of the dose due to naturally occurring radiation.

Collective doses to the Irish population from fish and shellfish were estimated using the quantities of fish landed at main east coast ports in 1982 which are given in Table 18. It was assumed, allowing for cleaning, filleting and exporting, that approximately 10% of this catch was actually consumed by the Irish public. Applying these figures to the east coast fish catch leads to values for the collective effective doses to the Irish population which are less than 2 man-Sv y⁻¹. The steady annual decreases between 1982 and 1984 can again be seen in these figures which represent extremely small percentages of the assumed environmental

radiation dose to the Irish population of 3500 man-Sv y⁻¹. These details are outlined in Table 19 .

CONCLUDING NOTE

The main usefulness of this report is the provision, in summarised form, of the results of the first three years of monitoring, by the Nuclear Energy Board, of radioactivity levels in fish and shellfish. While attempting to be as comprehensive as possible the report does not cover all possible uses of the data from the measurements carried out over the three years. One such use would be the estimation of doses arising from catches landed at ports such as Howth and Clogherhead. The relevant data are contained in the tables presented here and indicate a steady decline in the radioactivity levels in the fish and shellfish from the Irish Sea. This report will form the basis for the external publication of the results of this aspect of the Board's marine environmental monitoring work.

REFERENCES

1. The analytical methods used in the work outlined in this report were adapted from the M.Sc. thesis "An Investigation of Radiocaesium Levels in the Irish Sea" Colin Doyle, submitted to the University of Dublin, August 1982.
2. "Radiocaesium Levels in Irish Sea Fish and the Resulting Dose to the Population of the Irish Republic" I.R. McAulay and C. Doyle, Health Physics, Vol. 48, No. 3 pp 333 - 337, 1985.
3. "Levels of Radioactive Caesium and Potassium in the Marine Environment of Ireland" P.I. Mitchell, M. Gonzalo and A. Vidal-Quadras, 1983, Energia Nuclear 27, 369 - 378 and later publication.
4. "The Contribution of Radioactivity in the Irish Sea to the Radiation Exposure of the Irish Population 1982-83". J.D. Cunningham and J. O'Grady, Report 84/1, Nuclear Energy Board.

TABLE 1

FISH AND SHELLFISH SAMPLING PROGRAMME 1982 - 1984

(a) Annual Totals

	1982	1983	1984	Overall Total
Annual Total	29	94	111	234

(b) Coastal Distribution

Coastal Region	Number of Samples Collected			Overall Totals
	1982	1983	1984	
East	29	67	89	185
West	-	20	20	40
South	-	7	3	10

(c) Species Distribution

Species	Number of Samples Collected			Overall Totals
	1982	1983	1984	
Whiting	7	24	27	58
✓ Cod	4	29	25	58
✓ Plaice	7	20	21	48
Herring	5	10	14	29
Haddock	-	2	4	6
Mackerel	-	1	3	4
Sole	-	1	2	3
Ray	-	1	-	1
✓ Prawns	6	4	9	19
✓ Mussels	-	2	6	8

TABLE 2

1982 FISH AND SHELLFISH SAMPLING DISTRIBUTION

LOCATION LANDED	NO. OF SAMPLES	SPECIES				
		WHITING	COD	PLAICE	HERRING	PRAWNS
Howth	14	4	3	6	1	-
Skerries	7	2	-	-	1	4
Clogherhead	6	1	1	1	2	1
Arklow	1	-	-	-	1	-
Irish Sea*	1	-	-	-	-	1
Overall Totals	29	7	4	7	5	6

* Irish Sea refers to samples from the Fisheries Research Centre for which the east coast ports of landing were not known.

TABLE 3

1983 FISH AND SHELLFISH SAMPLING DISTRIBUTION

LOCATION LANDED	NO. OF SAMPLES	SPECIES									
		WHITING	COD	PLAICE	HERRING	MACKEREL	HADDOCK	SOLE	RAY	PRAWNS	MUSSELS
Howth	39	9	16	8	6	-	-	-	-	-	-
Killybegs	9	3	2	2	1	-	1	-	-	-	-
Clogherhead	8	3	2	1	1	-	-	-	-	1	-
Arklow	8	1	2	5	-	-	-	-	-	-	-
Irish Sea *	6	3	-	2	-	-	-	-	-	1	-
Galway	7	1	2	-	-	1	1	1	1	-	-
Dunmore East	5	2	2	1	-	-	-	-	-	-	-
Skerries	3	1	-	-	-	-	-	-	-	2	-
Cleggan	3	1	1	1	-	-	-	-	-	-	-
Wexford	1	-	-	-	-	-	-	-	-	-	1
Greystones	1	-	1	-	-	-	-	-	-	-	-
Donegal	1	-	-	-	1	-	-	-	-	-	-
Arranmore	1	-	-	-	1	-	-	-	-	-	-
Dingle	1	-	1	-	-	-	-	-	-	-	-
Kerry	1	-	-	-	-	-	-	-	-	-	1
Overall Totals	94	24	29	20	10	1	2	1	1	4	2

* Irish Sea refers to samples from the Fisheries Research Centre for which the east coast ports of landing were not known.

TABLE 4

1984 FISH AND SHELLFISH SAMPLING DISTRIBUTION

LOCATION LANDED	NO. OF SAMPLES	SPECIES								
		WHITING	COD	PLAICE	HERRING	MACKEREL	HADDOCK	SOLE	PRAWNS	MUSSELS
Howth	37	10	9	10	2	2	1	-	3	-
Clogherhead	13	3	4	2	1	-	1	-	2	-
Killybegs	12	2	2	2	5	-	-	1	-	-
* Lough Beltra	13	4	6	1	-	-	2	-	-	-
Galway	8	2	2	1	1	1	-	1	-	-
** Irish Sea	6	2	1	1	2	-	-	-	-	-
Mornington	6	-	-	-	-	-	-	-	-	6
Skerries	4	-	-	-	-	-	-	-	4	-
Arklow	3	-	-	2	1	-	-	-	-	-
Dunmore East	3	1	1	1	-	-	-	-	-	-
Ardglas	2	2	-	-	-	-	-	-	-	-
Dunlaoire	2	-	-	1	1	-	-	-	-	-
Greencastle	1	1	-	-	-	-	-	-	-	-
Porta vogie	1	-	-	-	1	-	-	-	-	-
Overall Total	111	27	25	21	14	3	4	2	9	6

* These samples were collected on the RV Lough Beltra cruise, 1st November 1984, which was conducted in the north-west sector of the Irish Sea.

** Irish Sea refers to samples from the Fisheries Research Centre for which the east coast ports of landing were not known.

TABLE 5

PERCENTAGE SAMPLING DISTRIBUTION OF FISH AND SHELLFISH 1982-1984

(a) PERCENTAGE DISTRIBUTION BY
COASTAL REGION

COASTAL REGION	% SAMPLING DISTRIBUTION			AVERAGE
	1982	1983	1984	
East	100	70	79	83
West	-	22	18	13
South	-	8	3	4

(b) PERCENTAGE DISTRIBUTION BY
SPECIES

SPECIES	% SAMPLING DISTRIBUTION			AVERAGE
	1982	1983	1984	
Whiting	24	26	24	25
Cod	14	31	23	23
Plaice	24	21	18	21
Herring	17	11	13	14
Haddock	-	2	4	3
Mackerel	-	1	3	1
Sole	-	1	2	1
Ray	-	1	-	<1
Prawns	21	4	8	11
Mussels	-	2	5	2

TABLE 5 (CONTINUED)

(c) PERCENTAGE DISTRIBUTION BY
LANDING LOCATION

LOCATION LANDED	% SAMPLING DISTRIBUTION			AVERAGE
	1982	1983	1984	
Howth	48	41	32	40
Clogherhead	21	10	12	14
Skerries	24	3	4	10
Killybegs	-	10	11	7
Arklow	3	9	3	5
Irish Sea	3	6	6	5
Galway	-	7	7	5
Lough Beltra	-	-	12	4
Dunmore East	-	5	3	3
Mornington	-	-	5	2
Other Locations	-	10	5	5

TABLE 6

WHITING (MERLANGIUS MERLANGUS)

SUMMARY DETAILS 1982-84

(a) Sample Distribution

	1982	1983	1984	total
EAST COAST	7	17	22	46
WEST COAST	-	5	4	9
SOUTH COAST	-	2	1	3
TOTAL	7	24	27	58

(b) Activity Levels in East Coast Samples (Bq kg⁻¹, wet)

	Average Cs-137 Activity	Range of Cs-137 Activities	Average Cs-134 Activity	Range of Cs-134 Activities	Average K-40 Activity	Range of K-40 Activities	Average % Dry/Wet
1982	90.4	75.0 to 120.0	3.0	1.1 to 5.5	112.8	82.6 to 146.7	20.7
1983	77.1	4.0 to 197.9	3.4	0.5 to 12.9	127.6	91.9 to 165.3	20.5
1984	65.9	5.6 to 132.3	3.0	0.5 to 5.6	122.9	85.4 to 170.8	19.9

(c) Three-Year Weighted Averages of East Coast Activities (Bq Kg⁻¹, Wet)

	Cs-137	Cs-134	K-40	%Dry/Wet
Weighted Average	73.8	3.1	123.1	20.2

TABLE 6 (Continued)

(d) ACTIVITY LEVELS IN EAST COAST SAMPLES BY LOCATION OF LANDING (Bq kg⁻¹, Wet)

LOCATION OF LANDING/YEAR	NUMBER OF SAMPLES	AVERAGE Cs-137 ACTIVITY	RANGE OF Cs-137 ACTIVITIES	AVERAGE Cs-134 ACTIVITY	RANGE OF Cs-134 ACTIVITIES	AVERAGE K-40 ACTIVITY	RANGE OF K-40 ACTIVITIES	AVERAGE % DRY/WET	
Howth	1982	4	84.8	75.0 to 95.5	3.6	2.3 to 5.5	105.1	32.6 to 117.8	19.9
	1983	9	57.3	4.0 to 123.0	2.3	0.5 to 4.2	126.8	95.6 to 135.6	20.6
	1984	10	85.0	21.0 to 151.8	3.9	1.0 to 7.2	126.1	98.5 to 170.8	20.4
Clogherhead	1982	1	89.9	-	3.4	-	146.7	-	24.0
	1983	3	97.1	73.1 to 118.6	4.3	3.8 to 5.0	132.2	106.4 to 165.3	19.8
	1984	3	57.1	29.4 to 102.4	3.0	0.5 to 5.6	104.8	85.4 to 136.9	19.6
Skerries	1982	2	101.8	83.6 to 120.0	1.6	1.1 to 2.0	111.1	110.9 to 111.3	20.7
Irish Sea	1983	3	134.1	72.1 to 197.9	7.0	3.6 to 12.9	128.2	97.6 to 145.4	20.7
	1984	2	73.1	32.7 to 113.4	3.7	1.8 to 5.5	106.0	97.9 to 114.1	19.2
Ardglas	1984	2	44.8	5.6 to 84.0	2.8	0.5 to 5.1	138.2	138.2 to 138.3	19.8
Lough Beltra	1984	4	33.1	28.3 to 36.1	N.D.	-	133.1	123.5 to 137.8	19.3
Killybeg	1983	3	6.2	2.0 to 10.2	N.D.	-	113.5	91.9 to 149.3	18.8
	1984	2	20.2	17.8 to 22.5	1.1	0.5 to 1.7	120.0	95.4 to 144.5	19.7
Galway	1983	2	4.3	3.6 to 5.0	N.D.	-	105.3	104.6 to 106.0	19.7
	1984	2							
Dunmore East	1983	2	17.1	7.0 to 27.2	1.1	0.5 to 1.7	125.0	114.1 to 135.9	19.6
	1984	1	20.1	-	N.D.	-	160.8	-	23.0

N.D. = Not Detected and means an activity <1.0 Bq kg⁻¹, wet. Where averages were calculated an activity of 0.5 Bq kg⁻¹ was used for these samples.

TABLE 7

COD (GADUS MORHUA)

SUMMARY DETAILS 1982 - 84

(a) Sample Distribution

	1982	1983	1984	total
EAST COAST	4	21	20	45
WEST COAST	-	5	4	9
SOUTH COAST	-	3	1	4
TOTAL	4	29	25	58

(b) Activity Levels in East Coast Samples (Bq kg⁻¹, wet)

	Average Cs-137 Activity	Range of Cs-137 Activities	Average Cs-134 Activity	Range of Cs-134 Activities	Average K-40 Activity	Range of K-40 Activities	Average % Dry/Wet
1982	68.7	60.0 to 89.8	2.1	0.5 to 4.3	116.5	109.4 to 127.0	20.5
1983	41.1	5.2 to 166.5	1.9	0.5 to 9.6	116.8	90.7 to 151.6	20.6
1984	39.0	12.0 to 118.4	1.8	0.5 to 3.4	110.8	54.3 to 144.5	19.5

(c) Three-Year Weighted Averages of East Coast Activities (Bq Kg⁻¹, Wet)

	Cs-137	Cs-134	K-40	%Dry/Wet
Weighted Average	42.6	1.9	114.1	20.1

TABLE 7 (Continued)

(d) ACTIVITY LEVELS IN EAST COAST SAMPLES BY LOCATION OF LANDING (Bq kg⁻¹, Wet)

LOCATION OF LANDING/YEAR	NUMBER OF SAMPLES	AVERAGE Cs-137 ACTIVITY	RANGE OF Cs-137 ACTIVITIES	AVERAGE Cs-134 ACTIVITY	RANGE OF Cs-134 ACTIVITIES	AVERAGE K-40 ACTIVITY	RANGE OF K-40 ACTIVITIES	AVERAGE % DRY/WET	
Howth	1982	3	70.8	60.6 to 89.8	2.7	1.1 to 4.3	113.0	109.4 to 115.1	20.0
	1983	16	46.1	5.2 to 166.5	2.3	0.5 to 9.6	117.2	101.0 to 145.7	21.0
	1984	8	29.1	12.0 to 58.1	1.2	0.5 to 3.3	105.2	54.3 to 124.0	18.8
Clogherhead	1982	1	62.7	-	N.D.	-	127.0	-	22.0
	1983	2	31.9	29.2 to 34.5	1.3	0.5 to 2.0	95.4	90.0 to 99.9	17.3
	1984	4	63.7	31.9 to 118.4	2.8	1.8 to 3.4	110.2	94.3 to 143.3	20.2
Arklow	1983	2	10.0	9.8 to 10.1	N.D.	-	128.9	127.4 to 130.3	21.4
Irish Sea	1984	2	29.0	23.1 to 34.8	2.1	1.4 to 2.7	118.6	105.0 to 132.2	20.4
Lough Beltra	1984	6	39.0	22.7 to 50.4	1.7	0.5 to 3.0	115.9	92.7 to 129.2	19.7
Killybegs	1983	2	17.7	13.9 to 21.4	N.D.	-	125.9	123.2 to 128.5	24.7
	1984	2	14.1	10.4 to 17.8	1.1	0.5 to 1.7	129.9	115.2 to 144.5	20.5
Galway	1983	2	5.2	2.0 to 8.3	N.D.	-	128.5	97.0 to 159.9	18.1
	1984	2	1.8	0.5 to 3.1	N.D.	-	116.5	106.5 to 126.4	22.2
Dunmore East	1983	2	17.3	15.0 to 19.5	1.5	0.5 to 2.4	135.8	105.9 to 165.6	22.3
	1984	1	11.8	-	N.D.	-	124.8	-	22.0

N.D. = Not Detected

TABLE 8

PLAICE (PLEURONECTES PLATESSA)

SUMMARY DETAILS 1982-84

(a) Sample Distribution

	1982	1983	1984	total
EAST COAST	7	16	17	40
WEST COAST	-	3	3	6
SOUTH COAST	-	1	1	2
TOTAL	7	20	21	48

(b) Activity Levels in East Coast Samples (Bq kg⁻¹, wet)

	Average Cs-137 Activity	Range of Cs-137 Activities	Average Cs-134 Activity	Range of Cs-134 Activities	Average K-40 Activity	Range of K-40 Activities	Average % Dry/Wet
1982	28.9	4.1 to 63.4	1.6	0.5 to 4.9	102.0	63.9 to 127.0	22.4
1983	27.0	8.6 to 57.5	1.3	0.5 to 2.9	115.0	90.7 to 151.6	22.0
1984	21.8	11.5 to 30.4	1.0	0.5 to 2.0	93.9	52.2 to 129.7	22.9

(c) Three-Year Weighted Averages of East Coast Activities (Bq Kg , Wet)

	Cs-137	Cs-134	K-40	%Dry/Wet
Weighted Average	25.1	1.2	103.8	22.5

TABLE 8 (Continued)

(d) ACTIVITY LEVELS IN EAST COAST SAMPLES BY LOCATION OF LANDING (Bq kg⁻¹, Wet)

LOCATION OF LANDING/YEAR	NUMBER OF SAMPLES	AVERAGE Cs-137 ACTIVITY	RANGE OF Cs-137 ACTIVITIES	AVERAGE Cs-134 ACTIVITY	RANGE OF Cs-134 ACTIVITIES	AVERAGE K-40 ACTIVITY	RANGE OF K-40 ACTIVITIES	AVERAGE % DRY/WEI	
Howth	1982	6	28.7	4.1 to 63.4	1.6	0.5 to 4.9	102.4	63.9 to 127.0	22.8
	1983	8	30.5	23.5 to 57.5	1.3	0.5 to 2.1	110.7	105.5 to 151.6	21.9
	1984	10	21.9	11.5 to 30.4	1.0	0.5 to 2.0	93.3	59.4 to 122.7	22.3
Clogherhead	1982	1	29.9	-	1.5	-	99.7	-	20.0
	1983	1	22.9	-	N.D.	-	99.4	-	22.6
	1984	2	24.5	20.4 to 28.5	1.1	0.5 to 1.7	71.8	52.2 to 91.4	21.1
Arklow	1983	5	24.9	9.6 to 48.1	1.1	0.5 to 2.9	108.9	90.7 to 135.9	21.8
	1984	2	21.7	15.8 to 27.6	1.1	0.5 to 2.7	105.9	98.4 to 113.4	24.8
Irish Sea	1983	2	18.8	17.7 to 19.9	1.4	1.3 to 1.4	103.4	93.2 to 113.6	22.5
	1984	1	22.9	-	1.5	-	108.8	-	26.3
Lough Beltra	1984	1	26.7	-	N.D.	-	104.9	-	22.0
Killybegs	1983	2	1.6	0.5 to 2.7	N.D.	-	110.4	101.7 to 119.6	21.5
	1984	2	4.1	2.3 to 5.8	N.D.	-	132.0	125.6 to 138.4	23.0
Galway	1984	1	5.0	-	N.D.	-	98.6	-	20.0
Dunmore East	1983	1	14.2	-	N.D.	-	96.5	-	21.8
	1984	1	23.5	-	1.6	-	118.4	-	20.1

N.D. = Not Detected.

TABLE 9

HERRING (CLUPEA HARENGUS)

SUMMARY DETAILS 1982-84

(a) Sample Distribution

	1982	1983	1984	total
EAST COAST	5	7	8	20
WEST COAST	-	3	6	9
SOUTH COAST	-	-	-	-
TOTAL	5	10	14	29

(b) Activity Levels in East Coast Samples (Bq kg⁻¹, wet)

	Average Cs-137 Activity	Range of Cs-137 Activities	Average Cs-134 Activity	Range of Cs-134 Activities	Average K-40 Activity	Range of K-40 Activities	Average % Dry/Wet
1982	69.2	52.0 to 78.0	3.1	2.5 to 4.1	139.9	135.0 to 147.0	33.3
1983	48.8	26.7 to 85.3	2.4	1.2 to 4.0	124.8	84.1 to 198.2	31.8
1984	35.3	15.4 to 73.0	1.6	0.5 to 4.3	111.8	83.7 to 162.6	31.6

(c) Three-Year Weighted Averages of East Coast Activities (Bq Kg⁻¹, Wet)

	Cs-137	Cs-134	K-40	%Dry/Wet
Weighted Average	48.5	2.3	123.4	32.1

TABLE 9 (Continued)

(d) ACTIVITY LEVELS IN EAST COAST SAMPLES BY LOCATION OF LANDING (Bq kg⁻¹, Wet)

LOCATION OF LANDING/YEAR	NUMBER OF SAMPLES	AVERAGE Cs-137 ACTIVITY	RANGE OF Cs-137 ACTIVITIES	AVERAGE Cs-134 ACTIVITY	RANGE OF Cs-134 ACTIVITIES	AVERAGE K-40 ACTIVITY	RANGE OF K-40 ACTIVITIES	AVERAGE % DRY/WE	
Howth	1982	1	78.0	-	2.9	-	134.0	-	33.0
	1983	6	42.7	26.7 to 61.5	2.2	1.2 to 3.1	120.8	84.1 to 198.2	32.5
	1984	2	26.7	22.5 to 30.8	1.3	0.5 to 2.0	106.8	100.3 to 113.2	32.5
Clogherhead	1982	2	59.0	52.0 to 66.0	2.7	2.5 to 2.9	141.5	136.0 to 147.0	31.0
	1983	1	85.3	-	4.0	-	149.3	-	27.5
	1984	1	73.0	-	4.3	-	104.7	-	18.2
Skerries	1982	1	74.2	-	3.3	-	143.6	-	38.0
Arklow	1982	1	75.9	-	4.1	-	139.0	-	33.0
Irish Sea	1984	2	31.7	30.8 to 31.5	1.8	1.4 to 2.1	114.3	102.2 to 126.3	37.7
Killybegs	1983	1	5.2	-	N.D.	-	128.5	-	27.6
	1984	5	9.2	2.3 to 30.9	N.D.	-	136.7	118.6 to 158.6	31.6

N.D. = Not Detected.

TABLE 10

PRAWNS (NEPHROPS NORVEGICUS)

SUMMARY DETAILS 1982-84

(a) Sample Distribution

	1982	1983	1984	total
EAST COAST	6	4	9	19
WEST COAST	-	-	-	-
SOUTH COAST	-	-	-	-
TOTAL	6	4	9	19

(b) Activity Levels in East Coast Samples (Bq kg⁻¹, wet)

	Average Cs-137 Activity	Range of Cs-137 Activities	Average Cs-134 Activity	Range of Cs-134 Activities	Average K-40 Activity	Range of K-40 Activities	Average % Dry/Wet
1982	28.9	23.2 to 37.3	1.5	0.5 to 2.6	119.5	100.1 to 182.5	25.2
1983	28.4	24.7 to 33.7	1.9	0.5 to 2.5	146.5	110.9 to 183.5	24.6
1984	19.0	8.7 to 24.9	0.9	0.5 to 1.8	113.1	92.9 to 141.3	25.2

(c) Three-Year Weighted Averages of East Coast Activities (Bq Kg⁻¹, Wet)

	Cs-137	Cs-134	K-40	%Dry/Wet
Weighted Average	24.1	1.3	99.0	25.1

TABLE 10(Continued)

(d) ACTIVITY LEVELS IN EAST COAST SAMPLES BY LOCATION OF LANDING (Bq kg⁻¹, Wet)

LOCATION OF LANDING/YEAR	NUMBER OF SAMPLES	AVERAGE Cs-137 ACTIVITY	RANGE OF Cs-137 ACTIVITIES	AVERAGE Cs-134 ACTIVITY	RANGE OF Cs-134 ACTIVITIES	AVERAGE K-40 ACTIVITY	RANGE OF K-40 ACTIVITIES	AVERAGE % DRY/WE	
Howth 1984	3	17.8	17.1 to 18.4	1.2	0.5 to 1.6	99.1	94.0 to 102.2	23.9	
Clogherhead	1982	1	-	2.3	-	182.5	-	32.0	
	1983	1	-	2.3	-	183.5	-	23.0	
	1984	2	16.8	8.7 to 24.9	N.D.	-	130.0	118.6 to 141.3	27.9
Skerries	1982	4	28.7	23.2 to 37.3	1.5	0.5 to 2.6	108.2	100.1 to 121.3	23.4
	1983	2	24.8	24.7 to 24.9	1.4	0.5 to 2.2	122.5	110.9 to 134.0	24.7
	1984	4	21.1	20.6 to 21.6	0.8	0.5 to 1.8	115.2	92.9 to 130.3	24.8
Irish Sea	1982	1	27.9	-	1.5	-	101.5	-	25.7
	1983	1	30.4	-	2.5	-	157.4	-	25.9

N.D. = Not Detected.

TABLE 11

RADIOACTIVITY CONCENTRATIONS IN FISH AND SHELLFISH SAMPLES 1982-84MISCELLANEOUS DETAILS(a) RADIOACTIVITY CONCENTRATIONS IN EAST COAST SAMPLES 1982-84

SPECIES	NUMBER OF SAMPLES	CONCENTRATION (Bq kg ⁻¹ , Wet)			AVERAGE % DRY/WET
		Cs-137	Cs-134	K-40	
Haddock	4	23.5	0.9	133.9	22.7
Mackerel	2	17.8	N.D.	105.4	33.5
Mornington Mussels	6	9.3	N.D.	85.6	25.0
Wexford Mussels	1	3.8	N.D.	68.7	19.6

(b) RADIOACTIVITY CONCENTRATIONS IN WEST COAST SAMPLES 1982-84

SPECIES	NUMBER OF SAMPLES	CONCENTRATION (Bq kg ⁻¹ , Wet)			AVERAGE % DRY/WET
		Cs-137	Cs-134	K-40	
Whiting	9	7.8	0.6	117.3	19.6
Cod	9	9.2	0.6	119.1	20.9
Plaice	6	2.8	N.D.	111.9	22.2
Herring	9	7.0	N.D.	130.6	31.7
Sole	3	6.6	N.D.	93.0	20.7
Haddock	2	0.8	N.D.	99.7	23.0
Mackerel	2	1.8	N.D.	83.1	29.6
Ray	1	N.D.	N.D.	58.5	20.0

(c) RADIOACTIVITY CONCENTRATIONS IN SOUTH COAST SAMPLES 1982-84

SPECIES	NUMBER OF SAMPLES	CONCENTRATION (Bq kg ⁻¹ , Wet)			AVERAGE % DRY/WET
		Cs-137	Cs-134	K-40	
Whiting	3	18.1	0.9	136.9	20.7
Cod	4	11.7	1.0	126.6	21.3
Plaice	2	18.9	1.1	107.5	20.8
Kerry Mussels	1	N.D.	N.D.	58.5	25.0

N.D. = NOT DETECTED

TABLE 12

AVERAGE RADIOCAESIUM CONCENTRATIONS IN EAST COAST SEAFOOD 1982-84

(a) AVERAGE RADIOCAESIUM CONCENTRATIONS
IN EAST COAST SAMPLES 1982

SPECIES	NUMBER OF SAMPLES	RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	
		Cs-137	Cs-134
Whiting	7	90.4	3.0
Cod	4	68.7	2.1
Plaice	7	28.9	1.6
Herring	5	69.2	3.1
Prawns	6	28.9	1.5

(b) AVERAGE RADIOCAESIUM CONCENTRATIONS
IN EAST COAST SAMPLES 1983

SPECIES	NUMBER OF SAMPLES	RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	
		Cs-137	Cs-134
Whiting	17	77.1	3.4
Cod	21	41.1	1.9
Plaice	16	27.0	1.3
Herring	7	48.8	2.4
Prawns	4	28.4	1.9

(c) AVERAGE RADIOCAESIUM CONCENTRATIONS
IN EAST COAST SAMPLES 1984

SPECIES	NUMBER OF SAMPLES	RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	
		Cs-137	Cs-134
Whiting	22	65.9	3.0
Cod	20	39.0	1.8
Plaice	17	21.8	1.0
Herring	8	35.3	1.6
Prawns	9	19.0	0.9

(d) THREE YEAR WEIGHTED AVERAGE RADIOCAESIUM
CONCENTRATION IN EAST COAST SAMPLES 1982-84

SPECIES	NUMBER OF SAMPLES	RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	
		Cs-137	Cs-134
Whiting	46	73.8	3.1
Cod	45	42.6	1.9
Plaice	40	25.1	1.2
Herring	20	48.5	2.3
Prawns	19	24.1	1.3

TABLE 14

ANNUAL INDIVIDUAL RADIATION EXPOSURES DUE TO THE CONSUMPTION
OF IRISH SEA FISH AND SHELLFISH 1982

CONSUMPTION RATES OF EDIBLE PORTIONS	RADIONUCLIDE	AVERAGE RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	EFFECTIVE DOSE EQUIVALENT (μSv)	% OF THE ICRP DOSE LIMIT OF 5000 μSv FOR MEMBER OF THE PUBLIC
200 g.d. ⁻¹ Fish	Cs-137	63.3	64.7	1.29
	Cs-134	2.4	3.7	0.07
	TOTAL	----	68.4	1.36
100 g.d. ⁻¹ Fish 20 g.d. ⁻¹ Shellfish	Cs-137	63.3	32.3	0.65
	Cs-134	2.4	1.8	0.04
	Cs-137	28.9	3.0	0.06
	Cs-134	1.5	0.2	0.004
	TOTAL	----	37.5	0.75
40 g.d. ⁻¹ Fish	Cs-137	63.3	12.9	0.26
	Cs-134	2.4	0.7	0.01
	TOTAL	----	13.6	0.27
15 g.d. ⁻¹ Fish	Cs-137	63.3	4.9	0.1
	Cs-134	2.4	0.3	0.01
	TOTAL	----	5.2	0.11

TABLE 15

ANNUAL INDIVIDUAL RADIATION EXPOSURES DUE TO THE CONSUMPTION

OF IRISH SEA FISH AND SHELLFISH 1983

CONSUMPTION RATES OF EDIBLE PORTIONS	RADIONUCLIDE	AVERAGE RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	EFFECTIVE DOSE EQUIVALENT (μSv)	% OF THE ICRP DOSE LIMIT OF 5000 μSv FOR MEMBERS OF THE PUBLIC
200 g.d. ⁻¹ Fish	Cs-137	48.3	49.4	0.99
	Cs-134	2.2	3.4	0.07
	TOTAL	----	52.8	1.06
100 g.d. ⁻¹ Fish	Cs-137	48.3	24.7	0.49
	Cs-134	2.2	1.7	0.03
20 g.d. ⁻¹ Shellfish	Cs-137	28.4	2.9	0.06
	Cs-134	1.9	0.3	0.01
	TOTAL	----	29.6	0.59
40 g.d. ⁻¹ Fish	Cs-137	48.3	9.9	0.2
	Cs-134	2.2	0.7	0.01
	TOTAL	----	10.6	0.21
15 g.d. ⁻¹ Fish	Cs-137	48.3	3.7	0.07
	Cs-134	2.2	0.3	0.01
	TOTAL	----	4.0	0.08

TABLE 16

ANNUAL INDIVIDUAL RADIATION EXPOSURES DUE TO THE CONSUMPTION

OF IRISH SEA FISH AND SHELLFISH 1984

CONSUMPTION RATES OF EDIBLE PORTIONS	RADIONUCLIDE	AVERAGE RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	EFFECTIVE DOSE EQUIVALENT (μ Sv)	% OF THE ICRP DOSE LIMIT OF 5000 μ Sv FOR MEMBERS OF THE PUBLIC
200 g.d. ⁻¹	Cs-137	43.0	43.9	0.88
	Cs-134	2.0	3.1	0.06
	TOTAL	----	47.0	0.94
100 g.d. ⁻¹ Fish 20 g.d. ⁻¹ Shellfish	Cs-137	43.0	22.0	0.44
	Cs-134	2.0	1.5	0.03
	Cs-137	19.0	1.9	0.04
	Cs-134	0.9	0.1	0.002
	TOTAL	----	25.5	0.51
40 g.d. ⁻¹ Fish	Cs-137	43.0	8.8	0.18
	Cs-134	2.0	0.6	0.01
	TOTAL	----	9.4	0.19
15 g.d. ⁻¹ Fish	Cs-137	43.0	3.3	0.07
	Cs-134	2.0	0.2	0.004
	TOTAL	----	3.5	0.07

TABLE 17

THREE-YEAR WEIGHTED INDIVIDUAL RADIATION EXPOSURES DUE TO THE CONSUMPTION

OF IRISH SEA FISH AND SHELLFISH 1982-84

CONSUMPTION RATES OF EDIBLE PORTIONS	RADIONUCLIDE	AVERAGE RADIOCAESIUM CONCENTRATIONS (Bq kg ⁻¹ , Wet)	EFFECTIVE DOSE EQUIVALENT (μSv)	% OF THE ICRP DOSE LIMIT OF 5000 μSv FOR MEMBERS OF THE PUBLIC
200 g.d. ⁻¹ Fish	Cs-137	48.3	49.4	0.99
	Cs-134	2.1	3.2	0.06
	TOTAL	----	52.6	1.05
100 g.d. ⁻¹ Fish 20 g.d. ⁻¹ Shellfish	Cs-137	48.3	24.7	0.49
	Cs-134	2.1	1.6	0.03
	Cs-137	24.1	2.5	0.05
	Cs-134		0.2	0.004
	TOTAL	----	29.0	0.57
40 g.d. ⁻¹ Fish	Cs-137	48.3	9.9	0.2
	Cs-134	2.1	0.6	0.01
	TOTAL	----	10.5	0.21
15 g.d. ⁻¹ Fish	Cs-137	48.3	3.7	0.07
	Cs-134	2.1	0.3	0.01
	TOTAL	----	4.0	0.08

TABLE 18

QUANTITIES OF FISH (TONNES) LANDED AT
MAIN EAST COAST PORTS IN 1982 *

PORT	DEMERSAL FISH		PELAGIC FISH	TOTAL	SHELLFISH	TOTAL
	FLAT	ROUND				
Clogherhead	109	868	213	1190	1379	2569
Greencastle	195	4201	0	4396	124	4520
Balbriggan	46	278	31	355	468	823
Skerries	77	1155	936	2168	1689	3857
Howth	186	4379	513	5078	739	5817
Dunlaoire	33	299	16	348	68	416
Arklow	27	238	33	298	49	347
Wexford	1	12	0	13	3317	3330
Rosslare	30	274	3	307	19	326
Totals	704	11704	1745	14153	7852	22005

* This is the latest year in which this information is available. These are the quantities used in Table 19 for calculating collective doses to the Irish population over the three-year period 1982-84.

TABLE 19

COLLECTIVE DOSES TO THE IRISH POPULATION

FROM EAST COAST FISH AND SHELLFISH

FISH TYPE	CONSUMPTION (Tonnes)
Demersal flat	70
Demersal round	1170
Pelagic	177
Shellfish	785
TOTAL	2202

YEAR	FISH TYPE	MEAN ACTIVITIES (Bq kg ⁻¹ , Wet)		COLLECTIVE EFFECTIVE DOSE EQUIVALENT (Man - Sv)	% OF ENVIRONMENTAL COLLECTIVE POPUL- ATION DOSE OF ABOUT 3500 Man - Sv y ⁻¹
		Cs-137	Cs-134		
1982	Demersal flat	28.9	1.6	0.031	0.056
	Demersal round	82.5	2.7	1.41	
	Pelagic	69.2	3.1	0.18	
	Shellfish	28.9	1.5	0.34	
	TOTAL	-	-	1.96	
1983	Demersal flat	27.0	1.3	0.028	0.043
	Demersal round	57.2	2.6	1.0	
	Pelagic	48.8	2.4	0.13	
	Shellfish	28.4	1.9	0.34	
	TOTAL	-	-	1.50	
1984	Demersal flat	21.8	1.0	0.023	0.036
	Demersal round	53.1	2.4	0.93	
	Pelagic	35.3	1.6	0.093	
	Shellfish	19.0	0.9	0.22	
	TOTAL	-	-	1.27	
Three- Year Period 1982-84 (Weighted Average)	Demersal flat	25.1	1.2	0.026	0.042
	Demersal round	58.4	2.5	1.02	
	Pelagic	48.5	2.3	0.13	
	Shellfish	24.1	1.3	0.29	
	TOTAL	-	-	1.47	

FIG. 1

MAJOR FISH AND SHELLFISH SAMPLING POINTS 1982-84

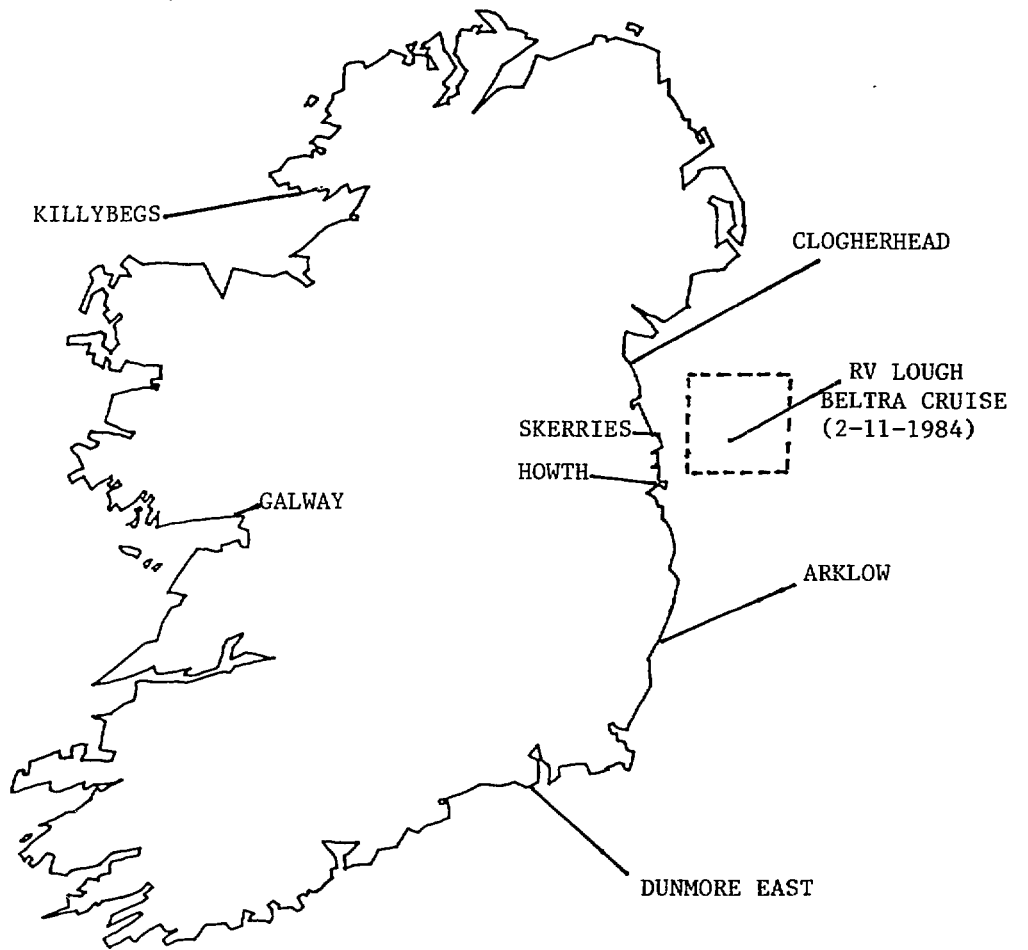
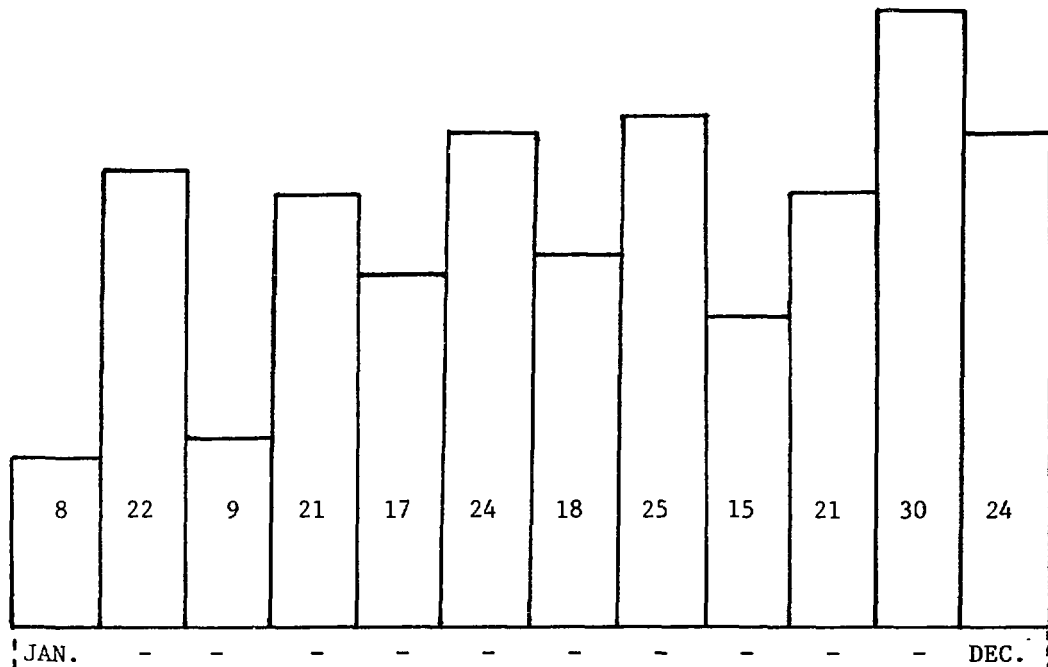


FIG. 2

MONTHLY SAMPLING OF FISH AND SHELLFISH 1982-84

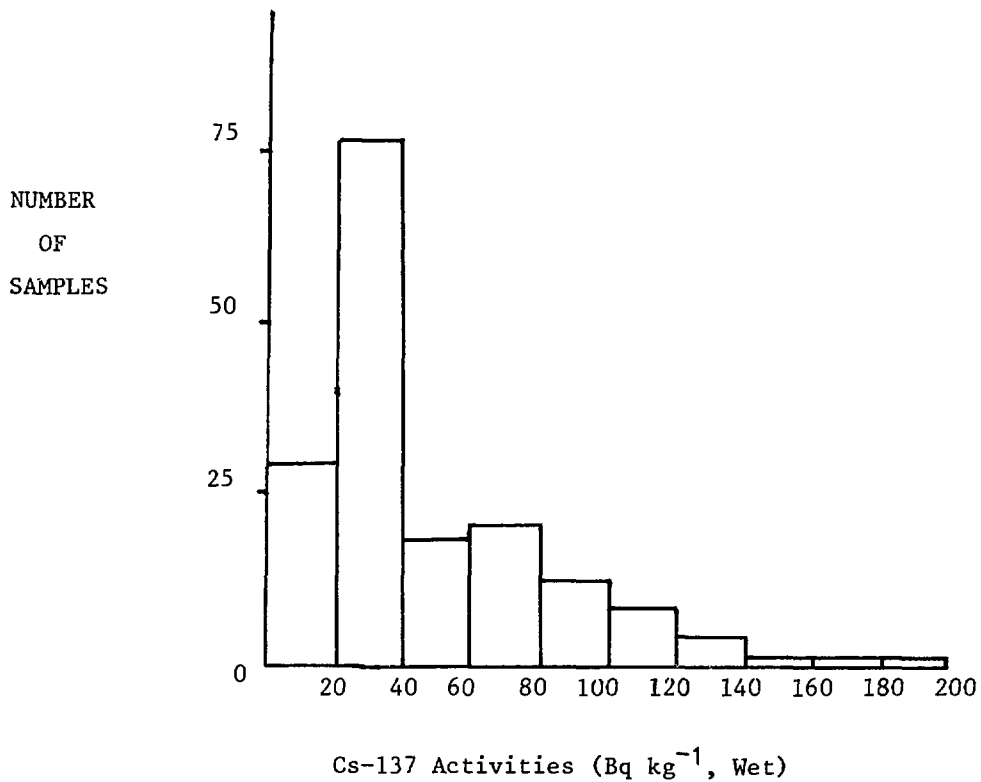


The breakdown on an annual basis is given below.

	NUMBER OF SAMPLES												TOTAL
	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	
1982	0	0	0	0	3	1	3	2	3	2	5	10	29
1983	7	4	7	6	1	12	9	9	11	11	13	4	94
1984	1	18	2	15	13	11	6	14	1	8	12	10	111
THREE-YEAR TOTAL												234	

FIG. 3

Cs-137 ACTIVITIES IN IRISH SEA FISH AND SHELLFISH 1982-84



The Cs-137 activities are positively skewed and clustered in the 0-60 Bq kg⁻¹ range. The positive skewness is confirmed by a coefficient of skewness of + 0.8.

MEAN Cs-137 ACTIVITY OVER THREE YEARS = 46 Bq kg⁻¹
 MEDIAN Cs-137 ACTIVITY OVER THREE YEARS = 37 Bq kg⁻¹

The Cs-134 activity expected in this average fish sample would probably lie in the range 1.0 - 1.5 Bq kg⁻¹.

K-40 activities varied over the range 50 - 200 Bq kg⁻¹ but the vast majority fell in the range 100 - 150 Bq kg⁻¹.

The predicted activity values, therefore, for a typical Irish Sea fish sample based on the 1982-84 measurement would be:-

<u>Cs-137</u>	<u>Cs-134</u>	<u>K-40</u>		
46	1.3	125	Bq kg ⁻¹	Wet
200	5.5	550	Bq kg ⁻¹	Dry