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L. TYRRELL
M. TWOMEY
D. GLYNN
B. McHUGH
E. JOYCE
J. COSTELLO
E. McGOVERN

Marine Institute
Foras na Mara

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L. TYRRELL, M. TWOMEY, D. GLYNN, B. MCHUGH, E. JOYCE, J. COSTELLO AND E. MCGOVERN [1]

Marine Institute
Marine Environment and Food Safety Services
Abbotstown, Dublin 15.

[1] Author to whom correspondence should be addressed

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ABSTRACT

The Marine Institute sample a range of finfish species landed at major Irish ports on an annual basis, in accordance with the monitoring requirements of various European legislation designed to ensure food safety.

During 2002, a total of 38 samples from 20 different species of finfish were collected from five major Irish fishing ports and analysed for total mercury concentration in the edible tissue (Common names and species names are listed in Appendix 3). The concentration of mercury ranged from less than the limit of quantitation (0.03 mg kg^{-1} wet weight) to 0.46 mg kg^{-1} wet weight with a mean and median of 0.09 and 0.06 mg kg^{-1} respectively. These levels are within the maximum limit of 0.50 mg kg^{-1} wet weight for mercury in fishery products set by the EU (1 mg kg^{-1} for selected species). This survey confirms previous studies, which show that Irish seafood is effectively free from mercury contamination.

Selected samples were also analysed for other trace metals and chlorinated hydrocarbons. Overall, the levels of lead and cadmium detected in the edible portion of the fish were low and well within the standard values of 0.20 and 0.05 mg kg^{-1} wet weight respectively, set by the EU. There are no internationally agreed standards or guidelines available for the remaining trace metals and chlorinated hydrocarbons in fishery products. Therefore results are compared with the strictest standards or guidance values for fish tissue, which are applied by contracting parties to the OSPAR Convention. The levels of these additional contaminants are well below the strictest values listed.

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INTRODUCTION

This study provides the results of analysis, by the Marine Institute, of total mercury, lead and cadmium concentrations in the edible portion of various fish species. Selected samples were also analysed for other trace metals and chlorinated hydrocarbons. Mercury, which occurs naturally in the earth's crust, can also be introduced into the aquatic environment from mining, agricultural, industrial and other human activities. Once in the aquatic environment, mercury can bioaccumulate in fish tissues and biomagnify through the food chain. To protect consumers of marine foodstuffs, the EC set a maximum limit for total mercury of 0.50 mg kg^{-1} wet weight in fishery products. For physiological reasons, certain species accumulate mercury more readily than others (Clark *et al*, 2001) and for these species a higher acceptable limit of 1.0 mg kg^{-1} applies. These species are listed in Appendix 2, Table 1.

Trace metals exist naturally in the environment and many, including chromium, cobalt, copper, iron, manganese, molybdenum, vanadium, strontium, and zinc are essential elements for living organisms. However, some trace metals such as lead and cadmium, which may be introduced into the aquatic environment from anthropogenic activities are not required for metabolic activity and are toxic at quite low concentrations. Once in the aquatic environment these metals can be concentrated in fish tissues.

To protect consumers of marine foodstuffs, the EU set maximum limits for total lead and cadmium of 0.20 and 0.05 mg kg^{-1} wet weight respectively, in fish muscle under Commission Regulation (EC) No. 466/2001 as amended by Commission Regulation (EC) No. 221/2002. Species with higher acceptable limits of 0.40 and 0.10 mg kg^{-1} for lead and cadmium are listed in Appendix 2, Tables 2 and 3 respectively.

Polychlorinated biphenyls (PCBs) and organo-chlorine pesticides (OCPs) are man-made compounds that are ubiquitous air and water-borne contaminants. These are persistent pollutants with a tendency to bioaccumulate in fish tissues and biomagnify through the food chain (Clark *et al*, 2001).

Previous results for the analysis of finfish species landed at major Irish ports have been reported (Tyrrell *et al*, 2003b, 2003a; Bloxham *et al*, 1998; Rowe *et al*, 1998; Nixon *et al*, 1995, 1994a, 1993, 1991 and O' Sullivan *et al*, 1991). Results from the monitoring of contaminants in shellfish are reported separately (Glynn *et al*, 2003b, 2003a: McGovern *et al*, 2001; Bloxham *et al*, 1998; Smyth *et al*, 1997 and Nixon *et al, 1994b*). Data on contaminants in marine biota are also good indicators of water quality (Stapleton *et al*, 2000 and Boelens *et al*, 1999)

Monitoring of contaminants in farmed fish is also carried out by the Marine Institute as part of the implementation of Council Directive 96/23/EC of 29 April 1996 on measures to monitor certain substances and residues thereof in live animals and animal products. Results for this programme are compiled as part of the National Residue Programme by Department of Agriculture and Food.

Marine Institute environmental monitoring reports are available on the Marine Institute website www.marine.ie/chem

MATERIALS AND METHODS

Sample Collection and Preservation

During 2002, fish landed at the major fishing ports of Castletownbere, Dunmore East, Howth, Killybegs and Rossaveal were sampled. Depending on availability, 10 fish of each species landed were sampled at each of the ports. The length of each fish was recorded and a portion of edible muscle tissue from each of the 10 fish was pooled to provide a sample. The pooled sample was homogenised prior to being divided into two sub-samples for metal and organic analysis. These were stored in a freezer at < -20ºC in pre-weighed, acid washed and solvent washed glass jars respectively. One sub sample was freeze-dried for 48 hours and analysed for trace metals (except mercury). The other sub-sample was analysed for mercury and chlorinated hydrocarbons. The moisture content was determined by drying approximately 1g of tissue overnight at 105ºC to constant weight. All samples were analysed for mercury and randomly selected samples from each port were also analysed for other trace metals and chlorinated hydrocarbons.

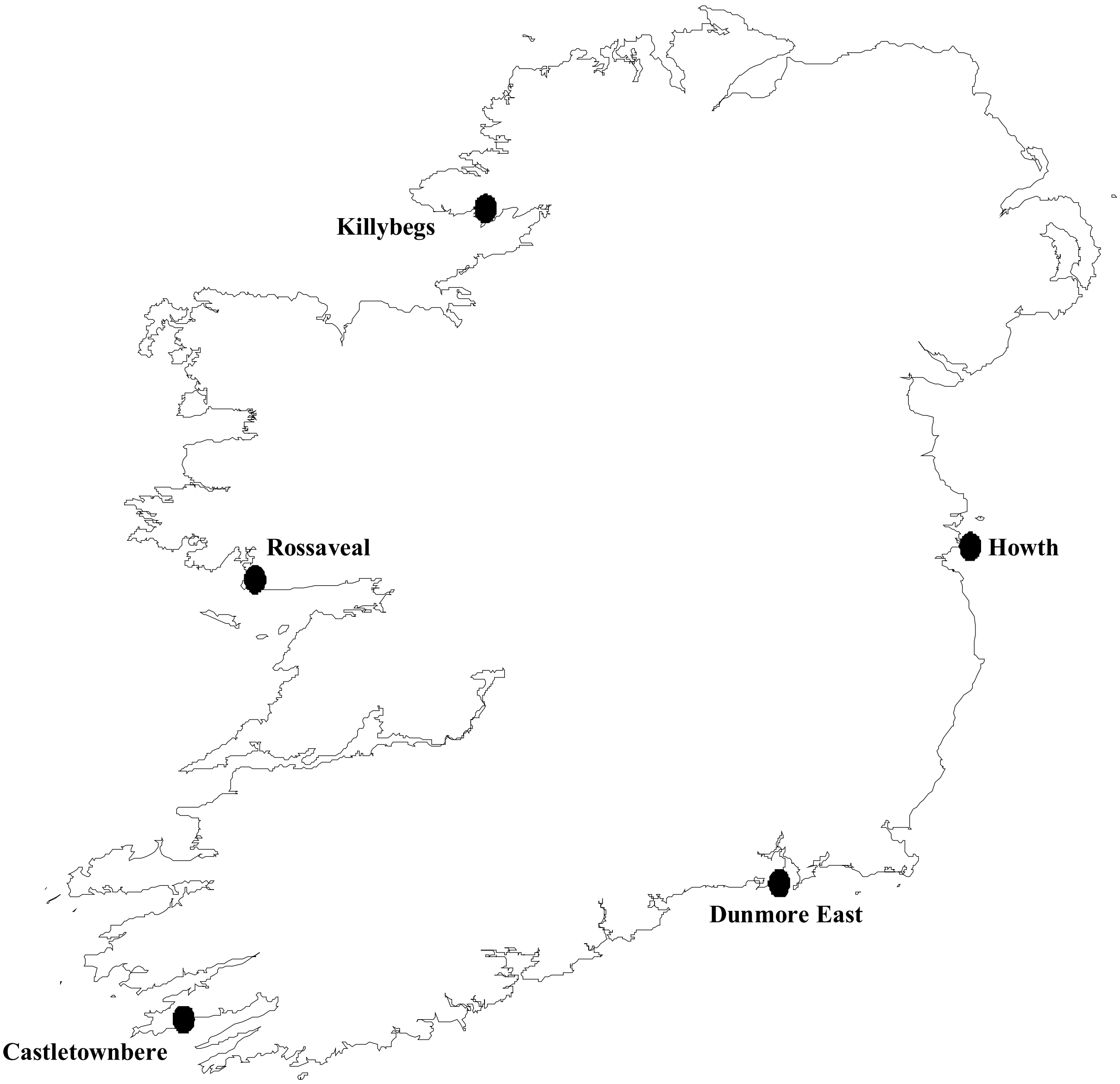

Figure 1. Locations of Irish ports sampled during 2002.

Mercury Analysis

Concentrated nitric acid (4ml) was added to 0.6 - 0.8g of accurately weighed wet tissue, which was then digested in a laboratory microwave oven (CEM Mars5). After cooling, potassium permanganate was added until the purple colour of the solution stabilized. Sufficient hydroxylamine sulphate/sodium chloride solution was added to neutralise the excess potassium permanganate and potassium dichromate was added as a preservative. The solution was diluted to 100mls with deionised water. Following reduction of the samples with tin (II) chloride, mercury concentrations were determined by Cold Vapour Atomic Fluorescence Spectroscopy (CV-AFS) using a PSA Merlin Analyser.

Trace Metal Analysis (cadmium, chromium, copper, lead and zinc)

Concentrated nitric acid (4ml) and hydrogen peroxide (4ml) were added to approximately 0.2g freeze-dried tissue, which was then digested in a laboratory microwave oven (CEM Mars5). After cooling, samples were diluted to 50mls with deionised water. Lead, cadmium, chromium and copper concentrations were determined using Graphite Furnace Atomic Absorption Spectrometry with Zeeman background correction (Varian SpectrAA 220Z). Zinc concentrations were determined using Flame Atomic Absorption Spectroscopy (Varian SpectrAA 20 Plus).

Table 1: Limits of Detection (LOD) for metals (mg kg^{-1} wet weight)

Metal	LOD
Cadmium	0.004
Chromium	0.07
Copper	0.16
Lead	0.02
Mercury	0.01
Zinc	1.21

Chlorinated Hydrocarbon Analysis

Due to the lipophilic nature of PCBs and OCPs, lipid was extracted from tissue using the method developed by Smedes, (QUASH, 1999; QUASH, 1998). Chlorinated hydrocarbons were removed from the lipids by alumina column chromatography followed by separation of PCBs from the chlorinated pesticides using silica column chromatography. Concentration levels were determined by dual column Gas Chromatography with Electron Capture Detection (GC-ECD) using a Varian 3800 gas chromatograph fitted with a 60 metre fused silica capillary column (HT8, J & W Scientific). A second column of different polarity was used as confirmation (CP-SIL 19CB, Chrompack Varian Inc).

Quality Assurance

A comprehensive analytical quality assurance programme underpins testing within the chemistry unit. This involves routine testing of quality control samples such as blanks, replicates and reference materials (including certified reference materials, (CRMs)) and participation in the QUASIMEME (Quality Assurance of Information for Marine

Environmental Monitoring) international laboratory proficiency-testing scheme. As the availability of appropriate marine certified reference materials is limited (de Boer and McGovern, 2001), reference materials supplied by QUASIMEME, FRS Marine Laboratory, Aberdeen, were used to supplement the use of CRMs. Although not certified, QUASIMEME RMs provide materials of suitable matrix and analyte concentrations and have assigned values derived from intercalibrations involving many expert laboratories in this field. A Z-score between –2 and 2 is generally considered satisfactory for environmental monitoring programmes. The quality assurance results obtained are reported in Table 2. Given the low concentrations in the reference materials and in the samples, this was adjudged to be acceptable for these purposes. The Marine Institute is accredited to ISO 17025 for the analysis of mercury, total lipid content and moisture content in marine biota.

Table 2: Results of the analyses of different reference materials obtained during the 2002 finfish testing.

a) Certified Reference Materials

Reference Material	Assigned Values	Measured Value (Mean ± SD)	No. of Analyses	Mean |Z| Score	No. –2<Z<2
Mussel Tissue CRM 278R					
Metal (mg kg^{-1} wet weight)					
Cadmium	0.348	0.30 ± 0.04	3	-0.75	3
Copper	9.45	7.98 ± 0.09	3	-1.20	3
Chromium	0.78	0.69 ± 0.07	3	-0.73	3
Lead	2.00	1.89 ± 0.11	3	-0.40	3
Zinc	83.1	81.5 ± 4.98	3	-0.14	3
Dogfish Muscle DORM2					
Metal (mg kg^{-1} wet weight)					
Cadmium	0.043	0.046 ± 0.004	2	0.47	2
Copper	2.34	1.82 ± 0.35	2	-1.53	1
Mercury	4.64	5.30 ± 0.38	18	1.11	17
Zinc	25.6	25.3 ± 1.20	2	-0.09	2

b) QUASIMEME Reference Materials

Reference Material	Assigned Values	Measured Value (Mean ± SD)	No. of Analyses	Mean |Z| Score
Herring Tissue QORO58BT				
PCBs (µg kg^{-1})				
PCB 28	0.93	0.60 ± 0.08	3	-1.98
PCB 52	1.58	1.49 ± 0.05	3	-0.36
PCB 101	3.14	2.17 ± 0.38	3	-2.18
PCB 105	0.84	0.80 ± 0.05	3	-0.25
PCB 118	2.44	2.01 ± 0.22	3	-1.20
PCB 138	4.70	3.09 ± 0.44	3	-2.52
PCB 153	5.57	5.39 ± 0.15	3	-0.24
PCB 156	0.36	0.45 ± 0.22	3	0.91
PCB 180	1.11	0.64 ± 0.07	3	-2.48
Organochlorine Pesticides (µg kg^{-1})				
HCB	1.43	1.70 ± 0.42	3	1.18
α - HCH	0.44	0.50 ± 0.05	3	0.54
trans-Nonachlor	1.33	1.23 ± 0.18	3	-0.48

RESULTS AND DISCUSSION

The results of monitoring in 2002 are presented in Appendix 1. European Regulation 466/2001/EC (as amended by Regulation 221/2001/EC) sets maximum levels for mercury, cadmium and lead in fish. While the monitoring presented in this report was carried out prior to the adoption of this regulation, results are compared with the values set in the regulation. The maximum levels are set out in the table below.

Table 3: European Regulation 466/2001/EC - Maximum levels for mercury, cadmium and lead in fish (mg kg^{-1} wet weight).

	Mercury	**Cadmium**	**Lead**
Muscle Meat of fish	0.5	0.05	0.2
Selected fish species*	1.0	0.1	0.4

Note: * Listed in Appendix 2 for each metal

Mercury

A total of 38 fish muscle samples were analysed for mercury in 2002. Results are reported in Appendix 1, Table 1a. These samples comprised 20 species of finfish collected from five major Irish fishing ports. The levels of mercury detected ranged from being less than the limit of quantitation (0.03 mg kg^{-1}) to 0.46 mg kg^{-1} wet tissue weight, with an upper bound mean and median of 0.09 and 0.06 mg kg^{-1} respectively. The highest levels detected were found in ling landed in Killybegs (0.46mg kg^{-1}) and gurnard landed in Howth (0.26 mg kg^{-1}).

Overall, the levels of mercury detected in the edible portion of the fish were within the standard value of 0.5 mg kg^{-1} wet weight set by the EU (1 mg kg^{-1} in selected species listed in Appendix 2, Table 1a).

Other Trace Metals

Heavy metal analysis was carried out on 16 tissue samples collected in 2002. These samples comprised 12 species taken from five major Irish ports. Results of these analyses are reported in Appendix 1, Table 1b.

Lead

Lead was not detected in 14 finfish samples and was present at concentrations below the limits of quantitation for the remaining 2 samples tested.

Cadmium

Cadmium was not present above the limits of detection (0.04 mg kg^{-1} wet weight) in the 16 samples tested.

Chromium

Chromium was not detected (LOD 0.07 mg kg^{-1} wet weight) in 15 of the 16 samples tested and was below the limit of quantitation (0.19 mg kg^{-1} wet weight) in the remaining sample.

Copper

Copper was not detected (LOD 0.16 mg kg^{-1} wet weight) in 12 of the 16 samples tested. Concentrations were below the limit of quantitation (<0.44 mg kg^{-1}) in a further 2 samples. Copper was measured at 0.91 mg kg^{-1} wet weight in mackerel and 0.75 mg kg^{-1} wet weight in herring, both of which were landed in Howth.

Zinc

Zinc concentrations in finfish samples from 2002 ranged from 1.71 mg kg^{-1} wet weight to 5.17 mg kg^{-1} wet weight, with an upper bound mean and median of 3.11 and 2.99 mg kg^{-1} respectively. The highest levels were detected in herring and mackerel landed in Howth (5.17 and 4.56 mg kg^{-1} wet weight respectively).

Overall, the levels of lead and cadmium detected in the edible portion of the fish were low and typically in the region of one order of magnitude less than the maximum limits set by the EU as outlined in Appendix 2, Tables 2 and 3. There are no internationally agreed standards or guidelines available for copper, chromium and zinc in fish for human consumption. However, there is a compilation of standard and guidance values for contaminants in fish tissue, applied by Contracting Parties to OSPAR (Anon 1992). Values are set out in Table 4. All samples analysed were below the strictest guidance values for copper and zinc in fish listed therein. None of the countries have set guidance values or standards for chromium in fish.

Chlorinated Hydrocarbons

There are no internationally agreed standards for chlorinated hydrocarbons in fishery products. The strictest standards and guidance values for these compounds as applied by Contracting Parties to the Oslo and Paris Conventions are given in Table 4. Chlorinated hydrocarbon analyses was carried out on 16 tissue samples collected in 2002, comprising 13 species. Results of these analyses are shown in Appendix 1, Table 1b. These results are very low in comparison with the values given in Table 4. Highest concentrations were found in gurnard, mackerel and herring, which are medium lipid content fish. This agrees with previous findings and is to be expected due to the lipophilic nature of these compounds.

Table 4: Synopsis of the strictest guidance and standard values applied by various OSPAR countries for contaminants in fish tissue

Contamination	Unit	Qualifiers*	Country
Copper	10 mg kg^{-1}	W/G	Norway
Zinc	50 mg kg^{-1}	W/G	U.K.
DDT and its transformation products	500 µg kg^{-1}	W/S	Finland
HCB	50 µg kg^{-1}	W/G	Norway
$\alpha + \beta$ HCH	50 µg kg^{-1}	W/G	Norway
γ HCH	100 µg kg^{-1}	W/S	Finland
$\alpha+\beta+\gamma$ HCH	200 µg kg^{-1}	W/G	Norway/Sweden
PCBs	1000 µg kg^{-1}	W/G	Norway
PCB 28	80 µg.kg^{-1}	W/S	Germany
PCB 52	40 µg kg^{-1}	W/S	Netherlands
PCB 101	80 µg kg^{-1}	W/S	Germany/Netherlands
PCB 118	80 µg kg^{-1}	W/S	Netherlands
PCB 138	100 µg kg^{-1}	W/S	Germany/Netherlands
PCB 153	100 µg.kg^{-1}	W/S	Germany/Netherlands
PCB 180	80 µg kg^{-1}	W/S	Germany
Aldrin + dieldrin	100 µg kg^{-1}	W/S	Finland
Lindane	100 µg kg^{-1}	W/S	Finland

*W = wet weight; S = standard; G = guidance value

CONCLUSIONS

Based on the analyses of the 2002 samples, total mercury and heavy metal concentrations in the commercial catch landed at 5 major Irish ports are low, which confirms previous studies (Tyrrell *et al*, 2003b, 2003a; Rowe *et al*, 1998; Nixon *et al*, 1994, 1993 and 1991 and O' Sullivan *et al*, 1991). All samples tested were well within the limits set by the Commission Regulation (EC) No. 466/2001 for mercury, cadmium and lead. For copper and zinc, levels were well below the strictest guidance values applied by OSPAR member states.

Chlorinated hydrocarbon concentrations were also very low and again confirm previous studies (Tyrrell *et al*, 2003b, 2003a; Bloxham *et al*, 1998; Rowe *et al*, 1998 and Nixon *et al*, 1995, 1994 and 1991). There are no EU standards for organochlorine pesticides or PCBs.

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Appendix 1 (Page 1 of 4): Results of monitoring of fish species from selected Irish Ports – 2002

Table 1a: Mercury (Hg) concentration (mg kg^{-1}wet weight) in the edible tissue, length statistics (mm) and moisture content (%) of various fish species landed and sampled at selected Irish Ports in 2002. Common and species names are listed in Appendix 3.

	Common Name	MI Reference	Sample Size	Hg	Length Range	Length Mean	Moisture Content
Castletownbere							
	Haddock	ENV 2002/044	10	**0.05**	300 – 450	400	81.3
	Hake	ENV 2002/045	10	**0.04**	310 – 420	336	80.8
	Ling	ENV 2002/046	10	**0.10**	520 – 780	646	77.7
	Megrim	ENV 2002/047	10	**0.06**	285 – 400	338	78.9
	Whiting*	ENV 2002/049	10	**0.05**	340 – 400	374	79.2
	Witch*	ENV 2002/048	10	**0.05**	270 – 320	294	81.1
Dunmore East							
	Black Sole	ENV 2002/020	10	**<0.03**	250 – 285	272	80.9
	Haddock*	ENV 2002/026	10	**0.04**	270 – 380	322	81.3
	Hake	ENV 2002/022	10	**0.04**	375 – 470	429	80.6
	John Dory	ENV 2002/021	10	**0.04**	240 – 310	283	80.0
	Lemon Sole	ENV 2002/025	10	**0.03**	270 – 300	283	81.8
	Megrim	ENV 2002/023	10	**0.06**	275 – 425	357	79.1
	Whiting	ENV 2002/019	10	**0.05**	280 – 365	313	80.1
	Witch	ENV 2002/024	9	**0.22**	295 – 455	363	83.1
Rossaveal							
	Anglerfish	ENV 2002/035	10	**0.09**	280 – 350	307	85.1
	Black Sole	ENV 2002/034	10	**0.10**	330 – 355	343	80.5
	Brill	ENV 2002/037	10	**0.08**	320 – 545	405	79.3
	Cod*	ENV 2002/030	10	**0.04**	320 – 380	354	79.6
	Haddock	ENV 2002/036	10	**0.06**	290 – 425	348	79.0
	Hake	ENV 2002/027	9	**<0.03**	300 – 395	351	81.4
	Lemon Sole	ENV 2002/031	10	**0.05**	240 – 300	262	80.3
	Megrim	ENV 2002/033	9	**<0.03**	275 – 330	293	78.5
	Plaice	ENV 2002/032	10	**0.06**	310 – 350	323	79.1
	Whiting	ENV 2002/028	10	**0.04**	300 – 455	338	80.4
	Witch	ENV 2002/029	10	**0.05**	250 – 340	279	82.9
Killybegs							
	Cod	ENV 2002/043	5	**0.17**	600 – 840	720	80.1
	Haddock*	ENV 2002/042	10	**0.15**	345 – 380	356	80.9
	Ling*	ENV 2002/040	5	**0.46**	720 – 940	806	80.0
	Ray	ENV 2002/039	4	**0.09**	580 – 660	625	78.0
	Saithe	ENV 2002/041	10	**0.07**	410 – 610	476	79.8
	Tusk	ENV 2002/038	5	**0.19**	480 – 635	552	79.7

Notes * = QC duplicate samples analysed and mean reported
nd: Not detected
For values reported as "nd" Substances were not detected above the Limit of Detection (LOD) LODs are given in Table 1.
For values reported as "< value", value = Limit of Quantitation (LOQ) for the relevant determinand

Appendix 1 (Page 2 of 4): Results of monitoring of fish species from selected Irish Ports – 2002

Table 1a (continued): Mercury (Hg) concentration (mg kg^{-1} wet weight) in the edible tissue, length statistics (mm) and moisture content (%) of representative fish species landed and sampled at selected Irish ports in 2002.

	Common Name	MI Reference	Sample Size	Hg	Length Range	Length Mean	Moisture Content
Howth							
	Anglerfish	ENV 2002/091	10	**0.08**	335 – 405	368	83.0
	[1]Gurnard*	ENV 2002/089	10	**0.26**	315 – 490	398	75.7
	Herring	ENV 2002/092	10	**<0.03**	190 – 255	236	70.4
	Mackerel	ENV 2002/086	10	**<0.03**	305 – 340	323	66.6
	Plaice	ENV 2002/090	10	**0.04**	285 – 345	306	80.1
	White Sole	ENV 2002/088	10	**0.16**	325 – 385	351	80.7
	Whiting	ENV 2002/087	10	**0.06**	320 – 395	351	80.4

Notes
* = QC duplicate samples analysed and mean reported
[1]Gurnard species identification was not confirmed.
Species may have been Red Gurnard (*Aspitrigla cuculus*) or Tub Gurnard (*Trigla lucerna*)
nd: Not detected
For values reported as "nd" Substances were not detected above the Limit of Detection (LOD)
LODs are given in Table 1.
For values reported as "< value", value = Limit of Quantitation (LOQ) for the relevant determinand

Appendix 1 (Page 3 of 4): Results of monitoring of fish species from selected Irish Ports – 2002

Table 1b: Heavy metal and chlorinated hydrocarbon concentrations (mg kg-1 and µg kg^{-1} wet weight respectively) in the edible tissue of representative fish species landed and sampled at selected Irish ports in 2002. Common and species names are listed in Appendix 3. (Lengths, moisture content, MI reference number and sample size are as Table 1a)

Port	**Castletownbere**			**Rossaveal**			**Killybegs**		
Date Sampled	16/08/02			31/07/02			02/08/02		
Common Name	Haddock	Hake	Witch	Cod	Haddock	Whiting	Cod	Ling	Ray
MI Reference	ENV 02/044	ENV 02/045	ENV 02/048	ENV 02/030	ENV 02/036	ENV 02/028	ENV 02/043	ENV 02/040	ENV 02/039
Metals									
Cadmium	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	nd	nd	nd	nd	nd	<0.19	nd	nd	nd
Copper	nd	nd	nd	nd	nd	nd	nd	nd	nd
Lead	<0.06	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	2.85	3.01	3.17	3.00	1.71	2.97	3.19	2.35	2.36
PCB Congeners									
PCB 28	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PCB 31	<0.02	0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PCB 52	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04
PCB 101	<0.03	0.05	<0.03	<0.03	<0.03	<0.03	<0.03	0.21	<0.03
PCB 105	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.10	<0.04
PCB 118	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.08	0.29	<0.07
PCB 138	<0.05	0.15	0.10	<0.05	<0.05	<0.05	0.15	0.57	<0.05
PCB 153	0.04	0.22	0.17	0.08	0.04	0.04	0.28	0.94	0.08
PCB 156	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	<0.02
PCB 180	<0.01	0.05	0.04	0.01	<0.01	<0.01	0.07	0.25	0.02
Organochlorine Pesticides									
HCB	0.06	0.07	0.05	0.04	0.05	0.05	0.07	0.10	0.04
α - HCH	0.02	0.02	0.02	0.03	0.02	0.06	0.01	0.03	0.06
trans-Nonachlor	0.01	0.06	<0.01	0.01	0.06	0.05	<0.01	0.12	<0.01
Aldrin	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
oxy-Chlordane	<0.01	<0.01	0.01	0.01	<0.01	0.02	0.01	0.08	<0.01
trans-Chlordane	<0.01	0.01	0.02	<0.01	0.01	0.01	<0.01	0.01	<0.01
cis-Chlordane	<0.01	0.06	0.02	0.01	0.02	0.01	<0.01	0.09	<0.01
Total Lipid (%)	0.59	0.63	0.64	0.50	0.51	0.51	0.46	0.35	0.53

Notes: nd: Not detected
For values reported as "nd" Substances were not detected above the Limit of Detection (LOD)
LODs are given in Table 1.
For values reported as "< value", value = Limit of Quantitation (LOQ) for the relevant determinand
Total Lipid % determined by Smedes Method

Appendix 1 (Page 4 of 4): Results of monitoring of fish species from selected Irish Ports – 2002

Table 1b (continued): Heavy metal and chlorinated hydrocarbon concentrations (mg kg^{-1} and µg kg-1 wet weight respectively) in the edible tissue of representative fish species landed and sampled at selected Irish ports in 2002. Common and species names are listed in Appendix 3. (Lengths, moisture content, MI reference number and sample size are as Table 1a)

Port	**Dunmore East**				**Howth**			
Date Sampled	11/07/02				15/11/02			
Common Name	Black Sole	Haddock	Hake	John Dory	Herring	Mackerel	Gurnard[1]	Plaice
MI Reference	ENV 02/020	ENV 02/026	ENV 02/022	ENV 02/021	ENV 02/092	ENV 02/086	ENV 02/089	ENV 02/090
Metals								
Cadmium	NA	nd	nd	nd	nd	nd	nd	nd
Chromium	NA	nd	nd	nd	nd	nd	nd	nd
Copper	NA	nd	<0.44	nd	0.75	0.91	<0.44	nd
Lead	NA	<0.06	nd	nd	nd	nd	nd	nd
Zinc	NA	2.70	4.13	2.79	5.17	4.56	2.68	3.11
PCB Congeners								
PCB 28	<0.02	<0.02	NA	<0.02	0.12	0.16	0.18	<0.02
PCB 31	<0.02	<0.02	NA	<0.02	0.03	0.24	0.08	0.03
PCB 52	<0.04	<0.04	NA	<0.04	<0.04	0.65	0.32	<0.04
PCB 101	0.04	<0.03	NA	0.05	n/a	0.48	0.95	0.05
PCB 105	<0.04	<0.04	NA	<0.04	0.06	0.25	0.44	0.06
PCB 118	<0.07	<0.07	NA	<0.07	0.41	0.57	1.44	<0.07
PCB 138	0.09	<0.05	NA	0.11	0.65	1.14	2.39	0.10
PCB 153	0.12	0.06	NA	0.17	1.04	1.59	3.78	0.20
PCB 156	<0.02	<0.02	NA	<0.02	0.03	0.07	0.20	<0.02
PCB 180	0.03	0.01	NA	0.04	0.15	0.29	0.94	0.03
Organochlorine Pesticides								
HCB	0.02	0.04	NA	0.05	0.22	n/a	0.22	0.04
α - HCH	0.03	0.02	NA	0.03	0.27	0.38	0.28	0.01
trans-Nonachlor	<0.01	<0.01	NA	0.11	0.36	0.49	0.19	0.02
Aldrin	<0.01	0.05	NA	<0.01	0.05	0.07	0.03	<0.01
oxy-Chlordane	<0.01	<0.01	NA	0.02	0.09	0.12	0.06	<0.01
trans-Chlordane	0.03	0.03	NA	0.08	na	0.19	0.02	0.02
cis-Chlordane	<0.01	0.01	NA	0.10	na	0.28	0.11	0.03
Total Lipid (%)	0.66	0.48	NA	0.57	10.4	11.7	2.88	0.53

Notes: [1]Gurnard species identification was not confirmed.
Species may have been Red Gurnard (*Aspitrigla cuculus*) or Tub Gurnard (*Trigla lucerna*)
NA: Sample not analysed
nd: Not detected
For values reported as "nd" Substances were not detected above the Limit of Detection (LOD)
LODs are given in Table 1.
For values reported as "< value", value = Limit of Quantitation (LOQ) for the relevant determinand
Total Lipid % determined by Smedes Method

Appendix 2 (Page 1 of 2): Selected species, as listed by the European Commission Regulation (EC) No 221/2002, where the higher acceptable limit of total mercury, lead and cadmium concentration apply

Table 1: Selected species where the higher acceptable limit (1.0 mg kg^{-1}) total mercury concentration applies

Common Name	*Species Name*
Anglerfish	*Lophius species*
Atlantic catfish	*Anarhichas lupus*
Bass	*Dicentrarchus labrax*
Blue ling	*Molva dipterygia*
Bonito	*Sarda sarda*
Eel	*Anguilla species*
Emperor or Orange Roughy	*Hoplostethus atlanticus*
Grenadier	*Coryphaenoides rupestris*
Halibut	*Hippoglossus hippoglossus*
Marlin	*Makaira species*
Pike	*Esox lucius*
Plain bonito	*Orcynopsis unicolor*
Portuguese dogfish	*Cantroscymnes coelolepis*
Rays	*Raja species*
Redfish	*Sebastes marinus, S. mentella, S. viviparus*
Sailfish	*Istiophorus platypterus*
Scabbard fish	*Lepidopus caudatus, Aphanopus carbo*
Sharks	*all species*
Snake mackerel or butterfish	*Lepidocybium flavobrunneum, Ruvettus pretiousus, Gempylus serpens*
Sturgeon	*Acipenser species*
Swordfish	*Xiphias gladius*
Tuna	*Thunnus species and Euthynnus species*

Appendix 2 (Page 2 of 2): Selected species, as listed by the European Commission Regulation (EC) No 221/2002, where the higher acceptable limit of total mercury, lead and cadmium concentration apply

Table 2: Selected species where the higher acceptable limit (0.4 mg kg^{-1}) total lead concentration applies

Common Name	***Species Name***
Bonito	*Sarda sarda*
Common two-banded seabream	*Diplodus vulgaris*
Eel	*Anguilla species*
Grey mullet	*Mugil labrosus labrosus*
Grunt	*Pomadasys benneti*
Horse mackerel or scad	*Trachurus trachurus*
Sardine	*Sardina pilchardus*
Sardinops	*Sardinops species*
Spotted seabass	*Dicentrarchus*
Tuna	*Thunnus species and Euthynnus species*
Wedge sole	*Dicologoglossa cuneata*

Table 3: Selected species where the higher acceptable limit (0.1 mg kg^{-1}) total cadmium concentration applies

Common Name	***Species Name***
Bonito	*Sarda sarda*
Common two-banded seabream	*Diplodus vulgaris*
Eel	*Anguilla species*
European anchovy	*Engraulis encrasicholus*
Grey mullet	*Mugil labrosus labrosus*
Horse mackerel or scad	*Trachurus trachurus*
Louvar or Luvar	*Luvarus imperialis*
Sardine	*Sardina pilchardus*
Sardinops	*Sardinops species*
Tuna	*Thunnus species and Euthynnus species*
Wedge sole	*Dicologoglossa cuneata*

Appendix 3: Finfish sampled during 2002 and their corresponding species name

Common Name	*Species Name*
Anglerfish	*Lophius spp.*
Black sole	*Solea solea*
Brill	*Scopthalmus rhombus*
Cod	*Gadus morhua*
Gurnard*	*Aspitrigla cuculus*
Haddock	*Melanogrammus aeglefinus*
Hake	*Merluccius merluccius*
Herring	*Clupea harengus*
John Dory	*Zeus faber*
Lemon sole	*Microstomus kitt*
Ling	*Molva molva*
Mackerel	*Scomber scombrus*
Megrim	*Lepidorhombus whiffiagonis*
Plaice	*Pleuronectes platessa*
Ray/Skate	*Raja spp.*
Saithe	*Pollachius virens*
Torsk/Tusk	*Brosme brosme*
Witch	*Glyptocephalus cynoglossus*
White Sole	*Glyptocephalus cynoglossus*
Whiting	*Merlangius merlangus*

* Unconfirmed species identification as red gurnard (*Aspitrigla cuculus*). However, it is possible that the species may have been tub gurnard (*Trigla lucerna*).

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HEADQUARTERS

MARINE INSTITUTE
Galway Technology Park
Parkmore
Galway
Tel: +353 91 730 400
Fax: +353 91 730 470
Email: institute.mail@marine.ie

(Moving to Oranmore in 2005)

MARINE INSTITUTE REGIONAL OFFICES & LABORATORIES

MARINE INSTITUTE
80 Harcourt Street
Dublin 2
Tel: +353 1 4766500
Fax: +353 1 4784988

MARINE INSTITUTE
Furnace
Newport
Co. Mayo
Tel: +353 98 42300
Fax: +353 98 42340

MARINE INSTITUTE
Snugboro Road
Abbottstown
Dublin 15
Tel: +353 1 822 8200
Fax: +353 1 820 5078